Recommendations for Water Quality Standards Revisions

**Reach changes and Site Specific Standards for Total Suspended Solids (TSS)
For the White and Little White Rivers, Fall River, Shannon, Penning ton,
Jackson, Bennett, Jones, Mellette, Todd, Lyman and Tripp Counties**

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

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Executive Summary

The White and Little White River watersheds have been listed as violating surface water quality standards since 1998 based on 303 (d), 305 (b) and Integrated Reports. Currently, uses are not supported due to violations of water quality criteria contained in ARSD 74:51:01. The 2008 Integrated Report for Surface Water Quality Assessment (SD DENR, 2008) lists White River (from Nebraska border to mouth) as an impaired waterbody due to high values of (TSS) total suspended solids (SD DENR, 2008).

The current monitoring reaches in the White River in South Dakota run from the Nebraska/South Dakota border to Interior, Interior to Black Pipe Creek, Black Pipe Creek to Oak Creek and Oak Creek to mouth. Current reaches in the Little White River run from Section 6, Township 6 North, Range 39 West to Rosebud Creek and Rosebud Creek to mouth (Figure 8). However, based on physical habitat classification and analyses of historical discharge and water-quality data the current reaches do not adequately represent the natural conditions in the watershed. Monitoring and assessment data identified three unique reaches on the White River. The breaks for these reaches were determined by geology of the watershed and hydrology of the system. The proposed reaches are as follows: (1) from the Nebraska border to the confluence of Willow Creek 13 river miles north of the gage station identified as the White River near Oglala; (2) Willow Creek to the confluence of the Little White River; and (3) the confluence of the Little White River to the mouth of the river near Oacoma, South Dakota. Current reaches in the Little White River watershed are adequate and do not need adjustment, as they represent geological and hydrological conditions in this watershed.

Long term (WQM) water quality monitoring and assessment data (1968 through 2008) indicate TSS concentrations in the White and Little White Rivers violate current surface water quality standards based on warmwater semipermanent fish life propagation water criteria. However, based on long-term trend analysis using USGS and SD DENR water quality data, TSS standard violations appear to be relatively constant showing a slight decline over time. The current TSS water-quality standard is unattainable and unreasonable in this system ($\geq$ 158 mg/L). Much of the load is coming from White River Group geology in and around the Badlands National Parks where the geology of the area causes steep-sided bluffs with little to no vegetation. This causes low infiltration rates with high runoff and erosion rates. Sediment composed of White River Group consists of clay, silt and mudstone soils of small particle size that can create suspensions and colloidal dispersions that remain suspended for long periods of time.

Biological data (fisheries and macroinvertebrate) support proposed reach changes and modified TSS concentrations. Based on recent fisheries assessment results (Fryda, 2001), the White River is typical of western South Dakota streams dominated by species that are adapted to the adverse conditions found in this arid region. The report suggests that it is likely the White River's species composition has changed very little from its historic condition, finding only one nonnative species, the common carp (*Cyprinus carpio*), along with several species of special concern representing a large percentage of the fish community. White River macroinvertebrate data suggest that the Oglala monitoring site had significantly lower TSS concentrations, a Rosgen G-type channel, and habitat more conducive to a diverse benthic community. Whereas, the lower reaches are characterized by higher TSS concentrations, Rosgen F-type channels with

shifting sand bottoms, creating extremely poor macroinvertebrate habitat and, in turn, community structure. Macroinvertebrate communities in the White River watershed appear to be driven more by physical habitat and less by TSS concentrations.

Based on physical habitat classification and analyses of historical discharge, water-quality and biological data, three unique reaches were identified on the White River. The breaks for these reaches were determined by geology of the watershed and hydrology of the system. The current criterion of 158 mg/l for TSS is unattainable in the White and Little White River watersheds in South Dakota. Site/reach specific standards for TSS in proposed reaches of the White and Little White Rivers based on a load duration curves developed for the Oglala, Kadoka, Oacoma and the Little White River below White River monitoring sites using the 95th percent exceedence concentrations. The proposed site/reach specific TSS concentrations are as follows: (1) 4,525 mg/L TSS from the Nebraska border to the confluence of Willow Creek; (2) 24,300 mg/L TSS from Willow Creek to the confluence of the Little White River; (3) 21,550 mg/L TSS from the confluence of the Little White River to the mouth of the river near Oacoma, South Dakota; and the site/reach specific TSS concentration for the Little White River below White River is 1,733 mg/L TSS from Rosebud Creek to the mouth of the Little White River near Westover, South Dakota. Current and historical data support implementation of these site-specific standards for TSS in each of the proposed reaches of the White and Little White River watersheds, based on the 95th percent exceedence level.

Watershed and Monitoring Site Information

The White River drains the northeastern portion of Sioux, northern portion of Dawes and northwestern portion of Sheridan Counties in Nebraska before entering Shannon County in South Dakota and discharges into the Missouri River south of Oacoma in Lyman County (Figure 1). The White River drains approximately 9,940 square miles (6,361,575 acres); 32% of the watershed is in Nebraska (2,035,704 acres) and 68% is in South Dakota (4,325,871 acres).

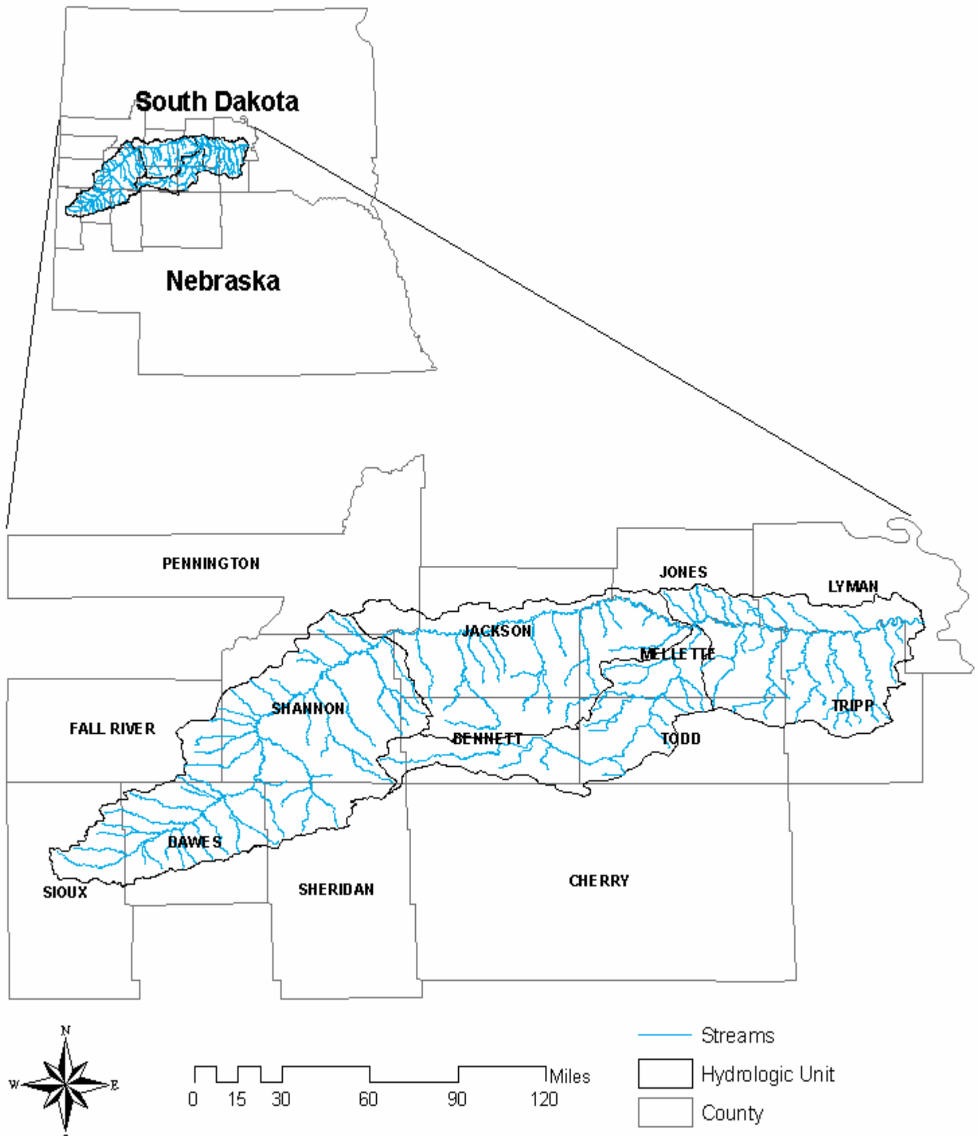

Figure 1. White River Watershed Location in South Dakota and Nebraska.

The White River is a plains stream that flows into South Dakota from Nebraska. The upper portions of the river in South Dakota from the Stateline to Oglala was classified as a Rosgen Type G channel (a well-entrenched channel (entrenchment ratios <1.4), low width to depth ratios and a moderate slope). The dominate substrate type in this section ranged from sand (Rosgen Type G5) at the Stateline to silt-clay (Rosgen Type G6) at Oglala. The remaining river was classified as a Rosgen Type F5 channel described as a sand-dominated entrenched system, with moderate to high sediment supply and gently sloping gradients under 2 percent. The riparian corridor of the White River in South Dakota is populated with trees from the Nebraska Stateline to Rockyford; from Rockyford to Westover (near the confluence with the Little White River) trees are sparse to lacking. Trees in the lower portion of the White River (from the confluence of the Little White River to Oacoma) are more numerous than in the middle reach of the river. Grasses and sedges grow to the rivers edge along the entire reach.

USGS and project monitoring sites in the White River watershed assessment project are shown in Figure 2 with USGS monitoring sites on the Little White River depicted separately. Of the fifteen gage stations shown in Figure 2, only one tributary (Little White River below White River) and three mainstem and gage sites (Oglala, Kadoka and Oacoma) had long-term discharge and flow data to do comprehensive water quality analysis (Figure 3). South Dakota Department of Environment and Natural Resources (SD DENR) and United States Geological Survey (USGS) water quality monitoring (WQM) sites are listed by number in Table 1 and Table 2.

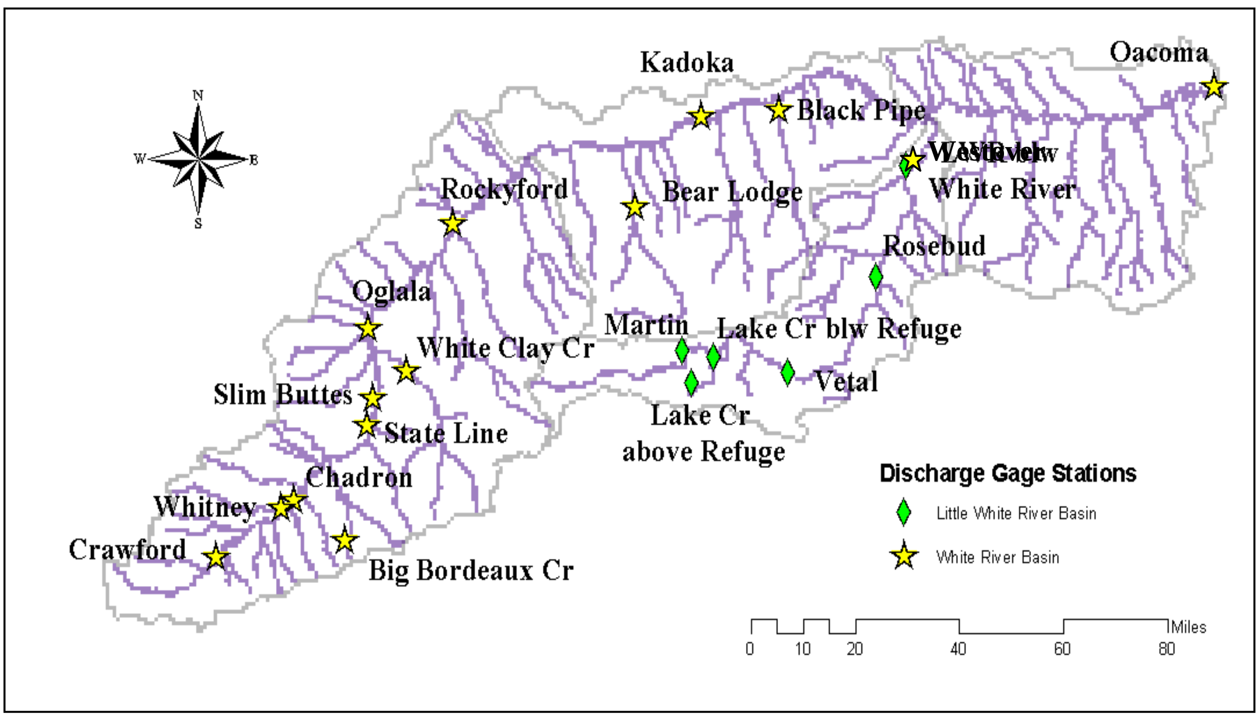

Figure 2. White River and Little White River monitoring sites for the White River watershed project.

Table 1. South Dakota Water Quality Monitoring (WQM) sites in the White River watershed in South Dakota.

SD DENR Station Number	Name	Hydrologic Unit
WQM 11	White River near Kadoka	10140202
WQM 12	White River near Oacoma	10140204
WQM 13	Little White River near White River	10140203
WQM 42	White River near Oglala	10140201
WQM 152*	White River at Highway 83 Crossing	10140202

Shaded = Mainstem White River monitoring sites
*** = WQM site has only been established since 1999.**

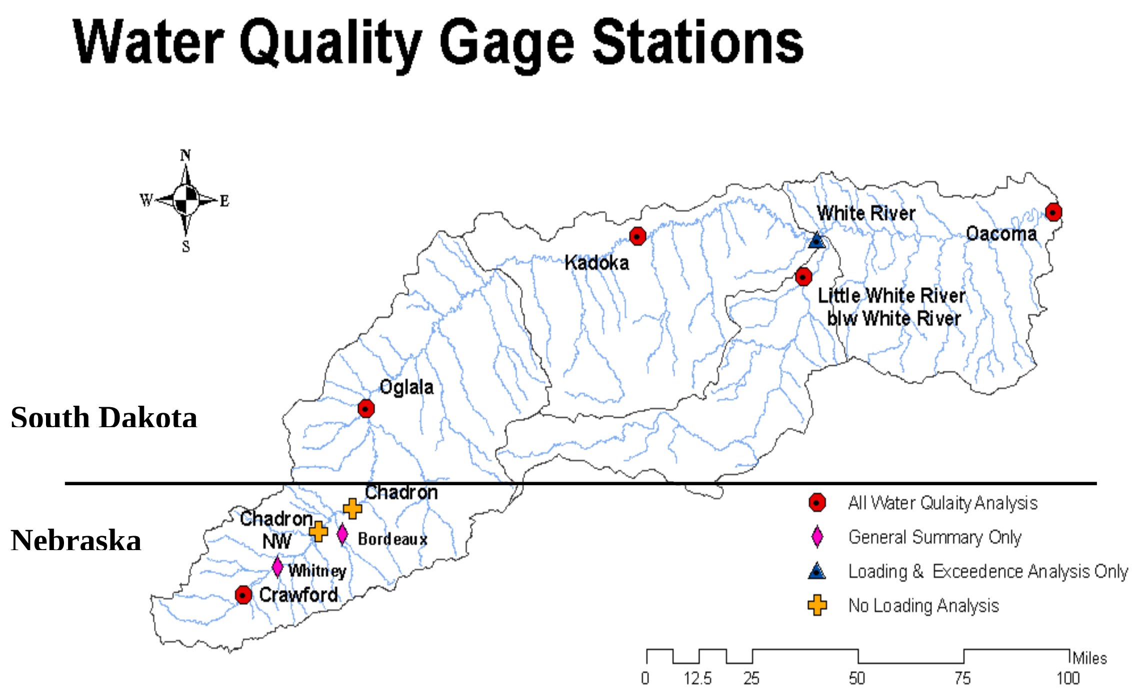

Figure 3. Water quality gage stations in the White River watershed

Table 2. USGS monitoring sites in the White River watershed within South Dakota.

