TOTAL DISSOLVED SOLIDS AND SPECIFIC CONDUCTANCE TOTAL MAXIMUM DAILY LOAD EVALUATION OF FREEMAN LAKE, JACKSON COUNTY, SOUTH DAKOTA

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

South Dakota Watershed Protection Program
Division of Financial and Technical Assistance
South Dakota Department of Environment and Natural Resources
Steven M. Pirner, Secretary

November, 2011

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Total Dissolved Solids Total Maximum Daily Load Summary

Entity ID:	SD-BA-L-FREEMAN_01
Location:	HUC Code: 1014010209
Size of Watershed:	3,409 acres
Water body Type:	Lake
303(d) Listing Parameter:	Total Dissolved Solids
Initial Listing date:	2006 IR
TMDL Priority Ranking:	2
Designated Use of Concern:	Fish, Wildlife, Propagation, Recreation & Stock Watering
Analytical Approach:	Reduction Response Model
Target:	Meet applicable water quality standards 74:51:01:55
Indicators:	Total Dissolved Solids
Threshold Value:	<2,500 mg/L geometric mean concentration with maximum single sample concentrations of <4,375 mg/L

Specific Conductance Total Maximum Daily Load Summary

Entity ID:	SD-BA-L-FREEMAN_01
Location:	HUC Code: 1014010209
Size of Watershed:	3,409 acres
Water body Type:	Lake
303(d) Listing Parameter:	Conductance
Initial Listing date:	2006 IR
TMDL Priority Ranking:	2
Designated Use of Concern:	Fish, Wildlife, Propagation, Recreation & Stock Watering
Analytical Approach:	Linear Regression, Reduction Response Model
Target:	Meet applicable water quality standards 74:51:01:55
Indicators:	Specific Conductance
Threshold Value:	<4,000 µmhos/cm @ 25 degrees C geometric mean concentration with maximum single sample concentrations of <7,000 µmhos/cm @ 25 degrees C

1.0 Introduction

The intent of this document is to clearly identify the components of the TMDL submittal to support adequate public participation and facilitate the United States Environmental Protection Agency (EPA) review and approval. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the total dissolved solids (TDS) and specific conductance (SC) impairments of Freeman Lake (SD-BA-L-FREEMAN_01) first listed in the 2006/2008 Integrated Reports (IR) and again in the 2010 and 2012 IRs. The elevated TDS and SC cause Freeman Lake to not support the fish and wildlife propagation, recreation, and stock watering beneficial use.

The 2012 IR list Freeman Lake as not meeting the Fish/Wildlife Propagation, Recreation, and Stock Watering beneficial use due to elevated concentrations of nitrate and does not meet the Warmwater Permanent Fish Life beneficial use because of elevated concentrations of selenium and low dissolved oxygen. A TMDL report for nitrate and selenium was prepared by South Dakota Department of Environment and Natural Resources (SD DENR) and approved by EPA in 2001. Dissolved oxygen and any other impairments will be addressed separately.

The South Dakota Lakes Assessment Final Report dated 1996 provided the following data on Freeman Lake:

Location: SE 1/4 of Sec. 8, T2N, R25W, Jackson County, South Dakota
Watershed Area: 3409 acres
Surface Area: 66 acres
Maximum Depth: 16 feet
Total Storage: 449 acre feet

1.1 Watershed Characteristics

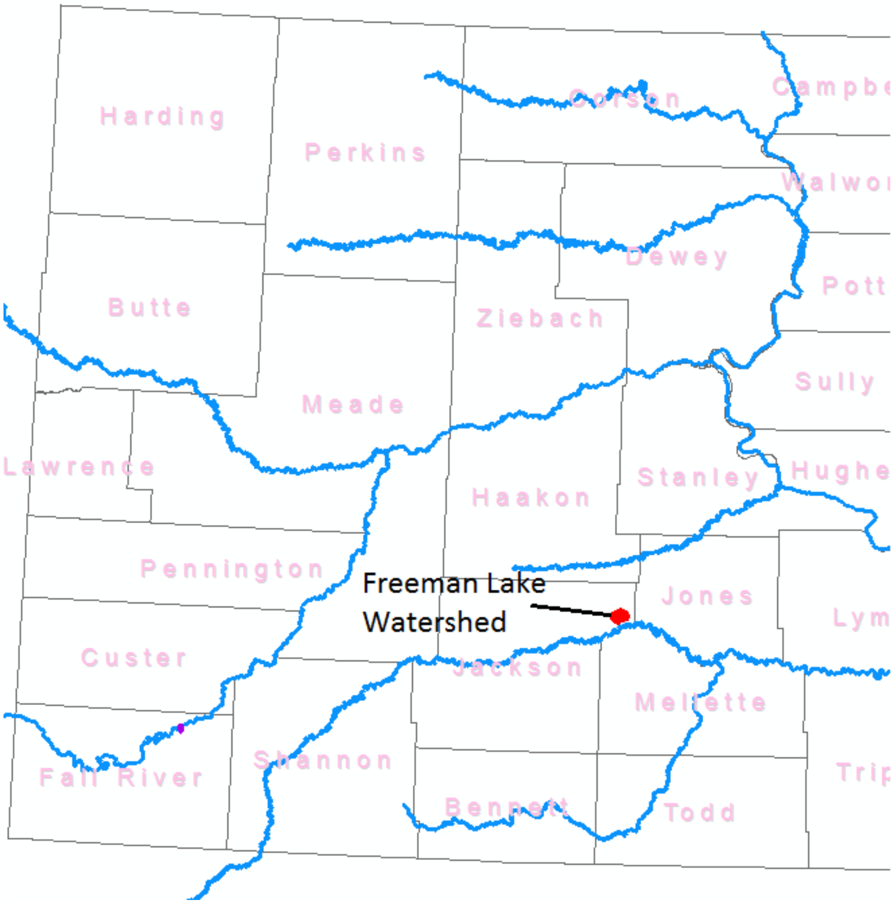

Figure 1. Freeman Lake watershed location in western South Dakota.

Freeman Lake is a 66 acre reservoir located in the northeast portion of Jackson County in the western part of south central South Dakota. Freeman Lake is located in the upper portion of Brave Bull Creek watershed, which is part of the Bad River watershed, which ultimately drains to the Missouri River.

The lake was created in 1939 by construction of an earthen embankment across an intermittent draw as part of the Works Progress Administration program. The South Dakota Game Fish & Parks department (SD GFP) is responsible for the management and operation of the lake and the lake is open to the public. A state game refuge is located west of the lake and is maintained in permanent vegetation. The land east of the lake is privately owned and is maintained in grass. The principal land use of the watershed when the lake was developed was native grassland with some small tracts of cropland used for forage and cash crops.

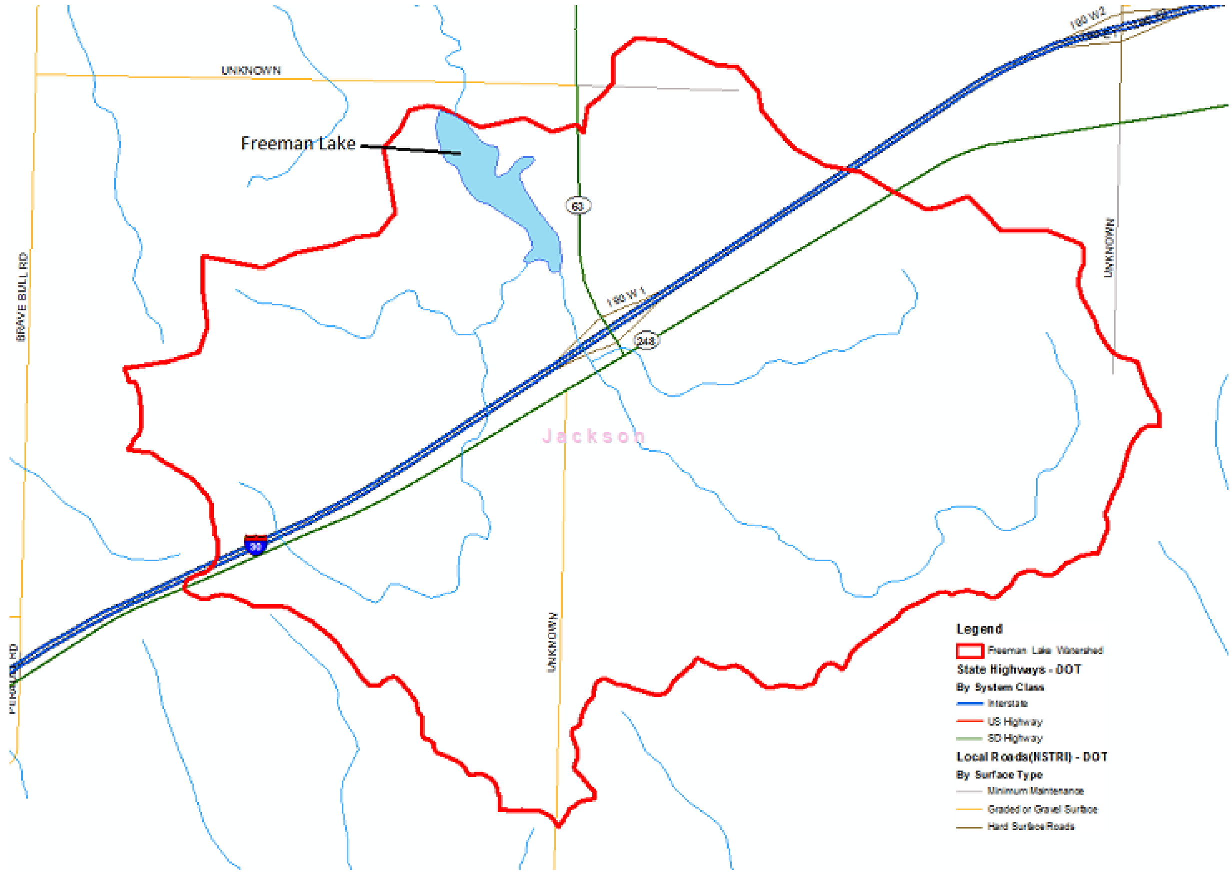

Figure 2. Freeman Lake watershed.

The U.S. Interstate 90 and SD Highway 248 grades cross the watershed just to the south of the inlet to Freeman Lake and SD Highway 63 is located east of the eastern shoreline. A KOA Campground is located on the east side of the Freeman Lake near the dam embankment. A tourist attraction, the 1880 Town, is located at the northeast intersection of I90 and SD Hwy 63.

Freeman Lake receives flows from the 3,409 acre watershed which is about 3 1/2 miles wide and 2 1/2 miles deep with gently rolling to steep topography. The drainage channels all have positive gradients with a straight to slightly meandering pattern.

The immediate watershed of Freeman Lake consists of a single soil association:

Pierre-Promise-Samil: Moderately deep and deep, well drained, nearly level to strongly sloping, clayey soils on uplands (USDA 1984).

The lake has been in existence for 73 years with a current depth of over 16 feet, so sediment accumulation has not been significant

By 1960, areas of the watershed were being broken to cropland to raise wheat. Today the watershed is predominately cropland producing wheat and some alfalfa/grass for hay. The land producing wheat is usually fallowed (left idle with no crop planted and the weeds controlled) every other year. There are no active farmsteads in the watershed and the only livestock activity involves 30 to 40 head of cattle grazed in the vicinity of the 1880 town.

Annual precipitation data from 1960 - 1990 at the Murdo weather coop, which is approximately 20 miles east of Freeman Lake, averages 18.08 inches per year. Current weather data shows that the annual rainfall has exceeded the average in the late 1990s and late 2000s (SDSU 2011).

While investigating high levels of nitrate and selenium in the lake in the late 1990s, investigators observed several active saline seeps in the watershed above Freeman Lake. Soil type and soil profile indicate that these areas have been functioning as seeps before the dam was constructed. Areas typical of saline seep activity were noted in the watershed upstream of the lake. Site visits indicated that seeps were active on a seasonal basis, flowing more often when vegetation is dormant and not able to intercept free groundwater in the recharge areas of the seeps. Contaminant loading to the lake was observed to be directly related to the amount of seep flow entering tributaries upstream of the lake.

Samples from observation wells, seep areas, and Freeman Lake tributaries downstream of seep areas were collected in the late 1990s and indicated that other sources of contamination were also flowing from the seeps. Total dissolved solids (TDS) concentrations in tributaries ranged from 572 mg/L to as high as 15,896 mg/L and specific conductance (SP) ranged from 821 µmhos/cm to as high as 13,200 µmhos/cm (Table 9). Samples taken directly from two seep areas yielded TDS concentrations of 17,075 and 14,196 mg/L and conductance values of 15,300 and 13,200 µmhos/cm. In-lake samples have shown TDS concentrations as high as 8,549 mg/L (Table 7) and Sc values as high as 11,685 µmhos/cm (Table 8), although the SC value may be erroneous as discussed later in this report.

The lake was a successful warm-water fishery for many years until it experienced a fish kill in 1989-90. Attempts by SD GFP to restock the fishery have been unsuccessful and the lake presently is managed for waterfowl benefits.

The lake shoreline has had a significant increase in population of cattails and other aquatic plants that occurred in correspondence with increased nutrient concentrations in the lake. Lake access for swimming and fishing has been limited because of dense cattails along the shoreline.

2.0 Water Quality Standards

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

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

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

Freeman Lake has been assigned the beneficial uses of: warm-water permanent fish life propagation, immersion recreation, limited contact recreation, and fish and wildlife propagation, recreation, and stock watering. Table 1 lists the criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion is used.

The numeric TMDL target established for Freeman Lake for total dissolved solids is 2,500 mg/L, which is based on the chronic standard for total dissolved solids. The total dissolved solids criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 4,375 mg/L and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 2,500 mg/L.

The numeric TMDL target established for Freeman Lake for specific conductance is 4,000 µmhos/cm, which is based on the chronic standard for conductance. The conductance criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 7,000 µmhos/cm and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 4,000 µmhos/cm.

Table 1. South Dakota water quality standards for Freeman Lake.

Parameters	Criteria	Unit of Measure	Beneficial Use Requiring this Standard
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L 30 average March 1 to October 31	Warmwater Permanent Fish Life Propagation
	Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards	mg/L 30 average November 1 to February 29	
	Equal to or less than the result from Equation c in Appendix A of Surface Water Quality Standards	mg/L Daily Maximum	
Dissolved Oxygen	≥5.0	mg/L	Warmwater Permanent Fish Life Propagation
Total Suspended Solids	≤90 (mean) ≤158 (single sample)	mg/L	Warmwater Permanent Fish Life Propagation
Temperature	≤26.6	°C	Warmwater Permanent Fish Life Propagation
Fecal Coliform Bacteria (May 1- Sept 30)	≤200 (geometric mean) ≤400 (single sample)	count/100 mL	Immersion Contact Recreation
Escherichia coli Bacteria (May 1- Sept 30)	≤126 (geometric mean) ≤235 (single sample)	count/100 mL	Immersion Contact Recreation
Alkalinity ($CaCO_3$)	≤750 (mean) ≤1,313 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Conductance	≤4,000 (mean) ≤7,000 (single sample)	µmhos/cm @ 25° C	Fish and Wildlife Propagation, Recreation and Stock Watering
Nitrogen, nitrate as N	≤50 (mean) ≤88 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
pH (standard units)	≥6.5 to ≤9.0	units	Warmwater Permanent Fish Life Propagation
Solids, total dissolved	≤2,500 (mean) ≤4,375 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Total Petroleum Hydrocarbon	≤10	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Oil and Grease	≤10		

2.1 Pollutants of Concern

Specific conductance is a measure of water's ability to conduct electrical current and is used to measure dissolved ionic particles in the water. It is often used as an indicator of total dissolved solids and ion concentration. Total dissolved solids (TDS) is the measure of salts in the water. Total dissolved solids and specific conductance are closely related because many dissolved solids are ions and act as electrical conductors. Based on regression analysis of the two parameters in Figure 10, an average TDS (mg/L) to conductance ratio (µmho/cm) of 0.87 was observed in Freeman Lake. The ratio of the water quality standards of TDS (4,375 mg/L) to specific conductance (7,000 µmho/cm) is 0.63. Therefore, attainment of the TDS standard results in attainment of the SC standard. Because the TDS standard is more protective, and because TDS is a direct measurement of particles that cause electrical conductance in water, TDS will be considered the pollutant of concern in regard to both water quality parameters for this TMDL report.

3.0 Significant Sources

3.1 Point Sources

The only permitted point source in the watershed is 1880 Town, which routes wastewater to a lagoon located to the north of the facility. The permit for 1880 Town is of the "no discharge" type, meaning that discharge from the lagoon is not authorized. There have not been any recorded discharges from this facility.

3.2 Non-Point Sources

The primary non-point sources of total dissolved solids in the Freeman Lake watershed are the saline seep areas located upstream of the lake that contribute flow to drainages running to the lake. Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. Ground water and hydrologically connected surface water in areas where marine shales are found, such as the Pierre shale soils, are typically high in TDS and nitrate (SDDA 1997). Because total dissolved solids and conductance are closely related, the seep areas are also the primary cause of the high conductance values in the lake.

In 1997 the South Dakota Geological Survey (SDGS) completed test drilling of the seep areas with the highest nitrate and selenium concentrations and installed two monitoring wells. Sample data showed concentrations of TDS, nitrate, specific conductance, and other water quality parameters that exceed state water quality standards. Sample data from the monitoring wells is presented in Table 10 in Appendix A.

