Total Suspended Solids Total Maximum Daily Load (TMDL) for One Segment of the Vermillion River Clay, Hutchinson, Lincoln, Turner and Yankton Counties South Dakota

South Dakota Department of Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

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Environment and Natural Resources
Water Resources Assistance Program

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Total Maximum Daily Load Summary for the Vermillion River -Segment R7

South Dakota (Clay, Hutchinson, Lincoln, Turner and Yankton Counties)

Waterbody Type:	River/Stream
303(d) Listing Parameter:	Total Suspended Solids (TSS)
Designated Uses (SD):	Warmwater semipermanent fish life propagation waters, limited-contact recreation waters, fish and wildlife propagation, recreation, and stock watering
Size of Impaired Waterbody:	Segment R7 - Approximately 52 km in length
Size of Watershed:	Segment R7 – 101,233 hectares (ha) Contributing Drainage Area - 563,735 ha
Indicator(s):	Concentration of total suspended solids
Analytical Approach:	FLUX and ANNAGNPS Modeling with Load Duration Curve
Location:	Hydrologic Unit Codes (8-digit HUC): 10170102
Goal:	Meet applicable water quality standards for total suspended solids
TMDL Priority Ranking:	Priority 1 (2010 Integrated Report)
Target (Water Quality Standards):	Maximum daily concentration of ≤ 158 mg/L and a concentration of ≤ 90 mg/L for a thirty-day average of three consecutive grab or composite samples taken on separate weeks.
Reach Number:	SD-VM-R-VERMILLION_02

1.0 Objective

The intent of this document is to clearly identify the components of the TMDL, support adequate public participation, and facilitate the US Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by US EPA. This TMDL document addresses the total suspended solids impairment of Segment R7 (SD-VM-R-VERMILLION_02) of the Vermillion River (Turkey Ridge Creek to Baptist Creek), which has been assigned to priority category 1 (high-priority) in the 2010 impaired waterbodies list.

Many of the ongoing adjustments to the Vermillion River system involve events and/or past perturbations associated with the various stages of stream evolution. It is important to identify the potentially stable stream type of the existing river after the root cause of impairment has been determined. Rates of sediment supply, bank erosion rates and other characteristics identified in this TMDL report represent the first steps towards a stable (quasi-equilibrium) geomorphic condition for the Vermillion River.

2.0 Watershed Characteristics

2.1 General

The project area for this TMDL report is shown in Figure 1. The Vermillion River drains approximately 1.43 million acres (2,233 miles^2) in South Dakota (SD). The East Fork and West Fork of the Vermillion River drain approximately 292,579 acres and 256,440 acres, respectively. Below the city of Parker, SD these two main tributaries merge forming the Vermillion River which drains into the Missouri River near Vermillion, SD (Figure 1).

The basin is about 150 miles in length and varies in width from 12 miles in the north to 36 miles in the south. Much of the lower 22 miles of the river is channelized. Agriculture is the leading source of income in the basin. It is estimated that 96% of the total surface area is devoted to agriculture (Figure 2). The remaining areas are municipalities, sand and gravel operations, and other uses.

The Vermillion River watershed is located in the Northern Glaciated Plains and Western Corn Belt Plains ecoregions. A flat to gently rolling landscape composed of glacial drift characterizes the Northern Glaciated Plains ecoregion. The Western Corn Belt Plains ecoregion is composed of level to gently rolling glacial-till plains with areas of moraine hills and loess deposits (Bryce et al., 1996 and Chapman et al., 2001). Wildlife species present in the area include whitetail deer, red fox, beavers, raccoons, ring-necked pheasants, mourning doves, and numerous other species of songbirds, waterfowl, reptiles, and amphibians (SD Game, Fish, and Parks, 2002).

On-going implementation projects in the Vermillion River basin include the Vermillion River, Turkey Ridge Creek, and Kingsbury County Lakes (which includes Lakes Preston, Thompson, Whitewood, and Henry) watersheds.

Segment R7 (2010 IR) is found within the Level IV Ecoregion 46n-James River Lowland. Ecoregion 46n can be described as glaciated level to slightly rolling plain composed of glacial drift. There are areas of concentrated seasonal wetlands. Native grass species consist of western wheatgrass, green needlegrass, big bluestem, and blue grama, which have been mostly converted to intensive row agriculture, i.e. corn and soybeans (Chapman, et. al, 2001).

Land uses in the various HUC 12 drainage areas in SD are generally similar. The majority of these areas are dominated by a combination of grassland, hay, pasture, corn, and soybeans land uses, followed by high intensity commercial, and industrial land uses. There is relatively limited residential area within these drainage areas and therefore impacts from these land uses are expected to be minimal (Figure 2).

The Vermillion River basin has a subhumid, continental climate characterized by pronounced seasonal differences in temperature, precipitation, and other climatic variables. Temperature varies slightly from the northern to the southern end of the basin. Annual temperatures are slightly cooler at the northern parts of the basin. January is typically the coldest month (13^{o}F in the north and 19^{o}F in the south). July is typically the warmest month (73^{o}F in the north and 75^{o}F in the south).

The frost free days at the northern end of the basin are typically from May 17th to September 21st, while the southern frost free days are from May 4th to October 5th. The average annual precipitation in the watershed is somewhat variable, both spatially and temporally, ranging from 22 to 26 inches Generally, average annual precipitation decreases as you move north within the study watershed. Average seasonal snowfall for this region is approximately 30 inches.

The Vermillion River Basin is divided into six main segments running from the two forks (East and West) in the North to the mouth near Vermillion, SD (Figure 1, Table 1). Five of the six segments were placed on the South Dakota 2010 303d Impaired Waterbody List for limited contact recreational or fish life use impairment caused by pathogens or sediment, respectively (Table 1). This sediment TMDL for Segment R7 (waterbody ID: SD-VM-R-Vermillion_02) is the first to be submitted for the Vermillion River basin and will address the warm water semipermanent fish life beneficial use (TSS criterion).

Table 1. Vermillion River Assessment Reaches and Impairment Cause.

Segment	Description	Cause
SD-VM-R-VERMILLION_E_FORK_01	McCook/Lake County line to Little Vermillion River	Pathogens
SD-VM-R-VERMILLION_E_FORK_02	Little Vermillion River to mouth	Pathogens
SD-VM-R-VERMILLION_WEST_FORK_01_USGS	Vermillion River to McCook-Miner County Line	Pathogens
SD-VM-R-VERMILLION_01	Headwaters to Turkey Ridge Creek	Full Support
SD-VM-R-VERMILLION_02	Turkey Ridge Creek to Baptist Creek	Pathogens and Sediment
SD-VM-R-VERMILLION_03	Baptist Creek to Mouth	Sediment

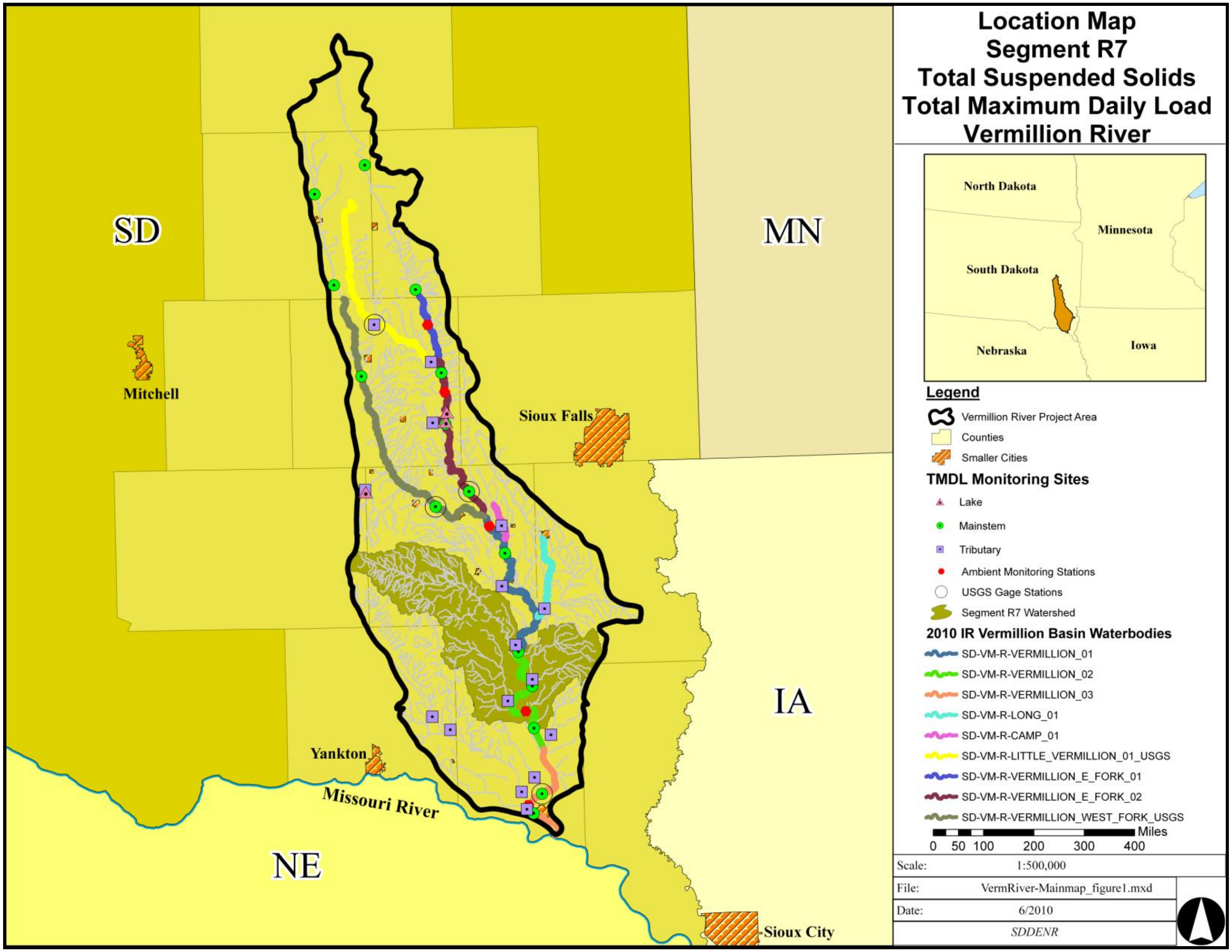
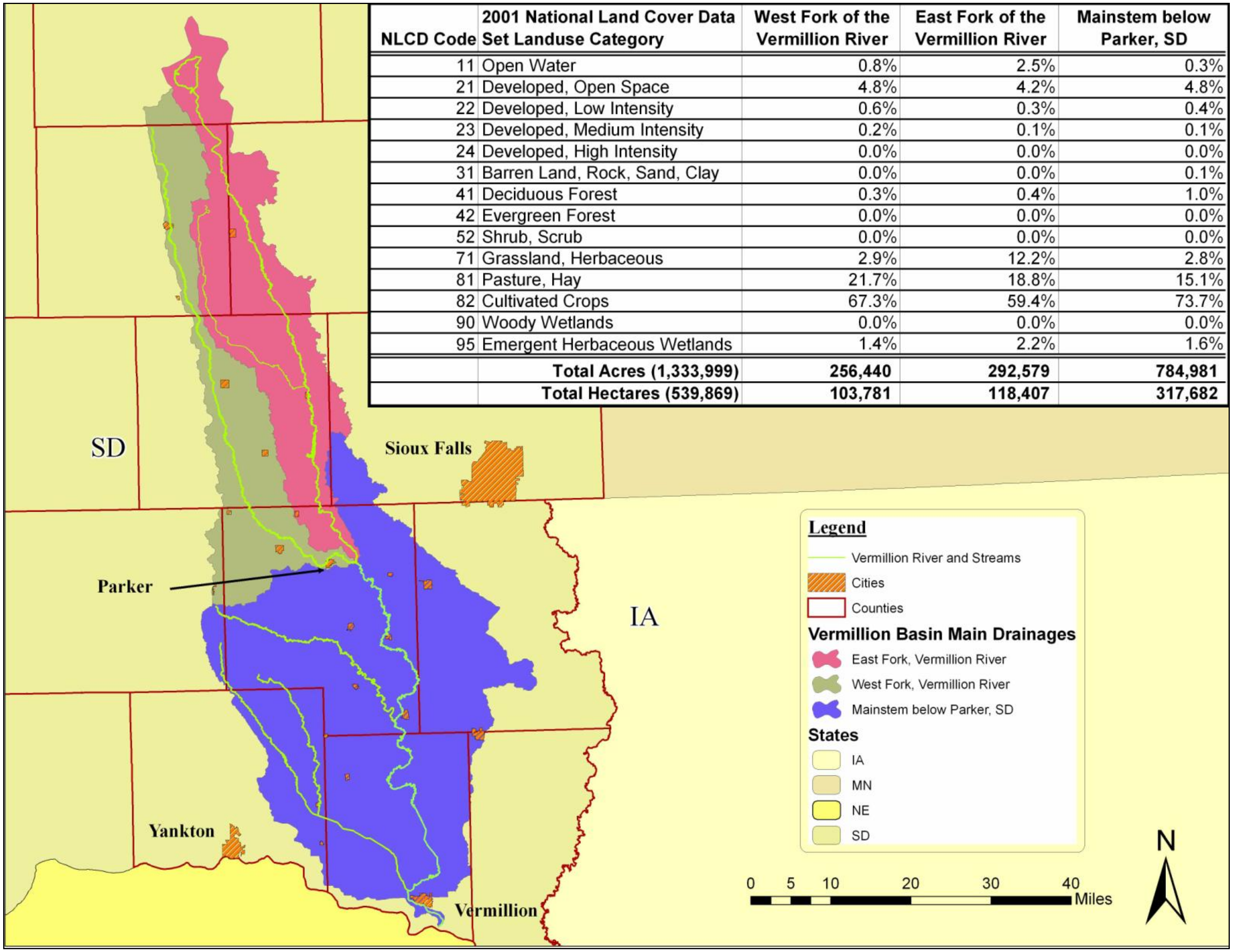


Figure 1. Location of Segment R7 subwatershed of the Vermillion River in southeastern South Dakota.



NLCD Code	2001 National Land Cover Data Set Landuse Category	West Fork of the Vermillion River	East Fork of the Vermillion River	Mainstem below Parker, SD
11	Open Water	0.8%	2.5%	0.3%
21	Developed, Open Space	4.8%	4.2%	4.8%
22	Developed, Low Intensity	0.6%	0.3%	0.4%
23	Developed, Medium Intensity	0.2%	0.1%	0.1%
24	Developed, High Intensity	0.0%	0.0%	0.0%
31	Barren Land, Rock, Sand, Clay	0.0%	0.0%	0.1%
41	Deciduous Forest	0.3%	0.4%	1.0%
42	Evergreen Forest	0.0%	0.0%	0.0%
52	Shrub, Scrub	0.0%	0.0%	0.0%
71	Grassland, Herbaceous	2.9%	12.2%	2.8%
81	Pasture, Hay	21.7%	18.8%	15.1%
82	Cultivated Crops	67.3%	59.4%	73.7%
90	Woody Wetlands	0.0%	0.0%	0.0%
95	Emergent Herbaceous Wetlands	1.4%	2.2%	1.6%
	Total Acres (1,333,999)	**256,440**	**292,579**	**784,981**
	Total Hectares (539,869)	**103,781**	**118,407**	**317,682**

Figure 2. Landuse for the entire Vermillion River Watershed (2001 NLCD).

2.2 Segment R7 (SD-VM-R-VERMILLION_02)

Segment R7 runs approximately 32 miles from Turkey Ridge Creek (near Centerville, SD) to Baptist Creek, which is approximately 7 miles north of the city of Vermillion, SD. Major tributaries to this segment include Turkey Ridge Creek (Site VRT11), Frog Creek (Site VRT07), and Ash Creek (Site VRT32).

Figure 3 shows similar land uses within the Segment R7 immediate subwatershed when compared to the overall basin. As expected row crops are by far the largest category of landuse within this segment at 73.3%.

The major soil associations for this segment are shown below and were taken from the soil surveys from each county (NRCS, Clay and Turner County, SD Soil Survey, 2003 and 1982, respectively).

For northern Clay County:

Egan-Ethan-Trent Association

Well drained and moderately well drained, nearly level to undulating, silty and loamy soils on till plains. Approximately 90 percent of this association is cultivated cropland. Water and wind erosion are a concern for this soil association.

Egan-Chancellor-Davison Association

Well drained, somewhat poorly drained, and moderately well drained, nearly level to gently undulating, silty and loamy soils on till plains. Approximately 95 percent of this association is cultivated cropland. Water and wind erosion are a concern for this soil association.

Lex-Dalesburg-Clamo Association

Somewhat poorly drained, moderately well drained, and poorly drained, level to gently undulating, loamy and clayey soils on flood plains. Approximately 95 percent of this association is cultivated cropland. Moderate available water capacity is a concern for this soil association.

For southern Turner County:

Egan-Trent Association

Well drained and moderately well drained, nearly level to undulating, silty soils on uplands and in upland swales. Approximately 90 percent of this association is cultivated cropland. Controlling erosion is one concern for this association.

Egan-Ethan Association

Well drained, nearly level to moderately steep, silty and loamy soils on uplands. Approximately 80 percent of this association is cultivated cropland. Erosion and moisture and fertility are the main concerns for this association.

Roxbury-Davis Association

Well drained and somewhat poorly drained, nearly level and gently sloping, silty and loamy soils on flood plains. Approximately 75 percent of this association is in cropland but there are few concerns with this association.

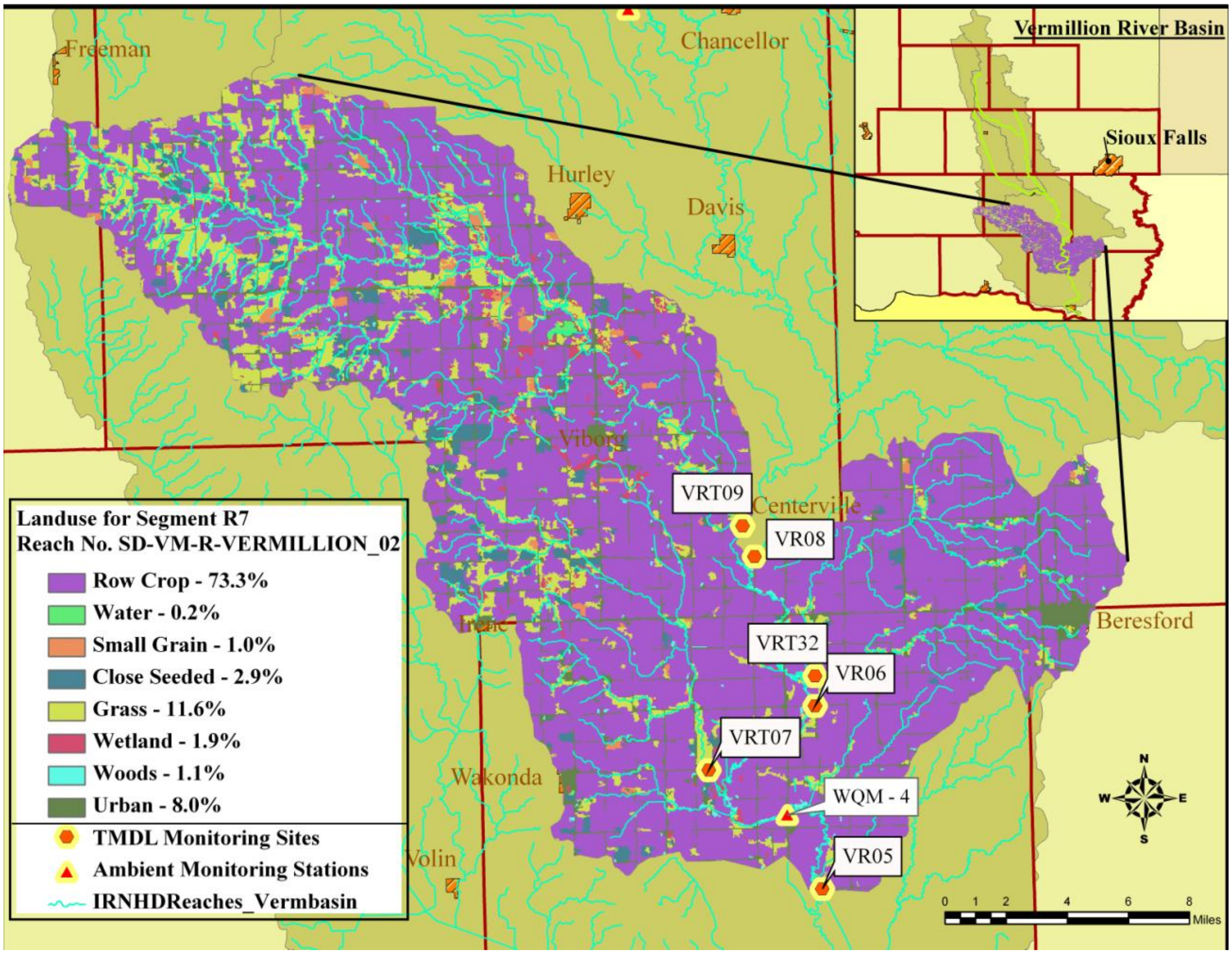


Figure 3. Landuse for Segment R7 in the Vermillion River Basin.

The current form of the Vermillion River Basin is a result of the retreat of the late Wisconsin ice. The meltwaters from the glacier carved the basin as the glacier retreated leaving behind the outwash. Westerly winds carried silt and fine sand from the Missouri and Vermillion outwash and deposited this material as loess and dune sand on the adjacent uplands. The constantly shifting channel of the Vermillion has left evidence of erosion and deposition within the basin (Christensen and Stephens, 1967).

3.0 Problem Identification

Sediment sources are overland runoff from nearby croplands and feedlots, inflow from tributaries, and streambank erosion. With the significant amount of cropland in the watershed in addition to the wetland loss, runoff from nearby croplands would appear to be a significant source of the sediment. There is also the element of bed/bank erosion and steepening channel gradient due to increased flows which may be a source of sediment as well.

The Vermillion River has had a long history of flooding problems. Multiple flood control studies and mitigation plans have been completed on the Vermillion River. Like most rivers in the glaciated prairie pothole region, the Vermillion River is flood prone. Because of wetland drainage, stream and river channelization, and an emphasis on cultivated crops, the watershed-river equilibrium has been upset. Water now enters the river at a faster rate making the downstream flooding worse. The increased water velocity and sediment load has resulted in stream impairments in the mainstem of the Vermillion River (Johnson, 1997; USACE, 1992; FEMA, 1994).

Figure 4 shows the results of the rapid geomorphic assessments (RGAs) collected from channel crossings throughout the river basin. The RGA is used to assess the current channel adjustment processes occurring in a segment (or reach) and to determine the stage of channel evolution (described below) that best describes the set of current and historic adjustment processes.

There are six stages identified in Simon's channel evolution model (Simon, 1989):

Stage I: The waterway is a stable, undisturbed natural channel.

Stage II: The channel is disturbed by some drastic change such as cultivation of grassland, forest clearing, urbanization, dam construction, or channel dredging.

Stage III: Instability sets in with scouring of the bed.

Stage IV: Destructive bank erosion and channel widening occur by collapse of bank sections.

Stage V: The banks continue to cave into the stream, widening the channel. The stream also begins to aggrade, or fill in, with sediment from eroding channel sections upstream.

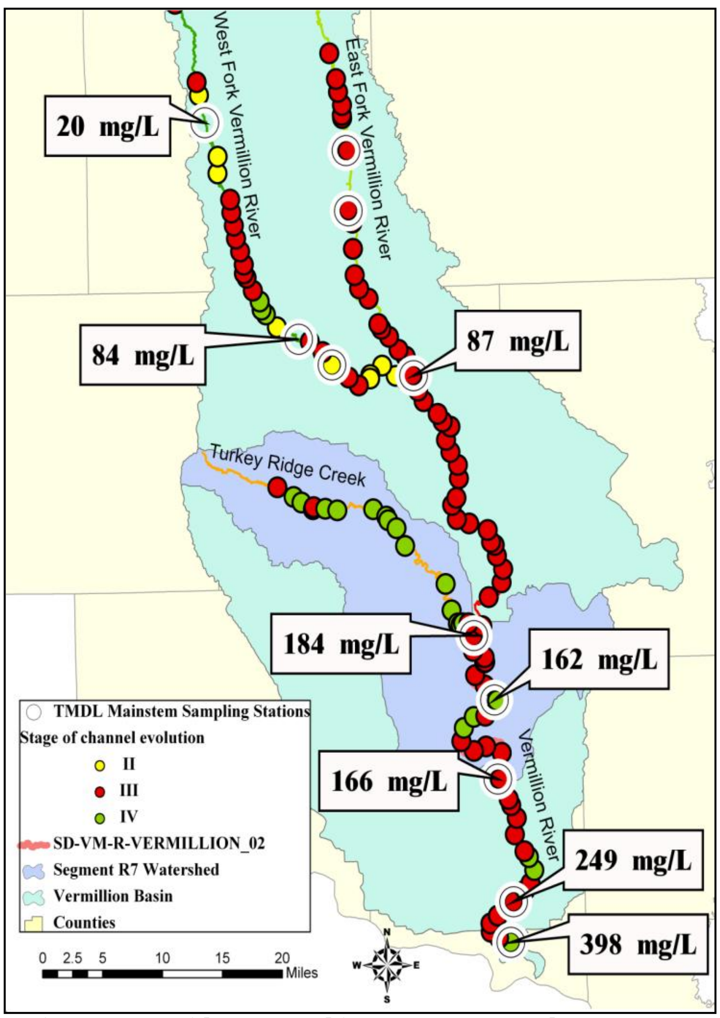


Figure 4. Rapid Geomorphic Assessments and Mean TSS Concentrations for Sites Along the Vermillion River.

Stage VI: Aggradation continues to fill the channel, re-equilibrium occurs, and bank erosion ceases. Riparian vegetation once again becomes established.

The Vermillion Basin is almost exclusively in Stage III and IV (Figure 4). This is also reflected in the mean TSS concentrations shown in Figure 4. There is a significant increase in sediment in the lower two segments of the Vermillion River. Landuse changes such as increased grassland conversion to cropland and channelization have led to increased sediment concentrations.

Segment R7 has a history of exceedance of the SD total suspended solids (TSS) water quality criterion. Initially listed in 1998 due to warmwater semipermanent beneficial use impairment, this segment has consistently been listed in 2002, 2004, 2006, 2008 and 2010 for this same impairment in SD. Other studies have cited the increased sediment loads and flooding problems in the Vermillion River (USACE, 1992). Figure 5 shows the long-term TSS concentrations for Segment R7. Although a trend (increasing or decreasing) was not detected the concentrations seem to indicate the same level of TSS impairment since circa 1972. The ambient monthly data were analyzed using the LOWESS procedure, as described in Helsel and Hirsch (2002). The trend analysis (TSS vs. time) did not indicate an increasing or decreasing trend ($P>0.05$). Excessive sediment loadings have existed since at least 1972 indicating the cause of impairment occurred prior to that time (Figure 5).

Figure 6 shows the TSS concentrations categorized by flow. Four flow zones for Site VR05 with WQM Site 4 (STORET Site WQM460755) are shown: High, Moist, Mid Range, and Low/Dry. Violations of the TSS criterion are clearly driven by flow. In fact, the most significant violations were sampled during storm events (>50% storm flow) (Figure 6). Higher flow zone violations are indicative of streambank erosion in both the mainstem and tributaries along with sheet and rill erosion from farm field runoff during moist conditions (Cleland, 2003). Lower flow violations can be attributed to sediment delivered from tributaries from smaller storm events, continued bank erosion, and the existing sediment load contained within the river.

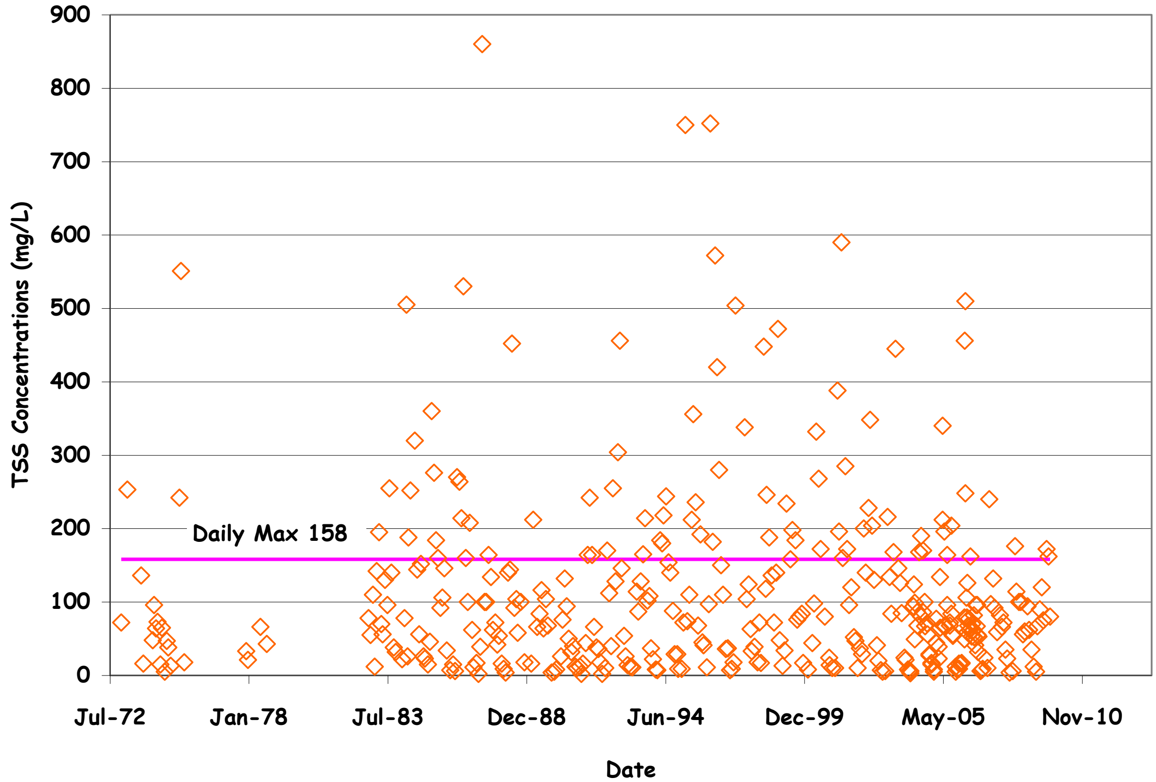


Figure 5. Longterm TSS Concentrations for Site WQM4 (STORET Site 460755).