USGS Station Number	Name	Hydraulic Unit
06445685	White River near Nebraska-South Dakota State Line	10140201
06446000	White River near Oglala	10140201
06446700	Bear in the Lodge Creek near Wanblee	10140202
06447000	White River near Kadoka	10140202
06447230	Black Pipe Creek near Belvidere	10140202
06447500	Little White River near Martin	10140203
06448000	Lake Creek above Refuge, near Tuthill	10140203
06449000	Little Creek below Refuge, near Tuthill	10140203
06449100	Little White River near Vetal	10140203
06449500	Little White River near Rosebud	10140203
06450500	Little White River below White River	10140203
06452000	White River near Oacoma	10140204

Shaded = Mainstem White River monitoring sites

A separate watershed assessment project was completed on the Little White River watershed in Mellette County. Five mainstem and eight tributary sites were set up in the watershed to monitor water quality and flow within Reach 5, SD_WH_R_LITTLE_WHITE_01 from Rosebud Creek to the mouth (Figure 4). USGS has six monitoring sites (gage stations) in the Little White River drainage (Figure 2 and Table 2). The Little White River is a major tributary of the White River and has the same beneficial use criteria and related water quality standards.

This document discusses the TSS impairment only and recommendations for site/reach specific standards based on the warm water semipermanent fishery beneficial use applied to the White and Little White Rivers in South Dakota.

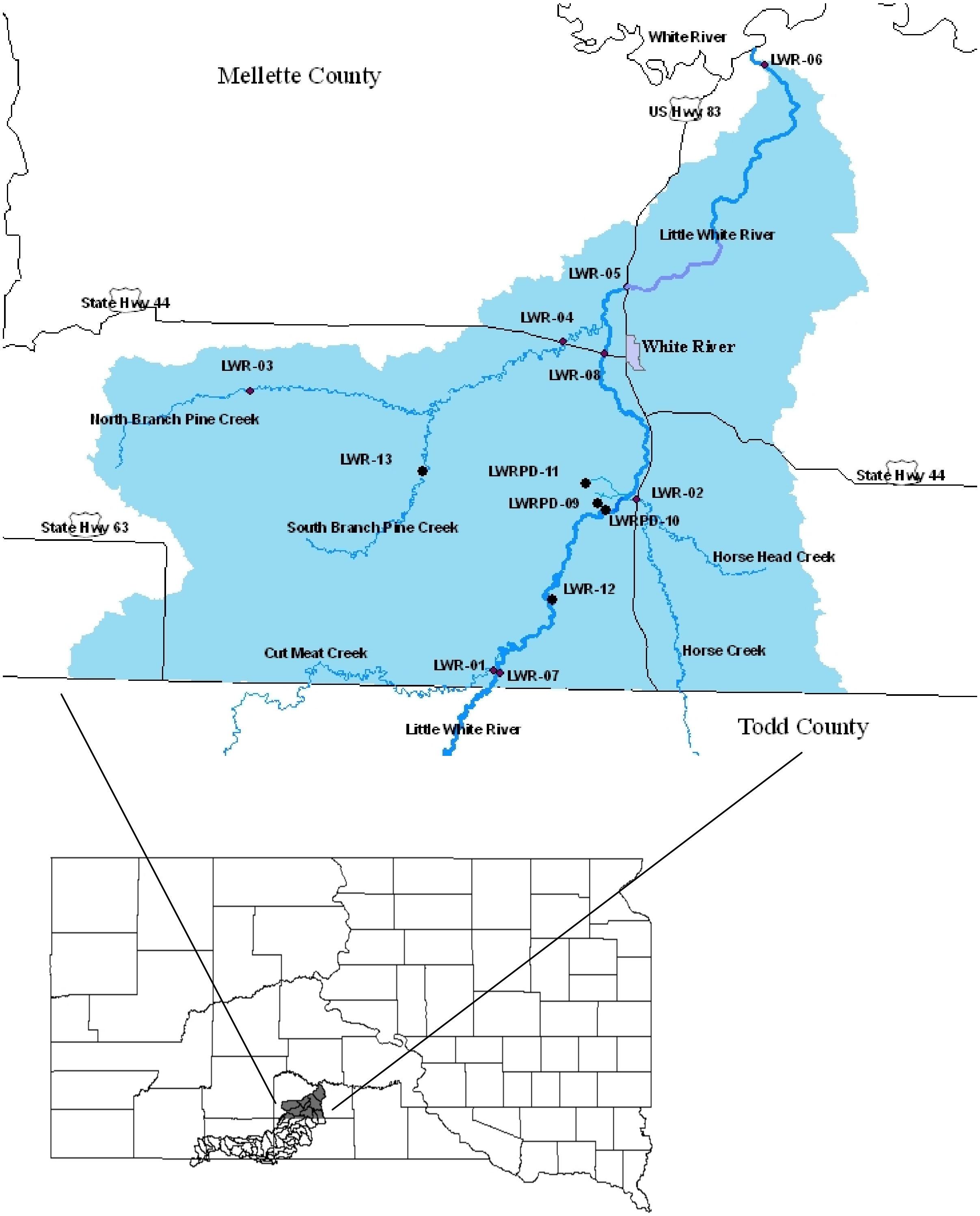

Figure 4. Little White River watershed and sampling sites.

Beneficial Uses and Water Quality Criteria

Chapter 74:51:03 of the Administrative Rules of South Dakota (ARSD) assigns the following beneficial uses to the White and Little White River (Table 3).

Table 3. Beneficial use classifications for the White and Little White River watersheds by 2008 Integrated Report reach.

	Integrated Report Reach ID's by Watershed*	
Beneficial use	**White River**	**Little White River**
Warmwater semipermanent fish life propagation	R6, R7, R8 and R9	R5 and R11
Limited contact recreation	R7, R8 and R9	R5 and R11
Fish and wildlife propagation, recreation and stock watering	R6, R7, R8 and R9	R5 and R11
Irrigation	R6, R7, R8 and R9	R5 and R11

*** = For current 2008 reach locations see Figure 8.**

The White and little White River watersheds have been listed as violating surface water quality standards since 1998 based on 303 (d), 305 (b) and Integrated Reports (SD DENR, 1998; SD DENR, 1998a; SD DENR, 2000; SD DENR, 2002a; SD DENR, 2004; SD DENR, 2006 and SD DENR, 2008). Currently, uses are not supported due to violations of water quality criteria contained in ARSD 74:51:01. The 2008 Integrated Report for Surface Water Quality Assessment (SD DENR, 2008) lists White River (from Nebraska border to mouth) as an impaired waterbody due to high values of total suspended solids (TSS). The report also lists violations in fecal coliform bacteria in the White River from Interior, SD to the mouth (SD DENR, 2008). Assessment data from the *Phase 1 Environmental Assessment of the White River Watershed White River, South Dakota* supports impairment listing for TSS (RESPEC, 2007).

Presently, the White and Little White River watersheds are designated with the beneficial use of warmwater semipermanent fish life propagation (ARSD §74:51:03:26), thus TSS must not exceed a 30-day average limit of 90 mg/L (arithmetic mean of a minimum of 3 consecutive grab or composite samples taken on separate weeks in a 30-day period) or a daily maximum limit of 158 mg/L (ARSD §74:51:01:48).

Warmwater semipermanent fish life propagation is defined as "a beneficial use assigned to waters of the state which support aquatic life and are suitable for the propagation or maintenance, or both, of warmwater fish but which may suffer occasional fish kills because of critical natural conditions" (ARSD §74:51:01:01 paragraph 62).

Based on biological evaluations (fishery and macroinvertebrate), the White and Little White Rivers support the classification of a warmwater semipermanent fish life propagation water. However, because of the natural geology of the White River basin which in part is comprised of highly erodible White River Group formations (28%), with naturally high sediment loading causing violations of water quality standards for TSS throughout all flow regimes. Geological and water quality data support a proposed site/reach specific standards change for TSS in monitored reaches of the White and little White River watersheds in South Dakota.

Reach Evaluations with Proposed Changes

Since the entire watershed has the same beneficial uses, reach length in the White River watershed was evaluated as to better represent chemical, morphological, hydrological and geological conditions in the White River watershed.

Table 4. Geologic name and percentage in the White River watershed in South Dakota.

Symbol	Geological Name	Percent of Drainage Area
Kp	Pierre Shale	6%
To	Ogallalla Group	2%
Qal	Alluvium	6%
Qe	Eolian Deposits	11%
Qt	Terrace Deposits	3%
Ta	Arikaree Group	44%
Tw	White River Group	28%

Geology of the White River Basin is shown in Figure 5. A transition occurs near the Oglala station with the main channel entering into the White River group deposits while the tributaries become dominated by the Arikaree group. The White River group, the geologic formation that forms the steep, bare side-slope bluffs in the Badlands National Park, is displayed in yellow (Figure 5). The percent of drainage area contributing between the Oglala and Kadoka stations containing different geologic formations or groups is shown in Table 4. The Arikaree and White River groups are the dominant geology types in this river reach. They are both dominated by clay and siltstones with volcanic ash formations being common. A detailed description of each of these geologic formations is given in Figure 6. Much of the data analyzed indicates the critical reach of the river, in regard to the water quality as well as physical habitat characteristics, and occurs in the area of transition to the White River geological group, which corresponds to a change in soils.

The river makes a significant change in direction roughly 5 statute miles north of the Oglala station, most likely due to the significant change in geology. It is at this point where the White River enters into and crosses the White River group formations. For the purpose of defining the different stream reaches, the clear transition between the upper reach of the watershed and the middle reach should be defined at this break in direction and change in geology. This break occurs approximately 16.2 river kilometers upstream of USGS stream gage number 06446000, White River near Oglala and is also sampled as SD DENR WQM 42 (Tables 1 and Table 2). This break is located at the confluence of Willow Creek where it enters the White River.

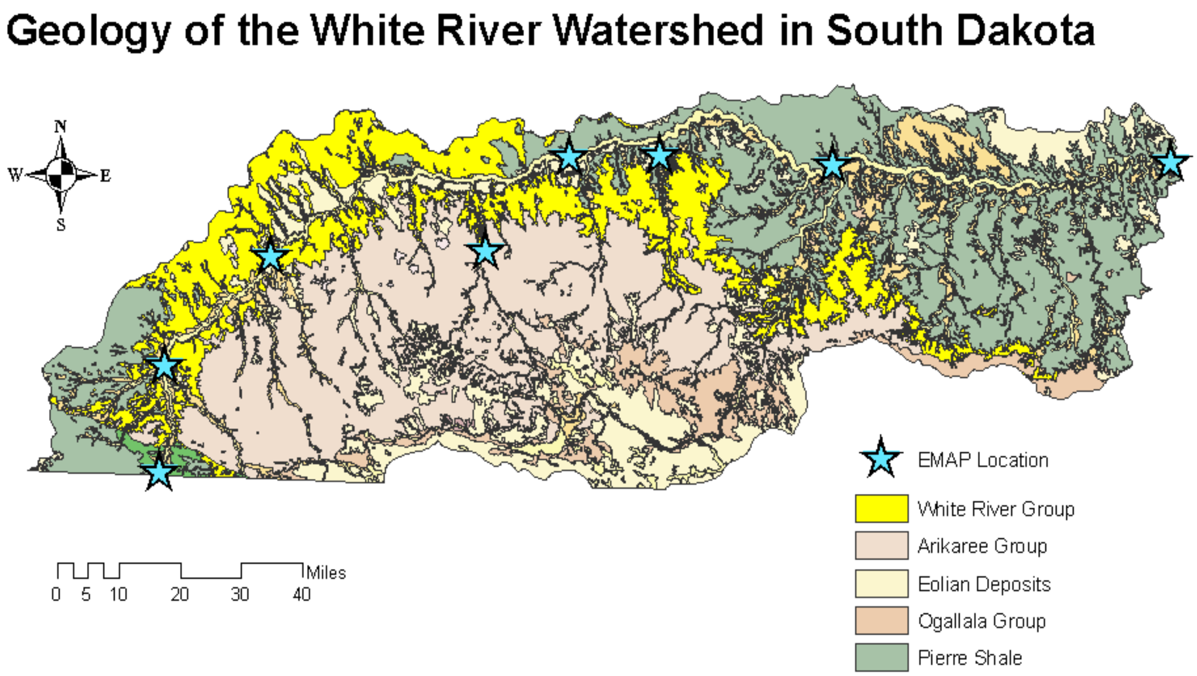

Figure 5. Geology of the White River watershed in South Dakota.

The current upper reach R6, SD_WH_R_WHITE_01 of the White River from the Nebraska border to Interior should be adjusted to better represent the morphology, hydrology, geology and water chemistry of the White River (Figure 8). The proposed reach R6, SD_WH_R_WHITE_01 should be adjusted to extend from the Nebraska border to the confluence of Willow Creek (Figure 9). This will reflect the natural conditions in the watershed.

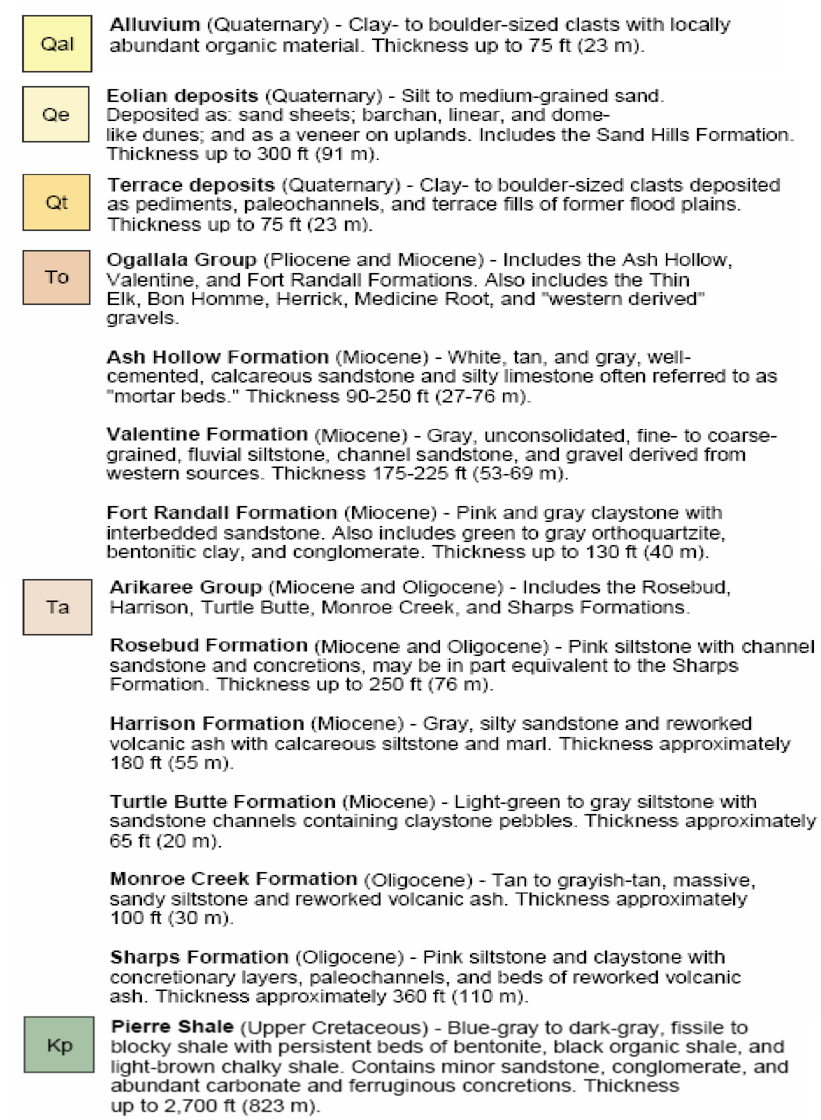

Figure 6. Geologic Units found in the White River watershed.