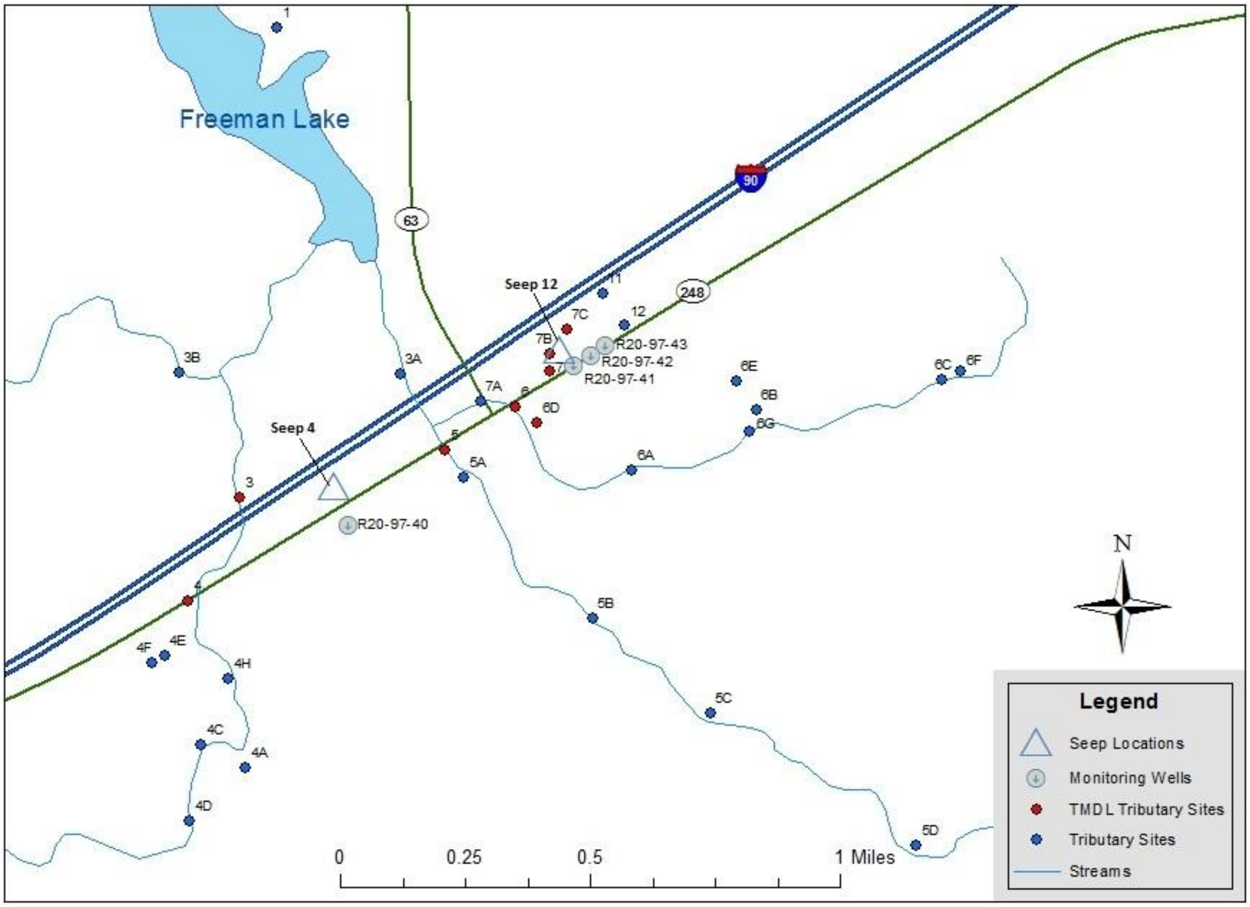

Figure 3. Location of Freeman Lake tributary sample sites, mapped seep locations, and monitoring wells.

There are four drainage areas south of I90 that presently yield seep flow to lake. The seep areas with highest concentrations of TDS and SC are located between I90 and Hwy 248 and had been farmed prior to seep activity. A visit to the watershed in October of 2011 showed that these areas have been too wet to farm recently and are either void of vegetation or have annual type grasses. At the time of the visit, producers were observed putting up livestock fencing, presumably to utilize the area for livestock grazing. There are three other small tributaries that carry groundwater effluent from seep areas to the lake. The areas north of I90 are mainly in permanent vegetation and very little seepage occurs in this area.

Drainage 1: Drains the western part of the watershed, flows through a culvert in I90 west of Freeman Lake and enter the lake in the west arm. Includes sample sites FREEMANT03, FREEMANT03B, and FREEMANT04.

Drainage 2: Drains the central and south eastern part of the watershed and flows directly north into Freeman Lake through a box culvert in Interstate 90. The site 2 drainage joins with Sites 3 & 4 just before it enters the culvert. Includes sample site FREEMANT05.

Drainage 3: Drains the eastern part of the watershed and joins with Site 4 drainage just below SD Hwy 16 and east of SD Hwy 63. This flow joins with Site 2 flow at the box culvert. Includes sample sites FREEMANT06 and FREEMANT06D.

Drainage 4: Drains the area between I 90 and SD Hwy 16 and east of SD Hwy 63. Includes sample sites FREEMANT07, FREEMANT07B, and FREEMANT07C.

Classifying pollutant contributions from the saline seeps upstream of the lake as natural or agricultural is difficult because several factors, both anthropogenic and natural, determine whether the seeps are active. While the seeps were present prior to construction of the dam, they did not actively flow in such a manner to cause significant alterations to the water chemistry of Freeman Lake until the early 1990s.

Saline seeps are common in western South Dakota and occur most commonly in the Pierre shale soils. The USDA Agricultural Research Service (ARS) conducted several studies of these types of seeps. ARS published a document entitled "Saline-Seep Diagnosis, Control, and Reclamation" which listed ten factors that contribute water to saline-seep problems in the Northern Great Plains, including:

1. Fallow
2. High precipitation periods
3. Poor surface drainage
4. Snow accumulation
5. Gravelly and sandy soils
6. Drainageways
7. Constructed ponds and dugouts that leak
8. Artesian water
9. Roadbeds across natural drainageways
10. Crop failure

Factors number 1, 2, 4, 6, 7, 9 and 10 are all potential contributors to the existing seep conditions in this watershed.

Some of the areas have a cropping history that dates back to the days of the Homestead Act with the major change to cropland occurring in the late 1970's and early 1980's (SD DENR 2000). The fallow practice commonly used on the cropland adds moisture to the soil profile during the year that no crop is grown (USDA 1983).

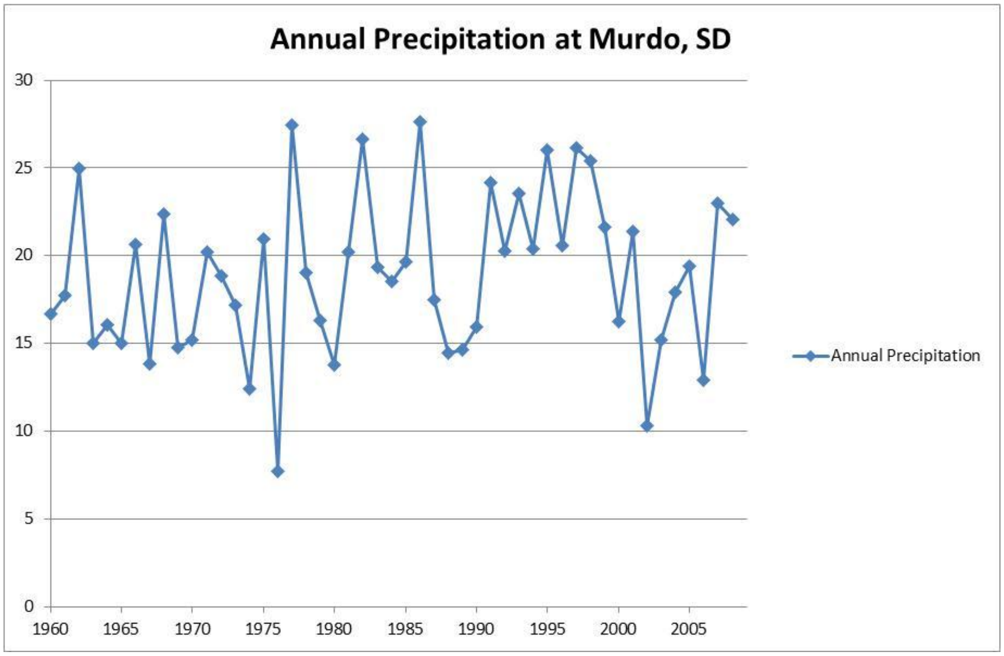

Figure 4. Annual precipitation in inches at Murdo, SD.

Weather data was collected from the weather station at Murdo, SD, which is approximately 20 miles east of Freeman Lake. Average annual precipitation from 1960-1990 was 18.08 inches. Average annual precipitation during the 1990s was 22.41 inches. This increase in precipitation likely influenced the activity of the saline seeps, which began contributing loadings to Freeman Lake in the early 1990s based on in-lake water quality sampling. The recent period of above normal precipitation that began in the late 2000s may also be causing activity in the seeps.

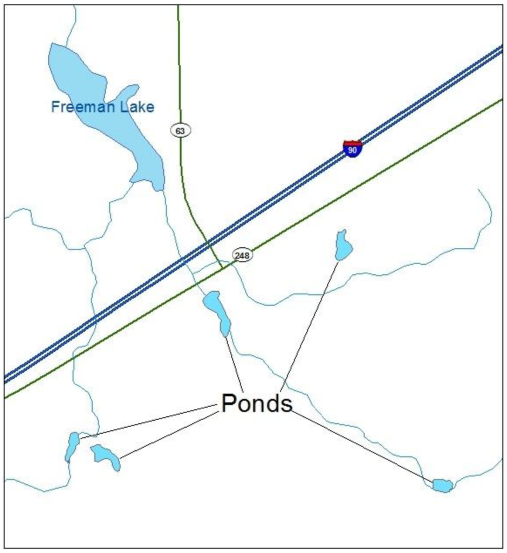

Figure 5. Map of ponds upstream of Freeman Lake contributing to seep activity.

Roads have existed in the area prior to the construction of the dam. Interstate Highway 90 was constructed in the late 1960's. Dams and ponds have been built since the homestead days with major government construction programs between 1950 and 1980. Snow accumulation is governed by amount of snow, existing ground cover, buildings, roadways, etc.

Fallow and the existing ponds upstream of the lake are the most likely human factors adding moisture to the soil profile. Trying to solve the problem by addressing only one factor is not a viable solution. The problem has emerged as a result of several factors. The ultimate goal is to reduce the flow of water from selected seep areas. This can be achieved be reducing the amount of recharge water occurring in the soil profile by increasing vegetation and removing other factors that cause soil profile recharge, such as dams (USDA 1983).

3.2.1 Human Sources

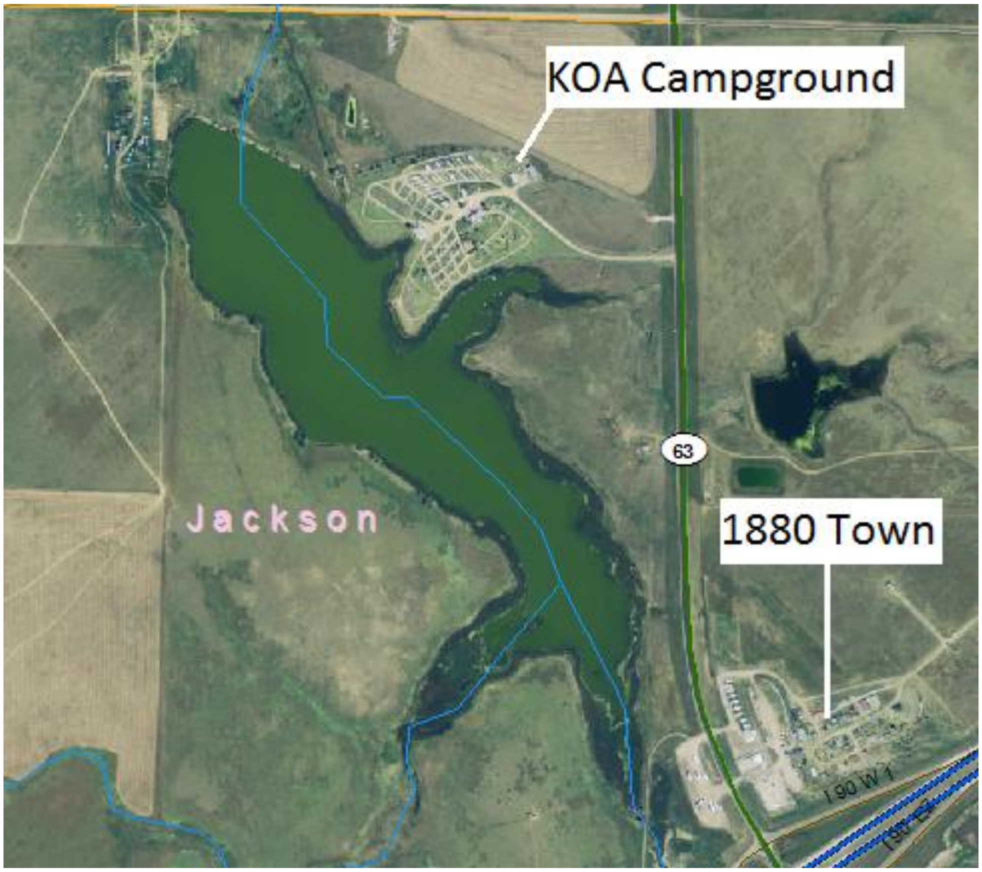

Figure 6. Location of KOA campground and 1880 Town in relation to Freeman Lake.

There are no significant human sources of the pollutants of concern in the watershed. The KOA campground discharges wastewater to a lagoon located northwest of the campground, downstream of the dam. No discharges are permitted from the lagoon, and there is not history of discharge from the lagoon. Also, because the lagoon is downstream of the lake, it is unlikely to have any impact on Freeman Lake water quality. 1880 Town discharges wastewater to a lagoon located to the north of the facility. 1880 Town has a "no discharge" permit (Permit #: SD0028100) and is not authorized to discharge from the lagoon. There have been no recorded discharges. Both systems are operating effectively and appear to have had no discernible effect on the lake.

3.2.2 Agricultural Sources

As previously mentioned, fallow practices used in the watershed contribute to saline seep activity, which results in pollutant loading to the lake. This practice is not a direct contributor of contaminant loadings, but impacts water quality in the lake indirectly by contributing to conditions that cause saline seep activity.

4.0 Technical Analysis

4.1 Data Collection Method

Freeman Lake was sampled on an irregular basis from 1989 to 2007 as part of the South Dakota Statewide Lakes Assessment Program. The samples collected during the period 2001-2007 were used to make the beneficial use support determination and to support listing of Freeman Lake on the EPA-approved 303(d) list for 2010.

Figure 7. Freeman Lake in-lake sampling sites.

In-lake samples were collected at the four sampling locations shown in Figure 7. Samples were collected at sites SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C as part of the South Dakota Statewide Lakes Assessment Program. Samples were collected at site FREEMANL10 as part of the nitrate and selenium TMDL completed by SD DENR.

As part of the South Dakota Statewide Lakes Assessment Program, separate surface and bottom TDS samples were composited from three sampling locations to form one surface composite sample and one bottom composite sample, except in 2007 when only surface samples were collected. As part of the selenium and nitrate TMDL study, another two samples were collected near the east shoreline at site FREEMANL10 in 1997 and 1999. As part of the development of the TDS and SC TMDLs, a single grab sample was collected by SD DENR staff in October 2011 at the sample site located in the center of the lake (SWLAZZZ3907B).

Conductance was measured throughout the vertical profile of the water column at the three Statewide Lakes Assessment Program sampling sites using a YSI multi-meter water quality probe. A sample was logged at approximately 1 meter vertical intervals. One additional measurement was collected from a single location in the center of the lake in October 2011.

Tributary samples were collected as part of the nitrate and selenium TMDL study completed in 2000 by SD DENR. Samples were collected in 1997 and 1999 and one additional sample was collected in 2011. A total of 29 TDS samples and 31 SC measurements were taken at 18 sampling locations. Of the 18 sampling locations, 9 most accurately represented tributary contributions to the lake and were used for data analysis. One additional sample was collected by DENR staff in October of 2011.

The TDS and SC data from lake and tributary sampling events are summarized in Appendix A.

4.2 Flow Analysis

Surface flow for the 2 major tributaries draining to Freeman Lake were estimated using the Elevation Derivatives for National Applications (EDNA) annual stream flow model provided online by the United States Geological Survey (USGS). According to the USGS EDNA website, "EDNA is a multi-layered database derived from a version of the National Elevation Dataset (NED), which has been hydrologically conditioned for improved hydrologic flow representation."

Mean annual stream flow for both tributaries was estimated by EDNA as 0.35 cubic feet per second.

Flow from the seep areas is variable and dependent on several factors including: precipitation, fallow practices on lands in the recharge areas of the seeps, crop failure, snow cover, and the existence and water level of ponds near the seep areas. Flows may be quite significant during wet cycles and nearly non-existent during periods of extended drought. The amount of flow depends on the amount of free water available, the size of the recharge area, and the time of the year. Seeps are more likely to flow when vegetation is dormant or growing slowly and at times of heaviest precipitation; therefore, flow is usually heaviest in the spring. The flow may be reduced or stop altogether during the late spring and summer and start again after frost has occurred in the fall. The water from the seep areas will reach Freeman Lake when seep flow is occurring and vegetative growth does not use up the available flow.

Table 2. Seep flow data for drainages contributing to Freeman Lake tributaries.

Tributary	Drainage	Sample Sites	Flow (CFS)
West	1	FREEMANT03, FREEMANT03B, FREEMANT04	0.009
East	2	FREEMANT05	0.075
East	3	FREEMANT06, FREEMANT06D	0.042
East	4	FREEMANT07, FREEMANT07B, FREEMANT07C	0.024

Flow from saline seeps contributes to flow in the tributaries. Seep flow data was reported in the Freeman Lake TMDL report for nitrate and selenium (Table 2). EDNA provides an estimate of surface flow and does not consider contributions from ground water, so any contributions from seeps must be taken into account. For reduction response modeling and calculation of tributary loads, data from EDNA was added to estimates of seep flow to take both overland runoff and seep flow into account. These values were multiplied by a coefficient representing the seasonal basis of the seep flow and then added to estimates from EDNA. The coefficient is defined as the number of days of presumed seep activity divided by 365 (number of days in a year). The resulting value yields an estimate of annual tributary flow combined with annual contributions from saline seeps.

4.3 Sample Data

Table 3. Freeman Lake TDS sample data from 2001-2007 used for beneficial use support determination.

Sample Date	Relative Depth	Sample Site	TDS (mg/L)
07/09/2001	Surface	SWLAZZZ3907	4138
07/09/2001	Bottom	SWLAZZZ3907	4109
09/12/2001	Surface	SWLAZZZ3907	4541
09/12/2001	Bottom	SWLAZZZ3907	4506
07/18/2002	Bottom	SWLAZZZ3907	5693
07/18/2002	Surface	SWLAZZZ3907	5698
08/29/2002	Bottom	SWLAZZZ3907	6090
08/29/2002	Surface	SWLAZZZ3907	6070
06/19/2003	Surface	SWLAZZZ3907	6334
06/19/2003	Bottom	SWLAZZZ3907	6307
07/30/2003	Surface	SWLAZZZ3907	6725
07/30/2003	Surface	SWLAZZZ3907	6741
06/23/2004	Bottom	SWLAZZZ3907	8121
06/23/2004	Surface	SWLAZZZ3907	8127
07/28/2004	Bottom	SWLAZZZ3907	8549
07/28/2004	Surface	SWLAZZZ3907	8543
06/14/2005	Surface	SWLAZZZ3907	5825
06/14/2005	Bottom	SWLAZZZ3907	5894
08/01/2005	Surface	SWLAZZZ3907	6310
08/01/2005	Bottom	SWLAZZZ3907	6273
06/13/2006	Bottom	SWLAZZZ3907	7411
06/13/2006	Surface	SWLAZZZ3907	7434
07/14/2006	Surface	SWLAZZZ3907	8030
07/14/2006	Bottom	SWLAZZZ3907	7978
07/03/2007	Surface	SWLAZZZ3907	625
08/23/2007	Surface	SWLAZZZ3907	1929

To determine whether Freeman Lake was supporting its designated beneficial uses and to support listing the lake on the EPA 303(d) list of impaired waters for 2010, SD DENR staff examined sample data spanning from 2001 to 2007. Table 3 shows the 26 TDS samples collected in this time period, of which 22 exceeded the daily TDS criterion of 4,375 mg/L, resulting in an exceedance rate of 85%. Concentrations of TDS during 2001 to 2007 ranged from 625 mg/L in July 2007 to a maximum of 8549 mg/L in July 2004. Out of a total of 163 conductance measurements collected between 2001 and 2007, 111 exceeded the daily SC criterion of 7,000 µmho/cm for an exceedance rate of 85%. Conductance values ranged from 4,437 to 11,689 µmho/cm in this time period. Because of the large number of conductance measurements, this data is presented in Table 8, Appendix A.

