Total Suspended Solids Total Maximum Daily Load (TMDL) for Segment R8 of the Vermillion River Clay, Hutchinson, Lincoln, Turner, Yankton, and Union 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
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Total Maximum Daily Load Summary for the Vermillion River -Segment R8

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 R8 - Approximately 33 km in length
Size of Watershed:	Segment R8 – 116,223 hectares (ha) Contributing Drainage Area - 551,163 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_03

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 R8 (SD-VM-R-VERMILLION_03) of the Vermillion River (Baptist Creek to mouth), 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 R8 (2010 IR) is found within three Level IV Ecoregions: 46n-James River Lowland, 46k-Prairie Couteau, and 47d-Missouri Alluvial Plain. Ecoregion 46k is characterized by a glaciated platform of hummocky or rolling hills with a high concentration of wetlands and lakes. The elevation puts it above the surrounding drift plain. 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. Ecoregion 47d is the level Missouri River floodplain consisting of alluvium with riparian wetlands that are largely drained (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 sub-humid, 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 R8 (waterbody ID: SD-VM-R-VERMILLION_03) is the second 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	Sediment
SD-VM-R-VERMILLION_03	Baptist Creek to Mouth	Sediment

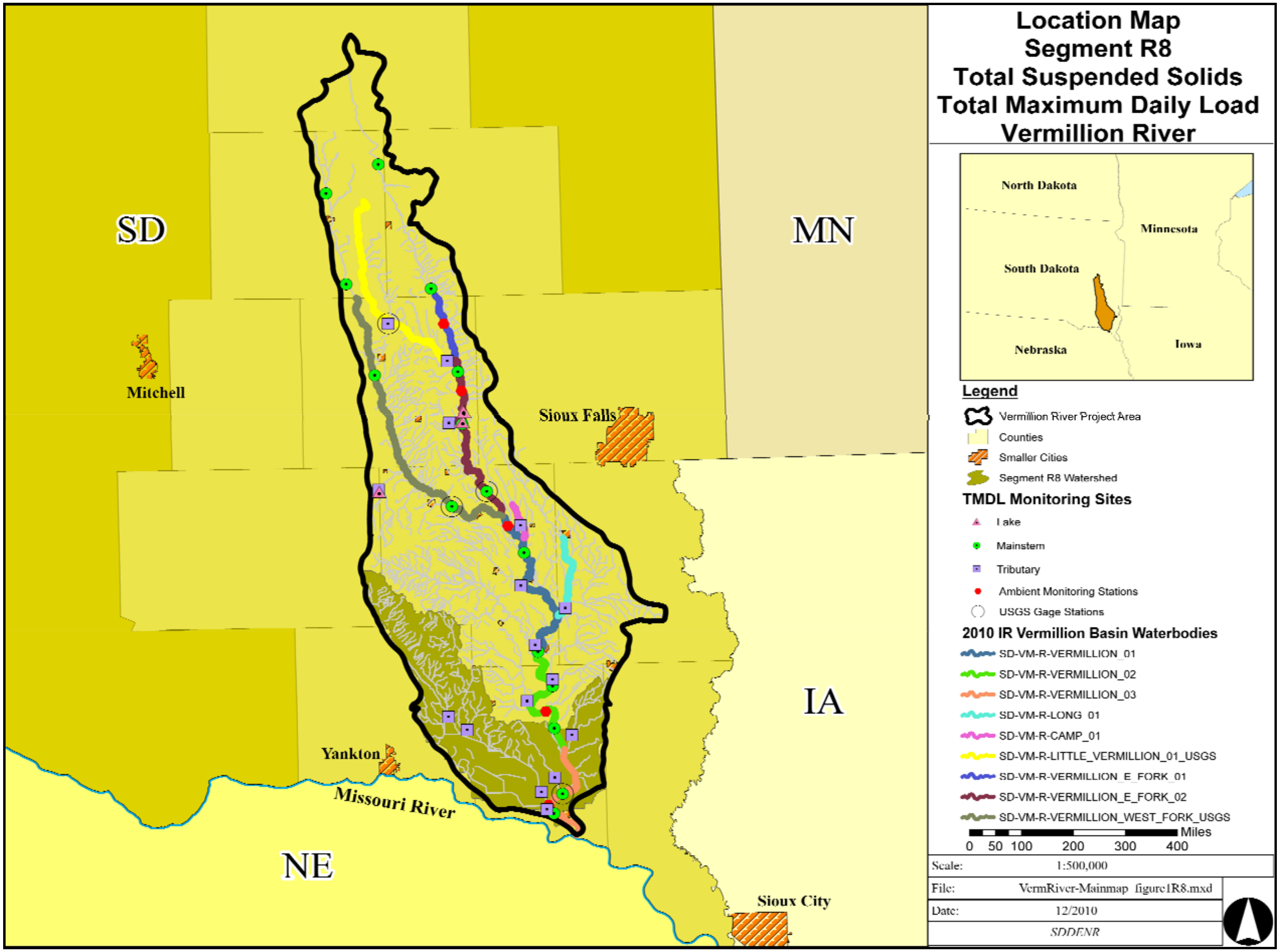
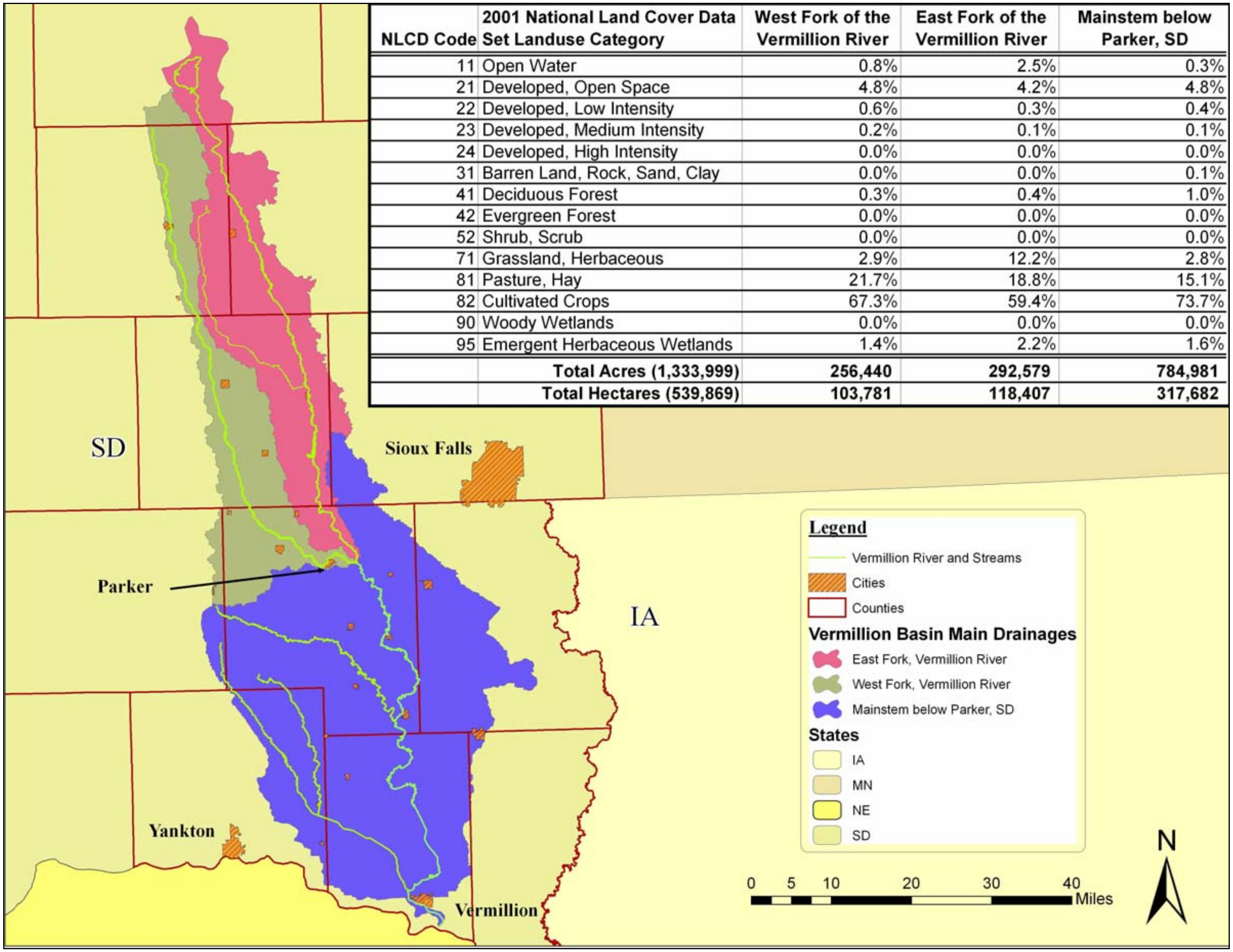


Figure 1. Location of Segment R8 subwatershed of the Vermillion River in southeastern South Dakota.



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 R8 (SD-VM-R-VERMILLION_03)

Segment R8 runs approximately 21 miles from Baptist Creek (north of the city of Vermillion approximately 10 miles) to the mouth, which is approximately 4 miles south of the city of Vermillion, SD. Major tributaries to this segment include Yankton Clay Ditch (Site VRT02), Clay Creek Ditch (Site VRT04), Spirit Mound Creek (Site VRT 30), and Baptist Creek (Site VRT31).

Figure 3 shows similar land uses within the Segment R8 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.

For southern and western Clay:

Luton-Blencoe Association

Poorly drained and somewhat poorly drained, nearly level and gently sloping, clayey soils on flood plains. Approximately 75 percent of this association is in cropland. Pasture or hayland is approximately 20 percent.

Napa-Luton-Blyberg Association

Poorly drained and well drained, level and nearly level, clayey and silty soils on flood plains. Approximately 50 percent is cultivated with the remaining 40 percent used for pasture, hay, or rangeland.

Davison-Tetonka-Egan Association

Moderately well drained, poorly drained, and well drained, nearly level and gently sloping, silty and loamy soils on till plains. Approximately 90 percent of this association is cultivated.

Owego-Lossing Association

Somewhat poorly drained and moderately well drained, nearly level to level, clayey soils on flood plains. Approximately 90 percent of this association is cultivated.

For northeastern Yankton County:

Ethan-Betts-Davis Association

Deep, well drained, gently sloping to steep, loamy soils on till plains and moraines. This soil association is considered better for rangeland and wildlife habitat.

Egan-Ethan-Trent Association

Deep, nearly level to gently rollin, well drained and moderately well drained silty and loamy soils on uplands. This soil association is considered good for cultivated crops.

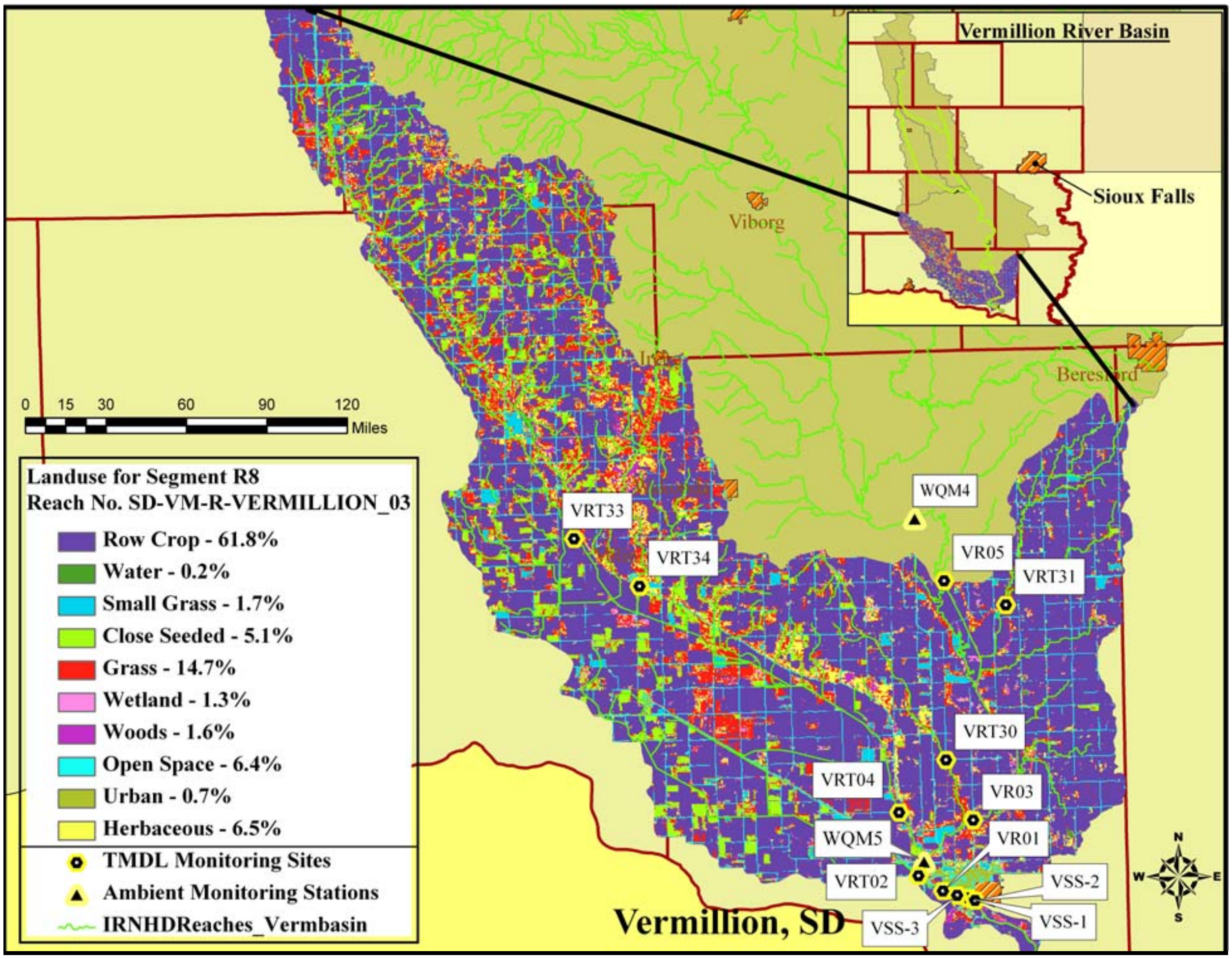


Figure 3. Landuse for Segment R8 in the Vermillion River Basin.

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.

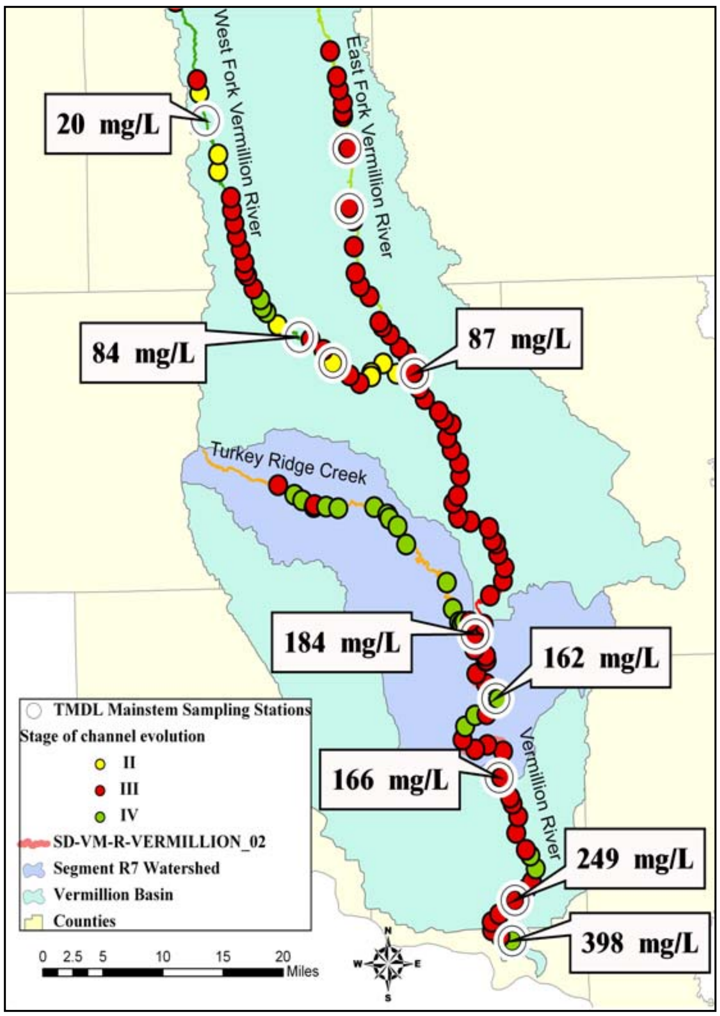


Figure 4. Rapid Geomorphic Assessments and Mean TSS Concentrations for Sites Along the Vermillion River.

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 R8 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 sampled from ambient station WQM5 (STORET ID: 460745) for Segment R8.

The ambient monthly data were analyzed using the Seasonal Kendall test for trend (Helsel, et al., 2006) (Figure 6). A LOWESS smooth was used to describe the relation between TSS concentrations and flow. Residuals from this procedure, as described in Helsel and Hirsch (2002), remove the effect of flow on the TSS concentrations. The Kendall trend analysis (TSS-flow residuals vs. time) indicated a significant increasing trend over time (n=344, Kendall's Tau = 0.099271, P>0.05). Although excessive sediment loadings have existed since at least 1972 it seems that higher concentrations are becoming more problematic with time. This might be attributed to continued channel degradation and excessive inflows from surrounding cropland.

Figure 7 shows the TSS concentrations categorized by flow. Four flow zones for Site VR01 with WQM Site 5 (STORET Site WQM460745) 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 7). 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.

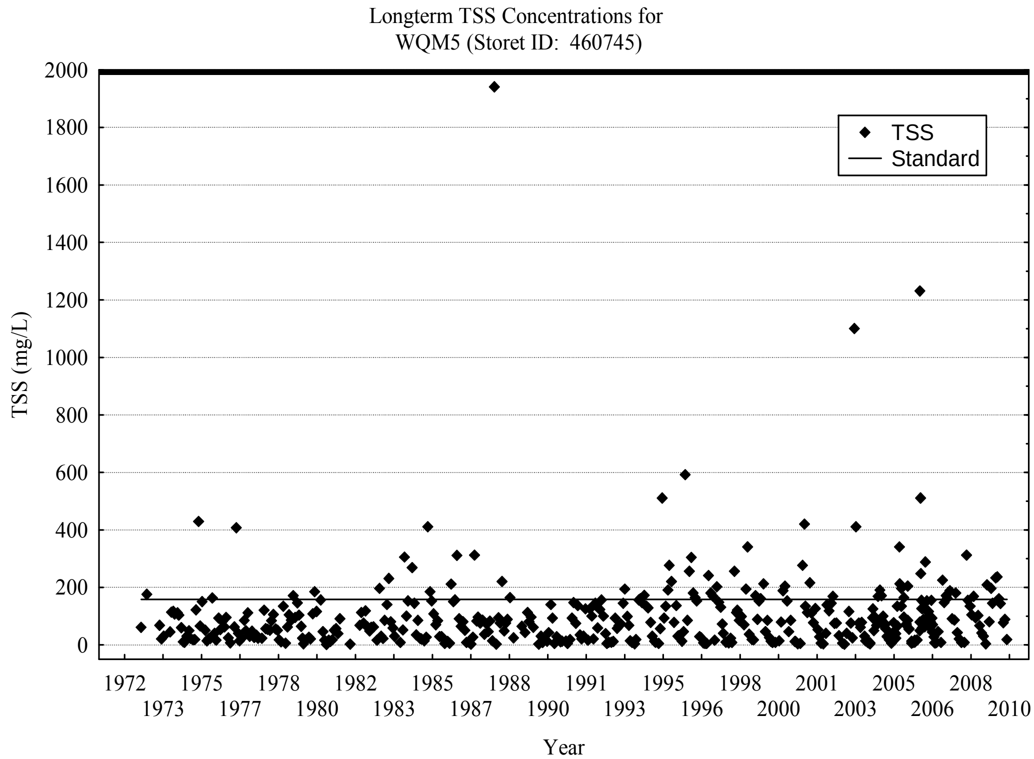


Figure 5. Longterm TSS Concentrations for WQM5.

