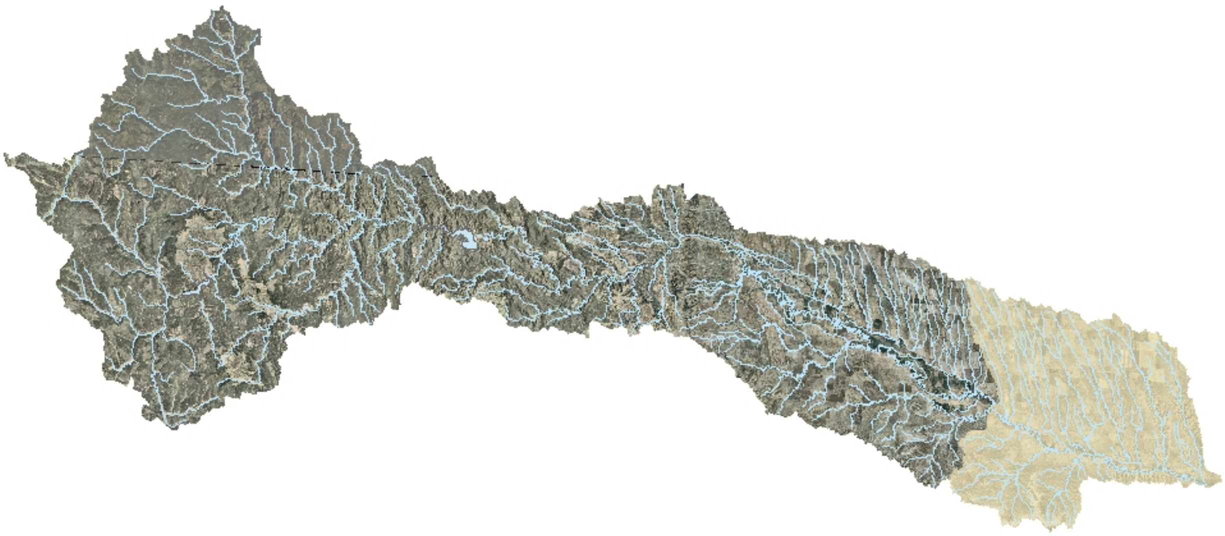
Total Suspended Solids Total Maximum Daily Load (TMDL) for Lower Rapid Creek, Pennington County, South Dakota



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Total Maximum Daily Load Summary Table

Water Body Name/Description:	Rapid Creek (from above Farmingdale to its confluence with the Cheyenne River)
Assessment Unit IDs:	SD-CH-R-RAPID_05
Size of Impaired Waterbody:	42.8 stream kilometers (26.6 stream miles)
Size of Watershed:	33,725 hectares, (83,334 acres)
Location:	Hydrologic Unit Codes (12-digit HUC): 101201100303, 101201100304 and 101201100305
Impaired Designated Use(s):	Warmwater permanent fish life propagation waters
Cause(s) of Impairment:	Total Suspended Solids (TSS)
Cycle First and Most Recently Listed:	
Total Suspended Solids	1998, 2002, 2004 and 2010 (SD-CH-R-RAPID_05)
Waterbody Type:	Stream
303(d) Listing Parameter:	TSS
Designated Uses:	Warmwater permanent fish life propagation waters, immersion recreation waters, limited-contact recreation waters, fish and wildlife propagation, recreation, and stock watering and irrigation waters
TMDL End Points	
Indicator Name:	TSS
Threshold Values:	
Total Suspended Solids	Maximum daily concentration of ≤ 158 mg/L in any one sample or a 30-day average of ≤ 90 mg/L based on a minimum of 3 consecutive grab or composite samples taken on separate weeks in a 30 day period. These criteria apply year round.
Analytical Approach:	Load Duration Curves, statistical analysis, and AnnAGNPS modeling
Waste Load Allocations	
High Flow Zone LA:	83,056 kg/day
High flow Zone WLA:	0
High Flow Zone MOS:	39,415 kg/day
High Flow Zone TMDL:	122,471 kg/day

TMDL Submittal Table for segments of Lower Rapid Creek, Pennington County, South Dakota.

				TMDL End Points		Wasteload Allocations		Load Allocations		
Waterbody Name / Description	**Waterbody ID**	**Cycle First/Most Recently Listed**	**Cause(s) of Impairment**	**Indicator Name**	**Threshold Values**	**WLA** TSS (kg/day)	**WLA Permitted Facilities** (Permit Number)	**LA** TSS(kg/day)	**MOS** TSS (kg/day)	**TMDL** TSS (kg/day)
Rapid Creek (Above Farmingdale to Cheyenne River)	SD-CH-R-RAPID_05	1998 / 2010	Total Suspended Solids	Total Suspended Solids	≤ 158 mg/L daily maximum; ≤ 90 mg/L 30-day average with a minimum of 3 samples obtained during separate weeks in a 30-day period	0	0	145,811	69,194	215,005 High Flow Zone (acute)

1.0 Introduction and Watershed Description

The intent of this document was to clearly identify the components of this TMDL, support adequate public participation, and facilitate the US Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by US EPA. The TMDL document addresses the TSS impairment of Rapid Creek segment SD-CH-R-Rapid_05 from near Farmingdale to the Cheyenne River. This impairment was assigned a priority 1-category (high-priority) in the 2010 Integrated Report (SD DENR, 2010). This segment is also listed for fecal coliform and *E. coli* bacteria which were addressed in a separate TMDL document (Smith, 2010).

1.1 CWA Section 303(d) Listing Information

Table 1 303(d) impaired reach in the lower half of Rapid Creek based on the 2010 Integrated Report*

Waterbody AUID	From	To	Parameter
SD-CH-R-RAPID_05	above Farmingdale	Mouth of the Cheyenne River	TSS

*** See Figure 2 map for reach location**

Total Suspended Solids (TSS)

Rapid Creek has been listed sporadically for TSS since 1998. 303(d) impairment listing for TSS occurred in 1998 and 2002 while 305(b) TSS listings were from 1998, 2000 and 2002 with the 2002 listing the lower segment (SD-CH-R-Rapid_05) specifically. The lower segment was again listed as impaired for TSS in the combined 303(d)/305(b) document 2004 Integrated Report (2004 IR). Lower Rapid Creek was not impaired for TSS based on the 2006 and 2008 Integrated Reports. However, the current Integrated Report (2010 IR) again listed the lower segment of Rapid Creek (SD-CH-R-Rapid_05) as impaired for TSS.

1.2 Topography

Rapid Creek is a perennial mountain stream located in Lawrence and Pennington Counties of South Dakota. Rapid Creek is a tributary of the Cheyenne River, which flows into the Missouri River. The drainage area of Rapid Creek is approximately 718 square miles (1,861 square kilometers) at the confluence with the Cheyenne River.

The impaired (303(d) listed) reach of Rapid Creek has a length of 26.6 stream miles (42.8 stream kilometers) beginning above Farmingdale and ends where Rapid Creek empties into the Cheyenne River (Figure 1, Figure 2 and Table 1). The drainage area of the 303(d) listed segment is approximately 130 square miles (337 square kilometers).

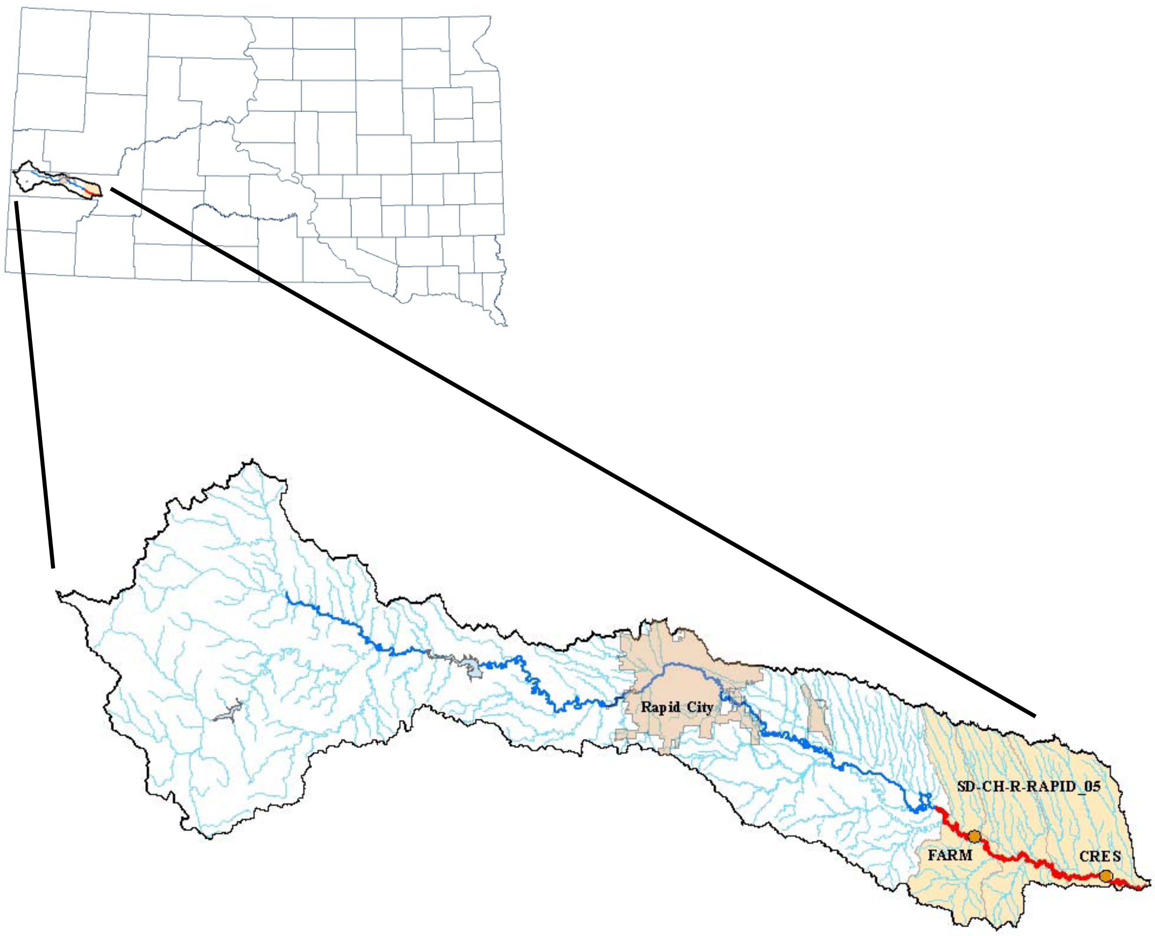

Figure 1 Location of the Upper/Lower Rapid Creek watersheds within South Dakota

1.3 Geology and Soils

The upper basin of the watershed is comprised of the Madison Group limestone and dolomite deposits gray to dark-gray phyllite, slate, and mica schist while the major portion of the Lower Rapid Creek watershed (the study area) is made up of Pierre shale, Terrace deposits and Alluvium (SD DENR, 2010).

The watershed's major soil associations along Lower Rapid Creek are the Owanka-Haverson-Colombo, the Nunn-Satanta north of Rapid Creek, Pierre-Kyle and Samsil-Pierre associations south of Rapid Creek. Owanka-Haverson-Colombo soil associations are deep, well drained, nearly level, loamy and silty soils on terraces, fans and flood plains. The most common soil in the Lower Rapid Creek watershed is Nunn loam part of the Nunn-Satanta association and is characterized as deep, well drained, nearly level to strongly sloping, loamy soils on high terraces. The remaining associations, Pierre-Kyle and Samsil-Pierre, are shallow to deep, well drained level to very steep, clayey soils on dissected plains and fans (USDA, 1990).

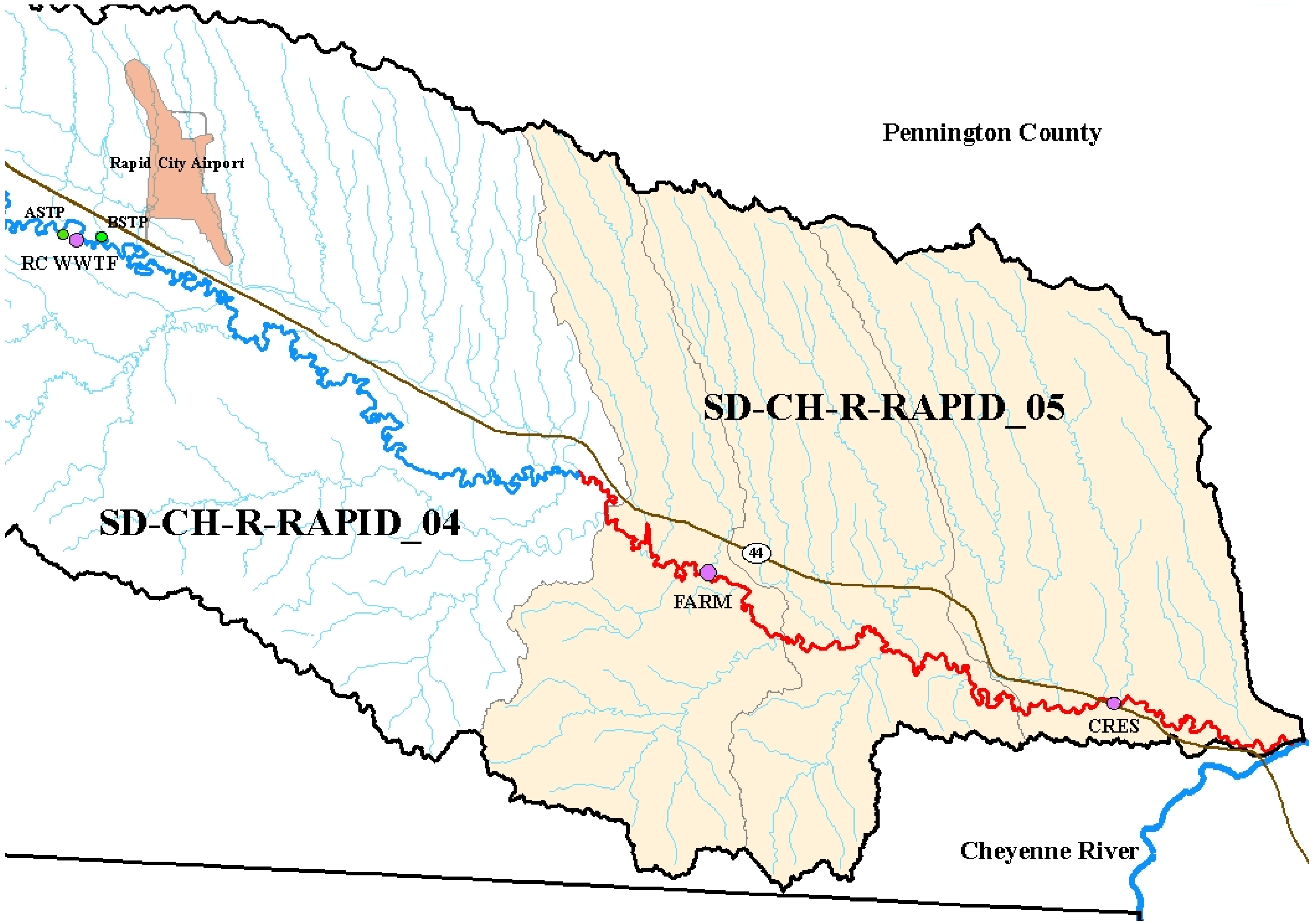

Figure 2 Lower Rapid Creek watershed with monitoring sites, AUID identifiers and current ADB reach lengths

1.4 Land Use/Land Cover

Much of the upper portion of the watershed (upstream of the study area) is located within the Black Hills National Forest and is predominantly forested with ponderosa pine (83 percent). The lower portion of the watershed is dominated by herbaceous rangeland (61 percent), cropland and pastureland (24 percent) and urban (7 percent).