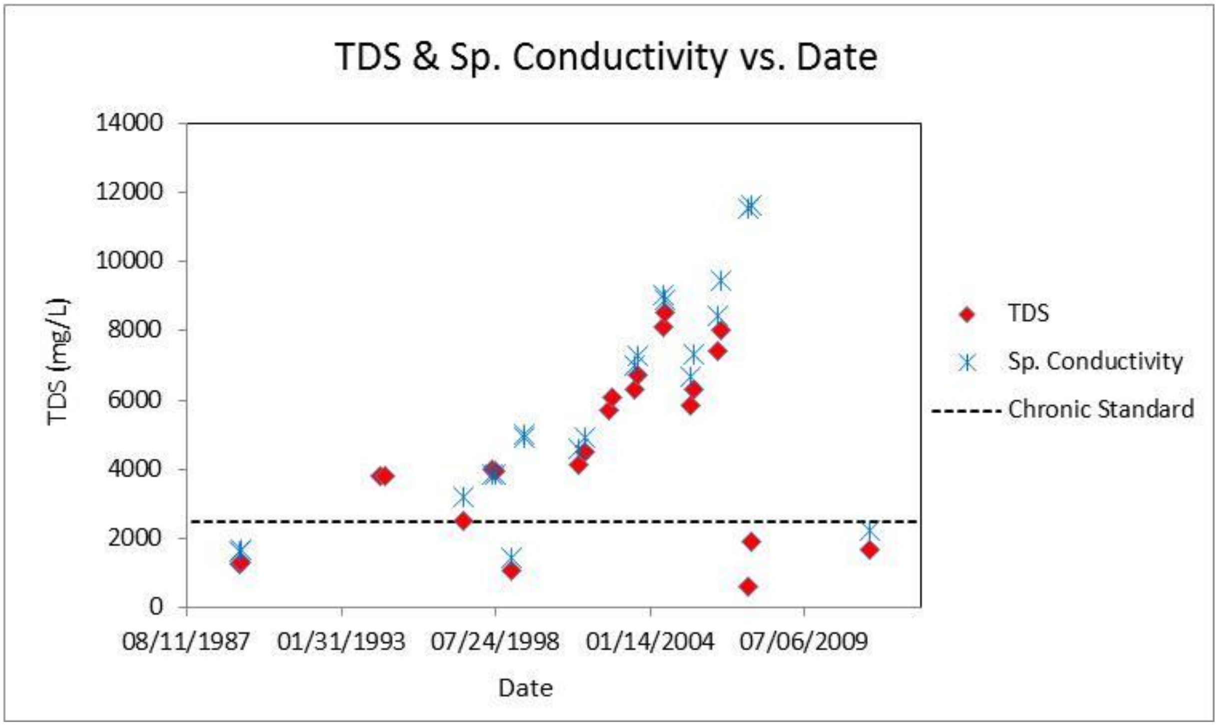

Figure 8. Freeman Lake total dissolved solids sample concentrations and specific conductance values plotted versus time.

As shown in Figure 8, TDS and specific conductance values began to show an increase between 1989 and 1994, when it is presumed that saline seep activity became sufficient to alter lake water chemistry. This period of time corresponds to a period of above average precipitation that may have provided free groundwater in seep recharge areas. Values of both parameters steadily increased until 2005, at which point values declined, perhaps due to drought conditions at the time causing flow from seeps to decrease. Values again increased after this point until 2007, when TDS concentrations dropped significantly. The drop in concentration was likely due to flushing of the lake that occurred with increased precipitation in the spring of 2007. A total of 12.85 inches of precipitation occurred between January and June of 2007, while only 12.93 inches of precipitation occurred in all of 2006. Corresponding specific conductance values collected simultaneously with TDS samples in 2007 did not drop with TDS concentrations. This discrepancy is likely due to sampling or data entry error.

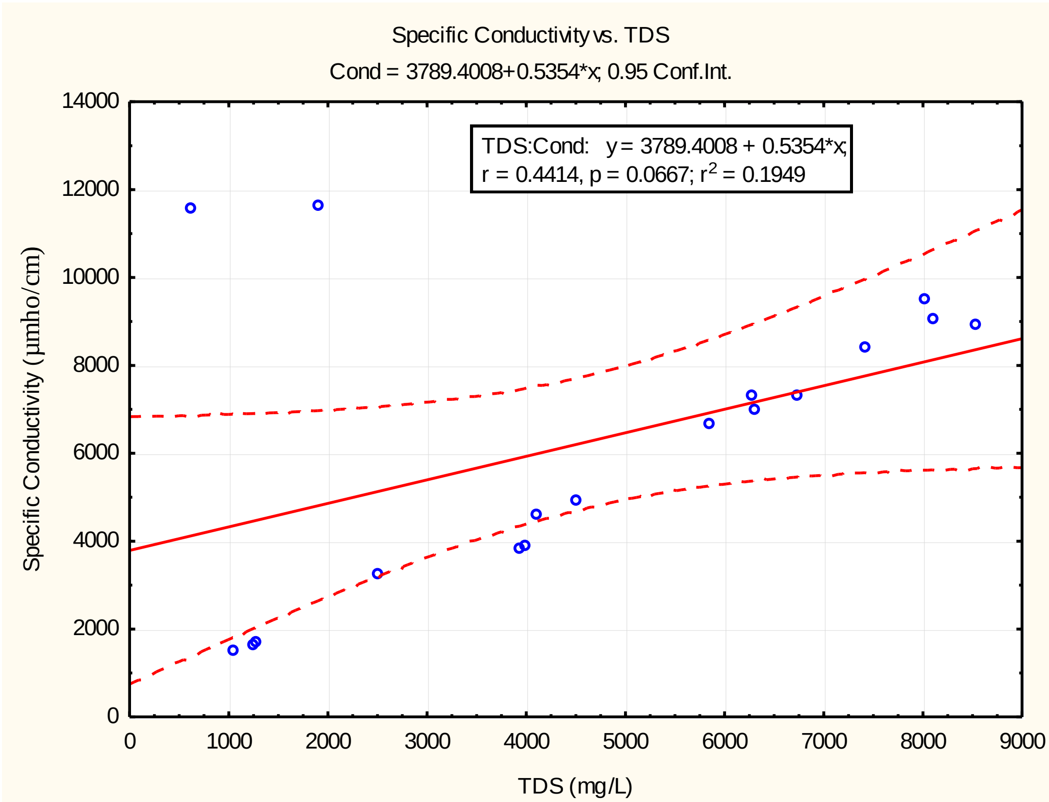

Figure 9. Total dissolved solids and specific conductance relationship including outlier data points from 2007 sample data.

A total of 17 paired specific conductance and TDS samples were collected from Freeman Lake. Specific conductance and TDS are related parameters because most dissolved solids are ions, and therefore electrical conductors. However, the relationship between the two parameters yields a relatively low R^2 value because of the two outlier data points from samples collected in 2007 (Figure 9). The two outliers fall outside the boundary of the 95$^{\%}$ confidence interval and the p-value of the relationship is not statistically significant at the 0.05 level.

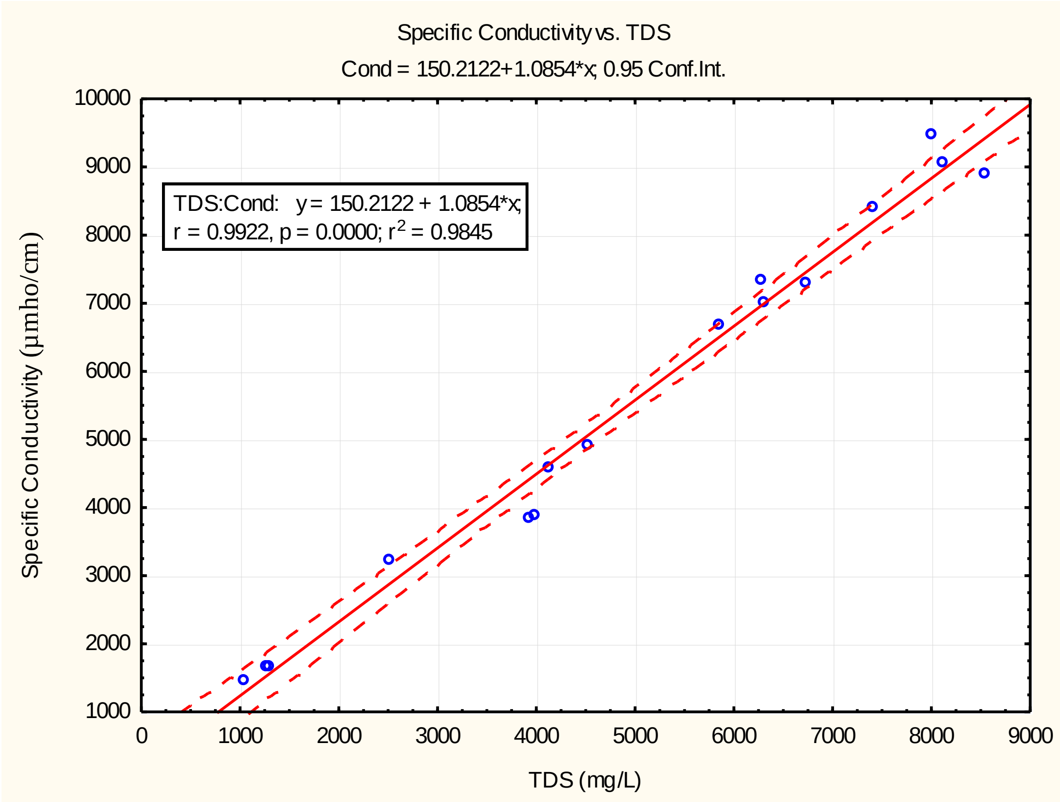

Figure 10. Total dissolved solids and specific conductance relationship excluding outlier data points from 2007 sample data.

It is strongly suspected that these two outliers are the result of sampling or data entry error because of the strong relationship (R^2 value = 0.98) between all other paired data points and a statistically significant p-value at the 0.05 level (Figure 10). The samples collected in 2007 will not be used in the data analysis of this report.

Because of the strong relationship between TDS and specific conductance, each parameter can be used as a surrogate for the other, and reductions in TDS will also result in relatively proportional reductions in specific conductance.

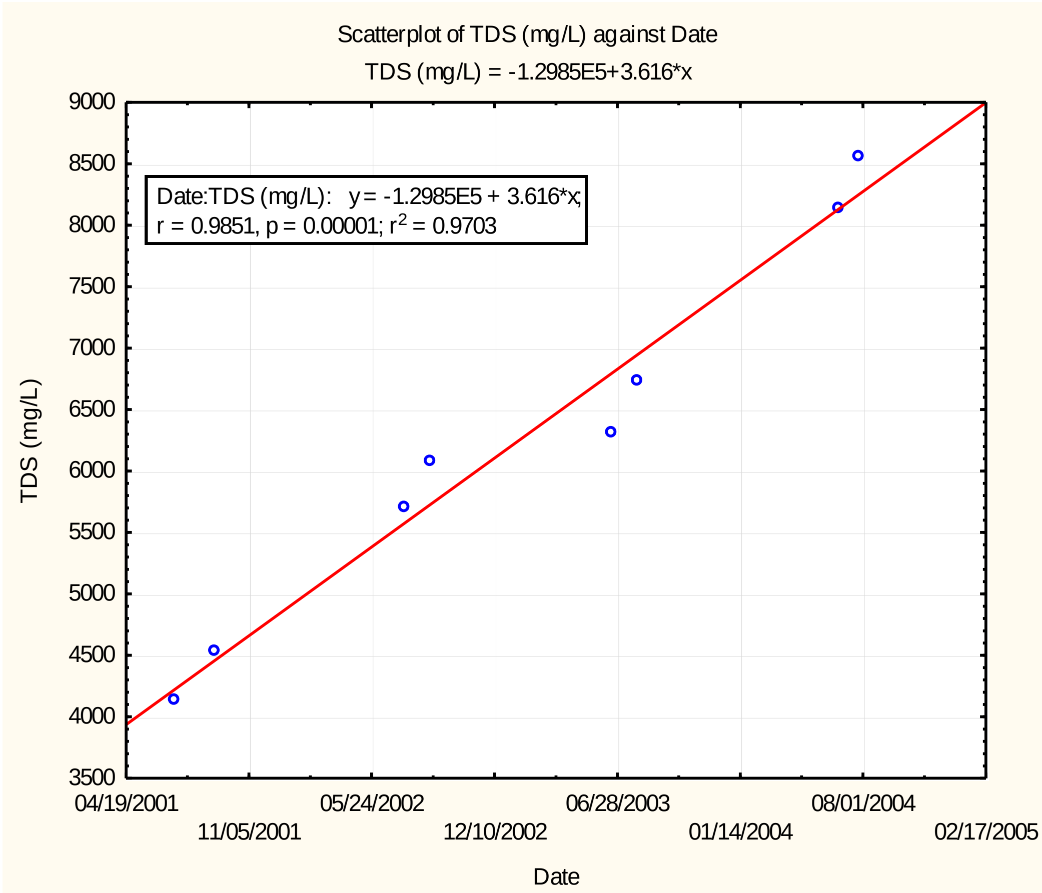

Figure 11. Freeman Lake TDS sample data from 2001-2004.

The drought period from the summer of 2001 to 2004 had Freeman Lake receiving little precipitation. The lake did not undergo flushing during this period of time. TDS concentrations increased in the lake at a relatively constant rate (Figure 11), as evidenced by the strong R^2 value between date and TDS concentration. With little free groundwater to recharge saline seep areas, it is likely that this increase is due to a decrease in water volume from evaporation which concentrated existing TDS in the lake. TDS concentrations increased more rapidly during the growing season than the rest of the year, with slopes of the lines between sample pairs for each year ranging from 6.15 to 12.06. Those values exceed the slope of the best fit line resulting from linear regression of all samples collected between 2001 and 2004 (Figure 11), which is 3.62. These results may explain why the TDS concentrations observed during wet years when the seeps should presumably be active, such as those collected in 2007 and 2011, are lower than those from the mid-2000s during the last drought cycle. Flushing and evaporation may currently be the most important factors regulating high TDS concentrations in the lake that result from saline seep inflows.

The tributaries upstream of the lake were sampled by various state and local agencies in 1997 and 1999 and once by SD DENR staff at site FREEMANT05 in 2011. Out of a total of 29 TDS samples collected, 21 exceeded the daily standard of 4,375 mg/L. Out of a total of 31 SC measurements, 12 did not meet the daily standard of 7,000 µmho/cm. The saline seep areas that flow to Freeman Lake tributaries are the primary source of TDS in the watershed and the primary cause of TDS concentrations and specific conductance values in the lake that exceed water quality standards. Table 4 presents the tributary sample data used to calculate tributary loadings needed for TMDL calculations and reduction response modeling. Additional tributary data is presented in Table 9, Appendix A.

4.4 Reduction Response Modeling

In-lake reduction response modeling was conducted with BATHTUB, an Army Corps of Engineers Eutrophication Response Model (Walker, 1999). The model was operated according to recommendations outlined in "Water Quality Modeling in South Dakota" (SD DENR 2009) unless otherwise described. System responses were calculated using reductions in TDS from tributaries. Loading data for Freeman Lake tributaries was developed from tributary TDS concentration data. Internal conditions of the lake were based on in-lake sample data.

BATHTUB provides numerous models for the calculation of inlake concentrations of phosphorus, nitrogen, chlorophyll *a*, Secchi depth, and a conservative substance, which in this case is TDS. Models are selected that most closely predict current inlake conditions from the loading data provided. As reductions in the TDS load are predicted in the loading data, the selected models will closely mimic the response of the lake to these reductions. BATHTUB not only predicts the in-lake concentrations of nutrients and a conservative substance; it also produces a number of diagnostic variables that help to explain the lake responses.

Table 4. Tributary sample data used to calculate tributary inputs for BATHTUB model of Freeman Lake and to develop the current load in TMDL calculations.

Drainage	Tributary	Sample Date	Sample Site	Sample Type	Total Dissolved Solids (mg/L)
4	West	02/04/1999	FREEMANT03	GRAB	6766
4	West	02/04/1999	FREEMANT03B	GRAB	4602
4	West	02/04/1999	FREEMANT04	GRAB	6754
4	West	07/27/1999	FREEMANT04	GRAB	7815
4	**Tributary 1 (West) Average**				**6484**
Tributary 1 Average x Seasonality Factor 305/365					**5418**
5	East	02/04/1999	FREEMANT05	GRAB	7420
5	East	07/27/1999	FREEMANT05	GRAB	5441
5	Average				6431
6	East	02/04/1999	FREEMANT06	GRAB	6294
6	East	07/27/1999	FREEMANT06	GRAB	4994
6	East	02/04/1999	FREEMANT06D	GRAB	6348
6	East	05/22/1997	FREEMANT06D	GRAB	12765
6	Average				7600
7	East	02/04/1999	FREEMANT07	GRAB	10974
7	East	05/22/1997	FREEMANT07B	GRAB	13358
7	East	02/04/1999	FREEMANT07C	GRAB	13170
7	East	07/27/1999	FREEMANT07C	GRAB	15896
7	Average				13350
	Tributary 2 (East) Average				**9127**
Tributary 2 Average x Seasonality Factor 305/365					**7626**

Tributary samples collected as part of the nitrate and selenium TMDL project were used for tributary concentration inputs. Sample data from 2011 was not available at the time of model development and calibration. Sample concentrations from each drainage were averaged. In the case of tributary 2 (east tributary), the average value for each drainage contributing to the tributary (drainages 5, 6, and 7) was then averaged to produce the average TDS concentration for tributary 2.

The BATHTUB model is a steady-state model that assumes continual loading at a constant rate. However, field observations indicate that the seeps are typically active on a seasonal basis. Field observations showed that during the months of July, August, and September, flow from the seeps may cease entirely. Flow data was estimated using EDNA and flow values recorded during the nitrate and selenium TMDL study, as described in section 4.2. The model was set up and calibrated to represent loadings that would result from seeps flowing for 305 days of the year. This scenario most accurately resembled conditions in Freeman Lake in 2006. TDS concentrations were multiplied by a factor of 305/365 to estimate annual average concentrations. These calculations results in an average annual TDS concentration for tributary 1 of 5418 mg/L and 7626 mg/L for tributary 2.

Output data for Freeman Lake and input data for tributaries, lake segments, and global variables are presented in Appendix B.

TDS concentrations in the lake did not exceed state water quality standards for the sample collected in 2011. In order to calculate reductions, in-lake sample concentrations from 2006, when the lake was not meeting water quality standards, were used to calibrate the model. It is likely the lake will not meet TDS and specific conductance standards if seep activity becomes prevalent again, therefore reductions from a documented state of impairment are appropriate to calculate reduction responses.

Table 5. Loading reduction scenarios from the BATHTUB model.