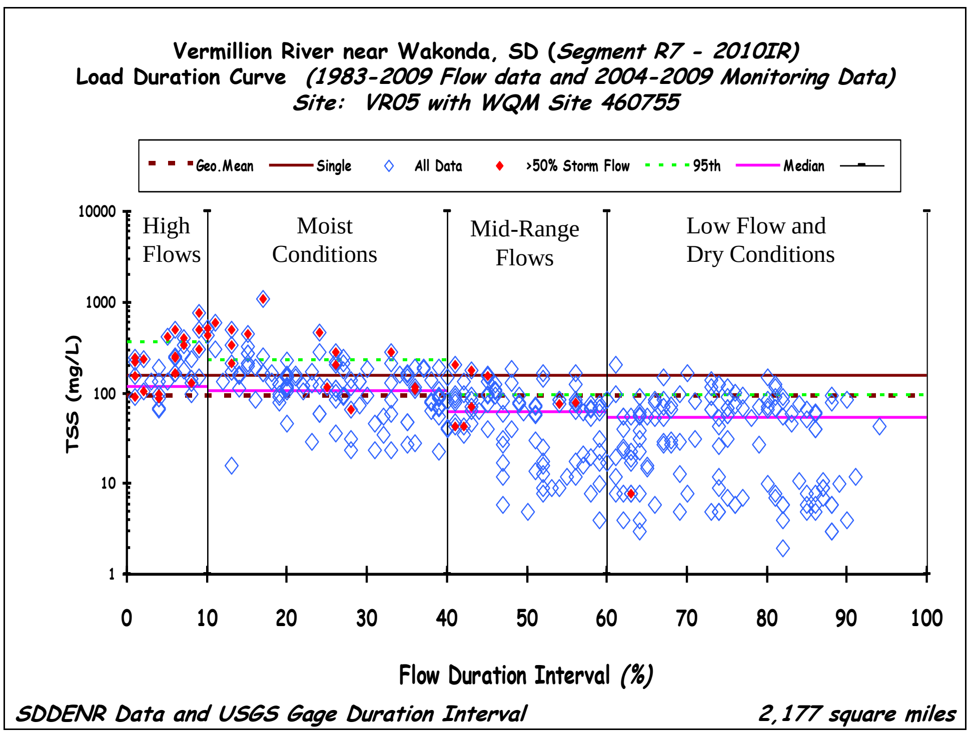


Figure 6. Segment R7 (Site VR05 and WQM-4) sampled TSS Concentrations compared to the daily maximum (≤158 mg/L) and 30 day average (≤90 mg/L) TSS Criteria.

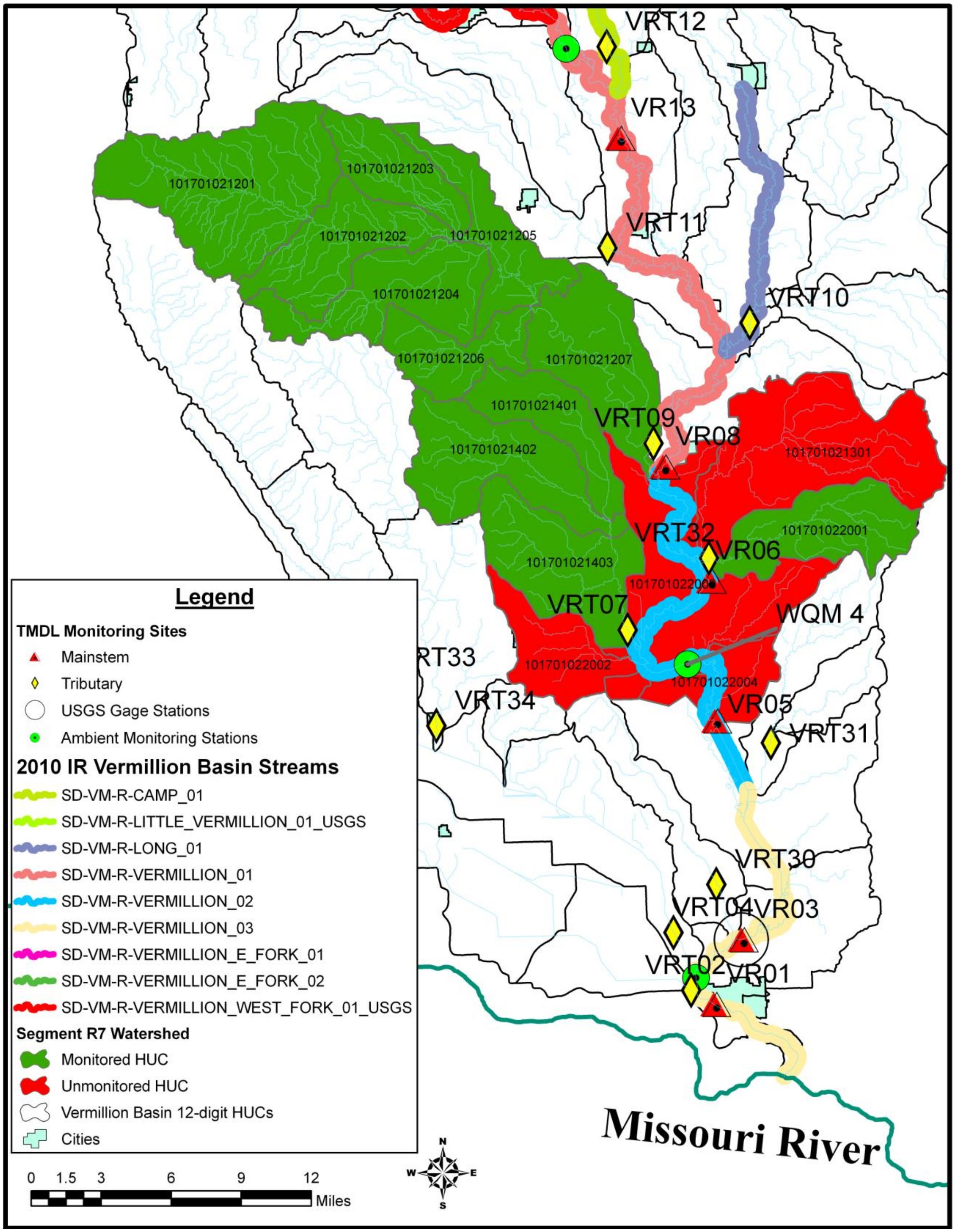


Figure 7. Segment R7 Subwatershed.

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

4.1 South Dakota Water Quality Standards

Each waterbody within SD are assigned designated or beneficial uses. All waters (both lakes and streams) within SD 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 SD state statutes in support of these uses. These standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed.

For the Vermillion River Basin, Segment R7 (waterbody ID: SD-VM-R-VERMILLION_02) has been assigned the following beneficial uses: warmwater semipermanent fish life propagation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 2 lists the criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion is used.

Individual parameters, determine the support of these beneficial uses (Table 2). South Dakota has numeric standards applied to the excessive rates of sedimentation. The criteria set forth in the Administrative Rules of South Dakota (ARSD) Article 74:51:01:48 for warmwater semipermanent fish life propagation waters prohibit elevated levels of suspended solids in the water column. Suspended solids have significant acute and chronic effects on the biological community. For fish, this includes effects on feeding and growth, cover and risk of predation, avoidance and displacement, egg development and survival, primary and secondary productivity through factors such as temperature, particle size and angularity, and duration of exposure.

Additional narrative standards that may apply can be found in ARSD Articles 74:51:01:05, 06, 08, and 09. These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, and nuisance aquatic life.

Table 2. South Dakota surface water quality standards for the lower two segments of the Vermillion River, Clay and Turner Counties, South Dakota.

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate	≤ 750	mg/L	30-day average
	≤ 1313	mg/L	daily maximum
Chlorides (warm water semipermanent)	≤ 100	mg/L	30-day average
	≤ 175	mg/L	daily maximum
Dissolved oxygen (warm water semipermanent)	≥ 5.0	mg/L	
Total ammonia nitrogen as N (warm water semipermanent)	Equal to or less than the result from Equation 3 in Appendix A	mg/L	30-day average March 1 - October 31
	Equal to or less than the result from Equation 4 in Appendix A	mg/L	30-day average November 1 - February 29
	Equal to or less than the result from Equation 2 in Appendix A	mg/L	daily maximum
Fecal coliform and *E. coli* (May 1 – September 30) (limited contact recreation)	≤ 1,000 (*E. coli* ≤ 630)	/100 mL	geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period
	≤ 2,000 (*E. coli* ≤ 1,178)		in any one sample
Conductivity at 25°C	≤ 2,500	micromhos/cm	30-day average
	≤ 4,375	micromhos/cm	daily maximum
pH (warm water permanent)	≥ 6.5 and ≤ 9.0	standard units	
Nitrates as N	≤ 88	mg/L	daily maximum
	≤ 50	mg/L	30-day average
Total dissolved solids	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	daily maximum
	≤ 158	mg/L	daily maximum
Total Suspended Solids (warm water semipermanent)	≤ 90	mg/L	30-day average
	≤ 158	mg/L	daily maximum
Temperature (warm water semipermanent)	≤ 90	°F	see § 74:51:01:31
Undisassociated hydrogen sulfide	≤ 0.002	mg/L	
Total petroleum hydrocarbon	≤ 10	mg/L	see § 74:51:01:10
Oil and grease	≤ 10	mg/L	see § 74:51:01:10
Sodium adsorption ratio	≤ 10		

4.2 Water Quality Targets

Of all the assessed parameters for which surface water quality criteria are established (Tables 2), *E. coli* and total suspended solids (TSS) exceeded criteria for the limited contact recreation and warmwater semipermanent fish life propagation beneficial uses on the Vermillion Segments. This sediment-based TMDL is the first of several to be submitted for this basin addressing water quality impairments on individual tributaries and the East and West Forks draining to the Vermillion River. The sediment caused warmwater fishery use impairment will be addressed by this TMDL. The sediment TMDL only involves SD water quality standards based on the existing total suspended solids standards outlined in the previous two sections.

Total suspended solids water quality criteria for the warmwater semipermanent fishery beneficial use requires that 1) no sample exceeds the daily maximum of 158 mg/L and 2) the arithmetic mean of a minimum of three (3) consecutive grab or composite samples taken on separate weeks in a 30-day period must not exceed 90 mg/L. Both criterion are applicable year round (ARSD 74:51:01:42). The appropriate target for the sediment TMDL for Segment R7 of the Vermillion River will be based on the 30-day average chronic criteria for total suspend solids.

During this study, each site shown in Table 4 exhibited several samples that exceeded the TSS daily maximum criterion (158 mg/L). Total Suspended Solids was listed as the cause of impairment for this reach in the SD 2010 Impaired Waterbodies List. Table 3 shows significant differences in violations rates between flow zones. There is a significant relationship between high flows (storm events) and high concentrations of TSS.

The numeric TMDL target established herein for Segment R7 warmwater semipermanent fish life propagation is based on South Dakota's 30-day average TSS criterion for the fishery use.

Table 3. Exceedance Rate of the TSS Daily Maximum Criterion for all three Vermillion River Segments (158 mg/L).

			High	Moist	Mid	Dry
Segment R7 Reach No.: SD-VM-R-VERMILLION_02	VR05	Samples per Zone	2	10	6	9
		Exceedances per Zone	1	2	0	0
		%Violation	50%	20%	0%	0%
	WQM4	Samples per Zone	7	25	18	37
		Exceedances per Zone	2	7	0	0
		%Violation	29%	28%	0%	0%
	VR06	Samples per Zone	1	10	6	6
		Exceedances per Zone	0	4	0	0
		%Violation	0%	40%	0%	0%
	VR08	Samples per Zone	1	9	6	7
		Exceedances per Zone	1	3	0	0
		%Violation	100%	33%	0%	0%

5.0 Data Collection Method

5.1 Water Quality Data and Discharge Information

Stream discharge information collected from 34 sites was used to develop stage/discharge curves for each monitoring site. Both targeted TMDL sites and ambient (monthly) monitoring data were used to assess TSS impairment and develop trend information. Table 4 shows sites used and numbers of samples collected during the project period.

The design of the assessment project was to estimate the sediment and nutrient loadings within the Vermillion River and major individual tributaries in the watershed through hydrologic, chemical and biological monitoring. The information was not only used to develop a TMDL for the Vermillion River but also locate critical areas in the watershed to be targeted for implementation.

A continuous stage record for the project period, with the exception of winter months after freeze up was maintained for each site. Discrete discharge measurements were taken on a regular schedule and during storm surges. Discharge measurements were taken with a hand-held current velocity meter under wadeable conditions or from a bridge crane during high flows using methods outlined by the U.S. Geological Survey (USGS). Discharge measurements and water level data were used to calculate a stage/discharge table for all stream systems.

Samples were collected during spring runoff, storm events, and monthly base flows. Locations of sites monitoring tributaries and the Vermillion River mainstem can be found in Figure 1 and Figure 3 and 7 as well as Appendix C. Sampling was conducted on a temporal basis over the course of two years (Jan'05 – Dec'06). Five ambient stations were also used to conduct long-term (1968 to Present) trend analysis (TSS vs. time). Samples were collected during the spring snowmelt runoff, and baseflow conditions for spring (March 1 to May 31), summer (June 1 to September 15), and fall (September 16 to November 15). Baseflow was defined as no significant increase in flow.

Storm event samples for each season were collected at or as near as possible to the peak discharge. During the project personnel from the Vermillion Basin Water Development collected all samples periodically aided by SDDENR. Autosamplers were used to collect at some of the more remote locations. The autosamplers were programmed to collect composite samples over the course of a storm event.

All sampling and discharge data collection conducted during this project were done with methods in accordance with the South Dakota *Standard Operating Procedures for Field Samplers* developed by the Water Resource Assistance Program and approved by USEPA Region VIII. All samples collected in SD, including the mainstem, were sent to the State Health Laboratory in Pierre, SD for analysis.

Table 4. Site and sample description, and sample numbers collected as part of the Vermillion Basin Watershed Assessment Project (2004-2007).

Site ID	Description	USGS Gage	Year	Samples	Blanks	Dups	Storm
Blank			2005-06		56		
VR01	Vermillion River at Vermillion, SD		2005-06	5		3	16
VR03	Vermillion River North of Vermillion, SD	6479010	2005-06	7		1	15
VR05	Vermillion River near Hub City, SD		2005-06	10			13
VR06	Vermillion River (Colfax Corner)		2005-06	9		1	14
VR08	Vermillion River at Centerville, SD		2005-06	9		1	13
VR13	Vermillion River near Hurley, SD		2005-06	9		2	16
VREF14	East Fork Vermillion River East of Parker, SD	6478600	2005-06	7		3	18
VREF17	East Lake Vermillion Outlet		2005-06	9			11
VREF19	East Fork Vermillion River near Montrose, SD		2005-06	8		3	17
VREF23	East Fork Vermillion River South of Winfred, SD		2005-06	7		1	12
VREF25	East Fork Vermillion River Outlet from Lake Thompson		2005-06	7		1	10
VREFT18	East Fork Vermillion River Unnamed Tributary		2005-06	3		3	15
VREFT21	Little Vermillion River Outlet near Montrose, SD		2005-06	9		3	16
VREFT29	Little Vermillion River near Salem, SD	6478540	2005-06	1			2
VRELV27	East Lake Vermillion South End		2005-06	43			
VRELV28	East Lake Vermillion North End		2005-06	27		5	
VRSL26	Silver Lake		2005-06	27		4	
VRT02	Yankton Clay Ditch		2005-06	2		1	7
VRT04	Clay Creek Ditch		2005-06	6		3	16
VRT07	Frog Creek		2005-06	9		1	11
VRT09	Turkey Ridge Creek		2005-06	9		2	14
VRT10	Long Creek		2005-06	8		4	13
VRT11	Hurley Creek		2005-06	4		1	12
VRT12	Camp Creek		2005-06	7			10
VRWF15	WestFork Vermillion River near Marion, SD	6478690	2005-06	9		1	14
VRWF20	West Fork Vermillion River near Salem, SD		2005-06	8		2	13
VRWF22	West Fork Vermillion River near Canova, SD		2005-06	8			10
VRWF24	West Fork Vermillion River near Howard, SD		2005-06	6		2	11
WQM150	East Fork Vermillion River North of Montrose, SD		2005-06	43			
WQM154	East Fork Vermillion River South of Montrose, SD		2005-06	43			
WQM4	Vermillion River near Wakonda, SD		2005-06	53			
WQM5	Vermillion River near Vermillion, SD		2005-06	54			
WQM61	Vermillion River near Parker, SD		2005-06	53			
VRT30	Spirit Mound Creek		2006			3	7
VRT31	Baptist Creek		2006	4		2	5
VRT32	Ash Creek		2006	6		1	5
VRT33	Clay Creek		2006	6		2	5
VRT34	Turkey Creek		2006	8			3
VSS-1	City of Vermillion, 48" Storm Sewer		2006				6
VSS-2	City of Vermillion, 36" Storm Sewer East		2006			1	6
VSS-3	City of Vermillion, 36" Storm Sewer West		2006				5
VSS-4	City of Vermillion, 60" Concrete Storm Sewer East		2006				1

5.2 FLUX Loadings

Average daily discharges (cfs) calculated from the stage/discharge tables were used in conjunction with the sediment concentration data to develop daily sediment loadings for each station shown in Table 4. FLUX is a statistical modeling program that allows estimation of tributary mass discharges (loadings) from sample concentration data and daily flow records. Five estimation methods are available and potential errors in estimates are quantified. The most robust method exhibiting the lowest coefficient of variation (cv) was typically used for the site specific daily loading calculation. FLUX modeling setup for each site can be found in Appendix H. Analysis completed with the FLUX model was done according to the most recent version of the "Water Quality Modeling in South Dakota" document.

5.3 Annualized AGNPS Modeling

Sediment and nutrient impacts on the surface water quality of the Vermillion Watershed were evaluated through the use of the Annualized Agricultural Nonpoint Source (ANN-AGNPS) model. Each of the 12-digit HUCs within the basin were modeled and ranked relative to other HUCs in the basin. Appendix – I shows the results for each HUC and how it statistically ranks to the other watersheds in the basin. Implementation targeting will focus on those HUCs that rank statistically higher by using watershed metrics such as the sediment export coefficient (tons/acre).

Ann-AGNPS Simulations

The Annualized Agricultural Nonpoint Source model (AnnAGNPS) was used to estimate the water quality impacts for two different land use scenarios. The model was used to rank 12-digit hydrologic units of the Watershed Boundary Dataset (WBD) in terms of sediment loading. The model uses data from climate, topography, soil, and land management to estimate field erosion and nutrient loadings. Observed climate data were obtained from the Automated Weather Data Network (AWDN) and cooperative (COOP) stations. Topographic parameters were derived from the National Elevation Dataset (NED), WBD, and the National Hydrography Dataset (NHD). The topographic and hydrographic data were used to segment the watershed into about 3200 cells and 1300 reaches. Soil data came from the Soil Survey Geographic (SSURGO) and National Soil Information System (NASIS) databases. A predominate soil map unit was selected from SSURGO for each watershed cell, and physical soil properties were obtained from NASIS. Data describing land management practices were obtained from the National Agricultural Statistics Service (NASS) cropland data, the Revised Universal Soil Loss Equation Version 2 (RUSLE2) database, the National Wetland Inventory (NWI). The NASS cropland dataset was used to assign a predominate land use for each watershed cell, and the RUSLE2 parameters were used to the estimate erosive properties of a cell. The NWI data were used to simulate water impoundments. The model uses the Soil Conservation Service (SCS) TR55 model to simulate the hydrology of a watershed, RUSLE2 is used to estimate sheet and rill erosion, and mass balance and decay equations are used to estimate dissolved and attached nutrients. The first scenario evaluated was current landuse conditions. Land use was assigned to each model cell from the NASS cropland dataset. South Dakota NASS cropland data was available for 2006, 2007, 2008, and 2009. A precursor to the NASS cropland data was available for 2000 and 2001. The data from these six years was used to assign a predominate landuse to a cell. Representative crops and management practices were selected from the RUSLE2 database for each landuse. These data were used in the AnnAGNPS model along with twenty-five years of observed climate data, SSURGO/NASIS soil data, and NWI impoundment data to model runoff and sediment for the period between January 1, 1984, and December 31, 2009. The second scenario evaluated was a grassed watershed. The land use in the model cells was changed to grass, and the run was made for the same time period as the first simulation.

This standardized modeling approach is outlined in the most recent version of the Water Quality Modeling in South Dakota Document.

5.4 Rapid Geomorphic Assessments

Physical and habitat assessments including Rapid Geomorphic assessments were completed for all mainstem and South Dakota tributary sites during the course of the project. These assessments were done in accordance with the South Dakota *Standard Operating Procedures for Field Samplers* developed by the Water Resource Assistance Program and approved by USEPA Region VIII.

The Rapid Geomorphic Assessment evaluates degradation, aggradation, widening, and planform adjustment processes on the RGA field form. The RGA provides a method to document the current adjustment processes occurring in a segment (or reach) and to determine the stage of channel evolution that best describes the set of current and historic adjustment processes observed. RGA scores were compared to determine overall conditions for each monitoring site on the mainstem and are shown in Figure 4. FLUX loadings, Ann-AGNPS and the RGA results were all used to help determine sources of sediment.

5.5 Source Allocation Methodology

There were four flow zones used in the development of the TMDL for each segment. These are the same flow zones used in the pathogen TMDL approved for five Lower Big Sioux River Segments in 2008. Within each of these flow zones the median (50^{th} percentile) flow was calculated. This flow was then multiplied by the 30-day average (chronic) standard for TSS (90 mg/L) to establish a water quality target for each flow zone.

To calculate the existing condition for each segment the most downstream site within each segment was used. The existing condition was calculated by using the average of the observed TSS loads within each flow zone. The TSS load was calculated by multiplying the concentration by the observed flow when the sample was collected. Each observed load was placed in the appropriate flow zone based on the observed flow rank from the flow distribution for that site.

To allocate sources for each segment, FLUX loadings were calculated for both tributary and mainstem sites. A mass balance approach using the relative percent contribution from all sources per segment was used for the allocation process. The daily flows used to establish the segment TMDL were separated in the one of four flow zones.

Table 5 shows an excerpt from the EXCEL table used to calculate percent contribution from each source for Segment R7. Site VR05 flows were sorted based on flow zone. Each daily output load from Site VR05 had a corresponding load from all inputs (tributaries and HUC12s) draining to this segment including the most upstream mainstem site in the segment (Site VR08). Daily loadings from each input source were summed for the entire flow zone so that a total input load for each segment could be calculated. Percent contribution for each source was then calculated.

Table 5. Example of Source Allocation Methodology (Segment R7)

Notes: Daily loadings for each zone within each year (2005-2006). Daily loadings were summed for each site. For those HUC12s where no monitoring data was available daily estimates were derived from the nearest monitored tributary by using the export co

									Acres								
							USGS Site VR03 ---->		1,473,280.00								
							Surface Acres Drained --->		1,392,969.08	1,309,909.53	1,144,402.42	47,848.18		111,233.50		14,630.82	
							HUC12 Designation --->		mainstem	mainstem	mainstem	101701021401,2,3		101701021201-1207		101701022001	
FlowZone		VR05	VR06	VR08	VRT07	VRT09	VRT32		VR05	VR06	VR08	VRT07	VRT07	VRT09	VRT09	VRT32	using vrt07
VR05	Date	Mass (Kg)	Mass (Kg)	Mass (Kg)	Mass (Kg)	Mass (Kg)	Mass (Kg)	Date	Mass (Kg)	Mass (Kg)	Mass (Kg)	Mass (Kg)	Kg/acre	Mass (Kg)	Kg/acre	Mass (Kg)	(Kg/acre)*VRT32acres
Dry	3/21/2005	20818.9	12344.1	21197.2	949.7	294.6	#N/A	3/21/2005	20,818.90	12,344.10	21,197.20	949.7	0.01985	294.6	0.0026		290.4
Dry	3/22/2005	21147.7	14168.7	20825.6	949.7	367.3	#N/A	3/22/2005	21,147.70	14,168.70	20,825.60	949.7	0.01985	367.3	0.0033		290.4
Dry	3/23/2005	22462.4	13548	18675.7	1039.1	378.6	#N/A	3/23/2005	22,462.40	13,548.00	18,675.70	1039.1	0.02172	378.6	0.0034		317.7
Dry	3/24/2005	22379.6	13628.7	18675.7	1233.6	451.2	#N/A	3/24/2005	22,379.60	13,628.70	18,675.70	1233.6	0.02578	451.2	0.0041		377.2
Dry	3/25/2005	21675.6	17991.4	21197.2	1658	848	#N/A	3/25/2005	21,675.60	17,991.40	21,197.20	1658	0.03465	848	0.0076		507.0
Mid	3/26/2005	30129	23672.2	23114.5	1752.6	1162.4	#N/A	3/26/2005	30,129.00	23,672.20	23,114.50	1752.6	0.03663	1162.4	0.0105		535.9
Mid	3/27/2005	31848.6	26458.7	24717.6	1596.7	1328.8	#N/A	3/27/2005	31,848.60	26,458.70	24,717.60	1596.7	0.03337	1328.8	0.0119		488.2
Mid	3/28/2005	32085.9	28111.6	25960.3	1478.6	1256	#N/A	3/28/2005	32,085.90	28,111.60	25,960.30	1478.6	0.03090	1256	0.0113		452.1
Mid	3/29/2005	33242.6	30184.5	30811.5	1421.7	1256	#N/A	3/29/2005	33,242.60	30,184.50	30,811.50	1421.7	0.02971	1256	0.0113		434.7
Mid	3/30/2005	31020.8	41094.9	43505.3	1917.9	3683.2	#N/A	3/30/2005	31,020.80	41,094.90	43,505.30	1917.9	0.04008	3683.2	0.0331		586.4
Mid	3/31/2005	49746.4	54637.9	55225.2	3357.6	9627.7	#N/A	3/31/2005	49,746.40	54,637.90	55,225.20	3357.6	0.07017	9627.7	0.0866		1026.7
High	6/1/2005	254792.3	282774.3	226884.9	2092.8	4002.4	#N/A	6/1/2005	254,792.30	282,774.30	226,884.90	2092.8	0.04374	4002.4	0.0360		639.9
High	6/2/2005	306061.2	289556.4	194815.4	2202.5	4067.9	#N/A	6/2/2005	306,061.20	289,556.40	194,815.40	2202.5	0.04603	4067.9	0.0366		673.5
High	6/3/2005	254134.6	212401.7	164295.6	3455.8	10203	#N/A	6/3/2005	254,134.60	212,401.70	164,295.60	3455.8	0.07222	10203	0.0917		1056.7
High	6/4/2005	450831.4	383119.9	338935.5	50546.2	39081.3	#N/A	6/4/2005	450,831.40	383,119.90	338,935.50	50546.2	1.05639	39081.3	0.3513		15455.8

2005 Total Load per Zone	VR05	VR06	VR08	VRT07	VRT09	VRT32 Estimate
High (>656 cfs)	15,261,607.40	14,368,781.10	13,992,578.90	523,177.90	685,390.40	159,975.19
Moist (<656 cfs but >117 cfs)	8,545,489.70	7,003,891.60	6,787,180.40	165,492.10	641,737.60	50,603.49
Mid (<117 cfs but >60 cfs)	2,024,972.90	1,512,456.70	1,275,750.60	65,395.90	177,301.00	19,996.49
Dry (<60 cfs)	1,835,006.10	1,305,160.80	1,374,872.10	100,936.70	104,051.30	30,864.01

5.6 Bed and Bank Erosion

For Segment R7 all input sources of sediment were summed within each flow zone. The total mass from all input sources was compared to Site VR05 (total output). The difference (output-input) was considered to be bed or bank erosion. Segment R7 inputs were slightly greater than outputs across all flow zones due to bank erosion as well as measurement error. RGA's show some mass wasting along this reach.