1.5 Climate and Precipitation

Average annual precipitation in the Rapid Creek watershed based on National Weather Service data at Rapid City was 16.1 inches (0.41 m). Over 70 percent of the annual precipitation occurred during the months of April through August and over 50 percent occurring during the months of May through July.

1.6 Available Water Quality Data

Since 1967, the South Dakota Department of Environment and Natural Resources (SD DENR) have collected TSS samples at various locations along Lower Rapid Creek. TSS samples have/are being collected at WQM 19 (DENR 460910) near Farmingdale, SD. Additional data was collected in this segment of Rapid Creek in 2007 through 2009 as part of the Lower Cheyenne River Assessment Project. This data was combined with the routine WQM 19 water quality monitoring data to assess TSS loading in Rapid Creek.

1.6.1 Total Suspended Solids Data

TSS concentrations have been collected at WQM 19 near Farmingdale since the spring of 1970 and have been assigned a warmwater permanent fish life propagation water beneficial use. 321 TSS samples have been collected at WQM 19 in segment SD-CH-R-RAPID_05 Rapid Creek from 1970 through 2010 (Table 2). Data indicate that approximately 13 percent of the samples (41 samples) exceeded beneficial use based water quality standards (Table 4).

Table 2 Data availability for TSS analysis by segment in Lower Rapid Creek

Parameter	Assessment Unit ID Reach [1]	Beneficial Use	Number of Samples
Total Suspended Solids	SD-CH-R-RAPID_05	Warmwater permanent	321

Shaded = Exceeded listing criteria for impairment.

[1] = SD-CH-R-RAPID_05 = Above Farmingdale to Cheyenne River.

1.6.4 Stream Flows

United States Geological Survey has monitored or is monitoring four stream gages in the Lower Rapid Creek watershed (Table 3).

Low flow conditions within the study reach were not identified as a concern. However, the frequency, duration and magnitude of high flows were identified as a concern. The change in duration, frequency and magnitude of high flow conditions can cause scour and bank erosion in the lower reaches of the system during those conditions. In a study on the impact of increases in impervious area, Coon (2000) showed that the magnitude (peak) of runoff from two year through ten year rainfall events increased 600 percent and 71 percent, respectively. The increase in magnitude and frequency of stormwater runoff does increase scour and bank erosion in the lower reaches during high flow events.

Table 3 USGS monitoring sites in Lower Rapid Creek used for long-term flow analysis

USGS Station Number	USGS Site Name	Available Data Dates	AUID Segment
06414000	Rapid Creek at Rapid City, SD	1942-2011	SD-CH-R-RAPID_03
06416000	Rapid Creek below Hawthorn Ditch at Rapid City, SD	1980-1982	SD-CH-R-RAPID_03
06418900	Rapid Creek below Sewage Treatment Plant near Rapid City, SD	1981-2011	SD-CH-R-RAPID_04
06421500	Rapid Creek near Farmingdale, SD	1960-2011	SD-CH-R-RAPID_05

Shaded = USGS monitoring site in the 303(d) listed segment of Rapid Creek for TSS impairment.

2.0 Water Quality Standards

2.1 Numeric Standards

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated with the use of fish and wildlife propagation, recreation, and stock watering. All streams are assigned the use of irrigation. Additional uses are assigned by the state based on a beneficial use analysis of each waterbody. Water quality standards have been defined in South Dakota state statutes (Administrative Rules of South Dakota, ARSD §74:51:01 – 74:51:03) in support of these uses. These standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed.

Individual parameters, determine the support of these beneficial uses. Each beneficial use classification has a set of numeric standards uniquely associated with that specific category. Water quality values that exceed those standards applicable to specific beneficial uses impair the beneficial use and violate water quality standards.

Lower Rapid Creek (segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05) has been assigned the following beneficial uses: warmwater permanent fish life propagation (S15 T1N R8E to Cheyenne River), immersion recreation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 4 lists the most stringent criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion was used.

Table 4 Numeric surface water quality standards for segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 in Lower Rapid Creek, Pennington County, South Dakota as of 2011

		Segment	
		SD_CH_R_RAPID_04 and SD_CH_R_RAPID_05	
Parameter	**Beneficial Use**	**Criterion**	**Special Conditions**
Total Dissolved Solids	Fish and wildlife propagation, recreation and stock watering	≤ 2,500 mg/L	30-day average
		≤ 4,375 mg/L	daily maximum
Total Suspended Solids	Warmwater permanent fish life propagation water	≤ 90	30-day average based on a minimum of 3 consecutive grab or composite samples taken on separate weeks in a 30 day period
		≤ 158	daily maximum
Total Ammonia Nitrogen as N	Warmwater permanent fish life propagation water	Equal to or less than the result from Equation 3 in Appendix A (SDCL§74:51:01)	30-day average March 1 – October 31
		Equal to or less than the result from Equation 4 in Appendix A (SDCL§74:51:01)	30-day average November 1 – February 29
		Equal to or less than the result from Equation 2 in Appendix A (SDCL§74:51:01)	daily maximum
Dissolved Oxygen	Warmwater permanent fish life propagation water	≥ 5 mg/l	daily minimum
Un-disassociated Hydrogen Sulfide	Warmwater permanent fish life propagation water	≤ 0.002 mg/l	daily maximum
pH	Warmwater permanent fish life propagation water	≥ 6.5 - ≤ 9.0	See §74:51:01:07

Table 4 (continued). Numeric surface water quality standards for segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 in Lower Rapid Creek, Pennington County, South Dakota as of 2011

		Segment	
		SD_CH_R_RAPID_04 and SD_CH_R_RAPID_05	
Parameter	**Beneficial Use**	**Criterion**	**Special Conditions**
Temperature	Warmwater permanent fish life propagation water	≤ 80° F	See §74:51:01:31
Fecal Coliform (May 1 to September 30)	Immersion recreation water	≤ 200CFU/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period
		≤ 400CFU/100ml	in any one sample
Escherichia coli **(May 1 to September 30)**	Immersion recreation water	≤ 126mpn/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period
		≤ 235mpn/100ml	in any one sample
Nitrates as N	Fish and wildlife propagation, recreation and stock watering	≤ 50 mg/L	30-day average
		≤ 88 mg/L	daily maximum
Sodium adsorption ratio	Irrigation water	≤ 10	See definition § 74:51:01:01 (54)
Oil and Grease	Fish and wildlife propagation, recreation and stock watering	≤ 10 mg/L	See § 74:51:01:10
Total Petroleum Hydrocarbons	Fish and wildlife propagation, recreation and stock watering	≤ 10 mg/L	See § 74:51:01:10

2.2 Narrative Standards

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

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

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

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

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

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

3.0 TMDL Target

3.1 Total Suspended Solids

The lower portions of the Rapid Creek watershed have been assigned the warmwater permanent fish life propagation water beneficial use from S15, T1N, R8E to above Farmingdale, segment SD-CH-R-RAPID_04, and above Farmingdale to the confluence of the Cheyenne River, SD-CH-R-RAPID_05. Water quality standards based on warmwater permanent fish life propagation waters for TSS are the target criteria which require that 1) no sample exceeds 158 mg/L (acute target) and 2) the average of a minimum of 3 consecutive grab or composite samples taken on separate weeks during a 30-day period must not exceed 90 mg/L (chronic target).

The 2010 IR lists segment SD-CH-R-RAPID_04 as meeting the warmwater permanent fish life propagation beneficial use standard for TSS; while the furthest downstream segment of Rapid Creek (SD-CH-R-RAPID_05) is listed as exceeding the warmwater permanent fish life propagation beneficial use water quality standard for TSS. Greater than 10 percent of samples must exceed water quality criteria for that parameter to be included as a cause of impairment on the 303(d) impaired waters list.

4.0 Significant Sources

4.1 Point Sources

4.1.1 SD-CH-R-RAPID_04, S15, T1N, R8E to above Farmingdale

Rapid City has a wastewater treatment facility (RC WWTF) that discharges into Rapid Creek between ASTP and BSTP (Figure 2). Rapid City was issued a discharge permit (Permit # SD-0023574) in 2001 by SD DENR. As part of their permit, RC WWTF routinely samples their effluent for TSS five times per week throughout the year. Although this segment is not impaired for TSS, it is discussed because it represents boundary conditions which influence segment SD-CH-R-RAPID_05.

4.1.2 SD-CH-R-RAPID_05, above Farmingdale to Cheyenne River

There are no point source discharges (WLA) in this reach of the Rapid Creek watershed.

4.2 Nonpoint Sources

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of TSS within segment SD-CH-R-RAPID_05 of Rapid Creek include agricultural pasture and range sources. Using the best available information, loadings were estimated from each of these sources using the Annualized Agricultural Non-Point Source model (AnnAGNPS). Livestock and wildlife in Lower Rapid Creek are discussed below numbers were obtained through South Dakota Agriculture 2009 put out by the National Agriculture Statistics Service; while wildlife numbers and densities were through SD GF&P Annual County Wildlife Assessments 1991 through 2002.

4.2.1 Agriculture

Livestock are a potential source of TSS to streams. Livestock in the basin are predominantly beef cattle, horses and some sheep. Other livestock in the basin include bison, chickens and swine. Livestock population densities in the watershed were estimated using Census of Agriculture data, which is summarized by county. Livestock may contribute to TSS load in Lower Rapid Creek by directly wading in the stream or indirectly by trampling or grazing vegetation creating increased sheet and rill erosion and bank failure by accessing streams for water. Both the indirect and direct sources of TSS loads from livestock and riparian condition were represented in the modeling application by representing buffers along the main channel.

4.2.2 Cropland

Cropland is considered as small grained row crops that are generally tilled and in segment SD-CH-R-RAPID_05 are generally located north of Highway 44 in the upland portions of the segment. Increased TSS concentrations in streams via cropland comes from increased sheet and rill erosion associated with the disturbance of breaking (tilling) fields with native cover and replacing them with planted crops with less aerial and basal cover that are seasonally harvested reducing cover and increasing runoff and erosion. Cropland sources were modeled using the AnnAGNPS model.

4.2.3 Natural background/wildlife

Wildlife within the watershed is a natural background source of TSS. For watershed modeling purposes, wildlife population density estimates were obtained from the South Dakota Department of Game, Fish and Parks (SD GF&P, 2002). Wildlife contributions to overall TSS loads in Lower Rapid Creek were considered minimal based on very low densities and that they generally do not congregate into large herds that could trample down or over graze vegetation increasing erosion or break down stream banks trying to access the stream for water.

4.2.4. Scouring and Mass Wasting

The frequency, duration and magnitude of high flows were identified as a concern. The change in duration, frequency and magnitude of high flow conditions may cause increased scour and bank erosion in the lower reaches of the system during those events. In a study on the impact of increases in impervious area, Coon (2000) showed that the magnitude (peak) of runoff from 2 year through 10 year rainfall events increased 600 % and 71 %, respectively. The increase in magnitude and frequency of stormwater runoff does increase scour and bank erosion in the lower reaches of Rapid Creek during those events.

Rapid Creek, in portions of segment SD-CH-R-RAPID_05 has laterally migrated up against bluffs composed of Pierre Shale formation known to have bank failures, sloughing, and mass wasting.

4.3 Source Assessment Modeling Results

Landuse Modeling – Annualized Agricultural Non-Point Source Model, version 5.01.g.6 (Beta) (AnnAGNPS)

In addition to water quality monitoring, information was collected to complete a comprehensive watershed land use model. AnnAGNPS (Annualized Agricultural Non-Point Source) is a landuse model to simulate/model sediment and nutrient loadings from watersheds. AnnAGNPS is a data intensive watershed model that routes sediment and nutrients through a watershed by utilizing land uses and topography. The watershed is broken up into cells of varying sizes based on topography (Appendix Table B-1). Each cell was then assigned a primary land use and soil type.

The input data set for AnnAGNPS Pollutant Loading Model consists of 33 data sets, which can be supplied by the user in a number of ways. This model execution utilized digital elevation maps (DEMs) to determine cell and reach geometry, SSURGO soil layers to determine primary soil types and the associated NASIS data tables for each soils properties, and primary land use was based on a 2010 digitized FSA Global Information System (GIS) ® layer of the watershed. Impoundment data was obtained using Digital Ortho Quads (DOQs) and FSA coverage layers using ArcMap software.

Climate/weather data from Rapid City, South Dakota was used to generate simulated weather data. Model results were based on five-years of climate data for initializing variables prior to 25-year watershed simulation. Simulated precipitation based on climate data ranged from 10.5 to 25.7 inches per year. Mean annual precipitation for this watershed was approximately 16.1 inches.

Part of the modeling process includes the assessment of Animal Feeding Operations (AFOs) Confined Animal Feeding Operations (CAFO) located in the watershed. Based on 2010 FSA aerial coverage layers of segment SD-CH-R-RAPID_05, no permitted CAFOs or significant AFOs occur in this reach of Rapid Creek.

Watershed calibration used annual USGS data from 06421500, Rapid Creek near Farmingdale, SD located in the middle portion of segment SD-CH-R-Rapid_05 on Lower Rapid Creek. After calibration, Best Management Practices (BMPs) were then simulated by altering land uses of individual cells with greater loading potential and reductions were calculated at the outlet to the watershed.

Findings from the AnnAGNPS report can be found throughout the water quality and source assessment modeling discussions in this document. Conclusions and recommendations will rely on both water quality and AnnAGNPS model data.

Table 5 AnnAGNPS Modeled TSS load reduction percentages based on landuse BMPs

Segment : SD-CH-R-RAPID_05

Landuse BMP Scenario	**Acres**	TSS **Modeled Load (tons)**	**Modeled Reduction Percentage (%)**
Current	83,341	2,363	0
All Grass	71,823		73.6
Mainstem Riparian	8,743		11.1
Cropland Residue	7,251		25.7
Pastureland/Rangeland	72,038		17.1
Estimated Sediment Reduction from: Segment: SD-CH-R-RAPID_04	-	-	5.0

Table 5 represents separate AnnAGNPS model runs based on landuse BMPs and estimates TSS load reductions within segment SD-CH-R-RAPID_05. The current run represents the current watershed load based on current landuse conditions. Four BMP scenarios were modeled to estimate potential load reductions for each landuse and are discussed below.

The all grass run converted all land uses in the watershed that were not grass to all grass to simulate "pristine conditions" with no anthropogenic influences. The all grass run exhibited the greatest sediment load reduction (73.6 percent) and suggests that needed reductions can be achieved by implementing a variety of BMPs (Table 5).

Mainstem riparian buffer improvements were modeled by converting all left and right bank AnnAGNPS cells along Rapid Creek from current coverage to CRP with improved canopy cover and root mass. This scenario resulted in an 11.1 percent reduction in sediment (Table 5). This reduction, however, should not interpreted as a reduction in sediment from stream bank runoff but rather as a reduction in sediment from those cells, which factor into the final sediment load for the watershed.

Sediment reduction modeling for crops consisted of changing current spring wheat crops to no till spring wheat and poor residue. This management change produced a 25.7 percent reduction in sediment from the Rapid Creek watershed (Table 5).