The proposed middle reach of the White River, Willow Creek to the confluence of the Little White River, is dominated by high sediment loads from the White River Group soils (yellow soils in Figure 5). This reach incorporates portions of current reach R6, SD_WH_R_WHITE_01 [Willow Creek to Interior], all of reach R7, SD_WH_R_WHITE_02 [Interior to Black Pipe Creek] and the upper portions of R8, SD_WH_R_WHITE_03 [Black Pipe Creek to the Little White River] (Figure 8 and Figure 9). Based on the White River watershed assessment project, the entire middle reach of the White River has similar geologic, morphologic, hydrologic and water quality characteristics influenced by White River Group geology, supporting the proposed reach change for the middle section of the White River.

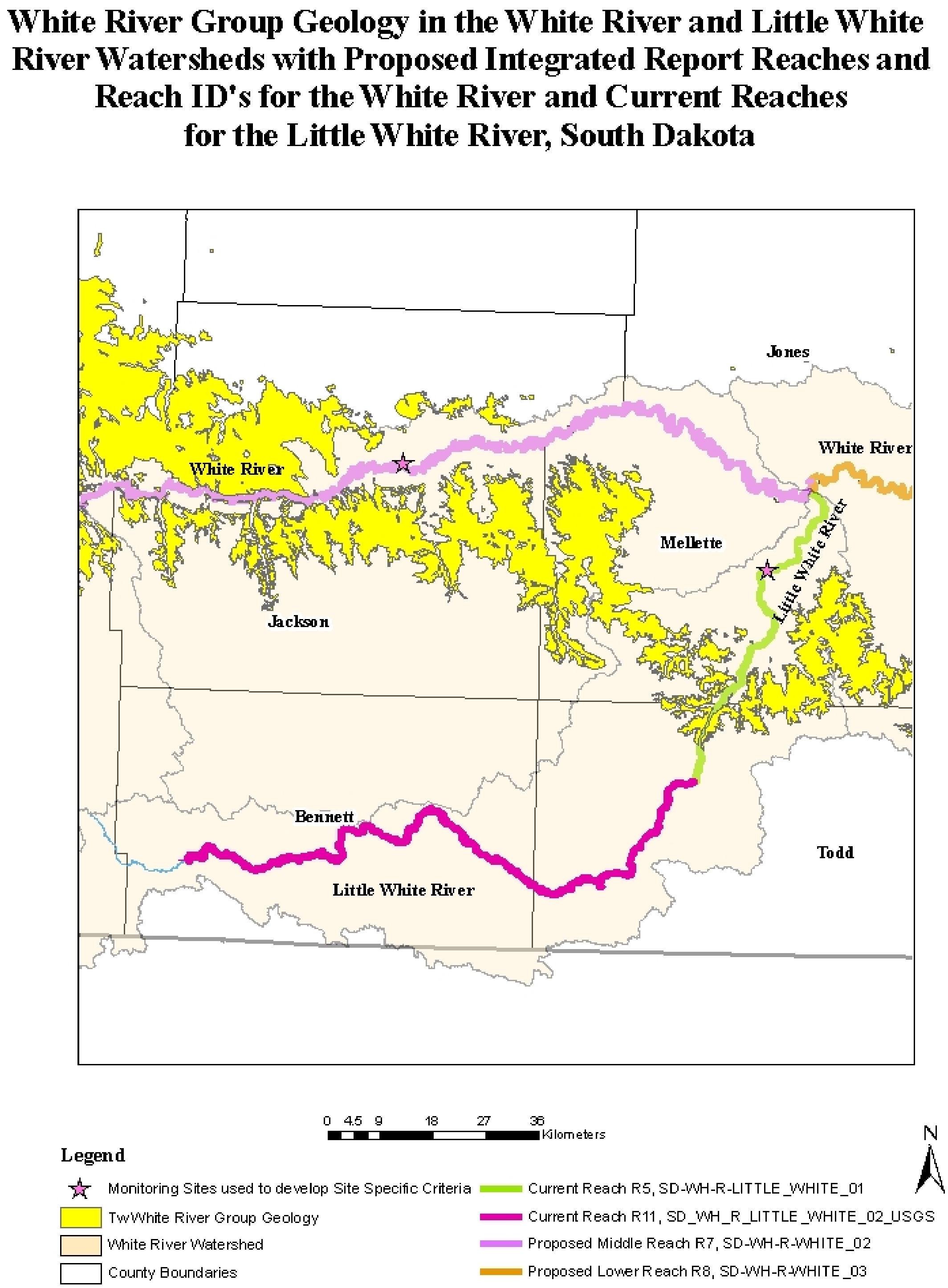

Figure 7. White River Group geology within select portions of the White and Little White River watershed.

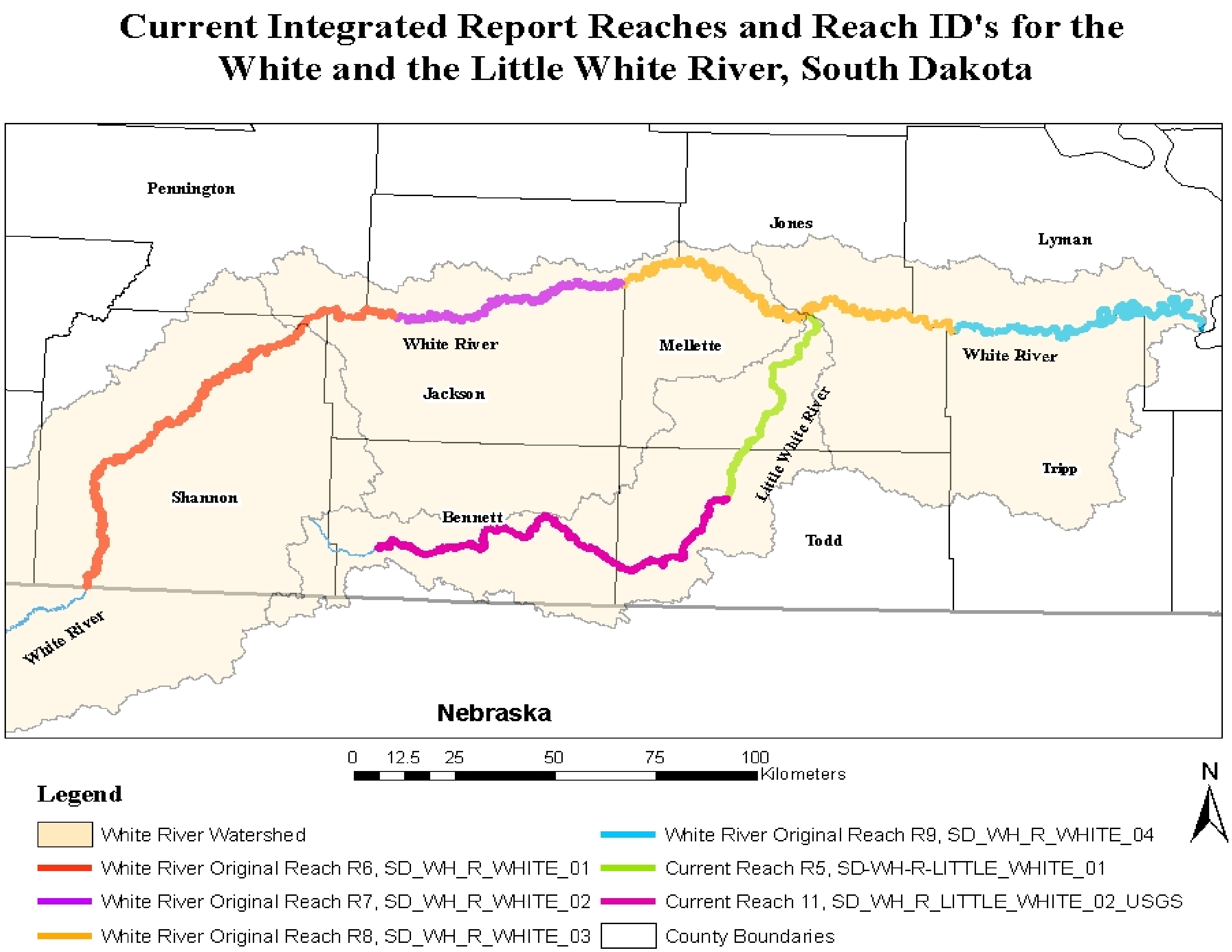

Figure 8. Current Integrated Report reaches and reach ID's for the White and Little White River watersheds in South Dakota 2008.

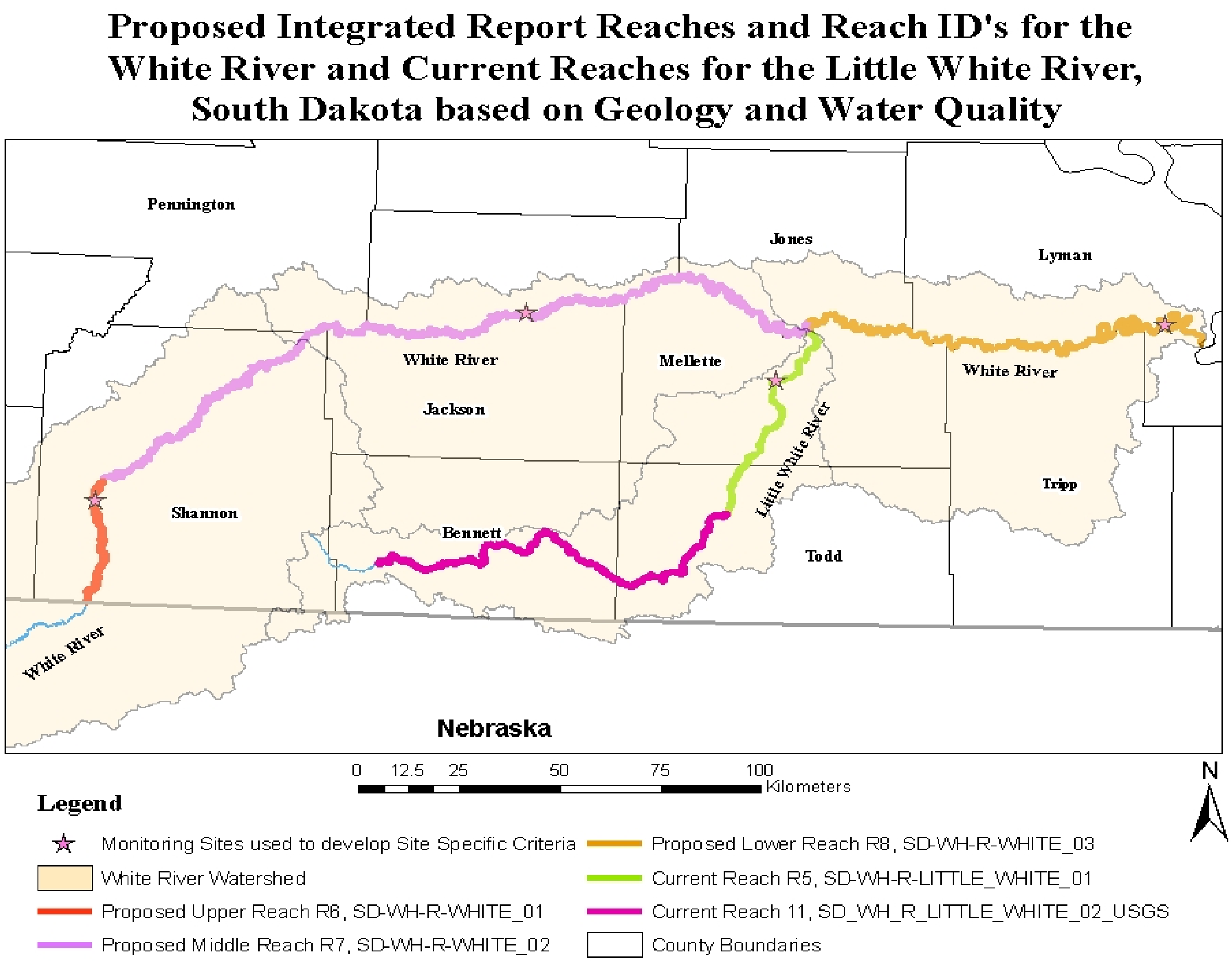

Figure 9. Proposed Integrated Report reach and reach ID changes for the White River watershed 2008.

The Little White River, a major tributary of the Whiter River, has different hydrology than the White River. Little White River flows originate from the high plains aquifer which originates from Arikaree, Eolian and Ogallala Groups with sand and silty-sand deposits (Figure 5 and Figure 6). This aquifer is very large and contributes enough flow to the Little White River to keep it flowing year-round. Based on the 2008 Integrated Report using USGS data, water quality in the Little White River from S6, T36N, R39W (South of Swett, South Dakota in Bennett County) to Rosebud Creek meets water quality standards [current Reach 11, SD_WH_R_LITTLE_WHITE_02_USGS] (Figure 7 and Figure 8).

When Reach 11 (SD_WH_R_LITTLE_WHITE_02_USGS) waters enter Reach 5 (SD_WH_R_LITTLE_WHITE_01 at Rosebud Creek) the Little White River begins to flow through the White River Group formations (approximately 9.5 river kilometers downstream) accumulating increased sediment load and exceeding the current daily maximum water quality criterion for TSS (158 mg/L) based on the beneficial use designation of warmwater semipermanent fish life propagation (Figure 7). Assessment data collected on the Little White River at the Mellette/Todd County line (monitoring site LWR-07, Figure 4) indicate a 57.9 percent violation rate in TSS concentrations while flowing through White River Group formations (Figure 7). Continuing further downstream, the TSS violation rate increased to 65.8 percent below the town of White River, South Dakota (monitoring site LWR-05, Figure 4) likely from TSS inputs from Pine Creek. By the time the Little White River reached the confluence with the White River the violation rate based on assessment data was 61.1 percent. TSS concentrations throughout this reach exceed current criteria. The 95th percent exceedence concentration for the Little White River was high (1,733 mg/L), but not as high as the White River above (24,300 mg/L) or below (21,550 mg/L) the confluence. Loading in this reach of the Little White River is significantly less than the White River, likely due to the hydrology and geology of the watershed. Thus the TSS loading from the Little White River may dilute waters of the White River below the confluence with the Little White River.

The proposed lower reach of the White River would incorporate the lower portion of reach R8 (SD_WH_R_WHITE_03) from the Little White River to Oak Creek and all of reach R9 (SD_WH_R_WHITE_09) from the Little White River to the White Rivers confluence with the Missouri River (Figure 9). As mentioned above the Little White River may augment flows and influence TSS concentrations in the lower portion of the White River. Another characteristic unique to the proposed lower reach of the Little White River is that the White River Group formations recede and diminish in coverage in a southeasterly direction away from the White River potentially reducing the amount of influence White River Group soils have on sediment loading in the lower reach of the White River (Figure 10). White River Group geological formations range from 16 to 43 kilometers away from the White River in the proposed lower reach of the river. The hydrology of the Little White River, the spatial location of the White River Group geology in relationship to the lower reach of the White River and TSS concentration data in this reach support the reach change proposed for the lower reach of the White River.

Assessment Result

Exceedence Analysis

Sample criteria for the determination of support status for beneficial use based water quality standards in streams are outlined in *The 2008 Integrated Report for Surface Water Quality Assessment* (Table 6, page 25 in SD DENR, 2008). The criteria are as follows: The number of samples in steams to be considered representative of actual conditions is at least 20 samples for any one parameter are usually required at any site. The sample threshold was reduced to 10 samples if greater than 25 percent of the samples exceed water quality standards since impairment is more likely. In addition, the sample threshold was reduced to five samples if 100 percent of the samples indicated full or nonsupport for that parameter. To determine support status in streams, greater than ten percent of the samples collected exceeded water quality standards (25 percent of the samples exceed water quality standards if less than 20 samples are available).

Exceedence analysis was performed on the four water-quality stations in the White and Little White River watersheds in South Dakota to determine (1) the percent of samples in which the standard was exceeded, (2) the concentration levels at which only 10 percent and 5 percent of the samples would exceed, and (3) the percent reduction needed to meet the required/current water-quality standard (≤158 mg/L) for TSS (Table 5 and Table 6).