The difference between the inputs and outputs for Segments R7 were insignificant. Estimates for bed and bank erosion were derived using methods described in special project completed in 2009 by the National Sedimentation Laboratory for the Big Sioux River (Bankhead et. al, 2009). The overall objective of this study was to determine rates and loadings of sediment from streambank erosion along main stem reaches of the Central and North Central parts of the Big Sioux River. In this report the author stated "sediment emanating from streambanks decreased non-linearly from the 90th percentile flow year to the 10th percentile flow year." In her plots of percentile years there is a significant decrease indicating a dramatic reduction in bank erosion during low flow periods. In low flow years there is some toe erosion, which increases the bank angle, and reduce the slope stability of the bank. In high flow years, the water table rises to the higher water surface in the river which also reduces the slope stability of the banks. Once the confining pressure of the water in the channel is removed when the river goes down, the over-steepened banks with higher pore water pressures fail.

Contributions of streambank erosion were calculated between 10-25% of the total suspended-sediment load. During a wet or high flow year, 25% of the total suspended sediment load over the 300 km study reach north of Sioux Falls was estimated from streambanks. Annual average contributions from streambanks were estimated at approximately 15% (Bankhead, et.al., 2009). This follows discussion by Cleland, 2003 regarding TSS load duration curves where higher flows result in larger contributions from streambank erosion.

Estimates for Segment R7 of the Vermillion River were calculated at 5% because of the lower flow periods that were monitored. This contribution would significantly increase during higher flow years.

5.7 Natural Background Sources

The percent contribution of the sediment from natural background sources were estimated by using the Ann-AGNPS results. Loading output from the model runs from the initial conditions scenarios was compared to the loadings output from "Presettlement" (or all grass) conditions modeling scenario. The percent difference, which was <5.00%, was used as an estimate of natural background sources.

6.0 Source Assessment and Allocation

6.1 Point Sources

There are five National Pollution Discharge Elimination System (NPDES) permittees located within the watershed of Segment R7. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment R7.

The City of Beresford, SD (NPDES Permit# SD0020079) is located out of the Vermillion flood plain on the uplands on the eastern side of the river basin on the Lincoln/Union County border. Although the Beresford WWTF is authorized to discharge, the three-cell pond system only does so seasonally.

Clay Rural Water Systems, Inc (NPDES Permit# SD0025275) is a small two-cell pond system in the center of Segment R7. Since this system was designed as a zero discharge facility there was no WLA calculated for it.

Lutheran Social Services near Beresford, SD (NPDES Permit# SD0025640) is another small two-cell pond system. This system is also a zero discharge facility and does not have a WLA.

The City of Viborg, SD (NPDES Permit# 0020541) is a three-cell pond system that may discharge seasonally to the Vermillion River. It is located in the Turkey Ridge Creek Watershed.

The City of Wakonda, SD (NPDES Permit# 0020257) is another small three-cell pond system that seasonally discharges to the Segment R7. It is located out of the Vermillion flood plain on the uplands on the western side of the river basin in Clay County.

Table 6. Source Allocation for all inputs to Segment R7.

Source Allocation	Percent Contribution of all inputs for Vermillion River Segment R7 per flowzone				Area	Ann-AGNPS Export Coefficients[2]
Subwatershed or 12-digit HUC	**High**	**Moist**	**Mid**	**Dry**	**acres**	**tons/yr/acre**
VR08 (mainstem upstream)	77.1%	74.8%	65.7%	67.1%	1,144,402	
VRT07-Frog Creek	2.6%	1.7%	3.0%	5.0%	47,848	0.22
VRT09-Turkey Ridge Creek	4.5%	9.6%	13.0%	5.4%	111,234	0.21
VRT-32-Ash Creek	0.8%	0.5%	0.9%	1.5%	14,631	0.29
Norwegian Gulch	0.6%	0.4%	0.7%	1.1%	10,394	0.42
Blind Creek	1.6%	1.1%	1.9%	3.1%	29,802	0.17
Vermillion River- Blind Creek	1.6%	1.0%	1.8%	3.0%	28,649	0.2
Vermillion River- Baptist Creek	1.0%	0.7%	1.2%	1.9%	18,358	0.35
Bed/Bank[1]	5.0%	5.0%	5.0%	5.0%		
Natural Background (AnnAGNPS estimate)	4.8%	4.8%	4.8%	4.8%		
WLA	0.4%	0.5%	2.2%	2.0%		
Sum of Inputs	100.0%	100.0%	100.0%	100.0%		
VR05 (mainstem downstream)	84.1%	92.5%	95.2%	87.1%	1,392,969	

Notes:
1. For pollutant assessment: An estimate of 5% added into the inputs for all flowzones. Based on Bankhead and Simon's 2009 Report on Bank Stability for the Big Sioux River. Mass Balance loading information indicates minimal contribution from bed/bank even though RGA's show Stage III channel evolution using Simon's Channel Evolution Model.
2. AnnAGNPS estimates based on initial or current conditions.

6.2 Nonpoint Sources

A review of available information and communication with local Natural Resources Conservation Service (NRCS) representatives, water quality and discharge data, FLUX loadings, Annualized-AGNPS modeling results, Rapid Geomorphic Assessments (RGAs), literature values, and load duration curves were used to identify nonpoint sources of sediment. The primary nonpoint sources of TSS for all three segments of the Vermillion River watershed include: 1) sheet and rill erosion from the agriculturally dominated landscape, and 2) bed and bank erosion from the various tributaries as well as the Vermillion River mainstem. Using the best available information, loadings were estimated from each of these sources within the four flow zones identified for each segment of the river.

Flux loadings were used to determine percent contribution from each possible source of sediment for all four flow zones. Estimates for bed and bank contributions were calculated through a mass balance approach (Inputs – Outputs). Bankhead and Simons (2009) Report for the Central Big Sioux River was used as a reference in the bed/bank calculations. Annualized-AGNPS modeling outputs were used where possible as another measure of input from sheet and rill erosional sources. Natural background was also estimated through Annualized-AGNPS. See Source Allocation Methodology Section for further discussion.

6.2.1 Segment R7 (Vermillion River) – Turkey Ridge Creek to Baptist Creek

Table 6 shows the percent contribution of sediment derived from the FLUX loadings from monitored tributary and mainstem sites. Estimates for unmonitored 12-digit HUCs were derived by using the FLUX export coefficients (daily kg/acre) from the nearest monitored tributary and applying them to the HUC surface area (acres).

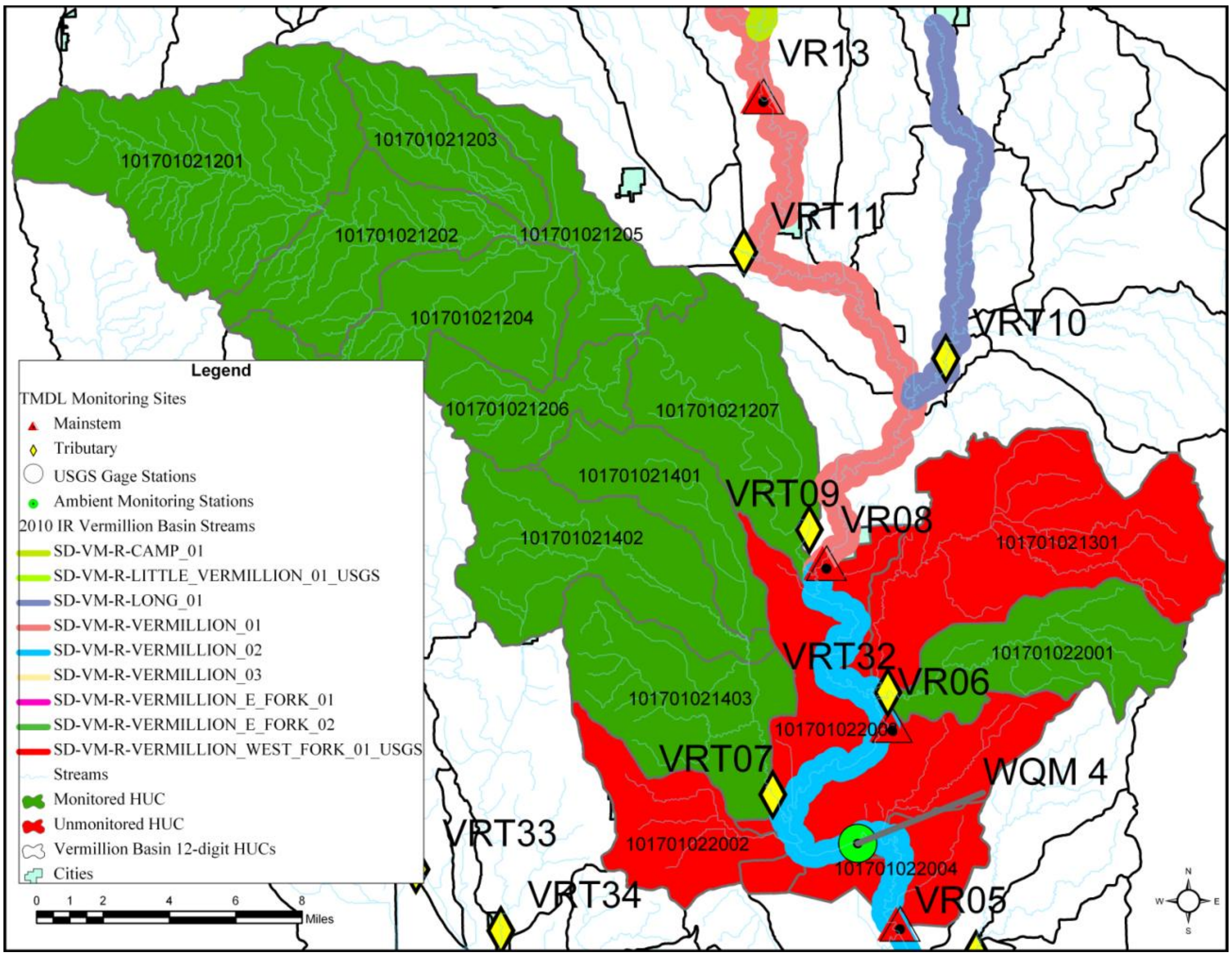


Figure 8. Segment R15 showing unmonitored 12-digit HUCs.

The upstream mainstem site (Site VR08) was the largest contributor of sediment. Of the remaining sources bed/bank, the Turkey Ridge Creek (VRT09), and Frog Creek (VRT07) were the largest contributors of sediment within all four flowzones. Figure 8 shows the immediate subwatershed area (12-digit HUCs) draining to Segment R7. Ann-AGNPS export coefficients suggest that implementation efforts should focus on these three largest contributors of sediment. See Appendix – I for the full listing of the Ann-AGNPS results for the Vermillion Basin River 12 digit HUCs.

7.0 Linkage Analyses

7.1 Load Duration Curve Analysis

This TSS TMDL was developed using a Load Duration Curve (LDC) approach resulting in a flow-variable target that considers the entire flow regime. In the Vermillion River, TSS was positively related to stream flow. This is shown in Table 3 and Figures 6 and 9 with increasing exceedance rates exhibited in the higher flow zones. Thus, the LDC approach was deemed an appropriate method for setting a flow-variable TSS TMDL similar to the sediment TMDLs established for the Lower Big Sioux River Segments in 2010.

The LDC is a dynamic expression of the allowable load for any given day. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into four flow zones representing high flows (0–10 percent), moist conditions (10-40 percent), mid-range flows (40–60 percent), and dry/low conditions (60–100 percent) according to EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2006). The ranges for these four zones were based on 26 years of flow data (1983-2009), five years of sampling data collected from Vermillion River as part of the watershed assessment, and the Section 106 ambient monitoring program.

For Segment R7, instantaneous loads were calculated by multiplying the TSS concentrations collected from SD DENR TMDL Site and long-term ambient monitoring Station WQM4 (Storet ID: 460755) by the daily average flow, and a units conversion factor.

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 plot shows, TSS samples collected from Segment R7 of Vermillion River exceed the daily maximum criterion mostly during high to mid-range flow conditions where flow rank ranges between 0 - 40% (see Figure 6 and 9). While loads exceeding the criteria in the low flow zone typically indicate point source load contributions, the bank erosion problems and the channel adjustment processes currently taking place throughout the watershed (tributaries and mainstem) reflect potential nonpoint source contributions within the two highest flow zones (Cleland, 2003).

8.0 TMDL Allocations

8.1 TMDL Allocations - Segment R7

The LDC (Table 7 and Figure 10) represents the dynamic expression of the TSS TMDL for Segment R7, resulting in a unique maximum daily load that corresponds to a measured average daily flow. To aid in the implementation of the TMDL and estimation of needed TSS load reductions, Table 11 presents a combination of allocations for each of four flow zones. Methods used to calculate the TMDL components are discussed below. This TMDL is in effect year round and is based on daily flow and the chronic (30-day average) water quality standard.

Table 7. Segment R7 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	**VR05 with Ambient Station WQM4**			
Station name:	**DENR Gaging Station upstream of USGS Gage 06479010**			
Parameter of Concern	**Flow Zone (expressed as tons/day)**			
TSS	**Extreme Flows (0-10)**	**High-Range (10-40)**	**Mid Range Flows (40-60)**	**Low Flows (60-100)**
Flow Range	**>656 cfs**	**117-656 cfs**	**60-117 cfs**	**<60 cfs**
Median Flow Per Zone	1563.22	227.86	81.81	31.24
Load Allocation	340.4	49.5	17.6	6.6
WLA - BERESFORD (SD0020079)	0.15	0.15	0.15	0.15
WLA - CLAY RWS INC (SD0025275)	0	0	0	0
WLA - LUTHERAN SOCIAL SERVICES (SD0025640)	0	0	0	0
WLA - VIBORG (SD0020541)	0.01	0.01	0.01	0.01
WLA - WAKONDA (SD0020257)	0.01	0.01	0.01	0.01
MOS (10% Explicit)	37.8	5.5	2.0	0.8
TMDL	**378.5**	**55.2**	**19.8**	**7.6**
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	414.329	70.025	13.320	3.781
Load Reduction	**8.7%**	**21.2%**	**-48.7%**	**-100.0%**
Average Concentration per Zone	116	106	62	53
Number of Values	8	35	24	46
Current Load or existing Condition is the average of the observed TSS Loads for each flow zone.				
Runoff calculated using Median Flow/Area				
mm/day	0.68	0.10	0.04	0.01
cfs/sqmile	0.72	0.10	0.04	0.01

8.1.1 Load Allocation (LA)

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment R7 (Turkey Ridge Creek to Baptist Creek) was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR05, which is approximately 12 miles upstream of USGS Gage 006479010. Site VR05 is the most downstream site within this segment. There were three mainstem sites located within this segment (Site VR08-upstream, VR06, and VR05-downstream) in addition to one ambient monitoring station (Site WQM4 Storet ID: 460755) (Figure 7).

The 30-day average criterion (90 mg/L) was used for the calculation of the LC, rather than the daily maximum criterion (158 mg/L) because the chronic criterion is considered more protective. The 30-day average, as defined in ARSD § 74:51:01:01, is the arithmetic mean of a minimum of three consecutive grab or composite samples taken on separate weeks in a 30-day period. The 30-day average TSS criteria (ARSD § 74:51:01:48) applies at all times but compliance can only be determined when a minimum of three samples are obtained during separate weeks for any 30-day period. In many instances, only one or two samples were collected during any 30-day period, so the average criterion was applied to each flow zone in Figure 10. Although the daily maximum criteria are exceeded, to be conservative it was decided to use the average criterion to develop the loading capacity of the stream in order to ensure that the most stringent water quality standards are met. Additional data are needed to accurately assess compliance with the 30-day average criterion. The loading capacities and reductions derived from the available data are estimates (i.e., the calculated loading capacities and reductions may be higher or lower if/when a more extensive data set is collected to fully assess compliance with the chronic standard). For each of the four flow zones, the 50^{th} percentile (median) of the range of LCs within a 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. Setting the flow zone goal at the 50^{th} percentile while using the average (90 mg/L) criterion within each flow zone will protect the warmwater semipermanent fish life propagation beneficial use and allow for the natural variability of the system (Figure 9).

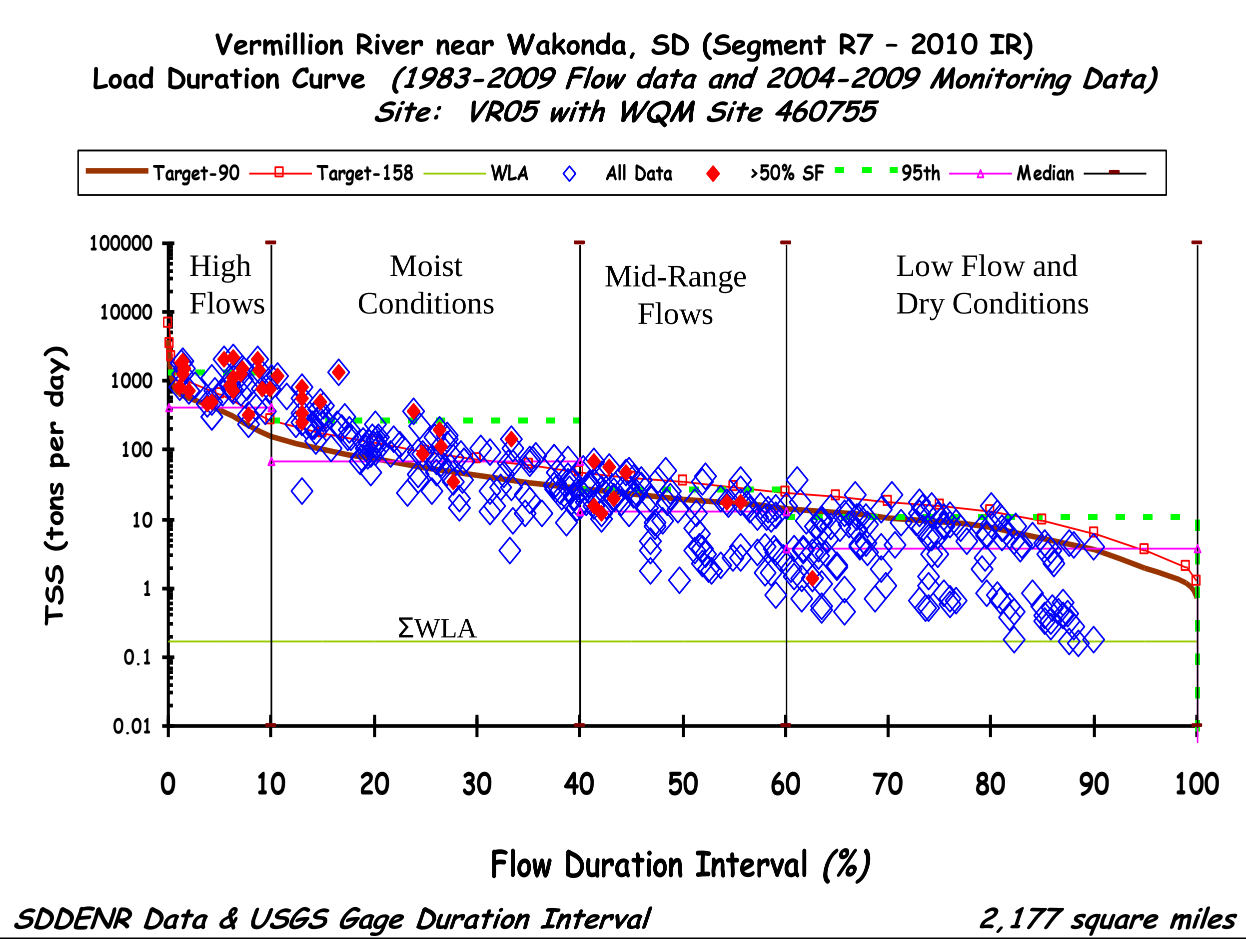


Figure 9. Segment R7 - Load duration curve representing allowable daily TSS loads based on the 30-day average and daily maximum criteria (≤90 mg/L and ≤158 mg/L, respectively). Plot showing median and 95th percentiles, and daily loads for each flow zone. The 30-day average was used to determine the loading capacity for the Segment R7 and the TMDL. Observed TSS concentrations are also displayed.

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

8.1.2 Waste Load Allocation (WLA)

There were five facilities or NPDES Permit holders located within this segment two of which are permitted as zero discharge facilities. The WLA is constant across all flow conditions and ensures that water quality standards will be attained (Table 7 and Figure 10).

8.1.3 TSS Reductions

For the immediate watershed of Segment R7 (Figure 8), reductions from each source are assumed to be based on the percent contribution outlined in the source allocation table (Table 6, pg. 23). This is only one scenario of where reductions might be achieved. Clearly, some reductions from all sources are critical for meeting water quality standards for this segment of the Vermillion River.

Table 8. Segment R7 necessary reductions from each input based on size of each subwatershed.

Sources	Potential Percent Reductions for all inputs for Vermillion River Segment R7 per flowzone (based on reductions in Table 7)			
Subwatershed or 12-digit HUC	**High**	**Moist**	**Mid**	**Dry**
VR08 (mainstem upstream)	7.0%	16.5%	0.0%	0.0%
VRT07-Frog Creek	0.2%	0.4%	0.0%	0.0%
VRT09-Turkey Ridge Creek	0.4%	2.1%	0.0%	0.0%
VRT-32-Ash Creek	0.1%	0.1%	0.0%	0.0%
Norwegian Gulch	0.1%	0.1%	0.0%	0.0%
Blind Creek	0.1%	0.2%	0.0%	0.0%
Vermillion River- Blind Creek	0.1%	0.2%	0.0%	0.0%
Vermillion River- Baptist Creek	0.1%	0.1%	0.0%	0.0%
Bed/Bank[1]	0.4%	1.1%	0.0%	0.0%
Natural Background (AnnAGNPS estimate)	0.0%	0.0%	0.0%	0.0%
WLA	0.0%	0.0%	0.0%	0.0%
Sum of Reductions	**8.7%**	**21.1%**	**0.0%**	**0.0%**

9.0 Margin of Safety (MOS) – All Segments

In accordance with the regulations, a margin of safety was established to account for uncertainty in the data analyses. A margin of safety may be provided (1) by using conservative assumptions in the calculation of the loading capacity of the waterbody and (2) by establishing allocations that in total are lower than the defined loading capacity. In the case of the Vermillion analysis, the latter approach was used to establish a safety margin.

A 10% explicit MOS was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity. The remaining assimilative capacity was attributed nonpoint sources (LA) or point sources (WLA).

As new information becomes available and the TMDL is revisited, this unallocated capacity may be attributed to nonpoint sources and added to the load allocation, or the unallocated capacity may be attributed to point sources and become part of the waste load allocation.

10.0 Seasonal Variation – All Segments

Discharge in the Vermillion River (USGS gage# 06479010, Vermillion, SD) displayed seasonal variation for the period of record (10/1/83 to 9/30/09). Highest stream flows typically occur during spring with highest monthly average stream flow reported in April (981 cfs), and lowest stream flows occur during the winter months with lowest monthly average stream flow reported in January (58 cfs). Total suspended solids concentrations also displayed seasonal variation relative to flow, i.e. positively correlated with stream flow. By using the LDC approach to develop the TMDL allocations, seasonal variability in total suspended loads is taken into account.

In addition, although the TMDL displays seasonality through flow, it is effective throughout the entire year.

11.0 Critical Conditions – All Segments

Critical conditions occur within the basin during the spring and summer storm events. Typically, during severe thunderstorms the largest concentrations are highest 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 a significant amount of sheet and rill erosion. The excessive flows and changing channel dynamics also increase the bed and bank erosion along the tributaries and mainstem of the river.

12.0 Follow-Up Monitoring

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 throughout the river basin especially for Segment R7 – WQM Site 4 (Storet ID: 460755). This station is sampled on a monthly basis.

Additional monitoring and evaluation efforts will be targeted toward the effectiveness of implemented BMPs. Sample sites will be based on BMP site selection and parameters will be based on a product-specific basis.

13.0 Public Participation

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

1. Various public meetings were held during the assessment phase.
2. A webpage was developed and used during the course of the assessment.
3. Presentations to local groups on the findings of the assessment.
4. 30-day public notice (PN) period for public review and comment.

The findings from these public meetings, the webpage, and 30-day PN comments have been taken into consideration in development of the Vermillion River TMDL.

14.0 Implementation

For Segment R7 the WLA contribution is insignificant in comparison to the overall TMDL within each flowzone. This is clearly shown in the table below. Because the sources for this segment are so heavily weighted towards nonpoint sources (LA) reasonable assurance through the National Pollution Discharge and Elimination System (NPDES) does not play a role in the implementation of this TMDL. In addition, the NPDES permits contain end of pipe limits at the water quality standard and any discharges should not cause or contribute to standards violations.

	Extreme Flows (0-10%)	High-Range Flows (10-40%)	Mid-Range Flows (40-60%)	Low Flows (60-100%)
WLA % of TMDL	0.05%	0.32%	0.88%	2.32%

Currently, there is an implementation project targeting sources of sediment and bacteria within the Vermillion Basin. During the next Section 319 funding round an expansion of the project will be proposed to include additional funds for BMPs targeting streambank erosion and sheet and rill erosion.

Several types of BMPs should be considered in the development of a water quality management implementation plan for watershed draining the impaired segments of the Vermillion River. The results of the FLUX loadings indicate that an estimated 5% or greater of the total suspended solids load originates from bank erosion in varying flowzones. Additional analysis through the Annualized AGNPS suggests that multiple drainages provide increased water and sediment loadings. A list of the AGNPS cells and their sediment export coefficients is presented in Appendix I. While several types of control measures are available for reducing sediment loads, the practicable control measures listed and discussed below are recommended to address these identified sources.

Example TMDL Summary Using Duration Curve Framework (Cleland, 2003).

<table>
<tr><th rowspan="2">TMDL SUMMARY</th><th colspan="5">Loads expressed as (tons per day)</th></tr>
<tr><th>High</th><th>Moist</th><th>Mid-Range</th><th>Dry</th><th>Low</th></tr>
<tr><td>TMDL[1]</td><td>173.35</td><td>67.20</td><td>40.21</td><td>27.57</td><td>18.96</td></tr>
<tr><td>Allocations</td><td>118.32</td><td>48.24</td><td>34.47</td><td>21.83</td><td>6.90</td></tr>
<tr><td>Margin of Safety</td><td>55.03</td><td>18.96</td><td>5.74</td><td>5.74</td><td>12.06</td></tr>
<tr><td rowspan="5">Implementation Opportunities</td><td>Post Development BMPs</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Streambank Stabilization</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Erosion Control Program</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Riparian Buffer Protection</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Municipal WWTP</td></tr>
<tr><td colspan="6">Note: 1. Expressed as a "daily load"; represents the upper range of conditions needed to attain and maintain applicable water quality standards.</td></tr>
</table>

- Livestock access to streams should be reduced, and livestock should be provided sources of water away from streams.
- Unstable stream banks should be protected by enhancing the riparian vegetation that provides erosion control and filters runoff of pollutants into the stream.
- Filter strips should be installed along the stream bordering cropland and pastureland.
- Animal confinement facilities should implement proper animal waste management systems.
- An assessment of the effect of tiling on peak flows and bank erosion should be completed for the tributaries draining into these three segments of the Vermillion River.

Since this basin involves multiple conservation districts and counties, a joint effort is required. This has already been undertaken through an agreement with the McCook County Conservation District acting as lead sponsor. This project will provide the necessary funding and control measures needed to reduce sediment impacts on the Vermillion River.

Funds to implement watershed water quality improvements can be obtained through 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 Nonpoint Source program.