Another modeled scenario looked at improving pasture and rangeland which initially used AnnAGNPS characteristics of shrubland with 55 percent residue cover, 60 percent annual cover, and 2,000 pounds per acre root mass to pasture good with 80 percent residue cover, 87 percent annual cover, and 1,779 pounds per acre root mass. Improving pasture and rangeland resulted in an annual sediment reduction of 17.1 percent (Table 5).

Long-term TSS loading data suggest that sediment loading from segment SD-CH-R-RAPID_04 does not significantly contribute to TSS exceedences observed in segment SD-CH-R-RAPID_05. Both segments have EPA approved fecal coliform TMDLs and segment SD-CH-R-RAPID_05 has an approved *E. coli* TMDL. These TMDLs will require a wide-variety of BMPs be installed to help meet reductions outlined in the TMDL document (Smith, 2010). Many of these BMPs for bacteria will also reduce sediment loading to segment SD-CH-R-RAPID_04 and in-turn segment SD-CH-R-RAPID_05. Thus implementation of bacteria BMPs in segment SD-CH-R-RAPID_04 will reduce sediment loading to TSS impaired segment SD-CH-R-RAPID_05. Sediment reduction through implementing bacteria BMPs in segment SD-CH-R-RAPID_04 was conservatively estimated using best professional judgment and was included in Table 5.

5.0 Technical Analysis

5.1 Stream Flows

Average daily discharge data from segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 were used to develop reach specific flow duration curves for Lower Rapid Creek analysis. Stream flow monitoring sites in these segments had excellent long-term USGS monitoring site data sets with segment SD-CH-R-RAPID_04 having 29 years of available data and segment SD-CH-R-RAPID_05 having 50 years of discharge data.

5.2 Flow Duration Curve Analysis

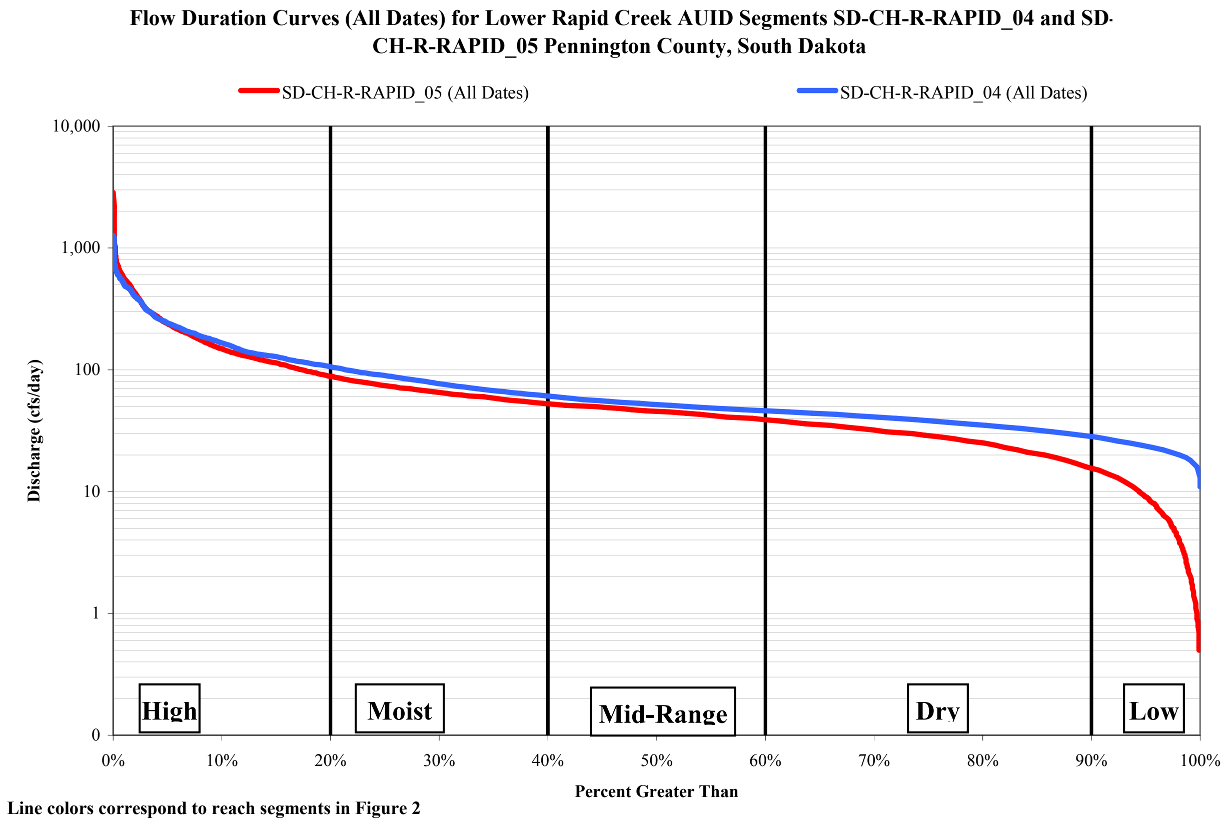

Figure 3 Flow duration curves for TSS impaired stream segment SD-CH-R-RAPID_05 and upstream non-impaired stream segment SD-CH-R-RAPID_04 in Lower Rapid Creek, Pennington County South Dakota and were developed using USGS discharge data.

Flow duration curves for segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 were developed using long-term un-adjusted USGS mean daily discharge data collected from January through December (Figure 3). Segment SD-CH-R-RAPID_04 had increased minimum flow values in the low flow zone and was from discharge from the Rapid City Wastewater Treatment Facility which increased low flow minimum discharge to 11 cubic feet per second. Segment SD-CH-R-RAPID_05 has no perennial tributary, stormwater or permitted National Pollution Discharge Elimination System (NPDES) discharge flows that modify the flow regime in this stream segment.

Flows in segment SD-CH-R-RAPID_05 above Farmingdale were lower in all flow zones (low through high) when compared to segment SD-CH-R-RAPID_04 (Figure 3). Although overall higher, flows in segment SD_CH-R-RAPID_04 especially in the moist through mid-range flow zones show similar flow duration characteristics in magnitude but diverge significantly (higher) in the dry and low flow zones. By the time increased flows from the dry and low flow zones reach segment SD-CH-R-RAPID_05 the influence of the RC WWTF NPDES discharge, increased flows from impervious surfaces, and stormwater discharge from Rapid City are reduced/modified to a more typical logarithmic pattern as seen in segment SD-CH-R-RAPID_05 flows.

5.3 Load Duration Curve Analysis

The TMDLs were developed using the Load Duration Curve (LDC) approach, resulting in flow-variable targets that consider the entire flow regime. The LDC is a dynamic expression of the allowable load for any given day based on flow. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones. Typically, the LDC flow intervals were grouped into five flow zones: high flows (0–10%), moist conditions (10–40%), mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%) based on EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA 2006). In Lower Rapid Creek, LDCs were developed for segment SD-CH-R-RAPID_04 above the impaired reach and segment SD-CH-R-RAPID_05 the impaired reach.

Acute and chronic LDCs were calculated by multiplying the water quality standard for TSS by the USGS Lower Rapid Creek monitoring sites discharges calculated for the period of record for each segment. These curves represent site specific acute and chronic TMDLs based on any flow and were used to determine TMDL compliance based on flow. Lower Rapid Creek TSS LDCs were developed for segment SD-CH-R-RAPID_04 based on discharges from USGS monitoring site 06418900 (Rapid Creek below Sewage Treatment Plant, near Rapid City, BSTP) and segment SD-CH-R-RAPID_05 was based on discharges from USGS monitoring site 06421500 (Rapid Creek near Farmingdale, FARM). The locations of the SD DENR water quality monitoring sites on Lower Rapid Creek are shown in Figure 2.

Instantaneous or "observed" loads were calculated by multiplying the sample concentrations from SD DENR assessment and ambient water quality monitoring data within the un-impaired segment (Site: 460692-below Sewage Treatment Plant segment: SD-CH-R-RAPID_04) and impaired AUID segment (Site: 460910-near Farmingdale segment: SD-CH-R-RAPID_05), with the measured flow at the time the water quality sample was collected, and a unit conversion factor. When instantaneous loads are plotted on LDCs, characteristics of the water quality impairment are shown for each reach. Instantaneous loads that plot above the solid black curve (solid black curve = TMDL) exceed the daily maximum water quality (acute) criterion, while those below the curve are in compliance. The average (chronic) criterion (orange curve) was assessed calculating the average of all instantaneous loads collected within each flow zone and comparing that value to the 95th percentile load of the chronic criterion load within each flow zone.

Based on instantaneous TSS load exceedence in the high and upper portions of the moist flow zones, the LDC flow intervals for segment SD-CH-R-RAPID_05 were modified to represent TSS loading characteristics unique to segment SD-CH-R-RAPID_05. The result adjusted the high and moist flow zones to the following percentages: high flows (0–20%), moist conditions (20–40%), while the remaining zones stayed the same as suggested by USEPA (2006) guidance with mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%).

LDCs and instantaneous loading for TSS in segment SD-CH-R-RAPID_04 were used to analyze the influence this segment may have on impaired segment SD-CH-R-RAPID_05 and should be interpreted as boundary conditions for the impaired segment. For ease of interpretation LDC flow zones for segment SD-CH-R-RAPID_04 were modified to reflect those in impaired segment SD-CH-R-RAPID_05 (high flows (0–20%), moist conditions (20–40%), mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%).

The LDCs shown in Figure 4 and Figure 5 represents a dynamic expression of parameter specific TMDLs for segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 of Lower Rapid Creek and are based on the daily maximum TSS criterion, resulting in a unique maximum daily load that corresponds to a measured average daily flow.

5.3.1. Total Suspended Solids

5.3.1.1. Segment SD-CH-R-RAPID_04 (Boundary Conditions)

The load duration curve based TMDL for TSS was developed for segment SD-CH-R-RAPID_04 using long-term USGS discharge data collected from 1981 through 2010 from site 06418900, Rapid Creek below Sewage Treatment Plant, near Rapid City, SD. Instantaneous TSS data consisted of SD DENR ambient monitoring site DENR 460692 collected downstream of the USGS monitoring site (Figure 2).

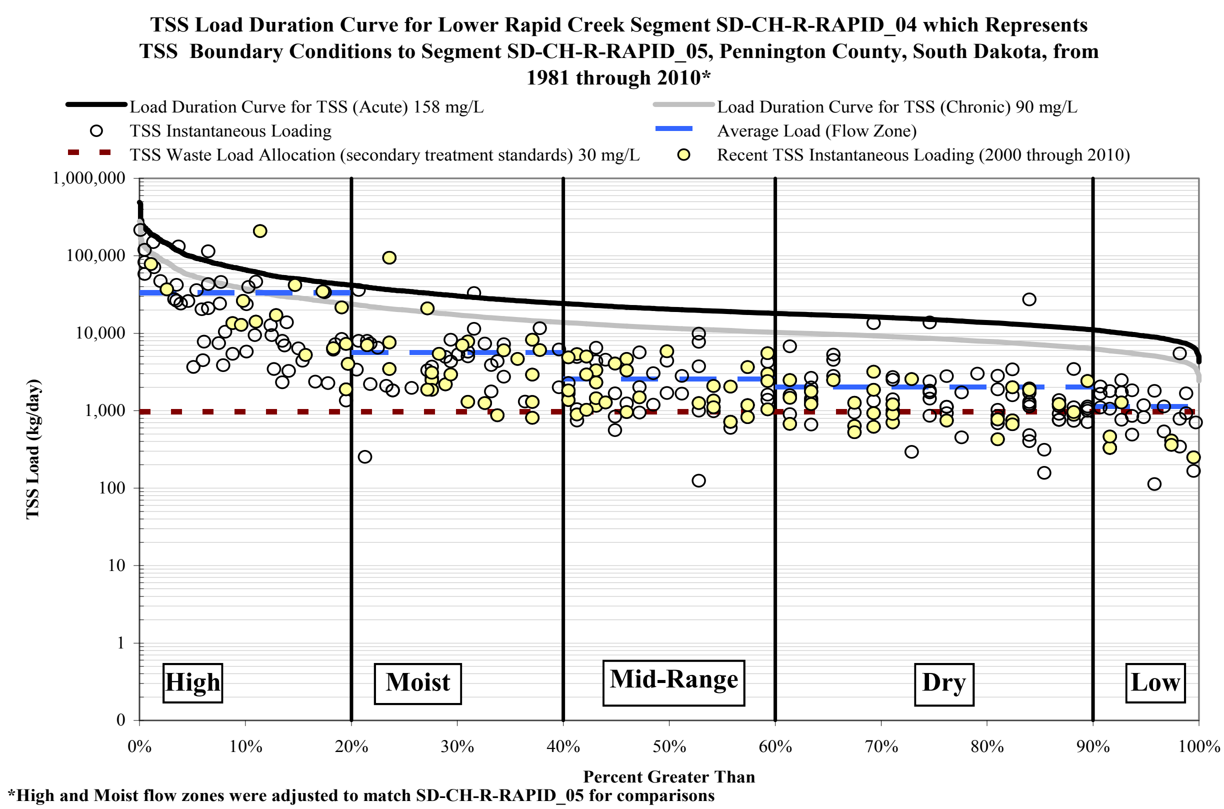

Figure 4 Load duration curve representing allowable daily TSS loads based on daily maximum acute TSS criterion (≤ 158 mg/L) and the 30-day average chronic criterion (≤ 90 mg/L) from 1960 through 2010. Observed ambient and watershed assessment project TSS loads from 1981 through 2010 are also displayed.

This segment is discussed because TSS loading from segment SD-CH-R-RAPID_04 directly impact impaired segment SD-CH-R-RAPID_05; thus segment SD-CH-R-RAPID_04 loadings were considered boundary conditions for impaired segment SD-CH-R-RAPID_05.

Water quality standards for TSS in segment SD-CH-R-RAPID_04 of Rapid Creek are based on warmwater permanent fish life propagation waters beneficial use (acute - $\leq$ 158 mg/L and chronic - $\leq$ 90 mg/L). The acute load duration curve represents the daily maximum load based on stream flow and the chronic curve represents the 30-day average which consists of the arithmetic mean of a minimum of three consecutive grab or composite samples collected on separate weeks in a 30-day period. TMDLs based on acute and chronic standards (black and grey lines, respectively) are shown in Figure 4; while instantaneous daily loading are shown as clear and yellow circles. Together these are used to determine TSS exceedence based on flow.

The majority of TSS loading (98.1 percent) met acute water quality standards. Although not exceeding water quality standards, exceedence percentages by flow zone were slightly higher in the moist and high flow zones (Table 6).

Table 6 TSS loading exceedence percentages (1981 through 2010) based on acute water quality standards for Lower Rapid Creek segment SD-CH-R-RAPID_04.

Flow Zone	Sample Size (#)	Exceedence Percentage by Flow Zone (%)	Flows (cfs)
High	65	4.6	109 – 1,270
Moist	58	3.4	63 -108
Mid-Range	66	0.0	47 - 62
Dry	94	1.1	29 - 46
Low	32	0.0	11 -28
Overall	**315**	**1.9**	**11 – 1,270**

Although minimal, acute exceedences generally occur during event conditions with flows greater than or equal to 75 cfs (high and moist flow zones). Below that point TSS loading rarely exceeds the beneficial use based acute water quality criteria (Figure 4 and Table 6). Thirty-day average chronic values for TSS by flow zone for segment SD-CH-R-RAPID_04 of Rapid Creek were below the chronic water quality standards (grey line) throughout the moist, mid-range, dry and low flow zones base on the 95th percentile of the chronic load within each flow zone (Figure 4).