Table 5. Descriptive statistics for White River monitoring sites used to develop site/reach specific criteria for TSS.

Station Name	TSS							
	Sample size	Percent Exceedence	Q1	Median	Q3	10% Exceedence	5% Exceedence	Required Reduction (5% Exceedence)
Oglala	165	47%	42	139	374	1,535	4,525	97%
Kadoka	478	78%	154	1,118	5,688	17,408	24,300	99%
Oacoma	489	79%	216	1,075	5,400	14,517	21,550	99%

Note: TSS Standard =158 mg/L

Ten percent exceedence concentration is the minimum water-quality standard required for the waterbody to be in compliance based on available data. The five percent exceedence concentration percent was calculated to take into account the extreme natural variability observed in TSS concentrations in the White River basin. TSS variability may be from rainfall patterns, drought, sample collection procedures, wind, etc. The site/reach specific standard for each segment of the White and the Little White Rivers should be representative of natural conditions in the watershed while taking into account variability and still be protective of the beneficial use classifications.

Table 6. Descriptive statistics for the Little White River monitoring site used to develop site/reach specific criteria for TSS.

	TSS							
Station Name	**Sample size**	**Percent Exceedence**	**Q1**	**Median**	**Q3**	**10% Exceedence**	**5% Exceedence**	**Required Reduction (5% Exceedence)**
Little White River below White River	350	57%	82	185	365	754	1,733	91%

Long-term TSS data from the White River had percent exceedence ranging from 47 percent at Oglala to 79 percent near the mouth of the White River (Table 5). The Little White River showed a similar trend with 57 percent of the samples exceeding current water quality standards for TSS based on concentrations (Table 6). All monitoring sites that were used to develop site/reach specific standards and would require percent reductions in TSS concentrations that would be unattainable (91 to 99 percent) because of the geological conditions that make up portions the White and Little White watersheds (Figure 7 and Figure 10). This can be seen in the large increase in concentrations from the Oglala site to the Kadoka site and continuing down, with a slight drop in concentrations below the Little White River, to Oacoma near the mouth of the White River. The increase in TSS concentrations occurs from Oglala, where the White River group geology begins to influence water quality, to Kadoka where the White River flows through a large portion of the highly erosive White River geological Group (Figure 10).

Sediment composed of White River Group sediment consists of clay, silt and mudstone soils of small particle size that can create suspensions and sometimes colloidal dispersions that remain suspended for a long period of time, which allow increased transport distance downstream and may play a role in the somewhat steady to gradual reduction in TSS concentrations observed in the proposed middle reach of the White River. Below the confluence of the White River and the Little White River, TSS concentrations in the White River appear to be diluted by the Little White River (Table 6). As mentioned earlier, the hydrology of the Little White River is different from the White River because it originates from the High Plains Aquifer and at certain time of the year (drought and low flow conditions) can make up a significant portion of flow downstream of the its confluence with the White River. TSS concentrations in the downstream reach of the White River measured at Oacoma were, though high, were relatively lower on average than those measured at Kadoka (Table 5). This may be due to the dilution affects of the Little White River and the spatial position of the White River Group geology in the proposed lower reach (Figure 10).

White River Group Geology in the White River and Little White River Watersheds with Proposed Integrated Report Reaches and Reach ID's for the White River and Current Reaches for the Little White River, South Dakota

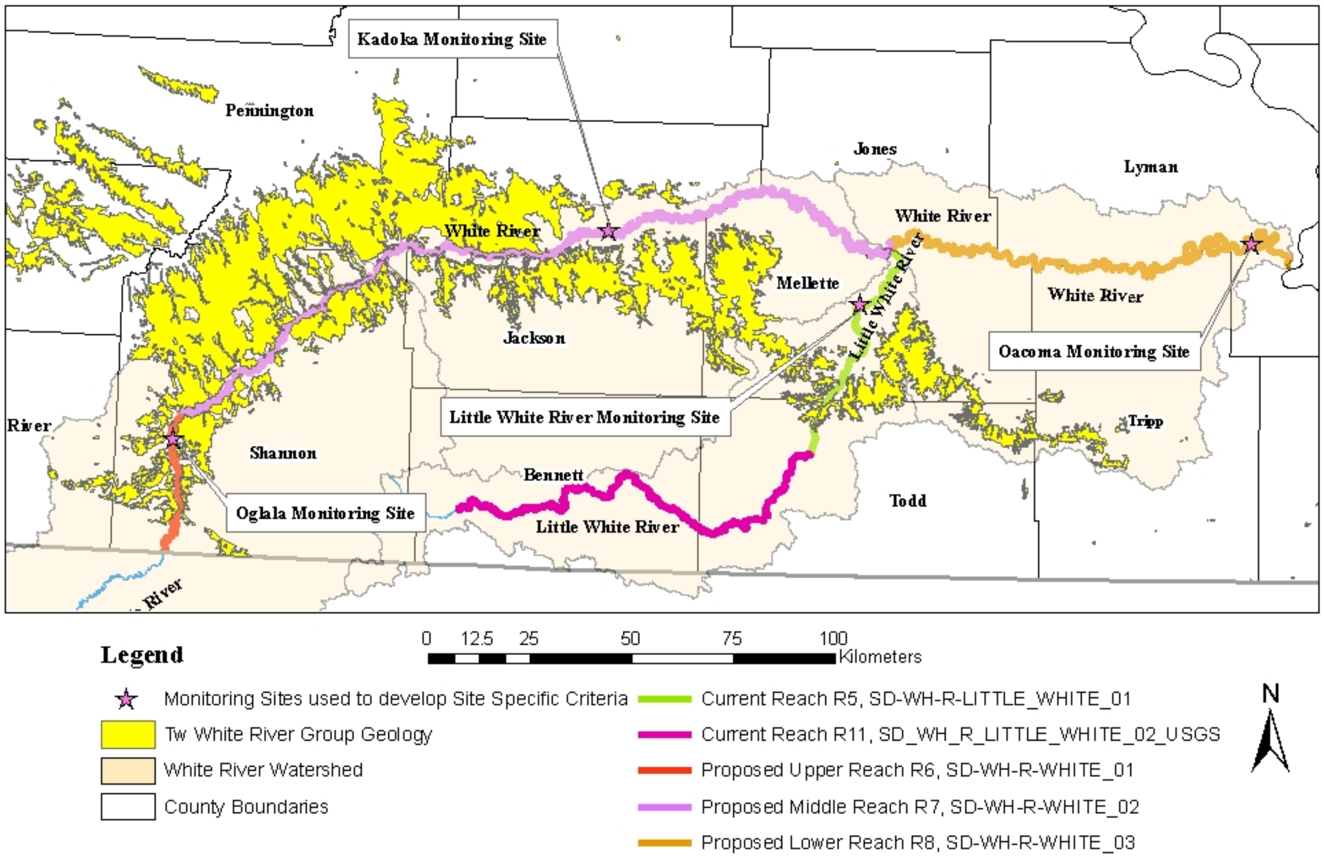

Figure 10. White River Group geology in relationship to reaches in the White and Little White River watersheds.

Increased TSS concentration from Oglala to Kadoka (Table 5) appears to be a function of the natural geology of those reaches of the White River watershed (Figure 10). Significantly lower TSS concentrations were observed in the Little White River. Lower concentrations were a function of different hydrology (groundwater fed) and a relatively small portion of the watershed that flows through White River Group formations. The slight reductions in TSS concentrations observed at Oacoma appears to be a function of a reduction in White River Group formations in the lower reach of the White River watershed and an apparent dilution affect the Little White River has on the lower reach of the White River. Long-term WQM data (1968 to 2008) indicate that high concentrations of TSS are common and normal (natural function in these watersheds) in the White and Little White River watersheds and are a result of naturally occurring and highly erosive White River Group geology. Data also indicate that adoption the site/reach specific TSS standards for the White and Little White Rivers would be representative, and at the same time, protective of the natural conditions unique to these watersheds. Site/reach-specific TSS criteria will allow the state to continue monitoring and detect any degradation in these watersheds.

TSS Load Duration Curves

Load duration curves were created following procedures presented by Cleland (2002). The data for the load duration curves came from stations on the White River near Oacoma, near Kadoka, near Oglala and on the Little White River below the town of White River. Load duration curves for Oglala, Kadoka and Oacoma were developed by RESPEC Consulting and Services (2007) while the Little White River load duration curve was developed by Smith (2006).

Load duration curves were created using complete data sets available from each site (all dates). The *y*-axis represents the estimated load for the day the sample was collected based on the mean daily flow times the sample TSS concentration collected for that day. The *x*-axis represents the percent of time (in days) the mean daily flow is greater than a specified flow. Daily loading estimates versus the flow duration interval on the sampling date are displayed as points. Allowable load based on flow duration curves and the current South Dakota water quality standard for TSS ($\leq$158 mg/L) is shown as the lower of the two lines on the figures (Figure 11 through Figure 14). The upper of the two lines represents the five percent exceedence concentrations for the entire flow interval. Five percent was chosen because of the extreme variability in TSS data in the White River watershed. The difference between these two lines represents the amount of reduction required to meet the current standard. The *x*-axis has been divided into five intervals: 0–10 percent flow exceedence representing flood conditions, 10–40 percent flow exceedence representing moist conditions, 40–60 percent flow exceedence representing midrange flows, 60–90 percent flow exceedence representing dry conditions, and 90–100 percent flow exceedence representing drought conditions. In each range, the median and the 10 percent exceedence levels of the estimated loads based on the water-quality samples are displayed. Load duration curves were developed to assess TSS exceedences with respect to flow for the White River watershed.

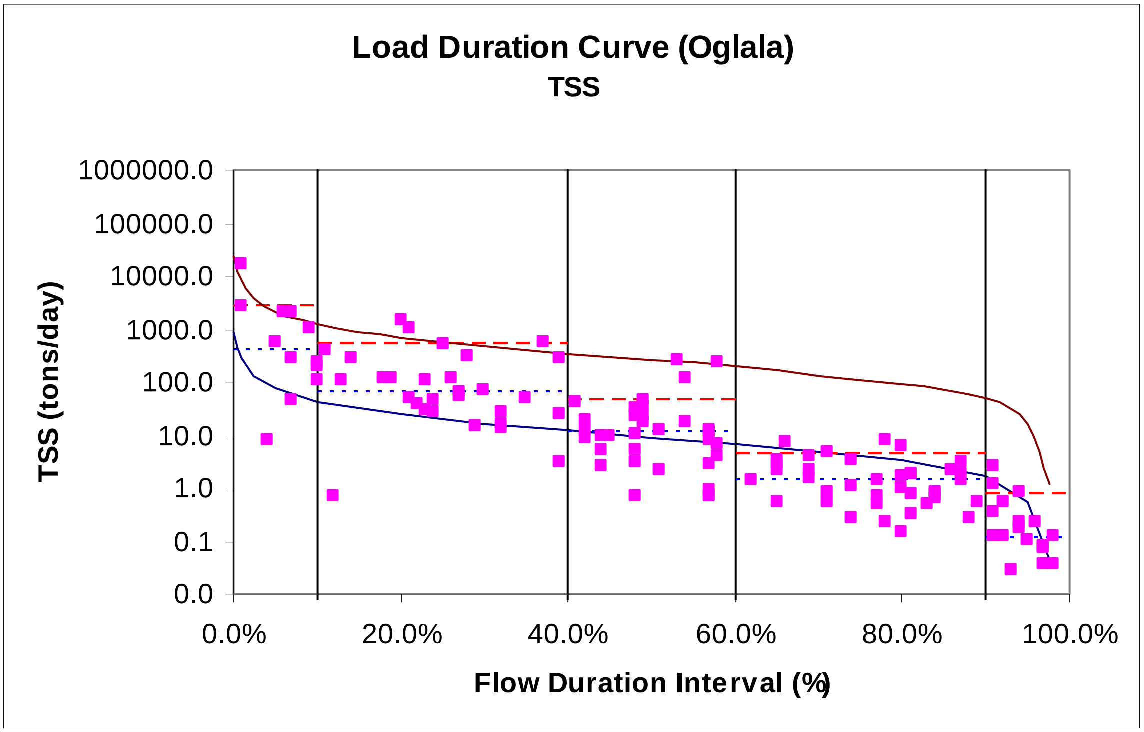

Figure 11. Load-duration curves for the Oglala monitoring site On the White River.

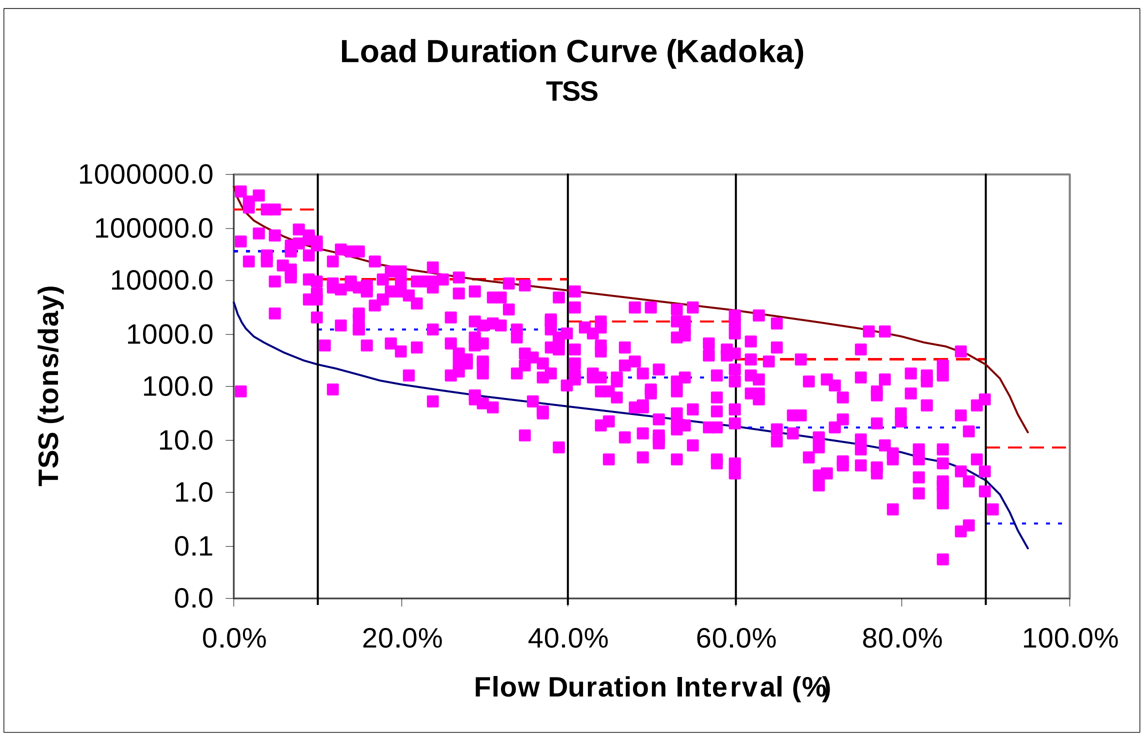

Figure 12. Load-duration curves for the Kadoka monitoring site on the White River.