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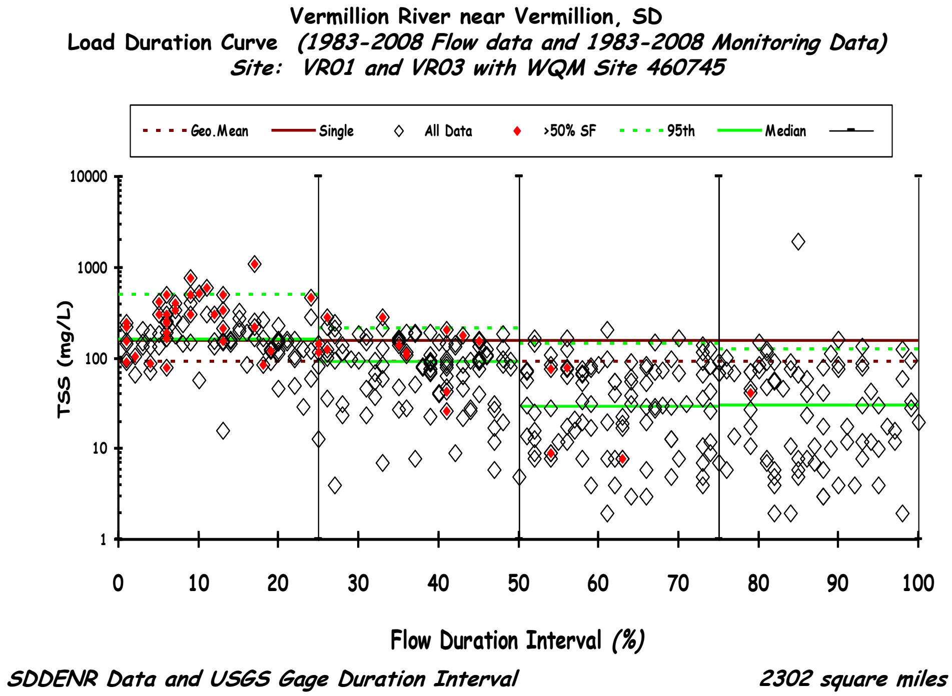
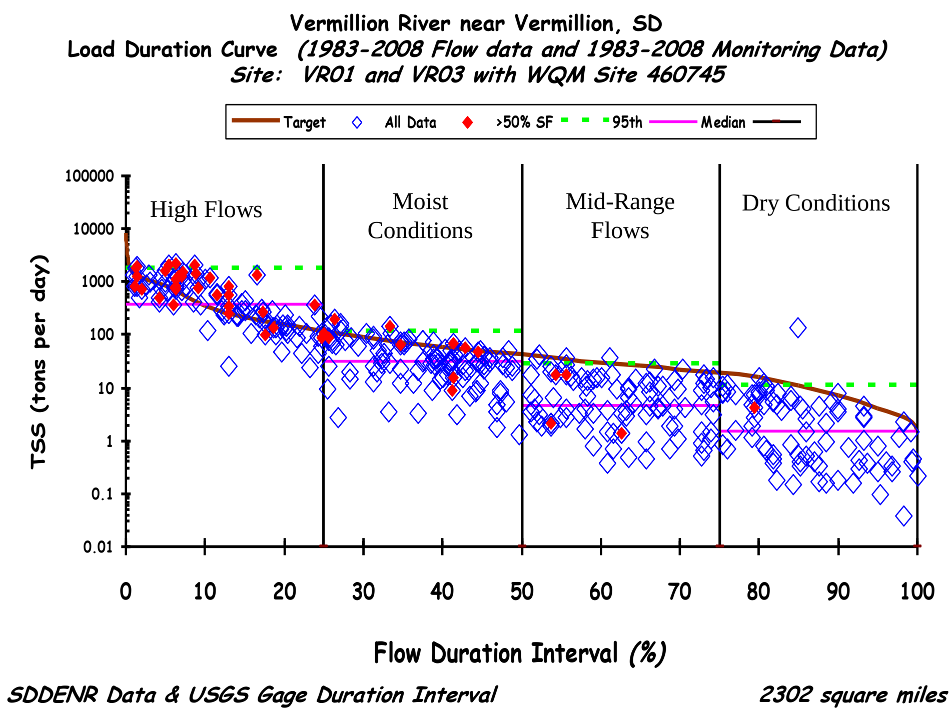
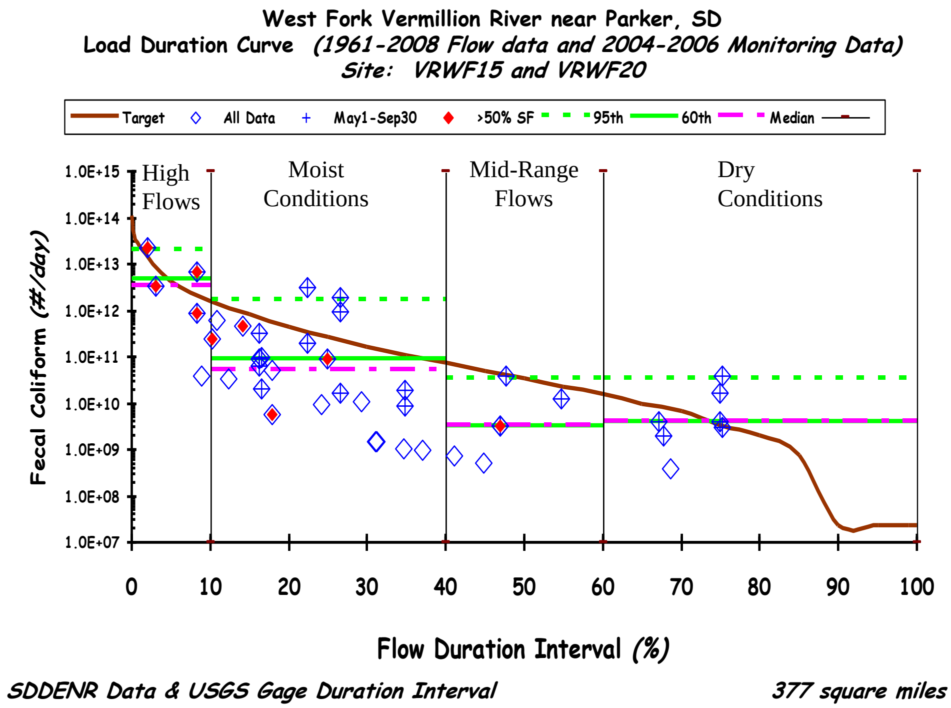
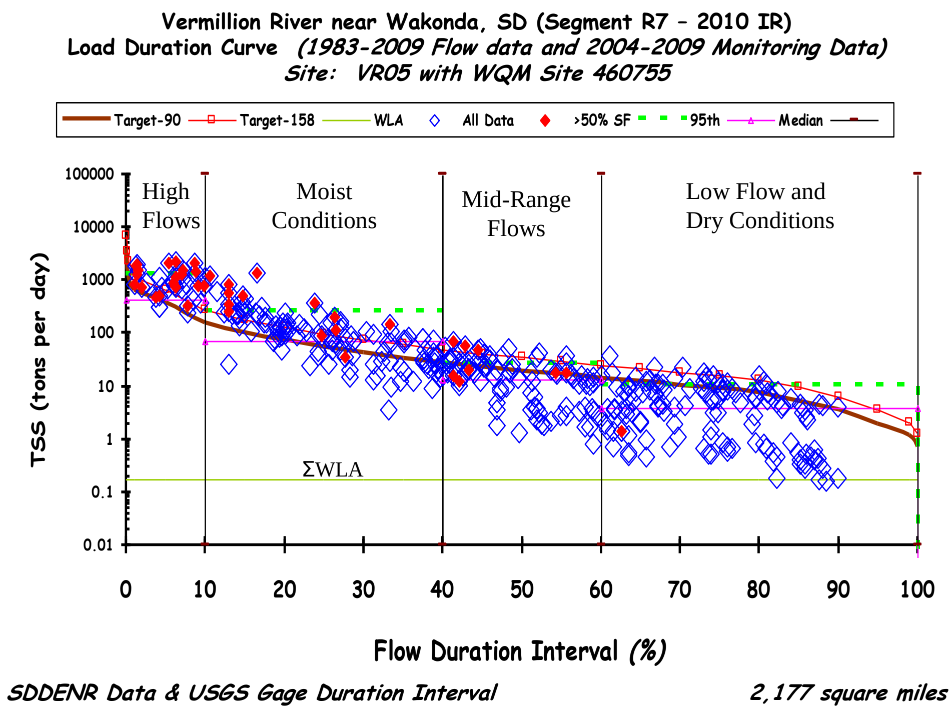
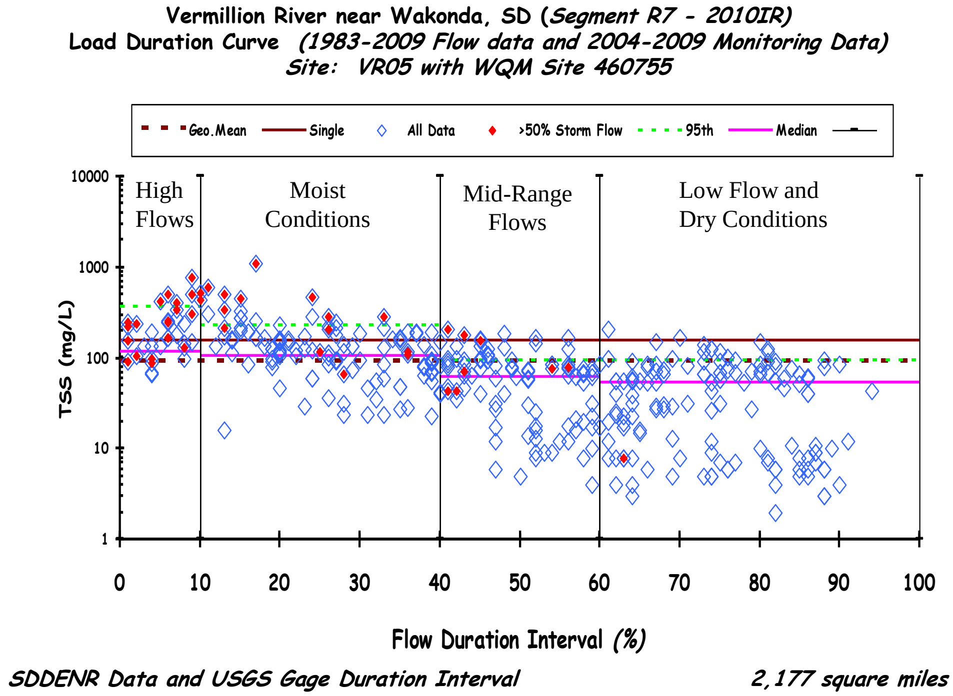
16.0 APPENDIX A: Load Duration Curves and Water Quality Assessment Graphs for Segment R7 Monitoring Sites

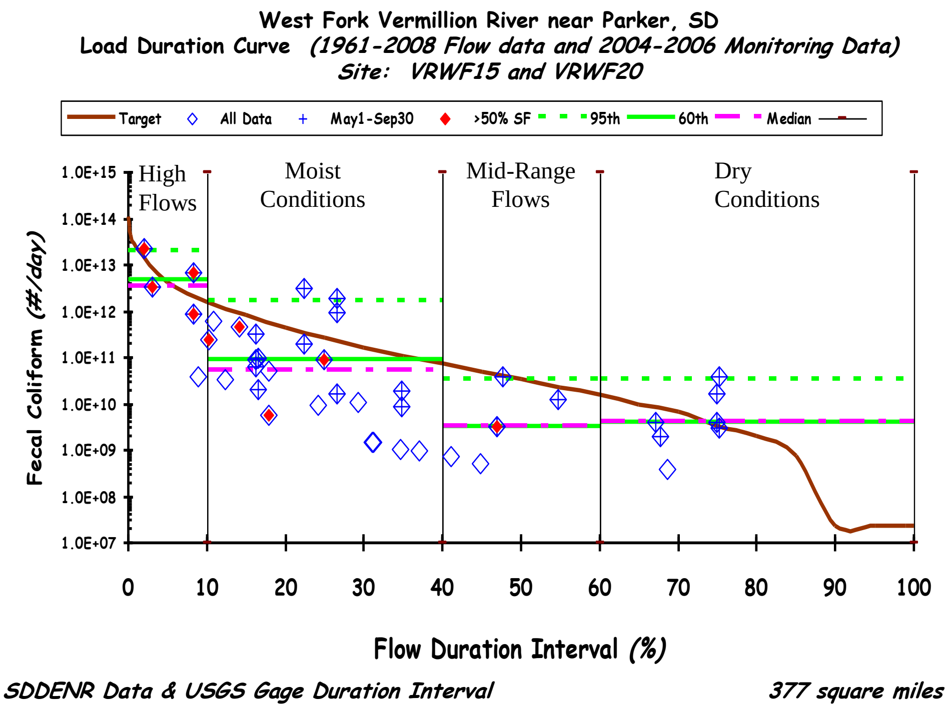

Vermillion River near Vermillion, SD
Load Duration Curve (1983-2008 Flow data and 1983-2008 Monitoring Data)
Site: VR01 and VR03 with WQM Site 460745
Geo.Mean
Single
All Data
>50% SF
95th
Median
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
2302 square miles

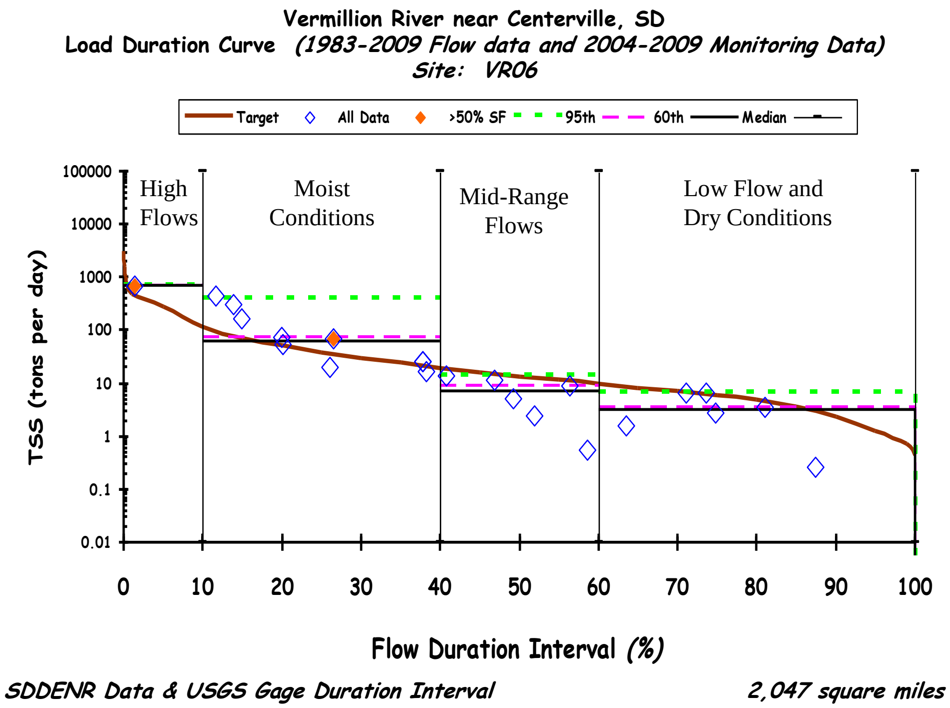

Vermillion River near Vermillion, SD
Load Duration Curve (1983-2008 Flow data and 1983-2008 Monitoring Data)
Site: VR01 and VR03 with WQM Site 460745
Target
All Data
>50% SF
95th
Median
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
2302 square miles

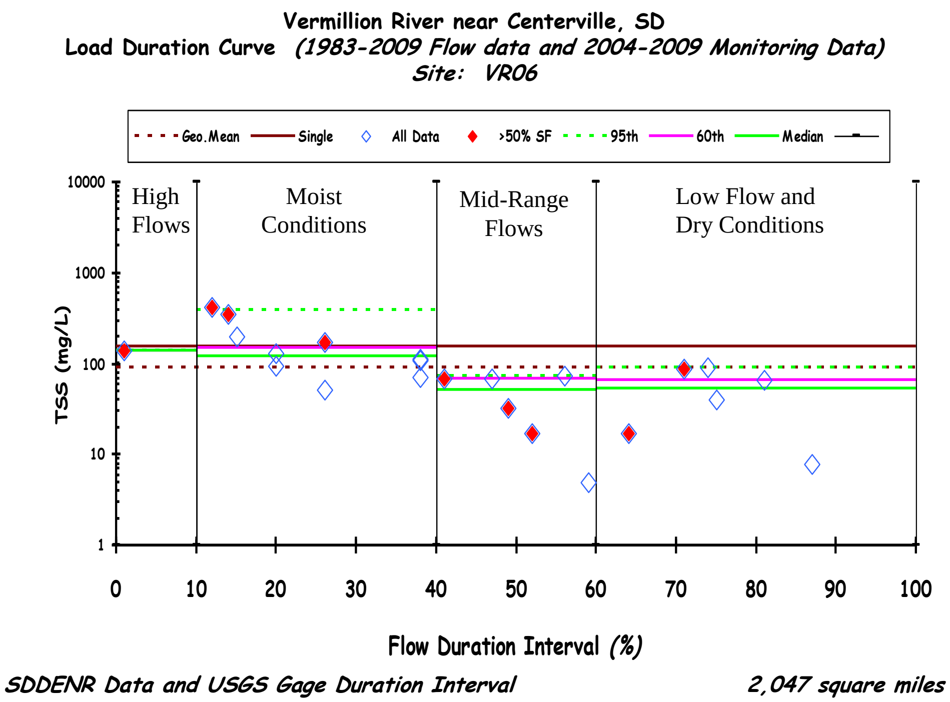

West Fork Vermillion River near Parker, SD
Load Duration Curve (1961-2008 Flow data and 2004-2006 Monitoring Data)
Site: VRWF15 and VRWF20
Target
All Data
May1-Sep30
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
Fecal Coliform (#/day)
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
377 square miles

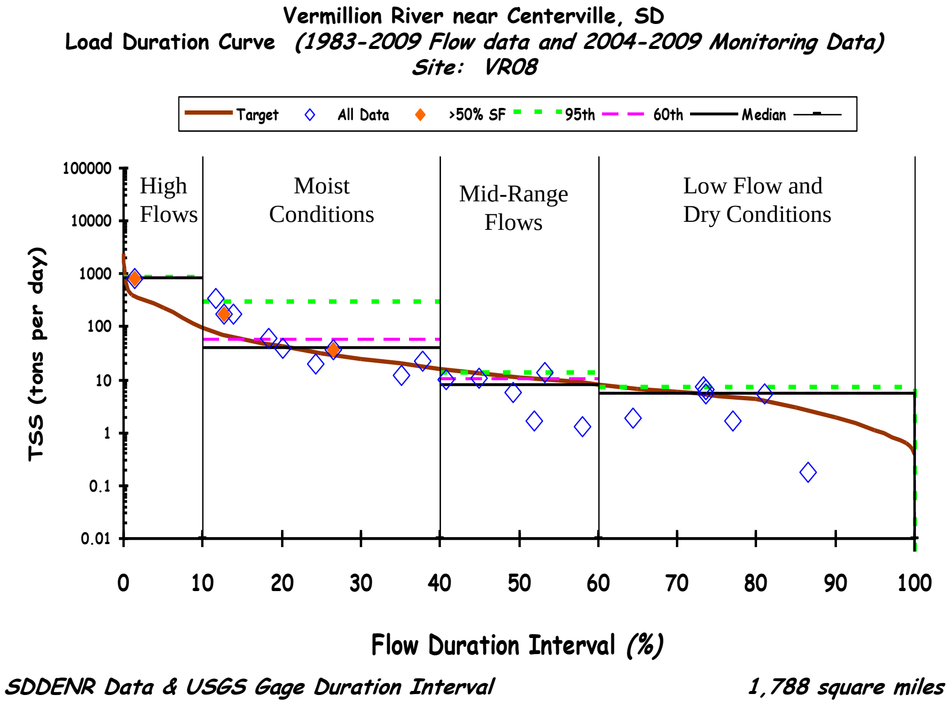

Vermillion River near Wakonda, SD (Segment R7 – 2010 IR)
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR05 with WQM Site 460755
Target-90
Target-158
WLA
All Data
>50% SF
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
ΣWLA
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
2,177 square miles

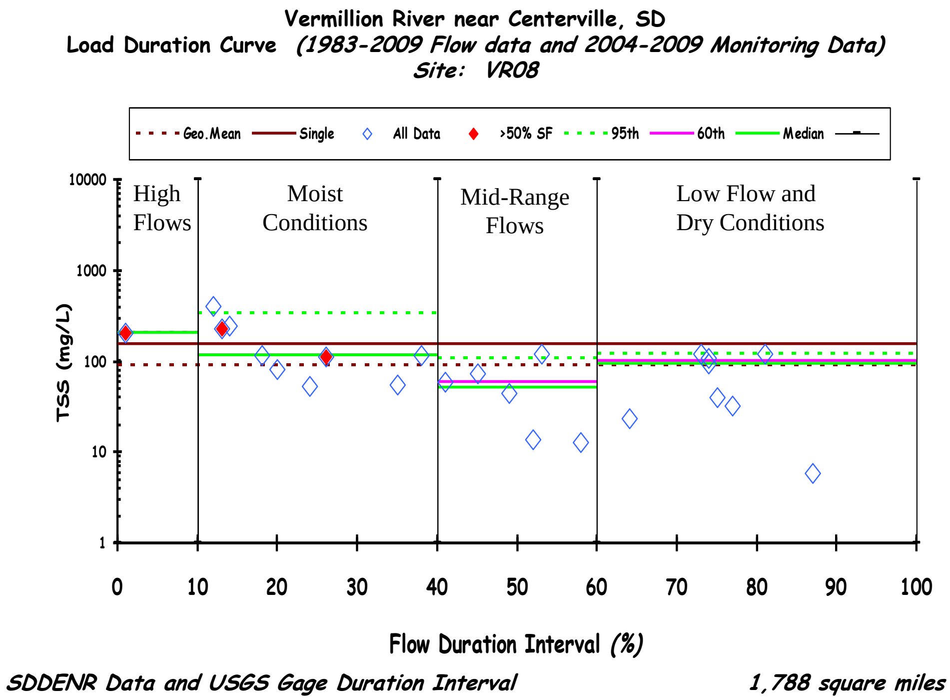

Vermillion River near Wakonda, SD (Segment R7 - 2010IR)
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR05 with WQM Site 460755
Geo.Mean
Single
All Data
>50% Storm Flow
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
2,177 square miles

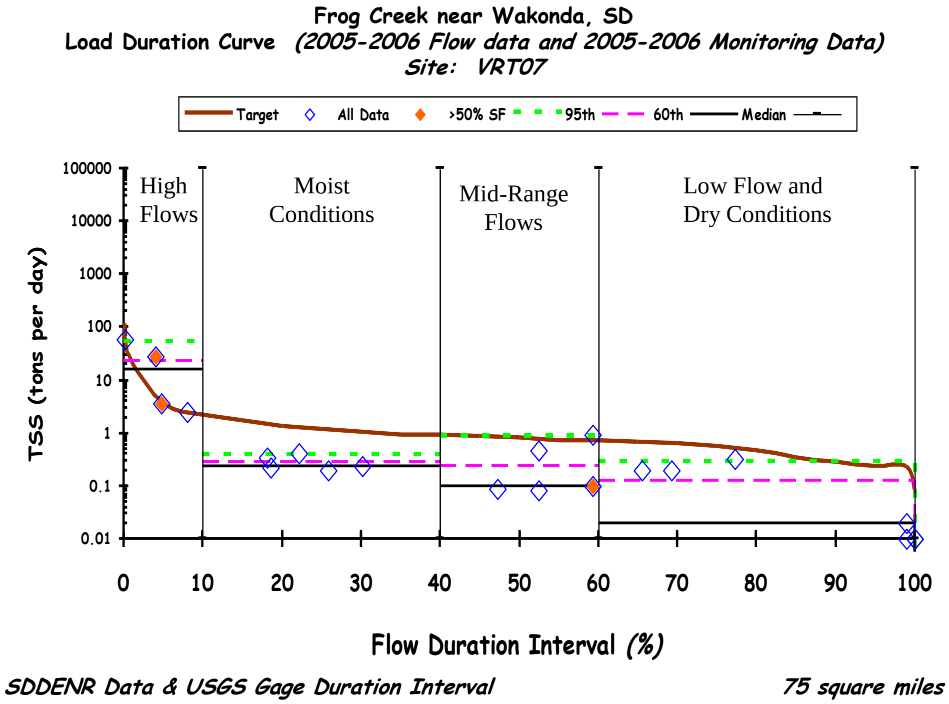

West Fork Vermillion River near Parker, SD
Load Duration Curve (1961-2008 Flow data and 2004-2006 Monitoring Data)
Site: VRWF15 and VRWF20
Target
All Data
May1-Sep30
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
Fecal Coliform (#/day)
1.0E+15
1.0E+14
1.0E+13
1.0E+12
1.0E+11
1.0E+10
1.0E+09
1.0E+08
1.0E+07
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
377 square miles

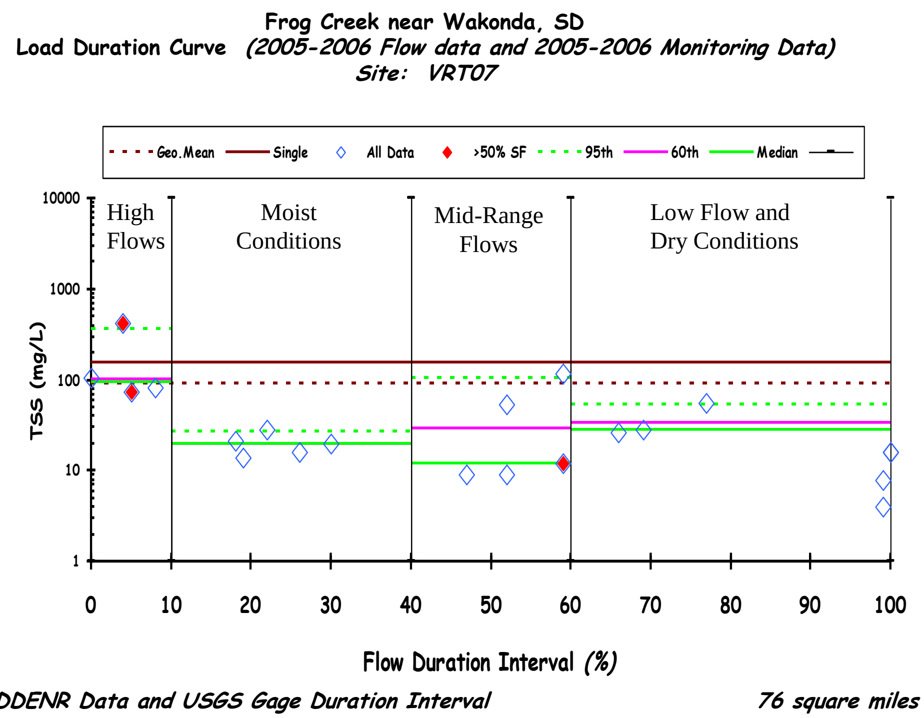

Vermillion River near Centerville, SD
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR06
Target
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
2,047 square miles

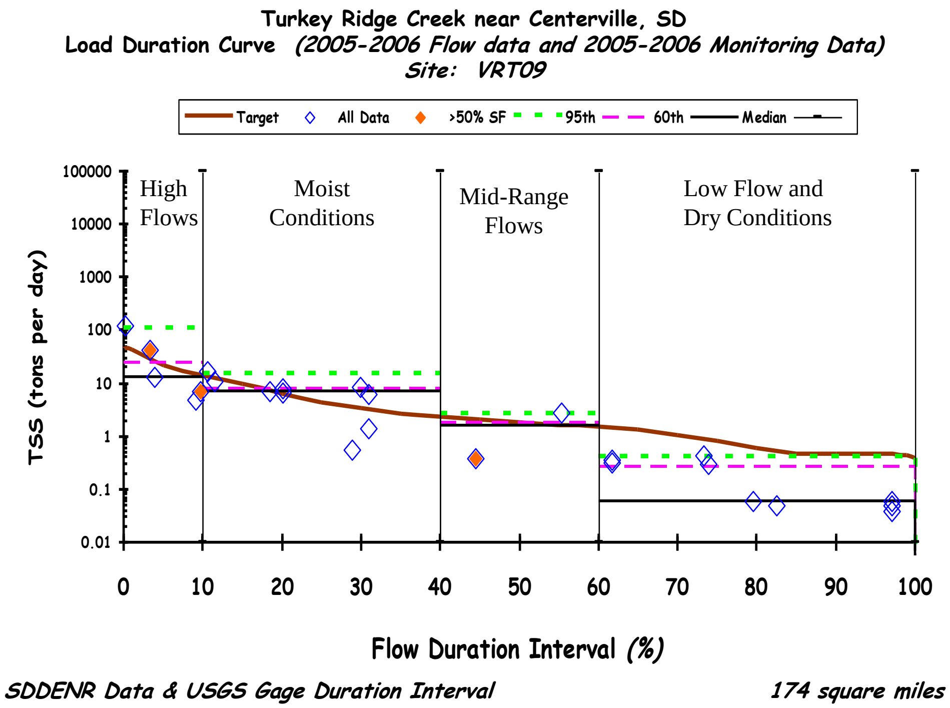

Vermillion River near Centerville, SD
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR06
Geo.Mean
Single
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
2,047 square miles

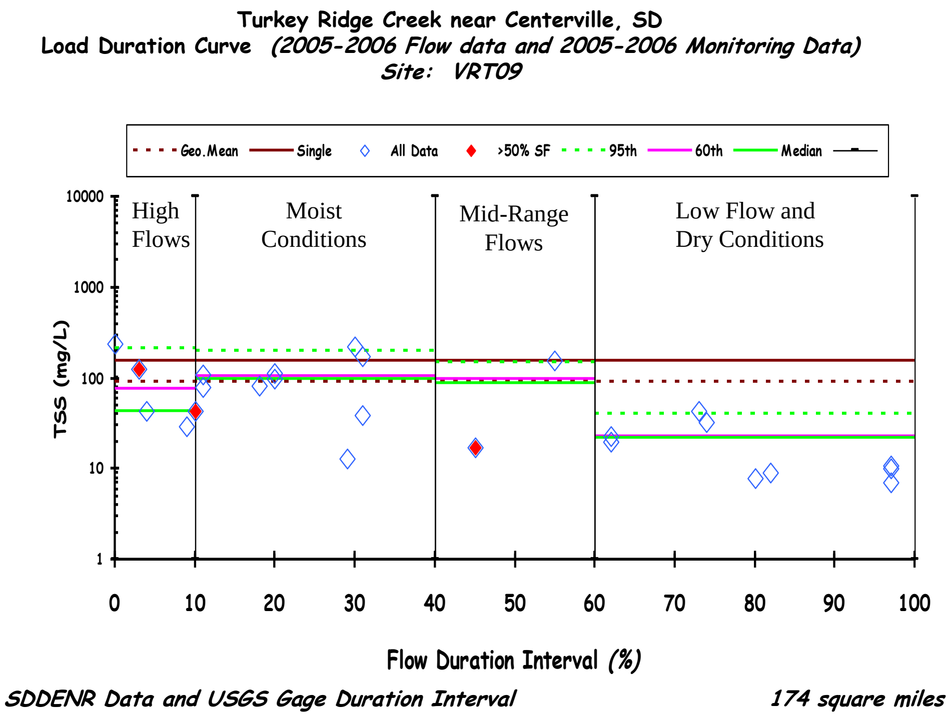

Vermillion River near Centerville, SD
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR08
Target
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
1,788 square miles