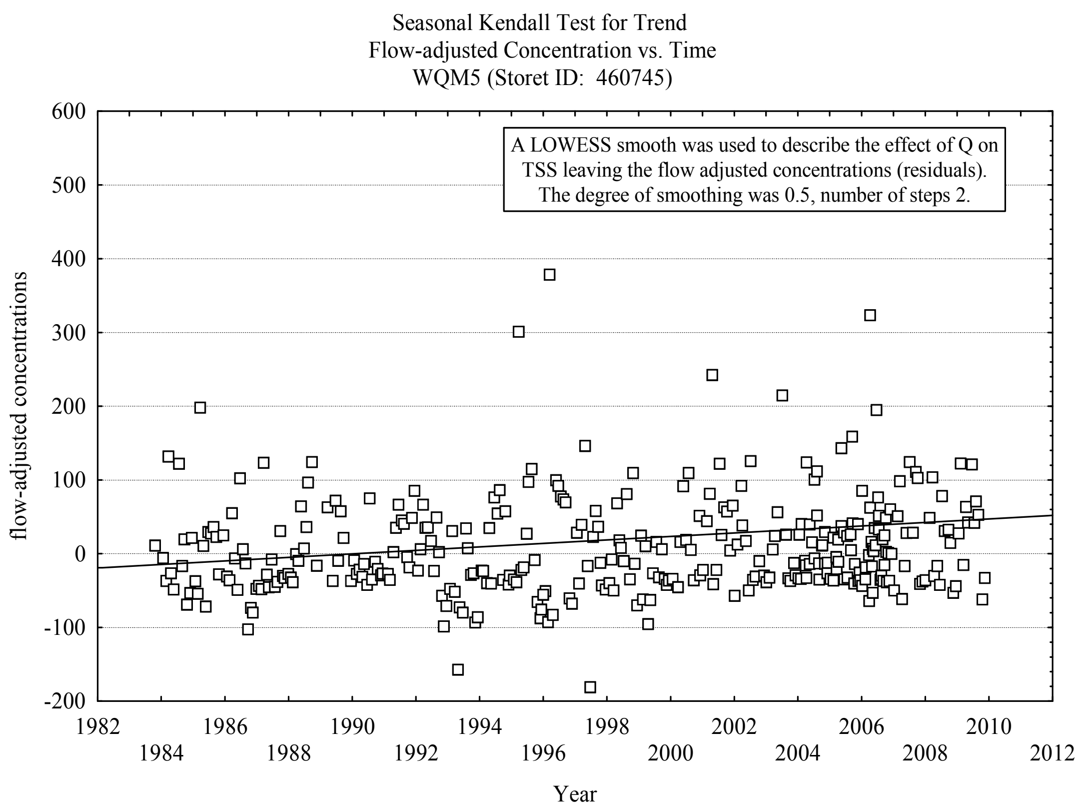


Figure 6. Seasonal Kendall Test for TSS Trend at WQM 5.

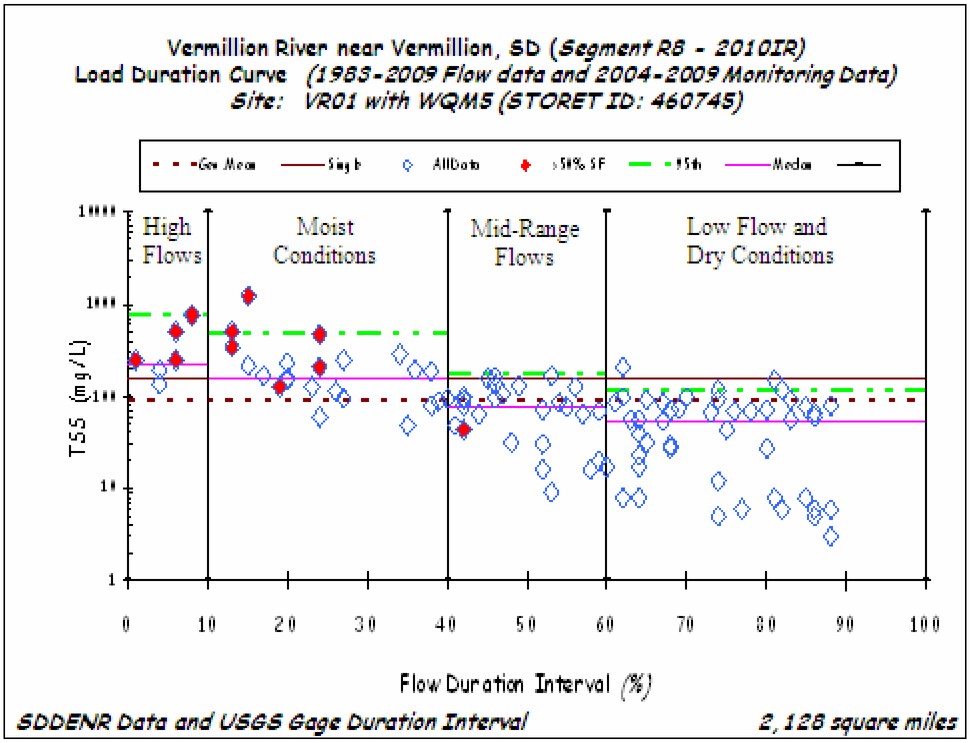


Figure 7. Segment R8 (Site VR01 with WQM5) sampled TSS Concentrations compared to the daily maximum (≤158 mg/L) and 30 day average (≤90 mg/L) TSS Criteria.

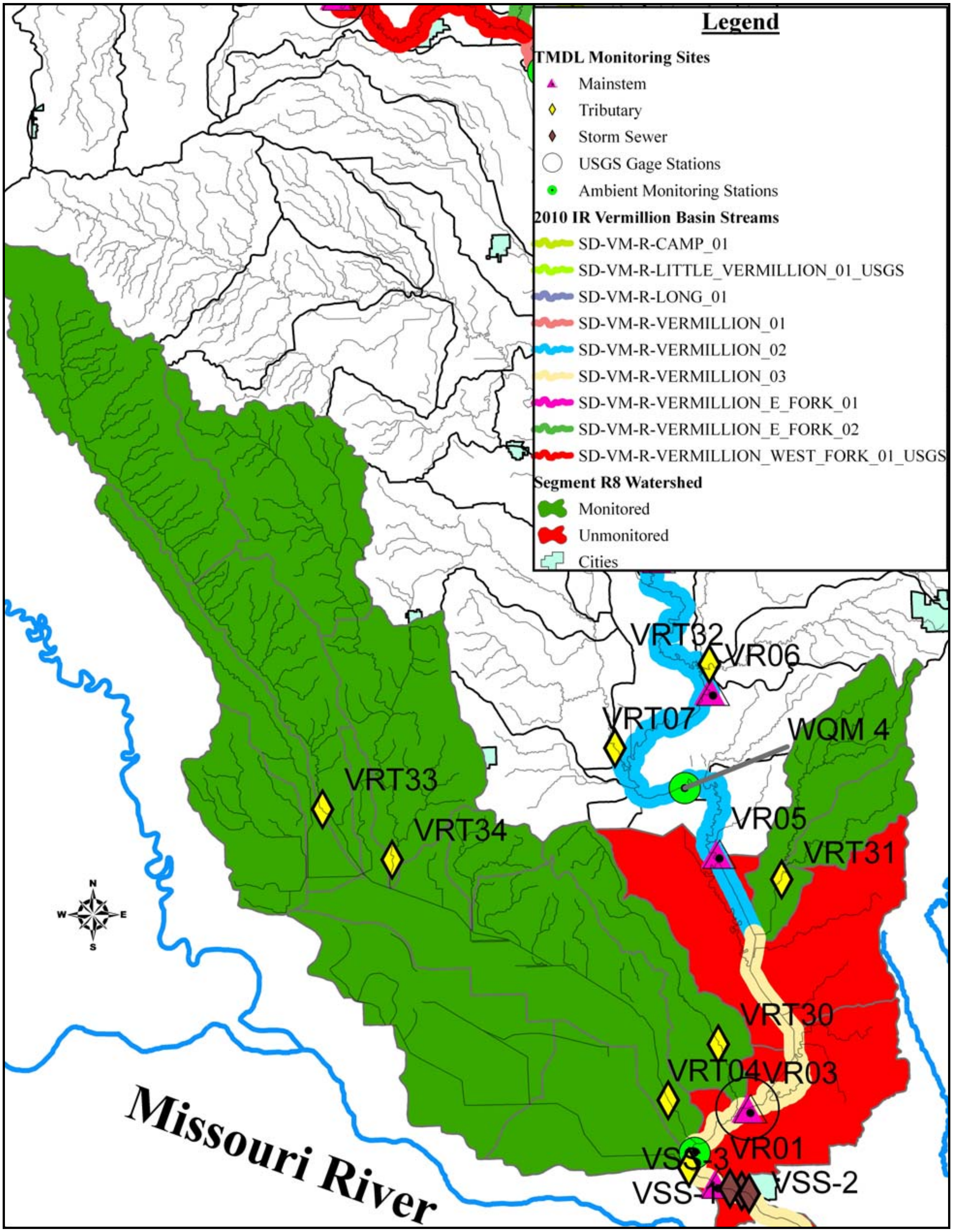


Figure 8. Segment R8 Subwatershed.

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 R8 (waterbody ID: SD-VM-R-VERMILLION_03) 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, 09, and 12. 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 of ARSD	mg/L	30-day average March 1 - October 31
	Equal to or less than the result from Equation 4 in Appendix A of ARSD	mg/L	30-day average November 1 - February 29
	Equal to or less than the result from Equation 2 in Appendix A of ARSD	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 one of several 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 R8 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 R8 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 R8 Reach No.: SD-VM-R-VERMILLION_03	VR05	Samples per Zone	2	10	6	9
		Exceedances per Zone	1	2	0	0
		%Violation	50%	20%	0%	0%
	VR03	Samples per Zone	2	8	8	6
		Exceedances per Zone	1	5	1	0
		%Violation	50%	63%	13%	0%
	WQM5	Samples per Zone	4	10	14	30
		Exceedances per Zone	3	4	1	1
		%Violation	75%	40%	7%	3%
	VR01	Samples per Zone	3	10	6	5
		Exceedances per Zone	3	6	0	0
		%Violation	100%	60%	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 D. 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 I. 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 – J 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 R8. Site VR01 flows were sorted based on flow zone. Each daily output load from Site VR01 had a corresponding load from all inputs (tributaries and HUC12s) draining to this segment including the most upstream mainstem site in the segment (Site VR05). 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 R8)

Notes: Daily loadings for each zone within each year (2005-2006) 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 daily export coefficient (kg/acre/day).

		4=Low 3=Dry	Acres from GIS Pile-->	1,361,905.94	Mainstem 1,139,038.30	Mainstem 1,074,200.27	Yankton Clay Ditch 39,738.35		Clay Creek Ditch 157,444.82		Frog Creek 47,848.18	Spirit Mound 14,161.08	2006 only	Baptist 20,417.43		Unmonitored 23,902.76	Unmonitored 39,440.60
Year	Date	2=Mid 1=High Flowzone	VR01 Flow (cfs)	VR01 Mass (kg)	VR03 Mass (kg)	VR05 Mass (kg)	VRT02 Mass (kg)	kg/acre	VRT04 Mass (kg)	kg/acre	VRT07 Mass (kg)	VRT30 Mass (kg)	kg*acre Estimate	VRT31 Mass (kg)	kg*acre Estimate	Lower Vermillion HUC kg*acre Estimate	Verm-River Baptist Creek HUC kg*acre Estimate
2006	9/5/2006	4	32.29	5489.6	2841.4	2450.8	124.6	0.003136	1230.9	0.01	312.90	0	44.40	12.8	133.52	74.95	123.67
2005	9/27/2005	4	99.31	16848.1	10767.4	6903	336.2	0.008460	661.6	0.00	906.90		119.81		386.99	202.23	333.68
2005	10/9/2005	4	99.31	16848.1	10767.4	9177.3	76.5	0.001925	1209.7	0.01	825.00		27.26		352.04	46.02	75.93
2005	9/17/2005	4	100.54	17055.4	10917	6315.6	97.1	0.002443	359.1	0.00	786.00		34.60		335.40	58.41	96.37
2005	8/11/2005	3	101.76	17262.7	11066.5	8449.7	106	0.002667	478.1	0.00	845.00		37.77		360.57	63.76	105.21
2005	8/12/2005	3	101.76	17262.7	11066.5	8082.1	76.5	0.001925	478.1	0.00	845.00		27.26		360.57	46.02	75.93
2005	5/14/2005	2	1074.83	1156169	485937.9	341295.9	607.8	0.015295	60812	0.39	6,315.50		216.59		2694.90	365.59	603.25
2005	6/6/2005	1	4067.60	2508125	1160379	723706.1	6585.5	0.165722	715038.6	4.54	57,417.50		2,346.80		24500.78	3961.20	6536.16
2005	6/5/2005	1	4485.27	2765607	1278707	693345.3	6054.1	0.152349	890378.8	5.66	138,632.10		2,157.43		59156.08	3641.56	6008.74

	# of Days per Zone	2005 Days per zone	2006 Days per zone	**VR01**	**VR03**	**VR05**	**VRT02**		**VRT04**		**VRT07**	**VRT30**	**est**	**VRT31**	**est**	**Lower Vermillion HUC**	**Verm-River Baptist Creek HUC**
Zone 1	32	24	8										VRT02		VRT07	VRT02	VRT02
Zone 2	116	59	57	96,000,189	58,492,142	40,769,641	125,128	3	8,640,036	55	1,058,627	15,792	44,590	381,508	451,729	75,265	124,190
Zone 3	84	41	43														
Zone 4	195	91	104														
subtotal	427	215	212														
Total	427																

2005 and 2006 Loadings

	Extreme Flows (0-10) Zone 1	High-Range (10-40) Zone 2	Mid Range Flows (40-60) Zone 3	Low Flows (60-100) Zone 4	**Total**
# of Days per zone	195	84	116	32	**279**
VR05	**22,835,177.40**	**15,622,655**	**1,306,879**	**1,004,929**	**38,457,833**
VR03	32,587,868.80	22,827,707	1,776,957	**1,299,609**	**55,415,576**
VRT07	**588,624.50**	**249,734**	**75,660**	**144,608**	**838,359**
VRT02	**54,444.80**	**43,690**	**8,461**	**18,532**	**98,135**
VRT04	**4,831,521.10**	**2,502,067**	**159,849**	**1,146,599**	**7,333,589**
VRT30	**174,208.50**	**73,911**	**22,392**	**42,798**	**248,119**
VRT31	**251,173.54**	**106,565**	**32,285**	**61,706**	**357,738**
Lower Verm HUC	**294,049.85**	**124,756**	**37,796**	**72,240**	**418,806**
Verm-River Baptist	**485,195.11**	**205,852**	**62,365**	**119,199**	**691,048**
MS42005	77,224	34,793	50,068	**20,367**	**112,017**
MS42006	61,738	25,526	33,837	**4,749**	**87,265**
MS4Total	**138,962**	**60,320**	**83,906**	**25,116**	**199,282**
Gayville	513	221	305	**84**	**734**
Irene	1,736	748	1,033	**285**	**2,484**
Vermillion	177,158	76,314	105,386	**29,072**	**253,472**
Volin	-	-	-	-	-
WLA Total	**179,407**	**77,283**	**106,724**	**29,441**	**256,690**
Bed/Bank					-
VR01	**56,549,186.10**	**34,940,723**	**2,275,670**	**2,234,610**	**91,489,909**

5.6 Bed and Bank Erosion

For Segment R8 all input sources of sediment were summed within each flow zone. The total mass from all input sources was compared to Site VR01 (total output). The difference (output-input) was considered to be bed or bank erosion. Segment R8 outputs were slightly greater than inputs across all flow zones. The RGA's also indicated some mass wasting along this lower reach.

The difference between the inputs and outputs for Segments R8 were significant. The estimates for bed and bank erosion derived using the output – input method were slightly higher to well within the range as described in the special project final report 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 -19% to 47% of the total suspended-sediment load (Table 6). 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 R8 of the Vermillion River were assumed to be the difference between inputs and outputs (mass balance) for each of the flow zones. 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 R8. A waste load allocation (WLA) was quantified for three of the facilities as part of the sediment TMDL for Segment R8.

The City of Gayville, SD (NPDES Permit# SD0022161) is small one-cell pond system located in the Vermillion flood plain in eastern Yankton County. It is in the Yankton-Clay Ditch watershed. Although the Gayville WWTF is authorized to discharge, the one-cell pond system only does so seasonally.

The City of Irene, SD (NPDES Permit# SD0022454) is a small three-cell pond system located in extreme northwest Clay County. It is in the Turkey Creek-Clay Creek watershed. Although the Irene WWTF is authorized to discharge, the three-cell pond system only does seasonally.

The City of Vermillion, SD (NPDES Permit# 0020061) is a mechanical plant that is authorized to discharge continuously. It is located 2 miles above the mouth of the Vermillion River.

The City of Vermillion, SD (MS4 NPDES Permit# SDR41A001) is a city with population in excess of 10,000 and, therefore, is subject to Phase II of the Municipal Separate Storm Sewer Systems (MS4) Program. Phase II MS4s are covered by a general permit. Each regulated MS4 is required to develop and implement a stormwater management program (SWMP) to reduce the contamination of stormwater runoff and prohibit illicit discharges. The expanded Phase II program required small MS4s in urbanized areas to obtain NPDES permits and implement minimum control measures. In order to quantify the total suspended load from the city of Vermillion, the Simple Method (Schueler 1987) was used. Appendix C describes the calculation process for the MS4 loadings.

The City of Volin, SD (NPDES Permit# 0020907) is a small one-cell pond system that is not authorized to discharge. It is located in eastern Yankton County in the Clay Creek Ditch watershed. A WLA was not calculated for this facility.