Table 7 Total Suspended Solids TMDL for SD-CH-R-RAPID_04 (Acute Standard).

		Flow Zone				
		High*	Moist*	Mid-Range	Dry	Low
TMDL Component		109-1,270 cfs	63-108 cfs	47-62 cfs	29-46 cfs	11-28 cfs
WLA	(kg/day)	971	971	971	971	971
LA	(kg/day)	167,898	33,046	20,290	12,945	5,214
MOS	(kg/day)	23,967	6,185	2,319	3,866	4,639
TMDL (95th Percentile)	(kg/day)	192,836	40,202	23,580	17,782	10,824
Current Load (95th Percentile)	(kg/day)	139,501	37,808	5,789	4,785	2,247
Load Reduction		0%	0%	0%	0%	0%

*** = Modified flow zones high (0% - 20%) and moist (20% - 40%)**

Acute and chronic TSS TMDL tables were created for segment SD-CH-R-RAPID_04 to further evaluate TSS conditions by flow zone and verify compliance with beneficial use based water quality standards for TSS in this segment of Rapid Creek (Table 7 and Table 8).

Critical conditions for segment: SD-CH-R-RAPID_04 occur during event conditions when flows greater than or equal to 75 cfs; however, exceedence percentages in the high and moist flow zones were well below action levels with all flow regimes meeting acute and chronic standards for TSS based on the load duration curve (Figure 4), flow zone water quality violation percentages (Table 6), and TMDL tables Table 7 and Table 8.

Table 8 Total Suspended Solids TMDL for SD-CH-R-RAPID_04 (Chronic Standard).

		Flow Zone				
		High*	Moist*	Mid-Range	Dry	Low
TMDL Component		109-1,270 cfs	63-108 cfs	47-62 cfs	29-46 cfs	11-28 cfs
WLA	(kg/day)	971	971	971	971	971
LA	(kg/day)	95,220	18,406	11,140	6,956	2,552
MOS	(kg/day)	13,652	3,523	1,321	2,202	2,642
TMDL (95th Percentile)	(kg/day)	109,843	22,900	13,432	10,129	6,165
Average (Flow Zone)	(kg/day)	33,120	5,619	2,566	2,039	1,143
Load Reduction		0%	0%	0%	0%	0%

*** = Modified flow zones high (0% - 20%) and moist (20% - 40%)**

As mentioned previously, TSS data and flow zone characteristics within segment SD-CH-R-RAPID_04 are provided to document and assess TSS boundary conditions influencing impaired segment SD-CH-R-RAPID_05 of Rapid Creek from above Farmingdale, SD to the Cheyenne River. Based on these data, loadings from segment SD-CH-R-RAPID_04 do not significantly contribute to TSS loading to impaired segment SD-CH-R-RAPID_05.

5.3.1.2. **Segment SD-CH-R-RAPID_05**

The load duration curve based TMDL for TSS was developed for segment SD-CH-R-RAPID_05 using long-term USGS discharge data collected from 1960 through 2010 from site 06421500, Rapid Creek near Farmingdale, SD. Instantaneous TSS data consisted of SD DENR ambient monitoring site DENR 460910 collected from 1970 through 2010 immediately downstream of the USGS monitoring site (Figure 2). Project specific instantaneous TSS loading data from the

Rapid Creek assessment project collected from 1999 through 2000 and Lower Cheyenne River assessment project collected from 2007 through 2009 were used to determine TSS impairment by flow regime (Figure 5).

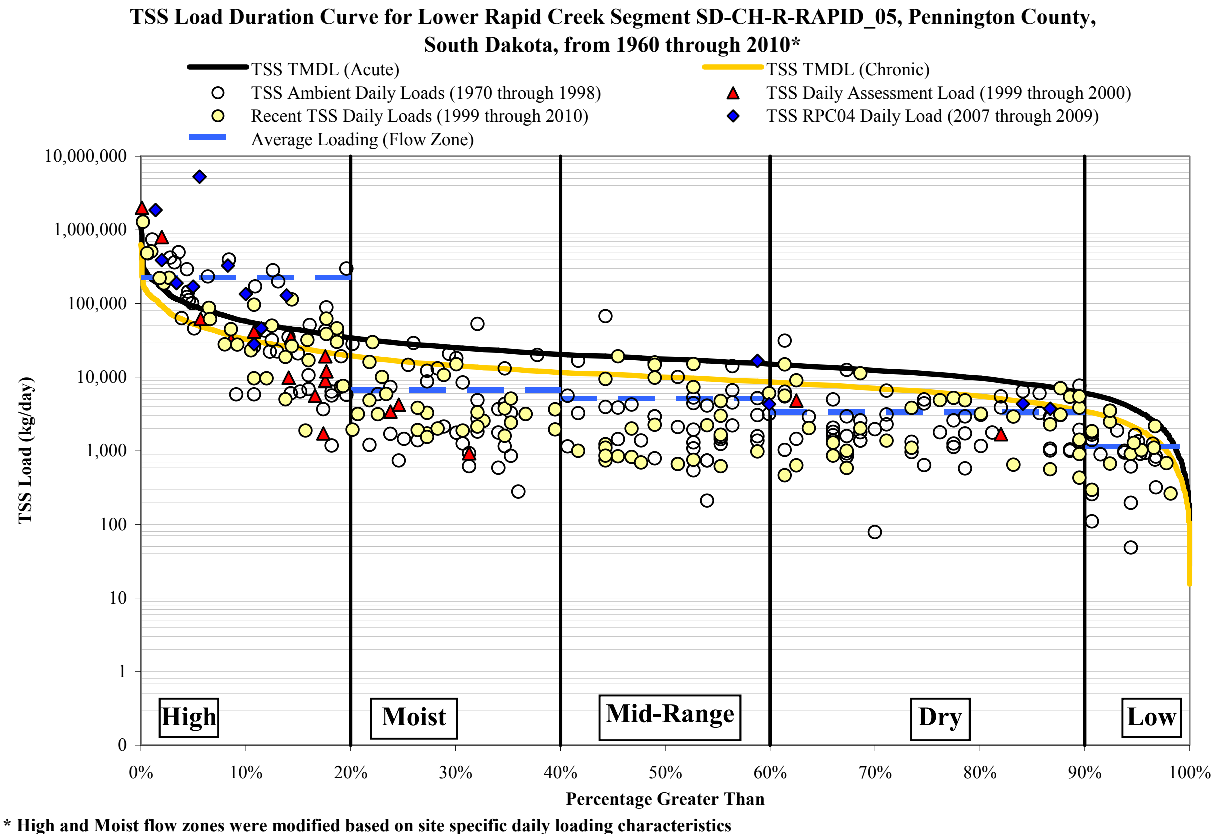

Figure 5 Load duration curve representing allowable daily TSS loads for SD-CH-R-RAPID_05 based on daily maximum acute TSS criterion (≤ 158 mg/L) and the 30-day average chronic criterion (≤ 90 mg/L) from 1960 through 2010. Observed ambient, assessment and Cheyenne River watershed project TSS loads from 1970 through 2010 are also displayed.

Water quality standards for TSS in segment SD-CH-R-RAPID_05 of Rapid Creek are based on the warmwater permanent fish life propagation waters beneficial use (acute – ≤ 158 mg/L and chronic - ≤ 90 mg/L). TMDLs based on acute (black line) and chronic (grey line) standards are shown in Figure 5; while instantaneous daily loading are shown as clear circles, yellow circles blue diamonds and red triangles. Instantaneous daily loads were used to calculate the average daily loads within each flow zone to determine if the chronic standard was being met within each flow zone.

TSS exceeded acute water quality standards at greater rates (higher percentages) in the modified high flow zone depicting an event based exceedence system (Figure 5 and Table 9). Most of the more recent samples in the high flow zone were collected for the Lower Cheyenne River watershed assessment project (RPC04) which tended to sample event conditions, with 75 percent of the samples collected during the project were in the high flow zone (Figure 5).

Table 9 TSS loading exceedence percentages based on acute standards for Lower Rapid Creek segment SD-CH-R-RAPID_05 from 1970 through 2010.

Flow Zone	Sample Size (#)	Flow Zone Exceedence Percentage (%)	Flows (cfs)
High	92	46.7	89 – 2,860
Moist	68	2.9	53 -88
Mid-Range	66	4.5	39 - 52
Dry	91	4.4	16 - 38
Low	34	0.0	0.07 -15
Overall	**351**	**14.8**	**0.07 – 2,860**

Acute exceedences generally occur during event conditions with flows greater than or equal to 89 cfs. Below that discharge point TSS loading rarely exceeds the beneficial use based acute water quality criteria (Figure 5 and Table 9). The acute values for TSS by flow zone for segment SD-CH-R-RAPID_05 of Rapid Creek were below acute water quality standard (black line) throughout the moist, mid-range, dry and low flow zones based on the 95th percentile of the acute load within each flow zone (Figure 5). Loading in the high flow zone exceeds the dynamic water quality standard for TSS by 46.7 percent over the entire flow zone and 26 percent based on the 95th percentile of the load in the high flow zone (Table 12).

Thirty-day average chronic values for TSS by flow zone for segment SD-CH-R-RAPID_05 of Rapid Creek were below the chronic water quality standards (grey line) throughout the moist, mid-range, dry and low flow zones based on the 95th percentile of the chronic load within each flow zone (Figure 5). The chronic loading exceedence percentage in the high flow zone was 8 percent (Table 13).

The critical condition for segment: SD-CH-R-RAPID_05 appears to be flow regimes at or above 89 cfs based on water quality violation percentages (Table 9). Applying conservative methodologies to TMDL development within segment SD-CH-R-RAPID_05, the beneficial use based TMDL throughout all flow zones will be developed for TSS based on the daily maximum acute criteria of 158 mg/L because percent reductions required to meet water quality standards were greater based on the acute criteria standard.

5.4 Loading Sources

In Section 4.0, significant sources of TSS loading were defined as non-point source pollution originating from pasture and range cover and crop residue. One of the more important concerns regarding nonpoint sources is variability in stream flows. Variable stream flows often cause different source areas and loading mechanisms to dominate (Cleland, 2003). Because there was long-term hydrologic data available within the TSS impaired segment of Lower Rapid Creek, five flow regimes (i.e., high, moist, mid-range, dry and low) were selected to represent the hydrology of the TMDL watersheds. By relating runoff and loading characteristics based on LDCs for each flow regime, inference can be made as to which sources are most likely to contribute to TSS loading within the impaired segment.

5.4.1. Total Suspended Solid Sources

5.4.1.1. Point Sources

No TSS point sources were identified in the impaired segment SD-CH-R-RAPID_05 of Lower Rapid Creek. However, the Rapid City WWTF discharges into segment SD-CH-R-RAPID_04 which is 42 stream kilometers (26 stream miles) upstream of segment SD-CH-R-RAPID_05 near Farmingdale, SD. Ambient surface water quality samples collected below the Rapid City WWTF since 1979 indicate that only six samples (1.9 percent) exceeded water quality standards for TSS (Table 6). Based on these data, point source TSS loading originating from Rapid City WWTF does not significantly impact segment SD-CH-R-RAPID_05. Thus Rapid City WWTP located in segment SD-CH-R-RAPID_04 is not a significant TSS source load to the TSS impaired segment SD-CH-R-RAPID_05 and is not considered a concern.

Table 10 Point and nonpoint sources of pollution and the potential to pollute[1] based on flow zones and TSS load duration curves for Lower Rapid Creek, Pennington County, South Dakota 2010.

			Flow Regime				
Impaired Segment	Parameter	Source	High	Moist	Mid-Range	Dry	Low
SD-CH-R-RAPID_05	Total Suspended Solids	Point Source					
		None	NA	NA	NA	NA	NA
		Non-Point Source					
		Wildlife	L	L	L	L	L
		Stream bank failures	H	H	M	M	L
		Sloughing banks (mass wasting)	H	H	M	L	L
		Pastureland/Rangeland	L	L	L	L	L
		Crop Residue	M	M	L	L	L
		Riparian Condition	M	M	L	L	L

[1] = Potential to pollute (H – High, M – Moderate, L – Low, NA – Not Applicable)

5.4.1.2. Nonpoint Sources

TSS loading potential from wildlife in segment SD-CH-R-RAPID_05 of the Lower Rapid Creek watershed was estimated to be low throughout all flow zones (Table 10). Wildlife have little impact on TSS loading because they are generally not congregated into large herds or restricted to confined fields or regions of the watershed.

Stream bank failures in lower segment of Rapid Creek (SD-CH-R-RAPID_05) were associated with increased flow frequencies creating increased scouring, toe erosion, and bank failure producing higher TSS loading. Ambient, assessment, and Cheyenne River Rapid Creek loading data indicated a steady increase in TSS loading from low flows (0.07 cfs) through most of the moist flow (89 cfs) suggests TSS loading is coming primarily from within the stream bed and banks during non-events. Data analysis showed the frequency, duration and magnitude of high flows were identified as a concern. The change in duration, frequency and magnitude of high flow conditions can cause scour and bank erosion in the lower reaches of the system. This may be seen in the high and moist flow zones in Figure 5, and Table 9.

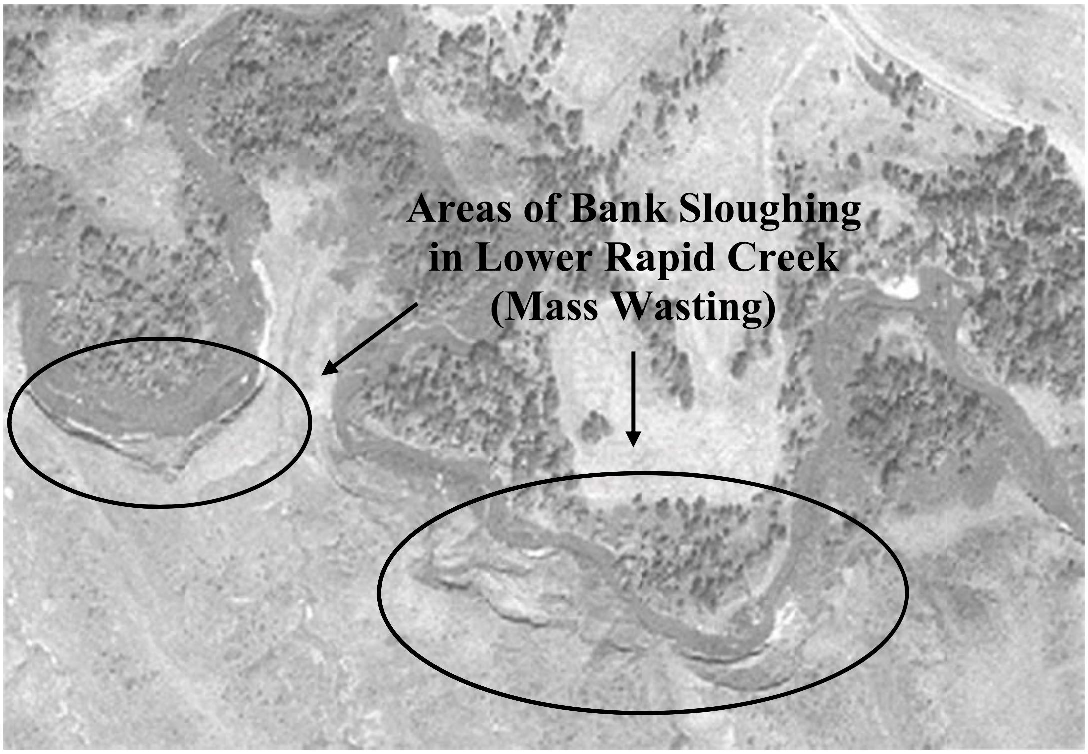

Figure 6 Examples of areas of bank sloughing/mass wasting in segment SD-CH-R-RAPID_05 of Lower Rapid Creek, Pennington County, South Dakota.