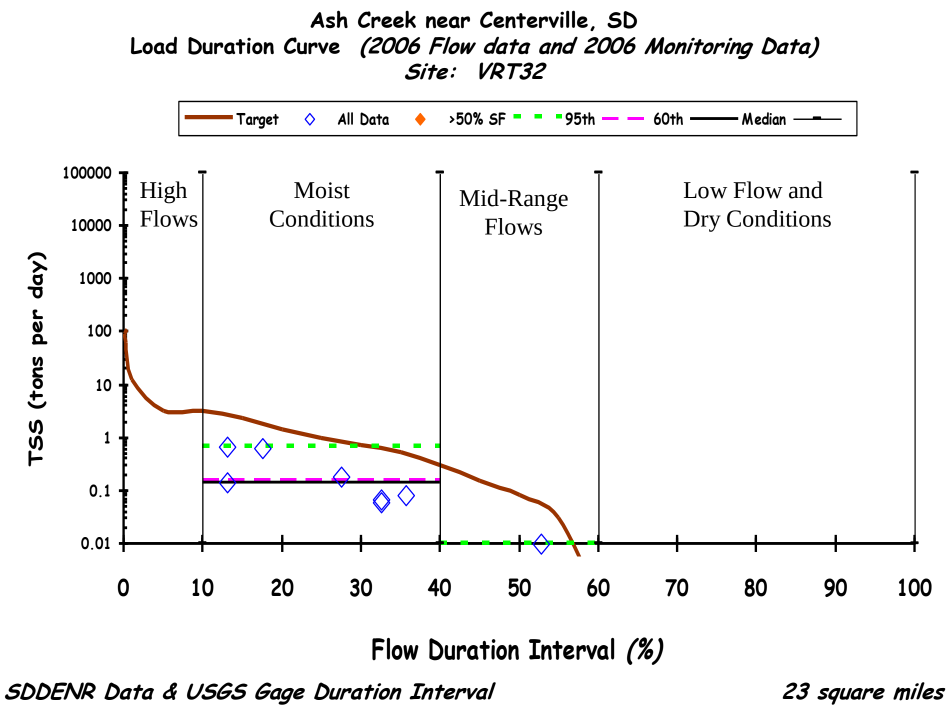

Vermillion River near Centerville, SD
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR08
Geo.Mean
Single
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
1,788 square miles

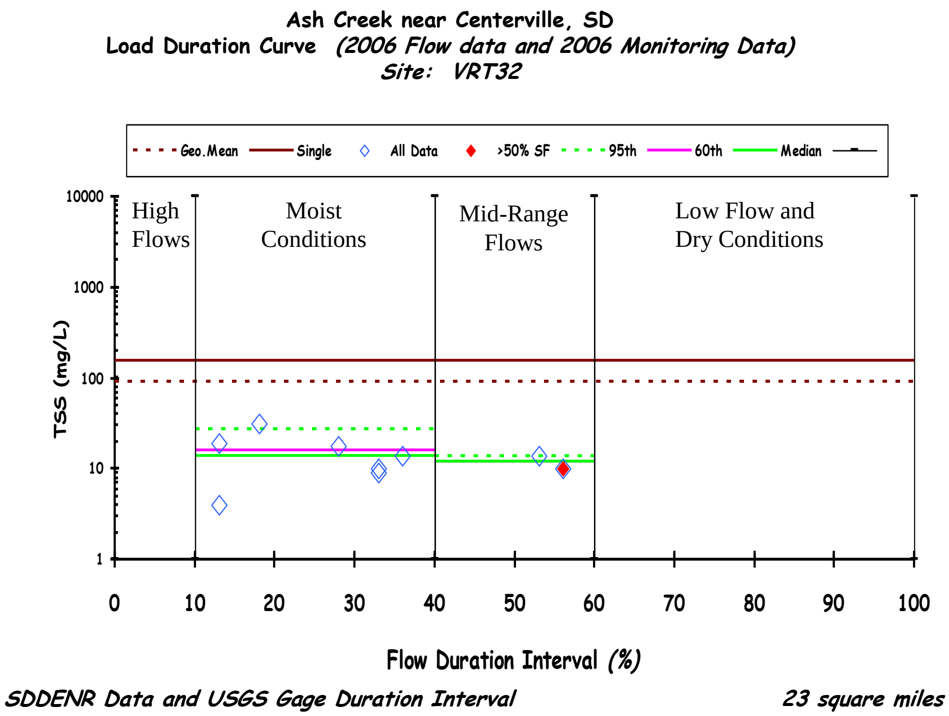

Frog Creek near Wakonda, SD
Load Duration Curve (2005-2006 Flow data and 2005-2006 Monitoring Data)
Site: VRT07
Target
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
75 square miles


Frog Creek near Wakonda, SD
Load Duration Curve (2005-2006 Flow data and 2005-2006 Monitoring Data)
Site: VRT07
Geo.Mean
Single
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
76 square miles


Turkey Ridge Creek near Centerville, SD
Load Duration Curve (2005-2006 Flow data and 2005-2006 Monitoring Data)
Site: VRT09
Target
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
174 square miles


Turkey Ridge Creek near Centerville, SD
Load Duration Curve (2005-2006 Flow data and 2005-2006 Monitoring Data)
Site: VRT09
Geo.Mean
Single
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
174 square miles


Ash Creek near Centerville, SD
Load Duration Curve (2006 Flow data and 2006 Monitoring Data)
Site: VRT32
Target
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
23 square miles


Ash Creek near Centerville, SD
Load Duration Curve (2006 Flow data and 2006 Monitoring Data)
Site: VRT32
Geo.Mean
Single
All Data
>50% SF
95th
60th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (mg/L)
10000
1000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
23 square miles

17.0 APPENDIX B: Load Allocation and Reduction Tables

Station ID:	VR05 with Ambient Station WQM4			
Station name:	DENR Gaging Station upstream of USGS Gage 06479010			
Parameter of Concern	Flow Zone (expressed as tons/day)			
TSS	**Extreme Flows (0-10)**	**High-Range (10-40)**	**Mid Range Flows (40-60)**	**Low Flows (60-100)**
Flow Range	**>656 cfs**	**117-656 cfs**	**60-117 cfs**	**<60 cfs**
Median Flow Per Zone	1563.22	227.86	81.81	31.24
Load Allocation	340.4	49.5	17.6	6.6
WLA - BERESFORD (SD0020079)	0.15	0.15	0.15	0.15
WLA - CLAY RWS INC (SD0025275)	0	0	0	0
VLA - LUTHERAN SOCIAL SERVICES (SD0025640)	0	0	0	0
WLA - VIBORG (SD0020541)	0.01	0.01	0.01	0.01
WLA - WAKONDA (SD0020257)	0.01	0.01	0.01	0.01
MOS (10% Explicit)	37.8	5.5	2.0	0.8
TMDL	**378.5**	**55.2**	**19.8**	**7.6**
Existing Condition				
Average Load per Zone	414.329	70.025	13.320	3.781
Load Reduction	**8.7%**	**21.2%**	**-48.7%**	**-100.0%**
Average Concentration per Zone	116	106	62	53
Number of Values	8	35	24	46
Current Load or existing Condition is the average of the observed TSS Loads for each flow zone.				
Runoff calculated using Median Flow/Area				
mm/day	0.68	0.10	0.04	0.01
cfs/sqmile	0.72	0.10	0.04	0.01

Station ID: VR06
Station name: DENR Gaging Station upstream of VR05

TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	1167.68	160.72	55.97	20.77
mm/day	0.54	0.07	0.03	0.01
cfs/sqmile	0.57	0.08	0.03	0.01
load_duration_target	**282.695**	**38.912**	**13.551**	**5.029**
Median %Flow	5.0%	25.0%	50.0%	80.0%

Existing Condition				
95th Percentile	696.714	394.806	13.714	6.753
60th Percentile	696.714	73.530	9.433	3.643
Median	**696.714**	**63.398**	**7.277**	**3.214**
Number of Values	1	10	6	6

Reductions				
95th Percentile	59.4%	90.1%	1.2%	25.5%
60th Percentile	59.4%	47.1%	-43.7%	-38.0%
Median	**59.4%**	**38.6%**	**-86.2%**	**-56.4%**

Station ID: VR08
Station name: DENR Gaging Station near Centerville, SD

TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	943.73	132.70	46.74	17.53
mm/day	0.50	0.07	0.02	0.01
cfs/sqmile	0.53	0.07	0.03	0.01
load_duration_target	**228.478**	**32.126**	**11.315**	**4.244**
Median %Flow	5.0%	25.0%	50.0%	80.0%

Existing Condition				
95th Percentile	832.473	292.426	13.369	7.295
60th Percentile	832.473	58.421	10.432	5.644
Median	**832.473**	**39.836**	**8.131**	**5.508**
Number of Values	1	9	6	7
Reductions				
95th Percentile	72.6%	89.0%	15.4%	41.8%
60th Percentile	72.6%	45.0%	-8.5%	24.8%
Median	**72.6%**	**19.4%**	**-39.2%**	**22.9%**

Station ID: VRT07
Station name: Frog Creek

TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	14.74	4.80	3.35	1.89
mm/day	0.19	0.06	0.04	0.02
cfs/sqmile	0.20	0.06	0.04	0.03
load_duration_target	**3.569**	**1.163**	**0.812**	**0.458**
Median %Flow	5.0%	25.0%	50.0%	80.0%

Existing Condition				
95th Percentile	53.402	0.391	0.851	0.288
60th Percentile	23.353	0.281	0.244	0.128
Median	**15.989**	**0.234**	**0.096**	**0.022**
Number of Values	4	5	5	7
Reductions				
95th Percentile	93.3%	-197.5%	4.6%	-59.3%
60th Percentile	84.7%	-314.4%	-232.9%	-258.2%
Median	**77.7%**	**-395.9%**	**-742.9%**	**-2030.4%**

Station ID: VRT09
Station name: Turkey Ridge Creek

TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	91.90	17.91	7.40	2.52
mm/day	0.50	0.10	0.04	0.01
cfs/sqmile	0.53	0.10	0.04	0.01
load_duration_target	**22.248**	**4.336**	**1.792**	**0.610**
Median %Flow	5.0%	25.0%	50.0%	80.0%

Existing Condition				
95th Percentile	108.582	14.645	2.645	0.416
60th Percentile	25.433	7.964	1.814	0.257
Median	**13.448**	**7.126**	**1.576**	**0.059**
Number of Values	5	9	2	9

Reductions				
95th Percentile	79.5%	70.4%	32.2%	-46.5%
60th Percentile	12.5%	45.6%	1.2%	-136.9%
Median	**-65.4%**	**39.2%**	**-13.7%**	**-930.1%**

Station ID: VRT32
Station name: Ash Creek

TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	9.70	2.43	0.10	0.01
mm/day	0.40	0.10	0.00	0.00
cfs/sqmile	0.42	0.11	0.00	0.00
load_duration_target	**2.349**	**0.589**	**0.025**	**0.003**
Median %Flow	5.0%	25.0%	50.0%	80.0%

Not Enough Flow Data

Existing Condition				
95th Percentile	#N/A	#N/A	#N/A	
60th Percentile	#N/A	#N/A	#N/A	
Median	**#N/A**	**#N/A**	**#N/A**	
Number of Values	1	4	2	0

Reductions				
95th Percentile	#N/A	#N/A	#N/A	#VALUE!
60th Percentile	#N/A	#N/A	#N/A	#VALUE!
Median	**#N/A**	**#N/A**	**#N/A**	**#VALUE!**

18.0 APPENDIX C: Monitoring Sites

See Figures 1 and 7 for maps showing locations of monitoring sites.

		Beneficial Uses	Decimal Degrees	
			Latitude	Longitude
STATION_ID	Waterbody			
VR01	Vermillion River	5,8,9,10	42.77264167	96.93054444
VRT02	Yankton Clay Ditch	9,10	42.78653056	96.96755556
VR03	Vermillion River	5,8,9,10	42.81728056	96.92442222
VRT04	Clay Creek Ditch	9,10	42.82266389	96.98124722
VR05	Vermillion River	5,8,9,10	42.95339167	96.94236667
VR06	Vermillion River	5,8,9,10	43.04034167	96.94410833
VRT07	Frog Creek	9,10	43.01109722	97.01378056
VR08	Vermillion River	5,8,9,10	43.11183333	96.98101944
VRT09	Turkey Ridge Creek	6,8,9,10	43.12654444	96.98820000
VRT10	Long Creek	9,10	43.19979167	96.90425556
VRT11	Hurley Creek	9,10	43.24842222	97.02329444
VRT12	Camp Creek	6,8,9,10	43.37335833	97.01999444
VR13	Vermillion River	5,8,9,10	43.31633611	97.01207778
VREF14	East Fork Vermillion River	6,8,9,10	43.44535556	97.10966944
VRWF15	West Fork Vermillion River	6,8,9,10	43.41564722	97.20512222
VRWFT16	Silver Lake outlet	6,8,9,10	43.45353333	97.40342500
VREF17	East Vermillion Lake outlet	6,8,9,10	43.58591389	97.17236944
VREFT18	Unnamed Tributary	9,10	43.58931111	97.20834722
VREF19	East Fork Vermillion River	6,8,9,10	43.69190000	97.18055833
VRWF20	West Fork Vermillion River	6,8,9,10	43.68815000	97.40805833
VREFT21	Little Vermillion River	9,10	43.71506111	97.20892500
VRWF22	West Fork Vermillion River	9,10	43.87751111	97.48106389
VREF23	East Fork Vermillion River	9,10	43.86497500	97.24889444
VRWF24	West Fork Vermillion River	9,10	44.06605556	97.53173889
VREF25	East Fork Vermillion River	9,10	44.12432222	97.38650556
VRSL26	Silver Lake	6,7,8	43.44870000	97.40404167
VRELV27	East Lake Vermillion	4,7,8	43.59037222	97.17262500
VRELV28	East Lake Vermillion	4,7,8	43.61053056	97.16965000
VREFT29	Little Vermillion River	9,10	43.79445278	97.36905000
VRT30	Spirit Mound	9,10	42.85184167	96.94411667
VRT31	Baptist Creek	9,10	42.93895278	96.89515833
VRT32	Ash Creek	9,10	43.05452778	96.94374167
VRT33	Clay Creek	6,8,9,10	42.98193333	97.22719444
VRT34	Turkey Creek	6,8,9,10	42.95431111	97.17741389

19.0 APPENDIX D: Water Quality Data

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR05	3/24/2005	236	1443	1419	24	3	<0.02	0.1	<0.5	0.103	0.033	4.4	959	12.08	8.33	5.86		
VR05	3/24/2005	235	1446	1421	25	5	<0.02	0.1	<0.5	0.100	0.028	4.4	959	12.08	8.33	5.86		
VR05	4/5/2005	220	1793	1651	142	26	<0.02	<0.1	1.68	0.306	0.029	18.9	1354	13.34	8.45	14.19	<10	4.1
VR05	4/25/2005	277	1982	1830	152	24	<0.02	<0.1	1.16	0.330	0.073	14.0		11.88	8.25	12.22	100	52.0
VR05	5/17/2005	245	2037	1761	276	52	0.16	3.3	2.34	0.518	0.134	23.0		9.24	8.06	16.45	340	488.0
VR05	5/20/2005	196	1754	1324	430	40	0.16	4.2	2.63	0.706	0.150	21.0		7.47	7.81	19.87	600	517.0
VR05	6/6/2005	139	972	856	116	20	0.09	6.2	2.59	0.375	0.190	30.0		6.11	7.60	22.16	1600	1990.0
VR05	7/7/2005	215	1410	1274	136	28	<0.02	<0.1	1.53	0.317	0.018	23.0		8.81	7.97	23.58	120	23.9
VR05	8/18/2005	222	1165	1108	57	15	<0.02	<0.1	0.95	0.207	0.033	31.0		15.34	8.21	25.50	80	9.4
VR05	9/22/2005	250	1331	1207	124	34	<0.02	<0.1	1.41	0.288	0.035			10.40	8.12	20.16	80	26.9
VR05	1/23/2006	290	1710	1692	18	8	<0.02	0.9	0.79	0.140	0.052	2		15.05	8.18	-0.04	<10	9.7
VR05	2/27/2006	280	1559	1549	10	4	<0.02	0.4	<0.5	0.083	0.016	7	954	17.95	8.11	1.37	<10	7.4
VR05	3/13/2006	227	1443	1402	41	11	<0.02	<0.1	0.82	0.123	0.011	-3	942	13.31	8.54	3.83	<10	3.1
VR05	3/28/2006	253	1863	1800	63	13	<0.02	0.3	0.81	0.145	0.012	7	1132	13.82	8.36	6.50	10	10.9
VR05	4/27/2006	253	1763	1647	116	20	<0.02	0.7	1.4	0.249	0.024	22	1336	11.34	8.32	13.45	<10	14.3
VR05	5/11/2006	255	1777	1692	85	16	<0.02	0.5	1.16	0.182	0.012	12	1534	12.49	8.50	14.27	30	
VR05	5/24/2006	232	1621	1540	81	20	<0.02	<0.1	0.98	0.187	0.014	27		12.04	8.31	20.85	20	
VR05	6/20/2006	164	1363	1155	208	40	<0.02	3.1	2.61	0.442	0.077	23	1316	7.50	8.33	21.45	1400	
VR05	6/29/2006	197	1512	1428	84	24	<0.02	<0.1	1.32	0.249	0.018			11.87	8.22	24.61	90	
VR05	8/7/2006	185	1319	1229	90	14	<0.02	<0.1	<0.5	0.232	0.018		1515	7.43	7.80	23.42	600	
VR05	9/29/2006	220	1492	1411	81	15	<0.02	0.2	1.6	0.264	0.068	19		11.22	8.41	13.08	100	
VR05	12/6/2006	304	1692	1683	9	1	<0.02	<0.1	0.53	0.066	0.011	2	1060	15.86	8.96	0.14	<10	
VR05	10/27/205	266	1268	1211	57	14	<0.02	<0.1	1.05	0.181	0.013	16.0		13.91	8.35	8.48	<10	16.0
VR06	3/17/2005	237	1482	1465	17	4	<0.02	0.2	<0.5	0.078	0.029		903	15.23	8.41	2.95		
VR06	4/5/2005	215	1731	1619	112	18	<0.02	<0.1	1.64	0.268	0.028	18.3	1341	10.10	8.45	14.57	10	7.4
VR06	4/5/2005	215	1722	1612	110	22	<0.02	<0.1	1.59	0.258	0.029	18.3	1341	10.10	8.45	14.57	<10	2.0
VR06	4/25/2005	274	1912	1780	132	20	<0.02	0.8	1.23	0.320	0.086	8.0		11.63	8.14	12.20	90	110.6
VR06	5/17/2005	241	1928	1726	202	38	0.05	3.1	1.90	0.423	0.129	22.0		9.28	8.12	16.22	330	435.0
VR06	5/19/2005	183	1642	1222	420	52	0.20	4.6	2.50	0.770	0.167	27.0		7.55	7.82	20.70	1400	1550.0
VR06	6/6/2005	141	998	858	140	26	0.12	6.8	1.82	0.431	0.213	30.0		6.61	7.61	21.60	1500	1553.0

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR06	6/29/2005	249	1565	1209	356	64	<0.02	0.8	2.44	0.667	0.108	29.0		7.04	8.08	25.41	580	727.0
VR06	8/23/2005	206	1237	1149	88	24	<0.02	<0.1	1.27	0.262	0.024	22.0		14.25	8.38	23.59	30	4.1
VR06	8/25/2005																30	4.1
VR06	9/22/2005	232	1283	1191	92	30	<0.02	<0.1	1.44	0.260	0.034			10.80	8.26	21.30	40	16.6
VR06	1/24/2006	284	1702	1685	17	5	<0.02	0.9	0.68	0.151	0.079	4		16.00	8.20	0.10	20	43.5
VR06	2/27/2006	270	1567	1562	5	3	<0.02	0.6	<0.5	0.078	0.026	1	918	13.16	8.04	0.26	10	18.7
VR06	3/14/2006	232	1483	1450	33	9	<0.02	<0.1	0.89	0.126	0.010	-1	907	12.24	8.43	1.84	<10	6.2
VR06	3/28/2006	260	1900	1828	72	16	<0.02	0.4	0.93	0.147	0.015	8	1172	13.59	8.38	6.89	<10	24.3
VR06	4/27/2006	250	1714	1618	96	16	<0.02	0.7	1.12	0.228	0.035	22	1413	11.17	8.38	14.38	<10	18.3
VR06	5/11/2006	252	1734	1683	51	12	<0.02	0.6	0.99	0.141	0.015	13	1514	12.66	8.53	14.00	10	
VR06	5/25/2006	228	1618	1550	68	15	<0.02	<0.1	1.11	0.179	0.012	20		9.38	8.13	18.57	30	
VR06	6/20/2006	162	1542	1366	176	26	<0.02	2.5	1.93	0.446	0.025	21	1495	53.00	8.37	21.72	2200	
VR06	6/29/2006	186	1497	1423	74	24	<0.02	<0.1	1.35	0.267	0.019			13.93	8.41	26.99	150	
VR06	8/7/2006	139	1339	1272	67	16	<0.02	<0.1	<0.5	0.247	0.028		1513	7.40	7.71	23.76	750	
VR06	9/29/2006	223	1512	1444	68	12	<0.02	0.2	1.46	0.203	0.072	21		13.50	8.41	13.63	190	
VR06	12/6/2006	316	1845	1837	8	1	<0.02	<0.1	0.64	0.071	0.020	1	1124	18.26	8.45	-0.07	<10	
VR06	10/27/205	260	1288	1247	41	12	<0.02	<0.1	0.99	0.162	0.014	12.0		13.82	8.45	8.53	50	16.6
VR08	3/21/2005	229	1277	1253	24	4	<0.02	0.2	<0.5	0.088	0.019	3.3	779	14.69	8.47	2.13		
VR08	4/5/2005	205	1494	1376	118	20	<0.02	<0.1	1.65	0.279	0.023	16.1	1166	8.48	8.45	14.05	20	7.4
VR08	4/22/2005	248	1653	1535	118	20	<0.02	0.7	1.01	0.237	0.058	8.0		10.15	8.32	12.57	110	84.2
VR08	5/16/2005	222	1734	1506	228	48	0.17	3.4	2.22	0.430	0.128	16.0		10.52	8.09	16.56	900	980.0
VR08	5/19/2005	179	1533	1125	408	52	0.13	4.4	2.57	0.658	0.143	27.0		8.11	7.92	19.18	1200	770.0
VR08	6/6/2005	149	1049	841	208	28	0.09	6.5	1.98	0.469	0.260	30.0		7.01	7.61	21.72	1600	1120.0
VR08	6/29/2005	252	1397	1153	244	48	0.02	0.4	2.40	0.468	0.051	29.0		8.57	8.16	24.91	420	461.0
VR08	8/24/2005	189	1255	1133	122	30	<0.02	<0.1	1.38	0.298	0.016	23.0		15.03	8.54	22.62	190	36.3
VR08	9/22/2005	226	1317	1223	94	24	<0.02	<0.1	1.59	0.261	0.029			8.89	7.91	19.32	140	28.1
VR08	9/22/2005	227	1334	1226	108	24	<0.02	<0.1	1.47	0.274	0.026			8.89	7.91	19.32	180	30.0
VR08	11/1/2005	223	1233	1200	33	11	<0.02	<0.1	0.69	0.118	0.014	18.0		13.24	8.22	10.12	20	32.7
VR08	1/24/2006	267	1523	1509	14	6	<0.02	0.8	0.68	0.138	0.074	5		16.85	8.22	0.09	<10	8.5
VR08	2/28/2006	236	1236	1223	13	6	<0.02	0.5	<0.5	0.082	0.025	-1	788	14.44	8.22	0.17	<10	6.3