Table 6. Source Allocation for all inputs to Segment R8.

Source Allocation	Percent Contribution of all inputs for Vermillion River Segment R8 per flowzone				Area	Ann-AGNPS Export Coefficients[3]
Subwatershed or 12-digit HUC	High	Moist	Mid	Dry	acres	tons/yr/acre
VR05 (mainstem upstream)	40.4%	44.7%	57.4%	45.0%	1,074,200	
VRT02 - Yankton-Clay Ditch	0.1%	0.1%	0.4%	0.8%	39,738	0.10
VRT04 - Clay Creek Ditch	8.5%	7.2%	7.0%	8.8%	157,445	0.24
VRT30 - Spirit Mound Creek	0.3%	0.2%	1.0%	1.9%	14,161	0.66
VRT31 - Baptist Creek	0.4%	0.3%	1.4%	2.8%	20,417	0.28
Lower Vermillion HUC	0.5%	0.4%	1.7%	3.2%	23,903	0.33
Vermillion River- Baptist Creek HUC	0.9%	0.6%	2.7%	5.3%	39,441	
MS4	0.0%	0.2%	2.7%	5.9%	1,329,867	
WLA[1]	0.1%	0.3%	3.4%	7.0%		
Bed/Bank[2]	43.8%	41.0%	17.3%	14.2%		
Natural Background (AnnAGNPS estimate)	5.0%	5.0%	5.0%	5.0%		
Sum of Inputs	100.0%	100.0%	100.0%	100.0%		
VR01 (mainstem downstream)	100.0%	100.0%	100.0%	100.0%	1,361,906	

Notes:
1. A WLA was calculated for three of the four permitted WWTF found within this segment. The fourth WWTF is a zero discharge facility.
2. Bed and Bank was remaining amount of sediment unaccounted for in the mass balance equation (inputs - outputs).
3. Ann-AGNPS estimates based on initial or current conditions. Lower Vermillion HUC and Vermillion River-Baptist Creek HUC modeled together as one HUC.

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.

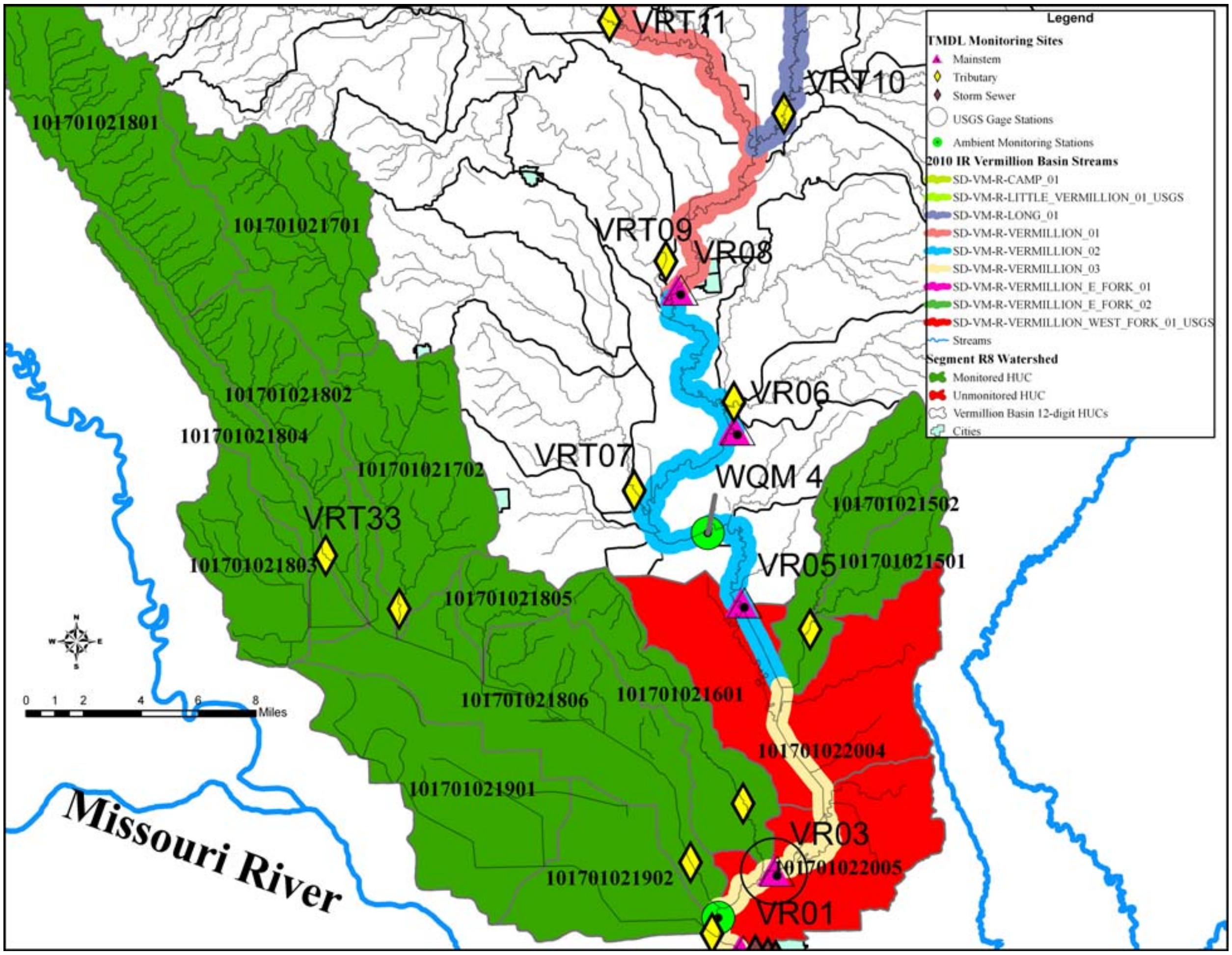


Figure 9. Segment R8 showing unmonitored 12-digit HUCs.

6.2.1 Segment R8 (Vermillion River) – Baptist Creek to mouth

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).

The upstream mainstem site (Site VR05) and bed/bank were the largest contributors of sediment. Of the remaining sources, Clay Creek (Site VRT04), and the two unmonitored HUCs (Lower Vermillion and Vermillion River-Baptist Creek were the largest contributors of sediment. Figure 9 shows the immediate subwatershed area (12-digit HUCs) draining to Segment R8. Ann-AGNPS export coefficients suggest that implementation efforts should focus on these three largest contributors of sediment as well as Spirit Mound Creek (Site VRT30). See Appendix – J 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 10 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 and Segment R7 of the Vermillion River 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 R8, instantaneous loads were calculated by multiplying the TSS concentrations collected from SD DENR TMDL Site VR01 and the long-term ambient monitoring Station WQM5 (Storet ID: 460745) 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 R8 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 10). 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 R8

The LDC (Table 7 and Figure 10) represents the dynamic expression of the TSS TMDL for Segment R8, 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 7 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 R8 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	**VR01 with Ambient Station WQM5**			
Station name:	**Sampling Station downstream of the city of Vermillion**			
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	**>1,075 cfs**	**171-1,075 cfs**	**101-171 cfs**	**<101 cfs**
Median Flow Per Zone	2588.37	333.29	128.15	57.22
Load Allocation	556.1	64.7	20.0	4.6
WLA - GAYVILLE (SD0022161)	0.95	0.95	0.95	0.95
WLA - IRENE (SD0022454)	0.77	0.77	0.77	0.77
WLA - VERMILLION (SD0020061)	1.00	1.00	1.00	1.00
WLA - VOLIN (SD0020907)	0.00	0.00	0.00	0.00
WLA - MS4 VERMILLION (SDR41A001)	5.18	5.18	5.18	5.18
MOS (10% Explicit)	62.7	8.1	3.1	1.4
TMDL	**626.6**	**80.7**	**31.0**	**13.9**
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	1527.580	171.724	26.348	7.556
Load Reduction	**59.0%**	**53.0%**	**-17.8%**	**-83.4%**
Average Concentration per Zone	224	157	77	54
Number of Values	11	40	33	55
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	1.15	0.15	0.06	0.03
cfs/sqmile	1.22	0.16	0.06	0.03

8.1.1 Load Allocation (LA)

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment R8 (Baptist Creek to mouth) was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR01, which is approximately 5 miles upstream of USGS Gage 006479010. Site VR01 is the most downstream site within this segment. There were three mainstem sites located within this segment (Site VR05-upstream, VR03-USGS, and VR01-downstream) in addition to one ambient monitoring station (Site WQM5 Storet ID: 460745) (Figure 9).

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 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 (e.g. top 5 percent) 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 semipermanent fish life propagation beneficial use and allow for the natural variability of the system (Figure 10).

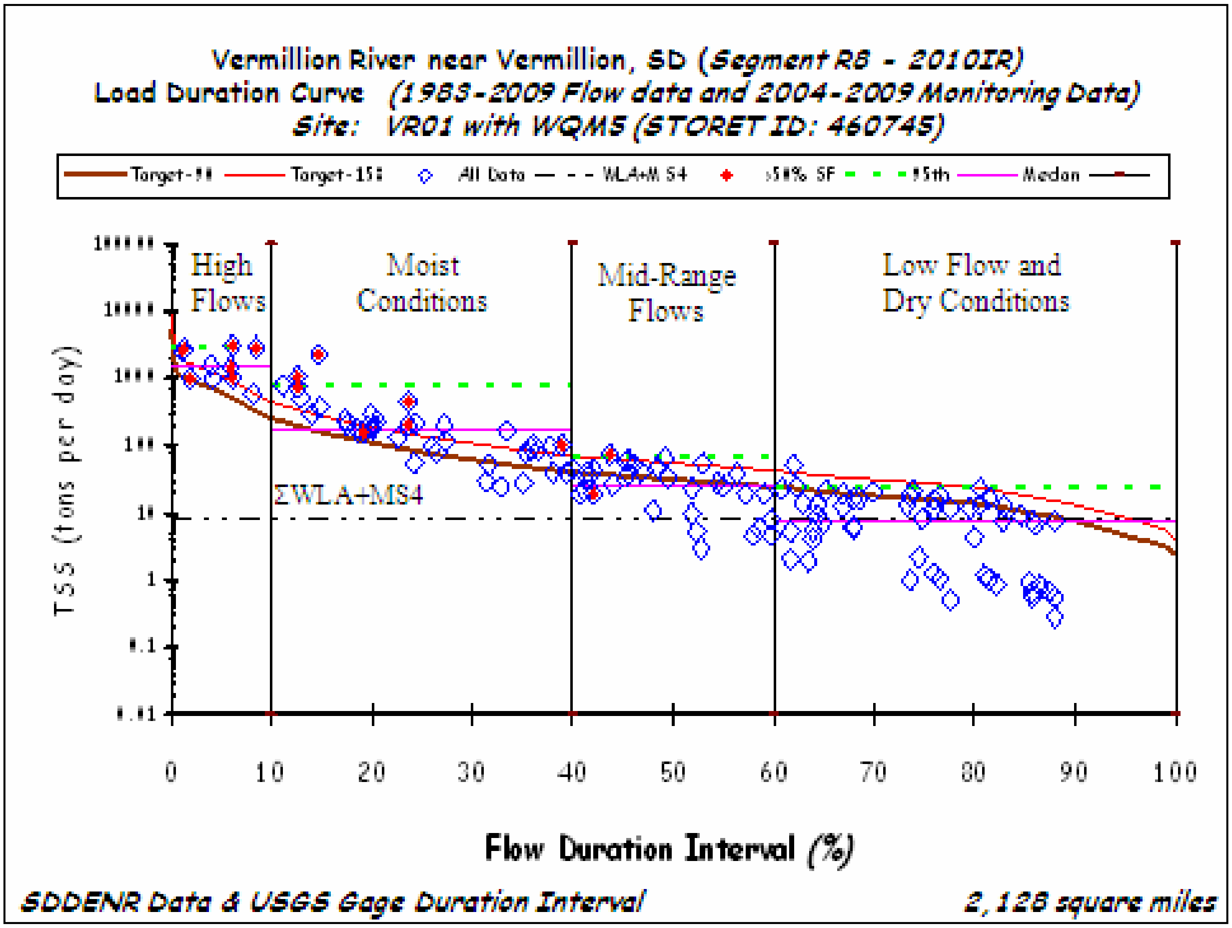


Figure 10. Segment R8 - Load duration curve representing allowable daily TSS loads based on the 30-day average and daily maximum criteria (≤90 mg/L and ≤158 mg/L, respectively). Plot showing median and 95th percentiles, WLA, MS4, and daily loads for each flow zone. The 30-day average was used to determine the loading capacity for the Segment R8 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 four facilities or NPDES Permit holders located within this segment one of which is permitted as zero discharge facility. There is one MS4 permit holder. The city of Vermillion has a population of approximately 10,000 and falls under Phase II of the MS4 program. The WLA and MS4 are 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 R8 (Figure 9), reductions from each source are assumed to be based on the percent contribution outlined in the source allocation table (Table 6, pg. 26). This is only a general recommendation 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 R8 estimated reductions from each input based on size of each subwatershed and percent contribution by flowzone.

Source	Estimated Percent Reductions for all inputs for Vermillion River Segment R8 per flowzone (based on reductions in Table 7)			
Subwatershed or 12-digit HUC	**High**	**Moist**	**Mid**	**Dry**
VR05 (mainstem upstream)	24.2%	24.0%		
VRT02 - Yankton-Clay Ditch	0.4%	0.4%		
VRT04 - Clay Creek Ditch	5.4%	4.1%		
VRT30 - Spirit Mound Creek	0.6%	0.4%		
VRT31 - Baptist Creek	0.6%	0.5%		
Lower Vermillion HUC	0.7%	0.5%		
Vermillion River- Baptist Creek HUC	0.9%	0.6%		
MS4	0.0%	0.1%		
WLA	0.0%	0.2%		
Bed/Bank	26.2%	22.1%		
Natural Background (AnnAGNPS estimate)	0.0%	0.0%		
Sum of Reductions	59.0%	53.0%	-17.8%	-83.4%

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 and, subsequently, Site VR01) 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 R8 – WQM Site 5 (Storet ID: 460745). 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 R8 the WLA and MS4 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	0.16%	1.26%	3.27%	7.32%
MS4 % of TMDL	0.13%	0.99%	2.56%	5.74%
Note the no reduction is necessary for the two lower flowzones.				

Currently, there is an implementation project targeting sources of sediment and bacteria within the Vermillion Basin. In 2011, additional Section 319 funds will be used for an expansion of the project that will include 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 estimated that over 40% of the total suspended solids load originates from bank erosion in the two higher 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 J. 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).

TMDL SUMMARY	**Loads expressed as *(tons per day)***				
	High	**Moist**	**Mid-Range**	**Dry**	**Low**
TMDL[1]	173.35	67.20	40.21	27.57	18.96
Allocations	118.32	48.24	34.47	21.83	6.90
Margin of Safety	55.03	18.96	5.74	5.74	12.06
Implementation Opportunities	***Post Development BMPs***				
	Streambank Stabilization				
	Erosion Control Program	***Erosion Control Program***	***Erosion Control Program***		
		Riparian Buffer Protection	***Riparian Buffer Protection***	***Riparian Buffer Protection***	
					Municipal WWTP

Note: 1. Expressed as a *"daily load"*; represents the upper range of conditions needed to attain and maintain applicable water quality standards.

- 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.

15.0 Literature Cited

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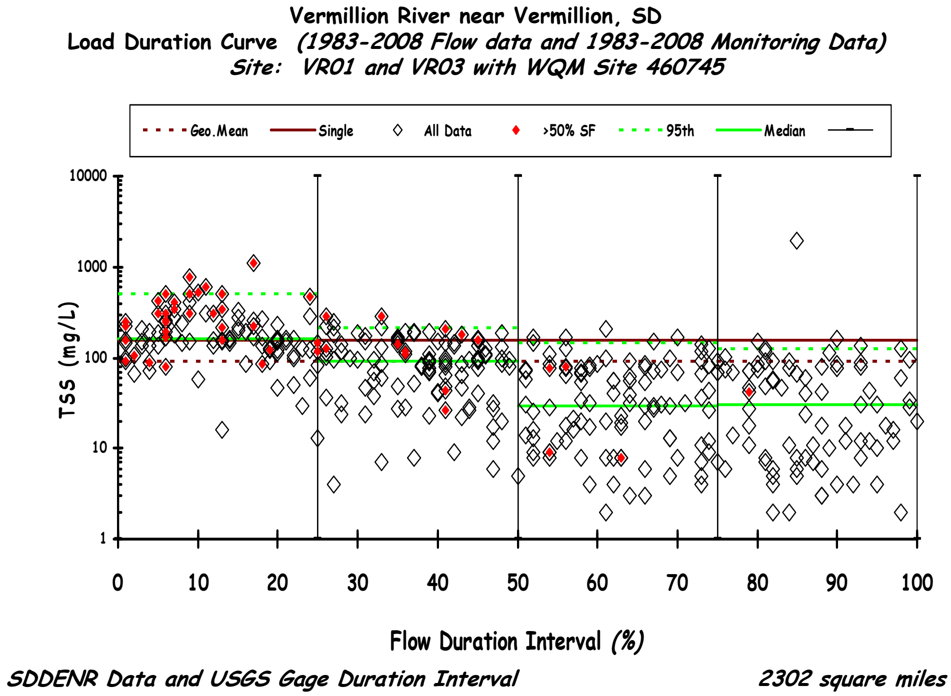
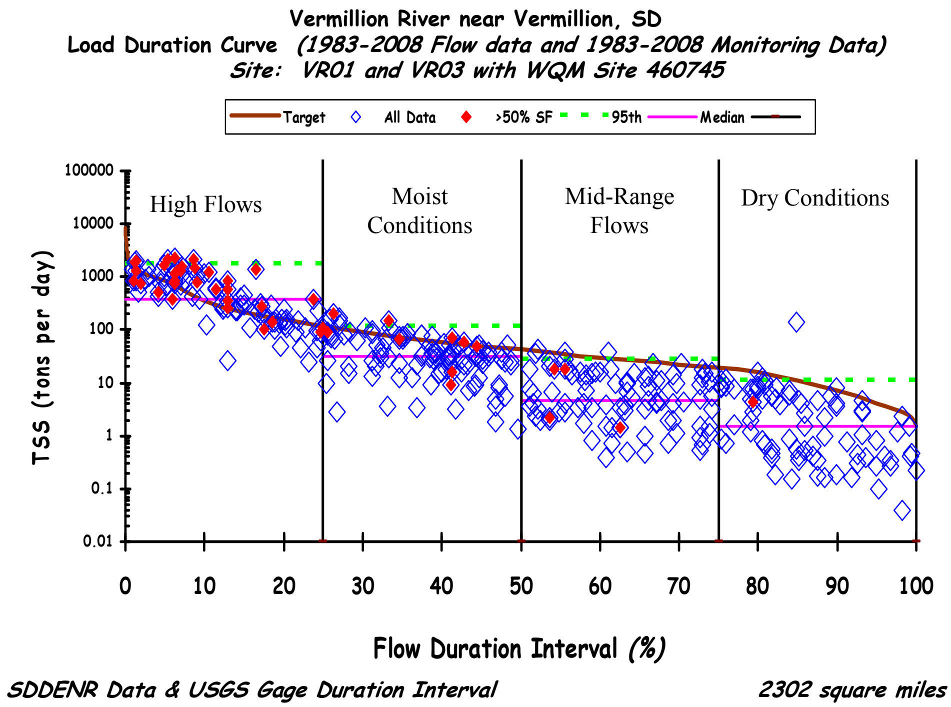
16.0 APPENDIX A: Load Duration Curves and Water Quality Assessment Graphs for Segment R8 Monitoring Sites