Bank sloughing in Lower Rapid Creek segment SD-CH-R-RAPID_05 is more prevalent because of the local geology. The lower portion of segment SD-CH-R-RAPID_05 of Rapid Creek outside of the alluvial deposits along the stream flows through and against Pierre Shale bluffs; which are prone to sloughing and mass wasting especially during wet years with above average rainfall (Figure 6). TSS load duration curve data for segment SD-CH-R-RAPID_05 indicated a sharp increase in TSS loading and water quality standard exceedences from the upper portion of the moist flow (89 cfs) zone through the high flow (2,860 cfs) zone. The significant increase between upper moist and high flow zones is due primarily to high sediment storage within the system which originated from sloughing banks and significant mass wasting along Lower Rapid Creek (Figure 5, and Tables 12 and 13).

Pastureland/Rangeland makes up the largest landuse percentage (86.3 percent) in segment SD-CH-R-RAPID_05 of Lower Rapid Creek; however, based on LDCs this landuse has a modest/low potential loading throughout all flow zones. AnnAGNPS modeling also indicated a minimal improvement in sediment reduction considering the spatial coverage of pastureland/rangeland in the Lower Rapid Creek watershed.

Cropland in this segment comprised 11.8 percent of the watershed and of that 8.7 percent is small and close seeded crops. LDCs based estimates a moderate potential to impact water quality in the high and moist flow zones while low potential impact in the mid-range to low flow zones (Table 10). Increasing residue in cropland fields will reduce sediment loading to Rapid Creek reducing the loading potential in the high and moist flow zones from moderate to low.

AnnAGNPS modeling supports a respectable reduction in sediment load to Rapid Creek by improving residue management (Table 5).

Riparian zones play a critical role in controlling sediment (buffering) in a watershed. Lower Rapid Creek watershed in segment SD-CH-R-RAPID_05 is impaired by increased sediment loading (TSS) in the high and moist flow zones (Figure 5 and Table 10). This suggests that the condition of the riparian zone may not be enough to control sediment loading in the higher flow zones. With the majority of the landuse in this segment of Lower Rapid Creek pasture and range, livestock grazing is a significant management practice used in this watershed. Riparian condition in this segment may be stressed by allowing livestock unlimited access to the riparian zone for watering and grazing. Livestock with access to the riparian zone and stream corridor may contribute to TSS loading by wearing down paths to the stream and breaking down stream banks to access water either for drink or to cool off on hot days. These areas are prone to increased erosion and bank stability problems especially during high moist flows. Livestock have immediate effects on the stream by disturbing bottom sediments and defecating in the stream which increase TSS loading and a long-term impact on water quality by feeding on and trampling riparian vegetation which increases erosion and reduces filtration efficiencies. AnnAGNPS modeling again supports a reasonable reduction (11.1 percent) in sediment load to Rapid Creek by improving riparian condition in Lower Rapid Creek (Table 5). Improving the riparian zone by managing and reducing livestock access to the stream and riparian zone will reduce erosion, sediment loading, and other disturbance related issues associated with livestock.

6.0 Margin of Safety and Seasonality

6.1 Margin of Safety (MOS)

An explicit MOS was identified using statistical analysis and is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). Each explicit MOS for TSS was calculated as the Inner Quartile Range (IQR) of the assimilative capacity within each of the five flow zones (75^{th} percentile minus the 25^{th} percentile). The IQR method is a viable way to account for natural variability because it excludes the extreme fluctuations in loading based on flow within each flow zone. Because allocations are a direct function of flow, accounting for potential flow and loading variability is an appropriate way to address the MOS.

6.2 Seasonality

Stream flows in Lower Rapid Creek displayed seasonal variation for the period of record (1960 through 2010). Highest stream flows typically occur during June while the lowest daily mean stream flows occurred in May for segment SD-CH-R-RAPID_05 based on year-round discharge measurements (Table 11). Seasonal fluctuations in flow were greatest between late spring and early summer; however, correlation coefficients for TSS (r = 0.33) indicated that for segment SD-CH-R-RAPID_05 was not significantly correlated with stream flow.

Table 11 Highest and lowest mean daily flow for USGS monitoring site in segment SD-CH-R-RAPID_05 of Lower Rapid Creek, Pennington County, South Dakota from 1960 through 2010.

		Highest Flows		Lowest Flows		
Segment	**Parameter**	**Month**	**Flow**	**Month**	**Flow**	**Season**
SD-CH-R-RAPID_05	TSS	June	2,860	May	0.07	All Year

Since the criteria for TSS concentrations are in effect year-round, the TMDLs developed for this parameter are applicable year-round.

7.0 TMDL

The TMDL can be described by the following equation**:**

TMDL = WLA + LA + MOS, where:

TMDL = loading capacity LC, or the greatest loading a waterbody can receive without violating water quality standards;
WLA = wasteload allocation, or the portion of the TMDL allocated to existing or future point sources;
LA = load allocation, or the portion of the TMDL allocated to existing or future nonpoint sources;
MOS = margin of safety, or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of loading capacity.

Year-round data from this time period were used to develop TMDL allocations and load reduction goals. The TSS TMDL is in effect year-round with all its applicable standards and criteria.

To ensure that all applicable TSS criteria are met and to aid in the implementation of these TMDLs, load allocations were calculated for each of the five flow zones using both the acute (daily maximum) and chronic (average) criteria. The criterion requiring the greatest load reduction from baseline conditions, which vary by flow zone, were used to establish each TMDL allocation. Methods used to calculate each TMDL allocation are discussed in more detail below.

The flow duration curve was developed for the impaired segment based on USGS stream gage in segment SD-CH-R-RAPID_05 and flow duration intervals were defined which were used as a general indicator of hydrologic condition (i.e., wet vs. dry conditions and to what degree). These intervals (or zones) provide additional insight about conditions and patterns associated with the impairments for TSS (USEPA, 2006). As depicted in Figure 3, select flow duration curves for Lower Rapid Creek (SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05) were plotted on one graph and divided into five zones. These zones represent high flow zones (0-20 percent), moist flow zones (20-40 percent), mid-range flow zones (40-60 percent), dry flow zones (60-90 percent), and low flow zones (90-100 percent). Flow intervals were defined by examining the range of flows for each of the sites based on flow duration curves plotted on Figure 3. A secondary factor in determining the flow intervals used in the analysis is the number of TSS observations available for each flow interval.

To develop TSS load allocations (LAs), the loading capacities (LCs) were first determined. Both the daily maximum (acute) criterion (158 mg/L) and the average (chronic) criterion (90 mg/L) were used. The TSS daily maximum (acute) criterion (158 mg/L) and the 30-day average (chronic) criterion (90 mg/L) were used for the calculation of the LC for segment SD-CH-R-RAPID_05. LCs for TSS in segments SD-CH-R-RAPID_04 and SD-CH-R-RAPID_05 were produced for Lower Rapid Creek based on the acute and chronic criterion. Loading capacities were calculated by multiplying the acute and chronic TSS criteria by segment specific USGS daily average flow measurements. Thus, the TMDL were developed using the LDC approach, resulting in a flow-variable target that considers the entire flow regime over the entire year based on TSS.

For each of the five flow zones, the 95th percentile of the range of LCs within each zone was set as the flow zone goal. TSS loads experienced during the largest stream flows (e.g. top 5 percent) cannot be feasibly controlled by practical management practices. Thus, setting the flow zone goal at the 95th percentile of the range of LCs will protect the warmwater permanent (TSS) beneficial use assigned to SD-CH-R-RAPID_05 and allow for the natural variability of the system.

The TMDL is the sum of WLA, LA, and MOS. Portions of the LC were allocated to nonpoint sources as a load allocation (LA) and the margin of safety (MOS) account for uncertainty in the calculations of load allocations. The method used to calculate the MOS is described in Section 6.1. The waste load allocation (WLA) for this segment that does not have any permitted facilities (point sources) that discharge TSS into the impaired segment of Lower Rapid Creek, thus the WLA was assigned zero values. The overall LAs were determined by subtracting WLA and MOS from the LC.

7.1. Total Suspended Solids

7.1.1. Segment SD-CH-R-RAPID_05

Current loading in segment SD-CH-R-RAPID_05 based on the acute standard exceeded water quality standards based on 158 mg/L in the modified high flow zone by 26 percent while meeting standards from the moist through low flow zones (Table 12).

Table 12 Acute TSS TMDL for segment SD-CH-R-RAPID_05 of Lower Rapid Creek, Pennington County, South Dakota 2010.

Total Suspended Solids TMDL for SD-CH-R-RAPID_05 (Acute)

		Flow Zone				
		High*	Moist*	Mid-Range	Dry	Low
TMDL Component		89-2,860 cfs	53-88 cfs	39-52 cfs	16-38 cfs	0.07-15 cfs
WLA	(kg/day)	0	0	0	0	0
LA	(kg/day)	145,811	18,169	17,395	10,051	2,744
MOS	(kg/day)	69,194	14,689	2,706	4,252	3,054
TMDL (95th Percentile)	(kg/day)	215,005	32,858	20,101	14,303	5,798
Current Load (95th Percentile)	(kg/day)	290,033	25,567	16,417	8,362	2,837
Load Reduction		26%	0%	0%	0%	0%

* = Modified flow zones high (0% - 20%) and moist (20% - 40%)

Exceedence criteria consisted of comparing the average load of all instantaneous loads within each flow zone to the 95th percentile chronic load which represents the TMDL within each flow zone. Chronic loading derived from the 30-day average load based on 90 mg/L exceeded water quality standards only in the high flow zone (Table 13).

Acute and chronic loading data segment SD-CH-R-RAPID_05 indicates that current loading based on in the moist, mid-range, dry and low flow zones currently meet acute and chronic standards.

Table 13 Chronic TSS TMDL for segment SD-CH-R-RAPID_05 of Lower Rapid Creek, Pennington County, South Dakota 2010.

Total Suspended Solids TMDL for SD-CH-R-RAPID_05 (Chronic)

		Flow Zone				
TMDL Component		High*	Moist*	Mid-Range	Dry	Low
		89-2,860 cfs	53-88 cfs	39-52 cfs	16-38 cfs	0.07-15 cfs
WLA	(kg/day)	0	0	0	0	0
LA	(kg/day)	83,056	6,340	8,510	5,945	1,563
MOS	(kg/day)	39,415	8,367	1,541	2,422	1,740
TMDL (95th Percentile)	(kg/day)	122,471	14,707	10,051	8,367	3,303
Average (Flow Zone)	(kg/day)	132,748	6,675	5,130	3,372	1,155
Load Reduction		8%	0%	0%	0%	0%

* = Modified flow zones high (0% - 20%) and moist (20% - 40%)

Critical conditions for segment SD-CH-R-RAPID_05 of the Lower Rapid Creek watershed based on the TSS TMDL are event-based runoff conditions with all water quality violations occurring in the modified high flow zone (flows ≥ 89 cfs).

TMDL goals are set based on the highest required load reduction percentage (either acute or chronic) by flow zone. The TMDL goal for TSS in segment SD-CH-R-RAPID_05 is the acute based TMDL for the modified high flow zone and, when met, will attain compliance with all applicable water quality standards for TSS in this segment of Rapid Creek (Table 12 and Table 13).

8.0 Allocations and Recommendations

8.1 Wasteload Allocations (WLAs)

8.1.1. Total Suspended Solids

8.1.2. Segment SD-CH-R-RAPID_05

There are no point source dischargers in this segment of the Rapid Creek watershed. Therefore, the WLAs in this TMDL is considered zero. Thus TMDLs are considered wholly included within the "load allocation" component of the equation.

8.2 Load Allocation (LA)

8.2.1. Segment SD-CH-R-RAPID_05

The majority of excess load allocations in segment SD-CH-R-RAPID_05 originate within segment SD-CH-R-RAPID_05 based on discharge data collected at USGS monitoring site 06418900, Rapid Creek below Sewage Treatment Plant, near Rapid City, SD. The TSS LDC for segment SD-CH-R-RAPID_04 shows minimal water quality violations of the acute or chronic standards throughout the entire flow regime (Figure 4). Based on this, most TSS loads from segment SD-CH-R-RAPID_04 have little impact on loading in segment SD-CH-R-RAPID_05. Approximately five percent of the excess total TSS load allocation in segment SD-CH-R-RAPID_05 was attributed to segment SD-CH-R-RAPID_04 based on Best Professional Judgment (BPJ).

The majority of the landuse in segment SD-CH-R-RAPID_05 is agricultural with 86.3 percent pasture/range and 11.8 percent cropland. AnnAGNPS modeling estimated, the riparian zone contributes approximately 11.1 percent of the excess TSS load allocation, cropland residue management 25.7 percent and pasture/range 17.1 percent in segment SD-CH-R-RAPID_05. The remainder of the load allocation (41.1 percent) was allocated to in-channel loading through mass wasting, scouring, channel migration, and failing banks.

TSS exceedences in this watershed primarily occur from March through June, which generally represents the high-flow season (snow melt and spring rains). Based on the acute TSS TMDL, to achieve water quality standards during high-flow ($\geq$ 89 cfs) requires the current TSS load be reduced by 26 percent. Monitoring and modeling data indicate that TMDL attainment is achievable by implementing a wide variety of BMPs in segment SD-CH-R-RAPID_04 and in segment SD-CH-R-RAPID_05.

9.0 Public Participation

Six public meetings have been held. The first meeting, held February 15, 2001 at Pennington County 4H building (Rapid City), had a limited attendance (9) primarily due to bad weather conditions. The second meeting, held March 29, 2001 in the basement of the Caputa Community Center, was well attended (28) with good representation from the Lower Rapid Creek ranchers. The third meeting was held April 19, 2001 again at the Pennington County 4H building and had 8 in attendance. Two key issues that seem to reflect the meetings were the control of flows on Rapid Creek through the operation of Pactola Reservoir and the impacts of Rapid City on both the quality and quantity (both urban runoff and the Rapid City Waste Water Treatment Facility discharge). Several additional presentations have been given to present results of the study, March 29, 2001 in the basement of the Caputa Community Center, May 2001 to a work group session of the City of Rapid City Council, to the Pennington County Commission meeting May 2001 and most recently to a meeting of stake holders (City of Rapid City, Pennington Conservation District, Pennington County, SD DENR, Natural Resources Conservation Service) was held November 8, 2004. Several technical presentations have also been given to various groups including South Dakota Engineering Society, Agricultural Resource Services, SD Society of Environmental Professionals and Black Hills Hydrology Conference with special emphasis on septic tank and sediment (TSS) issues.

A significant component of this project has been collaboration with several agencies including the South Dakota GFP, Pennington County Conservation District, Natural Resource Conservation Service, Rapid Valley Water District, City of Rapid City, and Pennington County Commission. The SD GFP conducted an extensive monitoring program over the period April 2001-November 2001 and April 2002-November 2002. The focus of this work was on monitoring stormwater runoff events from the sub-urban segment through Rapid City.