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR08	3/14/2006	238	1368	1323	45	12	<0.02	<0.1	1.07	0.152	0.009	2	897	14.02	8.22	3.92	<10	2.2
VR08	3/29/2006	243	1639	1583	56	13	<0.02	0.5	0.69	0.147	0.013	4	991	12.46	8.22	4.75	<10	5.2
VR08	4/27/2006	241	1529	1446	83	13	<0.02	0.5	0.82	0.197	0.027	20	1325	12.00	8.22	15.87	<10	14.8
VR08	5/9/2006	251	1625	1572	53	12	<0.02	0.6	0.99	0.140	0.018	14	1474	10.27	8.22	15.11	10	
VR08	5/25/2006	234	1547	1488	59	14	<0.02	0.3	0.76	0.145	0.011	19		10.56	8.22	18.59	60	
VR08	6/20/2006	180	1638	1524	114	24	<0.02	2.3	1.8	0.272	0.013	19	1604	8.37	8.22	21.03	2000	
VR08	6/28/2006	188	1418	1296	122	22	<0.02	<0.1	1.43	0.238	0.007			13.93	8.22	26.99	130	
VR08	8/7/2006	150	1677	1557	120	24	<0.02	<0.1	0.76	0.311	0.026		1815	10.46	8.22	26.04	600	
VR08	9/28/2006	216	1444	1370	74	16	<0.02	<0.1	1.36	0.241	0.085	7		11.00	8.22	11.57	170	
VR08	12/5/2006	335	1095	1089	6	<1	<0.02	<0.1	<0.5	0.052	0.015	4	1262	18.83	8.22	-0.14	<10	
VRT07	3/17/2005	250	2611	2602	9	5	<0.02	0.3	<0.5	0.023	0.014		1439	17.87	8.26	3.94		
VRT07	4/4/2005	258	2367	2353	14	5	<0.02	0.2	0.50	0.044	0.018	25.5	1794	19.14	8.52	15.27	20	24.6
VRT07	4/22/2005	316	2451	2369	82	12	0.05	0.9	1.13	0.242	0.104	8.0		8.10	8.15	10.87	15000	>2420
VRT07	5/12/2005	256	2216	1800	416	60	0.28	2.9	2.89	0.680	0.122	10.0		9.34	7.88	10.88	12000	>2420
VRT07	6/6/2005	209	1221	1115	106	16	<0.02	2.1	1.19	0.331	0.208	30.0		9.41	7.68	22.91	1500	1553.0
VRT07	7/7/2005	257	2301	2245	56	22	<0.02	1.1	1.71	0.159	0.027	28.0		21.85	8.30	28.63	2700	2420.0
VRT07	7/27/2005	251	2881	2763	118	30	<0.02	0.5	1.77	0.198	0.014	30.0		22.23	8.29	27.07	220	7.0
VRT07	9/22/2005	253	3021	2993	28	10	<0.02	0.1	0.91	0.097	0.020			10.20	7.86	19.11	100	7.1
VRT07	10/25/2005	286	3082	3066	16	2	<0.02	0.4	<0.50	0.032	0.014	12.0		14.94	8.22	9.25	2900	1730.0
VRT07	10/25/2005	288	3062	3046	16	3	<0.02	0.4	<0.50	0.028	0.013	12.0		14.94	8.22	9.25	110	127.0
VRT07	1/24/2006	319	2668	2660	8	4	<0.02	1.8	0.52	0.096	0.075	5		14.32	8.28	-0.19	10	22.3
VRT07	2/27/2006	294	2464	2460	4	2	<0.02	1	<0.5	0.018	0.006	6	1280	13.96	8.09	0.03	<10	21.6
VRT07	3/14/2006	244	2264	2255	9	1	<0.02	0.2	<0.5	0.020	0.008	-3	1188	12.16	8.23	0.39	<10	1.0
VRT07	3/28/2006	265	2244	2216	28	8	<0.02	0.7	0.51	0.067	0.021	5	1264	13.40	8.25	5.19	30	11.0
VRT07	4/11/2006	250	1987	1913	74	10	<0.02	1.5	0.66	0.190	0.078	21	1626	9.96	7.93	15.48	70	111.0
VRT07	5/10/2006	246	2364	2348	16	4	<0.02	1.7	<0.5	0.041	0.014	16	2067	12.83	8.01	16.66	110	
VRT07	5/24/2006	179	2694	2674	20	7	<0.02	1.9	0.98	0.040	0.006	23		16.11	8.21	22.35	150	
VRT07	6/19/2006	246	2629	2603	26	10	<0.02	1.5	1.13	0.075	0.021	24	2603	10.86	8.09	28.59	560	
VRT07	6/29/2006	213	2744	2690	54	36	<0.02	0.5	1.18	0.111	0.038			16.72	8.18	30.91	4800	
VRT07	9/25/2006	311	2876	2855	21	4	<0.02	0.4	0.8	0.114	0.071	15		12.23	8.34	11.75	1100	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VRT07	11/27/2006	281	2790	2778	12	<1	<0.02	0.4	<0.5	0.020	0.009	-1	1514	17.34	7.12	0.63	200	
VRT09	3/21/2005	234	2036	2028	8	2	<0.02	<0.1	<0.5	0.053	0.022	3.3	1160	15.59	8.41	2.47		
VRT09	4/4/2005	297	2381	2342	39	12	<0.02	<0.1	1.16	0.200	0.080	23.9	1751	13.49	8.46	13.66	50	75.4
VRT09	4/13/2005	272	2317	2274	43	12	<0.02	0.6	1.04	0.233	0.120	15.0	1553	11.02	7.98	9.38	900	1410.0
VRT09	4/21/2005	324	2583	2500	83	14	0.31	0.6	1.80	0.245	0.119	13.0		13.03	8.05	14.76	150	236.0
VRT09	5/12/2005	221	1987	1877	110	16	0.30	1.6	1.97	0.490	0.246	10.0		10.12	8.08	11.34	22000	>2420
VRT09	6/6/2005	195	1384	1144	240	32	0.20	5.3	3.24	0.523	0.189	29.0		8.96	7.67	22.17	2600	>2420
VRT09	7/7/2005	193	2065	1909	156	32	<0.02	<0.1	1.93	0.488	0.059	30.0		14.20	8.47	29.26	520	13.3
VRT09	8/25/2005	225	1881	1861	20	5	<0.02	<0.1	1.44	0.236	0.074	26.0		16.16	8.60	24.17	110	7.3
VRT09	9/14/2005	155	1495	1451	44	14	0.53	1.4	2.60	0.452	0.258	9.0		5.55	8.76	15.44	87000	>2420
VRT09	9/22/2005	186	1806	1773	33	12	<0.02	<0.1	1.00	0.170	0.068			16.45	8.48	23.62	260	12.7
VRT09	11/1/2005	256	2226	2203	23	10	<0.02	<0.1	1.14	0.165	0.077	18.0		12.82	8.34	12.41	140	185.0
VRT09	1/24/2006	329	2380	2370	10	7	0.06	1.2	0.73	0.203	0.122	4		22.22	8.18	-0.19	170	147.0
VRT09	1/24/2006	329	2370	2359	11	5	0.05	1.2	0.71	0.201	0.122	4					90	276.0
VRT09	2/28/2006	244	1819	1812	7	4	<0.02	0.5	<0.5	0.057	0.021	2	1055	17.92	8.19	0.03	220	548.0
VRT09	3/14/2006	225	1903	1890	13	2	<0.02	<0.1	0.45	0.074	0.025	1	1196	15.34	8.51	4.38	<10	<1
VRT09	3/29/2006	281	2175	2146	29	8	<0.02	0.6	0.58	0.123	0.039	6	1247	13.01	8.29	4.57	210	579.0
VRT09	4/12/2006	267	2187	2144	43	10	0.05	1.6	0.9	0.228	0.128	26	1785	11.21	8.01	15.43	100	148.0
VRT09	5/9/2006	281	2481	2384	97	18	0.07	1	1.12	0.280	0.089	17	2135	10.01	8.21	16.40	220	
VRT09	5/9/2006	283	2522	2407	115	18	0.07	1	1.17	0.315	0.091	17					260	
VRT09	5/25/2006	221	2345	2173	172	44	<0.02	<0.1	2.56	0.560	0.046	21		13.71	8.58	19.89	1200	
VRT09	6/20/2006	196	1486	1358	128	20	0.22	1.8	1.77	0.506	0.224	26		9.85	7.92	23.30	2400	
VRT09	6/28/2006	215	2099	1877	222	54	<0.02	<0.1	2.99	0.555	0.028			21.30	8.45	27.12	440	
VRT09	8/11/2006	188	1767	1758	9	<1	0.34	<0.1	1.45	0.271	0.169		2030	10.44	8.40	26.49	390	
VRT09	9/26/2006	220	1647	1569	78	12	0.16	1.8	1.51	0.449	0.224	23		9.24	8.27	14.89	4000	
VRT09	12/5/2006	336	2745	2728	17	4	<0.02	<0.1	0.67	0.091	0.012	7	1525	21.47	9.39	-0.07	10	
VRT32	3/14/2006	239	2966	2962	4	<1	<0.02	0.7	<0.5	0.027	0.008	-1	1565	12.77	8.30	1.17	<10	<1
VRT32	3/28/2006	257	2830	2811	19	4	<0.02	2.1	0.52	0.044	0.013	8	1671	12.71	8.30	6.91	40	108.0
VRT32	4/12/2006	274	2891	2860	31	7	<0.02	4.9	0.73	0.119	0.053	14	2060	11.50	8.14	11.33	40	85.7
VRT32	5/10/2006	219	3019	3010	9	7	<0.02	3.8	<0.5	0.029	0.006	16	2620	13.15	8.46	17.05	<10	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VRT32	5/10/2006	218	3058	3048	10	7	<0.02	3.8	<0.5	0.026	0.006	16					20	
VRT32	5/24/2006	209	2749	2735	14	5	0.12	1.9	0.52	0.045	0.014	22		9.14	8.11	18.90	290	
VRT32	6/19/2006	200	2140	2122	18	8	0.03	2.2	1.17	0.091	0.052	24	2202	8.87	8.14	23.85	700	
VRT32	6/29/2006	244	3061	3047	14	7	<0.02	1	0.6	0.061	0.042			13.26	8.29	25.67	400	
VRT32	9/26/2006	243	2439	2429	10	2	0.07	2.4	0.59	0.176	0.145	21		10.40	8.23	11.62	630	
VRT33	4/6/2006	208	2062	1997	65	15	0.07	0.4	1.18	0.16	0.026	20				no sample found	10	44.8
VRT33	4/12/2006	205	2005	1913	92	16	<0.02	0.5	1.09	0.23	0.050	22	1551	11.11	8.03	13.77	340	1730.0
VRT33	4/12/2006	205	2009	1904	105	19	<0.02	0.6	1.03	0.215	0.049	22					360	980.0
VRT33	4/27/2006	203	2057	2036	21	4	<0.02	<0.1			0.015	19		11.98	8.42	15.62	10	38.4
VRT33	5/24/2006	234	2241	2207	34	7	<0.02	0.2	<0.5	0.046	0.008	26		10.08	8.13	22.88	480	
VRT33	6/20/2006	188	2237	2167	70	22	<0.02	0.2	2.57	0.161	0.010	28	2190	7.70	8.26	25.53	800	
VRT33	6/29/2006	236	2292	2277	15	6	<0.02	0.4	0.8	0.048	0.019			10.22	8.11	24.28	180	
VRT33	9/25/2006	290	2232	2223	9	1	<0.02	0.5	<0.5	0.053	0.040	21		12.59	8.29	12.49	730	
VRT33	11/21/2006	272	2276	2248	28	1	<0.02	0.2	0.56	0.064	0.012	14	1269	14.10	7.49	1.65	<10	
VRT33	11/21/2006	272	2283	2251	32	1	<0.02	0.2	0.76	0.058	0.012	14					10	
VRT34	4/12/2006	279	2052	1916	136	18	<0.02	0.7	0.69	0.237	0.060	18	1514	10.30	8.08	12.63	70	167.0
VRT34	4/27/2006	257	2204	2169	35	7	<0.02	0.2			0.013	19		12.52	8.23	13.78	20	60.9
VRT34	5/24/2006	240	1888	1857	31	6	<0.02	0.2	<0.5	0.049	0.009	26		10.99	8.16	21.64	160	
VRT34	6/20/2006	260	2196	2070	126	18	<0.02	1.2	1.95	0.281	0.090	28	2038	7.26	8.05	24.43	2900	
VRT34	6/29/2006	244	2016	1979	37	13	<0.02	0.1	<0.5	0.05	0.016			11.59	8.10	23.20	510	
VRT34	9/25/2006	262	1760	1703	57	11	<0.02	0.4	0.64	0.157	0.050	22		11.23	8.35	14.14	710	
VRT34	11/21/2006	263	1917	1910	7	1	<0.02	0.2	<0.5	0.026	0.008	14	1197	14.18	7.61	4.13	20	
WQM4	12/11/1968		1413					0									42000	
WQM4	12/27/1972		1402		72			0										
WQM4	3/26/1973		1451		253			2.3						5			330	
WQM4	10/10/1973	198	1128		136			1.25									1200	
WQM4	11/12/1973		1332		16			1.15						13.2			1400	
WQM4	3/26/1974	235	1371		48			0.13	1.11		0.143			12.2			170	
WQM4	4/15/1974	278	1790		96			0.55	0.94		0.168			10.4			240	
WQM4	5/14/1974	256	1432		64			0.14	1.44		0.175			9.7			4300	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	6/4/1974	219	1335		73			0.03	1.1		0.091			18.69999			47	
WQM4	7/15/1974	209	1205		15			0.08	1.58		0.164			16.39999			30	
WQM4	8/5/1974	200.39	1112		65			0.18	0.99		0.127			14.9			87	
WQM4	9/16/1974	234	1183		5			0.54	1.808		0.15			5.9			270	
WQM4	10/15/1974	296.79	1341		47			0.12	1.48		0.365			5.7			200	
WQM4	11/6/1974	274.79	1242		38				1.63		0.366						430	
WQM4	12/9/1974	288.59	1261		13				2.72		0.473			7.3			3300	
WQM4	4/15/1975	140	606		242			3.45			0.154			9			250	
WQM4	5/6/1975	181	1841		551						0.096			7			10	
WQM4	6/23/1975	176	1094		18						0.131			16			6	
WQM4	12/1/1977				33			0.8			0.161			11			10000	
WQM4	12/28/1977				21			0.5			0.051			8			2600	
WQM4	1/12/1978							0.3			0.165			5.3			29000	
WQM4	6/26/1978				66			0.7			0.106			5.9			4100	
WQM4	9/25/1978				43			0.1			0.053			9.6			1000	
WQM4	9/28/1982	0			78						0.129			8.7			320	
WQM4	10/26/1982	0			55						0.301			9.5			1500	
WQM4	11/30/1982	0			110						0.308			12.5			260	
WQM4	12/27/1982	0			12						0.084			11				
WQM4	1/25/1983	0			142						0.234			10.4			80	
WQM4	3/1/1983	0			195					0.492	0.365			11.1			60	
WQM4	3/30/1983	0			70					0.38	0.136			12.1			450	
WQM4	4/20/1983				56					0.207	0.084			10.9			70	
WQM4	5/24/1983	0			130					0.231	0.094			9.5			26	
WQM4	6/28/1983	0	604		96					0.346	0.203			5.5			16000	
WQM4	7/26/1983	0	1568		255					0.566	0.134			6.5			700	
WQM4	8/23/1983		1311		140					0.247	0.05			7.8			290	
WQM4	9/27/1983		1267		38					0.132	0.009			8.5			70	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	10/25/1983		1326		32					0.132	0.019			9.7			20	
WQM4	1/25/1984		1372		22					0.095	0.028			10.2			10	
WQM4	2/28/1984		1529		78					0.356	0.207			12.1			120	
WQM4	3/27/1984		1257		505					0.742	0.141			11.6			570	
WQM4	4/11/1984		415		26					0.122	0.026			11.4			50	
WQM4	4/25/1984		1018		188					0.251	0.184			10.5			130	
WQM4	5/22/1984		1466		252					0.0339	0.103			7.7			60	
WQM4	7/24/1984	263	1432		320					0.651	0.068			6.5			170	
WQM4	8/28/1984	224	1288		144					0.254	0.051			8			100	
WQM4	9/25/1984	241	1268		56					0.039	0.027			10.1			70	
WQM4	10/23/1984	216	1371		152					0.329	0.111			11.1			8000	
WQM4	11/27/1984	283	1399		26					0.112	0.019			12.5			60	
WQM4	12/18/1984	305	1610		23					0.122	0.035			13.6			290	
WQM4	1/29/1985	320	1383		15					0.081	0.02			11.6			20	
WQM4	2/27/1985	188	1103		46					0.329	0.303			12.1			60	
WQM4	3/26/1985	142	1031		360						0.143			10.1			220	
WQM4	4/29/1985	184	1444		276					0.439	0.107			8.8			1800	
WQM4	5/28/1985	235	1510		184					0.088	0.014			8.6			110	
WQM4	6/25/1985	225	1463		160					0.298	0.034			7.5			180	
WQM4	7/30/1985	242	1495		92					0.146	0.012			5.5			160	
WQM4	8/27/1985	227	1595		106					0.193	0.009			9.1			640	
WQM4	9/24/1985	278	1671		146					0.2	0.049			10			52000	
WQM4	10/28/1985	275	1566		34					0.132	0.012			10.6			50	
WQM4	12/17/1985	344	1537		7					0.081	0.012			12				
WQM4	1/28/1986	334	1632		15					0.085	0.011			12.2				
WQM4	2/25/1986	308	1437		6					0.17	0.009			13.2				
WQM4	3/25/1986	149	947		270					0.224	0.19			9.9			50	
WQM4	4/29/1986	291	1115		264					0.359	0.087			9.1				
WQM4	5/27/1986	255	1559		214					0.064	0.058			8.3			290	
WQM4	6/24/1986	183	1552		530					0.451	0.065			6.5			1500	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	7/29/1986	215	1357		160					0.258	0.029			7.6			700	
WQM4	8/26/1986	199	1144		100					0.258				7.6			6000	
WQM4	9/24/1986	146	1004		208					0.468	0.298			6.1			800	
WQM4	10/28/1986	288	1580		62					0.197	0.072			10			80	
WQM4	11/18/1986	323	1591		11					0.112	0.036			13.1			40	
WQM4	12/30/1986	304	1494		17					0.105	0.018			13.4			20	
WQM4	1/28/1987	316	1523		2					0.078	0.009			13				
WQM4	2/24/1987	279	1583		39					0.105	0.032			13				
WQM4	3/24/1987	230	2498		860					0.864	0.131			10.6				
WQM4	4/28/1987	251			100					0.197				9.3			30	
WQM4	5/19/1987	257	1550		100					0.217	0.006			10.2			50	
WQM4	6/23/1987	202	1569		164					0.264	0.013			7.2			300	
WQM4	7/29/1987	215	1393		134					0.193	0.054			6.9			160	
WQM4	8/26/1987	236	1410		62					0.14	0.007			8.5				
WQM4	9/30/1987	245	1439		72					0.166				9.1			50	
WQM4	10/27/1987	267	1441		42					0.102	0.006			12				
WQM4	11/17/1987	252	1438		54			0.1		0.088	0.005			11.3			70	
WQM4	12/29/1987	294	1550		16			0.1		0.068	0.005			13.5				
WQM4	1/26/1988	313	1520		9			0.3		0.061				8.2				
WQM4	2/23/1988	197	927		4			0.5			0.612			11.2			80	
WQM4	3/29/1988	762	1381		140					0.529	0.006			11.4			50	
WQM4	4/27/1988	239	1641		144			0.1		0.251				11.4			1500	
WQM4	5/25/1988	208	1886		452					0.614	0.075			7.9				
WQM4	6/30/1988	227	1330		92					0.193	0.009			7.6			800	
WQM4	7/27/1988	239	1458		104					0.149	0.017			6.7			120	
WQM4	8/16/1988	240	1368		58					0.156	0.017			6.4			150	
WQM4	9/28/1988	197	998		100			0.2		0.2	0.069			8.4			3000	
WQM4	11/22/1988	255	1293		18			0.6		0.095	0.01			13			20	
WQM4	2/28/1989	276	1412		16					0.054	0.024			13.2				
WQM4	3/28/1989	136	878		212					0.332	0.04			9.3			10	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	5/23/1989	243	1424		66					0.244				10			40	
WQM4	6/27/1989	123	1177		84					0.281	0.024			9.8			550	
WQM4	7/25/1989	182	1430		116					0.22	0.011			9.8			200	
WQM4	8/22/1989	200	1293		64					0.159	0.016			4.5			2000	
WQM4	9/26/1989	233	1323		104					0.17	0.013			6.8			170	
WQM4	10/24/1989	268	1535		68					0.119	0.008						10	
WQM4	11/21/1989	264	1398					0.1		0.044	0.032			7				
WQM4	12/18/1989	340	1734		4			0.1		0.037	0.008			8			30	
WQM4	1/23/1990	274	1372		5			0.1		0.04	0.033			8				
WQM4	2/21/1990	253	1369		8			0.1		0.028	0.007			8.9				
WQM4	3/27/1990	203	1190							0.081				4.9				
WQM4	4/30/1990	232	1322		26					0.095				9.8				
WQM4	5/22/1990	208	1364		76					0.258	0.02			9.8			460	
WQM4	6/25/1990	215	1412		132			0.7		0.562	0.031			3.5			1300	
WQM4	7/23/1990	219	1280		94					0.322	0.008			3.8			340	
WQM4	8/20/1990	237	1505		50					0.254	0.023			8.1			130	
WQM4	9/25/1990	239	1571		32					0.125	0.018			9.7			270	
WQM4	10/23/1990	259	1513		40					0.081	0.02			11.8			30	
WQM4	11/26/1990	254	1411		12					0.044				14			20	
WQM4	12/18/1990	303	1587		10					0.048	0.024			15			10	
WQM4	1/28/1991	306	1502		12			0.1		0.034				14				
WQM4	2/19/1991	257	1331		2					0.034				14.4				
WQM4	3/12/1991	207	1353		16					0.075				16.59999			40	
WQM4	4/22/1991	241	1356		44					0.142	0.008			10.6			28	
WQM4	5/21/1991	233	1802		164			0.2		0.403	0.008			8.3			140	
WQM4	6/18/1991	210	1226		242			0.9		0.424	0.1			10.9			460	
WQM4	7/23/1991	184	961		164			0.6		0.132	0.052			7.9			0	
WQM4	8/19/1991	246	1383		66			0.7		0.2	0.027			11			200	
WQM4	9/23/1991	271	1491		38					0.078	0.012			11			220	
WQM4	10/21/1991	302	1558		36					0.098	0.024			10			40	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	11/18/1991	524	1175		18			0.1		0.064	0.011			12.2			10	
WQM4	12/16/1991	331	1432		2						0.015			11.9			10	
WQM4	1/28/1992	289	1432		10			0.1		0.04	0.013			17.39999				
WQM4	2/25/1992	121	569		170			1.2		0.631	0.216			12.8				
WQM4	3/24/1992	190	1106		112					0.339				14.5				
WQM4	4/21/1992	218	1198		40					0.139				12.8			10	
WQM4	5/19/1992	175	1272		255			0.7		0.405	0.043			7.5			560	
WQM4	6/23/1992	262	1673		128					0.229	0.005			9.2			300	
WQM4	7/28/1992	193	1172		304			0.3		0.425	0.117			6.3			420	
WQM4	8/25/1992	178	938		456			0.3		0.624	0.255			8			100000	
WQM4	9/22/1992	273	1335		146			0.6		0.382	0.151			8.3			170	
WQM4	10/26/1992	279.3999	1593		54			1		0.166	0.026			10.7			140	
WQM4	11/17/1992	276.5999	1761		26			1.4		0.123	0.032			12.9			30	
WQM4	12/15/1992	289.3999	1654		14			1.5		0.053	0.02			14.1			10	
WQM4	1/26/1993	133.2	1476		12			1		0.033	0.012			11.5			10	
WQM4	2/23/1993	313	1626		11			1.2		0.083	0.02			11.4				
WQM4	4/27/1993	239	1372		114			0.3		0.259	0.039			8.3			30	
WQM4	5/18/1993	186	902		87			0.2		0.325	0.132			7.2			100	
WQM4	6/22/1993	220.4	959		128			0.6		0.395	0.177			5.7			150	
WQM4	7/27/1993	203	807		165			0.2		0.398	0.146			6.1			2300	
WQM4	8/24/1993	204	1176		214			0.5		0.442	0.142			6			190	
WQM4	9/28/1993	266	1485		102			0.5		0.276	0.042			10.2			290	
WQM4	10/26/1993	272	1498		108			0.3		0.163	0.007			9.5				
WQM4	11/16/1993	263	1595		37			1.1		0.123	0.01			12.6			280	
WQM4	12/15/1993	260	1554		22			1.2		0.076	0.008			12.9			30	
WQM4	1/26/1994	318	1395		8			1		0.043				11				
WQM4	2/16/1994	311	1352		7			1		0.057				11.4				

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	3/29/1994	248	1324		184			0.8		0.343	0.081			11.5			20	
WQM4	4/26/1994	248	1584		180			0.4		0.233	0.013			8.1			170	
WQM4	5/17/1994	249	1841		218			0.2		0.366	0.007			9.9				
WQM4	6/21/1994	239	1811		244					0.283				7.7			160	
WQM4	7/27/1994	245	1679		154					0.206	0.013			9				
WQM4	8/23/1994		1520		140			0.1		0.163	0.019			8				
WQM4	9/27/1994	235	1211		88					0.2	0.005			9.5			150	
WQM4	10/25/1994	267	1382		29			0.1		0.07	0.006			9.8			30	
WQM4	11/29/1994	287	1411		29			0.1		0.063				13			10	
WQM4	12/13/1994	368	1472		9			0.2		0.057	0.016							
WQM4	1/31/1995	316	1475		9			0.2		0.041				14			10	
WQM4	2/28/1995	133	810		72			1.4		0.321	0.165			11.3				
WQM4	3/28/1995	207.5	2008		750			1.6		0.992	0.121			10			12000	
WQM4	4/25/1995	122	1070		74			0.8		0.4	0.093			9.1			110	
WQM4	5/23/1995	204	1118		110			0.2		0.295				7.6			90	
WQM4	6/27/1995		1598		212									6.7			50	
WQM4	7/19/1995	277	1411		356			0.4		0.577				6.1			230	
WQM4	8/22/1995		1238		236									7.3			6700	
WQM4	9/26/1995		1138		68									9.2			40	
WQM4	11/1/1995	271	1242		192			0.6		0.397				12.1				
WQM4	11/29/1995		1367		45									13.4				
WQM4	12/13/1995		1491		41									12.4				
WQM4	1/30/1996	411	1236		11			0.4		0.157				9.5				
WQM4	2/27/1996		921		97									11.2				
WQM4	3/19/1996		1318		752									13.3				
WQM4	4/23/1996	284	1301		182			0.1		0.402				10.8				
WQM4	5/29/1996		2091		572									8.9			14000	
WQM4	6/25/1996		1709		420									7.9			220	
WQM4	7/24/1996	306	1414		280			0.4		0.402				8.8			140	
WQM4	8/22/1996		1382		150									6.9			70	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	9/18/1996		1235		110									8.8			90	
WQM4	10/30/1996	294	1277		36			0.1		0.178				12.1				
WQM4	11/27/1996		1734		37									13				
WQM4	12/30/1996		1603		7									10.8				
WQM4	1/23/1997	336	1693		9			0.8		0.047				7.6				
WQM4	2/19/1997		1607		18									11.4				
WQM4	3/19/1997		1187		504									11.2				
WQM4	7/28/1997	238	1398		338			0.7		0.56				6			700	
WQM4	8/27/1997		1154		104									6.3			150	
WQM4	9/24/1997		1233		124									8.4			3300	
WQM4	10/22/1997	273	1236		63			0.1		0.21				13.4				
WQM4	11/5/1997		1205		33													
WQM4	12/17/1997		1418		39									15				
WQM4	1/30/1998	312	1365		18			0.4		0.058				11.8				
WQM4	2/26/1998		1349		72									14.9				
WQM4	3/19/1998		1329		17									15.3				
WQM4	4/29/1998	197	1700		448			2		0.612				8.6				
WQM4	5/27/1998		1053		118									8.6				
WQM4	6/10/1998		2024		246									9.1			2100	
WQM4	7/15/1998	252	1690		188			0.2		0.35				6.2			500	3
WQM4	8/19/1998		1548		136									10.6			120	
WQM4	9/24/1998		1434		72									9.3			410	97
WQM4	10/26/1998	272	1484		140			0.4		0.374				9.7				
WQM4	11/18/1998		1630		472			1.7	1.26	0.647				11.7				
WQM4	12/14/1998		1752		48			1.1	0.8	0.345				12.5				
WQM4	1/26/1999	303	1625		13			0.9	0.43	0.09				13.2				
WQM4	2/23/1999	267	1567		34			0.8	0.54	0.182								
WQM4	3/22/1999	270	1884		234			0.8	0.93	0.46				11				
WQM4	4/19/1999	197	1569					1.5	1.28	0.497				10.3				
WQM4	5/19/1999	268	1847		158			0.8	1.18	0.39				8.6			290	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	6/16/1999	259	1818		198			1.4	1.03	0.437							600	
WQM4	7/29/1999	251	1716		184			0.2	1.15	0.548				6.1			210	
WQM4	8/23/1999	256	1517		76				0.53	0.21				10.9				
WQM4	9/23/1999	234	1324		80				1.24	0.219				8.7			260	
WQM4	10/28/1999	289	900		84				1.13	0.52				9.7				
WQM4	11/18/1999	272	1370		17			0.1	0.64	0.085				10.9				
WQM4	1/27/2000	225	1581		8			0.3	0.51	0.045				13.5				
WQM4	3/28/2000	188	1226		44			0.1	0.75	0.143				11.9				
WQM4	4/24/2000	241	1650		98			0.1	1.22	0.287				9.7				
WQM4	5/25/2000	233	1599		332			1.1	1.38	0.61				8.2			290	
WQM4	6/28/2000	187	1804		268				0.82	0.563				7.3			670	
WQM4	7/27/2000	210	1573		172				0.95	0.359				5.9			410	
WQM4	9/23/2000	234	1324		80				1.24	0.219				8.7			260	
WQM4	11/27/2000	294	1482		24			0.2	0.56	0.053				13.4				
WQM4	12/4/2000	281	1430		14			0.2	0.36	0.036				13.7				
WQM4	1/9/2001	288	1377		10			0.2	0.55	0.041				11.6				
WQM4	2/20/2001	281	1341		10			0.3	0.4	0.044				12.4				
WQM4	3/26/2001	105	774		388			1.2	1.98	1.436				11.1				
WQM4	4/18/2001	149	898		196			0.9	0.88	0.883				10.4				
WQM4	5/21/2001	194	1495		590			0.8	1.18	1.169				8.2			9100	2400
WQM4	6/11/2001	258	1305		160				0.68	0.349				6.9			20	15.5
WQM4	7/16/2001	280	1400		285			0.4	0.36	0.603				7.5			390	70.5
WQM4	8/13/2001	266	1242		172				0.85	0.512				8.3			180	133
WQM4	9/10/2001	301	1166		96				0.6	0.427				8.5				
WQM4	10/10/2001	294	1201		120				1.12	0.359				10.6				
WQM4	11/19/2001	282	1233		52				0.82	0.213				11.6			22	26.5
WQM4	12/10/2001	259	1529		47			1.7	0.79	0.333				12.6				
WQM4	1/9/2002	344	1612		10			0.6	0.85	0.099				12.2				
WQM4	2/11/2002	295	1379		37			0.2	0.64	0.112				14.1				
WQM4	3/14/2002	294	1396		29			0.2	0.65	0.075				11.3				

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	4/8/2002	204	1116		200			0.7	1.56	0.348				9.2				
WQM4	5/6/2002	249	1587		140				0.97	0.27				9			20	24.6
WQM4	6/18/2002	247	1424		228			0.1	0.85	0.479				6.9			250	435
WQM4	7/10/2002	253	1465		348			0.1	0.7	0.63				6.3			4000	1990
WQM4	8/5/2002	209	1296		204			0.1	0.58	0.41				6			2700	1300
WQM4	9/4/2002	236	1155		130				0.62	0.37				7.6			580	25.7
WQM4	10/15/2002	255	1335		41				0.83	0.19				10.2				
WQM4	11/6/2002	265	1366		20					0.103				12.5				
WQM4	12/10/2002	322	1623		7			0.1		0.057				7.9				
WQM4	1/6/2003	295	1536		5					0.056				13.5				
WQM4	2/11/2003	325	1682		6				0.34	0.048				14.6				
WQM4	3/17/2003	149	851		216			0.7	2.02	1.303				11.3				
WQM4	4/14/2003	246	1726		134				0.71	0.28				8.8				
WQM4	5/12/2003	253	1857		84			0.5	0.86	0.222							130	155
WQM4	6/10/2003	237	1568		168				0.32	0.361				8.4			400	299
WQM4	7/8/2003	224			445			0.4	0.82	0.898				5.8			6100	1200
WQM4	8/19/2003	246			146				0.5	0.338				6.3			670	292
WQM4	9/15/2003	181			126			0.6	0.82	0.551				9.5			2400	1730
WQM4	10/6/2003	268			85				0.5	0.202				10.3				
WQM4	11/17/2003	275			24				0.58	0.093				12.2				
WQM4	12/1/2003	292			21				0.58	0.057				13.6				
WQM4	1/5/2004	319			8			0.4	0.41	0.072				12.5				
WQM4	01/21/2004													13.2	8	1		
WQM4	01/21/2004	312	1639	1633	6		<0.02	0.5	0.34		0.018							
WQM4	2/9/2004	322			3			0.3	0.37	0.04				10				
WQM4	02/10/2004													5.5	7.6	1		
WQM4	02/10/2004	325	1381	1375	6		0.29	0.5	0.33		0.022							
WQM4	3/23/2004	264			94			1.2		0.369				10.7				
WQM4	03/29/2004													10	7.6	9		
WQM4	03/29/2004	237	1837	1713	124		<0.02	1.1	1.4		0.116							