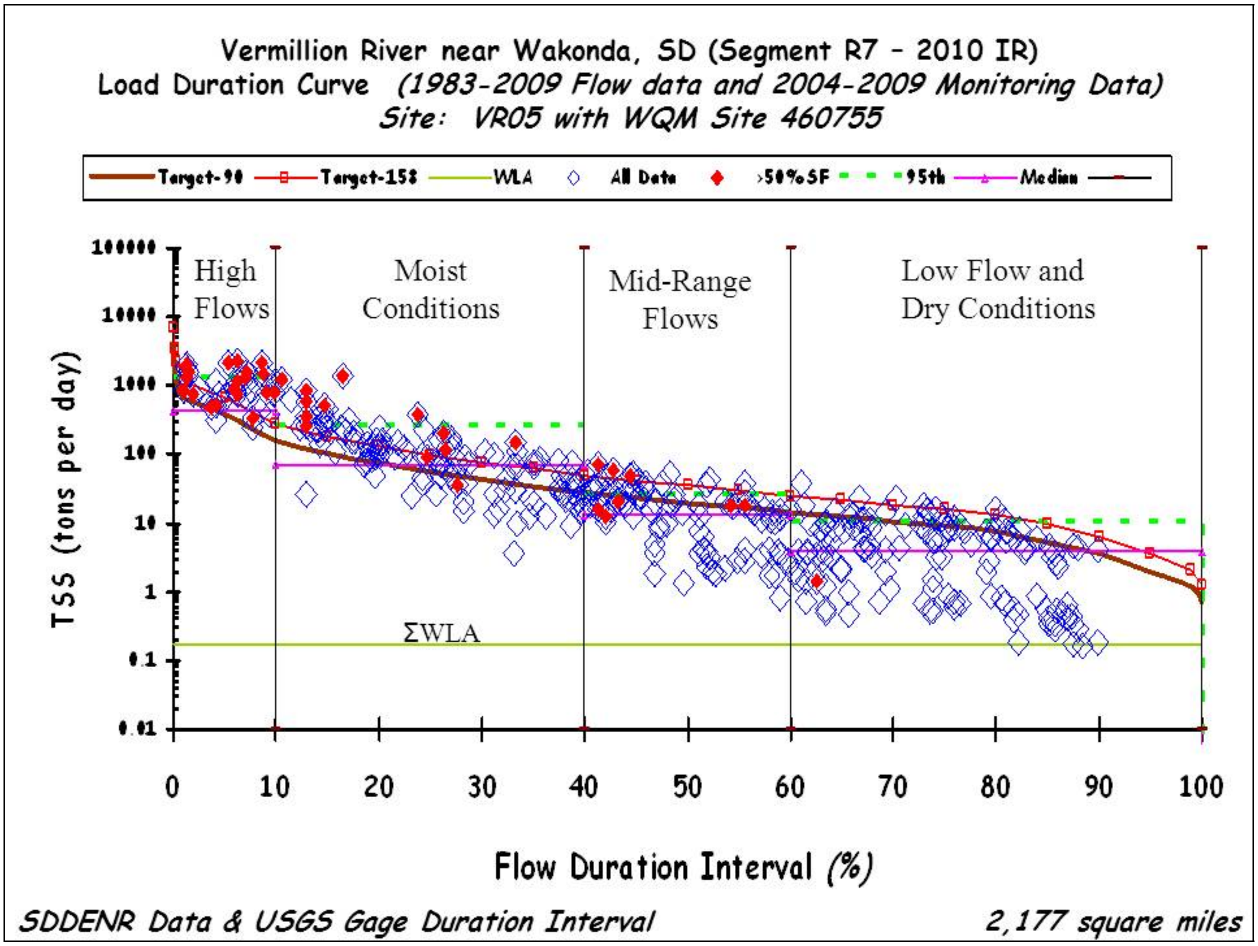

Vermillion River near Vermillion, SD
Load Duration Curve (1983-2008 Flow data and 1983-2008 Monitoring Data)
Site: VR01 and VR03 with WQM Site 460745
Geo.Mean
Single
All Data
>50% SF
95th
Median
TSS (mg/L)
Flow Duration Interval (%)
SDDENR Data and USGS Gage Duration Interval
2302 square miles

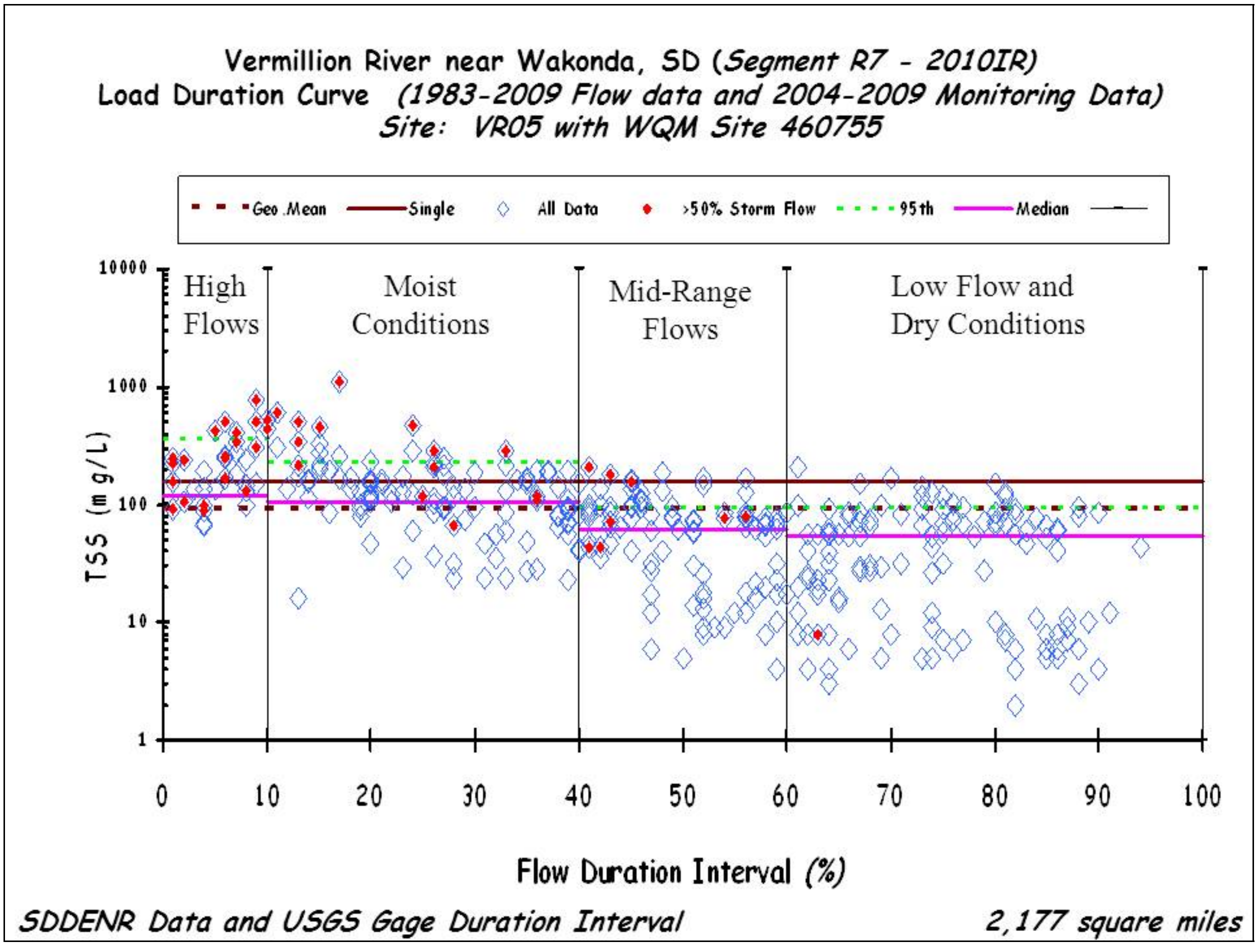

Vermillion River near Vermillion, SD
Load Duration Curve (1983-2008 Flow data and 1983-2008 Monitoring Data)
Site: VR01 and VR03 with WQM Site 460745
Target
All Data
>50% SF
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
TSS (tons per day)
Flow Duration Interval (%)
SDDENR Data & USGS Gage Duration Interval
2302 square miles

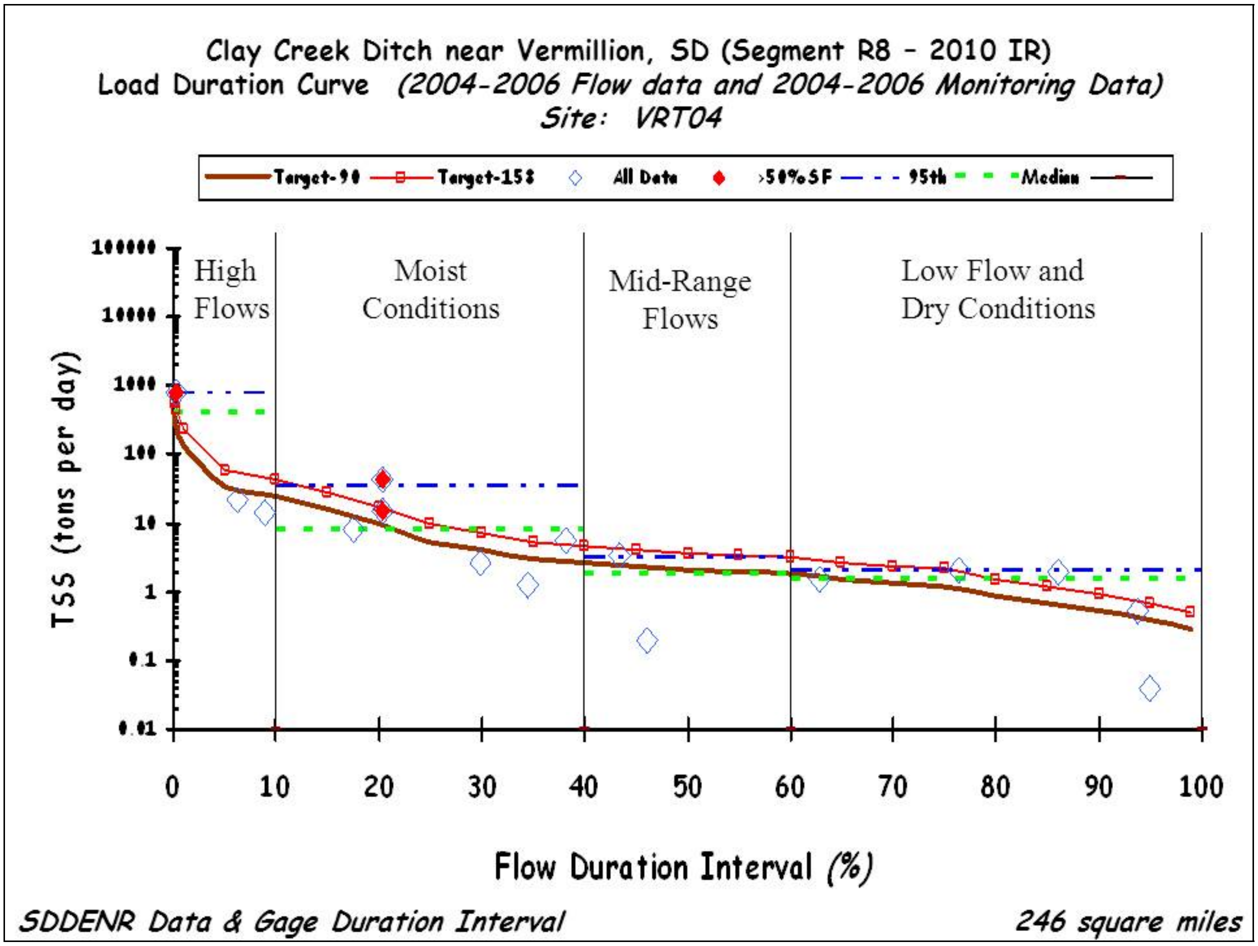
Baptist Creek near Vermillion, SD (Segment R8 – 2010 IR)
Load Duration Curve ***(2004-2006 Flow data and 2004-2006 Monitoring Data)***
Site: VRT31

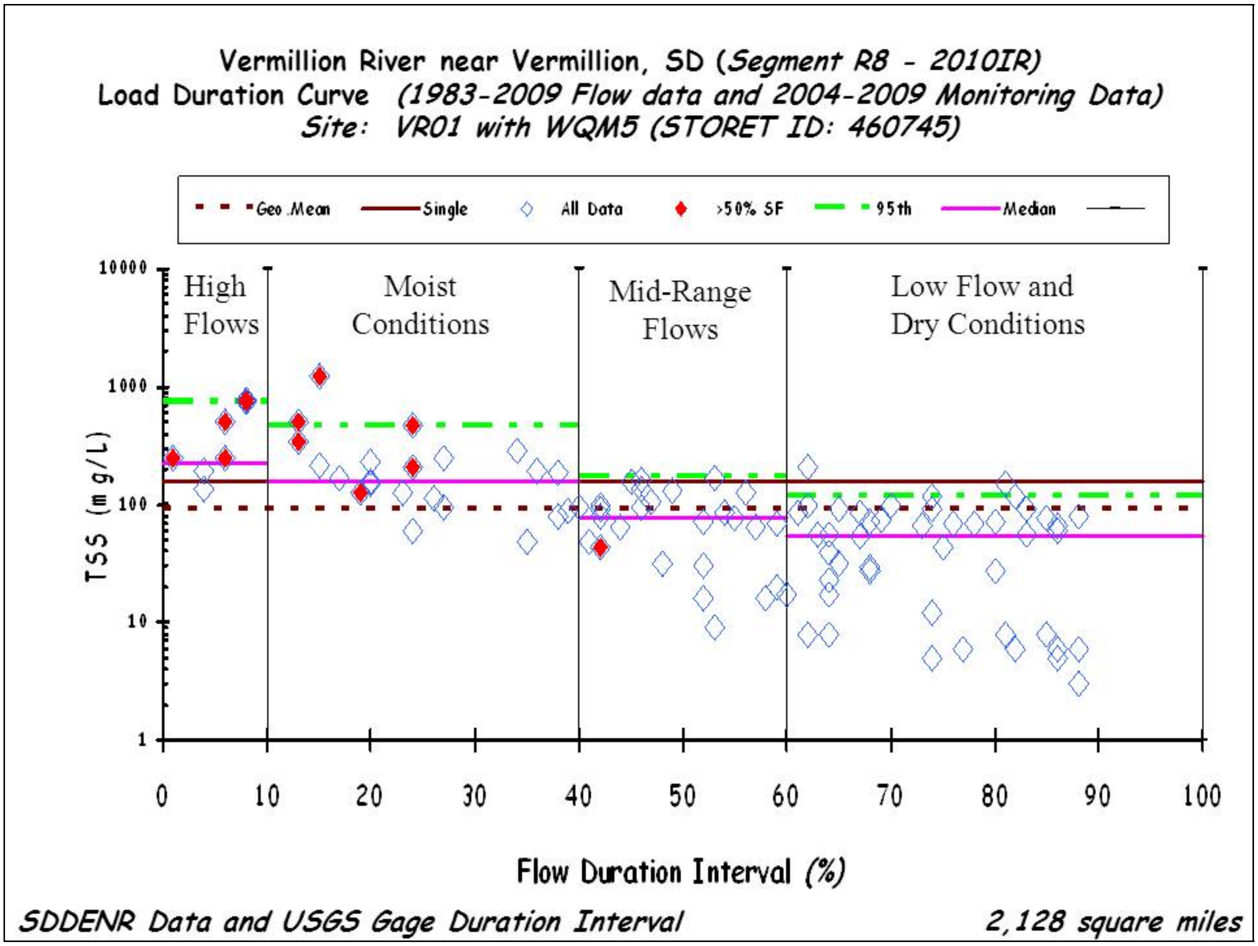
Not enough flow data to produce graph

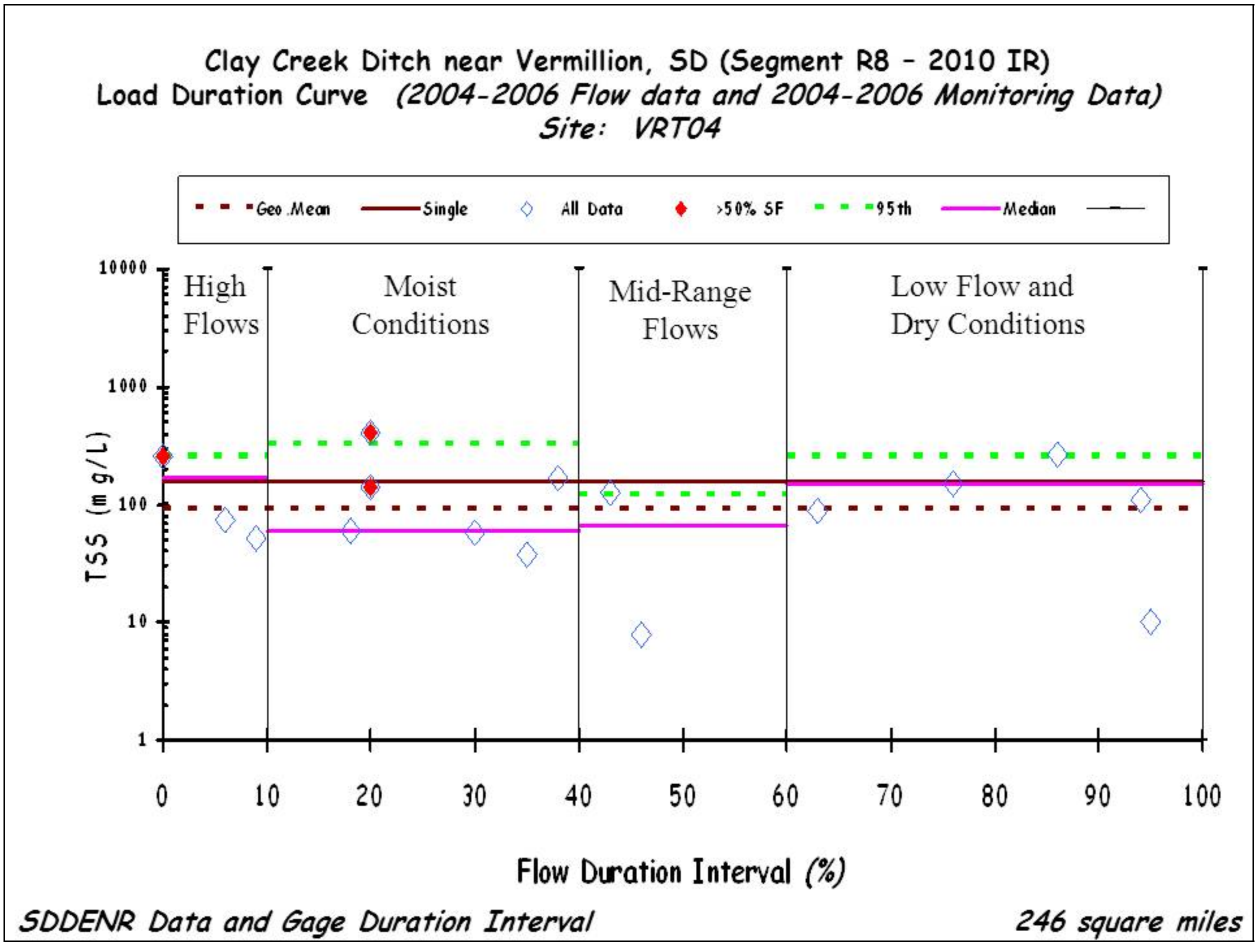
SDDENR Data & Gage Duration Interval ***32 square miles***