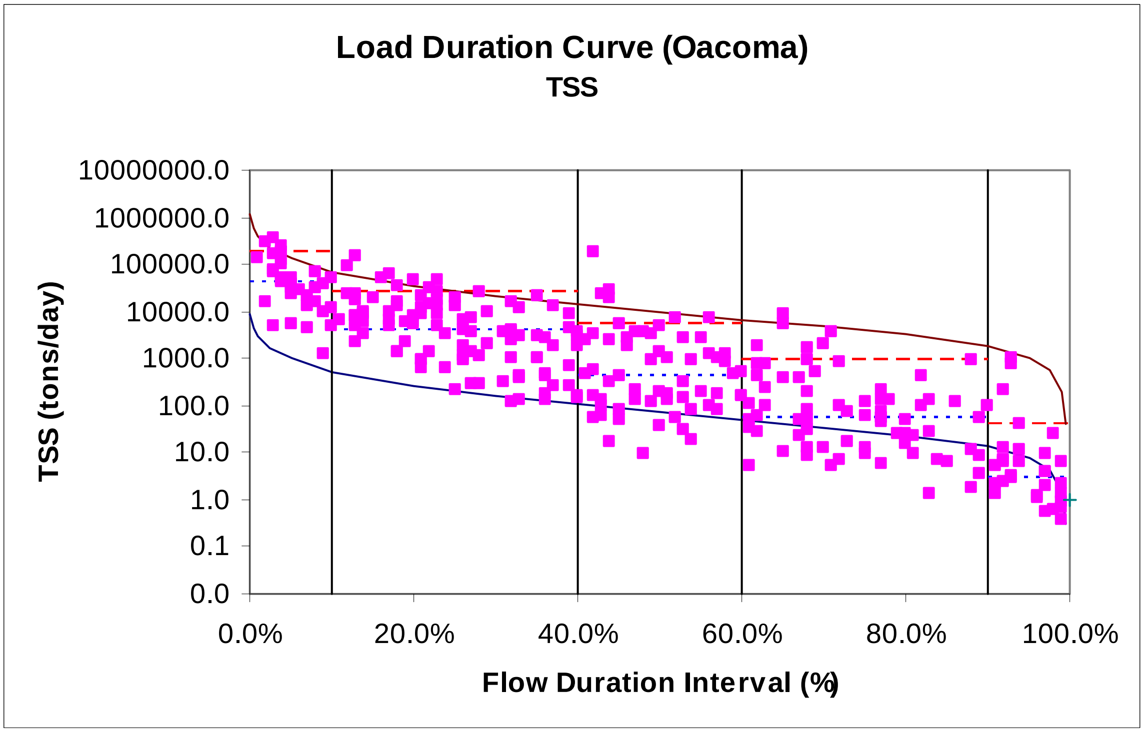

Figure 13. Load-duration curves for the Oacoma monitoring site on the White River.

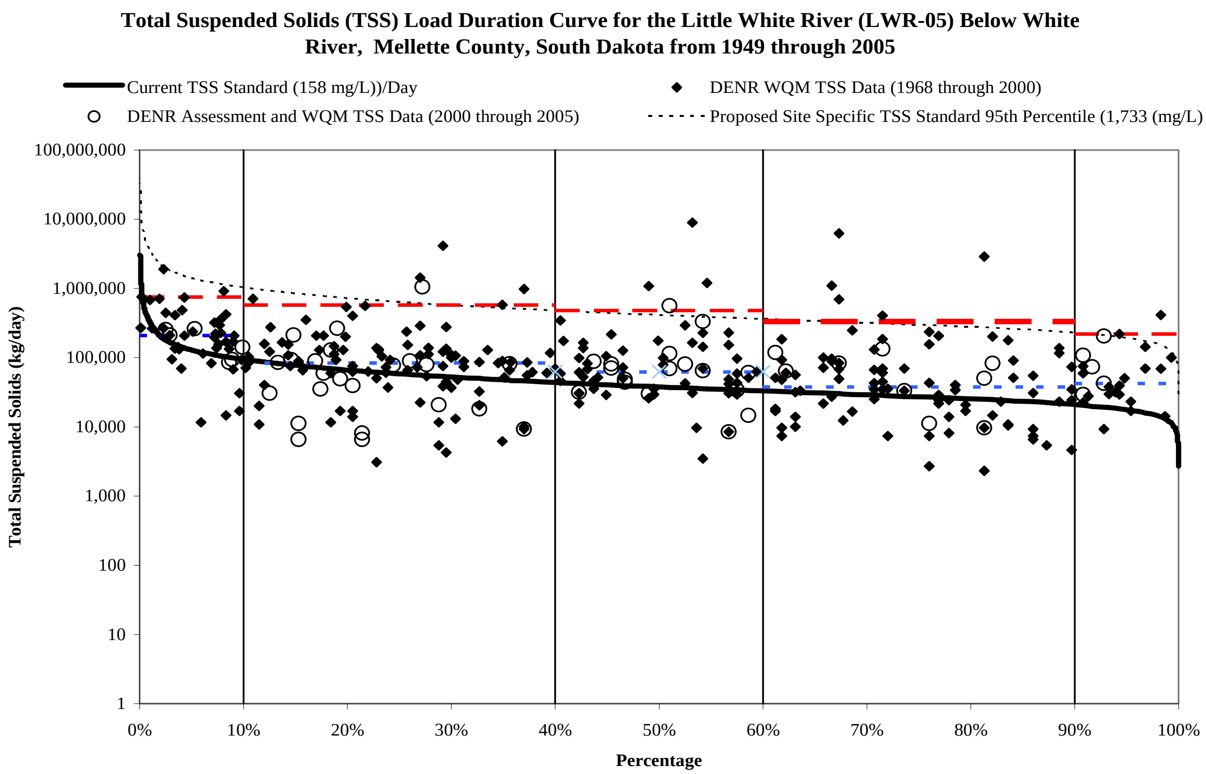

Figure 14. Load-duration curves for the Little White River below White River.

Oglala TSS exceedences with respect to flows became apparent generally during moderate to high flows (zero to 60 percent), suggesting that TSS exceedences were associated with sheet and rill erosion originating in watershed with deposits of highly erodible White River Group soils increasing sediment concentrations in the White River during mid-range to flooding flows (Figure 11). In the proposed reach R6 (SD_WH_R_WHITE_06 from the Nebraska border to Willow Creek), the White River flows approximately 18 river kilometers (km) before being influenced, either directly or indirectly, by White River Group deposits. The White River continues to flow through the White River Group for approximately 60 river km to USGS/SD DENR monitoring site northwest of Oglala, South Dakota (Figure 9 and Figure 10). Data from USGS site ID 06446000 and SD DENR WQM site 460842 were used to evaluate and develop a site/reach specific standard for TSS concentrations. The White River continues to flow through the White River Group geology approximately 13 river km to the end of the reach at Willow Creek (Figure 10). This reach had the lowest median and 95th percent exceedence TSS concentration of any of the proposed White River reaches in South Dakota (Table 5). TSS data indicate that median and 95th percent exceedence concentration before the influence of White River Group deposits based on TSS data from Chadron, Nebraska (98 mg/L and 1,748 mg/L, respectively) were significantly lower than the median and 95th percent exceedence concentrations at the monitoring site near Oglala, South Dakota which is influenced by runoff from White River Group deposits (139 mg/L and 4,525 mg/L, respectively).

Long term USGS and SD DENR (1974 to 2004) trend analysis at Oglala suggest that TSS concentrations and loading have been relatively stable over the period of record suggesting observations at this site represent natural conditions that exist in the this reach of the White River and warrant a site/reach specific standard to better represent the long term natural functions within this segment of the White River (Appendix B). The site/reach specific standard for TSS in this reach of the White River is based on a load duration curve developed for the Oglala monitoring site using the 95th percent exceedence concentration of 4,525 mg/L TSS (Table 5 and Figure 11).

The TSS load duration curve developed for the White River at Kadoka changes (increases) significantly compared to the curve developed for the site at Oglala (Figure 11 and Figure 12). TSS concentrations and loading at the Kadoka monitoring site exceeded the current water quality standard for TSS in all flow regimes, and similar to the Oglala monitoring site, a greater percentage of concentrations/loading exceeded current water quality standards in the higher flow zones (moist conditions, 40 percent to 10 percent to flood conditions, zero to 10 percent). Figure 12 was generated using long term USGS and SD DENR data sets which indicate TSS concentrations within each flow regime exceeded current water quality standards for TSS and were highly variable. Data from USGS site ID 06447000 and SD DENR WQM site 460835 were used to evaluate and develop a site/reach specific standard for TSS concentrations.

As mentioned in the watershed and monitoring site section of this report (page 4) the morphology of the river changes after the Oglala monitoring site (between Oglala and Rockyford) from a G-type channel near Oglala to a F-type channel at Rockyford and continues to be classified an F-type channel down to the mouth of the White River (RESPEC, 2007). The proposed middle reach R7 (SD_WH_R_WHITE_02 from Willow Creek) to the confluence with the Little White River, flows through the largest section of White River Group geology in South Dakota (approximately 428 river km). From Willow Creek, the White River flows approximately 250 river km to the Kadoka monitoring site, picking up significant sediment load originating from White River Group geology (Figure 10). The median and 95th percent exceedence concentrations in the proposed upper reach of the White River at the monitoring site near Oglala (139 mg/L and 4,525 mg/L, respectively) were significantly lower than TSS concentrations at the Kadoka monitoring site (1,118 mg/L and 24,300 mg/L). Another study within the proposed middle reach of the White River watershed examined sediment concentrations and loading from White River Group formations. The watershed in the study area included portions of Badlands National Park with various land uses practices. For comparison, the median and 95th percent exceedence concentration during that study was 9,200 mg/L and 48,295 mg/L, respectively. Data from the Conata Basin and White River Phase 1 Assessment suggests that high concentrations of TSS are common in these natural erosive watersheds with White River Group formations (Smith, 2007 and RESPEC, 2007). Data suggest high TSS concentrations and water quality standard exceedences are common in this reach of the White River and assessment data indicate an unrealistic 99 percent reduction in TSS loading is needed from the watershed to meet the current water quality standard for TSS.

Based on long-term USGS and SD DENR trend analysis at Kadoka, TSS concentrations and loadings have been relatively stable over the period of record (1968 to 2004) suggesting that high concentrations of TSS are natural in this reach of the White River and a site/reach specific standard should be adopted to better represent natural conditions in this watershed (Appendix B). The site/reach specific standard for TSS in this reach of the White River is based on the load duration curve for the Kadoka monitoring site using the 95th percent exceedence concentration of 24,300 mg/L TSS.

The Oacoma monitoring site near the mouth of the White River was used to develop a TSS load duration curve for the proposed lower reach of the White River R8 (SD_WH_R_WHITE_08 from the Little White River to the mouth of the Missouri River) (Figure 13). Data from USGS site ID 06452000 and SD DENR WQM site 460825 were used to evaluate and develop site/reach specific standard for TSS concentrations. White River Group deposits in this reach of the river are located near the southwestern boundary of the watershed at least 16 km away from the White River. Descriptive statistics indicate the median and 95th exceedence concentration (1,075 mg/L and 21,550 mg/L, respectively), though high, were relatively lower than the values from the middle reach (1,118 mg/L and 24,300 mg/L, respectively) (Table 5). Possible reasons for the slightly lower median TSS concentration observed in this reach are the relative distance the White River is separated from White River Group deposits and dilution from the spring fed Little White River that can contributes a significant portion of the flow in the lower portion of the White River (low flow and drought conditions). Load duration curve and TSS concentration data indicate TSS concentrations and loading exceed current water quality standards throughout all flow regimes and were similar to the load duration curve developed for the Kadoka monitoring site (Figure 12 and Figure 13). This indicates that significant concentrations and loading found in the proposed middle reach of the river continue past the confluence of the Little White River an additional 171 river km downstream to the Oacoma monitoring site and another 26 river km empting into Francis Case Reservoir on the Missouri River.

Similar to Oglala and Kadoka, long term trend analysis at the Oacoma site suggest that TSS concentrations and loading have been relatively stable over the period of record (1968 to 2008) indicating the high TSS concentrations in White River are normal in this reach of the White

River and a site/reach specific standard should be adopted to better represent the natural conditions in this watershed (Appendix B). The site/reach specific standard for TSS in this reach of the White River is based on load duration curve for the Kadoka monitoring site using the 95th percent exceedence concentration of 21,550 mg/L TSS (Table 5).

Load duration curves were developed for reach R5 (SD_WH_R_LITTLE_WHITE_01 on the Little White River) during the Little White River watershed assessment project in 2003 and 2004 and are shown in Figure 14 (Smith, 2006). USGS and SD DENR data (USGS site ID 06450500 and SD DENR WQM site 460840) collected on the Little White River were also studied during the Phase 1 White River Assessment (RESPEC, 2007). The watershed study was initiated because the Little White River was, and continues to be, listed as impaired for TSS concentrations (SD DENR, 1998a and SD DENR, 2008). TSS concentrations were lower in the Little White River than the mainstem of the White River. Median and 95th exceedence percentage for TSS in reach R5 (SD_WH_R_LITTLE_WHITE_01) of the Little White River was 185 mg/L and 1,733 mg/L, respectively. Waters from this reach originate from the High Plains Aquifer and flow through the least amount (spatially) of White River Group geology and still requires an unattainable 91 percent reduction based on the 95th percentile to meet the current water quality standard for TSS ($\leq$ 158 mg/L). The load duration curve based on USGS, assessment and WQM data indicate the lower reach of the Little White River exceeded surface water quality standard for TSS throughout all flow zones and require a site/reach specific standard that adequately reflects natural conditions in the watershed (Figure 14). Long term USGS and SD DENR (1968 to 2005) trend analysis suggest high TSS concentrations and water quality standard exceedences are common and relatively stable over the period of record (Appendix B). The site/reach specific standard for TSS in this reach of the Little White River is based on load duration curve developed for the Little White River below White River monitoring site using the 95th percent exceedence concentration of 1,733 mg/L TSS (Table 6 and Figure 14).

The upper reach of the Little White River from Section 6, Township 36N, Range, 39W to Rose bud Creek (R11, SD_WH_R_LITTLE_WHITE_02_USGS) currently meets beneficial use based water quality standards for a warmwater semipermanent fish life propagation water based on water quality data from multiple USGS sites (SD DENR, 2008). The watershed draining into this reach does not contain White River Group deposits known to influence (increase) TSS concentrations and water originates from groundwater. This reach was the only reach in the White River watershed not listed for TSS violations.

Water Quality Sampling Results

Descriptive statistics for samples collected at Oglala, Kadoka, Oacoma and Little White River below White River, SD are shown in Table 7. Data in Table 7 include monthly water quality samples collected from Kadoka, Oacoma and Little White River SD DENR WQM sites and quarterly samples collected from the Oglala monitoring site. Date ranges were from 1968 through 2002 at Kadoka, Oacoma and Little White River monitoring sites and 1974 through 2005 at the Oglala monitoring site. All monitoring sites continue to be sampled as part of South Dakota’s surface water quality monitoring network.

Table 7. Descriptive statistics for selected monitoring sites on the White and Little White River based on SD DENR WQM data.