Percent Reduction	Trib 1 TDS (mg/L)	Trib 1 flow (hm3/yr)	Trib 1 load (kg/d)	Trib 2 TDS (mg/L)	Trib 2 flow (hm3/yr)	Trib 2 load (kg/d)	Total TDS load (kg/d)	Predicted in-lake TDS (mg/L)	Predicted in-lake SC (µhmo/cm)
0%	5418	0.320	4.75	7626	0.418	8.78	13.53	7732	8582
10%	4877	0.320	4.28	6864	0.418	7.90	12.17	6959	7736
20%	4335	0.320	3.80	6101	0.418	7.02	10.82	6186	6890
30%	3793	0.320	3.33	5339	0.418	6.14	9.47	5412	6045
40%	3251	0.320	2.85	4576	0.418	5.27	8.12	4639	5199
50%	2709	0.320	2.38	3813	0.418	4.39	6.76	3866	4353
60%	2167	0.320	1.90	3051	0.418	3.51	5.41	3093	3507
70%	1626	0.320	1.43	2288	0.418	2.63	4.06	2320	2661
80%	1084	0.320	0.95	1525	0.418	1.76	2.71	1546	1815
90%	542	0.320	0.48	763	0.418	0.88	1.35	773	969
100%	0	0.320	0.00	0	0.418	0.00	0.00	0	0
67.7%	**1608**	**0.320**	**1.41**	**2576**	**0.418**	**2.96**	**4.37**	**2500**	**2858**

Scenarios for successive 10% reductions in tributary TDS loading were modeled to determine the degree of loading reduction that results in the lake meeting water quality standards (Table 5). The BATHTUB model estimates that a 68% reduction in TDS from saline seep areas is required to meet the target of 2,500 mg/L. While the lake may currently be meeting water quality standards, there exists a strong likelihood that saline seeps will become active to such a degree that the lake will not meet water quality standards in the future if recommendations for controlling seep flow are not implemented.

5.0 TMDL and Allocations

Table 6. TMDL and allocations for Freeman Lake regarding TDS.

TMDL Component	kg/day TDS
LA	3.93
WLA	0.00
MOS	0.44
TMDL @ 2500 mg/L	4.37
Current Load (kg/day)	13.53
Load Reduction	68%

The proposed reduction in TDS will also result in attainment of the chronic SC standard of 4,000 µmho/cm because the TDS standard is relatively more protective. Using the equation from the TDS/SC relationship in Figure 10, a TDS concentration of 2,500 mg/L in the lake is equal to SC of 2,858 µmho/cm.

5.1 Wasteload Allocation

There are no point sources in this watershed. The wasteload allocation will be given a value of zero.

5.2 Load Allocation

The primary source of TDS in Freeman Lake is saline seep areas that contribute TDS to tributary drainages that flow into the lake. A 68% reduction in TDS loading to Freeman Lake can be achieved by reducing or eliminating recharge of saline seep areas, and thus flow from the seeps. This reduction in TDS will also result in the lake meeting water quality standards for specific conductance.

6.0 Margin of Safety and Seasonality

6.1 Margin of Safety

A total of 10% of the TMDL was set aside as an explicit margin of safety to account for uncertainty in tributary loadings and in-lake conditions.

6.2 Seasonality

Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. The amount of flow depends on the amount of free water available, the size of the recharge area, and the time of the year. Seeps are more likely to flow when vegetation is dormant or growing slowly and at times of heaviest precipitation; therefore, flow is usually heaviest in the spring. The flow may be reduced or stop altogether during the late spring and summer and start again after frost has occurred in the fall.

Field trips conducted during the TMDL study for selenium and nitrate indicated that seepage yield approaches zero in July, August, and September. Flow begins to increase as vegetative growth decreases and reaches a constant flow by the beginning of December. This flow will continue throughout the winter and may even increase after the spring thaw. Flow starts to diminish in late April and usually approaches zero by July. A field trip to the seep areas in late October of 2011 showed that one of the seeps in the eastern tributary was currently active and contributing flow to the lake.

7.0 Public Participation

STATE AGENCIES

South Dakota Department of the Environment and Natural Resources (SD DENR) was the primary state agency involved in the completion of this assessment. Also contributing to the assessment are the South Dakota Game, Fish, and Parks Department, the South Dakota Geological Survey, and the South Dakota Department of Agriculture.

FEDERAL AGENCIES

Environmental Protection Agency (EPA) provided the primary source of funds for the completion of the assessment on Freeman Lake.

LOCAL GOVERNMENT, INDUSTRY, ENVIRONMENTAL, AND OTHER GROUPS AND PUBLIC AT LARGE

The Jackson County Conservation District provided assistance in collecting data as part of the selenium and nitrate TMDL study. Public comment and input was made available through the public notice period. Public notices were placed in the Murdo Coyote, the Kadoka Press, and the Pioneer Review. All comments received are taken into consideration in the final document.

8.0 Monitoring Strategy

The Department may adjust the load and/or waste load allocations in this TMDL to account for new information or circumstances that are developed or come to light during the implementation of the TMDL and a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation. New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information and land use information. The Department will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity; the adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable TDS and SC water quality standards for Freeman Lake; and any adjusted WLA will be supported by a demonstration that load allocations are practicable. The Department will notify EPA of any adjustments to this TMDL within 30 days of their adoption.

Freeman Lake will continue to be monitored as part of the South Dakota Statewide Lakes Assessment Program. Sampling will occur twice throughout the growing season to examine seasonal patterns. The results from this monitoring cycle can be used to supplement the modeling to judge project effectiveness or TMDL adjustments.

9.0 Implementation Strategy

Because saline seeps are the primary source of TDS and conductance contamination, implementation efforts should focus on reducing flow from the seep areas. To reduce flow out of the seeps, implementation efforts must be directed toward recharge areas. The USDA ARS, in the document titled "Saline-Seep Diagnosis, Control, and Reclamation" states: "Since seeps are caused by water moving below the root zone in the recharge area, there will be no permanent solution to the saline-seep problem unless control measures are applied to the recharge area."

The USDA ARS goes on to state that there are two general procedures for managing seeps.

1. Agronomically using the water before it percolates below the root zone.
2. Mechanically draining ponded surface water where possible before it infiltrates, and or by intercepting lateral flow of subsurface water before it reaches the discharge area.

It should be noted that subsurface drainage is not a preferred method of removing recharge water because the water is salt contaminated and disposal without downstream surface or ground water pollution is difficult.

The primary objective of implementation efforts should be planting deep rooted vegetation in seep recharge areas that will capture subsoil moisture via transpiration. Recharge areas should be seeded with alfalfa, which is the most effective way to dry the deep subsoil and stop water flow to the saline seep (Brown et al. 1976). Variation exists between the effectiveness of alfalfa cultivars in using water in recharge areas. The most effective cultivar is Beaver alfalfa, which used the greatest amount of water (net soil water depletion of 41" in 6 years) and had roots that penetrated as deep as 24 feet. Several other cultivars of alfalfa are nearly as effective as Beaver, including the Roamer and MS 243 cultivars (USDA ARS 1982). If preferred cultivars are not available, other cultivars of alfalfa could also be used with favorable results.

It is imperative that alfalfa be planted over the majority of the recharge area. Halverson and Reule (1976, 1980) found that growing alfalfa on 80% of the recharge area effectively reduced flow from several saline seeps, while a narrow strip of alfalfa covering less than 20% of the recharge area on the immediate upslope of the discharge area did not effectively control flow from the saline seeps.

Planting grasses in the recharge areas is a secondary option for controlling flow from the seeps. However, grasses are not as effective as alfalfa at capturing deep subsoil moisture. Several species of grass have roots that penetrate as deep as 15 feet when properly fertilized and depleted soil moisture by up to 29" between 1976 and 1980 (Brown, unpublished data).

Once flow to the recharge area of seeps has been controlled to the extent that the water table in the saline seep has been lowered or eliminated, the land in the discharge area may be reclaimed for agricultural purposes. More information on this process can be found in USDA ARS publication titled "Saline-Seep Diagnosis, Control, and Reclamation".

There is not an implementation project currently underway in the Freeman Lake watershed. If possible, efforts should be made to involve local agencies and conservation districts to examine possible means of implementing the measures recommended in this report.

10.0 Literature Cited

Brown, P. L. 1976. Saline Seep Detection by Visual Observation. Montana Cooperative Extension Service Bulletin No. 1132:59-61.

Brown, P. L., A. D. Halvorson, F. H.Siddoway, H. F. Mayland, and M. R. Miller. 1982. Saline-Seep Diagnosis, Control, and Reclamation. U.S. Department of Agriculture Conservation Research Report No. 30.

Halvorson, A. D., Reule, C.A. 1976. Controlling saline seeps by intensive cropping of recharge areas, Montana Cooperative Extension Service Bulletin No. 1132:115-124.

Halvorson, A. D., Reule, C.A. 1980. Alfalfa for hydrologic control of saline seeps. Soil Science Society of America Journal 44:370-374.

Saline-Seep Diagnosis, Control and Reclamation, USDA (United States Department of Agriculture), Agricultural Research Services, Conservation Research Report Number 30, May 1983.

SDDA (South Dakota Department of Agriculture) Division of Agricultural Services. 1997. Report of Results: Nitrate and Selenium Reconnaissance Project. Pierre, SD.

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

SDDENR (South Dakota Department of Environment and Natural Resources). 2000. Nitrate and Selenium Total Maximum Daily Load for Freeman Lake. Pierre, SD.

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

South Dakota State University (SDSU). South Dakota Climate and Weather – Monthly Coop Weather Data for Murdo, SD. Web. Dec. 2011. http://climate.sdstate.edu/coop/monthly.asp.

USDA (United States Department of Agriculture). 1984 Soil Survey of Jackson County, South Dakota.

USGS (United States Geological Survey). Elevation Derivative for National Applications. Web. Nov. 2011. http://edna.usgs.gov/.

Walker, W. W., 1999 Simplified Procedures for Eutrophication Assessment and Prediction: User Manual, U.S. Army Corps of Engineers.

Appendix A

Freeman Lake and Tributary Water Quality Data – Total Dissolved Solids and Specific Conductance

Table 7. Total dissolved solids sample data collected from Freeman Lake.

Sample Date	Relative Depth	Sample Site	TDS (mg/L)
06/14/1989	Surface	SWLAZZZ3907	1274
06/14/1989	Bottom	SWLAZZZ3907	1271
07/20/1989	Bottom	SWLAZZZ3907	1295
07/20/1989	Surface	SWLAZZZ3907	1295
06/14/1994	Bottom	SWLAZZZ3907	1295
06/14/1994	Surface	SWLAZZZ3907	6325
08/16/1994	Surface	SWLAZZZ3907	3869
08/16/1994	Bottom	SWLAZZZ3907	3755
08/16/1994	Surface	SWLAZZZ3907	3790
05/22/1997	Surface	FREEMANL10	2505
06/16/1998	Surface	SWLAZZZ3907	3985
06/16/1998	Bottom	SWLAZZZ3907	4003
07/28/1998	Bottom	SWLAZZZ3907	3930
07/28/1998	Surface	SWLAZZZ3907	3938
02/10/1999	Bottom	FREEMANL10	1054
07/09/2001	Surface	SWLAZZZ3907	4138
07/09/2001	Bottom	SWLAZZZ3907	4109
09/12/2001	Surface	SWLAZZZ3907	4541
09/12/2001	Bottom	SWLAZZZ3907	4506
07/18/2002	Bottom	SWLAZZZ3907	5693
07/18/2002	Surface	SWLAZZZ3907	5690
07/18/2002	Surface	SWLAZZZ3907	5698
08/29/2002	Bottom	SWLAZZZ3907	6090
08/29/2002	Surface	SWLAZZZ3907	6070
06/19/2003	Surface	SWLAZZZ3907	6334
06/19/2003	Bottom	SWLAZZZ3907	6307
07/30/2003	Surface	SWLAZZZ3907	6725
07/30/2003	Surface	SWLAZZZ3907	6741
06/23/2004	Bottom	SWLAZZZ3907	8121
06/23/2004	Surface	SWLAZZZ3907	8127
07/28/2004	Bottom	SWLAZZZ3907	8549
07/28/2004	Surface	SWLAZZZ3907	8543
06/14/2005	Surface	SWLAZZZ3907	5825
06/14/2005	Bottom	SWLAZZZ3907	5894
08/01/2005	Surface	SWLAZZZ3907	6310
08/01/2005	Bottom	SWLAZZZ3907	6273
06/13/2006	Bottom	SWLAZZZ3907	7411
06/13/2006	Surface	SWLAZZZ3907	7434
07/14/2006	Surface	SWLAZZZ3907	8042
07/14/2006	Surface	SWLAZZZ3907	8030
07/14/2006	Bottom	SWLAZZZ3907	7978
07/03/2007	Surface	SWLAZZZ3907	625
08/23/2007	Surface	SWLAZZZ3907	1929
10/27/2011	Surface	SWLAZZZ3907B	1674

*Samples collected at site SWLAZZZ3907 were composited from all three SWLA in-lake sampling sites (SWLAZZZ3907A, SWLAZZZ3907B, SWLAZZZ3907C).

Table 8. Specific conductance sample data collected from Freeman Lake.

Sample Date	Sample Site	Sample Depth	Specific Conductivity (µmhos/cm)	Sample Date	Sample Site	Sample Depth	Specific Conductivity (µmhos/cm)
06/14/1989	SWLAZZZ3907		1648	07/28/2004	SWLAZZZ3907A	4.02	8981
06/14/1989	SWLAZZZ3907		1644	07/28/2004	SWLAZZZ3907A	3.07	8980
07/20/1989	SWLAZZZ3907		1680	07/28/2004	SWLAZZZ3907A	1.99	8977
07/20/1989	SWLAZZZ3907		1663	07/28/2004	SWLAZZZ3907A	4.85	8974
06/16/1998	SWLAZZZ3907		3911	07/28/2004	SWLAZZZ3907A	0.84	8973
06/16/1998	SWLAZZZ3907		3759	07/28/2004	SWLAZZZ3907A	1.09	8972
06/16/1998	SWLAZZZ3907A	0.91	3740	07/28/2004	SWLAZZZ3907B	0.86	8997
06/16/1998	SWLAZZZ3907A	1.80	3736	07/28/2004	SWLAZZZ3907B	3.02	8994
06/16/1998	SWLAZZZ3907A	2.76	3709	07/28/2004	SWLAZZZ3907B	3.29	8993
06/16/1998	SWLAZZZ3907B	0.90	3763	07/28/2004	SWLAZZZ3907B	1.07	8991
06/16/1998	SWLAZZZ3907B	0.93	3763	07/28/2004	SWLAZZZ3907B	2.05	8991
06/16/1998	SWLAZZZ3907B	1.89	3755	07/28/2004	SWLAZZZ3907C	1.09	9007
06/16/1998	SWLAZZZ3907B	2.70	3748	07/28/2004	SWLAZZZ3907C	2.05	8999
06/16/1998	SWLAZZZ3907B	3.48	3706	07/28/2004	SWLAZZZ3907C	0.87	8998
06/16/1998	SWLAZZZ3907C	5.37	4319	07/28/2004	SWLAZZZ3907C	2.75	8876
06/16/1998	SWLAZZZ3907C	3.37	4142	06/14/2005	SWLAZZZ3907		6484
06/16/1998	SWLAZZZ3907C	4.27	4113	06/14/2005	SWLAZZZ3907		5741
06/16/1998	SWLAZZZ3907C	5.15	4063	06/14/2005	SWLAZZZ3907A	4.80	8377
06/16/1998	SWLAZZZ3907C	2.52	3942	06/14/2005	SWLAZZZ3907A	2.00	6621
06/16/1998	SWLAZZZ3907C	1.80	3810	06/14/2005	SWLAZZZ3907A	4.00	6610
06/16/1998	SWLAZZZ3907C	0.89	3775	06/14/2005	SWLAZZZ3907A	3.00	6605
07/28/1998	SWLAZZZ3907		3809	06/14/2005	SWLAZZZ3907A	1.00	6603
07/28/1998	SWLAZZZ3907		2736	06/14/2005	SWLAZZZ3907A	0.50	6601
07/28/1998	SWLAZZZ3907A	0.48	4084	06/14/2005	SWLAZZZ3907B	4.50	7100
07/28/1998	SWLAZZZ3907A	1.76	4001	06/14/2005	SWLAZZZ3907B	3.00	6601
07/28/1998	SWLAZZZ3907A	2.71	3932	06/14/2005	SWLAZZZ3907B	4.00	6589
07/28/1998	SWLAZZZ3907A	0.05	3000	06/14/2005	SWLAZZZ3907B	1.00	6587
07/28/1998	SWLAZZZ3907B	0.51	4104	06/14/2005	SWLAZZZ3907B	0.50	6587
07/28/1998	SWLAZZZ3907B	0.52	4103	06/14/2005	SWLAZZZ3907B	2.00	6587
07/28/1998	SWLAZZZ3907B	1.87	3975	06/14/2005	SWLAZZZ3907C	2.00	6563
07/28/1998	SWLAZZZ3907B	2.80	3931	06/14/2005	SWLAZZZ3907C	3.00	6562
07/28/1998	SWLAZZZ3907B	3.97	3930	06/14/2005	SWLAZZZ3907C	1.00	6561
07/28/1998	SWLAZZZ3907B	3.66	3913	06/14/2005	SWLAZZZ3907C	0.50	6560
07/28/1998	SWLAZZZ3907C	0.50	4121	06/14/2005	SWLAZZZ3907C	3.30	6560
07/28/1998	SWLAZZZ3907C	0.49	4101	08/01/2005	SWLAZZZ3907		7382
07/28/1998	SWLAZZZ3907C	1.82	3968	08/01/2005	SWLAZZZ3907		7378
07/28/1998	SWLAZZZ3907C	2.93	3932	08/01/2005	SWLAZZZ3907A	0.50	7431
07/28/1998	SWLAZZZ3907C	3.88	3889	08/01/2005	SWLAZZZ3907A	1.00	7425
07/28/1998	SWLAZZZ3907C	5.00	3682	08/01/2005	SWLAZZZ3907A	0.50	7424
07/28/1998	SWLAZZZ3907C	5.57	3565	08/01/2005	SWLAZZZ3907A	2.00	7395
07/09/2001	SWLAZZZ3907		4707	08/01/2005	SWLAZZZ3907A	3.00	7392
07/09/2001	SWLAZZZ3907		4440	08/01/2005	SWLAZZZ3907A	1.00	7174
07/09/2001	SWLAZZZ3907A	1.00	4707	08/01/2005	SWLAZZZ3907B	1.00	7430
07/09/2001	SWLAZZZ3907A	11.00	4437	08/01/2005	SWLAZZZ3907B	0.50	7425
07/09/2001	SWLAZZZ3907B	1.00	4691	08/01/2005	SWLAZZZ3907B	2.00	7401
07/09/2001	SWLAZZZ3907B	11.00	4440	08/01/2005	SWLAZZZ3907B	3.50	7397
07/09/2001	SWLAZZZ3907C	1.00	4684	08/01/2005	SWLAZZZ3907B	3.00	7390
07/09/2001	SWLAZZZ3907C	5.00	4638	08/01/2005	SWLAZZZ3907C	2.00	7268
09/12/2001	SWLAZZZ3907A	3.54	4899	08/01/2005	SWLAZZZ3907C	3.00	7090
09/12/2001	SWLAZZZ3907A	3.63	4899	08/01/2005	SWLAZZZ3907C	4.00	6951
09/12/2001	SWLAZZZ3907A	1.16	4896	08/01/2005	SWLAZZZ3907C	4.80	6911
09/12/2001	SWLAZZZ3907A	1.51	4893	06/13/2006	SWLAZZZ3907		8418
09/12/2001	SWLAZZZ3907B	0.91	4898	06/13/2006	SWLAZZZ3907		8416
09/12/2001	SWLAZZZ3907B	2.82	4894	06/13/2006	SWLAZZZ3907A	3.49	8419
09/12/2001	SWLAZZZ3907B	1.93	4892	06/13/2006	SWLAZZZ3907A	1.50	8415
09/12/2001	SWLAZZZ3907C	0.84	4913	06/13/2006	SWLAZZZ3907A	2.50	8415
09/12/2001	SWLAZZZ3907C	2.94	4904	06/13/2006	SWLAZZZ3907A	0.50	8414
09/12/2001	SWLAZZZ3907C	1.90	4897	06/13/2006	SWLAZZZ3907A	4.51	8413