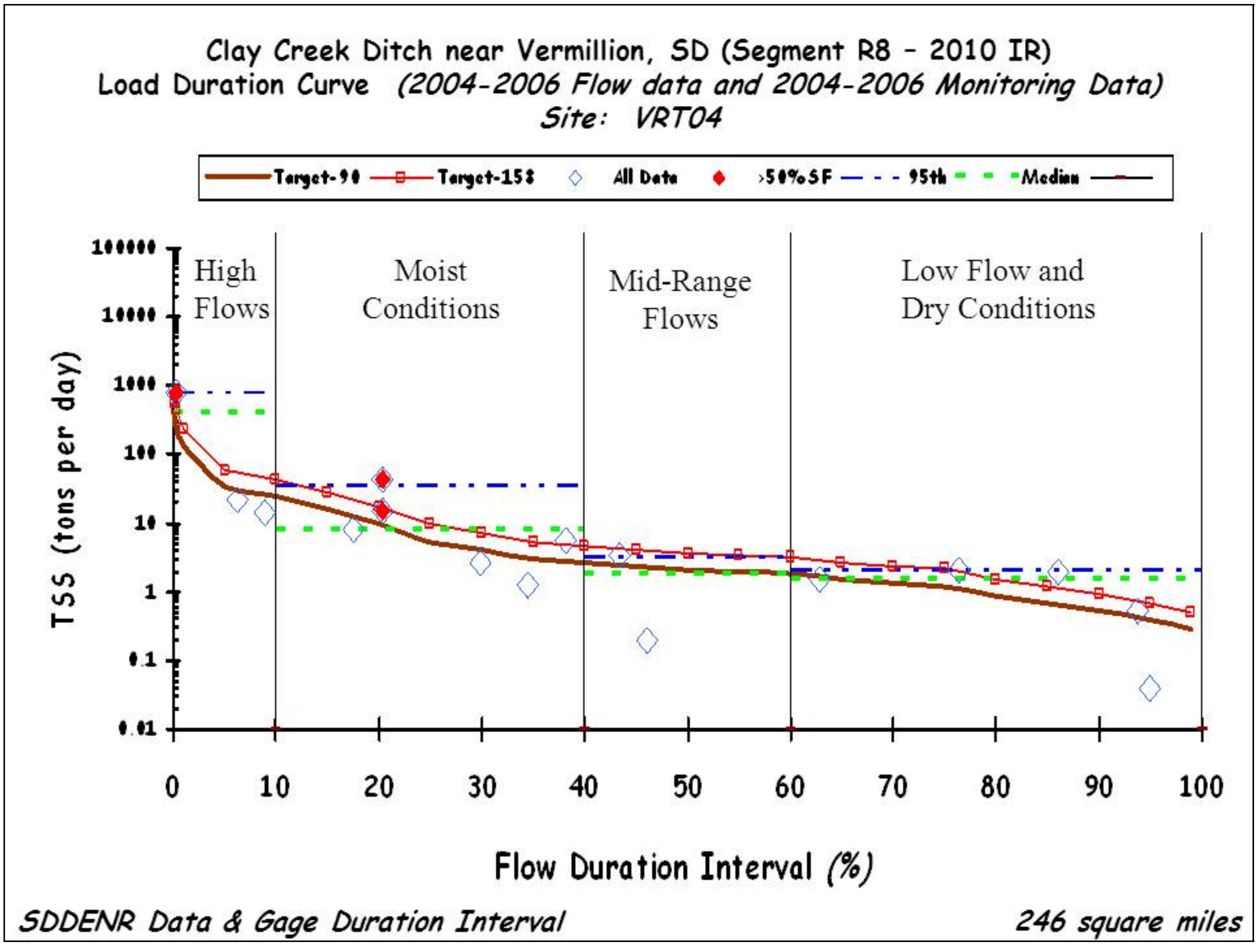

Vermillion River near Wakonda, SD (Segment R7 – 2010 IR)
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR05 with WQM Site 460755
Target-90
Target-158
WLA
All Data
>50%SF
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
ΣWLA
TSS (tons 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

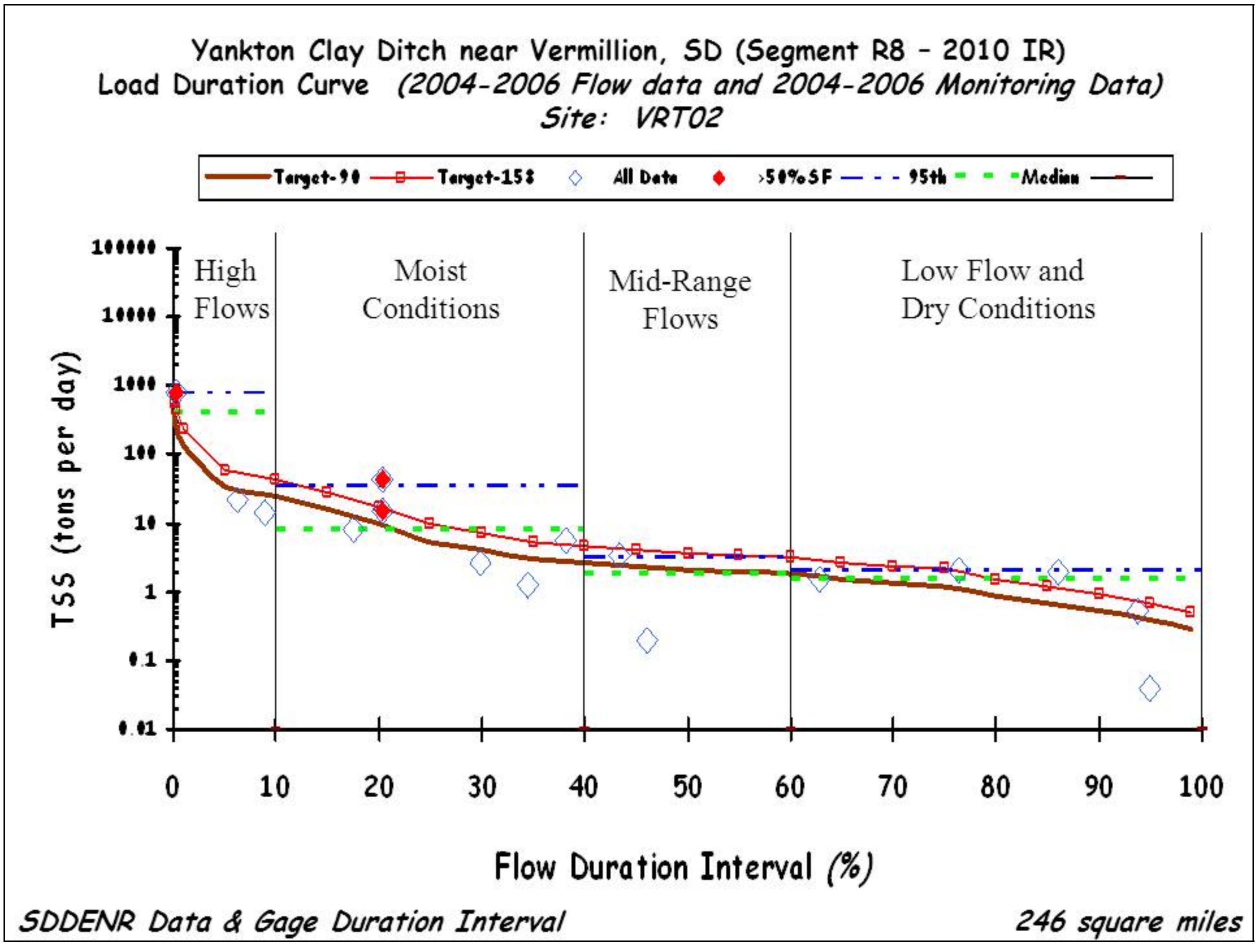

Vermillion River near Wakonda, SD (Segment R7 - 2010IR)
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR05 with WQM Site 460755
Geo.Mean
Single
All Data
>50% Storm Flow
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
10000
1000
100
10
1
TSS (mg/L)
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

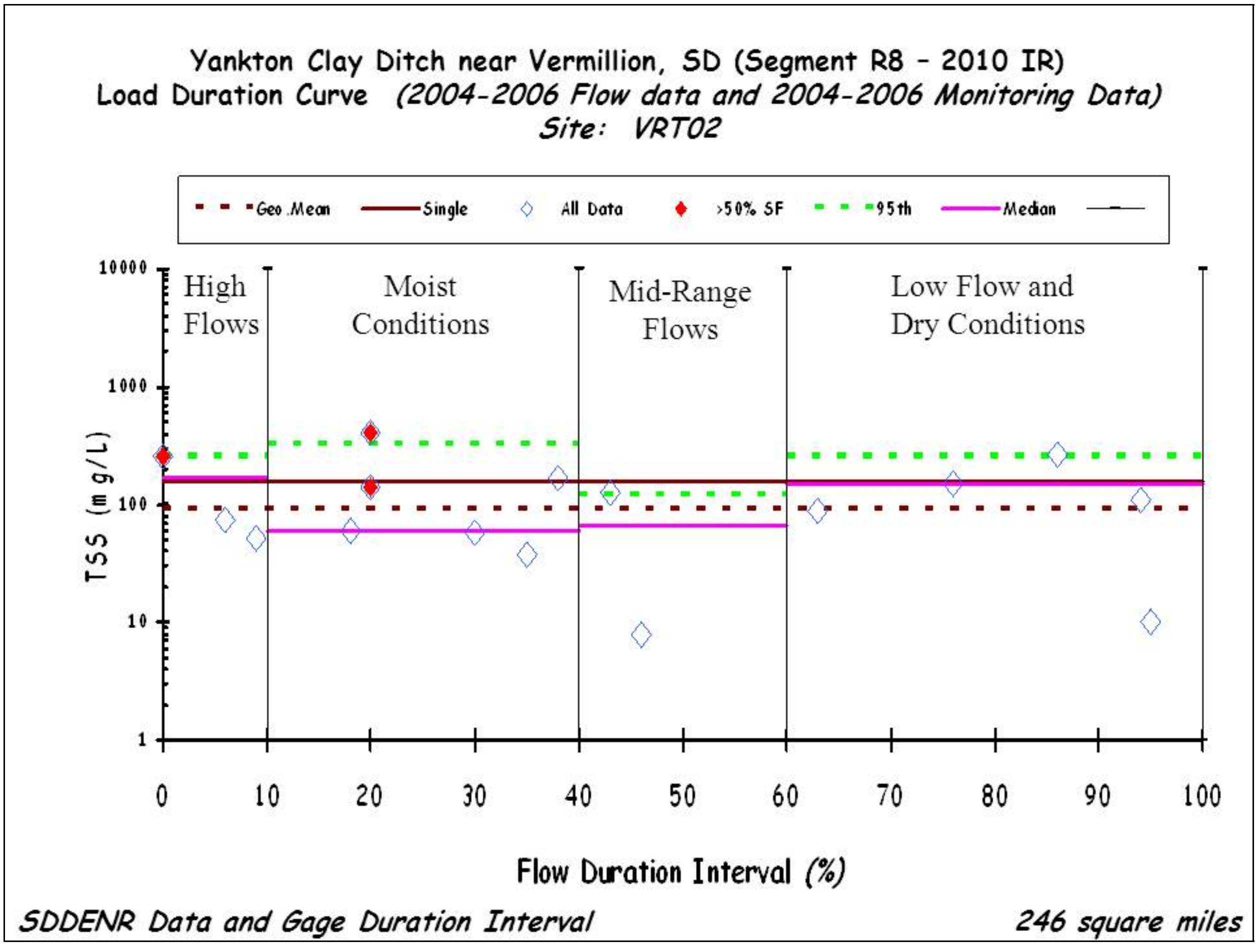

Clay Creek Ditch near Vermillion, SD (Segment R8 - 2010 IR)
Load Duration Curve (2004-2006 Flow data and 2004-2006 Monitoring Data)
Site: VRT04
Target-90
Target-158
All Data
>50%SF
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
TSS (tons per day)
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data & Gage Duration Interval
246 square miles


Vermillion River near Vermillion, SD (Segment R8 - 2010IR)
Load Duration Curve (1983-2009 Flow data and 2004-2009 Monitoring Data)
Site: VR01 with WQM5 (STORET ID: 460745)
Geo.Mean
Single
All Data
>50% SF
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
2,128 square miles


Clay Creek Ditch near Vermillion, SD (Segment R8 – 2010 IR)
Load Duration Curve (2004-2006 Flow data and 2004-2006 Monitoring Data)
Site: VRT04
Geo.Mean
Single
All Data
>50% SF
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 Gage Duration Interval
246 square miles


Clay Creek Ditch near Vermillion, SD (Segment R8 – 2010 IR)
Load Duration Curve (2004-2006 Flow data and 2004-2006 Monitoring Data)
Site: VRT04
Target-90
Target-158
All Data
>50%SF
95th
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 & Gage Duration Interval
246 square miles


Yankton Clay Ditch near Vermillion, SD (Segment R8 - 2010 IR)
Load Duration Curve (2004-2006 Flow data and 2004-2006 Monitoring Data)
Site: VRT02
Target-90
Target-158
All Data
>50%SF
95th
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 & Gage Duration Interval
246 square miles


Yankton Clay Ditch near Vermillion, SD (Segment R8 – 2010 IR)
Load Duration Curve (2004-2006 Flow data and 2004-2006 Monitoring Data)
Site: VRT02
Geo.Mean
Single
All Data
>50% SF
95th
Median
High Flows
Moist Conditions
Mid-Range Flows
Low Flow and Dry Conditions
10000
1000
100
10
1
TSS (mg/L)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
SDDENR Data and Gage Duration Interval
246 square miles

Spirit Mound Creek near Vermillion, SD (Segment R8 – 2010 IR)
Load Duration Curve ***(2004-2006 Flow data and 2004-2006 Monitoring Data)***
Site: VRT30

Not enough flow data to produce graph

SDDENR Data & Gage Duration Interval ***22 square miles***

17.0 APPENDIX B: Load Allocation and Reduction Tables

Station ID:	VR01 with Ambient Station WQM5			
Station name:	Sampling Station downstream of the city of Vermillion			
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	**>1,075 cfs**	**171-1,075 cfs**	**101-171 cfs**	**<101 cfs**
Median Flow Per Zone	2588.37	333.29	128.15	57.22
Load Allocation	556.1	64.7	20.0	4.6
WLA - GAYVILLE (SD0022161)	0.95	0.95	0.95	0.95
WLA - IRENE (SD0022454)	0.77	0.77	0.77	0.77
WLA - VERMILLION (SD0020061)	1.00	1.00	1.00	1.00
WLA - VOLIN (SD0020907)	0.00	0.00	0.00	0.00
WLA - MS4 VERMILLION (SDR41A001)	5.18	5.18	5.18	5.18
MOS (10% Explicit)	62.7	8.1	3.1	1.4
TMDL	**626.6**	**80.7**	**31.0**	**13.9**
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	1527.580	171.724	26.348	7.556
Load Reduction	**59.0%**	**53.0%**	**-17.8%**	**-83.4%**
Average Concentration per Zone	224	157	77	54
Number of Values	11	40	33	55
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	1.15	0.15	0.06	0.03
cfs/sqmile	1.22	0.16	0.06	0.03

Station ID:	VRT02			
Station name:	Yankton Clay Ditch			
TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	4.57	0.60	0.39	0.00
mm/day	0.07	0.01	0.01	0.00
cfs/sqmile	0.07	0.01	0.01	0.00
load_duration_target	**1.108**	**0.145**	**0.093**	**0.000**
Median %Flow	5.0%	25.0%	50.0%	80.0%
Existing Condition				
95th Percentile	11.469	1.940	0.038	0.148
60th Percentile	11.407	0.412	0.038	0.069
Median	**11.390**	**0.393**	**0.038**	**0.034**
Number of Values	2	7	1	14
Reductions				
95th Percentile	90.3%	92.5%	-143.2%	100.0%
60th Percentile	90.3%	64.8%	-143.2%	100.0%
Median	**90.3%**	**63.1%**	**-143.2%**	**100.0%**

Station ID:	VRT04			
Station name:	Clay Creek Ditch			
TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	136.07	22.28	8.45	3.68
mm/day	0.52	0.09	0.03	0.01
cfs/sqmile	0.55	0.09	0.03	0.01
load_duration_target	**32.943**	**5.394**	**2.046**	**0.891**
Median %Flow	5.0%	25.0%	50.0%	80.0%
Existing Condition				
95th Percentile	796.545	34.759	3.266	2.015
60th Percentile	633.200	8.024	2.136	1.695
Median	**403.844**	**8.024**	**1.814**	**1.547**
Number of Values	4	7	2	5
Reductions				
95th Percentile	95.9%	84.5%	37.4%	55.8%
60th Percentile	94.8%	32.8%	4.2%	47.5%
Median	**91.8%**	**32.8%**	**-12.8%**	**42.4%**

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

Station ID:	VR03			
Station name:	USGS Gaging Station 06479010 near Vermillion, SD			
TSS Target	Extreme Flows (0-10)	High-Range (10-40)	Mid Range Flows (40-60)	Low Flows (60-100)
Median Flow	1643.51	228.89	75.50	22.66
mm/day	0.67	0.09	0.03	0.01
cfs/sqmile	0.71	0.10	0.03	0.01
load_duration_target	**397.894**	**55.415**	**18.278**	**5.487**
Median %Flow	5.0%	25.0%	50.0%	80.0%
Existing Condition				
95th Percentile	1078.046	312.114	27.998	10.768
60th Percentile	1043.007	128.261	24.316	7.215
Median	**1032.996**	**110.409**	**15.074**	**5.110**
Number of Values	2	8	8	6
Reductions				
95th Percentile	63.1%	82.2%	34.7%	49.0%
60th Percentile	61.9%	56.8%	24.8%	23.9%
Median	**61.5%**	**49.8%**	**-21.3%**	**-7.4%**

Site VRT30 – Spirit Mound Creek had limited data so no reduction table calculated.