From 2004 through 2006, the City of Rapid City and Pennington County held numerous public meetings to develop an On-Site Wastewater Disposal and Treatment Ordinance. In March 2006 the City of Rapid City approved Ordinance NO. 4083 that was added to Rapid City Municipal Code § 13.09. An additional (>30) public and committee meetings (public informational, clean water committee, planning commission, and county commission meetings) were held by the County to further develop the Pennington County On-Site Wastewater Treatment Ordinance. County ordinance 34-08 was approved and adopted in July 2010. The basis for these ordinances were partially due to the results from the Rapid Creek Fecal Coliform/*E. coli* Report and TMDL and Rapid Creek being listed on the 303(d) list as impaired for fecal coliform, *E. coli* and TSS. Assessment and TMDL data were used to emphasize the need for these ordinances as adaptive and proactive BMP measures to help reduce point and non-point source bacterial loading to Rapid Creek. Many BMPs for reducing bacteria in streams also reduce sediment loading such as buffers, filter strips, riparian zone improvement, etc.

In 2007, the original document was revised to include updated SD DENR WQM data sets and re-formatted for informal submittal to US EPA for review. The report and TMDL was submitted to US EPA in January 2008 with comments received in February 2008. After reviewing US EPA responses, SD DENR pulled the document from the submittal process due to significant alterations required to restructure the document to conform to US EPA comments and updated submittal requirements. The current document was significantly updated and modified in 2008 and 2009 and incorporates all US EPA informal comments originally received in 2008.

All comments and public input from meetings, written, or personal communications regarding the Rapid Creek report and TMDL results including current US EPA comments were addressed and incorporated in the current document. Specific responses to US EPA specific comments are attached in Appendix C.

In 2009, Rapid Creek TMDL data, sampling and analysis methodologies, and results were presented and discussed at multiple meetings with interested parties (SD DENR, Hill City, SDSM&; Pennington County, US Forest Service, RESPEC Consulting Services, City of Rapid City and interested stakeholders) during design and development of the Spring Creek Implementation Project.

This TMDL will be public noticed in the following newspapers: the Rapid City Journal, the Rapid City Native Sun News, and the New Underwood Post.

10.0 Monitoring Strategy

During and after the implementation of management practices, monitoring will be necessary to assure attainment of the TMDL. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations on Rapid Creek (WQM 92, DENR 460692 below RC WWTF and WQM 19, DENR 460910 near Farmingdale, SD), which are sampled on a monthly basis. Additional monitoring and evaluation efforts should be targeted toward the effectiveness of implemented BMPs. Monitoring locations should be based on the location and type of BMPs installed.

SD DENR may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that develop during the implementation phase of the TMDL. New information generated during TMDL implementation may include monitoring data, BMP effectiveness information and land use information. SD DENR 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. SD DENR will notify EPA of any adjustments to this TMDL within 30 days of their adoption. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation.

11.0 Reasonable Assurance

Reasonable assurance means a demonstration that the wasteload and load allocations will be realized through regulatory or voluntary actions. As mentioned previously, there are no point source dischargers in Rapid Creek segment SD-CH-R-RAPID_05 thus the wasteload allocation is zero and all reductions in TSS will come from non-point sources.

11.1. Non-Point Source

There are many active watershed groups that provide watershed stewardship and have vested interest in the Lower Rapid Creek watershed. These include the City of Rapid City, Rapid Valley Water District, Pennington County, South Dakota GFP, Pennington County Conservation District, Natural Resource Conservation Service, Black Hills Fly Fishers, Cheyenne River Watershed Partnership, South Dakota School of Mines and Technology, and the United States Geological Survey. These groups have supported the Lower Rapid Creek Assessment Project with comments, technical and/or financial support and are eager to plan and support an upcoming implementation project.

The City of Rapid City and Pennington County are committed to reducing non-point source TSS concentrations in Lower Rapid Creek. The past and present support from local governments and the substantial number of active watershed groups that support an implementation project in Lower Rapid Creek provides reasonable assurance non-point source reductions achieving TMDL targets and improved water quality will be achieved in Lower Rapid Creek watershed.

Reasonable assurance for non-point sources in segment SD-CH-R-RAPID_05 of Lower Rapid Creek will be accomplished through methods and projects outlined in Section 12.0 Restoration Strategy but are not exhaustive.

12.0 Restoration Strategy

Implementation of BMPs is required to achieve the recommended TMDL for segment SD-CH-R-RAPID_05 of Lower Rapid Creek. The study area is represented by one reach 1) above Farmingdale to the confluence with Cheyenne River (SD-CH-R-RAPID_05). As part of a comprehensive monitoring plan, BMPs that reduce TSS should be implemented within segment SD-CH-R-RAPID_04, to improve and support work being done in segment SD-CH-R-RAPID_05. BMPs that reduce TSS loads within segment SD-CH-R-RAPID_04 should include but are not limited to:

- relocation or implementation of stormwater runoff,
- implement management practices to improve and protect the riparian buffer zone through grazing management practices with off-stream watering and residential zoning, and
- development and implementation of a stormwater management program with BMPs designed to treat runoff from rainfall events up to 0.5 inches.

For segment SD-CH-R-RAPID_05, reductions in TSS will take place with implementation of BMPs upstream and should include but are not limited to:

- implement management practices to improve and protect the riparian buffer zone through grazing management practices with off-stream watering and vegetation development,
- cropland residue management with reduced tillage
- riparian and stream bank erosion control measures, and
- development of cattle crossing areas for reduced stream access and erosion,

Sufficient sample data to evaluate the 30-day average criterion were unavailable. Increased TSS sampling during the year should be initiated to attain more than three TSS samples per site per month to monitor attainment of the chronic standard.

The Lower Cheyenne River Watershed Assessment Project nearing completion and broad support to begin an implementation project is evident. Rapid Creek is part of the Cheyenne River watershed and could be included in a larger, basin-wide implementation project. Major entities that should be involved in planning, funding and supporting this project as it pertains to Rapid Creek are the West Dakota Water Development District, Pennington County, Pennington County Conservation District, the City of Rapid City, Cheyenne River Partnership and the Natural Resource Conservation Service. In 2010, the Pennington County Conservation District has expressed interest in sponsoring a Lower Rapid Creek Implementation Project.

Funds to implement watershed water quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Non-point Source Program.

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APPENDIX A: Total Suspended Solids Sample Data