	Oglala				Kadoka				Oacoma				Little White River			
Parameter	**Count**	**Average**	**Minimum**	**Maximum**	**Count**	**Average**	**Minimum**	**Maximum**	**Count**	**Average**	**Minimum**	**Maximum**	**Count**	**Average**	**Minimum**	**Maximum**
ALKALINITY (mg/L)	109	242	62	476	255	333	0	1,633	250	291	0	1,664	139	150	0	687
ALUMINUM (µg/L)									5	41,734	471	90,200				
AMMONIA (mg/L)	163	0.06	0.02	0.60	295	0.06	0.01	0.52	267	0.06	0.02	1.50	232	0.08	0.02	1.22
ANTIMONY (µg/L)									5	0.74	0.40	2.10				
ARSENIC (µg/L)									5	29.10	5.60	55.90				
BERYLLIUM (µg/L)									3	6.40	0.70	9.60				
CADMIUM (µg/L)									5	1.27	0.47	2.50				
CALCIUM (mg/L)	86	93.64	18.00	440.00	139	75.52	1.00	1,982.00	123	93.79	6.70	830.00	82	42.25	25.60	70.70
CHLORIDE (mg/L)	31	15.71	0.00	60.10	42	11.81	4.20	74.60	45	10.98	1.00	55.30	31	4.06	0.00	12.30
CHROMIUM (µg/L)									4	24.87	1.60	51.00				
SPECIFIC CONDUCTANCE (µS/cm)	135	906	300	1850	240	661	332	4170	209	630	288	2670	327	402	239	12400
COPPER (µg/L)									5	0.07	0.02	0.14				
DISSOLVED OXYGEN (mg/L)	164	9.52	5.60	14.00	282	10.94	3.50	19.20	257	10.98	4.20	18.00	9	9.28	7.50	12.73
***E. Coli* (colonies/100 ml)**					19	1,143	23	2,420	19	734	3	2,420	1	43	43	43
FECAL COLIFORM (colonies/100 ml)	119	449	1	20,000	183	3,985	3	200,000	161	1,163	3	29,000	275	1,346	8	210,000
FLUORIDE (mg/L)					10	0.50	0.25	1.10	6	0.47	0.30	0.86	4	0.48	0.36	0.64
HARDNESS, Ca + Mg (mg/L)	82	322	57	1,500	169	266	17	6,036	156	309	25	2,364	3	159	141	189
HARDNESS, CARBONATE (mg/L)	57	323	57	1,138	117	319	17	2,290	120	317	25	2,360	81	138	75	480
IRON DISSOLVED (µg/L)	6	0.04	0.02	0.10	31	2.34	0.00	15.20	33	0.28	0.02	2.10				
LEAD (µg/L)									5	63.56	2.60	117.00				
MAGNESIUM (mg/L)	86	20.59	2.80	100.00	138	22.58	0.49	264.00	122	18.98	0.00	180.00	82	6.16	2.70	11.00
MANGANESE (µg/L)	31	170.97	20.00	770.00	45	503.33	20.00	6,500.00	44	416.59	10.00	5,500.00	41	224.50	20.00	810.00
MERCURY (µg/L)									5	0.21	0.20	0.25				
NICKEL (µg/L)									5	25.24	3.10	90.00				
NITROGEN, NITRATE (mg/L)	114	0.42	0.01	3.60												
NITROGEN, NITRITE (mg/L)	58	0.01	0.01	0.07	54	0.02	0.01	0.19	26	0.01	0.00	0.03	57	0.01	0.01	0.03
NITROGEN, NITRITE + NITRATE (mg/L)	30	0.49	0.06	1.60	230	0.70	0.00	2.70	199	0.85	0.00	7.50	65	0.35	0.00	1.00
PH (s.u) *	150	8.10	7.30	8.87	301	8.49	5.90	9.98	266	8.30	5.96	9.17	469	8.30	6.40	9.04
PHOSPHATE (mg/L)	80	0.408	0.009	5.800	44	1.757	0.038	28.820	38	0.435	0.030	2.070	78	0.299	0.048	1.440
PHOSPHATE, SOLUBLE (mg/L)	12	0.102	0.027	0.197	60	2.079	0.026	21.300	39	0.855	0.028	21.020				
PHOSPHOROUS, ORTHOPHOSPHATE (mg/L)	128	0.163	0.004	3.400	219	0.389	0.005	11.900	192	0.143	0.002	6.170	214	0.200	0.008	3.755
PHOSPHORUS (mg/L)	103	0.464	0.010	14.400	265	2.064	0.000	28.820	259	1.744	0.004	30.900	209	0.351	0.003	4.010
POTASSIUM (mg/L)	33	13.33	6.80	21.50	44	7.14	3.10	27.90	44	6.79	1.90	19.10	31	9.70	7.10	15.60
SELENIUM (µg/L)									5	3.42	0.11	15.20				
SODIUM (mg/L)	71	103.56	42.00	227.00	139	141.76	12.00	1,110.00	120	113.58	18.60	282.00	81	24.44	15.60	63.60
SOLIDS, DISSOLVED (mg/L)	151	671	198	1,929	260	1,334	142	19,309	223	807	178	9,031	269	349	23	10,647
SOLIDS, TOTAL (mg/L)	99	1,465	201	10,100	249	6,103	499	68,765	251	5,782	258	56,589	116	903	232	27,501
SOLIDS, TOTAL SUSPENDED (mg/L)	165	683	3	9,370	331	5,404	2	73,060	302	5,459	10	300,110	283	548	6	23,200
STREPTOCOCCI, FECAL (colonies/100 ml)	29	771	5	9,200	39	840	20	2,800	39	1,136	5	9,400	38	500	15	3,500
SULFATE (SO4) AS SO4 (mg/L)	34	317.28	75.00	1,130.00	43	167.19	26.00	940.00	45	113.68	40.20	350.00	32	24.10	11.80	63.00
TEMPERATURE, WATER (°C)	168	10.84	0.00	30.00	345	10.57	-1.11	31.10	311	12.10	-1.67	36.70	361	12.01	-2.00	32.20
TOTAL KJELDAHL NITROGEN (mg/L)	22	1.37	0.46	6.00	68	0.63	0.14	3.58	68	0.78	0.14	7.19	22	0.80	0.45	1.13
UNIONIZED AMMONIA (mg/L)	134	0.00208	0.00005	0.01793	224	0.00448	0.00000	0.07205	188	0.00293	0.00001	0.08323	2	0.001090	0.000290	0.001890
ZINC (µg/L)									5	128.00	19.00	384.00				

*** = pH values are median not average**

Most average water quality samples from the White and Little White Rivers were below beneficial use based water quality standards applicable to the White River watershed (Table 7). The two parameters that do not meet water quality standards based on beneficial uses of warmwater semipermanent fish life propagation and limited contact recreation waters were TSS and fecal coliform bacteria. Average TSS concentrations exceed the current daily maximum water quality criterion at all four monitoring sites while average fecal coliform bacteria exceed the water quality standard at the Kadoka monitoring site. These parameters (TSS and fecal coliform bacteria) are already listed parameters of concern in the 2008 Integrated Report. All other parameters associated with beneficial uses of the White River meet water quality standards.

Biological Survey Analysis

Fisheries

The most recent fisheries data were collected as part of a comprehensive habitat sampling and population monitoring project through South Dakota State University as part of a graduate research project (Fryda, 2001). A total of 11 sites were sampled by South Dakota State University personnel in the White River watershed: 4 sites in the upper White River Basin, 4 sites in the middle White River Basin, and 3 sites in the lower White River Basin. Seining multiple habitat types within each reach was the main sampling technique; however, in an attempt to increase the efficiency of sampling channel catfish (*Ictalurus punctatus*), baited trap nets and hoop nets were also used. Twenty species of fish, representing five different families, were sampled in the White River. Cyprinidae (minnow family, 74 percent) and Ictaluridae (catfish family, 23 percent) represented the dominant families in the White River with Clupiedae (herring family), Catostomidae (suckers family), Centrarcidae (sunfish family), and Percidae (perch family) comprising the remaining 3 percent of the sample (Table 8).

The results of this study show that the White River is typical of western South Dakota streams dominated by species that are adapted to the adverse conditions found in this arid region (Fryda, 2001). The report suggests that it is likely the White River's species composition has changed very little from its historic condition, finding only one nonnative species, the common carp (*Cyprinus carpio*), along with several species of special concern representing a large percentage of the fish community. Several species of concern comprised a large percentage of the fish community. Sturgeon chub, flathead chub and plains minnow have declined extensively throughout their range (Hesse 1994; Werdon 1992; Loomis 1997), but were commonly found during this study (Fryda, 2001). Flathead chub and plains minnow were the first and third most abundant species and cumulatively composed 57% of the fishes sampled (Table 8). In South Dakota, the sturgeon chub (*Macrhybopsis gelida*) and the pearl dace (*Margariscus margarita*) are state threatened species based on the Natural Heritage database, while the plains topminnow (*Fundulus sciadicus*) has a federal status of G4 (Table 9). The later two species were collected in tributaries to the White and the Little White River watersheds (Figure 15). During Fryda's study in 1998 and 1999, sturgeon chub, a state threatened species, were sampled at 10 sites and composed 4% of the fish community (Table 8). Two sturgeon chubs were collected from the Little White River during the watershed assessment during macroinvertebrate sample collection in 2004 (Smith, 2006). These chubs were collected in a D-frame kicknet while sampling for benthic macroinvertebrates on the mainstem of the Little White River just upstream of the

Highway 83 Bridge north of White River, South Dakota (USGS site ID 06450500). The fish were collected, identified and released unharmed back to the river. Based on SD DENR, South Dakota Department of Game, Fish and Parks (SD GF&P) and GIS data, the sturgeon chub appears to be endemic and prefers the White River and the lower portions of the Little White River watersheds with naturally high TSS concentrations and turbidity. This relationship is apparent and may be seen in Figure 16 based on SD GF&P data.

Contrary to the expected pattern, as reported by Vannote et al. (1980), species richness declined in the downstream reaches of the watershed. This corresponds to the general trend found in this TMDL project's index of biotic integrity based on both the periphyton and benthic macroinvertebrate communities. The trends in species richness and diversity may be linked to similar trends in habitat diversity. Similar to the findings of Wiley et al. (1990), habitat diversity in the White River generally decreases in a downstream direction. For example, SD DENR study upper reaches had a variety of macrohabitats (i.e. pools, riffles and runs), substrate types (i.e. sand, gravel and cobble), depths, and woody debris. By contrast, habitat at SD DENR study middle and lower reaches were mostly riffles and runs that had fine substrates, shallow water, and a lack of instream cover (i.e. woody debris, large substrates).

Channel catfish represented the only abundant sport fish found in the river; however, the abundance of relatively small, immature fish led researchers to conclude that the White River is mostly a nursery and staging area for spawning activities with adults migrating into the river in the spring high flow months from Francis Case Reservoir on the Missouri River and returning in the fall.

Future management of the White River as a sport fishery is limited due to the limited abundance of sport fish. The report (Fryda, 2001) suggests that the White River will most likely play an important role in conservation of rare species and maintenance of freshwater biodiversity. Fryda citing *Rivers of Life*, a publication by the Nature Conservancy, identified the White River as a watershed critical to protecting freshwater biodiversity and at-risk fish species.

SD GF&P have not conducted extensive fishery surveys in the Little White River; however, SD GF&P have funded other studies that surveyed Little White River. Fisheries survey data indicate the Little White River and the more turbid White River have a diverse fish community with 31 species identified in the Little White River basin including tributaries while 30 species have been identified in the White River since 1962 (Baily and Allum, 1962, Bliss and Schainost, 1973, Cunningham et al., 1995, USF&WS, 1997, Fryda, 2001 and Harland, 2003). These studies indicate that based on fisheries data, the Little White River and White River basins, although turbid and carrying high sediment loads, have viable fish populations that are not adversely impacted by high TSS concentrations.

Table 8. Fish sampling summary collected from eleven stations on the White River from 1998 and 1999, from Fryda, 2001.

Table 2-3. Summary of fishes sampled during 1998 and 1999 on the White River in South Dakota. Relative species composition is expressed as percentage of total individuals sam led.

Family and species	Mean length (mm) ± SE	Mean weight (g) ± SE	Relative Species composition (%)	Total number of fishes sampled	Reaches where sampled
Cypnrudae					
common carp	392 ± 10	827 ± 49	3	119	2-4,6
emerald shiner	NA	NA	<1	1	11
fathead minnow	41 ± 1	1 ± <1	6	260	4,9,10
flathead chub	71 ± 1	6 ± <1	44	1754	1-11
longnose dace	53 ± 4	1 ± <1	<1	6	1,3,7
plains minnow	69 ± 1	3 ± <1	13	520	3,4,6-11
Red shiner	48 ± 2	NA	<1	7	1,2,11
sand shiner	44 ± <1	1 ± <1	2	77	1,4,10
W. silvery minnow	70 ± 3	8 ± 3	2	63	5,9-11
sturgeon chub	61 ± 1	2 ± <1	4	171	2-11
Ictaluridae					
black bullhead	100 ± 8	20 ± 7	<1	17	2-4,6
channel catfish	166 ± 4	88 ± 9	22	888	1-11
stonecat	137 ± 9	27 ± 5	1	33	1-3,9
Catostomidae					
river carpsucker	248 ± 18	212 ± 37	<1	11	1-3,5,6,10
shorthead redhorse	256 ±	149 ± 14	<1	13	1,2
white sucker	NA	NA	<1	1	1
Centrarchidae					
green sunfish	48 ± 4	2 ± 1	<1	7	4,6,11
largemouth bass	NA	NA	<1	1	1
Clupeidae					
goldeye	359±3	347 ± 11	1	60	1-4,6,8,9
Percidae					
sauger	357±14	359 ± 43	<1	12	1,2,5,6,8,10

NA lengths and weights not collected

Table 9. Fish species collected in the Little White River and its tributaries based on Fryda, 2001 and Heritage listings from SD GF&P.

Common Name	Scientific Name	Mainstem Little White River	Little White River Tributaries	Federal Status	South Dakota Listing Status	State Rank
bigmouth shiner	*Notropis dorsalis*		X			
black crappie	*Pomoxis nigromaculatus*	X	X			
blacknose dace	*Rhinichths atratulus*		X			
blacknose shiner	*Notropis heterolepis*		X			
bluegill	*Lepomis macrochirus*	X				
brassy minnow	*Hybognathus hankinsoni*		X			
brook stickleback	*Culea inconstans*		X			
channel catfish	*Ictalurus punctatus*	X	X			
creek chub	*Semotilus atromaculatus*	X	X			
fathead minnow	*Pimephales promelas*		X			
finescale dace	*Phoxinus neogaeus*		X			
flathead chub	*Platygobio gracilis*	X				
golden shiner	*Notemigomus crysoleucas*		X			
green sunfish	*Lepomis cyanellus*	X	X			
Iowa darter	*Ethostoma exile*		X			
largemouth bass	*Micropterus salmoides*	X				
longnose dace	*Rhinichthys cataractae*	X	X			
northern pike	*Esox lucius*	X				
northern redbelly dace	*Phoxinus eos*		X			
pearl dace	*Margariscus margarita*		X	G5	ST	S2
plains minnow	*Hybognathus placitus*		X			
plains topminnow	*Fundulus sciadicus*		X	G4		S3
red shiner	*Cyprinella lutrensis*	X				
sand shiner	*Notropis ludibundus*	X	X			
shorthead redhorse	*Moxostoma macrolepidotum*	X				
stonecat	*Noturus flavus*	X				
sturgeon chub	*Macrhybopsis gelida*	X		G3	ST	S2
western silvery minnow	*Hybognathus argyritis*	X				
white crappie	*Pomoxis annularis*	X				
white sucker	*Catostomus commersoni*	X	X			
yellow perch	*Perca flavescens*	X	X			
Total species		**18**	**21**	**3**	**2**	**3**

ST = State Threatened
G3 = Either very rare and local throughout its range, or found locally even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 to 100 occurrences.
G4 = Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long term concern.
G5 = Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.
S2 = Imperiled because of rarity (6 to 20 occurrences nor few remaining individuls) or because of some factor(s) making it very vulnerable
S3 = Either very rare and local throughout its range, or found locally even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 to 100 occurrences