Site VRT30 – Spirit Mound Creek had limited data so no reduction table calculated.

18.0 APPENDIX C: Municipal Separate Storm Sewer Systems (MS4s) Calculation Method

The Simple Method (Schueler 1987) was used to estimate the Total Suspended Solids Loadings from the city of Vermillion, SD. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

The Simple Method only estimates pollutant loads generated during storm events. It does not consider loads associated with baseflow volume. Watersheds do generate baseflow volume but sediment loads are generally low during these periods and are not significantly different from natural background loadings. Typically, baseflow pollutant loads normally constitute only a small percentage of the total sediment load delivered from urban settings. It is important to remember that the load estimates refer only to storm event derived loads and should not be confused with the total pollutant load from an area.

The city of Vermillion provided a planning and zoning CAD map. This was brought into ARCMAP v.9.3. Acres were calculated and zones with similar characteristics were grouped (see table below).

Map Designation	Land use Category	% Imperviousness	Total Acres per General Category
R-1	Residential-Low Density	28	1,492.07
R-2	Residential-Medium Density	28	
R-3	Residential-High Density	28	
R-4	Residential-Manufactured Homes	28	
CB	Central Business	70	369.69
GB	General Business	70	
NC	Neighborhood Commercial	70	
GI	General Industrial	56	303.12
HI	Heavy Industrial	56	
PDD	Planned Development District	9	419.94
PUD	Planned Unit Development	9	
NRC	Natural Resource Conservation	9	

The percent imperviousness (**Ia**) was estimated by using Table A.3 found in the description of the Simple Method as part of a series of documents put together by the Stormwater Section of the New York Department of Environmental Conservation.

The annual runoff (**R**) was calculated using the equation:

R = P * Pj * Rv

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

"In the Simple Method, the runoff coefficient is calculated based on impervious cover in the subwatershed. This relationship is shown in Figure A.1 in the aforementioned publication. Although there is some scatter in the data, watershed imperviousness does appear to be a reasonable predictor of Rv."

The annual runoff coefficient (Rv) was calculated by the equation:

Rv=0.05+0.9Ia

Rainfall data (**P**) was taken from the COOP weather station 2 miles SE of Vermillion SD (COOP ID 398622). The fraction of annual rainfall events that produce runoff (***Pj***) was left at 0.9.

The average concentration for storm events was calculated from the samples collected from four storm sewer outfalls within the city of Vermillion. Each land use category used the average concentration sampled from the nearest storm sewer outfall (see EXCEL table on following page).

The annual runoff and pollutant load was calculated and then divided by 365 to get a daily loading. This daily load for 2005 and 2006 was averaged resulting in the 5.18 tons per day presented in the following table as well as the TMDL table on page 29 (Table 7).

Rv=0.05+0.9Ia where:
Rv =runoff coefficient
R=P*Pj*Rv
R=annual runoff (inches
P=Annual Rainfall (inches)
Pj=Fraction of annual rainfall events that produce runoff (0.9)

	L2005	L2006	C2006	R2006	R2005		Rv	Ia
	352,136.39	**246,332.07**	111	6.56	9.37		0.302	0.28
	185,120.33	**129,498.33**	105	14.76	21.10		0.68	0.7
	123,660.75	**86,505.14**	105	12.03	17.19		0.554	0.56
	22,068.50	**15,437.71**	57	2.84	4.07		0.131	0.09
Total (tons)	**341.49**	**238.89**	**Average**					
lbs	682,985.97	477,773.25	1,160,759.21					
lbs/day	12,196.18	8,531.67	10363.92155					
kg/day	5,531.15	3,869.24	4,700.19	0.453515				
tons/day	6.10	4.27	**5.18**					

	2005	2006
P =	34.48	24.12
Pj=	0.9	0.9
C =		

Dividing the annual WLA by 365 days to get a daily WLA assumes there are storm water discharges from the MS4 every day. This does not reflect actual discharge conditions. We are proposing dividing the annual WLA by the average number of days per year with more than 0.1 inches of precipitation as published by NRCS for that location. This will be more representative of actual discharges from the MS4. NRCS says that on average Vermillion has 56 days per year with more than 0.1 inches of precipitation. This was over the period of 1971-2000.

TSS (mg/L)	Mean		
Overall	94		
VSS-1	105		
VSS-2	111		
VSS-3	57		
VSS-4	156	included with VSS2	

19.0 APPENDIX D: Monitoring Sites

See Figures 1 and 8 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

20.0 APPENDIX E: Water Quality Data

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR01	3/10/2005	254	1625	1525	100	10	<0.02	0.2	0.50	0.151	0.023		1014.0	13.21	8.10	5.76	20	17.3
VR01	4/5/2005	237	1890	1702	188	36	<0.02	<0.1	1.54	0.381	0.028	21.1	1443.0	10.90	8.39	15.66	20	6.3
VR01	4/25/2005	276	2129	1895	234	32	<0.02	0.9	1.22	0.391	0.074	13.0		10.78	8.06	12.41	200	40.8
VR01	5/13/2005	229	2093	1593	500	90	0.31	3.2	2.51	0.710	0.101	11		10.51	7.84	11.73	11600	>2420
VR01	6/1/2005	136	1600	840	760	130	0.15	6.5	2.98	1.180	0.152	18		7.51	7.61	16.68	3700	>2420
VR01	6/1/2005				750	130						18		7.51	7.61	16.68		
VR01	6/6/2005	134	1018	766	252	4	0.09	4.3	2.76	0.692	0.166	29		6.04	6.95	20.29	2100	1733.0
VR01	7/6/2005	247	1643	1391	252	36	<0.02	<0.1	1.82	0.488	0.041	31		11.02	8.00	23.60	120	34.1
VR01	9/22/2005	256	1431	1339	92	18	<0.02	<0.1	1.17	0.228	0.016			9.47	7.92	19.96	90	24.8
VR01	10/14/2005	270	1403	1330	73	7	<0.02	<0.1	0.73	0.170	0.024	13		11.80	8.28	12.91	90	82.3
VR01	1/23/2006	286	1752	1722	30	5	<0.02	0.8	0.61	0.121	0.017	8		15.60	8.06	0.16	<10	7.4
VR01	2/27/2006	294	1683	1663	20	7	<0.02	0.3	<0.5	0.075	0.011	13	1092.0		8.16	3.48	<10	<1
VR01	3/13/2006	106	1525	1494	31	3	<0.02	<0.1	0.75	0.107	0.011	-3	974.0	13.71	8.07	3.21	<10	2.0
VR01	3/27/2006	264	1894	1802	92	11	<0.02	0.1	1.10	0.154	0.010	7	1193.0	13.48	8.21	7.48	30	25.3
VR01	4/27/2006	257	1881	1733	148	18	<0.02	0.4	1.48	0.028	0.019	14	1400.0	10.17	8.23	12.22	30	33.2
VR01	4/27/2006	256	1876	1724	152	24	<0.02	0.5	1.49	0.294	0.017	15	1424.0	10.55	8.18	12.99	<10	16.6
VR01	5/11/2006	264	1883	1771	112	16	<0.02	0.5	1.23	0.228	0.015	10	1535.0	10.37	8.37	13.31	30	
VR01	5/23/2006	247	1744	1648	96	16	<0.02	<0.1	0.85	0.187	0.011	33		10.49	7.91	20.26	10	
VR01	6/19/2006	167	1792	1320	472	48	<0.02	2.5	2.29	0.525	0.024	24		10.12	8.11	21.63	1200	
VR01	6/19/2006	193	1669	1461	208	40	<0.02	0.4	2.13	0.432	0.017	24					1100	
VR01	6/29/2006	218	1647	1521	126	38	<0.02	<0.1	1.12	0.280	0.014			7.23	8.18	21.12	180	
VR01	9/11/2006	194	1202	1147	55	6	<0.02	<0.1	0.67	0.147	0.023	14		9.23	7.95	15.82	460	
VR01	9/29/2006	227	1555	1449	106	14	<0.02	0.2	1.53	0.256	0.042	16		10.15	8.37	11.93	260	
VR01	12/6/2006	309	1747	1740	7	<1	<0.02	<0.1	<0.5	0.044	0.007	4	1073.0	17.17	8.06	0.03	10	
VR03	3/17/2005	250	1507	1488	19	5	<0.02	0.1	<0.5	0.088	0.017		1008.0	13.83	8.18	6.35		
VR03	4/5/2005	235	1859	1669	190	38	<0.02	<0.1	1.56	0.346	0.030	20.0	1387.0	11.26	8.40	14.74	20	7.4
VR03	4/21/2005	264	2072	1788	284	24	<0.02	0.6	1.63	0.223	0.055	14.0		15.45	8.10	16.94	110	88.4
VR03	5/17/2005	243	2070	1746	324	52	0.20	3.5	1.45	0.550	0.122	24.0		9.20	7.96	16.36	350	260.0
VR03	5/20/2005	195	1852	1332	520	40	0.17	4.3	3.16	0.927	0.132	24.0		7.48	7.82	19.48	500	727.0
VR03	6/6/2005	127	914	758	156	16	0.09	5.8	2.89	0.449	0.202	29.0		5.72	7.44	20.82	1700	1046.0
VR03	7/6/2005	235	1608	1392	216	36	<0.02	<0.1	1.54	0.422	0.039	31.0		11.93	7.90	24.03	200	47.4
VR03	8/18/2005	243	1308	1247	61	14	<0.02	<0.1	0.94	0.172	0.025	30.0		14.76	8.25	23.24	130	15.8
VR03	9/22/2005	259	1434	1296	138	28	<0.02	<0.1	1.30	0.274	0.020			11.44	8.12	19.72	400	53.4
VR03	10/25/2005	276	1361	1335	26	6	<0.02	<0.1	0.70	0.127	0.014	14.0		14.14	8.18	8.43	10	6.2

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR03	1/23/2006	285	1679	1665	14	4	<0.02	0.8	0.66	0.107	0.022	6		14.54	8.13	0.16	20	10.9
VR03	2/27/2006	292	1635	1627	8	2	<0.02	0.3	0.51	0.069	0.010	12	1116.0	108.11	8.12	5.24	<10	<1
VR03	3/13/2006	236	1474	1447	27	6	<0.02	<0.1	0.77	0.112	0.010	-3	979.0	14.27	8.27	4.26	<10	4.1
VR03	3/13/2006	236	1480	1453	27	7	<0.02	<0.1	0.75	0.111	0.010	-3					<10	2.0
VR03	3/27/2006	254	1881	1795	86	15	<0.02	0.2	1.08	0.155	0.012	7	1190.0	13.68	8.26	7.24	20	26.5
VR03	4/27/2006	254	1794	1672	122	20	<0.02	0.5	1.36	0.253	0.019	20	1388.0	11.15	8.22	13.12	10	8.5
VR03	5/11/2006	259	1813	1711	102	18	<0.02	0.5	1.1	0.227	0.011	11	1495.0	11.39	8.32	13.59	20	
VR03	5/24/2006	242	1665	1575	90	14	<0.02	<0.1	1.15	0.178	0.009	26		10.61	8.05	20.03	30	
VR03	6/20/2006	155	1350	1062	288	48	<0.02	3.2	2.51	0.466	0.046	26	1237.0	7.25	8.22	21.71	1300	
VR03	6/29/2006	217	1648	1480	168	40	<0.02	<0.1	1.11	0.295	0.015			8.86	8.06	20.45	160	
VR03	8/7/2006	231	1448	1322	126	16	<0.02	<0.1	1.14	0.246	0.009		1574.0	9.07	7.87	22.47	1400	
VR03	9/11/2006	212	1358	1300	58	11	<0.02	<0.1	0.71	0.139	0.016	16					450	
VR03	9/29/2006	228	1549	1441	108	18	<0.02	0.2	1.64	0.292	0.045	17		10.97	8.36	12.59	200	
VR05	3/24/2005	236	1443	1419	24	3	<0.02	0.1	<0.5	0.103	0.033	4.4	959.0	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	959.0	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	1354.0	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	954.0	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	942.0	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	1132.0	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	1336.0	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	1534.0	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	1316.0	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		1515.0	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	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VR05	12/6/2006	304	1692	1683	9	1	<0.02	<0.1	0.53	0.066	0.011	2	1060.0	15.86	8.96	0.14	<10	
VR05	10/27/2005-10/31/2005	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
VRT02	3/17/2005	349	807		<1	<1	0.58	0.1	0.66	0.026	0.014		706.0	8.25	7.64	8.41		
VRT02	4/4/2005	388	861		<1	<1	0.53	0.1	0.54	0.011	0.007	26.6	874.0	10.21	7.98	14.33	<10	<1
VRT02	4/22/2005	151	389	374	15	3	<0.02	0.3	0.80	0.202	0.133	8.0		9.79	7.70	11.32	670	980.0
VRT02	5/13/2005	109	388	339	49	9	0.70	10.1	2.20	0.372	0.246	11.0		6.66	7.65	11.57	1000	816.0
VRT02	6/1/2005	183	535	522	13	5	<0.02	0.1	0.63	0.199	0.161	18.0		6.42	7.42	18.29	4200	>2420
VRT02	6/1/2005	184	535	522	13	6	<0.02	0.1	0.68	0.200	0.155	18.0		6.42	7.42	18.29	3000	>2420
VRT02	6/6/2005	81	538	374	164	8	0.04	0.8	2.73	0.790	0.359	28.0		3.60	7.19	21.21	230	260.0
VRT02	7/6/2005	294	892	888	4	2	<0.02	<0.1	0.93	0.447	0.390	31.0		11.08	7.88	27.46	<10	25.6
VRT02	4/11/2006	90	461	394	67	12	<0.02	0.6	1.23	0.675	0.417	21	328.0	6.16	7.67	15.19	20	4.1
VRT02	5/11/2006	388	1036	969	67	16	<0.02	<0.1	1.48	0.237	0.031	9	1101.0	9.26	8.59	12.04	<10	
VRT04	3/15/2005	269	2119	2106	13	2	<0.02	<0.1	<0.5	0.045	0.018		1126.0	15.06	7.84	1.21	<10	2.0
VRT04	4/4/2005	247	2004	1872	132	24	<0.02	<0.1	1.05	0.176	0.017	26.1	1509.0	11.66	8.39	14.97	30	51.2
VRT04	4/4/2005	247	2009	1877	132	24	<0.02	<0.1	1.06	0.216	0.016	26.1	1509.0	11.66	8.39	14.97	40	37.9
VRT04	4/21/2005	254	2081	1903	178	24	<0.02	0.2	1.42	0.256	0.062	14.0		11.11	8.00	14.71	340	517.0
VRT04	5/12/2005										0.187							
VRT04	5/12/2005	185	1818	1414	404	28	0.14	2.5	2.08	0.757	0.187	10.0		9.75	7.92	12.10	52000	>2420
VRT04	6/6/2005	173	1220	964	256	40	0.04	1.3	2.32	0.513	0.112	29.0		5.89	7.54	21.41	1700	1300.0
VRT04	6/6/2005	171	1214	954	260	44	<0.02	1.3	2.42	0.502	0.150	29.0		5.89	7.54	21.41	1300	921.0
VRT04	7/7/2005	237	1924	1774	150	28	<0.02	<0.1	1.43	0.334	0.017	21.0		8.42	7.97	23.27	360	40.1
VRT04	8/2/2005	254	2280	2016	264	28	<0.02	<0.1	1.51	0.411	0.032			6.34	7.93	25.24	560	33.5
VRT04	9/22/2005	215	1831	1721	110	14	<0.02	<0.1	0.77	0.226	0.029			8.67	7.87	20.86	410	27.1
VRT04	10/25/2005	260	2071	2061	10	<1	<0.02	<0.1	<0.50	0.061	0.031	9.0		13.33	8.13	6.99	90	65.7
VRT04	1/23/2006	288	2110	2099	11	6	<0.02	0.2	<0.5	0.030	0.011	7		16.65	8.27	0.25	<10	13.2
VRT04	2/27/2006	291	1964		<1	<1	<0.02	<0.1	<0.5	0.015	0.005	9	1101.0	14.00	7.97	0.66	<10	1.0
VRT04	3/13/2006	235	1932	1881	51	5	<0.02	<0.1	<0.5	0.072	0.010	-3	1121.0	13.82	8.21	2.29	<10	1.0
VRT04	3/27/2006	272	2072	1999	73	10	<0.02	0.2	0.71	0.090	0.018	7	1258.0	11.55	7.98	6.58	<10	16.0
VRT04	4/25/2006	263	2173	2113	60	9	<0.02	0.3	0.66	0.116	0.020	5					90	145.0
VRT04	4/25/2006	263	2173	2113	60	10	<0.02	0.3	0.66	0.123	0.031	5					120	138.0
VRT04	5/11/2006	269	2269	2211	58	11	<0.02	0.2	0.59	0.100	0.018	12	1718.0	11.06	8.30	11.46	10	
VRT04	5/23/2006	269	2265	2097	168	30	<0.02	0.1	0.7	0.259	0.026	32		8.97	8.00	24.96	30	
VRT04	6/20/2006	210	2160	2020	140	30	<0.02	1.4	2.22	0.259	0.020	28	2009.0	9.53	7.89	23.64	410	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
VRT04	6/29/2006	215	2130	2004	126	30	<0.02	<0.1	0.98	0.223	0.023			8.31	8.03	21.49	720	
VRT04	8/7/2006	136	2065	1977	88	4	<0.02	<0.1	0.85	0.193	0.024		2146.0	8.42	8.03	24.81	600	
VRT04	9/26/2006	219	1714	1677	37	5	<0.02	<0.1	<0.5	0.094	0.019	14		9.61	8.38	13.88	170	
VRT04	11/21/2006	268	1957	1949	8	<1	<0.02	0.1	<0.5	0.035	0.012	12	1203.0	13.53	7.70	4.43	<10	
VRT30	3/13/2006	254	2422	2417	5	2	<0.02	1	<0.5	0.030	0.018	-2	1392.0	18.68	8.37	2.96	<10	9.7
VRT30	3/27/2006	293	2629	2617	12	6	<0.02	0.6	0.68	0.038	0.018	7	1533.0	16.79	7.80	6.59	20	9.6
VRT30	3/27/2006	293	2650	2641	9	8	<0.02	0.6	0.62	0.038	0.020	7					20	5.2
VRT30	4/11/2006	252	2228	2212	16	3	<0.02	1.3	<0.5	0.076	0.048	22	1812.0	13.37	7.85	15.29	10	42.8
VRT30	4/11/2006	252	2222	2209	13	3	<0.02	1.3	0.54	0.076	0.048	22					40	40.5
VRT30	5/11/2006	318	2783	2758	25	10	<0.02	1.8	0.77	0.098	0.048	13	21.4	11.64	8.23	13.01	340	
VRT30	5/24/2006	295	2895	2862	33	5	0.05	2.4	0.63	0.134	0.073	27		10.35	8.07	21.12	1200	
VRT30	6/20/2006	312	2951	2928	23	5	<0.02	3.1	0.81	0.214	0.142	27	2629.0	8.60	7.95	21.38	1900	
VRT30	6/20/2006	323	3084	3063	21	2	<0.02	0.9	0.89	0.185	0.125	27					780	
VRT30	6/29/2006	303	3044	2964	80	24	0.26	1.6	1.53	0.360	0.166			10.35	8.23	17.77	1500	
VRT31	3/14/2006	266	3067	3050	17	<1	<0.02	1	0.5	0.035	0.008	-7	1533.0	12.83	8.23	0.00	50	285.0
VRT31	3/28/2006	260	2794	2758	36	7	<0.02	2.1	0.73	0.066	0.013	7	1545.0	13.72	8.23	5.83	<10	5.2
VRT31	3/28/2006	261	2827	2750	77	11	<0.02	2.1	<0.5	0.115	0.013	8	1560.0	13.29	8.25	6.24	170	167.0
VRT31	4/12/2006	276	2614	2581	33	5	<0.02	3.7	0.76	0.118	0.068	11	18.1	10.69	8.08	10.34	20	67.7
VRT31	5/10/2006	240	2801	2783	18	6	<0.02	2.8	<0.5	0.036	0.005	17	2440.0	12.21	8.38	17.52	30	
VRT31	5/24/2006	240	2792	2779	13	4	<0.02	1.2	<0.5	0.037	0.007	24		11.62	8.22	20.33	600	
VRT31	5/24/2006	241	2818	2771	47	10	<0.02	1.2	0.53	0.087	0.007	24					830	
VRT31	6/20/2006	270	3007	2975	32	8	<0.02	1.7	0.94	0.075	0.024	22	2658.0	8.69	8.25	20.99	2000	
VRT31	6/29/2006	204	2849	2831	18	6	<0.02	0.2	0.77	0.075	0.033			12.58	8.24	30.15	270	
WQM5	01/05/2004													12.5	7.9	1		
WQM5	01/05/2004	319	1720	1712	8		<0.02	0.4	0.41		0.027							
WQM5	1/21/2004	312			6			0.5	0.34	0.069				13.2				
WQM5	02/09/2004													10	7.4	1		
WQM5	02/09/2004	322	1518	1515	3		0.22	0.3	0.37		0.013							
WQM5	2/10/2004	325			6			0.5	0.33	0.07				5.5				
WQM5	03/23/2004													10.7	7.9	8		
WQM5	03/23/2004	264	1827	1733	94		<0.02	1.2	Non-detect		0.098							
WQM5	3/29/2004	237			124			1.1	1.4	0.421				10				
WQM5	04/12/2004													11.9	7.7	8		