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
05/11/1970	290	700	mg/L	Total suspended solids	WQM Ambient
05/22/1973	114	75	mg/L	Total suspended solids	WQM Ambient
09/18/1973	59	91	mg/L	Total suspended solids	WQM Ambient
11/12/1973	58	23	mg/L	Total suspended solids	WQM Ambient
11/20/1973	45	91	mg/L	Total suspended solids	WQM Ambient
04/02/1974	42	15	mg/L	Total suspended solids	WQM Ambient
05/01/1974	10	37	mg/L	Total suspended solids	WQM Ambient
06/06/1974	6.6	77	mg/L	Total suspended solids	WQM Ambient
08/19/1974	19	62	mg/L	Total suspended solids	WQM Ambient
09/30/1974	25	19	mg/L	Total suspended solids	WQM Ambient
10/28/1974	26	27	mg/L	Total suspended solids	WQM Ambient
11/25/1974	35	16	mg/L	Total suspended solids	WQM Ambient
12/16/1974	44	5	mg/L	Total suspended solids	WQM Ambient
01/15/1975	35	19	mg/L	Total suspended solids	WQM Ambient
03/13/1975	33	17	mg/L	Total suspended solids	WQM Ambient
04/23/1975	51	134	mg/L	Total suspended solids	WQM Ambient
05/27/1975	65	114	mg/L	Total suspended solids	WQM Ambient
06/25/1975	72	165	mg/L	Total suspended solids	WQM Ambient
07/24/1975	38	68	mg/L	Total suspended solids	WQM Ambient
08/19/1975	29	70	mg/L	Total suspended solids	WQM Ambient
09/24/1975	11	37	mg/L	Total suspended solids	WQM Ambient
10/28/1975	34	35	mg/L	Total suspended solids	WQM Ambient
11/18/1975	41	45	mg/L	Total suspended solids	WQM Ambient
12/17/1975	35	24	mg/L	Total suspended solids	WQM Ambient
01/12/1976	43	39	mg/L	Total suspended solids	WQM Ambient
02/12/1976	48	36	mg/L	Total suspended solids	WQM Ambient
03/29/1976	39	33	mg/L	Total suspended solids	WQM Ambient
04/12/1976	35	58	mg/L	Total suspended solids	WQM Ambient
05/11/1976	16	34	mg/L	Total suspended solids	WQM Ambient
06/22/1976	308	479	mg/L	Total suspended solids	WQM Ambient
07/14/1976	40	53	mg/L	Total suspended solids	WQM Ambient
08/24/1976	16	49	mg/L	Total suspended solids	WQM Ambient
09/29/1976	30	18	mg/L	Total suspended solids	WQM Ambient
10/26/1976	44	18	mg/L	Total suspended solids	WQM Ambient
11/22/1976	51	26	mg/L	Total suspended solids	WQM Ambient
01/12/1977	37	16	mg/L	Total suspended solids	WQM Ambient
02/08/1977	46	26	mg/L	Total suspended solids	WQM Ambient
03/16/1977	59	8	mg/L	Total suspended solids	WQM Ambient
04/11/1977	258	463	mg/L	Total suspended solids	WQM Ambient
05/23/1977	96	27	mg/L	Total suspended solids	WQM Ambient
06/29/1977	29	62	mg/L	Total suspended solids	WQM Ambient
07/26/1977	33	32	mg/L	Total suspended solids	WQM Ambient
08/23/1977	9	61	mg/L	Total suspended solids	WQM Ambient
09/26/1977	41	66	mg/L	Total suspended solids	WQM Ambient
10/05/1977	41	140	mg/L	Total suspended solids	WQM Ambient
11/08/1977	44	41	mg/L	Total suspended solids	WQM Ambient
12/19/1977	40	14	mg/L	Total suspended solids	WQM Ambient
01/09/1978	27	19	mg/L	Total suspended solids	WQM Ambient
02/22/1978	40	31	mg/L	Total suspended solids	WQM Ambient
03/08/1978	90	26	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
04/05/1978	44	49	mg/L	Total suspended solids	WQM Ambient
05/01/1978	98	370	mg/L	Total suspended solids	WQM Ambient
06/06/1978	334	515	mg/L	Total suspended solids	WQM Ambient
07/10/1978	66	128	mg/L	Total suspended solids	WQM Ambient
08/08/1978	27	39	mg/L	Total suspended solids	WQM Ambient
09/06/1978	15	48	mg/L	Total suspended solids	WQM Ambient
10/03/1978	32	1	mg/L	Total suspended solids	WQM Ambient
11/08/1978	43	7	mg/L	Total suspended solids	WQM Ambient
12/07/1978	49	32	mg/L	Total suspended solids	WQM Ambient
01/04/1979	27	17	mg/L	Total suspended solids	WQM Ambient
02/07/1979	44	10	mg/L	Total suspended solids	WQM Ambient
03/06/1979	80	30	mg/L	Total suspended solids	WQM Ambient
04/04/1979	90	1350	mg/L	Total suspended solids	WQM Ambient
05/08/1979	10	25	mg/L	Total suspended solids	WQM Ambient
06/06/1979	8	48	mg/L	Total suspended solids	WQM Ambient
07/05/1979	127	905	mg/L	Total suspended solids	WQM Ambient
08/07/1979	55	148	mg/L	Total suspended solids	WQM Ambient
09/17/1979	17	25	mg/L	Total suspended solids	WQM Ambient
10/03/1979	19	22	mg/L	Total suspended solids	WQM Ambient
11/05/1979	46	26	mg/L	Total suspended solids	WQM Ambient
12/12/1979	33	22	mg/L	Total suspended solids	WQM Ambient
01/08/1980	42	14	mg/L	Total suspended solids	WQM Ambient
02/04/1980	44	12	mg/L	Total suspended solids	WQM Ambient
03/05/1980	40	16	mg/L	Total suspended solids	WQM Ambient
04/02/1980	52	44	mg/L	Total suspended solids	WQM Ambient
05/07/1980	23	69	mg/L	Total suspended solids	WQM Ambient
06/03/1980	38	336	mg/L	Total suspended solids	WQM Ambient
07/02/1980	23	97	mg/L	Total suspended solids	WQM Ambient
08/06/1980	20	123	mg/L	Total suspended solids	WQM Ambient
09/10/1980	19	23	mg/L	Total suspended solids	WQM Ambient
10/08/1980	8.6	43	mg/L	Total suspended solids	WQM Ambient
12/11/1980	32	25	mg/L	Total suspended solids	WQM Ambient
01/07/1981	33	17	mg/L	Total suspended solids	WQM Ambient
02/03/1981	30	13	mg/L	Total suspended solids	WQM Ambient
03/06/1981	35	21	mg/L	Total suspended solids	WQM Ambient
04/08/1981	24	30	mg/L	Total suspended solids	WQM Ambient
05/14/1981	6.2	21	mg/L	Total suspended solids	WQM Ambient
06/22/1981	15	45	mg/L	Total suspended solids	WQM Ambient
07/08/1981	12	64	mg/L	Total suspended solids	WQM Ambient
11/04/1981	31	30	mg/L	Total suspended solids	WQM Ambient
04/07/1982	45	19	mg/L	Total suspended solids	WQM Ambient
05/06/1982	9.9	2	mg/L	Total suspended solids	WQM Ambient
06/16/1982	139	500	mg/L	Total suspended solids	WQM Ambient
07/15/1982	107	195	mg/L	Total suspended solids	WQM Ambient
08/19/1982	140	75	mg/L	Total suspended solids	WQM Ambient
09/09/1982	92	85	mg/L	Total suspended solids	WQM Ambient
10/21/1982	124	660	mg/L	Total suspended solids	WQM Ambient
11/02/1982	82	6	mg/L	Total suspended solids	WQM Ambient
12/16/1982	74	8	mg/L	Total suspended solids	WQM Ambient
01/06/1983	64	8	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
02/03/1983	43	2	mg/L	Total suspended solids	WQM Ambient
04/14/1983	125	73	mg/L	Total suspended solids	WQM Ambient
05/18/1983	241	171	mg/L	Total suspended solids	WQM Ambient
06/09/1983	14	26	mg/L	Total suspended solids	WQM Ambient
07/13/1983	26	46	mg/L	Total suspended solids	WQM Ambient
08/04/1983	31	86	mg/L	Total suspended solids	WQM Ambient
10/06/1983	38	11	mg/L	Total suspended solids	WQM Ambient
12/08/1983	43	7	mg/L	Total suspended solids	WQM Ambient
01/05/1984	75	4	mg/L	Total suspended solids	WQM Ambient
02/08/1984	140	17	mg/L	Total suspended solids	WQM Ambient
03/08/1984	49	12	mg/L	Total suspended solids	WQM Ambient
04/11/1984	88	131	mg/L	Total suspended solids	WQM Ambient
05/10/1984	206	460	mg/L	Total suspended solids	WQM Ambient
07/10/1984	128	102	mg/L	Total suspended solids	WQM Ambient
08/08/1984	9.4	71	mg/L	Total suspended solids	WQM Ambient
09/14/1984	28	26	mg/L	Total suspended solids	WQM Ambient
10/01/1984	58	6	mg/L	Total suspended solids	WQM Ambient
11/14/1984	65	11	mg/L	Total suspended solids	WQM Ambient
12/05/1984	63	6	mg/L	Total suspended solids	WQM Ambient
01/08/1985	63	4	mg/L	Total suspended solids	WQM Ambient
02/07/1985	29	9	mg/L	Total suspended solids	WQM Ambient
03/14/1985	100	15	mg/L	Total suspended solids	WQM Ambient
04/02/1985	118	121	mg/L	Total suspended solids	WQM Ambient
05/08/1985	6.3	49	mg/L	Total suspended solids	WQM Ambient
06/11/1985	62	349	mg/L	Total suspended solids	WQM Ambient
07/18/1985	21	125	mg/L	Total suspended solids	WQM Ambient
09/03/1985	20	66	mg/L	Total suspended solids	WQM Ambient
10/17/1985	36	33	mg/L	Total suspended solids	WQM Ambient
11/06/1985	50	32	mg/L	Total suspended solids	WQM Ambient
12/09/1985	42	12	mg/L	Total suspended solids	WQM Ambient
01/09/1986	47	12	mg/L	Total suspended solids	WQM Ambient
02/21/1986	46	7	mg/L	Total suspended solids	WQM Ambient
03/26/1986	56	23	mg/L	Total suspended solids	WQM Ambient
04/09/1986	70	71	mg/L	Total suspended solids	WQM Ambient
05/06/1986	62	32	mg/L	Total suspended solids	WQM Ambient
06/04/1986	17	24	mg/L	Total suspended solids	WQM Ambient
08/13/1986	171	944	mg/L	Total suspended solids	WQM Ambient
09/24/1986	68	79	mg/L	Total suspended solids	WQM Ambient
10/22/1986	77	39	mg/L	Total suspended solids	WQM Ambient
11/06/1986	113	23	mg/L	Total suspended solids	WQM Ambient
12/03/1986	77	9	mg/L	Total suspended solids	WQM Ambient
01/06/1987	50	550	mg/L	Total suspended solids	WQM Ambient
02/04/1987	60	12	mg/L	Total suspended solids	WQM Ambient
03/05/1987	96	24	mg/L	Total suspended solids	WQM Ambient
04/08/1987	108	40	mg/L	Total suspended solids	WQM Ambient
05/14/1987	38	59	mg/L	Total suspended solids	WQM Ambient
06/10/1987	99	176	mg/L	Total suspended solids	WQM Ambient
07/16/1987	11	35	mg/L	Total suspended solids	WQM Ambient
08/12/1987	34	150	mg/L	Total suspended solids	WQM Ambient
09/03/1987	31	41	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
10/28/1987	26	9	mg/L	Total suspended solids	WQM Ambient
11/04/1987	34	10	mg/L	Total suspended solids	WQM Ambient
12/01/1987	41	22	mg/L	Total suspended solids	WQM Ambient
01/19/1988	15	3	mg/L	Total suspended solids	WQM Ambient
02/16/1988	15	7	mg/L	Total suspended solids	WQM Ambient
03/10/1988	10	8	mg/L	Total suspended solids	WQM Ambient
04/21/1988	19	59	mg/L	Total suspended solids	WQM Ambient
05/25/1988	16	136	mg/L	Total suspended solids	WQM Ambient
06/07/1988	18	69	mg/L	Total suspended solids	WQM Ambient
07/11/1988	16	196	mg/L	Total suspended solids	WQM Ambient
08/22/1988	6.2	55	mg/L	Total suspended solids	WQM Ambient
09/12/1988	15	38	mg/L	Total suspended solids	WQM Ambient
10/19/1988	34	19	mg/L	Total suspended solids	WQM Ambient
11/09/1988	34	11	mg/L	Total suspended solids	WQM Ambient
10/27/1993	67	13	mg/L	Total suspended solids	WQM Ambient
01/09/1995	52	9	mg/L	Total suspended solids	WQM Ambient
02/23/1995	60	25	mg/L	Total suspended solids	WQM Ambient
03/16/1995	59	30	mg/L	Total suspended solids	WQM Ambient
04/18/1995	70	51	mg/L	Total suspended solids	WQM Ambient
05/11/1995	549	550	mg/L	Total suspended solids	WQM Ambient
06/22/1995	632	310	mg/L	Total suspended solids	WQM Ambient
07/12/1995	132	133	mg/L	Total suspended solids	WQM Ambient
08/23/1995	64	54	mg/L	Total suspended solids	WQM Ambient
09/28/1995	57	2	mg/L	Total suspended solids	WQM Ambient
10/27/1995	62	18	mg/L	Total suspended solids	WQM Ambient
11/28/1995	62	12	mg/L	Total suspended solids	WQM Ambient
12/13/1995	60	4	mg/L	Total suspended solids	WQM Ambient
01/11/1996	71	8	mg/L	Total suspended solids	WQM Ambient
02/20/1996	86	15	mg/L	Total suspended solids	WQM Ambient
04/08/1996	129	70	mg/L	Total suspended solids	WQM Ambient
07/23/1996	73	82	mg/L	Total suspended solids	WQM Ambient
10/25/1996	108	26	mg/L	Total suspended solids	WQM Ambient
01/23/1997	159	15	mg/L	Total suspended solids	WQM Ambient
04/16/1997	260	192	mg/L	Total suspended solids	WQM Ambient
07/28/1997	254	232	mg/L	Total suspended solids	WQM Ambient
10/23/1997	117	21	mg/L	Total suspended solids	WQM Ambient
01/22/1998	96	5	mg/L	Total suspended solids	WQM Ambient
04/16/1998	237	79	mg/L	Total suspended solids	WQM Ambient
07/16/1998	252	180	mg/L	Total suspended solids	WQM Ambient
10/21/1998	280	92	mg/L	Total suspended solids	WQM Ambient
01/15/1999	140	28	mg/L	Total suspended solids	WQM Ambient
02/09/1999	131	30	mg/L	Total suspended solids	WQM Ambient
03/29/1999	157	72	mg/L	Total suspended solids	WQM Ambient
04/27/1999	570	366	mg/L	Total suspended solids	WQM Ambient
05/20/1999	396	194	mg/L	Total suspended solids	WQM Ambient
06/21/1999	639	308	mg/L	Total suspended solids	WQM Ambient
07/19/1999	205	174	mg/L	Total suspended solids	WQM Ambient
08/10/1999	177	64	mg/L	Total suspended solids	WQM Ambient
09/02/1999	166	79	mg/L	Total suspended solids	Assessment
09/23/1999	82	24	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
10/07/1999	77	18	mg/L	Total suspended solids	Assessment
10/12/1999	64	12	mg/L	Total suspended solids	WQM Ambient
10/27/1999	63	6	mg/L	Total suspended solids	Assessment
11/09/1999	70	10	mg/L	Total suspended solids	WQM Ambient
11/18/1999	75	23	mg/L	Total suspended solids	Assessment
12/09/1999	120	17	mg/L	Total suspended solids	WQM Ambient
12/14/1999	104	22	mg/L	Total suspended solids	Assessment
01/05/2000	118	34	mg/L	Total suspended solids	Assessment
01/10/2000	110	7	mg/L	Total suspended solids	WQM Ambient
02/01/2000	100	7	mg/L	Total suspended solids	Assessment
02/23/2000	92	33	mg/L	Total suspended solids	WQM Ambient
02/29/2000	98	50	mg/L	Total suspended solids	Assessment
03/13/2000	120	64	mg/L	Total suspended solids	WQM Ambient
03/28/2000	99	37	mg/L	Total suspended solids	Assessment
04/10/2000	108	64	mg/L	Total suspended solids	WQM Ambient
04/21/2000	421	776	mg/L	Total suspended solids	Assessment
04/25/2000	1070	764	mg/L	Total suspended solids	Assessment
05/09/2000	221	114	mg/L	Total suspended solids	Assessment
05/24/2000	203	124	mg/L	Total suspended solids	WQM Ambient
06/28/2000	140	122	mg/L	Total suspended solids	Assessment
06/29/2000	116	93	mg/L	Total suspended solids	WQM Ambient
07/20/2000	82	80	mg/L	Total suspended solids	WQM Ambient
08/03/2000	99	79	mg/L	Total suspended solids	Assessment
08/12/2000	23	30	mg/L	Total suspended solids	Assessment
08/22/2000	38	60	mg/L	Total suspended solids	WQM Ambient
08/31/2000	37	53	mg/L	Total suspended solids	Assessment
09/28/2000	43	21	mg/L	Total suspended solids	WQM Ambient
10/18/2000	59	26	mg/L	Total suspended solids	WQM Ambient
11/01/2000	117	120	mg/L	Total suspended solids	Assessment
11/20/2000	88	9	mg/L	Total suspended solids	WQM Ambient
12/07/2000	86	15	mg/L	Total suspended solids	WQM Ambient
01/18/2001	71	11	mg/L	Total suspended solids	WQM Ambient
02/15/2001	70	9	mg/L	Total suspended solids	WQM Ambient
03/22/2001	91	34	mg/L	Total suspended solids	WQM Ambient
04/18/2001	143	66	mg/L	Total suspended solids	WQM Ambient
05/22/2001	67	65	mg/L	Total suspended solids	WQM Ambient
06/14/2001	140	280	mg/L	Total suspended solids	WQM Ambient
07/10/2001	27	79	mg/L	Total suspended solids	WQM Ambient
08/28/2001	28	71	mg/L	Total suspended solids	WQM Ambient
09/25/2001	46	20	mg/L	Total suspended solids	WQM Ambient
10/31/2001	53	28	mg/L	Total suspended solids	WQM Ambient
11/19/2001	58	17	mg/L	Total suspended solids	WQM Ambient
12/06/2001	62	14	mg/L	Total suspended solids	WQM Ambient
01/07/2002	70	19	mg/L	Total suspended solids	WQM Ambient
02/19/2002	68	12	mg/L	Total suspended solids	WQM Ambient
03/12/2002	80	16	mg/L	Total suspended solids	WQM Ambient
04/17/2002	65	94	mg/L	Total suspended solids	WQM Ambient
05/20/2002	81	150	mg/L	Total suspended solids	WQM Ambient
06/19/2002	10	37	mg/L	Total suspended solids	WQM Ambient
07/22/2002	116	400	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
08/19/2002	13	21	mg/L	Total suspended solids	WQM Ambient
09/18/2002	46	140	mg/L	Total suspended solids	WQM Ambient
11/04/2002	58	36	mg/L	Total suspended solids	WQM Ambient
12/12/2002	50	6	mg/L	Total suspended solids	WQM Ambient
01/21/2003	51	8	mg/L	Total suspended solids	WQM Ambient
02/27/2003	49	160	mg/L	Total suspended solids	WQM Ambient
03/20/2003	94	170	mg/L	Total suspended solids	WQM Ambient
04/23/2003	50	77	mg/L	Total suspended solids	WQM Ambient
05/15/2003	46	130	mg/L	Total suspended solids	WQM Ambient
06/11/2003	44	68	mg/L	Total suspended solids	WQM Ambient
07/14/2003	16	98	mg/L	Total suspended solids	WQM Ambient
08/25/2003	15	50	mg/L	Total suspended solids	WQM Ambient
09/18/2003	33	25	mg/L	Total suspended solids	WQM Ambient
10/09/2003	16	23	mg/L	Total suspended solids	WQM Ambient
11/20/2003	45	6	mg/L	Total suspended solids	WQM Ambient
12/18/2003	48	7	mg/L	Total suspended solids	WQM Ambient
01/22/2004	47	6	mg/L	Total suspended solids	WQM Ambient
02/23/2004	50	10	mg/L	Total suspended solids	WQM Ambient
03/17/2004	56	23	mg/L	Total suspended solids	WQM Ambient
04/21/2004	13	78	mg/L	Total suspended solids	WQM Ambient
05/17/2004	44	140	mg/L	Total suspended solids	WQM Ambient
06/15/2004	30	52	mg/L	Total suspended solids	WQM Ambient
07/15/2004	6.4	70	mg/L	Total suspended solids	WQM Ambient
08/25/2004	17	130	mg/L	Total suspended solids	WQM Ambient
09/16/2004	33	140	mg/L	Total suspended solids	WQM Ambient
10/20/2004	31	18	mg/L	Total suspended solids	WQM Ambient
12/09/2004	42	6	mg/L	Total suspended solids	WQM Ambient
01/20/2005	61	17	mg/L	Total suspended solids	WQM Ambient
02/14/2005	42	16	mg/L	Total suspended solids	WQM Ambient
03/21/2005	44	7	mg/L	Total suspended solids	WQM Ambient
04/13/2005	22	12	mg/L	Total suspended solids	WQM Ambient
05/25/2005	13	110	mg/L	Total suspended solids	WQM Ambient
06/23/2005	18	70	mg/L	Total suspended solids	WQM Ambient
07/20/2005	6.3	140	mg/L	Total suspended solids	WQM Ambient
08/18/2005	8.3	50	mg/L	Total suspended solids	WQM Ambient
09/22/2005	9.5	55	mg/L	Total suspended solids	WQM Ambient
10/20/2005	25	50	mg/L	Total suspended solids	WQM Ambient
11/10/2005	40	10	mg/L	Total suspended solids	WQM Ambient
12/14/2005	38	5	mg/L	Total suspended solids	WQM Ambient
01/17/2006	49	7	mg/L	Total suspended solids	WQM Ambient
02/28/2006	45	6	mg/L	Total suspended solids	WQM Ambient
04/11/2006	46	87	mg/L	Total suspended solids	WQM Ambient
05/23/2006	16	36	mg/L	Total suspended solids	WQM Ambient
06/22/2006	16	140	mg/L	Total suspended solids	WQM Ambient
07/27/2006	13	110	mg/L	Total suspended solids	WQM Ambient
08/17/2006	18	160	mg/L	Total suspended solids	WQM Ambient
09/25/2006	37	100	mg/L	Total suspended solids	WQM Ambient
10/19/2006	37	7	mg/L	Total suspended solids	WQM Ambient
11/13/2006	53	15	mg/L	Total suspended solids	WQM Ambient
01/16/2007	34	7	mg/L	Total suspended solids	WQM Ambient