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	4/12/2004	245			49				0.87	0.158				11.9				
WQM4	04/13/2004													12		7		
WQM4	04/13/2004	245	1601	1502	99		<0.02	0.2	1.39		0.014							
WQM4	5/17/2004	257			86				0.67	0.205				8.3			320	308
WQM4	05/19/2004													8.2	8.2	16		
WQM4	05/19/2004	240	1424	1356	68		<0.02	<0.1	1.18		0.014						40	
WQM4	06/14/2004													7.6	8.1	22		
WQM4	06/14/2004	255	1442	1274	168		<0.02	1	1.41		0.102						390	
WQM4	7/12/2004	235			190				1.32	0.364				6.4			350	260
WQM4	07/13/2004													5.6	7.7	27		
WQM4	07/13/2004	186	1148	1068	80		<0.02	<0.1	1.24		0.022						110	
WQM4	8/9/2004	245			170				1.15	0.161				8.1			360	42.2
WQM4	08/10/2004													6.9		19		
WQM4	08/10/2004	210	1162	1076	86		<0.02	<0.1	1.17		0.037						210	
WQM4	9/1/2004	239			100				0.88	0.235				7.9			320	167
WQM4	09/07/2004													7.5	7.2	18		
WQM4	09/07/2004	215	1103	1036	67		<0.02	<0.1	0.86		0.037						160	
WQM4	10/5/2004	240			71				0.88	0.284				10				
WQM4	10/12/2004													9	8.1	12		
WQM4	10/12/2004	233	1176	1120	56		<0.02	<0.1	0.68		0.029							
WQM4	11/08/2004	254	1339	1312	27		<0.02	<0.1	0.6		0.017							
WQM4	11/8/2004	264			29				0.53	0.124				12.5				
WQM4	12/7/2004	274			17				0.34	0.052				12.4				
WQM4	12/08/2004													13.6	8.4	2		
WQM4	12/08/2004	266	1496	1480	16		<0.02	0.2	0.68		0.004							
WQM4	12/08/2004	265	1506	1491	15		<0.02	0.2	0.38		0.004							
WQM4	12/08/2004										Non-detect							
WQM4	1/11/2005	327			8			0.4	0.51	0.063				11.4				
WQM4	01/12/2005													9.4	7.7	1		
WQM4	01/12/2005	336	1525	1520	5		<0.02	0.7	0.63		0.022							

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	2/14/2005	226			77			0.9	1.07	0.361				12.3				
WQM4	02/15/2005													13	8.1	1		
WQM4	02/15/2005	203	1177	1133	44		0.37	1.4	1.53		0.246							
WQM4	3/21/2005	259			39			0.2		0.141				12.7				
WQM4	03/22/2005													13	8.2	1		
WQM4	03/22/2005	236	1416	1393	23		<0.02	0.1	0.57		0.023							
WQM4	4/11/2005	241			134				1	0.299				8.8				
WQM4	04/12/2005													9.3	8.3	10		
WQM4	04/12/2005	246	1744	1679	65		<0.02	0.2	0.99		0.028							
WQM4	5/16/2005	242			340			3.3	2.43	0.74				9			1000	866
WQM4	05/17/2005													8.4	8	14		
WQM4	05/17/2005	240	1916	1704	212		<0.02	3.5	1		0.149						260	
WQM4	6/13/2005	168			196			1.8	1.64	0.698				6.1			410	276
WQM4	06/14/2005													5.6	7.7	19		
WQM4	06/14/2005	176	981	915	66		0.03	1.8	1.22		0.226						350	
WQM4	06/14/2005	176	980	912	68		0.03	1.8	1.24		0.218						420	
WQM4	06/14/2005											Non-detect						
WQM4	07/21/2005													7.4	7.7	28		
WQM4	07/21/2005	204	1268	1172	96		<0.02	<0.1	1.36		0.02						450	
WQM4	7/21/2005	239			164				1.09	0.375				7.5			900	31
WQM4	8/29/2005	254			68				0.73	0.172				8.2			200	12.6
WQM4	08/30/2005													6.9	8	20		
WQM4	08/30/2005	232	1243	1171	72		<0.02	<0.1	1.09		0.036						90	
WQM4	9/19/2005	227			204			0.2	1.6	0.41				7.7			1800	239
WQM4	09/20/2005													7.5	8.2	17		
WQM4	09/20/2005	237	1211	1127	84		<0.02	0.1	1.44		0.055						210	
WQM4	10/11/2005	265			56			0.1	0.84	0.177				10.4				
WQM4	10/12/2005													9.3	8.2	12		
WQM4	10/12/2005	255	1185	1131	54		<0.02	0.2	0.84		0.065							
WQM4	11/21/2005	271			12			0.1		0.062				12.5				

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	11/22/2005													12.8	8.2	4		
WQM4	11/22/2005	242	1200	1195	5		<0.02	0.1	0.5		0.03							
WQM4	12/12/2005	283			8			0.4	0.59	0.039				12.4				
WQM4	12/13/2005													12.4	7.9	1		
WQM4	12/13/2005	280	1365	1357	8		0.04	0.5	0.78		0.022							
WQM4	1/9/2006	288			16			0.8	0.75	0.123				13.6				
WQM4	01/10/2006													14.1	8.2	1		
WQM4	01/10/2006	289	1697	1688	9		0.04	1	0.61		0.098							
WQM4	2/13/2006	307			16			0.6	0.51	0.106				14				
WQM4	02/14/2006													14.2	8.2	1		
WQM4	02/14/2006	293	1660	1643	17		<0.02	0.7	0.74		0.056							
WQM4	3/27/2006	266			79			0.2	1.03	0.178				11.9				
WQM4	03/29/2006													13	8.4	6		
WQM4	03/29/2006	259	1859	1810	49		<0.02	0.5	0.69		0.016							
WQM4	3/31/2006				456							10						
WQM4	4/10/2006	211			510			1.7	2.29	0.904				9				
WQM4	04/11/2006													8.8	7.9	13		
WQM4	04/11/2006	191	1400	1152	248		0.14	1.6	1.63		0.148							
WQM4	4/25/2006				106							9						
WQM4	5/1/2006				79							17					120	105.0
WQM4	5/8/2006	267			126			0.7	1.17	0.322				9.5			80	3.1
WQM4	05/09/2006													9.7	8.2	16		
WQM4	05/09/2006	260	1731	1672	59		<0.02	0.8	1.02		0.024						30	
WQM4	5/15/2006											14					50	
WQM4	5/18/2006											19					<10	
WQM4	5/22/2006				68							28					<10	
WQM4	6/1/2006				77							26					80	
WQM4	06/13/2006	229	1454	1392	62		<0.02	<0.1	1.12	0.216	0.014			9.6	8.2	18	100	
WQM4	6/15/2006											22					220	
WQM4	6/22/2006				162												640	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	6/28/2006																50	
WQM4	7/5/2006											21					70	
WQM4	7/12/2006				53							32					210	
WQM4	07/18/2006	230	1326	1256	70		<0.02	<0.1	0.86	0.208	0.045			8.4	8.2	26	230	
WQM4	7/19/2006											32					110	
WQM4	7/21/2006				60												160	
WQM4	8/3/2006				62							27					250	
WQM4	8/11/2006				82												330	
WQM4	08/15/2006	208	1441	1389	52		<0.02	<0.1	1.04	0.229	0.048			8.4	8.1	24	180	
WQM4	8/23/2006																50	
WQM4	8/29/2006				41							21					140	
WQM4	9/8/2006				96							22					290	
WQM4	9/12/2006											21					130	
WQM4	9/14/2006											31					150	
WQM4	9/21/2006				67							13					360	
WQM4	09/26/2006	194	1343	1247	96		<0.02	0.9	1.46	0.295	0.068			9.4	8.1	14	610	
WQM4	10/5/2006				55							20					100	
WQM4	10/11/2006	254	1401	1369	32		<0.02	<0.1	0.91	0.168	0.033			10.1	8.1	10		
WQM4	10/16/2006				53							14					90	
WQM4	10/25/2006											13					30	
WQM4	10/31/2006											0					<10	
WQM4	11/8/2006											23					<10	
WQM4	11/13/2006				6							9					20	
WQM4	11/16/2006											2					20	
WQM4	11/28/2006				7							3					10	
WQM4	12/14/2006	307	1708	1699	9		<0.02	<0.1	<0.50	0.071	0.02			15.7	7.6	1		
WQM4	01/09/2007	185	1174	1150	24		0.29	1.3	1.55	0.484	0.392			13.2	7.6	1		
WQM4	02/21/2007	310	1509	1499	10		0.67	0.9	1.3	0.127	0.102			12	6.8	1		
WQM4	03/20/2007	142	726	486	240		0.91	0.8	2.7	0.769	0.365			12	7.7	6		
WQM4	04/12/2007	217	1362	1265	97		0.11	1.6	1.24	0.426	0.263			12.1	8	3		

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM4	05/15/2007	218	1144	1012	132		<0.02	0.7	1.53	0.545	0.306			7.2	7.9	19	70	
WQM4	06/05/2007	236	1520	1428	92		<0.02	1.1	1.43	0.276	0.015			10.3	8.1	19	310	
WQM4	07/10/2007	213	1228	1169	59		<0.02	<0.1	1.18	0.213	0.026			7	7.9	25	140	
WQM4	08/21/2007	185	1195	1113	82		<0.02	<0.1	1.1	0.23	0.054			6.7	7.3	24	1100	
WQM4	09/18/2007	224	1266	1200	66		<0.02	0.2	0.98	0.219	0.04			7.6	7.3	20	240	
WQM4	10/10/2007	160	1048	976	72		<0.02	0.4	1.73	0.228	0.034			9	8.2	14		
WQM4	11/07/2007	273	1486	1451	35		<0.02	0.5	1.27	0.202	0.035			14.7	8.4	3		
WQM4	12/04/2007	304	1730	1707	23		<0.02	0.4	1.08	0.125	0.024			17.8		0		
WQM4	01/08/2008	307	1525	1521	4		0.06	1.2	0.57	0.063	0.038			10.4	7.6	0		
WQM4	02/20/2008	315	1469	1463	6		0.08	1.2	<0.50	0.054	0.033			8.9	7.56			
WQM4	03/25/2008	179	1213	1037	176		0.78	2.5	2.64	0.763	0.479			12.7	8	2		
WQM4	04/15/2008	250	1855	1741	114		<0.02	1	1.8	0.382	0.094			11.8	8.4	7		
WQM4	05/20/2008	259	1772	1672	100		<0.02	0.3	1.42		0.023			9.9	8.3	17	20	
WQM4	06/17/2008	211	1153	1053	100		<0.02	2.7	1.58	0.411	0.214			6.7	7.9	22	70	
WQM4	07/16/2008	218	1281	1225	56		<0.02	<0.2	1.21	0.227	0.023			6.5	7.9	24	80	
WQM4	08/12/2008	199	1269	1209	60		<0.02	<0.2	1.26	0.233	0.025			7.7	7.9	23	290	
WQM4	09/23/2008	223	1330	1236	94		<0.02	<0.2	1.3	0.289	0.027			7.4	7.9	20	140	
WQM4	9/14/2009	233		1341	62		<0.05	<0.2	0.92	0.224	0.057	22		7.8	7.7	20	80	37.8
WQM4	8/11/2009	238		1368	80		<0.05	<0.2	1.09	0.292	0.064	21		6.6	8	24	240	89.4
WQM4	7/21/2009	266		1370	162		<0.05	0.3	1.6	0.534	0.229	25		7.8	8.1	21	250	50.6
WQM4	6/23/2009	185		1794	172		<0.05	<0.2	2.92	0.448	0.012	28		5.8	7.8	27	400	334
WQM4	5/5/2009	253		1673	75		<0.05	<0.2	1.42	0.182	0.02	20		10.1	8.1	15	10	24.3
WQM4	4/14/2009	254		1630	120		<0.05	0.5	1.39	0.245	0.042	12		10.7	8.2	9		
WQM4	3/17/2009	210		1086	90		0.14	0.9	1.2	0.296	0.134	9		14.1	8	3		
WQM4	2/11/2009	156		813	67		0.45	1.4	1.9	0.553	0.35	4		11.6	7.9	1		
WQM4	1/22/2009	321		1485	5		0.13	1.3	0.64	0.058	0.054	2		9.5	7.9	1		
WQM4	12/18/2008	336		1759	12		<0.02	1.3	0.84	0.104	0.025	-9		11.8	7.6	1		
WQM4	11/18/2008	280		1765	35		<0.02	1	1.39	0.231	0.027	2		14.1	8.2	2		
WQM4	10/15/2008	224		1241	62		<0.02	0.2	1.6	0.21	0.016	10		10.3	8.1	10		

20.0 APPENDIX E: Stage/Discharge Calculations and Graphs for all Sites.

Because of the large volume of information, these data are available upon request from the SD Department of Environment and Natural Resources.

21.0 APPENDIX F: Sediment Loading output with Discharge and TSS information from Each monitoring Sites.

Because of the large volume of information, these data are available upon request from the SD Department of Environment and Natural Resources.

22.0 APPENDIX G: Mass Balance Calculations and Supplementary Loading Information

Because of the large volume of information, these data are available upon request from the SD Department of Environment and Natural Resources.

23.0 APPENDIX H: FLUX Loading Setup for Vermillion River Mainstem Sites.

```
Site VR05
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       628  23  22 100.0      156.809      235.276        .568   .001
***       628  23  22 100.0      156.809      235.276

 FLOW STATISTICS
 FLOW DURATION =      628.0 DAYS  =  1.719 YEARS
 MEAN FLOW RATE =   156.809 HM3/YR
 TOTAL FLOW VOLUME =     269.61 HM3
 FLOW DATE RANGE   = 20050324 TO 20061211
 SAMPLE DATE RANGE = 20050324 TO 20061206

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD     66627600.0     38751160.0      .2887E+15  247124.00    .439
 2 Q WTD C     44406510.0     25827200.0      .6807E+14  164705.30    .319
 3 IJC         43431530.0     25260140.0      .8935E+14  161089.00    .374
 4 REG-1       35273260.0     20515220.0      .1840E+15  130829.70    .661
 5 REG-2       35243090.0     20497670.0      .2225E+16  130717.80   2.301
 6 REG-3       70068490.0     40752410.0      .9015E+15  259886.40    .737


Site VR06
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       537  20  19 100.0      131.882      225.465        .431   .001
***       537  20  19 100.0      131.882      225.465

 FLOW STATISTICS
 FLOW DURATION =      537.0 DAYS  =  1.470 YEARS
 MEAN FLOW RATE =   131.882 HM3/YR
 TOTAL FLOW VOLUME =     193.90 HM3
 FLOW DATE RANGE   = 20050314 TO 20061204
 SAMPLE DATE RANGE = 20050317 TO 20060929

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD     61949990.0     42136370.0      .3776E+15  319500.10    .461
 2 Q WTD C     36236610.0     24646970.0      .5522E+14  186886.30    .301
 3 IJC         35494750.0     24142380.0      .7511E+14  183060.20    .359
 4 REG-1       28765540.0     19565390.0      .1153E+15  148355.00    .549
 5 REG-2       31913450.0     21706490.0      .1270E+16  164590.00   1.642
 6 REG-3       45293040.0     30806860.0      .2810E+15  233593.80    .544
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Site VR08
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       509  20  19 100.0      120.511      200.708        .338   .005
***       509  20  19 100.0      120.511      200.708

 FLOW STATISTICS
 FLOW DURATION =     509.0 DAYS  =  1.394 YEARS
 MEAN FLOW RATE =   120.511 HM3/YR
 TOTAL FLOW VOLUME =     167.94 HM3
 FLOW DATE RANGE   = 20050321 TO 20061204
 SAMPLE DATE RANGE = 20050321 TO 20060928

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD     59328770.0     42573350.0      .5114E+15  353273.20    .531
 2 Q WTD C     35622830.0     25562360.0      .1990E+14  212116.10    .175
 3 IJC         36100390.0     25905040.0      .1730E+14  214959.80    .161
 4 REG-1       29978720.0     21512240.0      .3383E+14  178508.30    .270
 5 REG-2       31027340.0     22264710.0      .3650E+15  184752.30    .858
 6 REG-3       35302840.0     25332730.0      .4846E+14  210210.70    .275
```

```
Site VRT07
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR       NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1       541  19  18 100.0        7.111       14.540        .405   .012
***       541  19  18 100.0        7.111       14.540

 FLOW STATISTICS
 FLOW DURATION =     541.0 DAYS  =  1.481 YEARS
 MEAN FLOW RATE =     7.111 HM3/YR
 TOTAL FLOW VOLUME =      10.53 HM3
 FLOW DATE RANGE   = 20050317 TO 20061205
 SAMPLE DATE RANGE = 20050317 TO 20061127

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD      2491449.0      1682073.0      .1204E+13  236554.90    .652
 2 Q WTD C      1218448.0       822621.1      .5152E+11  115687.60    .276
 3 IJC          1198251.0       808985.4      .6384E+11  113770.00    .312
 4 REG-1         911790.3       615584.8      .2329E+12   86571.49    .784
 5 REG-2        1197890.0       808741.5      .8495E+13  113735.70   3.604
 6 REG-3        1185813.0       800588.2      .1823E+12  112589.10    .533
```

```
Site VRT09
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR        NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1        565  21  20 100.0       22.422       36.019        .412   .010
***        565  21  20 100.0       22.422       36.019

 FLOW STATISTICS
 FLOW DURATION =      565.0 DAYS  =  1.547 YEARS
 MEAN FLOW RATE =     22.422 HM3/YR
 TOTAL FLOW VOLUME =       34.68 HM3
 FLOW DATE RANGE   = 20050321 TO 20061203
 SAMPLE DATE RANGE = 20050321 TO 20060926

 METHOD          MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD       6498113.0      4200771.0      .3970E+13  187350.90    .474
 2 Q WTD C       4045133.0      2615017.0      .7559E+12  116627.60    .332
 3 IJC           4184835.0      2705329.0      .9231E+12  120655.40    .355
 4 REG-1         3327509.0      2151102.0      .3833E+12   95937.36    .288
 5 REG-2         3622818.0      2342008.0      .2846E+12  104451.60    .228
 6 REG-3         4378547.0      2830556.0      .5258E+12  126240.40    .256


Site VRT32
 Vermillion Segment R7             VAR=TSS       METHOD= 2 Q WTD C
 COMPARISON OF SAMPLED AND TOTAL FLOW DISTRIBUTIONS
 STR        NQ  NC  NE  VOL%   TOTAL FLOW SAMPLED FLOW   C/Q SLOPE SIGNIF
  1        200   7   6 100.0        4.607        2.390        .117   .298
***        200   7   6 100.0        4.607        2.390

 FLOW STATISTICS
 FLOW DURATION =      200.0 DAYS  =   .548 YEARS
 MEAN FLOW RATE =      4.607 HM3/YR
 TOTAL FLOW VOLUME =        2.52 HM3
 FLOW DATE RANGE   = 20060403 TO 20061019
 SAMPLE DATE RANGE = 20060412 TO 20060926

 METHOD          MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD         26483.6        48365.7      .7741E+09   10498.30    .575
 2 Q WTD C         51053.5        93236.4      .1189E+10   20237.94    .370
 3 IJC             53915.4        98463.0      .1482E+10   21372.43    .391
 4 REG-1           55116.0       100655.5      .1753E+10   21848.35    .416
 5 REG-2          197077.5       359912.8      .1188E+12   78122.90    .958
 6 REG-3           46122.2        84230.6      .9074E+09   18283.14    .358
```

24.0 APPENDIX I: Annualized AGNPS Modeling and Rapid Geomorphic (RGA) Field Sampling Results

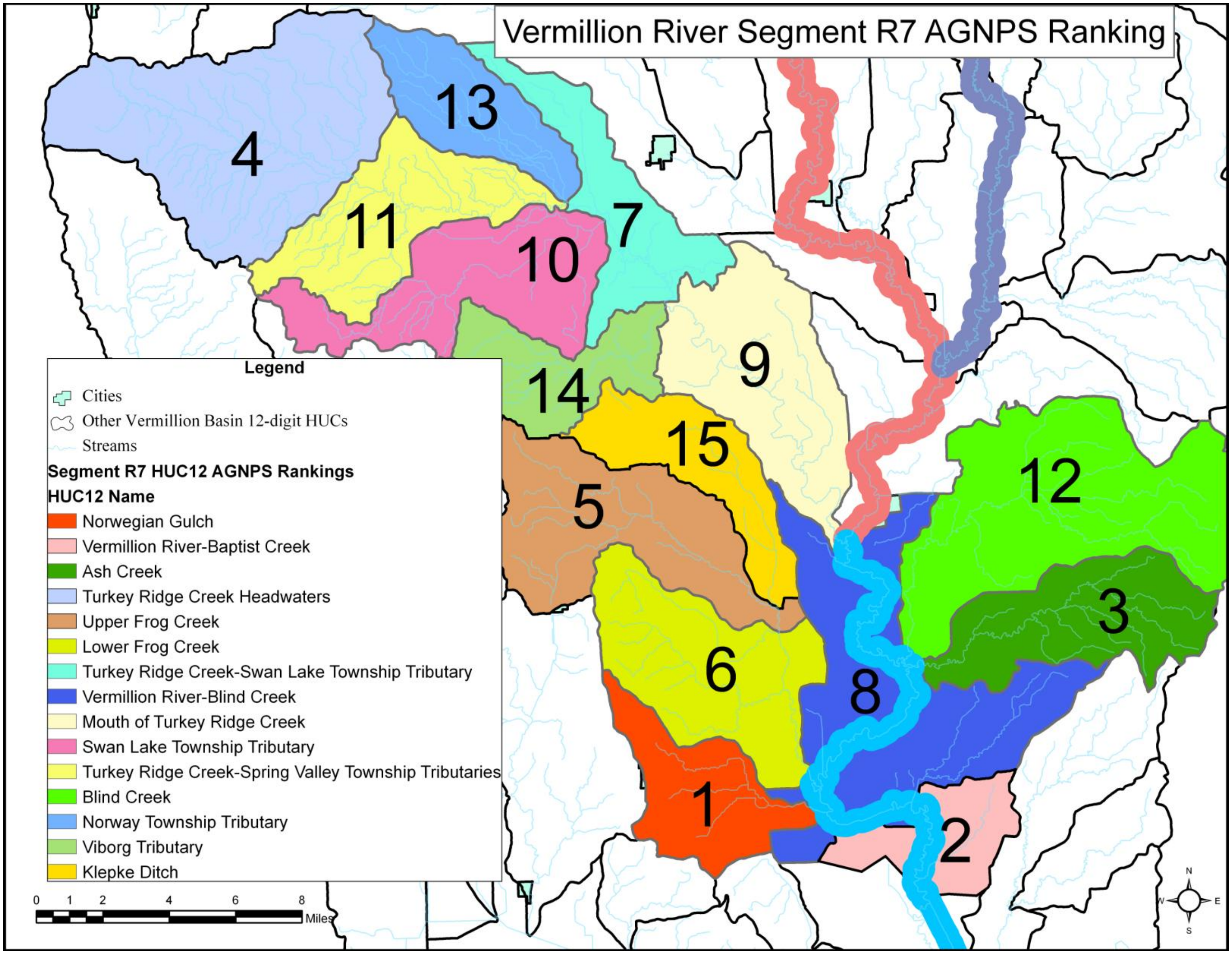
Because of the large volume of information, these data are available upon request from the SD Department of Environment and Natural Resources.

Raw Cell Data for the AGNPS model for the entire Vermillion Basin will be available upon request. A table outlining the AGNPS sediment yield ranking and a map for each HUC within Segment R7 is shown in the following pages.

The raw RGA data are also available upon request.

Current Conditions Ranking

HU12	HUC12 Name	Load Description	Load tn/yr	Area ac	Yield tn/yr/ac	Rank
101701021201	Turkey Ridge Creek Headwaters	Sum of Current Load	8479.786	30527.19	0.277778	4
101701021202	Turkey Ridge Creek- Spring Valley Township Tributaries	Sum of Current Load	2757.14	14692.06	0.187662	11
101701021203	Norway Township Tributary	Sum of Current Load	1588.698	9924.105	0.160085	13
101701021204	Swan Lake Township Tributary	Sum of Current Load	3105.476	16447.52	0.188811	10
101701021205	Turkey Ridge Creek- Swan Lake Township Tributary	Sum of Current Load	2461.476	11589.38	0.212391	7
101701021206	Viborg Tributary	Sum of Current Load	1454.051	9831.509	0.147897	14
101701021207	Mouth of Turkey Ridge Creek	Sum of Current Load	3527.074	18221.29	0.193569	9
101701021301	Blind Creek	Sum of Current Load	4967.622	29802.18	0.166687	12
101701021401	Klepke Ditch	Sum of Current Load	1453.841	10569.41	0.137552	15
101701021402	Upper Frog Creek	Sum of Current Load	5093.85	19107.7	0.266586	5
101701021403	Lower Frog Creek	Sum of Current Load	3826.575	17806.88	0.214893	6
101701022001	Ash Creek	Sum of Current Load	4249.191	14630.76	0.290429	3
101701022002	Norwegian Gulch	Sum of Current Load	4365.821	10393.72	0.420044	1
101701022003	Vermillion River- Blind Creek	Sum of Current Load	5845.23	28648.9	0.20403	8
101701022004	Vermillion River- Baptist Creek	Sum of Current Load	2808.323	7958.321	0.352879	2


Vermillion River Segment R7 AGNPS Ranking
4
13
11
10
7
9
14
15
12
5
3
6
8
1
2
Legend
Cities
Other Vermillion Basin 12-digit HUCs
Streams
Segment R7 HUC12 AGNPS Rankings
HUC12 Name
Norwegian Gulch
Vermillion River-Baptist Creek
Ash Creek
Turkey Ridge Creek Headwaters
Upper Frog Creek
Lower Frog Creek
Turkey Ridge Creek-Swan Lake Township Tributary
Vermillion River-Blind Creek
Mouth of Turkey Ridge Creek
Swan Lake Township Tributary
Turkey Ridge Creek-Spring Valley Township Tributaries
Blind Creek
Norway Township Tributary
Viborg Tributary
Klepke Ditch
0 1 2 4 6 8
Miles
N
E
S
W

25.0 APPENDIX J: Public Notice Comments including EPA and Response to Comments

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Total Suspended Solids Total Maximum Daily Load (TMDL) for One Segment of the Vermillion River Clay, Hutchinson, Lincoln, Turner and Yankton Counties, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**July 6, 2010**
Review Date:	**July 22, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

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

- ☐ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

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

1. Problem Description
   1.1. TMDL Document Submittal Letter
   1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   4.1. Data Set Description
   4.2. Waste Load Allocations (WLA)
   4.3. Load Allocations (LA)
   4.4. Margin of Safety (MOS)
   4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

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

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

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

1. Problem Description

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

1.1 TMDL Document Submittal Letter

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

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

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

SUMMARY: The public notice draft Vermillion River, Segment 7, total suspended solids (TSS) TMDL was submitted to EPA for review during the public notice period via an email from Cheryl Saunders, SD DENR on July 6, 2010. The email included the draft TMDL document and a public notice announcement requesting review and comment.

COMMENTS: None.

DENR RESPONSE TO COMMENTS: None.

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

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

Minimum Submission Requirements:

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

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

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

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

SUMMARY: The Vermillion River is located in south eastern South Dakota and is part of the Northern Glaciated Plains and Western Corn Belt Plains ecoregions. The Vermillion River watershed (HUC 10170102) is part of the larger Missouri River basin. The Vermillion River has a total drainage area of approximately 1.43 million acres in South Dakota. This TMDL document covers one of the listed segments of the Vermillion River from Turkey Ridge Creek to Baptist Creek (32.3 miles, SD-VM-R-VERMILLION_02). The segment is listed as high priority for TMDL development.

The designated uses for the Vermillion River segment includes warmwater semi permanent fish life propagation waters, limited contact recreation waters, irrigation, fish and wildlife propagation, recreation, and stock watering. This segment was listed in 2010 for *E. coli* bacteria which is impairing the limited contact recreational use, and for total suspended solids (TSS) which is impairing the warmwater semi permanent fish life propagation use. The bacteria impairment in this segment will be addressed by SD DENR in a separate TMDL document.

COMMENTS: None.

DENR RESPONSE TO 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 Vermillion River segment addressed by this TMDL is impaired based on the total suspended solids (TSS) concentrations for warmwater semi permanent fish life propagation. South Dakota has applicable numeric standards for TSS that is applicable to this river 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 Vermillion River, Segment 7, can be found on pages 12 - 13 of the TMDL document.

COMMENTS: On page 1 of the TMDL, and in the 2010 IR, it says that the two lower mainstem segments of the Vermillion River have beneficial uses that include limited contact recreation uses. However, the WQS in Table 2 include criteria for fecal coliform based on the immersion recreation uses, and the text on pages 3 and12 mention immersion recreation as a designated use. It seems that the reference to the immersion recreation use in the context of this segment and TMDL document is an error. Also, the WQS for *E.coli* should be included in Table 2 in addition to the fecal coliform criteria.

DENR RESPONSE TO COMMENTS: Changes were made to the document reflecting the comments for Section 1.3 Water Quality Standards.