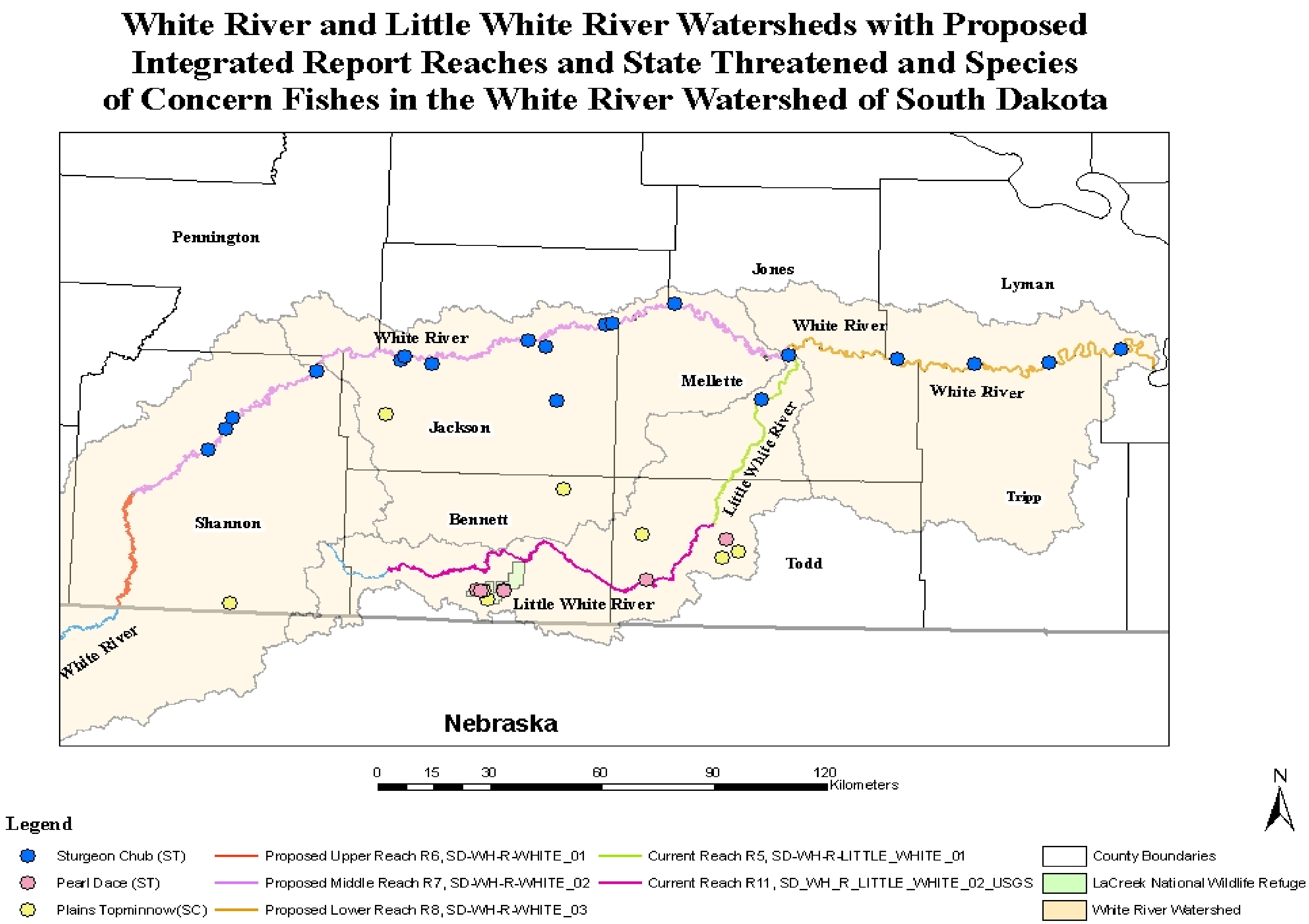

Figure 15. State threatened and species of concern fish locations in the White and Little White River watersheds, South Dakota.

White River and Little White River Watersheds with Proposed Integrated Report Reaches and State Threatened and Species of Concern Fish Locations with respect to White River Group Geology in the White River Watershed of South Dakota

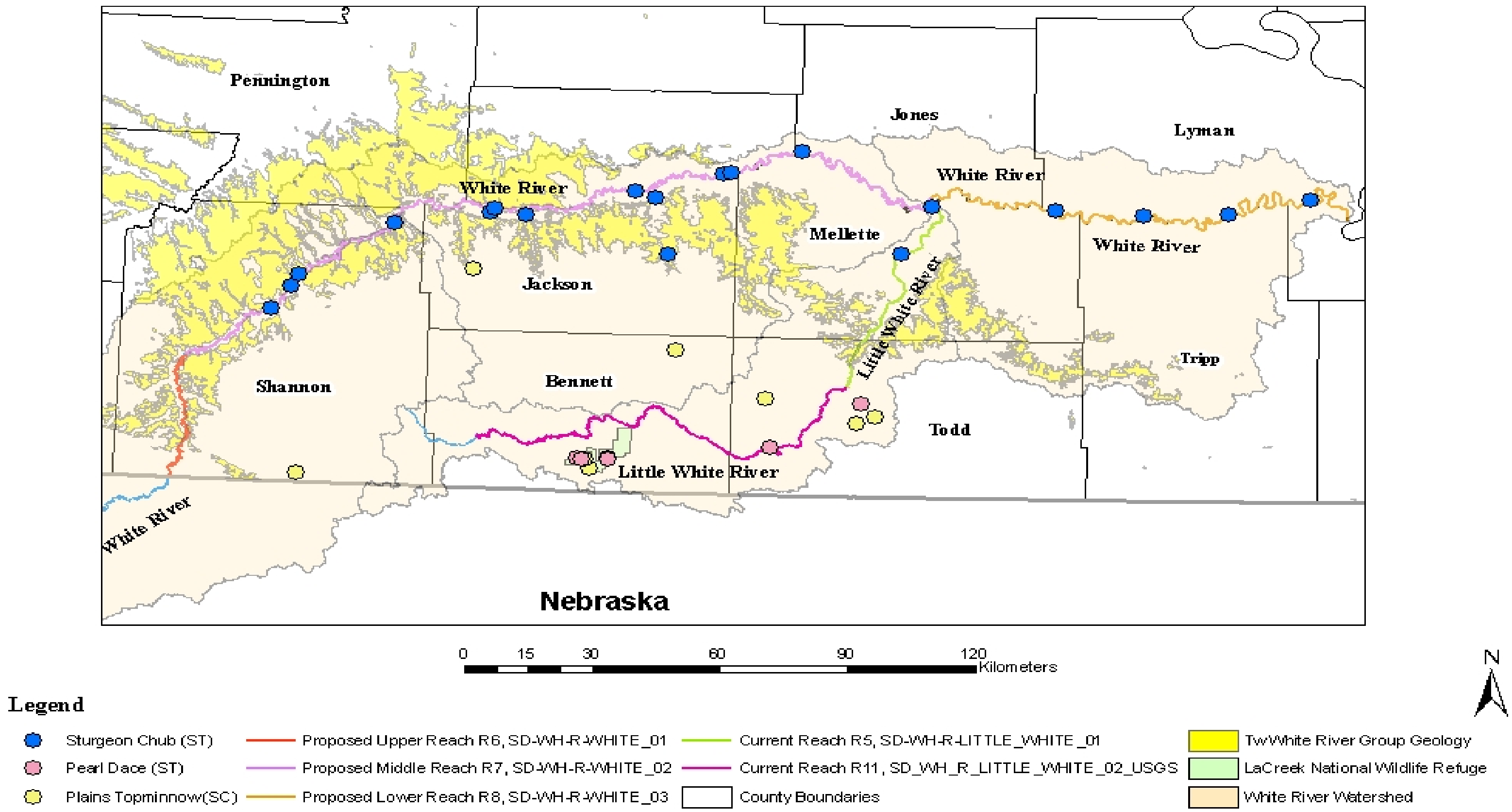

Figure 16. State threatened and species of concern fish locations in the White and Little White River watersheds with respect to White River Group geology in South Dakota as of 2008.

Macroinvertebrate

Benthic macroinvertebrates were collected along the mainstem of the White River at the South Dakota/Nebraska border, Oglala, Kadoka, Westover and Oacoma monitoring sites; while four mainstem monitoring sites on the Little White River (LWR-07, LWR-12, LWR-05 and LWR-06) were sampled in June, July and August, 2004 (Figure 2 and Figure 4). D-framed kick nets were used to collect macroinvertebrate samples during these studies. Sampling took place in timeed intervals at each of the 11 transects. All the samples collected from each transect were combined into a single reach-wide composite sample. The first 300 organisms were identified to lowest practical taxonomic level. The total number of organisms was then estimated based on the volume sampled compared to the total volume of the sample. If 300 organisms were not found, the total sample was identified.

White River

The lower two sites represent reaches of the river influenced by White River Group deposits and high TSS concentrations correspond with very low core metric values for total abundance values of 11 at Oacoma and 3 at Kadoka. The lower sites also exhibited low Hilsenhoff Biotic Index (HBI) values and low Ephemeroptera, Plecoptera and Trichoptera EPT abundance. The Kadoka and Oacoma reaches also exhibited relatively high percentage of Diptera species.

The Oglala monitoring site represents the upper reach in of the White River in South Dakota. This site has significantly lower TSS concentrations (95^{th} percentile 4,525 mg/L) than the downstream reaches (Kadoka 24,300 mg/L and Oacoma 21,550 mg/L). Core metrics show relatively high total abundance (425 individuals) and species richness (23 species) values. EPT abundance (207 individuals), with the EPT taxonomic group (*Caenis latipennis*-mayfly), representing a high percentage of the total abundance. The HBI, a biotic tolerance/intolerance metric that is orientated toward detecting organic pollution (Barbour et al., 1999) is higher (7.12), indicating a higher level of disturbance when compared to the Kadoka and Oacoma monitored sites.

White River macroinvertebrate data suggest that the Oglala monitoring site had significantly lower TSS concentrations, a Rosgen G-type channel, and habitat more conducive to a diverse benthic community. Whereas, the lower reaches are characterized by high TSS concentrations, Rosgen F-type channels and shifting sand bottoms, creating extremely poor macroinvertebrate habitat and, in turn, community structure. Differences in macroinvertebrate data between Oglala and Kadoka also support the proposed reach change for reach R6 (SD_WH_R_WHITE_01 from the Nebraska boarder to Interior) and should be changed to the Nebraska border to the confluence of Willow Creek.

Little White River

Taxa richness during the study ranged from 22 to 29 taxa on the mainstem of the Little White River. Taxa richness at each site was relatively high, which indicates a diverse and stable biological community. Hilsenhoff Biotic Index (HBI) values ranged from 4.11 at LWR-07 at the

Todd/Mellette County line to 6.14 at LWR-05 at the Highway 83 Bridge below the town of White River, South Dakota (see Figure 4 for site locations). HBI values calculated for Mellette County were similar to values reported in the Todd County study conducted by United States Geological Survey (Williamson, 2005). EPT taxa (comprised of Ephemeroptera, Plecoptera and Trichoptera) tend to be more abundant in erosional habitat. Plecopterans are relatively rare within streams in Ecoregion 43; however, during this study one Plecopteran Genus *Perlesta*, was identified at LWR-07 and LWR-05, which were categorized as erosional during the June sampling period. EPT richness ranged from 9 to 16 taxa and was interpreted as relatively high in the plains of western South Dakota. EPT/Chironomidae ratio values were relatively high in erosional and depositional habitat in June and July and were reduced, although not significantly, in depositional sites (LWR-12 and LWR-06) by August 2004. Scrapers to collector-filterer ratios were used to evaluate organic pollution based on functional feeding groups. This metric indicated relatively low ratios throughout the summer of 2004 with little change between sites and sampling months, suggesting a relatively stable physical and biological community (Smith, 2006).

Cluster analysis was used to determine relationships between sites in the Little White River based solely on biology (community structure). Clustering was performed based on 24 species (variables) to determine monitoring site relationships based on biology. Data indicated that macroinvertebrate communities in monitoring sites LWR-07 and LWR-05 were related biologically and were also erosional sites with hardpan bedrock and cobble substrate; while communities in monitoring sites LWR-06 and LWR-12 showed a biological relationship and both were depositional habitats with shifting sand substrate. This suggests that based on biology and driven by habitat, a variety of macroinvertebrate communities exist in the Little White River even with fluctuations in TSS concentrations.

Data indicate that the benthic macroinvertebrate community in the Little White River, Mellette County is robust with 108 identified taxa and appears to be relatively stable based on . Organic enrichment does not appear to be substantially impacting the benthic community based on ten intolerant taxa populating all five monitoring sites in the basin. As mentioned above, calculated metrics and statistical analysis also show a relatively stable benthic community populates the Little White River in Mellette County. The stable benthic community exists in the Little White River despite the fact that the River segment is listed in the 2008 Integrated Report as impaired by violations in the TSS standard (SD DENR, 2008). As previously mentioned in this document, violations in TSS have occurred both spatially and temporally during all flow regimes throughout the period of record indicating a natural condition (Figure 14). Macroinvertebrate data collected during the assessment supports the SD DENR recommendation that the current water quality based TSS standard for the Little White River ($\leq$158 mg/L) be changed to a site specific TSS standard of 1,733 mg/L (the 95th percent exceedence value) to reflect natural conditions based on all available data in the listed segment of the Little White River. Site-specific standards should not significantly impact the biological community, because this community originally developed under these unique conditions and have adapted to high TSS concentrations.

Summary and Recommendations

Long term and assessment data indicate TSS concentrations in the White and Little White Rivers violate current surface water quality standards based on warmwater semipermanent fish life propagation water criteria. However, based on long-term trend analysis using USGS and SD DENR water quality data TSS standard violations appear to be relatively constant, showing only a slight decline over time. Ancillary biological data (macroinvertebrate and fisheries) appear to be relatively robust, suggesting stability based on species diversity over time. This indicates TSS concentrations exceeding the current water quality standard for the White and Little White River watersheds frequently occur and should be considered a naturally occurring condition in these watersheds. The current TSS water-quality standard is unattainable and unreasonable in this system. Much of the load is coming from White River Group geology in and around the Badlands National Parks where the geology of the area causes steep-sided bluffs with little to no vegetation. This causes low infiltration rates with high runoff and erosion rates.

Table 10. Ninety-Five Percent Exceedence Concentrations (mg/l) for the White River, South Dakota.

Reach	95 % Exceedence Concentrations (mg/L)
Nebraska State-Line to Willow Creek	4,525
Willow Creek to Little White River	24,300
Little White River to Mouth	21,550

Table 11. Ninety-Five Percent Exceedence Concentrations (mg/l) for the Little White River, South Dakota.

Reach	95 % Exceedence Concentrations (mg/L)
Rosebud Creek to mouth	1,733

Based on physical habitat classification and analyses of historical discharge and water-quality data, three unique reaches were identified on the White River. The breaks for these reaches were determined by geology of the watershed and hydrology of the system. The reaches are as follows: (1) from the Nebraska border to the confluence of Willow Creek 5 miles north of the gage station identified as the White River near Oglala; (2) Willow Creek to the confluence of the Little White River; and (3) the confluence of the Little White River to the mouth of the river near Oacoma, South Dakota. Current reaches in the Little White River watershed are adequate and do not need adjustment, as they represent geological and hydrological conditions in this watershed. The current criterion of 158 mg/l for TSS is unattainable in the White and Little White River watersheds in South Dakota. Site-specific standards for TSS, based on the 95^{th} percent exceedence level, should be implemented for each defined reach of the White River. The 95 percent exceedence levels for each of the three proposed reaches of the White River are given in Table 10 and one reach of the Little White River in Table 11.

The White River derived its name from the milky color of its waters due to the sediments carried down from the Badlands. The Sioux name for the river means Smoky Earth River, which was given because of a phenomenon of pre-settlement days, when twisting columns of smoke arose from the surrounding hills and gradually blanketed the entire valley. In very early accounts of this region, the river was referred to as the White Earth River because of the whitish color. Thus, as far back as recorded history, the White River has always appeared white with high sediment loads from White River Group deposits (WWP, 1941). The Journals of Lewis and Clark on September 14, 1804 mentions stopping at the mouth of the White River and sent two men a days journey up the White River (University of Nebraska Press / University of Nebraska-Lincoln Libraries-Electronic Text Center, 2005). This historical evidence including references to the White River as a muddy river with sand bars and current similar to the Missouri River over 200-years ago also supports the proposed standards change.