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM5	04/12/2004	245	1619	1570	49		0.03	<0.1	0.87		0.02							
WQM5	4/13/2004	245			99			0.2	1.39	0.226				12				
WQM5	05/17/2004													8.3	8	15		
WQM5	05/17/2004	257	1539	1453	86		<0.02	<0.1	0.67		0.01						320	308
WQM5	5/19/2004	240			68			0	1.18	0.242				8.2			40	
WQM5	6/14/2004	255			168			1	1.41	1.001				7.6			390	
WQM5	07/12/2004													6.4	7.7	25		
WQM5	07/12/2004	235	1495	1305	190		<0.02	<0.1	1.32		0.027						350	260
WQM5	7/13/2004	186			80			0	1.24	0.284				5.6			110	
WQM5	08/09/2004													8.1	7.2	20		
WQM5	08/09/2004	245	1310	1140	170		<0.02	<0.1	1.15		0.029						360	42.2
WQM5	8/10/2004	210			86			0	1.17	0.315				6.9			210	
WQM5	09/01/2004													7.9	7.3	21		
WQM5	09/01/2004	239	1310	1210	100		<0.02	<0.1	0.88		0.016						320	167
WQM5	9/7/2004	215			67			0	0.86	0.247				7.5			160	
WQM5	10/05/2004													10	8.3	12		
WQM5	10/05/2004	240	1228	1157	71		<0.02	<0.1	0.88		0.044							
WQM5	10/12/2004	233			56			0	0.68	0.236				9				
WQM5	11/08/2004													12.5	8	8		
WQM5	11/08/2004	264	1442	1413	29		<0.02	<0.1	0.53		0.012							
WQM5	11/8/2004	254			27			0	0.6	0.144				12.8				
WQM5	12/07/2004													12.4	8.1	4		
WQM5	12/07/2004	274	1547	1530	17		<0.02	<0.1	0.34		0.005							
WQM5	12/8/2004	531			31			0.4	1.06	0.095				13.6				
WQM5	01/11/2005													11.4	7.7	1		
WQM5	01/11/2005	327	1557	1549	8		0.08	0.4	0.51		0.013							
WQM5	1/12/2005	336			5			0.7	0.63	0.1				9.4				
WQM5	02/14/2005													12.3		1		
WQM5	02/14/2005	226	1297	1220	77		0.11	0.9	1.07		0.106							
WQM5	2/15/2005	203			44			1.4	1.53	0.636				13				
WQM5	03/21/2005													12.7	8	2		
WQM5	03/21/2005	259	1520	1481	39		<0.02	0.2			0.024							
WQM5	3/22/2005	236			23			0.1	0.57	0.117				13				
WQM5	04/11/2005													8.8	8	12		

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM5	04/11/2005	241	1715	1581	134		<0.02	<0.1	1									
WQM5	4/12/2005	246			65			0.2	0.99	0.212				9.3				
WQM5	05/16/2005													9	7.9	11		
WQM5	05/16/2005	242	2087	1747	340		0.15	3.3	2.43		0.125						1000	866
WQM5	5/17/2005	240			212			3.5	1	0.647				8.4			260	
WQM5	06/13/2005													6.1	7.7	18		
WQM5	06/13/2005	168	1034	838	196		0.05	1.8	1.64		0.214						410	276
WQM5	6/14/2005	352			134			3.6	2.46	1.161				5.6			770	
WQM5	07/21/2005													7.5	7.6	26		
WQM5	07/21/2005	239	1492	1328	164		<0.02	<0.1	1.09		0.02						900	31
WQM5	7/21/2005	204			96			0	1.36	0.305				7.4			450	
WQM5	08/29/2005													8.2	7.9	19		
WQM5	08/29/2005	254	1395	1327	68		<0.02	<0.1	0.73		0.019						200	12.6
WQM5	8/30/2005	232			72			0	1.09	0.278				6.9			90	
WQM5	09/19/2005													7.7	7.9	19		
WQM5	09/19/2005	227	1366	1162	204		<0.02	0.2	1.6		0.03						1800	239
WQM5	9/20/2005	237			84			0.1	1.44	0.329				7.5			210	
WQM5	10/11/2005													10.4	8	11		
WQM5	10/11/2005	265	1350	1294	56		<0.02	0.1	0.84		0.021							
WQM5	10/12/2005	255			54			0.2	0.84	0.253				9.3				
WQM5	11/21/2005													12.5	7.9	5		
WQM5	11/21/2005	271	1417	1405	12		<0.02	0.1			0.015							
WQM5	11/22/2005	242			5			0.1	0.5	0.089				12.8				
WQM5	12/12/2005													12.4		2		
WQM5	12/12/2005	283	1439	1431	8		0.06	0.4	0.59		0.011							
WQM5	12/13/2005	280			8			0.5	0.78	0.062				12.4				
WQM5	01/09/2006													13.6	8.1	2		
WQM5	01/09/2006	288	1665	1649	16		0.04	0.8	0.75		0.027							
WQM5	1/10/2006	289			9			1	0.61	0.253				14.1				
WQM5	02/13/2006													14	8	1		
WQM5	02/13/2006	307	1776	1760	16		0.05	0.6	0.51		0.026							
WQM5	2/14/2006	293			17			0.7	0.74	0.185				14.2				
WQM5	03/27/2006													11.9	8.2	7		
WQM5	03/27/2006	266	1823	1744	79		<0.02	0.2	1.03		0.016							

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM5	3/29/2006	259			49			0.5	0.69	0.151				13				
WQM5	3/31/2006				1230							10						
WQM5	04/10/2006													9	7.7	10		
WQM5	04/10/2006	211	1764	1254	510		0.16	1.7	2.29		0.096							
WQM5	4/11/2006	191			248			1.6	1.63	0.72				8.8				
WQM5	4/25/2006				154							9						
WQM5	5/1/2006				126							17					150	210
WQM5	05/08/2006													9.5	8	16		
WQM5	05/08/2006	267	1849	1723	126		<0.02	0.7	1.17		0.042						80	3.1
WQM5	5/9/2006	260			59			0.8	1.02	0.196				9.7			30	
WQM5	5/15/2006											14					50	
WQM5	5/18/2006											18					50	
WQM5	5/22/2006				88							26					30	
WQM5	6/1/2006				132							26					170	
WQM5	06/12/2006	247	1544	1481	63		<0.02	<0.1	0.84	0.17	0.013			9.7	7.9	17	150	276
WQM5	6/15/2006											21					1300	
WQM5	6/22/2006				288												690	
WQM5	6/28/2006																90	
WQM5	7/5/2006											22					260	
WQM5	7/12/2006				118							28					180	
WQM5	07/17/2006	255	1563	1411	152		<0.02	<0.1	1.02	0.278	0.015			7.4	8	27	350	63
WQM5	7/19/2006											33					80	
WQM5	7/21/2006				92												390	
WQM5	8/3/2006				66							26					300	
WQM5	8/11/2006				116												420	
WQM5	08/14/2006	219	1504	1428	76		<0.02	<0.1	0.82	0.169	0.019			9	7.8	22	330	79.9
WQM5	8/23/2006																460	
WQM5	8/29/2006				60							18					410	
WQM5	9/8/2006				80							22					340	
WQM5	9/12/2006											21					80	
WQM5	9/14/2006											29					60	
WQM5	9/21/2006				72							13					290	
WQM5	09/25/2006	192	1309	1155	154		<0.02	0.3	1.42	0.321	0.036			9.2	8.4	13	410	517
WQM5	10/5/2006				92							20					150	

WQMID	StartDate	ALK	TS	TDS	TSS	VTSS	NH3	NO3	TKN	TP	TDP	ATEMP	Cond	DO	PH	WTEMP	Fecal	Ecoli
WQM5	10/10/2006	259	1511	1467	44		<0.02	<0.1	0.73	0.14	0.023			10.4	7.9	11		
WQM5	10/16/2006				69							14					120	
WQM5	10/25/2006											11					20	
WQM5	10/31/2006											0					10	
WQM5	11/06/2006	271	1457	1430	27		<0.02	0.1	0.68	0.081	0.012			12.2	7.7	6		
WQM5	11/8/2006											23					40	
WQM5	11/13/2006				6							10					<10	
WQM5	11/16/2006											2					<10	
WQM5	11/28/2006				6							3					20	
WQM5	12/13/2006	313	1683	1675	8		<0.02	<0.1	<0.50	0.039	0.01			14	7.7	1		
WQM5	01/08/2007	197	1231	1185	46		0.23	1.3	1.29	0.427	0.301			13.9	7.8	1		
WQM5	02/20/2007	304	1495	1488	7		0.32	0.6	<0.50	0.055	0.02			12.2	7.3	1		
WQM5	03/19/2007	131	689	465	224		0.98	0.7	2.88	0.8	0.361			11.5	7.2	5		
WQM5	04/11/2007	217	1321	1175	146		0.06	1.2	1.15	0.455	0.202			10.5	7.7	5		
WQM5	05/14/2007	200	1127	957	170		<0.02	0.5	1.76					8.8	7.9	21	100	74.4
WQM5	06/04/2007	245	1561	1399	162		<0.02	0.5	1.46	0.31	0.012			10.3	7.8	18	230	168
WQM5	07/09/2007	250	1480	1292	188		<0.02	<0.1	1.34	0.35	0.022			8	7.8	24	290	45.4
WQM5	08/15/2007	206	1364	1274	90		<0.02	0.1	0.78	0.216	0.02			7.1	8.1	24	330	243
WQM5	09/17/2007	247	1399	1313	86		<0.02	<0.2	0.79	0.197	0.018			11	6.6	18	40	51.2
WQM5	10/09/2007	230	1356	1176	180		<0.02	<0.2	1.51	0.32	0.031			8.5	8	14		
WQM5	11/05/2007	270	1487	1445	42		<0.02	0.5	1.07	0.224	0.062			13	7.8	7		
WQM5	12/03/2007	302	1665	1645	20		<0.02	0.3	0.91	0.094	0.008			15	8	0		
WQM5	01/07/2008	303	1498	1490	8		0.08	0.8	<0.50	0.046	0.011			11.6	7.6	0		
WQM5	02/20/2008	319	1524	1517	7		0.08	0.8	<0.50	0.031	0.015			9.8	7.6			
WQM5	03/24/2008	178	1491	1179	312		0.81	2.7	2.92	0.949	0.441			12.5	7.6	1		
WQM5	04/14/2008	240	1861	1707	154		<0.02	1.4	1.58	0.41	0.111			12.8	7.9	5		
WQM5	05/19/2008	261	1858	1724	134		<0.02	0.2	1.7	0.301	0.026			10.2	8	17	10	17.2
WQM5	06/16/2008	201	1126	1022	104		<0.02	2.8	1.55	0.444	0.22			6.5	7.9	22	30	81.6
WQM5	07/14/2008	237	1530	1362	168		<0.02	<0.2	1.32	0.328	0.025			7.6	7	21	160	46
WQM5	08/11/2008	231	1432	1338	94		<0.02	<0.2	1.18	0.238	0.02			8.2	7.7	22	70	12.2
WQM5	09/22/2008	252	1452	1350	102		<0.02	<0.2	1.15	0.232	0.03			9	7.8	19	140	326

21.0 APPENDIX F: 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.

22.0 APPENDIX G: 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.

23.0 APPENDIX H: 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.

24.0 APPENDIX I: FLUX Loading Setup for Vermillion River Mainstem Sites.

```
Site VR05
 Vermillion Segment R8            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 VR01 Setup
 S8                               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       779  65  62  18.1       75.848       80.098        .746   .015
  2       183  18  16  16.6      297.586      303.017        .484   .233
  3       132  14  13  65.3     1618.399     1793.757       -.533   .072
***      1094  97  91 100.0      299.061      368.797

 FLOW STATISTICS
 FLOW DURATION =    1094.0 DAYS  =  2.995 YEARS
 MEAN FLOW RATE =   299.061 HM3/YR
 TOTAL FLOW VOLUME =     895.75 HM3
 FLOW DATE RANGE   = 20041001 TO 20070929
 SAMPLE DATE RANGE = 20041005 TO 20070917

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD    245899200.0     82097520.0      .1398E+15  274517.90    .144
 2 Q WTD C    224442900.0     74933980.0      .1632E+15  250564.50    .170
 3 IJC        221509800.0     73954710.0      .1501E+15  247290.00    .166
 4 REG-1      234365800.0     78246900.0      .1572E+15  261642.20    .160
 5 REG-2      234875200.0     78416980.0      .1594E+15  262210.90    .161
 6 REG-3      249338600.0     83245830.0      .2008E+15  278357.70    .170
```

Site VR03 Setup

S8 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	1094	23	22	100.0	227.065	278.329	.558	.007
***	1094	23	22	100.0	227.065	278.329		

FLOW STATISTICS
FLOW DURATION = 1094.0 DAYS = 2.995 YEARS
MEAN FLOW RATE = 227.065 HM3/YR
TOTAL FLOW VOLUME = 680.11 HM3
FLOW DATE RANGE = 20041001 TO 20070929
SAMPLE DATE RANGE = 20050317 TO 20060929

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	171400600.0	57224930.0	.5946E+15	252019.80	.426
2 Q WTD C	139831200.0	46684960.0	.1608E+15	205601.60	.272
3 IJC	137142200.0	45787180.0	.2052E+15	201647.70	.313
4 REG-1	124812000.0	41670540.0	.7938E+15	183517.90	.676
5 REG-2	122361600.0	40852440.0	.1103E+17	179915.00	2.571
6 REG-3	267614500.0	89347540.0	.5010E+16	393488.40	.792

Site VRT02 Setup

S8 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	690	7	6	100.0	.912	4.874	.143	.778
***	690	7	6	100.0	.912	4.874		

FLOW STATISTICS
FLOW DURATION = 690.0 DAYS = 1.889 YEARS
MEAN FLOW RATE = .912 HM3/YR
TOTAL FLOW VOLUME = 1.72 HM3
FLOW DATE RANGE = 20050209 TO 20061231
SAMPLE DATE RANGE = 20050422 TO 20060511

METHOD	MASS (KG)	FLUX (KG/YR)	FLUX VARIANCE	CONC (PPB)	CV
1 AV LOAD	783926.0	414969.5	.1200E+12	454981.40	.835
2 Q WTD C	146682.7	77646.2	.2805E+10	85132.90	.682
3 IJC	165684.7	87704.9	.3884E+10	96161.46	.711
4 REG-1	115329.3	61049.3	.3226E+10	66935.78	.930
5 REG-2	141332.6	74814.1	.4978E+10	82027.79	.943
6 REG-3	115864.3	61332.5	.4386E+10	67246.24	1.080

Site VRT04 Setup

```
 S8                              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       517  10  10  16.2        5.349        7.106        .014   .976
  2       109   8   6  83.8      131.536      299.051        .234   .314
***       626  18  16 100.0       27.321      136.859

 FLOW STATISTICS
 FLOW DURATION =     626.0 DAYS  =  1.714 YEARS
 MEAN FLOW RATE =    27.321 HM3/YR
 TOTAL FLOW VOLUME =      46.83 HM3
 FLOW DATE RANGE   = 20050415 TO 20061231
 SAMPLE DATE RANGE = 20050512 TO 20061121

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD     21904170.0     12780350.0      .1252E+15  467787.80    .876
 2 Q WTD C      9916292.0      5785824.0      .6715E+13  211773.40    .448
 3 IJC         10172500.0      5935312.0      .7807E+13  217245.00    .471
 4 REG-1        8298424.0      4841852.0      .8125E+13  177222.10    .589
 5 REG-2        8134113.0      4745982.0      .8282E+13  173713.00    .606
 6 REG-3        9097137.0      5307875.0      .1144E+14  194279.50    .637
```

Site VRT30 Setup

```
 S8                              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       279   7   5 100.0        1.140        2.507       -.376   .027
***       279   7   5 100.0        1.140        2.507

 FLOW STATISTICS
 FLOW DURATION =     279.0 DAYS  =   .764 YEARS
 MEAN FLOW RATE =     1.140 HM3/YR
 TOTAL FLOW VOLUME =        .87 HM3
 FLOW DATE RANGE   = 20060328 TO 20061231
 SAMPLE DATE RANGE = 20060411 TO 20060629

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD        34986.4        45802.1      .4469E+09   40185.50    .462
 2 Q WTD C        15908.7        20826.7      .1013E+09   18272.76    .483
 3 IJC            15191.6        19888.0      .1001E+09   17449.15    .503
 4 REG-1          21390.2        28002.8      .5126E+08   24568.84    .256
 5 REG-2          10303.5        13488.7      .3568E+07   11834.60    .140
 6 REG-3          15741.2        20607.4      .1307E+07   18080.33    .055
```

```
Site VRT31 Setup
 S8                                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       279   8   6 100.0       11.901        4.585        .306   .153
***       279   8   6 100.0       11.901        4.585

 FLOW STATISTICS
 FLOW DURATION =     279.0 DAYS  =   .764 YEARS
 MEAN FLOW RATE =    11.901 HM3/YR
 TOTAL FLOW VOLUME =       9.09 HM3
 FLOW DATE RANGE   = 20060328 TO 20061231
 SAMPLE DATE RANGE = 20060328 TO 20060629

 METHOD         MASS (KG)   FLUX (KG/YR)  FLUX VARIANCE CONC (PPB)      CV
 1 AV LOAD       147553.2       193167.8      .1087E+11   16230.83    .540
 2 Q WTD C       383022.9       501430.5      .2000E+11   42132.45    .282
 3 IJC           387622.3       507451.7      .2067E+11   42638.38    .283
 4 REG-1         499565.5       654001.1      .6667E+11   54952.13    .395
 5 REG-2       10327140.0     13519670.0      .1190E+15 1135983.00    .807
 6 REG-3         447570.1       585931.8      .3231E+11   49232.63    .307
```

25.0 APPENDIX J: 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 R8 is shown in the following pages.

The raw RGA data are also available upon request.