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 numeric TMDL target established for Vermillion River, segment 7, is based on the 30-day average water quality standard for TSS for the warmwater semi-permanent fish life propagation beneficial use. The TMDL target is the TSS 30-day average value of ≤ 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: Similar to the comment above, Section 4.2, page 14 mentions the immersion recreation use in the text of the water quality targets discussion. We believe it should reference the limited contact recreation use. Section 4.2 also mentions R7 as exceeding criteria for fecal coliform, whereas the 2010 IR shows the segment impaired for *E. coli*.

DENR RESPONSE TO COMMENTS: Changes were made to the document reflecting the comments for Section 2.0 Water Quality Targets.

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 majority landuse in the Vermillion River watershed is dominated by a combination of grassland, hay, pasture, corn, and soybeans land uses, followed by high intensity commercial, and industrial land uses. Row crop agriculture is by far the largest category of landuse within this segment at 73.3%. There is relatively limited residential area within the drainage area and therefore impacts from these land uses are expected to be minimal. The table below, excerpted from the TMDL, shows the significant percentages of the landuse categories taken from the 2001 National Land Cover Data set (NLCD, 2001) used for the Vermillion River. The table lists both the total acreage and the percent land uses. Figure 3 in the TMDL document presents a visual breakdown of landuse within the drainage area of segment 7 of the Vermillion River.

NLCD Code	2001 National Land Cover Data Set Landuse Category	West Fork of the Vermillion River	East Fork of the Vermillion River	Mainstem below Parker, SD
11	Open Water	0.8%	2.5%	0.3%
21	Developed, Open Space	4.8%	4.2%	4.8%
22	Developed, Low Intensity	0.6%	0.3%	0.4%
23	Developed, Medium Intensity	0.2%	0.1%	0.1%
24	Developed, High Intensity	0.0%	0.0%	0.0%
31	Barren Land, Rock, Sand, Clay	0.0%	0.0%	0.1%
41	Deciduous Forest	0.3%	0.4%	1.0%
42	Evergreen Forest	0.0%	0.0%	0.0%
52	Shrub, Scrub	0.0%	0.0%	0.0%
71	Grassland, Herbaceous	2.9%	12.2%	2.8%
81	Pasture, Hay	21.7%	18.8%	15.1%
82	Cultivated Crops	67.3%	59.4%	73.7%
90	Woody Wetlands	0.0%	0.0%	0.0%
95	Emergent Herbaceous Wetlands	1.4%	2.2%	1.6%
	Total Acres (1,333,999)	**256,440**	**292,579**	**784,981**
	Total Hectares (539,869)	**103,781**	**118,407**	**317,682**

The TMDL document identifies the main sediment sources as: overland runoff from nearby croplands and feedlots, inflow from tributaries, and streambank erosion. With the significant amount of cropland in the watershed, in addition to the wetland loss, runoff from cropland appears to be a significant source of sediment. Also, bed/bank erosion and steepening channel gradient due to increased flows may be a source of sediment as well. The Vermillion River has had a long history of flooding problems. The Vermillion River is flood prone because of wetland drainage, stream and river channelization, and an emphasis on cultivated crops. Water now enters the river at a faster rate making the downstream flooding worse. The increased water velocity and sediment load has resulted in stream impairments in the mainstem of the Vermillion River.

There are five National Pollution Discharge Elimination System (NPDES) permittees located within the watershed of Segment 7. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment 7. The following two facilities are not allowed to discharge, therefore were not assigned a WLA: 1) Clay Rural Water Systems, Inc (NPDES Permit# SD0025275) is a small two-cell pond system in the center of Segment 7, and is a zero discharge facility; and 2) Lutheran Social Services near Beresford, SD (NPDES Permit# SD0025640) is another small two-cell pond system, and is a zero discharge facility.

The following three facilities were assigned WLAs for this TMDL: 1) The City of Beresford, SD (NPDES Permit number: SD0020079) is located out of the Vermillion flood plain on the uplands on the eastern side of the river basin on the Lincoln/Union County border. Although the Beresford WWTF is authorized to discharge, the three-cell pond system only does so seasonally; 2) The City of Viborg, SD (NPDES Permit number: SD0020541) is a three-cell pond system that may discharge seasonally to the Vermillion River. It is located in the Turkey Ridge Creek Watershed; and 3) The City of Wakonda, SD (NPDES Permit number: SD0020257) is another small three-cell pond system that seasonally discharges to the Segment 7. It is located out of the Vermillion flood plain on the uplands on the western side of the river basin in Clay County.

COMMENTS: There is a passing mention of reducing livestock access to the stream in the Implementation section, but no mention of the number of cattle or number of AFOs or CAFOs in the watershed. Loss of riparian vegetation due to unrestricted cattle grazing along the river can lead to unstable banks and cattle using the river as a water source can make the bed and bank more erosive and contribute to the sediment loading. The landuse shows that a portion of the watershed is pasture. Are AFOs possible sources?

The Source Allocation Methodology section (5.5) mentions pathogen TMDLs approved for five Vermillion River segments in 2008. We believe that this reference should be to the five Big Sioux River TMDLs approved in 2008.

DENR RESPONSE TO COMMENTS: Figure 3 shows only 11.6% of the immediate watershed as grassland whereas >70% of the watershed is under some type of cultivation. DENR, through the Section 319 Implementation Project for the Vermillion River, will certainly target overgrazing within the sensitive areas along the streams margins. However, most of the violations occurred during high flow events indicating streambank erosion along the Vermillion River and its tributaries as well as sheet and rill erosion from the croplands. This was confirmed through the Ann-AGNPS modeling. DENR will prioritize areas where the modeling and water quality data indicate the greatest reduction can be achieved. Included in this prioritization will be those AFOs that received an AGNPS feedlot pollutant ranking higher than 50.

The Source Allocation Methodology in Section 5.5 reference was changed to the five Big Sioux River TMDLS approved in 2008.

4. TMDL Technical Analysis

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

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

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

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

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

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

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

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

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

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

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

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

(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

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

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

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

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

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Vermillion River TMDL describes how the TSS loads were derived in order to meet the applicable water quality standards for the impaired stream segment.

A combination of FLUX and AnnAGNPS models along with load duration curves were used as part of the technical analysis for the Vermillion River, Segment 7, TSS TMDL. FLUX is a statistical modeling program that allows estimation of tributary mass discharges (loadings) from sample concentration data and daily flow records. Sediment and nutrient impacts on the surface water quality of the Vermillion watershed were evaluated through the use of the Annualized Agricultural Nonpoint Source (AnnAGNPS), a watershed runoff model. However, AnnAGNPS does not address channel stability or channel erosion, so a number of rapid geomorphic assessments (RGAs) were conducted at many mainstem sites as well as at sites on the West Fork Vermillion River, East Fork Vermillion River and Turkey Ridge Creek (see Figure 4 in the TMDL for site locations), during the course of the project. Scores from the RGAs helped to determine whether the channel is stable or unstable.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach that results in a flow-variable target that considers the entire flow regime. The LDC is a dynamic expression of the allowable load for any given day. To aid in the interpretation of the TMDL, the LDC flow intervals were grouped into four flow zones. Once the loading capacity was derived for each flow zone then the load allocations were calculated by subtracting the WLA and MOS. The following table from the TMDL document shows the calculated loads for each flow regime for Segment 7.

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 7 of Vermillion River exceed the daily maximum criterion mostly during high to mid-range flow conditions where flow rank ranges between 0 - 40% (see Figure 10 of the TMDL).

Table 7. Segment R7 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	**VR05 with Ambient Station WQM4**			
Station name:	**DENR Gaging Station upstream of USGS Gage 06479010**			
Parameter of Concern	**Flow Zone (expressed as tons/day)**			
TSS	**Extreme Flows (0-10)**	**High-Range (10-40)**	**Mid Range Flows (40-60)**	**Low Flows (60-100)**
Flow Range	**>656 cfs**	**117-656 cfs**	**60-117 cfs**	**<60 cfs**
Median Flow Per Zone	1563.22	227.86	81.81	31.24
Load Allocation	340.4	49.5	17.6	6.6
WLA - BERESFORD (SD0020079)	0.15	0.15	0.15	0.15
WLA - CLAY RWS INC (SD0025275)	0	0	0	0
WLA - LUTHERAN SOCIAL SERVICES (SD0025640)	0	0	0	0
WLA - VIBORG (SD0020541)	0.01	0.01	0.01	0.01
WLA - WAKONDA (SD0020257)	0.01	0.01	0.01	0.01
MOS (10% Explicit)	37.8	5.5	2.0	0.8
TMDL	**378.5**	**55.2**	**19.8**	**7.6**
Existing Condition				
Average Load per Zone	414.329	70.025	13.320	3.781
Load Reduction	**8.7%**	**21.2%**	**-48.7%**	**-100.0%**
Average Concentration per Zone	116	106	62	53
Number of Values	8	35	24	46
Current Load or existing Condition is the average of the observed TSS Loads for each flow zone.				
Runoff calculated using Median Flow/Area				
mm/day	0.68	0.10	0.04	0.01
cfs/sqmile	0.72	0.10	0.04	0.01

COMMENTS: The Linkage Analysis section and other sections throughout the TMDL mention that the TMDL addresses 3 segments or includes 3 TSS TMDLs. While this may be accurate in some context of the TMDL (e.g., SD-VM-R-VERMILLION_01, _02 and _03) it seems that some of the language may be a carryover from another TMDL. We recommend checking the TMDL to make sure all references to multiple segments and TMDLs are consistent with Segment 7 of the Vermillion River. We further recommend checking the Table and Figure number references throughout the document (e.g., Section 7.1 references Table 6 and Figure 7 as showing exceedance rates, whereas we believe exceedance rates are contained in Table 3 and Figure 10). On page 26 we expected to see the LDC (Figure 10), but found instead Figure 9 which appears to be identical to Figure 6. Also, see the comment related to reasonable assurance in the Restoration Strategy section below.

DENR RESPONSE TO COMMENTS: Changes were made to the document reflecting the comments for Section 4.0 TMDL Technical Analysis. A statement regarding reasonable assurance was added to the Implementation section as well.

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 Lower Vermillion River TMDL data description and summary are included mainly in the Data Collection Method section of the document and are plotted on the load duration curve for site VR05. The full data set is included in Appendix D of the TMDL. Sampling was conducted on a temporal basis over the period from January 2005 to December 2006. The data set also includes long term data from SD WQM sites in the watershed, and 26 years of flow record on the Vermillion River.

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 five National Pollution Discharge Elimination System (NPDES) permittees located within the watershed of Segment 7. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment 7. The City of Beresford, SD (NPDES Permit number: SD0020079) is located on the uplands on the eastern side of the river basin. Although Beresford's WWTF is authorized to discharge, the three-cell pond system only does so seasonally. The City of Viborg, SD (NPDES Permit number: SD0020541) is a three-cell pond system that may discharge seasonally to the Vermillion River. It is located in the Turkey Ridge Creek Watershed. The City of Wakonda, SD (NPDES Permit number: SD0020257) is another small three-cell pond system that seasonally discharges to the Segment 7. It is located on the uplands on the western side of the river basin in Clay County. The WLAs for all three facilities are included in Table 7 of the TMDL document.

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 Load Allocations section explains how the loading capacity and load allocation was derived. Since the majority of the landuse in the watershed is nonpoint sources, the majority of the loading capacity has been allocated to the nonpoint sources in the form of load allocations. Table 7 includes the load allocation for each of the four flow regimes for Segment 7.

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment 7 was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR05, which is approximately 12 miles upstream of USGS Gage 006479010. Site VR05 is the most downstream site within this segment.

The 30-day average criterion (90 mg/L) was used for the calculation of the LC, rather than the daily maximum criterion (158 mg/L) because the chronic criterion is considered more protective. The 30-day

average TSS criteria applies at all times but compliance can only be determined when a minimum of three samples are obtained during separate weeks for any 30-day period. In many instances, only one or two samples were collected during any 30-day period, so the average criterion was applied to each flow zone. Although the daily maximum criteria are exceeded, to be conservative it was decided to use the average criterion to develop the loading capacity of the stream in order to ensure that the most stringent water quality
standards are met. Additional data are needed to accurately assess compliance with the 30-day average criterion. The loading capacities and reductions derived from the available data are estimates (i.e., the calculated loading capacities and reductions may be higher or lower if/when a more extensive data set is collected to fully assess compliance with the chronic standard). For each of the four flow zones, the 50th percentile (median) of the range of LCs within a zone was set as the flow zone goal. TSS loads experienced during the largest stream flows cannot be feasibly controlled by practical management practices. Setting the flow zone goal at the 50th percentile while using the average (90 mg/L) criterion within each flow zone will protect the warmwater semi permanent fish life propagation beneficial use 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 Vermillion River TMDL includes an explicit MOS of 10% that was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity. The remaining assimilative capacity was attributed nonpoint sources (LA) or point sources (WLA). Table 7 includes the MOS for each of the four flow regimes for Segment 7.

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 TSS loads are taken into account. 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 largest concentrations are highest 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. Implementation targeted to the critical conditions should reduce the sediment loading in 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 State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process so far. 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: The Lower Vermillion River should continue to be monitored as part of DENR's ambient water quality monitoring at stations within the impaired segment addressed by this TMDL document. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

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 Implementation section of the TMDL document says that an implementation project has already been developed to address the sediment and pathogen sources within the Vermillion River watershed. During the next round of Section 319 project funding, an expansion of the project will be proposed to address the TSS impairment sources detailed in the TMDL document. Since the point sources in the Vermillion River watershed are insignificant contributors of TSS, there is no need to include a discussion of reasonable assurance in this TMDL document.

COMMENTS: We recommend adding a brief discussion of reasonable assurance in this TMDL. In this case the WLAs for the three point sources seem to be a minor part of the current load. The current load or existing condition at VR05 should be added to Table 10 along with an explanation of what percent of the current load is coming from the point sources. If the permits include end of pipe limits equal to the water quality standards and if the WLAs are an insignificant portion of the total existing load, then those facts can be used as the basis for why reasonable assurance is not needed.

DENR RESPONSE TO COMMENTS: Table 10 should Table 7 which does include the existing condition or current load for Site VR05. However, adjustments were made to the table to ensure the existing condition can be more easily found on the table.

A table showing the percent contribution of the WLA to the current load along with a statement regarding reasonable assurance was added to the implementation section. The statement includes language regarding end of pipe limits equal to the water quality standards.

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 Vermillion River TSS TMDL includes daily loads expressed as tons per day. The daily TMDL loads are included in the TMDL Allocations section of the TMDL document.

COMMENTS: None.

26.0 APPENDIX K: EPA TMDL Approval Letter

RESERVED

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

SEP 27 2010

Ref: 8EPR-EP

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

Re: TMDL Approvals
Vermillion River R7; TSS; SD-VM-R-VERMILLION_02

Dear Mr. ~~Pirner~~ Steve:

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 TMDLs 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 TMDLs 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 One Segment of the Vermillion River, Clay, Hutchinson, Lincoln, Turner and Yankton Counties, South Dakota (SD DENR, June 2010)

Submitted: 8/23/2010

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

Segment: Vermillion River from Turkey Ridge Creek to Baptist Creek

303(d) ID: SD-VM-R-VERMILLION 02

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

Water Quality Targets: Maximum daily concentration of <= 158 mg/L, and a concentration of <= 90 mg/L for 30-day average.

Allocation*	Value	Units	Permits
WLA	0.01	TONS/DAY	SD0020541
WLA	0.01	TONS/DAY	SD0020257
WLA	0.15	TONS/DAY	SD0020079
LA	49.5	TONS/DAY	
MOS	5.5	TONS/DAY	
TMDL	55.2	TONS/DAY	

Notes: The loads shown represent the loads during the high flow regime as defined by the load duration curve for the Vermillion River, Segment 7 (see Figure 9 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 One Segment of the Vermillion River Clay, Hutchinson, Lincoln, Turner and Yankton Counties, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**August 23, 2010**
Review Date:	**September 21, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Final**
Notes:	

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

- ☒ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

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

1. Problem Description
   1.1. TMDL Document Submittal Letter
   1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   4.1. Data Set Description
   4.2. Waste Load Allocations (WLA)
   4.3. Load Allocations (LA)
   4.4. Margin of Safety (MOS)
   4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

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

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

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

1. Problem Description

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

1.1 TMDL Document Submittal Letter

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

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☒ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

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

SUMMARY: The final Vermillion River, Segment 7, total suspended solids (TSS) TMDL was submitted to EPA for review and approval via an email from Cheryl Saunders, SD DENR on August 23, 2010. 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: The Vermillion River is located in south eastern South Dakota and is part of the Northern Glaciated Plains and Western Corn Belt Plains ecoregions. The Vermillion River watershed (HUC 10170102) is part of the larger Missouri River basin. The Vermillion River has a total drainage area of approximately 1.43 million acres in South Dakota. This TMDL document covers one of the listed segments of the Vermillion River from Turkey Ridge Creek to Baptist Creek (32.3 miles, SD-VM-R-VERMILLION_02). The segment is also known as Vermillion River watershed, river Segment 7, or R7 as identified by SD DENR in the 2010 Integrated Report. Segment 7 is listed as high priority for TMDL development.

The designated uses for the Vermillion River segment includes warmwater semi permanent fish life propagation waters, limited contact recreation waters, irrigation, fish and wildlife propagation, recreation, and stock watering. This segment was listed in 2010 for *E. coli* bacteria which is impairing the limited contact recreational use, and for total suspended solids (TSS) which is impairing the warmwater semi permanent fish life propagation use. The bacteria impairment in this segment will be addressed by SD DENR in a separate TMDL document.

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 Vermillion River segment addressed by this TMDL is impaired based on the total suspended solids (TSS) concentrations for warmwater semi permanent fish life propagation. South Dakota has applicable numeric standards for TSS that are applicable to this river 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 Vermillion River, Segment 7, can be found on pages 12 - 13 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 numeric TMDL target established for Vermillion River, Segment 7, is based on the 30-day average water quality standard for TSS for the warmwater semi permanent fish life propagation beneficial use. The TMDL target is the TSS 30-day average value of ≤ 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 majority landuse in the Vermillion River watershed is dominated by a combination of grassland, hay, pasture, corn, and soybeans land uses, followed by high intensity commercial, and industrial land uses. Row crop agriculture is by far the largest category of landuse within this segment at 73.3%. There is relatively limited residential area within the drainage area and therefore impacts from these land uses are expected to be minimal. The table below, excerpted from the TMDL, shows the significant percentages of the landuse categories taken from the 2001 National Land Cover Data set (NLCD, 2001) used for the Vermillion River. The table lists both the total acreage and the percent land uses. Figure 3 in the TMDL document presents a visual breakdown of landuse within the drainage area of Segment 7 of the Vermillion River.

NLCD Code	2001 National Land Cover Data Set Landuse Category	West Fork of the Vermillion River	East Fork of the Vermillion River	Mainstem below Parker, SD
11	Open Water	0.8%	2.5%	0.3%
21	Developed, Open Space	4.8%	4.2%	4.8%
22	Developed, Low Intensity	0.6%	0.3%	0.4%
23	Developed, Medium Intensity	0.2%	0.1%	0.1%
24	Developed, High Intensity	0.0%	0.0%	0.0%
31	Barren Land, Rock, Sand, Clay	0.0%	0.0%	0.1%
41	Deciduous Forest	0.3%	0.4%	1.0%
42	Evergreen Forest	0.0%	0.0%	0.0%
52	Shrub, Scrub	0.0%	0.0%	0.0%
71	Grassland, Herbaceous	2.9%	12.2%	2.8%
81	Pasture, Hay	21.7%	18.8%	15.1%
82	Cultivated Crops	67.3%	59.4%	73.7%
90	Woody Wetlands	0.0%	0.0%	0.0%
95	Emergent Herbaceous Wetlands	1.4%	2.2%	1.6%
	Total Acres (1,333,999)	**256,440**	**292,579**	**784,981**
	Total Hectares (539,869)	**103,781**	**118,407**	**317,682**

The TMDL document identifies the main sediment sources as: overland runoff from nearby croplands and feedlots, inflow from tributaries, and streambank erosion. With the significant amount of cropland in the watershed, in addition to the wetland loss, runoff from cropland appears to be a significant source of sediment. Also, bed/bank erosion and steepening channel gradient due to increased flows may be a source of sediment as well. The Vermillion River has had a long history of flooding problems. The Vermillion River is flood prone because of wetland drainage, stream and river channelization, and an emphasis on cultivated crops. Water now enters the river at a faster rate making the downstream flooding worse. The increased water velocity and sediment load has resulted in stream impairments in the mainstem of the Vermillion River.

There are five National Pollution Discharge Elimination System (NPDES) permittees located within the watershed of Segment 7. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment 7. The following two facilities are not allowed to discharge, therefore were not assigned a WLA: 1) Clay Rural Water Systems, Inc (NPDES Permit# SD0025275) is a small two-cell pond system in the center of Segment 7, and is a zero discharge facility; and 2) Lutheran Social Services near Beresford, SD (NPDES Permit# SD0025640) is another small two-cell pond system, and is a zero discharge facility.

The following three facilities were assigned WLAs for this TMDL: 1) The City of Beresford, SD (NPDES Permit number: SD0020079) is located out of the Vermillion flood plain on the uplands on the eastern side of the river basin on the Lincoln/Union County border. Although the Beresford WWTF is authorized to discharge, the three-cell pond system only does so seasonally; 2) The City of Viborg, SD (NPDES Permit number: SD0020541) is a three-cell pond system that may discharge seasonally to the Vermillion River. It is located in the Turkey Ridge Creek Watershed; and 3) The City of Wakonda, SD (NPDES Permit number: SD0020257) is another small three-cell pond system that seasonally discharges to the Segment 7. It is located out of the Vermillion flood plain on the uplands on the western side of the river basin in Clay County.

COMMENTS: None.

4. TMDL Technical Analysis

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

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

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

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

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

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

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

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

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

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

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

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;

(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

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

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

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

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

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Vermillion River TMDL describes how the TSS loads were derived in order to meet the applicable water quality standards for the impaired stream segment.

A combination of FLUX and AnnAGNPS models along with load duration curves were used as part of the technical analysis for the Vermillion River, Segment 7, TSS TMDL. FLUX is a statistical modeling program that allows estimation of tributary mass discharges (loadings) from sample concentration data and daily flow records. Sediment and nutrient impacts on the surface water quality of the Vermillion watershed were evaluated through the use of the Annualized Agricultural Nonpoint Source (AnnAGNPS), a watershed runoff model. However, AnnAGNPS does not address channel stability or channel erosion, so a number of rapid geomorphic assessments (RGAs) were conducted at many mainstem sites as well as at sites on the West Fork Vermillion River, East Fork Vermillion River and Turkey Ridge Creek (see Figure 4 in the TMDL for site locations), during the course of the project. Scores from the RGAs helped to determine whether the channel is stable or unstable.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach that results in a flow-variable target that considers the entire flow regime. The LDC is a dynamic expression of the allowable load for any given day. To aid in the interpretation of the TMDL, the LDC flow intervals were grouped into four flow zones. Once the loading capacity was derived for each flow zone then the load allocations were calculated by subtracting the WLA and MOS. The following table from the TMDL document shows the calculated loads for each flow regime for Segment 7.

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 7 of Vermillion River exceed the daily maximum criterion mostly during high to mid-range flow conditions where flow rank ranges between 0 - 40% (see Figure 9 of the TMDL).

Table 7. Segment R7 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	VR05 with Ambient Station WQM4			
Station name:	DENR Gaging Station upstream of USGS Gage 06479010			
Parameter of Concern	Flow Zone (expressed as tons/day)			
TSS	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Flow Range	>656 cfs	117-656 cfs	60-117 cfs	<60 cfs
Median Flow Per Zone	1563.22	227.86	81.81	31.24
Load Allocation	340.4	49.5	17.6	6.6
WLA - BERESFORD (SD0020079)	0.15	0.15	0.15	0.15
WLA - CLAY RWS INC (SD0025275)	0	0	0	0
WLA - LUTHERAN SOCIAL SERVICES (SD0025640)	0	0	0	0
WLA - VIBORG (SD0020541)	0.01	0.01	0.01	0.01
WLA - WAKONDA (SD0020257)	0.01	0.01	0.01	0.01
MOS (10% Explicit)	37.8	5.5	2.0	0.8
TMDL	378.5	55.2	19.8	7.6
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	414.329	70.025	13.320	3.781
Load Reduction	8.7%	21.2%	-48.7%	-100.0%
Average Concentration per Zone	116	106	62	53
Number of Values	8	35	24	46
Current Load or existing Condition is the average of the observed TSS Loads for each flow zone.				
Runoff calculated using Median Flow/Area				
mm/day	0.68	0.10	0.04	0.01
cfs/sqmile	0.72	0.10	0.04	0.01

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 Vermillion River TMDL data description and summary are included mainly in the Data Collection Method section of the document and are plotted on the load duration curve for site VR05. The full data set is included in Appendix D of the TMDL. Sampling was conducted on a temporal basis over the period from January 2005 to December 2006. The data set also includes long term data from SD WQM sites in the watershed, and 26 years of flow record on the Vermillion River.

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 five National Pollution Discharge Elimination System (NPDES) permittees located within the watershed of Segment 7. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment 7. The City of Beresford, SD (NPDES Permit number: SD0020079) is located on the uplands on the eastern side of the river basin. Although Beresford's WWTF is authorized to discharge, the three-cell pond system only does so seasonally. The City of Viborg, SD (NPDES Permit number: SD0020541) is a three-cell pond system that may discharge seasonally to the Vermillion River. It is located in the Turkey Ridge Creek Watershed. The City of Wakonda, SD (NPDES Permit number: SD0020257) is another small three-cell pond system that seasonally discharges to the Segment 7. It is located on the uplands on the western side of the river basin in Clay County. The WLAs for all three facilities are included in Table 7 of the TMDL document.

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 Load Allocations section explains how the loading capacity and load allocation was derived. Since the majority of the landuse in the watershed is nonpoint sources, the majority of the loading capacity has been allocated to the nonpoint sources in the form of load allocations. Table 7 includes the load allocation for each of the four flow regimes for Segment 7.

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment 7 was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR05, which is approximately 12 miles upstream of USGS Gage 006479010. Site VR05 is the most downstream site within this segment.

The 30-day average criterion (90 mg/L) was used for the calculation of the LC, rather than the daily maximum criterion (158 mg/L) because the chronic criterion is considered more protective. The loading capacities and reductions derived from the available data are estimates (i.e., the calculated loading capacities and reductions may be higher or lower if/when a more extensive data set is collected to fully assess compliance with the chronic standard). For each of the four flow zones, the 50th percentile (median) of the range of LCs within a zone was set as the flow zone goal. TSS loads experienced during the largest stream flows cannot be feasibly controlled by practical management practices. Setting the flow zone goal at the 50th percentile while using the average (90 mg/L) criterion within each flow zone will protect the warmwater semi permanent fish life propagation beneficial use 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 Vermillion River TMDL includes an explicit MOS of 10% that was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity. The remaining assimilative capacity was attributed nonpoint sources (LA) or point sources (WLA). Table 7 includes the MOS for each of the four flow regimes for Segment 7.

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 TSS loads are taken into account. 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 largest concentrations are highest 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. Implementation targeted to the critical conditions should reduce the sediment loading in 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 State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process so far. 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: 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 throughout the river basin especially for Segment 7 at WQM Site 4 (Storet ID: 460755). This station is sampled on a monthly basis.

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 Implementation section of the TMDL document says that an implementation project has been initiated to address the sediment and pathogen sources within the Vermillion River watershed.

For Segment 7 of the Vermillion River the WLA contribution is insignificant in comparison to the overall TMDL within each flowzone. Because the sources for this segment are so heavily weighted towards nonpoint sources, reasonable assurance through the National Pollution Discharge and Elimination System (NPDES) does not play a role in the implementation of this TMDL. In addition, the NPDES permits contain end of pipe limits at the water quality standard and any discharges should not cause or contribute to standards violations.

During the next Section 319 funding round, an expansion of the existing watershed project will be proposed to include additional funds for BMPs targeting streambank erosion and sheet and rill erosion. Several types of BMPs should be considered in the development of a water quality management implementation plan for watershed draining the impaired segments of the Vermillion River. The results of the FLUX loadings indicate that an estimated 5% or greater of the total suspended solids load originates from bank erosion in varying flowzones. Additional analysis through the Annualized AGNPS suggests that multiple drainages provide increased water and sediment loadings. While several types of control measures are available for reducing sediment loads, the practicable control measures listed and discussed below are recommended to address these identified sources.

- Livestock access to streams should be reduced, and livestock should be provided sources of water away from streams;
- Unstable stream banks should be protected by enhancing the riparian vegetation that provides erosion control and filters runoff of pollutants into the stream;
- Filter strips should be installed along the stream bordering cropland and pastureland;
- Animal confinement facilities should implement proper animal waste management systems; and
- An assessment of the effect of tiling on peak flows and bank erosion should be completed for the tributaries draining into these three segments of the Vermillion River.

Since this basin involves multiple conservation districts and counties, a joint effort is required. This has already been undertaken through an agreement with the McCook County Conservation District acting as lead sponsor. This project will provide the necessary funding and control measures needed to reduce sediment impacts on the Vermillion River.

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 Vermillion River TSS TMDL includes daily loads expressed as tons per day. The daily TMDL loads are included in the TMDL Allocations section of the TMDL document.

COMMENTS: None.