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Appendix A

Photographs for Oglala, Kadoka and Oacoma Monitoring Sites on the White River and the Little White River Site below White River

White River upstream of USGS Monitoring site near Oglala

White River upstream of USGS Monitoring site near Oglala

White River upstream of USGS Monitoring site near Oglala

White River upstream of USGS Monitoring site near Oglala

White River upstream Highway 73 Bridge near Kadoka

White River upstream Highway 73 Bridge near Kadoka

White River upstream Highway 73 Bridge near Kadoka

White River upstream Highway 73 Bridge near Kadoka

White River up stream of Highway 47 Bridge near Oacoma

White River upstream of Highway 47 Bridge near Oacoma

Consistency of sediment near Oacoma site

White River just upstream of Highway 47 Bridge

Little White River near Mellette/Todd County line

Little White River near Horse Creek

Little White River between County line and Horse Creek

Little White River near the Town of White River

Appendix B

Trend Analysis Graphs for Oglala, Kadoka and Oacoma Monitoring sites on the White and Little White Rivers in South Dakota

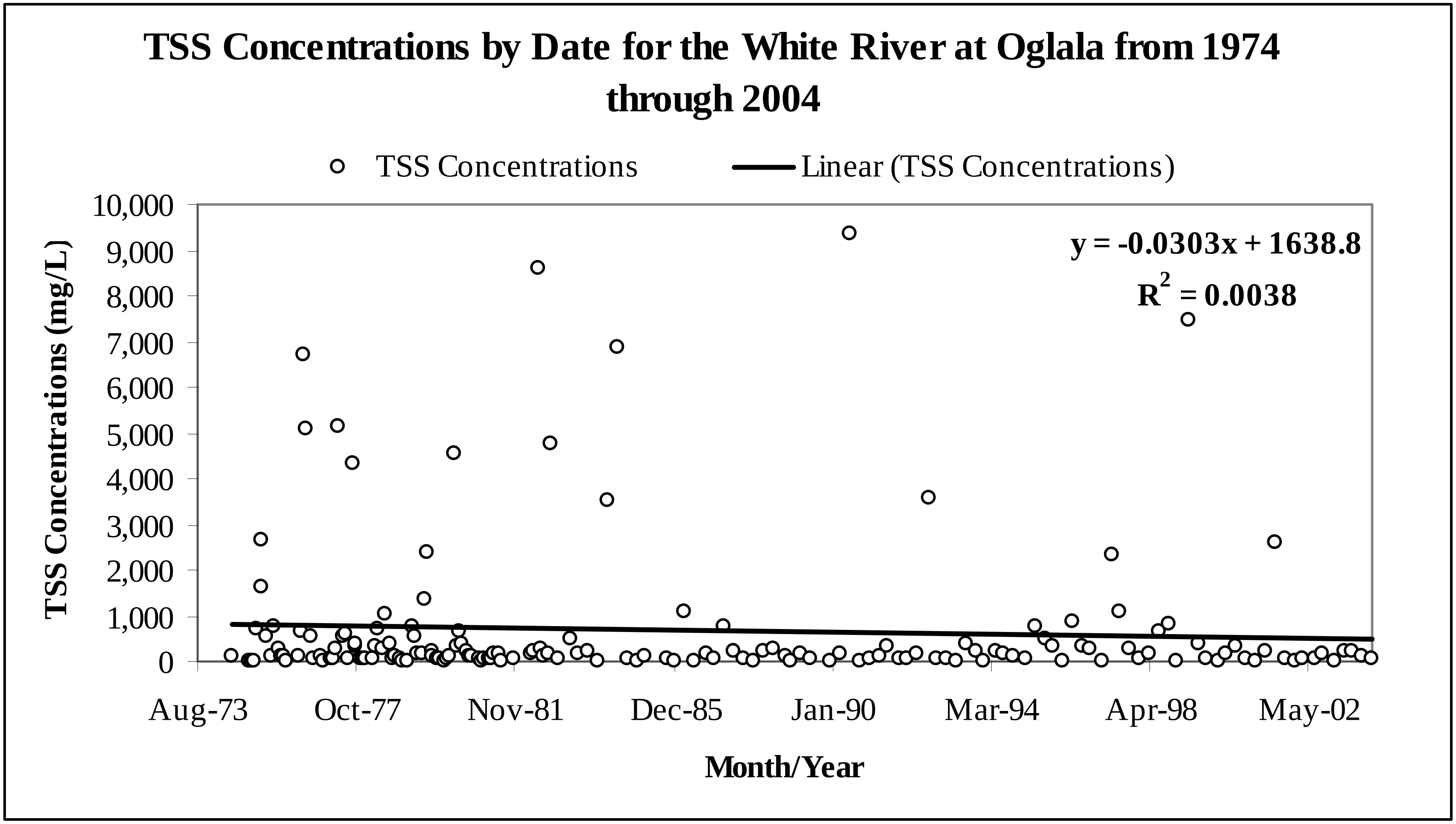

Figure B-1. TSS concentrations by date for the White River at Oglala from 1974 through 2004.

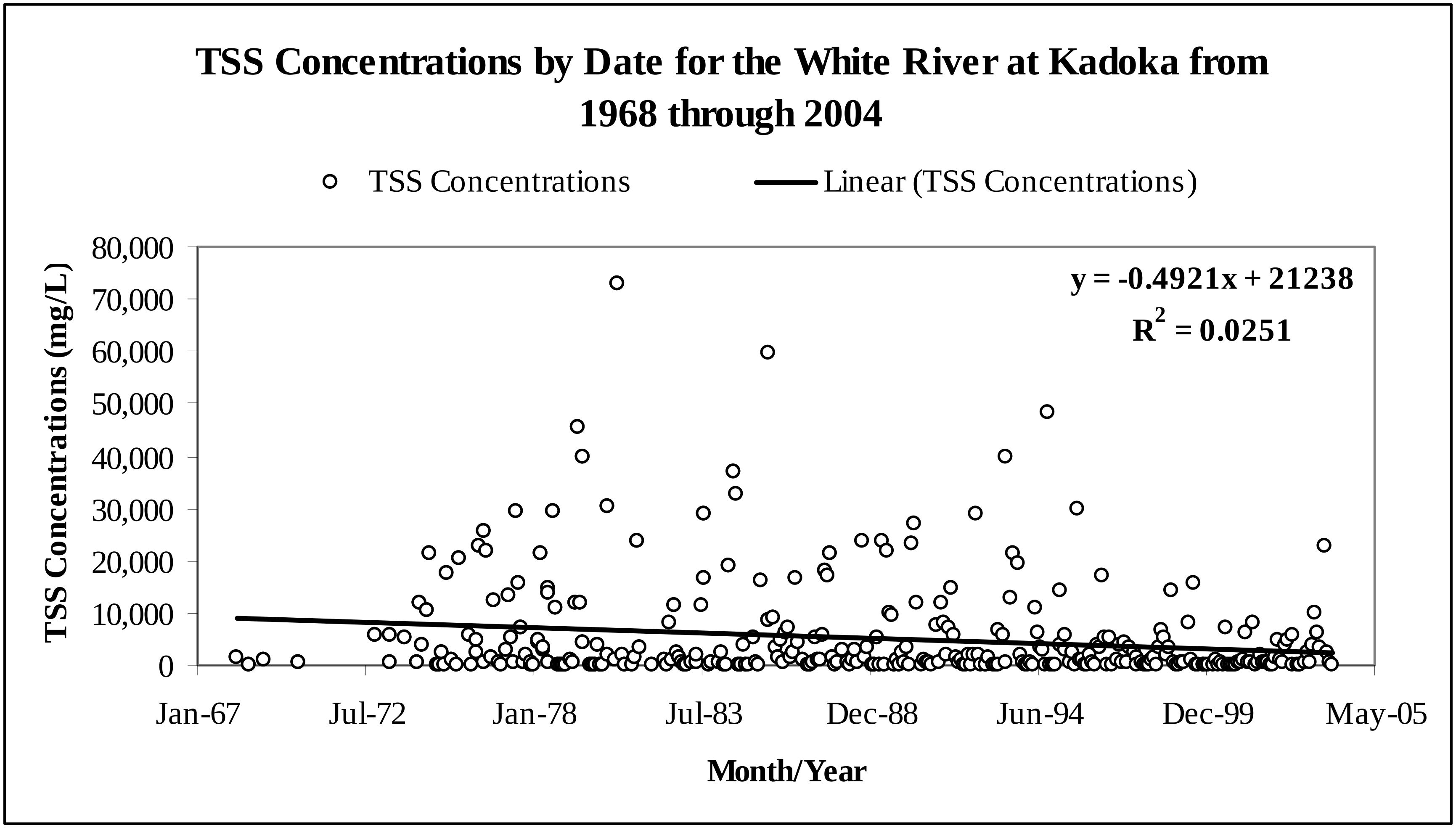

Figure B-2. TSS concentrations by date for the White River at Kadoka from 1968 through 2004.

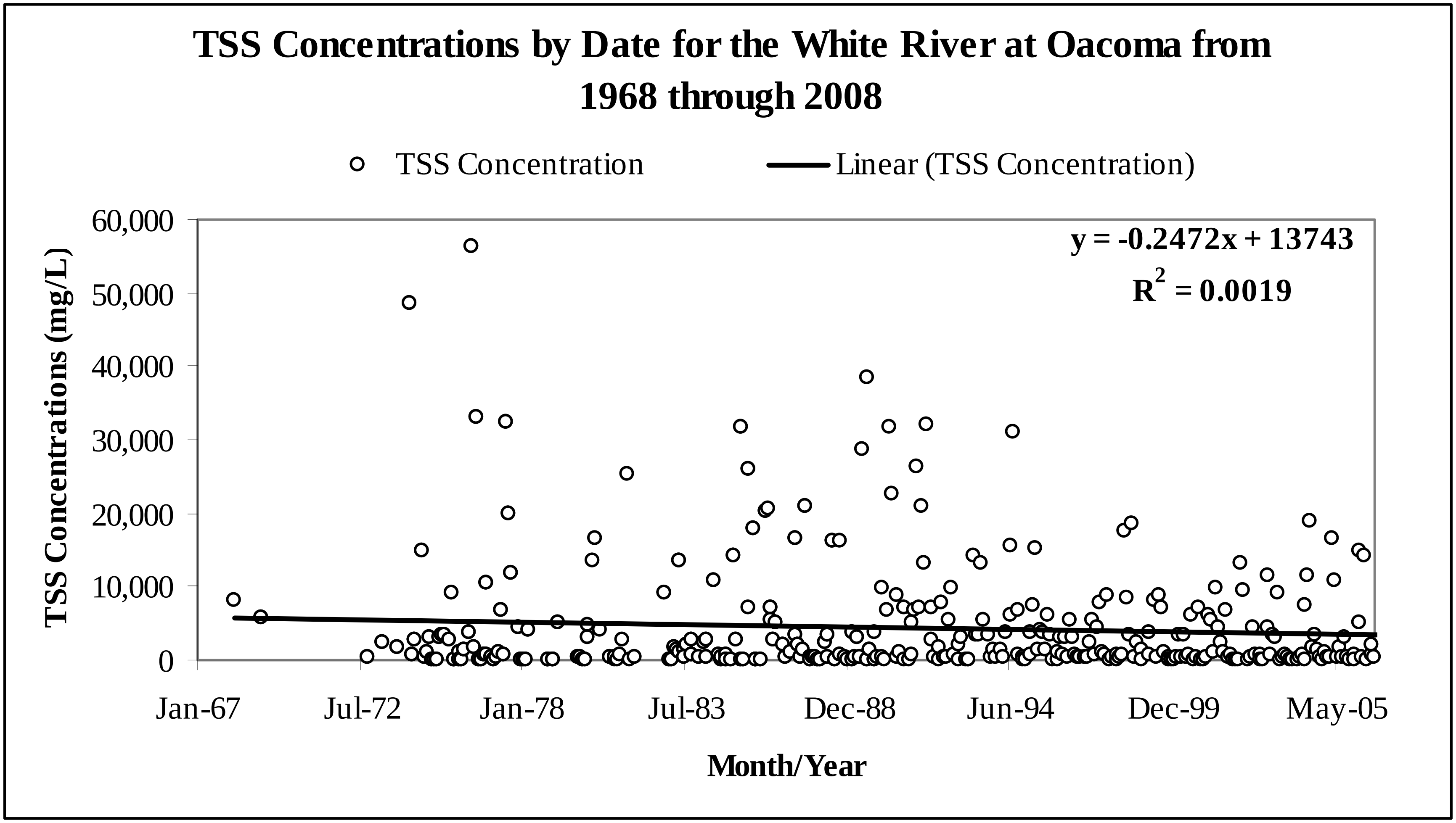

Figure B-3. TSS concentrations by date for the White River at Oacoma from 1968 through 2008.

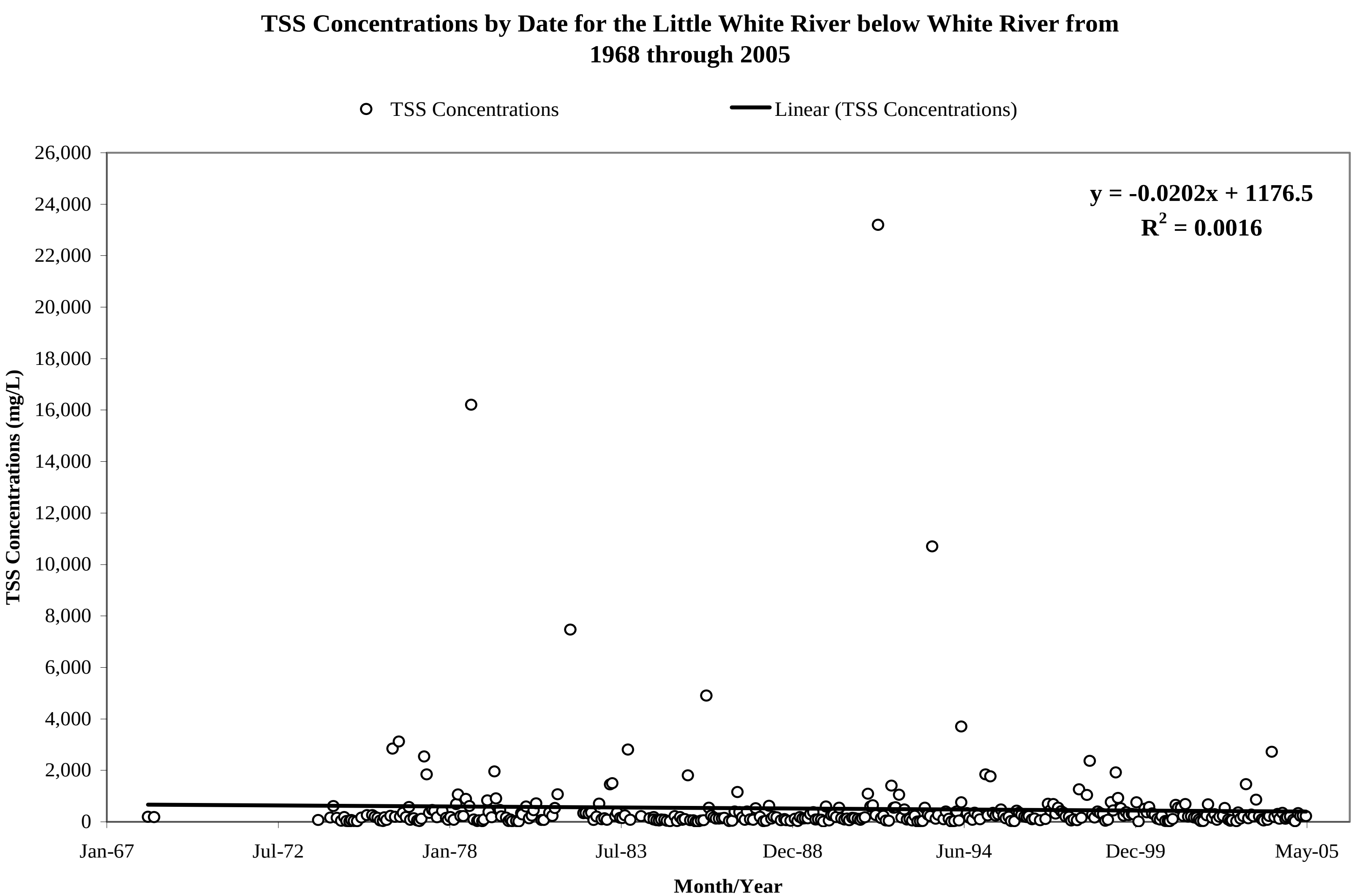

Figure B-4. TSS concentrations by date for the Little White River below White River from 1968 through 2005.