Sample Date	Flow (cfs)	TSS	Units	Parameter	Project
03/19/2007	39	63	mg/L	Total suspended solids	WQM Ambient
04/11/2007	35	15	mg/L	Total suspended solids	WQM Ambient
05/07/2007	98	260	mg/L	Total suspended solids	WQM Ambient
05/22/2007	40	170	mg/L	Total suspended solids	Lower Cheyenne
05/29/2007	172	780	mg/L	Total suspended solids	Lower Cheyenne
06/12/2007	21	85	mg/L	Total suspended solids	Lower Cheyenne
06/21/2007	3.7	29	mg/L	Total suspended solids	WQM Ambient
07/17/2007	4.6	60	mg/L	Total suspended solids	WQM Ambient
07/27/2007	119	440	mg/L	Total suspended solids	Lower Cheyenne
08/18/2007	508	1500	mg/L	Total suspended solids	Lower Cheyenne
08/23/2007	38	160	mg/L	Total suspended solids	WQM Ambient
09/11/2007	26	76	mg/L	Total suspended solids	WQM Ambient
10/15/2007	39	45	mg/L	Total suspended solids	Lower Cheyenne
11/19/2007	35	10	mg/L	Total suspended solids	WQM Ambient
12/13/2007	15	8	mg/L	Total suspended solids	WQM Ambient
03/12/2008	50	9	mg/L	Total suspended solids	WQM Ambient
04/22/2008	19	12	mg/L	Total suspended solids	WQM Ambient
05/04/2008	238	290	mg/L	Total suspended solids	Lower Cheyenne
05/19/2008	22	54	mg/L	Total suspended solids	WQM Ambient
06/03/2008	224	9600	mg/L	Total suspended solids	Lower Cheyenne
06/11/2008	128	160	mg/L	Total suspended solids	WQM Ambient
06/17/2008	140	82	mg/L	Total suspended solids	Lower Cheyenne
07/08/2008	94	200	mg/L	Total suspended solids	WQM Ambient
07/24/2008	149	370	mg/L	Total suspended solids	Lower Cheyenne
08/10/2008	19	80	mg/L	Total suspended solids	Lower Cheyenne
08/21/2008	25	52	mg/L	Total suspended solids	WQM Ambient
09/24/2008	30	15	mg/L	Total suspended solids	WQM Ambient
10/22/2008	48	17	mg/L	Total suspended solids	WQM Ambient
11/17/2008	71	22	mg/L	Total suspended solids	WQM Ambient
12/10/2008	42	29	mg/L	Total suspended solids	WQM Ambient
02/26/2009	34	12	mg/L	Total suspended solids	WQM Ambient
03/19/2009	50	7	mg/L	Total suspended solids	WQM Ambient
04/13/2009	420	380	mg/L	Total suspended solids	Lower Cheyenne
04/15/2009	350	260	mg/L	Total suspended solids	WQM Ambient
04/23/2009	296	260	mg/L	Total suspended solids	Lower Cheyenne
05/14/2009	166	110	mg/L	Total suspended solids	WQM Ambient
05/25/2009	134	140	mg/L	Total suspended solids	Lower Cheyenne
06/24/2009	94	130	mg/L	Total suspended solids	WQM Ambient
07/21/2009	36	23	mg/L	Total suspended solids	WQM Ambient
08/13/2009	42	46	mg/L	Total suspended solids	WQM Ambient
09/09/2009	19	49	mg/L	Total suspended solids	WQM Ambient
10/27/2009	62	14	mg/L	Total suspended solids	WQM Ambient
11/12/2009	59	11	mg/L	Total suspended solids	WQM Ambient
12/14/2009	16	11	mg/L	Total suspended solids	WQM Ambient
03/22/2010	78	31	mg/L	Total suspended solids	WQM Ambient
04/14/2010	79	52	mg/L	Total suspended solids	WQM Ambient
05/26/2010	844	620	mg/L	Total suspended solids	WQM Ambient
06/16/2010	452	200	mg/L	Total suspended solids	WQM Ambient
07/21/2010	109	120	mg/L	Total suspended solids	WQM Ambient
08/10/2010	98	160	mg/L	Total suspended solids	WQM Ambient
09/20/2010	62	22	mg/L	Total suspended solids	WQM Ambient

APPENDIX B: AnnAGNPS Watershed Map

Figure B-1. AnnAGNPS watershed and cell distribution for Lower Rapid Creek 2011.

APPENDIX C: Public Comments

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

RECEIVED
OCT 3 2011
DEPT. OF ENVIRONMENT AND NATURAL RESOURCES, SECRETARY'S OFFICE

Ref: 8EPR-EP

SEP 27 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
Rapid Creek, Segment 5, Total Suspended Solids;
SD-CH-R-RAPID_05

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

Total Suspended Solids Total Maximum Daily Load (TMDL) for Lower Rapid Creek, Pennington County, South Dakota (SD DENR, August 2011)

Submitted: 8/25/2011

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

Segment: Rapid Creek from above Farmingdale to its confluence with the Cheyenne River

303(d) ID: SD-CH-R-RAPID 05

Parameter/Pollutant (303(d) list cause): TOTAL SUSPENDED SOLIDS - 518

Water Quality Targets: <= 90 mg/L

Allocation*	Value	Units	Permits
WLA	0	KG/DAY	
LA	145811	KG/DAY	
TMDL	215005	KG/DAY	
MOS	69194	KG/DAY	

Notes: The loads shown represent the loads during the high flow regime as defined by the load duration curve for Rapid Creek, Segment 5 (see Figure 5 of the TMDL). The high flows are when the largest differences occur between the existing load and the target load, therefore the greatest load reduction is needed to meet the water quality standards.

* 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:	**Total Suspended Solids Total Maximum Daily Load (TMDL) for Lower Rapid Creek, Pennington County, South Dakota**
Submitted by:	**Rich Hanson, SD DENR**
Date Received:	**August 25, 2011**
Review Date:	**September 20, 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: Based on the review presented below, I recommend approval of the TMDL submitted in this document.

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 final Rapid Creek, Segment 5, total suspended solids (TSS) TMDL was submitted to EPA for review and approval via an email from Rich Hanson, SD DENR on August 25, 2011. The email included the final TMDL document and a letter requesting approval of the TMDL.

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: Rapid Creek is perennial stream located in western South Dakota in Lawrence and Pennington Counties. The Rapid Creek watershed is part of the larger Cheyenne River basin in the Rapid sub-basin (HUC 10120110). Rapid Creek has a total drainage area of approximately 460,000 acres (718 square miles) in South Dakota. This TMDL document covers one of the listed segments of Rapid Creek from above Farmingdale to the mouth at its confluence with the Cheyenne River (26.6 miles; SD-CH-R-RAPID_05), which drains approximately 83,334 acres. The segment is listed as high priority for TMDL development.

The designated uses for Segment 5 of Rapid Creek include warmwater permanent fish life propagation waters, immersion recreation waters, limited contact recreation waters, irrigation, fish and wildlife propagation, recreation, and stock watering. This segment was listed in 2010 for total suspended solids (TSS) which is impairing the warmwater permanent fish life propagation use, and for fecal coliform and E. coli which are impairing the recreational uses. EPA approved South Dakota's TMDLs for fecal coliform and E. coli for Segment 5 of Rapid Creek in September 2010. This TMDL document only addresses the TSS impairment.

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 Rapid Creek segment addressed by this TMDL is impaired based on the available total suspended solids (TSS) data which are exceeding the water quality standards set to protect the warmwater permanent fish life propagation beneficial use. South Dakota has applicable numeric standards for TSS that are applicable to this stream segment. The numeric standards being implemented in this TMDL are: a daily maximum value of TSS of 158 mg/L in any one sample, or an arithmetic mean of 90 mg/L over a 30 day period. Discussion of additional applicable water quality standards for Rapid Creek, Segment 5, can be found on pages 5 - 8 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 TSS established to protect the warmwater semi permanent fish life propagation beneficial use for Segment 5 of Rapid Creek. The TSS TMDL target for the impaired stream segment is: $\leq$ 90 mg/L. While the standard is intended to be expressed as the 30-day average, 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 (average of 3 samples) standard.

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 lower Rapid Creek watershed as predominately agricultural consisting of herbaceous rangeland (61%), cropland and pastureland (24%), developed/urban (7%), riparian (6%) and barren or water (2%).

There are no point source discharges within Segment 5 of the Rapid Creek watershed.

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of TSS within segment SD-CH-R-RAPID_05 of Rapid Creek include agricultural pasture and range sources. Using the best available information, loadings were estimated from each of these sources using the Annualized Agricultural Non-Point Source model (AnnAGNPS).

Livestock are a potential source of TSS to streams. Livestock in the basin are predominantly beef cattle. Livestock may contribute to TSS load in Lower Rapid Creek by directly wading in the stream or indirectly by trampling or grazing vegetation creating increased sheet and rill erosion and bank failure by accessing streams for water. Both the indirect and direct sources of TSS loads from livestock and riparian condition were represented in the modeling application by representing buffers along the main channel.

Stream bed and bank scour, erosion and mass wasting may result from the change in flow duration, frequency and magnitude in the lower reaches of the stream segment during and after storm events. In a study on the impact of increases in impervious area, Coon showed that the magnitude (peak) of runoff from 2 year through 10 year rainfall events increased 600 % and 71 %, respectively. The increase in magnitude and frequency of stormwater runoff has increased scour and bank erosion in the lower reaches of Rapid Creek. Portions of Rapid Creek, Segment 5, have laterally migrated up against bluffs composed of Pierre Shale formation known to have bank failures, sloughing, and mass wasting.

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 TMDL technical analysis for Segment 5 of Rapid Creek describes how the TSS loads were derived in order to meet the applicable water quality standards.

A combination of AnnAGNPS modeling along with load duration curves (LDCs) were used as part of the technical analysis for the Rapid Creek, Segment 5, TSS TMDL. Sediment and nutrient impacts on the surface water quality of the Rapid Creek watershed were evaluated through the use of the Annualized Agricultural Nonpoint Source runoff model. The AnnAGNPS watershed calibration process used annual USGS data from station 06421500 on Rapid Creek near Farmingdale, SD. It is located in the middle portion of Segment 5 of Rapid Creek. After calibration, BMPs were simulated by altering land uses of individual cells with greater loading potential and reductions were calculated at the outlet to the watershed.

Average daily flow data from the gage station within the segment was used to develop the flow duration curve for Rapid Creek, Segment 5. The stream flow monitoring site in this segment had an excellent long-term USGS monitoring site data set with 50 years of flow data.

The TMDL was developed using the LDC approach, resulting in flow variable targets that consider the entire flow regime. The LDC is a dynamic expression of the allowable load for any given day based on flow. Typically, the LDC flow intervals were grouped into five flow zones: high flows (0–10%), moist conditions (10–40%), mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%) based on EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs*. Due to TSS load exceedences in the high and upper portions of the moist flow zones, the LDC flow intervals for Rapid Creek were modified to represent TSS loading characteristics unique to Segment 5. The adjusted the high and moist flow zone percentages are: high flows (0–20%) and moist conditions (20–40%).

Acute and chronic LDCs were derived by multiplying the water quality standard for TSS by the USGS Rapid Creek monitoring site flow calculated for the period of record for the segment. These curves represent site specific acute and chronic TMDLs based on any flow and were used to determine TMDL compliance based on flow. When the instantaneous loads are plotted on the LDC, characteristics of the water quality impairment are shown in each segment. Instantaneous loads that plot above the curve are exceeding the TMDL, while those below the curve are in compliance. As the LDC plot shows, TSS samples collected from Segment 5 of Rapid Creek exceed the acute and chronic TSS criteria mostly during the high flow conditions where flow frequencies rank between 0 – 20 percent (see Figure 5 of the TMDL document).

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 Rapid Creek, Segment 5 TMDL data description and summary are included mainly in the Technical Analysis section of the document and are plotted on the load duration curve. The full dataset is included in Appendix A of the TMDL document. SD DENR has collected TSS samples at various locations along Rapid Creek for many years including at WQM 19 near Farmingdale, SD. Additional data was collected within the segment from 2007 through 2009 as part of the Lower Cheyenne River assessment project. The full dataset was used to assess the TSS loading to Segment 5 of Rapid Creek. A total of 321 TSS samples have been collected at WQM 19 from 1970 through 2010. The dataset for this TMDL also includes approximately 50 years of flow data collected by the USGS at station 06421500.

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: There are no point source discharges to Segment 5 of Rapid Creek. However, the Rapid City WWTF discharges into Segment 4 which is 26 miles upstream of Segment 5. Ambient surface water quality samples collected below the Rapid City WWTF since 1979 indicate that only six samples (1.9 percent) exceeded water quality standards for TSS. Based on this data, SD DENR concluded that the point source TSS load originating from the Rapid City WWTF does not significantly impact Segment 5. Therefore, the WLA for Rapid Creek, Segment 5, is zero.

COMMENTS: None.

4.3 Load Allocations (LA):

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

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 TMDL Section explains how the loading capacities and load allocations were derived for each flow regime shown in the LDC. Since the majority of the source loads in the watershed comes from agricultural nonpoint sources, the majority of the loading capacity has been allocated to the nonpoint sources in the form of load allocations. Tables 12 and 13 in the TMDL document show the load allocations for each of the five flow regimes for Segment 5 of Rapid Creek.

To develop TSS load allocations (LAs), the loading capacities (LCs) were first determined. The TSS daily maximum (acute) criterion (158 mg/L) and the 30-day average (chronic) criterion (90 mg/L) were used for the calculation of the LC for Segment 5. LCs for TSS in Segment 5 were produced for lower Rapid Creek based on the acute and chronic criterion. Loading capacities were calculated by multiplying the acute and chronic TSS criteria by segment specific USGS daily average flow measurements. Thus, the TSS TMDLs were developed using the LDC approach, resulting in a flow-variable target that considers the entire flow regime over the entire year.

For each of the five flow zones, the 95th percentile of the range of LCs within each zone was set as the flow zone goal. TSS loads experienced during the largest stream flows (e.g. top 5 percent) cannot be feasibly controlled by practical management practices. Thus, setting the flow zone goal at the 95th percentile of the range of LCs will protect the warmwater permanent (TSS) beneficial use assigned to Segment 5 and allow for the natural variability of the system.

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 Rapid Creek, Segment 5 TSS TMDL includes an explicit MOS identified by using statistical analysis and is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). Each explicit MOS for TSS was calculated as the Inner Quartile Range (IQR) of the assimilative capacity within each of the five flow zones (75^{th} percentile minus the 25^{th} percentile). The IQR method is a viable way to account for natural variability because it excludes the extreme fluctuations in loading based on flow within each flow zone. Because allocations are a direct function of flow, accounting for potential flow and loading variability is an appropriate way to address the MOS.

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 the TSS loads are taken into account. The highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months. Critical conditions occur within the basin during the spring and summer storm events. Typically, during severe thunderstorms, the highest concentrations occur in the basin during the summer months. Combined with the peak in tillage for agricultural crops, high-intensity rainstorm events, which are common during the spring and summer, produce significant amounts of sheet and rill erosion. The implementation targeted to the critical conditions should reduce the sediment loading to the river.

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 has been 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: Rapid Creek should continue to be monitored as part of DENR's ambient water quality monitoring. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations on Rapid Creek (WQM 92, DENR 460692 below RC WWTF and WQM 19, DENR 460910 near Farmingdale, SD), which are sampled on a monthly basis. Additional monitoring and evaluation efforts should be targeted toward the effectiveness of implemented BMPs. Monitoring locations should be based on the location and type of BMPs installed.

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 the Lower Cheyenne River Watershed Assessment Project is nearing completion and that broad support to begin an implementation project is evident. Rapid Creek is part of the Cheyenne River watershed and could be included in a larger, basin-wide implementation project. Major entities that should be involved in planning, funding and supporting this project as it pertains to Rapid Creek are the West Dakota Water Development District, Pennington County, Pennington County Conservation District, the City of Rapid City, Cheyenne River Partnership and the Natural Resource Conservation Service. In 2010, the Pennington County Conservation District expressed interest in sponsoring a Lower Rapid Creek implementation project.

For Segment 5, reductions in TSS will take place with implementation of BMPs and should include but are not limited to:

- implement management practices to improve and protect the riparian buffer zone through grazing management practices with off-stream watering and vegetation development;
- cropland residue management with reduced tillage;
- riparian and stream bank erosion control measures; and
- development of cattle crossing areas for reduced stream access and erosion.

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 Rapid Creek TSS TMDL includes daily loads expressed as kilograms per day. The daily TMDL loads are included in the TMDL section of the TMDL document.

COMMENTS: None.