Current Conditions Ranking

HUC_10	HU_10_NAME	Acres	CurrentLoa	GrassLoad	percentdif
1017010218	Clay Creek Ditch	157449.8	37146.19922	2557.550049	0.931148
1017010215	Baptist Creek	20413.69	5694.620117	285.4100037	0.949881
1017010216	Spirit Mound Tributary	14161.53	9369.530273	462.480011	0.95064
1017010219	Yankton Clay Ditch	39739.6	3984.26001	246.0800018	0.938237
1017010220	Lower Vermillion River	55419.49	18292.5	802.0499878	0.956151

26.0 APPENDIX K: 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 Segment R8 of the Vermillion River Clay, Hutchinson, Lincoln, Turner, Yankton and Union Counties, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**April 4, 2011**
Review Date:	**April 26, 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 R8, 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 April 4, 2011. The email included the draft TMDL document and a public notice announcement requesting review and comment.

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 Baptist Creek to the mouth at its confluence with the Missouri

River (20.7 miles, SD-VM-R-VERMILLION_03). 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 total suspended solids (TSS) which is impairing the warmwater semi permanent fish life propagation use.

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, all TMDL documents must be written to meet the existing water quality standards 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 the Vermillion River, Segment R8, can be found on pages 15 - 16 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 R8, 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 the largest category of landuse within this segment at 62%. There is a relatively limited urbanized area in the lower portion of the drainage area, and therefore impact from this land use is expected to be localized to the source. Figure 3 in the TMDL document presents a visual breakdown of landuse within the drainage area of Segment R8 of the Vermillion River. The landuse statistics are as follows: 62% row crops, 21.5% grassland/hayland, 6.5% herbaceous, 6% open space, 3% water/wetland/woods, 1% urban.

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.

A series of rapid geomorphic assessments (RGAs) were conducted throughout the Vermillion River basin. The RGAs were used to assess the current channel stability along the river and to determine the stage of channel evolution. Results from the RGAs show that most sites are in Stage III and IV of channel evolution indicating instability, bank erosion, and channel widening from collapse of bank sections. Landuse changes such as increased grassland conversion to cropland and channelization have led to increased sediment concentrations. Although excessive sediment loadings have existed since at least 1972 it seems that higher concentrations are becoming more problematic with time. This might be attributed to continued channel degradation and excessive inflows from surrounding cropland.

There are four municipal wastewater facilities with National Pollution Discharge Elimination System (NPDES) permits located within the watershed of Segment R8. The following three facilities were assigned WLAs for this TMDL: 1) The City of Gayville, SD (NPDES permit number SD0022161) is small one-cell pond system located in the Vermillion flood plain in eastern Yankton County. It is in the Yankton-Clay Ditch watershed. Although the Gayville WWTF is authorized to discharge, the one-cell pond system only does so seasonally; 2) The City of Irene, SD (NPDES permit number SD0022454) is a small three-cell pond system located in extreme northwest Clay County. It is in the Turkey Creek-Clay Creek watershed. Although the Irene WWTF is authorized to discharge, the three-cell pond system only does seasonally; and 3) The City of Vermillion, SD (NPDES permit number 0020061) is a mechanical plant that is authorized to discharge continuously. It is located 2 miles above the mouth of the Vermillion River.

The City of Volin, SD (NPDES permit number 0020907) is a small one-cell pond system that is not authorized to discharge. It is located in eastern Yankton County in the Clay Creek Ditch watershed. A WLA was not calculated for this facility.

COMMENTS: The point source subsection of the Source Assessment and Allocation Section does not include any mention of the WLA for the discharge from the City of Vermillion's MS4. The discharge from the MS4 needs to be included in Section 6.1 in the context of point sources, and the text also needs to include the MS4 NPDES permit number. Also, the number of NPDES permittees in the Segment R8 watershed should be changed to five to include the MS4 permit.

SDDENR RESPONSE TO COMMENTS: A discussion of the city of Vermillion storm sewer system and MS4 NPDES permit number was added to the point source discussion. Section 6.1 was changed and the number of NPDES permittees was changed to five.

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 R8, 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 R8.

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 R8 of Vermillion River exceed the daily maximum criterion mostly during high to mid-range flow conditions where flow frequencies rank between 0 – 40 percent (see Figure 10 of the TMDL).

Table 7. Segment R8 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	VR01 with Ambient Station WQM5			
Station name:	Sampling Station downstream of the city of Vermillion			
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	>1,075 cfs	171-1,075 cfs	101-171 cfs	<101 cfs
Median Flow Per Zone	2588.37	333.29	128.15	57.22
Load Allocation	556.1	64.7	20.0	4.6
WLA - GAYVILLE (SD0022161)	0.95	0.95	0.95	0.95
WLA - IRENE (SD0022454)	0.77	0.77	0.77	0.77
WLA - VERMILLION (SD0020061)	1.00	1.00	1.00	1.00
WLA - VOLIN (SD0020907)	0.00	0.00	0.00	0.00
MS4 Load Allocation VERMILLION	5.18	5.18	5.18	5.18
MOS (10% Explicit)	62.7	8.1	3.1	1.4
TMDL	626.6	80.7	31.0	13.9
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	1527.580	171.724	26.348	7.556
Load Reduction	59.0%	53.0%	-17.8%	-83.4%
Average Concentration per Zone	224	157	77	54
Number of Values	11	40	33	55
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	1.15	0.15	0.06	0.03
cfs/sqmile	1.22	0.16	0.06	0.03

COMMENTS: The MS4 load shown in Table 7 should be identified as a WLA, similar to the WLAs for the wastewater facilities, and include the NPDES permit number. Additional explanation of the MS4 point source WLA (e.g., why it's considered a point source, how the load was derived) should be added to Section 6.1 of the document. Also, Section 8.1 should include a reference to the MS4 WLA derivation in Appendix C. Lastly, the MS4 WLA shown in Table 7 (5.18 tons/day at all flows), is not consistent with the derivation of the load in Appendix C (0.8 tons/day average). The load in Table 7 should be revised to be consistent with Appendix A or an explanation needs to be added as to why the loads are different.

We further recommend checking the Appendix references throughout the document (e.g., Section 5 references Appendix H as the FLUX set-up and Appendix I as the AnnAGNPS results – it seems that the correct references should be Appendix I and J respectively). See also the appendix references on pages 18, 27 and 35.

SDDENR RESPONSE TO COMMENTS: The MS4 load was changed in Table 7 identifying it as a WLA. The NPDES permit number was added as well. A discussion of the MS4 permit and the city of Vermillion was added to Section 6.1.

Appendix C was updated reflecting the current load of 5.18 tons/day shown in Table 7. The appendix references throughout the document were updated and should be correct.

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 VR01. The full data set is included in Appendix E of the TMDL document. 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.

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. 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.

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. Auto-samplers were used at some of the more remote locations. The auto-samplers were programmed to collect composite samples over the course of a storm event.

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 R8. There are four municipal wastewater facilities with National Pollution Discharge Elimination System (NPDES) permits located within the watershed of Segment R8. The following three facilities were assigned WLAs for this TMDL: 1) The City of Gayville, SD (NPDES permit number SD0022161) is small one-cell pond system located in the Vermillion flood plain in eastern Yankton County. It is in the Yankton-Clay Ditch watershed. Although the Gayville WWTF is authorized to discharge, the one-cell pond system only does so seasonally; 2) The City of Irene, SD (NPDES permit number SD0022454) is a small three-cell pond system located in extreme northwest Clay County. It is in the Turkey Creek-Clay Creek watershed. Although the Irene WWTF is authorized to discharge, the three-cell pond system only does seasonally; and 3) The City of Vermillion, SD (NPDES permit number 0020061) is a mechanical plant that is authorized to discharge continuously. It is located 2 miles above the mouth of the Vermillion River. Also, the City of Vermillion has an NPDES permit for stormwater discharges from its MS4. A WLA was calculated for the MS4 discharge based on the assumptions explained in Appendix C of the TMDL document. The WLAs for the three wastewater facilities and the MS4 are included in Table 7 of the TMDL document.

The City of Volin, SD (NPDES permit number 0020907) is a small one-cell pond system that is not authorized to discharge. It is located in eastern Yankton County in the Clay Creek Ditch watershed. A WLA was not calculated for this facility.

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 R8.

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment R8 was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR01, which is approximately 5 miles upstream of USGS Gage 006479010. Site VR01 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).

- ☐ <u>If the MOS is implicit</u>, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.
- ☒ <u>If the MOS is explicit</u>, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.
- ☐ <u>If</u>, rather than an explicit or implicit MOS, the <u>TMDL relies upon a phased approach</u> to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

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

SUMMARY: The Vermillion River, Segment R8 TSS 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 R8.

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

Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations throughout the river basin especially for Segment R8 at WQM Site 5 (Storet ID: 460745). 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.

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. 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 estimated that over 40 percent of the total suspended solids load originates from bank erosion in the two higher flow zones. Additional analysis through the Annualized AGNPS suggests that multiple drainages provide increased water and sediment loadings.

For Segment R8 the WLA and MS4 contribution is insignificant in comparison to the overall TMDL within each flow zone. 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. 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.

27.0 APPENDIX L: EPA TMDL Approval Letter

RESERVED

END of Document

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

JUL 05 2011

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, Segment R8; TSS;
SD-VM-R-VERMILLION_03

Dear Mr. Pirner:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq.*), we approve all aspects of the 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

Total Suspended Solids Total Maximum Daily Load (TMDL) for R8 of the Vermillion River, Clay, Hutchinson, Lincoln, Turner, Yankton and Union Counties, South Dakota (SD DENR, April 2011)

Submitted: 5/19/2011

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

Segment: Vermillion River from Baptist Creek to mouth (coufluence with Missouri River)

303(d) ID: SD-VM-R-VERMILLION 03

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

Water Quality Targets: <= 158 mg/L daily maximum; and <= 90 mg/L 30-day average of three consecutive grab or composite samples taken on separate weeks

Allocation*	Value	Units	Permits
WLA	0.77	TONS/DAY	SD0022454
WLA	0.95	TONS/DAY	SD0022161
WLA	1.0	TONS/DAY	SD0020061
WLA	5.18	TONS/DAY	SDR41A001
LA	556.1	TONS/DAY	
MOS	62.7	TONS/DAY	
TMDL	626.6	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 R8 (see Figure 10 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 Segment R8 of the Vermillion River Clay, Hutchinson, Lincoln, Turner, Yankton and Union Counties, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**May 19, 2011**
Review Date:	**June 28, 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 R8, total suspended solids (TSS) TMDL was submitted to EPA for review and approval via an email from Cheryl Saunders, SD DENR on May 19, 2011. The email included the final TMDL document and a letter requesting approval of the TMDL.

COMMENTS: None.

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

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

Minimum Submission Requirements:

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

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

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

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

SUMMARY: 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 Baptist Creek to the mouth at its confluence with the Missouri River (20.7 miles, SD-VM-R-VERMILLION_03). 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 total suspended solids (TSS) which is impairing the warmwater semi permanent fish life propagation use.

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, all TMDL documents must be written to meet the existing water quality standards 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 the Vermillion River, Segment R8, can be found on pages 15 - 16 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 R8, 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 the largest category of landuse within this segment at 62%. There is a relatively limited urbanized area in the lower portion of the drainage area, and therefore impact from this land use is expected to be localized to the source. Figure 3 in the TMDL document presents a visual breakdown of landuse within the drainage area of Segment R8 of the Vermillion River. The landuse statistics are as follows: 62% row crops, 21.5% grassland/hayland, 6.5% herbaceous, 6% open space, 3% water/wetland/woods, 1% urban.

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.

A series of rapid geomorphic assessments (RGAs) were conducted throughout the Vermillion River basin. The RGAs were used to assess the current channel stability along the river and to determine the stage of channel evolution. Results from the RGAs show that most sites are in Stage III and IV of channel evolution indicating instability, bank erosion, and channel widening from collapse of bank sections. Landuse changes such as increased grassland conversion to cropland and channelization have led to increased sediment concentrations. Although excessive sediment loadings have existed since at least 1972 it seems that higher concentrations are becoming more problematic with time. This might be attributed to continued channel degradation and excessive inflows from surrounding cropland.

There are four municipal wastewater facilities with National Pollution Discharge Elimination System (NPDES) permits located within the watershed of Segment R8. The following three facilities were assigned WLAs for this TMDL: 1) The City of Gayville, SD (NPDES permit number SD0022161) has small one-cell pond system located in the Vermillion flood plain in eastern Yankton County. It is in the Yankton-Clay Ditch watershed. Although the Gayville WWTF is authorized to discharge, the one-cell pond system only does so seasonally; 2) The City of Irene, SD (NPDES permit number SD0022454) has a small three-cell pond system located in extreme northwest Clay County. It is in the Turkey Creek-Clay Creek watershed. Although the Irene WWTF is authorized to discharge, the three-cell pond system only does seasonally; and 3) The City of Vermillion, SD (NPDES permit number SD0020061) has a mechanical plant that is authorized to discharge continuously. It is located 2 miles above the mouth of the Vermillion River.

The City of Volin, SD has a small one-cell pond system that is not authorized to discharge. It is located in eastern Yankton County in the Clay Creek Ditch watershed. A WLA was not calculated for this facility.

The City of Vermillion, SD (MS4 NPDES permit number SDR41A001) is a city with population in excess of 10,000 and, therefore, is subject to Phase II of the Municipal Separate Storm Sewer Systems (MS4) Program. In order to quantify the total suspended load from the city of Vermillion, the Simple Method (Schueler 1987) was used. The WLA calculations are included in Appendix C of the TMDL document.

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 R8, 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 R8.

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 R8 of Vermillion River exceed the daily maximum criterion mostly during high to mid-range flow conditions where flow frequencies rank between 0 – 40 percent (see Figure 10 of the TMDL).

Table 7. Segment R8 – TSS Total Maximum Daily Load (TMDL) allocations by flow zone.

Station ID:	VR01 with Ambient Station WQM5			
Station name:	Sampling Station downstream of the city of Vermillion			
Parameter of Concern	Flow Zone (expressed as tons/day)			
TSS	Extreme Flows	High-Range	Mid Range Flows	Low Flows
	(0-10)	(10-40)	(40-60)	(60-100)
Flow Range	>1,075 cfs	171-1,075 cfs	101-171 cfs	<101 cfs
Median Flow Per Zone	2588.37	333.29	128.15	57.22
Load Allocation	556.1	64.7	20.0	4.6
WLA - GAYVILLE (SD0022161)	0.95	0.95	0.95	0.95
WLA - IRENE (SD0022454)	0.77	0.77	0.77	0.77
WLA - VERMILLION (SD0020061)	1.00	1.00	1.00	1.00
WLA - VOLIN (SD0020907)	0.00	0.00	0.00	0.00
WLA - MS4 VERMILLION (SDR41A001)	5.18	5.18	5.18	5.18
MOS (10% Explicit)	62.7	8.1	3.1	1.4
TMDL	626.6	80.7	31.0	13.9
	Existing Condition per Zone (expressed as tons/day)			
Average Load per Zone	1527.580	171.724	26.348	7.556
Load Reduction	59.0%	53.0%	-17.8%	-83.4%
Average Concentration per Zone	224	157	77	54
Number of Values	11	40	33	55
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	1.15	0.15	0.06	0.03
cfs/sqmile	1.22	0.16	0.06	0.03

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 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 VR01. The full data set is included in Appendix E of the TMDL document. 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.

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. 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.

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. Auto-samplers were used at some of the more remote locations. The auto-samplers were programmed to collect composite samples over the course of a storm event.

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 R8. There are four municipal wastewater facilities with National Pollution Discharge Elimination System (NPDES) permits located within the watershed of Segment R8. The following three facilities were assigned WLAs for this TMDL: 1) The City of Gayville, SD (NPDES permit number SD0022161) has small one-cell pond system located in the Vermillion flood plain in eastern Yankton County. It is in the Yankton-Clay Ditch watershed. Although the Gayville WWTF is authorized to discharge, the one-cell pond system only does so seasonally; 2) The City of Irene, SD (NPDES permit number SD0022454) has a small three-cell pond system located in extreme northwest Clay County. It is in the Turkey Creek-Clay Creek watershed. Although the Irene WWTF is authorized to discharge, the three-cell pond system only does seasonally; and 3) The City of Vermillion, SD (NPDES permit number SD0020061) has a mechanical plant that is authorized to discharge continuously. It is located 2 miles above the mouth of the Vermillion River. Also, the City of Vermillion has an NPDES permit for stormwater discharges from its MS4. A WLA was calculated for the MS4 discharge based on the assumptions explained in Appendix C of the TMDL document. The WLAs for the three wastewater facilities and the MS4 are included in Table 7 of the TMDL document.

The City of Volin, SD has a small one-cell pond system that is not authorized to discharge. It is located in eastern Yankton County in the Clay Creek Ditch watershed. A WLA was not calculated for this facility.

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 R8.

To develop the TSS load allocation (LA), the loading capacity (LC) was first determined. The LC for Segment R8 was calculated by multiplying the 30-day average (90 mg/L) TSS criterion by the daily average flow measured at Site VR01, which is approximately 5 miles upstream of USGS Gage 006479010. Site VR01 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, Segment R8 TSS 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 R8.

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

Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations throughout the river basin especially for Segment R8 at WQM Site 5 (Storet ID: 460745). 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.

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 <u>is not</u> 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. 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 estimated that over 40 percent of the total suspended solids load originates from bank erosion in the two higher flow zones. Additional analysis through the Annualized AGNPS suggests that multiple drainages provide increased water and sediment loadings.

For Segment R8 the WLA and MS4 contribution is insignificant in comparison to the overall TMDL within each flow zone. 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. 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.