Sample Date	Sample Site	Sample Depth	Specific Conductivity (µmhos/cm)	Sample Date	Sample Site	Sample Depth	Specific Conductivity (µmhos/cm)
06/19/2003	SWLAZZZ3907		6983	06/13/2006	SWLAZZZ3907B	2.50	8429
06/19/2003	SWLAZZZ3907A	4.05	7014	06/13/2006	SWLAZZZ3907B	3.50	8419
06/19/2003	SWLAZZZ3907A	3.07	7014	06/13/2006	SWLAZZZ3907B	0.51	8418
06/19/2003	SWLAZZZ3907A	0.52	7013	06/13/2006	SWLAZZZ3907B	1.50	8416
06/19/2003	SWLAZZZ3907A	1.06	7006	06/13/2006	SWLAZZZ3907C	2.50	8420
06/19/2003	SWLAZZZ3907A	1.56	7006	06/13/2006	SWLAZZZ3907C	1.50	8418
06/19/2003	SWLAZZZ3907A	2.54	7006	06/13/2006	SWLAZZZ3907C	0.50	8414
06/19/2003	SWLAZZZ3907A	2.01	7004	07/14/2006	SWLAZZZ3907		9477
06/19/2003	SWLAZZZ3907A	3.51	7003	07/14/2006	SWLAZZZ3907		9476
06/19/2003	SWLAZZZ3907A	0.52	7001	07/14/2006	SWLAZZZ3907A	3.06	9467
06/19/2003	SWLAZZZ3907A	4.31	6893	07/14/2006	SWLAZZZ3907A	3.92	9467
06/19/2003	SWLAZZZ3907A	4.48	6882	07/14/2006	SWLAZZZ3907A	1.91	9457
06/19/2003	SWLAZZZ3907B	1.01	6985	07/14/2006	SWLAZZZ3907A	0.98	9455
06/19/2003	SWLAZZZ3907B	2.51	6984	07/14/2006	SWLAZZZ3907A	0.10	9450
06/19/2003	SWLAZZZ3907B	1.53	6983	07/14/2006	SWLAZZZ3907B	2.05	9467
06/19/2003	SWLAZZZ3907B	2.03	6983	07/14/2006	SWLAZZZ3907B	2.70	9466
06/19/2003	SWLAZZZ3907B	0.48	6982	07/14/2006	SWLAZZZ3907B	0.09	9461
06/19/2003	SWLAZZZ3907B	3.14	6980	07/14/2006	SWLAZZZ3907C	1.91	9489
06/19/2003	SWLAZZZ3907B	3.01	6972	07/14/2006	SWLAZZZ3907C	0.97	9489
06/19/2003	SWLAZZZ3907C	2.02	6974	07/14/2006	SWLAZZZ3907C	0.08	9482
06/19/2003	SWLAZZZ3907C	1.52	6972	07/03/2007	SWLAZZZ3907		11535
06/19/2003	SWLAZZZ3907C	0.51	6970	07/03/2007	SWLAZZZ3907A	0.57	11562
06/19/2003	SWLAZZZ3907C	1.00	6970	07/03/2007	SWLAZZZ3907A	1.45	11545
06/19/2003	SWLAZZZ3907C	2.52	6970	07/03/2007	SWLAZZZ3907A	3.49	11506
07/30/2003	SWLAZZZ3907		7404	07/03/2007	SWLAZZZ3907A	2.47	11502
07/30/2003	SWLAZZZ3907		7404	07/03/2007	SWLAZZZ3907B	0.50	11548
07/30/2003	SWLAZZZ3907A	0.50	7202	07/03/2007	SWLAZZZ3907B	1.59	11547
07/30/2003	SWLAZZZ3907A	1.50	7197	07/03/2007	SWLAZZZ3907B	2.59	11537
07/30/2003	SWLAZZZ3907A	3.50	7170	07/03/2007	SWLAZZZ3907C	0.52	11516
07/30/2003	SWLAZZZ3907A	2.50	7166	07/03/2007	SWLAZZZ3907C	1.57	11515
07/30/2003	SWLAZZZ3907A	4.50	7131	08/23/2007	SWLAZZZ3907		11675
07/30/2003	SWLAZZZ3907A	5.00	7107	08/23/2007	SWLAZZZ3907A	2.95	11689
07/30/2003	SWLAZZZ3907B	0.50	7293	08/23/2007	SWLAZZZ3907A	2.00	11685
07/30/2003	SWLAZZZ3907B	1.50	7267	08/23/2007	SWLAZZZ3907A	1.02	11685
07/30/2003	SWLAZZZ3907B	2.50	7245	08/23/2007	SWLAZZZ3907A	3.76	11683
07/30/2003	SWLAZZZ3907B	3.00	7241	08/23/2007	SWLAZZZ3907A	0.61	11678
07/30/2003	SWLAZZZ3907C	1.50	7395	08/23/2007	SWLAZZZ3907B	0.65	11675
07/30/2003	SWLAZZZ3907C	2.50	7391	08/23/2007	SWLAZZZ3907B	1.17	11668
07/30/2003	SWLAZZZ3907C	3.00	7385	08/23/2007	SWLAZZZ3907B	1.50	11663
07/30/2003	SWLAZZZ3907C	0.50	7383	08/23/2007	SWLAZZZ3907C	0.54	11577
06/23/2004	SWLAZZZ3907		9061	08/23/2007	SWLAZZZ3907C	0.99	11574
06/23/2004	SWLAZZZ3907		9058	08/23/2007	SWLAZZZ3907C	1.19	11535
07/28/2004	SWLAZZZ3907		8477	08/23/2007	SWLAZZZ3907C	1.27	11526
07/28/2004	SWLAZZZ3907		8169	10/27/2011	SWLAZZZ3907B	surface	2220

Table 9. Freeman Lake tributary sample data.

Sample Date	Station	Sample Type	Specific Conductivity (µmho/cm)	Total Dissolved Solids (mg/L)
02/10/1999	FREEMANT01	GRAB	4560	3960
05/22/1997	FREEMANT01	GRAB	821	572
07/27/1999	FREEMANT01	GRAB		4162
02/04/1999	FREEMANT03	GRAB	7020	6766
02/04/1999	FREEMANT03A	GRAB	7470	7240
07/27/1999	FREEMANT03A	GRAB		3955
07/27/1999	FREEMANT03A	MSR/OBS	4665	
07/27/1999	FREEMANT03A	MSR/OBS	4436	
07/27/1999	FREEMANT03A	MSR/OBS	4804	
02/04/1999	FREEMANT03B	GRAB	5160	4602
02/04/1999	FREEMANT04	GRAB	7050	6754
07/27/1999	FREEMANT04	GRAB		7815
07/27/1999	FREEMANT04	MSR/OBS	7908	
07/27/1999	FREEMANT04	MSR/OBS	7825	
02/04/1999	FREEMANT04A	GRAB	2430	1830
07/27/1999	FREEMANT04A	GRAB		1836
07/27/1999	FREEMANT04A	MSR/OBS	2581	
02/04/1999	FREEMANT04B	GRAB	6030	5566
02/04/1999	FREEMANT04C	GRAB	5080	4648
07/27/1999	FREEMANT04C	GRAB		3540
07/27/1999	FREEMANT04C	MSR/OBS	4656	
07/27/1999	FREEMANT04C	MSR/OBS	4675	
02/04/1999	FREEMANT04F	GRAB	11200	11422
02/04/1999	FREEMANT05	GRAB	7480	7420
07/27/1999	FREEMANT05	GRAB		5441
07/27/1999	FREEMANT05	MSR/OBS	6354	
07/27/1999	FREEMANT05	MSR/OBS	6324	
10/27/2011	FREEMANT05	GRAB	10900	11167
02/04/1999	FREEMANT06	GRAB	6440	6294
07/27/1999	FREEMANT06	GRAB		4994
07/27/1999	FREEMANT06	MSR/OBS	4915	
02/04/1999	FREEMANT06B	GRAB	6920	6888
02/04/1999	FREEMANT06C	GRAB	6460	6396
02/04/1999	FREEMANT06D	GRAB	6410	6348
05/22/1997	FREEMANT06D	GRAB	12700	12765
02/04/1999	FREEMANT07	GRAB	10900	10974
05/22/1997	FREEMANT07B	GRAB	13200	13358
02/04/1999	FREEMANT07C	GRAB	12700	13170
07/27/1999	FREEMANT07C	GRAB		15896
07/27/1999	FREEMANT11	GRAB		3885

Table 10. Monitoring well and seep sample data collected by South Dakota Geological Survey.

Source Name	Date	Nitrate (mg/L	TDS (mg/L)	Conductivity (µmhos/cm)
SEEP 4	09/15/1997	1066	17075	15300
R20-97-42	09/16/1997	216	7352	7770
DUPLICATE	09/16/1997	885	11454	11000
SEEP 12	09/16/1997	1225	14196	13200
R20-97-41	09/16/1997	870	11644	11000
R20-97-40	09/15/1997	752	9689	9490

Appendix B

BATHTUB Model Inputs and Outputs

Table 11. BATHTUB inputs for global variables, atmospheric loads, and model selections for Freeman Lake.

Global Variables	Mean	CV	Model Options	Code	Description
Averaging Period (yrs)	1	0.0	Conservative Substance	1	COMPUTED
Precipitation (m)	0.48	0.0	Phosphorus Balance	8	CANF & BACH, LAKES
Evaporation (m)	0.86	0.0	Nitrogen Balance	1	2ND ORDER, AVAIL N
Storage Increase (m)	0	0.0	Chlorophyll-a	1	P, N, LIGHT, T
			Secchi Depth	3	VS. TOTAL P
Atmos. Loads (kg/km^2-yr)	**Mean**	**CV**	Dispersion	1	FISCHER-NUMERIC
Conserv. Substance	0	0.00	Phosphorus Calibration	1	DECAY RATES
Total P	30	0.50	Nitrogen Calibration	1	DECAY RATES
Total N	1300	0.50	Error Analysis	1	MODEL & DATA
Ortho P	15	0.50	Availability Factors	0	IGNORE
Inorganic N	700	0.50	Mass-Balance Tables	1	USE ESTIMATED CONCS
			Output Destination	2	EXCEL WORKSHEET

Table 12. BATHTUB inputs for segment morphometry, observed water quality, and calibration factors and tributary input data for Freeman Lake.

Segment Morphometry												
			Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})
Seg	Name		Segment	Group	km^2	m	km	Mean	CV	Mean	CV	Mean
1	Segname 1		0	1	0.267	2.069999933	1.20000005	2.059999943	0	2.609999895	0	0.280000001
Segment Observed Water Quality												
	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	7779000	0	156	0	17628	0	89.3799973	0	0.40000001	0	4744	0
Segment Calibration Factors												
	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	1	0	1	0	1	0	1	0	1	0	1	0
Tributary Data												
					Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)
Trib	Trib Name		Segment	Type	km^2	Mean	CV	Mean	CV	Mean	CV	Mean
1	West		1	1	6.03	0.319999993	0	5418346	0	206	0	162755
2	East		1	1	7.51	0.418000013	0	7626462	0	206	0	400278

Table 13. BATHTUB model coefficients for Freeman Lake.

Model Coefficients	Mean	CV
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.050	0.55
Chl-a Model	1.200	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

Table 14. BATHTUB model mass balance output information regarding TDS in Freeman Lake.

Overall Mass Balance Based Upon				Predicted		Outflow & Reservoir Concentrations				
Component:				CONSERVATIVE SUBST.						
				Load		Load Variance			Conc	Export
Trb	Type	Seg	Name	kg/yr	%Total	$(kg/yr)^2$	%Total	CV	mg/m^3	$kg/km^2/yr$
1	1	1	West	1733870.6	35.2%	0.00E+00		0.00	5418346.0	287540.7
2	1	1	East	3187861.3	64.8%	0.00E+00		0.00	7626462.0	424482.2
TRIBUTARY INFLOW				4921732.0	100.0%	0.00E+00		0.00	6669013.0	363495.7
***TOTAL INFLOW				4921732.0	100.0%	0.00E+00		0.00	5682243.0	356466.4
ADVECTIVE OUTFLOW				4921732.0	100.0%	0.00E+00		0.00	7732007.5	356466.4
***TOTAL OUTFLOW				4921732.0	100.0%	0.00E+00		0.00	7732007.5	356466.4
	Overflow Rate (m/yr)			2.4		Nutrient Resid. Time (yrs)			0.8683	
	Hydraulic Resid. Time (yrs)			0.8683		Turnover Ratio			1.2	
	Reservoir Conc (mg/m3)			7732008		Retention Coef.			0.000	

Table 15. Predicted and observed values from BATHTUB model for Freeman Lake.

Predicted & Observed Values Ranked Against CE Model Development Dataset					
Segment:	**1**	**Segname 1**			
	Predicted Values--->		**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**Rank**
CONSERVATIVE SUB	7732007.5			########	
TOTAL P MG/M3	158.2	0.33	90.8%	156.0	90.5%
TOTAL N MG/M3	17908.8	0.26	100.0%	17628.0	100.0%
C.NUTRIENT MG/M3	157.3	0.32	96.8%	155.1	96.7%
CHL-A MG/M3	87.9	0.31	99.8%	89.4	99.8%
SECCHI M	0.4	0.27	8.4%	0.4	9.6%
ORGANIC N MG/M3	2181.6	0.31	99.9%	4744.0	100.0%
TP-ORTHO-P MG/M3	159.0	0.34	96.0%	123.5	93.2%
HOD-V MG/M3-DAY	862.0	0.22	99.9%		
MOD-V MG/M3-DAY	496.5	0.31	99.7%		
ANTILOG PC-1	5696.9	0.52	99.2%	7353.5	99.5%
ANTILOG PC-2	14.0	0.24	93.0%	16.7	96.5%
(N - 150) / P	112.3	0.42	99.7%	112.0	99.7%
INORGANIC N / P	15727.2	0.30	100.0%	396.4	99.5%
TURBIDITY 1/M	0.3		18.9%	0.3	18.9%
ZMIX * TURBIDITY	0.6		1.4%	0.6	1.4%
ZMIX / SECCHI	5.4	0.27	58.8%	5.1	55.2%
CHL-A * SECCHI	33.3	0.29	95.3%	35.8	96.2%
CHL-A / TOTAL P	0.6	0.30	94.9%	0.6	95.4%
FREQ(CHL-a>10) %	99.9	0.00	99.8%	99.9	99.8%
FREQ(CHL-a>20) %	98.1	0.02	99.8%	98.2	99.8%
FREQ(CHL-a>30) %	92.3	0.08	99.8%	92.7	99.8%
FREQ(CHL-a>40) %	83.1	0.15	99.8%	83.8	99.8%
FREQ(CHL-a>50) %	72.6	0.23	99.8%	73.5	99.8%
FREQ(CHL-a>60) %	62.0	0.31	99.8%	63.0	99.8%
CARLSON TSI-P	77.2	0.06	90.8%	77.0	90.5%
CARLSON TSI-CHLA	74.5	0.04	99.8%	74.7	99.8%
CARLSON TSI-SEC	74.0	0.05	91.6%	73.2	90.4%

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Total Dissolved Solids and Specific Conductance Total Maximum Daily Load Evaluation of Freeman Lake, Jackson County, South Dakota**
Submitted by:	**South Dakota Department of Environment an dNatural Resources**
Date Received:	**March 12, 2012**
Review Date:	**July 30, 2012**
Reviewer:	**Bonnie Lavelle**
Rough Draft / Public Notice / Final Draft?	**Public Notice**
Notes:	

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

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

Approval Notes to the 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 TMDL review 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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ 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 ☐ N/A

Summary:

The public notice version of the Freeman Lake TMDLs for specific conductance (SC) and total dissolved solids (TDS) was transmitted to EPA via email on March 12, 2012 with a request for formal review. A copy of the public notice announcing the availability of the document and how to comment was also attached to the email message.

Comments:

No comments.

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.

Review Elements:

☒ 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:

This TMDL document addresses the TDS and SC impairments of Freeman Lake (SD-BA-L-FREEMAN_01).

The summary tables on page 4 of the TMDL document clearly identify the waterbody and associated impairments as they appear on the 2010 EPA- approved 303(d) list for South Dakota. The tables include a full waterbody description, assessment unit/waterbody ID, and the priority ranking for the TMDL.
Freeman Lake (SD-BA-L-FREEMAN_01) is a 66 acre reservoir located in the northeast portion of Jackson County in the western part of south central South Dakota. Freeman Lake is located in the upper portion of Brave Bull Creek watershed, which is part of the Bad River watershed, which ultimately drains to the Missouri River.

The "2010 South Dakota Integrated Report for Surface Water Quality Assessment" dated March 29, 2010 (2010 IR) identifies Freeman Lake as not supporting its designated beneficial use of fish and wildlife propagation, recreation, and stock watering due to elevated SC and elevated TDS concentrations. The following table summarizes the information on impairment from the 2010 IR.

Waterbody	*Entity ID*	*HUC Code*	*Impaired Beneficial Use*	*Source of Impairment*	*Water Quality Criteria*	*Cause*	*Priority*
Freeman Lake	*SD-BA-L-FREEMAN_01*	*1014010209*	*Fish and Wildlife Propagation, Recreation, Stock Watering*	*Specific Conductance*	*≤4000 µmhos/cm as 30 day average* *≤7000 µmhos/cm daily max*	*Natural sources*	*2*
				Total Dissolved Solids	*≤2,500 mg/L as 30 day average* *≤ 4375 mg/L daily max*	*Natural sources*	*2*

The SC and TDS impairments were first listed on the EPA- approved South Dakota list of impaired waters requiring a TMDL, the 303(d) list, in 2006 and again in 2010 and 2012.

Freeman Lake also does not support the designated beneficial use of warmwater permanent fish life propagation due to low concentrations of dissolved oxygen and elevated concentrations of selenium.

The dissolved oxygen impairment was first listed on the EPA-approved South Dakota 303(d) list in 2010. The selenium impairment was first listed on the EPA-approved South Dakota 303(d) list in 1998 (reference: Waterbody History Report for SD-BA-L-FREEMAN_01, from EPA's WATERS website).

EPA approved a TMDL for the selenium impairment in 2001. No TMDL has been developed yet for the dissolved oxygen impairment. This TMDL does not address the dissolved oxygen impairment.

Freeman Lake also does not support the beneficial use of fish and wildlife propagaton , recreation and stock watering due to elevated nitrates. This impairment was first listed on the EPA-approved South Dakota 303(d) list in 1998 (reference: Waterbody History Report for SD-BA-L-FREEMAN_01, from EPA's WATERS website). EPA approved a TMDL for the nitrate impairment in 2001.

The EPA-approved TMDLs for nitrate and selenium have not been implemented to date.

The Freeman Lake watershed is 3,409 acres. Several figures in the TMDL document provide the general location of the waterbody and other features relevant to the understanding of the TMDL analysis:

- *Figure 1 on page 5 provides a vicinity map*
- *Figure 2 on page 6 provides a map of the watershed*
- *Figure 3 on page 10 provides the locations of tributary (seep) sampling sites*
- *Figure 5 on page 13 illustrates surrounding land use adjacent to Freeman Lake*
- *Figure 6 on page 15 provides the locations of in-lake sampling sites*

Comments:

1. *Section 1.0, Introduction:*
    a. *For completeness, please add that the TDS and SC impairments are also listed on the EPA-approved 303(d) list in the 2010 and 2012 South Dakota Integrated Reports.*
    b. *The date of EPA approval of the TMDL for nitrate and selenium is listed as 2000. Our records show that these TMDLs were approved on February 7, 2001. To avoid future confusion, please correct this date.*
    c. *Please include the beneficial uses that are not supported by all impairments. For example, the elevated TDS and SC cause Freeman Lake to not support the fish and wildlife propagation, recreation, and stock watering use. Freeman Lake is also listed in the 2012 South Dakota IR as impaired for fish and wildlife propagation, recreation, and stock watering use due to elevated concentrations of nitrate, and impaired for warmwater permanent fish life propagation due to low dissolved oxygen and elevated concentrations of selenium.*
    d. *The description of the lake on page 7 states that the lake has been in existence for about 60 years with a current depth of over16 feet. Please correct the age – the lake has now been in existence for about 73 years. Also is this depth information still correct? Please update if necessary.*

e. The eighth paragraph on page 7 summarizes the concentrations of TDS and SC measured in seep samples. Please include the dates of the sampling. Additionally, since the lowest TDS and SC measurements were from duplicate samples and the parent samples had much higher concentrations, the acceptability of the results is questionable (4mg/L TDS and 9 umhos/cm SC). We recommend that you use the measurements 572 mg/L TDS and 821 umhos/cm SC as the lowest concentrations when describing the range of results as these values appear to be more acceptable.

f. Please check the maximum TDS value in the eighth paragraph on page 7. According to the data in Table 9 in Appendix A, the maximum concentration of TDS measured in seep samples was 13,358 mg/L in sample FREEMAN07B, collected in May, 1997.

g. The statement "Samples were also collected downstream from the seep areas and above the lake" indicates that additional sampling was conducted. For completeness,please provide all of the data associated with this additional sampling in Appendix A and provide a short summary of the results in the main text.

2. Figure 3, Location of Freemen Lake Tributary Sample Sites (page 10): It would be helpful to identify the 4 seep areas that are described on page 11 on this figure. Also, adding arrows to indicate the seep the flow directions would be helpful.

DENR Response:

1. Section 1.0 Introduction

a. Reference to the 2010 and 2012 Integrated Reports was added to Section 1.0.

b. The date of EPA approval of the nitrate/selenium TMDL was corrected to show that it was approved in 2001.

c. Language was included in Section 1.0 that describes the beneficial uses that are not met because of each impairment.

d. The age of the lake on page 7 was corrected to show that it has been in existence for 73 years. Lake levels fluctuate with precipitation, but the lake is still approximately 16 feet deep at its maximum depth.

e. Dates for saline seep sample data are available in Tables 7, 8, and 9 in Appendix A. A reference to those tables was included to direct readers interested in particular sample dates. The dataset used to develop the TMDL is described in detail in later sections pertaining to data analysis. The minimum TDS and SC values were corrected to the numbers suggested by EPA.

f. A sample concentration of 15,896 was recorded on 7/27/1999 at sample site FREEMAN07C. This data point was mistakenly excluded from Table 9. That omission was corrected and other information, such as sample type, was included in Table 9 for completeness.

g. The statement in question referred to the fact that some samples were taken from tributaries downstream of the seeps rather than the seeps themselves. This sample data was already present in Table 9. Language was included to indicate that samples were collected from tributaries as well as directly from seep areas. The statement in question was removed.

2. Figure 3, Location of Freeman Lake Tributary Sample Sites: A new map was created that shows all sample sites, even those not used in the development of this TMDL, plus the only two seep areas that were specifically identified and mapped. Drainages that contribute seep flow to Freeman Lake had been referred to as "seep areas" in the previous draft of this document. It is more appropriate to simply refer to these areas as "drainages" because the term "seep area" is misleading and confers the notion that contributions from four particular seeps have been documented. There are many seeps spread throughout the watershed and most have not been directly sampled. All contributing seeps are naturally composited in the drainages flowing to the lake and therefore readily quantified. "Drainage" was chosen instead of "tributary" to avoid confusion with tributary inputs for the BATHTUB model. All references to "seep area" were changed to "drainage" when referring to a loading or rate of flow in a drainage contributing to the lake.

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).

Review Elements:

☒ 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 identified sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)). *Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous.*

However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

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

Summary:

Freeman Lake has been assigned the following beneficial uses:

- *warm-water permanent fish life propagation,*
- *immersion recreation,*
- *limited contact recreation, and*
- *fish and wildlife propagation, recreation, and stock watering.*

The water quality criteria protective of these beneficial uses is summarized in ***"Table 1, South Dakota Water Quality Standards for Freeman Lake"*** *(page 9).*

Parameters	Criteria	Unit of Measure	Beneficial Use Requiring this Standard
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L 30 average March 1 to October 31	Warmwater Permanent Fish Life Propagation
	Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards	mg/L 30 average November 1 to February 29	
	Equal to or less than the result from Equation c in Appendix A of Surface Water Quality Standards	mg/L Daily Maximum	
Dissolved Oxygen	$\geq$5.0	mg/L	Warmwater Permanent Fish Life Propagation
Total Suspended Solids	$\leq$90 (mean) $\leq$158 (single sample)	mg/L	Warmwater Permanent Fish Life Propagation
Temperature	$\leq$26.6	°C	Warmwater Permanent Fish Life Propagation
Fecal Coliform Bacteria (May 1- Sept 30)	$\leq$200 (geometric mean) $\leq$400 (single sample)	count/100 mL	Immersion Contact Recreation
Escherichia coli Bacteria (May 1- Sept 30)	$\leq$126 (geometric mean)	count/100 mL	Immersion Contact Recreation

	<235 (single sample)		
Alkalinity ($CaCO_3$)	<750 (mean) <1,313 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Conductance	<4,000 (mean) <7,000 (single sample)	µmhos/cm @ 25° C	Fish and Wildlife Propagation, Recreation and Stock Watering
Nitrogen, nitrate as N	<50 (mean) <88 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
pH (standard units)	>6.5 to <9.0	units	Warmwater Permanent Fish Life Propagation
Solids, total dissolved	<2,500 (mean) <4,375 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Total Petroleum Hydrocarbon Oil and Grease	<10 <10	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering

Section 2.0, "Water Quality Standards" (page 8) and Table 1 (page 9) provide a complete description of the applicable State water quality standards, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criteria, and the anti-degradation policy.

The numeric water quality target established for Freeman Lake for TDS is 2,500 mg/L, which is based on the chronic water quality criterion for TDS. The TDS criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 4,375 mg/L and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 2,500 mg/L.

The numeric water quality target established for Freeman Lake for SC is 4,000 µmhos/cm, which is based on the chronic water quality criterion for SC. The conductance criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 7,000 µmhos/cm and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 4,000 µmhos/cm.

Comments:

Page 8 of the text refers to Table 2 for a summary of the water quality criteria that must be met to support the designated beneficial uses of Freeman Lake. This should be Table 1 not Table 2. Please correct.

DENR Response: *The text was corrected to refer to Table 1.*

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

Review Elements:

☒ 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

<u>Summary:</u>

The TDS water quality criteria protective of the fish and wildlife propagation, recreation, and stock watering beneficial use require that:

1) no sample exceeds 4,375 mg/L and
2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 2,500 mg/L.

The numeric water quality target established for Freeman Lake for TDS is 2,500 mg/L, which is based on the chronic water quality criterion for TDS.

The SC criteria protective of the fish and wildlife propagation, recreation, and stock watering beneficial use requires that:

1) no sample exceeds 7,000 µmhos/cm and
2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 4,000 µmhos/cm.

The numeric water quality target established for Freeman Lake for SC is <4,000 µmhos/cm, which is based on the chronic water quality criterion for SC.

Section 2.1, "Pollutants of Concern" (page 9) provides the rationale for selecting a TDS concentration of <2,500 mg/L as the water quality target for both the TDS TMDL and the SC TMDL. TDS is the measure of dissolved salts in the water. TDS and SC are closely related because many dissolved solids are ions and act as electrical conductors. Based on a regression analysis of the concentration of TDS and SC measured in 17 samples collected from Freeman Lake from 1989 -2011, the average TDS (mg/L) to SC (µmho/cm) ratio of 0.87 was observed in Freeman Lake.

The ratio of the water quality criteria for TDS (<2,500 mg/L) to SC (<4,000 µmho/cm) is 0.63. Therefore, if the TDS water quality criterion of 2,500 mg/L is achieved in Freeman Lake, it's expected that the SC concentration will be (0.87) x (2,500) or 2,175 µmho/cm, thus the SC standard of <4,000 will be achieved. For this reason and because TDS is a direct laboratory measurement of particles that cause electrical conductance in water, TDS is considered the pollutant of concern in regard to both water quality parameters for this TMDL.

Comments:

No comments.

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

Review Elements:

☒ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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**:*

Section 3.0, "Significant Sources" (page 10) identifies the point and nonpoint sources of the pollutant of concern, TDS.

There are no point sources in the Freeman Lake watershed.

The primary non-point sources of total dissolved solids in the Freeman Lake watershed are the four saline seep areas located upstream of the lake. Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. Ground water and hydrologically connected surface water in areas where marine shales are found, such as the Pierre shale soils, are typically high in TDS and nitrate (SDDA 1997). Because TDS and SC are closely related, the seep areas are also the primary cause of the elevated SC values in the lake. The excess free moisture in the soil is the result of land use practices in the recharge area.

Saline seeps are common in western South Dakota and occur most commonly in the Pierre shale soils. The USDA Agricultural Research Service (ARS) conducted several studies of these types of seeps. ARS published a document entitled "Saline-Seep Diagnosis, Control, and Reclamation" which listed ten factors that contribute water to saline-seep problems in the Northern Great Plains. The following seven of the ten factors are potential contributors to the existing seep conditions in the Freeman Lake watershed:

Fallow
High precipitation periods
Snow accumulation
Drainageways
Constructed ponds and dugouts that leak
Roadbeds across natural drainageways

Crop failure

Figure 3, "Location of Freeman Lake Tributary Sample Sites" (page 10) shows the geographic location of eight seep sample sites.

There are four drainage areas south of Interstate Highway 90 (I90) and upgradient of Freeman Lake that presently yield seep flow to lake. The seep areas with highest concentrations of nitrate and TDS (based on 1997 and 1999 sampling) are located between I90 and Hwy 248. These areas have been farmed in the past but recently, due to wet conditions, they have not been farmed and are either void of vegetation or have annual type grasses. There are three other small tributaries that carry groundwater effluent from seep areas to the lake. The areas north of I90 are mainly in permanent vegetation and very little seepage occurs in this area. The seep areas considered to be the main nonpoint sources of loading to Freeman Lake are as follows:

Seep Area 1: Drains the western part of the watershed, flows through a culvert in I90 west of Freeman Lake and enter the lake in the west arm. Includes sample sites FREEMANT03 and FREEMANT04.

Seep Area 2: Drains the central and south eastern part of the watershed and flows directly north into Freeman Lake through a box culvert in Interstate 90. The site 2 drainage joins with Sites 3 & 4 just before it enters the culvert. Includes sample sites FREEMANT05.

Seep Area 3: Drains the eastern part of the watershed and joins with Site 4 drainage just below SD Hwy 16 and east of SD Hwy 63. This flow joins with Site 2 flow at the box culvert. Includes sample sites FREEMANT06 and FREEMANT06D.

Seep Area 4: Drains the area between I 90 and SD Hwy 16 and east of SD Hwy 63. Includes sample sites FREEMANT07, FREEMANT07B, and FREEMANT07C.

Saline seep samples and flow data were collected from 3 locations in 1997 and from 15 locations 1999 as part of the nitrate and selenium TMDL study completed in 2000 by SD DENR. One additional seep sample was collected in 2011. A total of 33 samples were collected from 17 seep locations in 1997-1999. Of the 17 seep sample locations, 8 are located in areas that are the primary source of loading to the lake.

Concentrations of TDS measured at these 8 locations ranged from 4994 mg/L (from FREEMANT06 in July 1999) to 13,358 mg/L (from FREEMAN07B in May 1997).

Measurements of SC at these 8 locations ranged from 4915 umhos/cm (from FREEMANT06 in July 1999) to 13,200 umhos/cm (from FREEMAN T07B in May 1997).

The following seep flow measurements were collected from the four drainage areas that yield seep flow to the lake:

Area 1: 0.009 cfs

Area 2: *0.075 cfs*
Area 3: *0.042 cfs*
Area 4: *0.024 cfs*

Lake samples were collected during only 2 seep sampling events and analyzed only for TDS, not SC. Results from these 2 events indicate the TDS WQC was achieved at the time of sampling. Since lake and seep samples were collected concurrently only twice, the existing data is limited in usefulness for establishing a relationship between seep and lake levels of TDS and SC over time.

However, the available data indicate elevated concentrations of TDS and SC in water flowing from seeps and flow pathways from seeps south of I90 to the lake.

The TDS and SC data from both lake and seep sampling events are summarized in Appendix A.

Comments:

1. *The analytical results for the seep sample collected at FREEMANT05 in 2011 aren't included in Appendix A. For completeness, please add the results to Table 9 in Appendix A.*

2. *The report is clear that 8 of the seep sampling locations are from areas that are the primary source of TDS to the lake. These 8 locations are shown on Figure 3. However, the locations of the other seep sampling sites (from Appendix A) are not shown on Figure 3. Please add these locations to Figure 3.*

3. *Please include the date when the seep flow measurements in Table 2 were collected. May 1997, February 1999, or July 1999?*

4. *Page 10 describes the test drilling and well installation completed by the South Dakota Geological Survey in the area of the existing seeps. Please add that the drilling was completed in 1997 and two monitoring wells were installed near the two seep areas with the highest concentrations of nitrate and selenium. For completeness, please include the sample results in Appendix A.*

5. *The first paragraph on page 11 states that the seep areas with the highest concentrations of nitrate and TDS are located between I90 and Highway 248 and have been farmed. These areas have been too wet to farm recently.*

    a. *We think you meant to refer to the highest concentrations of SC, not nitrate. Please correct as necessary.*
    b. *The seeps haven't been sampled since 1999. Is the statement that the areas have been too wet to farm recently still valid? If yes, what information are you relying on? Please add it to this section of the text.*

6. *The last paragraph on page 12 states that fallow and existing ponds upstream of the lake are the most likely human factors adding moisture to the soil profile. Please indicate the locations of the upstream ponds on one of the figures.*

7. *Section 3.2.1, "Human Sources" (page 13) states that the KOA campground and 1880 town lagoon are operating effectively and have had no discernible effect on the lake. Please provide a short summary of the record of discharges from the lagoons to support this statement.*

DENR Response:
1. The datapoint collected in October of 2011 was added to Table 10 in Appendix A.
2. All sample locations were added to Figure 3. It should be noted that some sample sites are located directly on seeps, but most are tributary sample sites. Many of these sites were not originally included because they were not used in TMDL or modeling calculations because they were located high enough in the watershed that they did not adequately represent loadings to the lake from each particular drainage.
3. SD DENR was unable to verify the date of flow estimations. This information is not available in any documents obtained by SD DENR. However, it is the opinion of SD DENR that the flow data in the EPA approved nitrate/selenium TMDL sufficiently represent seep flow during periods of seep activity in the 4 drainages described.
4. The sample results for data collected by South Dakota Geological Survey were added to Appendix A as Table 11. Language describing the approximate date of monitoring well completion was included.
5. a. Yes, we meant to refer to SC, not nitrate. This was corrected.
b. While seeps and drainages flowing to the lake had not been sampled since the late 1990's, a site visit was conducted in October of 2011. The areas between I90 and Highway 248 were too wet to farm at the time of the visit. The soils in the areas were moist and standing pools of water were present in depressions, presumably from seep flow. The area was not suitable for crop production. Producers were installing livestock fencing at the time of the site visit, presumably for the purpose of having livestock graze the areas. This information was included in the text.
6. A map with the location of the upstream ponds was included in the report. This map is presented as Figure 5.
7. 1880 Town is a permitted facility with a "no discharge" designation, meaning that it is not authorized to discharge. There have been no recorded discharges from this facility. This information, including the permit number for this facility, was included in Section 3.1 Point Sources. The KOA campground discharges to a lagoon northwest of the campground. No discharges from the lagoon are authorized. Because the facility is located downstream of the lake and does not contribute to the lake, it is unlikely to have impacted Freeman Lake water quality. This explanation was included in the 3.2.1 Human Sources section.

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ 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:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- 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…;
- 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);
- 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:

Important Assumptions Used in the Technical Analysis

Freeman Lake receives flow from a 3,409 acre watershed, approximately 3.5 miles wide and 2.5 miles deep with gently rolling to steep topography. The watershed is predominately cropland producing wheat and some alfalfa/grass for hay. The land producing wheat is usually fallowed every other year. There are no active farmsteads in the watershed and the only livestock are 30 to 40 head of cattle grazed in the area east of the lake.

TDS is the pollutant of concern for this TMDL. Section 2.1, "Pollutants of Concern" (page 9) provides
the rationale for selecting a TDS concentration of <2,500 mg/L as the water quality target for both the TDS TMDL and the SC TMDL.

TDS is the measure of dissolved salts in the water. TDS and SC are closely related because many dissolved solids are ions and act as electrical conductors. Based on a regression analysis of the concentration of TDS and SC measured in 17samples collected from Freeman Lake from 1989 -2011, the average TDS (mg/L) to SC (µmho/cm) ratio of 0.87 was observed in Freeman Lake (i.e., TDS = 0.87 SC).

The ratio of the water quality criteria for TDS (<2,500 mg/L) to SC (<4,000 µmho/cm) is 0.63. Therefore, if the TDS water quality criterion of 2,500 mg/L is achieved in Freeman Lake, it's expected that the SC concentration will be (0.87) x (2,500) or 2,175 µmho/cm, thus the SC standard of <4,000 will be achieved. For this reason and because TDS is a direct laboratory measurement of particles that cause electrical conductance in water, TDS was selected as the pollutant of concern in regard to both water quality parameters for this TMDL.

Methodology

The TDS loading capacity of Freeman Lake is based on reduction response modeling performed using BATHTUB, a US Army Corps of Engineers Eutrophication Response Model. The model calculates reductions in TDS concentrations in Freeman Lake for various percent reductions in TDS loading from tributaries. The loading reduction that is predicted to result in Freeman Lake achieving the WQC for TDS becomes the basis for the loading capacity.

Inputs to the BATHTUB model include:

- *TDS loading to Freeman Lake from tributaries was developed from results of seep sampling at eight locations in 1997 and 1999 combined with flow measurements at these same seep areas, averaged over a calendar year. The flow measurements appear to be from a single seep sampling event.*
- *Internal conditions of Freeman Lake are based on results of lake sampling. Sample results from 2006 were used to calibrate the model. The year 2006 was selected because the most recent in-lake sampling results (from 2011) indicate the TDS concentrations meet the WQC for TDS. The lake did not achieve WQC for TDS in 2006. Results from 2006 are considered to best represent the impaired condition of the lake.*

- *Atmospheric loads were provided by SD DENR.*

Documentation and Data

An inventory of the water quality data used to support the development of the TMDL is provided in Appendix A. There are three tables of data:

***Table 7** summarizes TDS sample results from in- lake sampling of Freeman Lake conducted by SD DENR from 1989 – 1997 as part of the South Dakota Statewide Lakes Assessment Program. Lake surface and lake bottom sample results are presented for site SWLAZZZ3907 , a composite of 3 in-lake locations, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C. Concentrations of TDS range from 625 mg/L (in surface sample collected in July 2007) to 8549 mg/l (in a bottom sample collected in July 2004). The most recent sample result is for surface sample collected on August 23, 2007: 1929 mg/L. Another two samples were collected near the east shoreline at site FREEMANL10 in 1997 and 1999 as part of the selenium and nitrate TMDL study. A single grab sample was collected by SD DENR staff in October 2011 at the sample site located in the center of the lake.*

***Table 8** summarizes SC sample results from vertical profile sampling at sample sites SWLAZZZ3907, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C, conducted by SD DENR from 1989 -2006. An additional four SC measurements were taken along the east shoreline at site FREEMANL10 in 1997 and 1999, and one SC measurement was collected from the center of the lake by SD DENR staff in October 2011. Concentrations of SC range from 1644 umhos/cm (in June 1989) to 9007 umhos/cm (in July 2004).*

***Table 9** summarizes TDS and SC sample results from seep samples collected during the development of the TMDL for nitrates and selenium. Note that during this time, lake samples were only collected during 2 tributary sampling events and only analyzed for TDS. Tributary sampling occurred in 1997 at three locations and in 1999 at numerous locations. As summarized above, only one lake sampling event occurred in 1997 and one lake sampling event occurred in 1999 and samples were analyzed for TDS only.*

The data in Appendix A were used to:

- *Establish a Freeman Lake-specific ratio of TDS to SC.*

- *As inputs to the BATHTUB model to predict reductions in loading from tributaries that are necessary to achieve the water quality target. Limitations in the data are not discussed in the TMDL document.*

- *To calibrate the BATHTUB model. Data from lake sampling events in 2006 were used to calibrate the BATHTUB model.*

Results

The TDS loading capacity for Freeman Lake (based on the water quality target of 2,500 mg/L TDS) is 5199 kg/day TDS. The BATHTUB model predicts that a 67% reduction in loading from the tributaries is necessary to achieve the WQC for TDS in Freeman Lake.

Section 5.0, "TMDL and Allocations" (page 23) and Table 6, "TMDL and allocations for Freeman Lake regarding TDS" provide a balanced TMDL equation for TDS, the pollutant of concern for this TMDL as follows:

Current TDS Load =	*13,921 kg/day*
TDS Loading Capacity (TMDL) =	*5,199 kg/day*
Load allocation =	*4,679 kg/day*
WLA =	*0*
Margin of Safety (10%) =	*520 kg/day*
Load Reduction =	*67%*

Comments:

1. *While a balanced TMDL equation is provided in Section 5.0, "TMDL and Allocations" (page 23), it appears to be inconsistent with the predictions of the BATHTUB model, so we're concerned that it may not be correct. It seems that, based on the BATHTUB model results, the TMDL should equate to a 67% reduction of the current load. Yet 5,199 kg/day reflects only a 63% reduction of the current load.*

We think the TMDL equation should reflect the following:

- *The model predicts that a 67% reduction in loading from seep areas will result in Freeman Lake achieving a concentration of 2,500 mg/L TDS, the pollutant of concern.*
- *If the current TDS loading is 13,921 kg/day, a 67% reduction is (13,921 kg/day x (0.33)) = 4594 kg/day. This should be the TMDL.*
- *A 10% MOS would then be (4594)(0.1) = 459 kg/day.*
- *The resulting LA would then be (4594 kg/day) – (459 kg/day) = 4135 kg/day*

2. *Also the value for the current load can't be reproduced. Please add an explanation of how it was determined.*

3. *A balanced TMDL equation should also be provided for SC. The SC equation could be developed using the BATHTUB model outputs for SC, or could be derived using the TDS TMDL and the Freeman Lake- specific relationship between TDS and SC.*

4. *Please modify the column headings in Table 5, "BATHTUB model TDS reduction response predictions for Freeman Lake" (page 22) to more accurately describe the values presented. Suggested modifications are:*
   - *1st column: Percent Reduction in Loading from Seep Areas*
   - *2nd column: Predicted TDS Concentration in Freeman Lake (mg/L)*
   - *3rd column: Predicted SC Concentrations in Freeman Lake (umhos/cm)*

DENR Response:
1. Mathematical errors led to the discrepancy between the load reduction scenario from BATHTUB and the TMDL equation. These errors were corrected and more information pertaining to the BATHTUB modeling scenarios was included in Table 6. It should be noted that percent reductions apply to tributaries flowing into the lake and not specific groundwater seep areas. A TDS loading reduction of 67.7% is required for the lake to meet water quality standards. This reduction is now accurately reflected in the TMDL equation.
2. The value for the current load was determined to be incorrect and was recalculated. The data used to calculate the current load and individual tributary loads for the bathtub model was included in the report as Table 5.
3. Presenting a load of SC would be inappropriate, as the result would be a load of a substance's (water) ability to conduct electricity. To address the SC impairment, language was included that states that the SC water quality standard will be met with attainment of the TDS standard because the TDS standard is more protective than the SC standard. The SC value that corresponds to the chronic TDS standard of 2500 was developed from linear regression in Figure 10 and presented to show that attainment of the TDS standard results in attainment of the SC standard.
4. Table 5 (now Table 6) was revised to include sufficient information for the reader to calculate the current load and reproduce BATHTUB inputs if so desired. Several columns were added that include flow data, concentration data, loading data for each tributary, and predicted in-lake SC and TDS concentration.

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…).

Review Elements:

☒ 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:

An inventory of the water quality data used to support the development of the TMDL is provided in Appendix A. There are three tables of data:

***Table 7** summarizes TDS sample results from in- lake sampling of Freeman Lake conducted by SD DENR from 1989 – 1997 as part of the South Dakota Statewide Lakes Assessment Program. Lake surface and lake bottom sample results are presented for site SWLAZZZ3907 , a composite of 3 in-lake locations, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C. Concentrations of TDS range from 625 mg/L (in surface sample collected in July 2007) to 8549 mg/l (in a bottom sample collected in July 2004). The most recent sample result is for surface sample collected on August 23, 2007: 1929 mg/L. Another two samples were collected near the east shoreline at site FREEMANL10 in 1997 and 1999 as part of the selenium and nitrate TMDL study. A single grab sample was collected by SD DENR staff in October 2011 at the sample site located in the center of the lake.*

***Table 8** summarizes SC sample results from vertical profile sampling at sample sites SWLAZZZ3907, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C, conducted by SD DENR from 1989 -2006. An additional four SC measurements were taken along the east shoreline at site FREEMANL10 in 1997 and 1999, and one SC measurement was collected from the center of the lake by SD DENR staff in October 2011. Concentrations of SC range from 1644 umhos/cm (in June 1989) to 9007 umhos/cm (in July 2004).*

***Table 9** summarizes TDS and SC sample results from seep samples collected during the development of the TMDL for nitrates and selenium. Note that during this time, lake samples were only collected during 2 tributary sampling events and only analyzed for TDS. Tributary sampling occurred in 1997 at three locations and in 1999 at numerous locations. As summarized above, only one lake sampling event occurred in 1997 and one lake sampling event occurred in 1999 and samples were analyzed for TDS only.*

The data in Appendix A were used to:

- *Establish a Freeman Lake-specific ratio of TDS to SC.*
- *As inputs to the BATHTUB model to predict reductions in loading from tributaries that are necessary to achieve the water quality target. Limitations in the data are not discussed in the TMDL document.*
- *Calibrate the BATHTUB model. Lake water quality data from 2006 sampling events were used to calibrate the BATHTUB model.*

Comments:

1. *Section 4.1, "Data Collection Method" (page 13) doesn't clearly describe the data that demonstrate and clearly define the water quality impairment. Please describe that the samples collected during the period 2001-2007 were used to make the beneficial use support determination and to support listing of Freeman Lake on the EPA-approved 303(d) list for 2010.*
2. *Section 4.1, "Data Collection Method" (page 13) doesn't clearly describe the data collection methodology.*
   a. *Please describe that measurements of TDS are from surface and bottom samples collected from 3 sampling locations on the lake, combined to form one composite surface and one composite bottom sample for each sampling event. Two sampling events were conducted each year during 2001-2007. Of the 24 samples collected, 22 samples exceed the daily maximum water quality criterion of 4375 mg/L TDS . Concentrations of TDS during 2001-2007 ranged from 625 mg/L in July 2007 to a maximum of 8549 mg/L in July 2004.*
   b. *Please describe that measurements of SC are from water quality profiles collected with YSI multi-meter water quality probes at 3 locations on the lake during each sampling event. During the period 2001-2007, 6 sampling events were conducted: 2 events in 2001, 1 event in 2004, 2 events in 2005, and 1 event in 2006.*
   c. *Please add to the second paragraph on page 14 that a total of 33 samples were collected from 17 seep locations. Of the 17 seep sample locations, 8 are in areas that are the primary source of loading to the lake.*
   d. *Please add a sentence that the TDS and SC data from lake and seep sampling events are summarized in Appendix A.*
   e. *Note that the 2011 seep sample result isn't included in Appendix A. For completeness, please add the result to Table 9 in Appendix A.*
   f. *Table 3, "Freeman Lake total dissolved solids and specific conductance data" (page 16) includes several results that are not included in Appendix A. The SC data from sample dates 7/14/2006, 7/3/2007, 8/23/2007 and 10/27/2011 and the TDS data from sample date 10/27/2011 are missing from the summary tables in Appendix A. Please check and ensure all data are included in Appendix A.*

DENR Response:

1. Language was included to describe that sample data from the ten years prior to the 303(d) listing was used to make the beneficial use support determination and to support listing Freeman Lake on the EPA-approved 303(d) list for 2010.
2. a. Language was added to more adequately describe the sampling protocol for samples collected as part of the Statewide Lakes Assessment Program. A more accurate description is that 26 samples were collected between 2001-2007, and 22 of those samples exceeded the daily standard of 4,375 mg/L.
b. SD DENR does not assess beneficial use support regarding SC in lakes by calculating criterion exceedance per sample event. Rather, all individual measurements are taken into account and the percent exceedence of these values is used to determine beneficial use support. This explanation was included rather than describing the number of sample events in order to most accurately reflect the 303(d) listing methodology used by SD DENR. Language was included to describe how SC data was collected. Language was added that states the minimum and maximum concentrations recorded.
c. It should be noted that these are tributary samples, not direct samples from seeps. A more accurate explanation was added to the text, describing that out of 18 tributary sample sites, 9 most effectively represent tributary contributions to the lake and were used in data analysis.
d. Language was included to direct the reader to Appendix A for additional sample data.
e. The 2011 seep sample was added to Table 9 in Appendix A.
f. The SC data missing from Appendix A were cut off when pasting the table into the document. This omission was corrected. The TDS sample data from 10/27/2011 was accidentally omitted. This omission was also corrected.

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☐ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

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

***Summary**:*

There are no point sources of TDS or SC in this watershed. The wasteload allocation is zero.

Comments*:*

No Comments.

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.

Review Elements:

☒ 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 the 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:

Section 5.2, "Load Allocation" (page 23) identifies the nonpoint source load as flow from saline seeps that contribute TDS to tributary drainages that feed Freeman Lake. Increase in seep flow occurs due to land use practices. Table 6, "TMDL and allocations for Freeman Lake regarding TDS" (page 23) identifies the load allocation as 4679 kg/day TDS.

Comments:

1. *It's not clear how the predicted 67% reduction in TDS loading from tributaries results in a LA of 4679 kg/day. Please add a detailed explanation, i.e., enough information to allow a reviewer to reproduce the results. .*

2. *Also, see our comments above that identify our concerns with the calculations of the TMDL, LA, and MOS.*

DENR Response:

1. The TMDL calculations were revised to show that the TMDL equals 4360 kg/d, the LA equals 3924 kg/d, and the reduction in the current load required to meet the TMDL is 68%.
2. The MOS is addressed in section 4.4 of this review document.

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).

Review Elements:

☒ 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:

Section 6.1, "Margin of Safety" (page 23) describes the selected MOS. A total of 10% of the load capacity or TMDL was set aside as an explicit margin of safety to account for uncertainty in tributary loadings and in-lake conditions.

Table 6, "TMDL and allocations for Freeman Lake regarding TDS" (page 23) identifies the explicit MOS as 520 kg/day TDS. This value is 10% of the TMDL for TDS of 5199 kg/day.

Comments:

1. *The first sentence of Section 6.1, "Margin of Safety"(page 23) states that 10% of the load allocation was set aside as an explicit MOS. The MOS should be a percentage of the loading capacity or TMDL. Please correct and re-calculate the TMDL, LA, and MOS.*
2. *Also, see our comments above that identify our concerns with the calculations of the TMDL, LA, and MOS.*

DENR Response:
1. The first sentence of section 6.1 was corrected to state that 10% of the TMDL was set aside as the MOS.
2. EPA concerns with the TMDL and LA were addressed in other sections of this document.

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.

Review Elements:

☐ 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:

Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. The amount of flow depends on the amount of free water available, the size of the recharge area, and the time of the year. Seeps are more likely to flow when vegetation is dormant or growing slowly and at times of heaviest precipitation; therefore, *flow is usually heaviest in the spring. The flow may be reduced or stop altogether during the late spring and summer and start again after frost has occurred in the fall.*

Field trips conducted during the TMDL study for selenium and nitrate indicated that seepage yield approaches zero in July, August, and September. Flow begins to increase as vegetative growth decreases and reaches a constant flow by the beginning of December. This flow will continue throughout the winter and may even increase after the spring thaw. Flow starts to diminish in late April and usually approaches zero by July. A field trip to the seep areas in late October of 2011 showed that one of the seeps in the eastern tributary was currently active and contributing flow to the lake.

Modeling performed to support the development of the TMDL assumed that seeps flow for 305 days per year, based on the assumption that flow ceases in July, August, and September. Flow data from seeps collected during periods when the seeps were flowing were used in the model.

***Comments**:*

It's not clear whether the BATHTUB model takes temporal variation in loading capacity (seasonality) into account. We understand that the model is a steady state model that assumes continual loading at a constant rate. Please provide an explanation.

DENR Response: BATHTUB is a steady state model and as such does not take temporal variation into account. BATHTUB can simulate lake responses to a constant loading rate over a defined period of time. The defined period of time is called the "averaging period". There is no means of varying model inputs at some point during the averaging period, such as having one set of inputs for the first 30 days and another for the remainder of the averaging period. Because the contributions from seep areas upstream of the lake vary temporally, and an averaging period of one year was desired for simplicity both in calculations and the understanding of the reader, the input concentration for each tributary was taken by a factor of an estimate of the number of days of seep activity (and therefore tributary loading) divided by the averaging period, which is 365 days. This factor accounts for the temporal variation in tributary loading from seep areas by mathematically accounting for seasonality. More information on the BATHTUB model is available in the US Army Corps of Engineers document Simplified Procedures for Eutrophication Assessment and Prediction: User Manual. This user guide is cited in the TMDL document.

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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.

Review Elements:

☒ 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 TMDL document is written in clear language that explains the impairment, the technical analysis, the loading capacity, the load allocation and margin of safety in terms understandable to the general public and scientific community.

Section 7.0, "Public Participation" (page 24) describes the public participation process used during the development of the TMDL.
SD DENR was the lead state agency involved in the completion of this assessment. Also contributing to the assessment were the South Dakota Game, Fish, and Parks Department, the South Dakota Geological Survey, and the South Dakota Department of Agriculture.

The Jackson County Conservation District provided assistance in collecting data as part of the selenium and nitrate TMDL study.

The draft TMDL was made available to the public for review and comment. In March 2012, public notices were placed in the Murdo Coyote, the Kadoka Press, and the Pioneer Review. A copy of the public notices was provided to EPA. The public notices included information about how to obtain a copy of the document and how to submit comments to SDDENR. Comments were requested by April 22, 2012. All comments received are taken into consideration in the final document.

***Comments**:*

No Comments. .

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.

Review Elements:

☐ 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:

Section 8.0, "Monitoring Strategy" (page 24) acknowledges that new information will be generated during implementation of the TMDL including monitoring data, best management practices effectiveness information, and land use information.

Additionally, SD DENR will continue to monitor Freeman Lake part of the South Dakota Statewide Lakes Assessment Program. Sampling will occur twice throughout the growing season to examine seasonal patterns. The results from this monitoring can be used to update the BATHTUB model and model outputs can be used to evaluate the project effectiveness or to determine TMDL adjustments.

The scope of the South Dakota Statewide Lakes Assessment Program is as follows:

- *Lakes are sampled on a 4-year rotation historically.*
- *Currently, lakes are selected annually for sampling according to the following criteria:*
    - *Annual sampling of the top 10-12 public high-profile lakes;*

    - *From the population of previously monitored lakes, 10-12 lakes are randomly selected annually; and*
    - *From the remaining population of classified lakes, 10-12 classified lakes are randomly selected annually.*
  - *Sampling frequency is: 2 samples during the growing season*
  - *Sample locations: 1-3 predetermined locations within the basin of each lake*
  - *Sample methodology*
    - *Samples collected 0.5 meters from the surface and in some instances 0.5 meters from the bottom*
    - *Samples are either individual samples or are composited from multiple stations or depths throughout the water column*
    - *For DO, T. pH, and SC, profile measurements are recorded at 1.0 meter increments throughout the water column. The entire population of data from profile sampling is used to make beneficial use support determinations.*

Comments:

No comments.

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.

Review Elements:

☐ 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:

Since there are no point source discharges of TDS or SC in the Freeman Lake watershed, there is no WLA, thus no requirement that the TMDL document demonstrate reasonable assurance.

Section 9.0, "Implementation Strategy" (page 24) provides details about the primary approach that will be used to successfully implement this TMDL and achieve the necessary loading reductions of TDS and SC.

Saline seeps are the primary source of TDS and SC loading to Freeman Lake. Therefore, implementation of this TMDL should focus on reducing flow from the seep areas. There are four main seep areas identified in the TMDL document. To reduce flow from the seeps, implementation efforts must be directed toward recharge areas of these seeps.

The primary objective of implementation efforts should be planting deep rooted vegetation in seep recharge areas that will capture subsoil moisture via transpiration. Recharge areas should be seeded with alfalfa, which is the most effective way to dry the deep subsoil and stop water flow to the saline seep. Recommended alfalfa cultivars include:

Beaver alfalfa (likely to be the most effective)
Roamer, and
MS243

If these preferred cultivars are not available, other cultivars of alfalfa could also be used with favorable results.

It's imperative that alfalfa be planted over the majority of the recharge area. Halverson and Reule (1976, 1980) found that growing alfalfa on 80% of the recharge area effectively reduced flow from several saline seeps, while a narrow strip of alfalfa covering less than 20% of the recharge area on the immediate upslope of the discharge area did not effectively control flow from the saline seeps.

Planting grasses in the recharge areas is a secondary option for controlling flow from the seeps and could be employed during implementation. However, grasses are not as effective as alfalfa at capturing deep subsoil moisture.

Once flow to the recharge area of seeps has been controlled to the extent that the water table in the saline seep has been lowered or eliminated, the land in the discharge area may be reclaimed for agricultural purposes. More information on this process can be found in USDA ARS publication titled "Saline-Seep Diagnosis, Control, and Reclamation" which could be an important resource in developing implementation plans.

There is not an implementation project currently underway in the Freeman Lake watershed. The TMDL for nitrate and selenium impairments of Freeman Lake, approved by EPA in 2001, has an identical implementation strategy but to date, the strategy has not been implemented.

Comments:

The implementation plan is practical and likely will be effective. We note that the 2001 EPA-approved TMDL for nitrate and selenium states that an implementation plan will be developed in cooperation with the Jackson County Conservation District and in consultation with affected landowners. The goal was to develop the implementation plan within one year of the TMDL approval by EPA (2002). The goal for completion of the first phase of the project was within 3 years (2005). However, no implementation project is underway at this time.

EPA would like to work with SD DENR to explore options for developing an implementation plan for the nitrate and selenium TMDLs as well as the TDS and SC TMDLs within the next year.

DENR Response: *SD DENR looks forward to developing an implementation plan with EPA.*

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.

Review Elements:

☒ 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:

Section 5.0, "TMDL and Allocations" (page 23) and Table 6, "TMDL and allocations for Freeman Lake regarding TDS"(page 23) provide an expression of the TMDL as a daily load:

TDS Loading Capacity (TMDL) =	*5,199 kg/day*
Load allocation =	*4,679 kg/day*
WLA =	*0*
Margin of Safety (10%) =	*520 kg/day*
Current TDS Load =	*13,921 kg/day*
Load Reduction =	*67%*

Comments:

While the TDS TMDL is provided in Section 5.0, "TMDL and Allocations" (page 23), and it is expressed in terms of a daily load, it appears to be inconsistent with the predictions of the BATHTUB model, so we're concerned that it may not be correct. It seems that, based on the BATHTUB model results, the TMDL should equate to a 67% reduction of the current load. Yet 5,199 kg/day reflects only a 63% reduction of the current load.

We think the TMDL equation should reflect the following:

The model predicts that a 67% reduction in loading from seep areas will result in Freeman Lake achieving a concentration of 2,500 mg/L TDS, the pollutant of concern.

If the current TDS loading is 13,921 kg/day, a 67% reduction is (13,921 kg/day x (0.33)) = 4594 kg/day. This should be the TMDL.

A 10% MOS would then be (4594)(0.1) = 459 kg/day.

The resulting LA would then be (4594 kg/day) – (459 kg/day) = 4135 kg/day

Also the value for the current load can't be reproduced. Please add an explanation of how it was determined.

A TMDL, expressed in terms of a daily load, should also be provided for SC. The SC TMDL could be developed using the BATHTUB model outputs for SC, or could be derived using the TDS TMDL and the Freeman Lake- specific relationship between TDS and SC.

DENR Response:

The values for current load, TMDL, MOS, LA, and percent reduction required to meet the TMDL were all incorrect and were revised. More information on the calculation of tributary loads was included in the report.

The current load was calculated as 13484 kg/d, and was developed from tributary data in Table 5.

To address the SC impairment in the TMDL section, language was included that states that the SC water quality standard will be met with attainment of the TDS standard because the TDS standard is more protective than the SC standard. The SC value that corresponds to the chronic TDS standard of 2500 was developed from linear regression in Figure 10 and presented to show that attainment of the TDS standard results in attainment of the SC standard.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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SEP 26 2012

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 Approval
Freeman Lake, Total Dissolved Solids
SD-BA-L-FREEMAN_01

Dear Mr. Pirner:

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

Thank you for submitting the TMDL for our review and approval. If you have any questions, the most knowledgeable person on my staff is Bonnie Lavelle and she may be reached at 303-312-6579.

Sincerely,

Howard M. Cantor, for
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures

ENCLOSURE 1: APPROVED TMDLs

TOTAL DISSOLVED SOLIDS AND SPECIFIC CONDUCTIVITY TOTAL MAXIMUM DAILY LOAD EVALUATION OF FREEMAN LAKE, JACKSON COUNTY, SOUTH DAKOTA

1	Pollutant TMDLs completed.
2	Causes addressed from the 2012 303(d) list.
0	Determinations that no pollutant TMDL needed.

Submitted: 9/14/2012

Segment: Freeman Lake

303(d) ID: SD-BA-L-FREEMAN 01

Parameter/Pollutant (303(d) list cause): TOTAL DISSOLVED SOLIDS - 509

Water Quality Targets: <2,500 mg/L 30 day average concentration with daily maximum concentration of <4,375 mg/L

Allocation*	Value	Units	State Permits	Permits
WLA	0	KG/DAY		
MOS	0.44	KG/DAY		
LA	3.93	KG/DAY		
TMDL	4.37	KG/DAY		

Notes:

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

ENCLOSURE 2: EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Total Dissolved Solids and Specific Conductivity Total Maximum Daily Load Evaluation of Freeman Lake, Jackson County, South Dakota**
Submitted by:	**South Dakota Department of Environment and Natural Resources**
Date Received:	**September 14, 2012**
Review Date:	**September 19, 2012**
Reviewer:	**Bonnie Lavelle**
Rough Draft / Public Notice / Final Draft?	**Final**
Notes:	

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

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

Approval Notes to the Administrator: Based on the review presented below, I recommend approval of the TMDLs submitted in this document.

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the TMDL review 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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☒ 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 ☐ N/A

Summary:

The final version of the Freeman Lake TMDLs for specific conductance (SC) and total dissolved solids (TDS) was transmitted to EPA via email on September 14, 2012 with a submittal letter requesting final review and approval.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document addresses the TDS and SC impairments of Freeman Lake (SD-BA-L-FREEMAN_01).

The summary tables on page 4 of the TMDL document clearly identify the waterbody and associated impairments as they appear on the 2010 EPA- approved 303(d) list for South Dakota. The tables include a full waterbody description, assessment unit/waterbody ID, and the priority ranking for the TMDL.
Freeman Lake (SD-BA-L-FREEMAN_01) is a 66 acre reservoir located in the northeast portion of Jackson County in the western part of south central South Dakota. Freeman Lake is located in the upper portion of Brave Bull Creek watershed, which is part of the Bad River watershed, which ultimately drains to the Missouri River. It has been in existence for 73 years and currently has a depth of 16 feet.

The "2010 South Dakota Integrated Report for Surface Water Quality Assessment" dated March 29, 2010 (2010 IR) identifies Freeman Lake as not supporting its designated beneficial use of fish and wildlife propagation, *recreation, and stock watering due to elevated SC and elevated TDS concentrations. The following table summarizes the information on impairment from the 2010 IR.*

Waterbody	*Entity ID*	*HUC Code*	*Impaired Beneficial Use*	*Source of Impairment*	*Water Quality Criteria*	*Cause*	*Priority*
Freeman Lake	*SD-BA-L-FREEMAN_01*	*1014010209*	*Fish and Wildlife Propagation, Recreation, Stock Watering*	*Specific Conductance*	*≤4000 µmhos/cm as 30 day average* *≤7000 µmhos/cm daily max*	*Natural sources*	*2*
				Total Dissolved Solids	*≤2,500 mg/L as 30 day average* *≤ 4375 mg/L daily max*	*Natural sources*	*2*

The SC and TDS impairments were first listed on the EPA- approved South Dakota list of impaired waters requiring a TMDL, the 303(d) list, in 2006 and again in 2010 and 2012.

Freeman Lake also does not support the designated beneficial use of warmwater permanent fish life propagation due to low concentrations of dissolved oxygen and elevated concentrations of selenium.

The dissolved oxygen impairment was first listed on the EPA-approved South Dakota 303(d) list in 2010. The selenium impairment was first listed on the EPA-approved South Dakota 303(d) list in 1998 (reference: Waterbody History Report for SD-BA-L-FREEMAN_01, from EPA's WATERS website).

EPA approved a TMDL for the selenium impairment in 2001. No TMDL has been developed yet for the dissolved oxygen impairment. This TMDL does not address the dissolved oxygen impairment.

Freeman Lake also does not support the beneficial use of fish and wildlife propagation, recreation and stock watering due to elevated nitrates. This impairment was first listed on the EPA-approved South Dakota 303(d) list in 1998 (reference: Waterbody History Report for SD-BA-L-FREEMAN_01, from EPA's WATERS website). EPA approved a TMDL for the nitrate impairment in 2001.

The EPA-approved TMDLs for nitrate and selenium have not been implemented to date.

The Freeman Lake receives flow from the 3,409 acre watershed which is about 3.5 miles wide and 2.5 miles deep with gently rolling to steep topography. Several figures in the TMDL document provide the general location of the waterbody and other features relevant to the understanding of the TMDL analysis:

- *Figure 1 on page 6 provides a vicinity map*
- *Figure 2 on page 7 provides a map of the watershed*

- *Figure 3 on page 12 provides the locations of tributary (seep) sampling sites, mapped seep locations, and monitoring wells*
- *Figure 5 on page 14 provides the locations of ponds upstream of Freeman Lake that contribute to seep activity*
- *Figure 6 on page 15 illustrates surrounding land use adjacent to Freeman Lake*
- *Figure 7 on page 16 provides the locations of in-lake sampling sites*

Comments: *No comments.*

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).

Review Elements:

☒ 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 identified 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:

Section 2.0, "Water Quality Standards" (page 8) and Table 1 (page 10) provide a complete description of the applicable State water quality standards, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criteria, and the anti-degradation policy.

Freeman Lake has been assigned the following beneficial uses:

- *warm-water permanent fish life propagation,*
- *immersion recreation,*
- *limited contact recreation, and*
- *fish and wildlife propagation, recreation, and stock watering.*

The water quality criteria protective of these beneficial uses is summarized in ***"Table 1, South Dakota Water Quality Standards for Freeman Lake"*** *(page 10).*

Parameters	Criteria	Unit of Measure	Beneficial Use Requiring this Standard
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L 30 average March 1 to October 31	Warmwater Permanent Fish Life Propagation
	Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards	mg/L 30 average November 1 to February 29	
	Equal to or less than the result from Equation 2 in Appendix A of Surface Water Quality Standards	mg/L Daily Maximum	
Dissolved Oxygen	≥5.0 (daily minimum)	mg/L	Warmwater Permanent Fish Life Propagation
Total Suspended Solids	≤90 (mean) ≤158 (single sample)	mg/L	Warmwater Permanent Fish Life Propagation
Temperature	≤26.6	°C	Warmwater Permanent Fish Life Propagation
Fecal Coliform Bacteria (May 1- Sept 30)	≤200 (geometric mean) ≤400 (single sample)	count/100 mL	Immersion Contact Recreation
Escherichia coli Bacteria (May 1- Sept 30)	≤126 (geometric mean) ≤235 (single sample)	count/100 mL	Immersion Contact Recreation
Alkalinity ($CaCO_3$)	≤750 (mean) ≤1,313 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Conductivity	≤4,000 (mean) ≤7,000 (single sample)	µmhos/cm @ 25° C	Fish and Wildlife Propagation, Recreation and Stock Watering
Nitrogen, nitrate as N	≤50 (mean) ≤88 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
pH (standard units)	≥6.5 to ≤9.0	units	Warmwater Permanent Fish Life Propagation
Solids, total dissolved	≤2,500 (mean) ≤4,375 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Total Petroleum Hydrocarbon Oil and Grease	≤10 ≤10	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering

The numeric water quality target established for Freeman Lake for TDS is 2,500 mg/L, which is based on the chronic water quality criterion for TDS. The TDS criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 4,375 mg/L and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 2,500 mg/L.

The numeric water quality target established for Freeman Lake for SC is 4,000 µmhos/cm, which is based on the chronic water quality criterion for SC. The conductivity criteria for the fish, wildlife propagation, recreation, and stock watering beneficial use requires that 1) no sample exceeds 7,000 µmhos/cm and 2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 4,000 µmhos/cm.

Comments: *No comments.*

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

Review Elements:

☒ 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 TDS water quality criteria protective of the fish and wildlife propagation, recreation, and stock watering beneficial use require that:

1) no sample exceeds 4,375 mg/L and
2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 2,500 mg/L.

The numeric water quality target established for Freeman Lake for TDS is 2,500 mg/L, which is based on the chronic water quality criterion for TDS.

The SC criteria protective of the fish and wildlife propagation, recreation, and stock watering beneficial use requires that:

1) no sample exceeds 7,000 µmhos/cm and
2) the arithmetic mean of a minimum of 3 consecutive grab samples taken on separate weeks in a 30 day period must not exceed 4,000 µmhos/cm.

The numeric water quality target established for Freeman Lake for SC is <4,000 µmhos/cm, which is based on the chronic water quality criterion for SC.

Section 2.1, "Pollutants of Concern" (page 10) provides the rationale for selecting a TDS concentration of ≤2,500 mg/L as the water quality target for both the TDS TMDL and the SC TMDL. TDS is the measure of dissolved salts in the water. TDS and SC are closely related because many dissolved solids are ions and act as electrical conductors. Based on a regression analysis of the concentration of TDS and SC measured in 17 samples collected from Freeman Lake from 1989 -2011, the average TDS (mg/L) to SC (µmho/cm) ratio of 0.87 was observed in Freeman Lake.

The ratio of the water quality criteria for TDS (≤2,500 mg/L) to SC (≤4,000 µmho/cm) is 0.63. Therefore, if the TDS water quality criterion of 2,500 mg/L is achieved in Freeman Lake, it's expected that the SC concentration will be (0.87) x (2,500) or 2,175 µmho/cm, thus the SC standard of ≤4,000 will be achieved. For this reason and because TDS is a direct laboratory measurement of particles that cause electrical conductivity in water, TDS is considered the pollutant of concern in regard to both water quality parameters for this TMDL.

Comments: *No comments.*

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

Review Elements:

- ☒ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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**:*

Section 3.0, "Significant Sources" (page 11) identifies the point and nonpoint sources of the pollutant of concern, TDS.

There are no point sources in the Freeman Lake watershed. The only permitted point source in the watershed is 1880 Town which routes wastewater to a lagoon located north of the Freeman Lake. The permit does not authorize discharges from the lagoon. The permit number is SD0028100.

The primary non-point sources of total dissolved solids in the Freeman Lake watershed are the four saline seep areas located upstream of the lake. Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. Ground water and hydrologically connected surface water in areas where marine shales are found, such as the Pierre shale soils, are typically high in TDS and nitrate (SDDA 1997). Because TDS and SC are closely related, the seep areas are also the primary cause of the elevated SC values in the lake. The excess free moisture in the soil is the result of land use practices in the recharge area.

Saline seeps are common in western South Dakota and occur most commonly in the Pierre shale soils. The USDA Agricultural Research Service (ARS) conducted several studies of these types of seeps. ARS published a document entitled "Saline-Seep Diagnosis, Control, and Reclamation" which listed ten factors that contribute water to saline-seep problems in the Northern Great Plains. The following seven of the ten factors are potential contributors to the existing seep conditions in the Freeman Lake watershed:

Fallow
High precipitation periods
Snow accumulation
Drainageways
Constructed ponds and dugouts that leak
Roadbeds across natural drainageways
Crop failure

Figure 3, "Location of Freeman Lake Tributary Sample Sites, Mapped Seep Locations, and Monitoring Wells" (page 12) shows the geographic location of eight seep sample sites.

There are four drainage areas south of Interstate Highway 90 (I90) and upgradient of Freeman Lake that presently yield seep flow to lake. The areas with highest concentrations of nitrate and TDS (based on 1997 and 1999 sampling) are located between I90 and Hwy 248. These areas have been farmed in the past but recently, due to wet conditions, they have not been farmed and are either void of vegetation or have annual type grasses. This was verified on a site visit in October 2011. There are three other small tributaries that carry groundwater effluent from seep areas to the lake. The areas north of I90 are mainly in permanent vegetation and very little seepage occurs in this area. The drainage areas considered to be the main nonpoint sources of loading to Freeman Lake are as follows:

Drainage Area 1: Drains the western part of the watershed, flows through a culvert in I90 west of Freeman Lake and enters the lake in the west arm. Includes sample sites FREEMANT03, FREEMANT03B and FREEMANT04.

Drainage Area 2: Drains the central and south eastern part of the watershed and flows directly north into Freeman Lake through a box culvert in Interstate 90. The site 2 drainage joins with Sites 3 & 4 just before it enters the culvert. Includes sample site FREEMANT05.

Drainage Area 3: Drains the eastern part of the watershed and joins with Site 4 drainage just below SD Hwy 16 and east of SD Hwy 63. This flow joins with Site 2 flow at the box culvert. Includes sample sites FREEMANT06 and FREEMANT06D.

Drainage Area 4: Drains the area between I 90 and SD Hwy 16 and east of SD Hwy 63. Includes sample sites FREEMANT07, FREEMANT07B, and FREEMANT07C.

Samples and flow data were collected from 3 tributary locations in 1997 and from 15 tributary locations 1999 as part of the nitrate and selenium TMDL study completed in 2000 by SD DENR. One additional sample was collected at location FREEMANT05 in 2011. A total of 33 samples were collected from 18 tributary locations in 1997-1999. Of the 18 sample locations, 9 are located in areas that are the primary source of loading to the lake. Figure 3 indicates the locations of all sample sites. It should be noted that some sites are located directly on seeps, but most are tributary sample sites. Many of the sites were not used in the TMDL or modeling calculations because they were located high enough in the watershed that they do not adequately represent loadings to the lake.

Concentrations of TDS measured at the 9 locations in areas that are primary sources of loading to the lake ranged from 4994 mg/L (from FREEMANT06 in July 1999) to 15,896 mg/L (from FREEMAN07C in July 1999).

Measurements of SC at these 9 locations ranged from 4915 umhos/cm (from FREEMANT06 in July 1999) to 13,200 umhos/cm (from FREEMAN T07B in May 1997).

The following seep flow measurements were collected from the four drainage areas that yield seep flow to the lake:

Area 1: 0.009 cfs
Area 2: 0.075 cfs
Area 3: 0.042 cfs
Area 4: 0.024 cfs

Lake samples were collected during only 2 tributary sampling events and analyzed only for TDS, not SC. Results from these 2 events indicate the TDS WQC was achieved at the time of sampling. Since lake and tributary samples were collected concurrently only twice, the existing data is limited in usefulness for establishing a relationship between tributary and lake levels of TDS and SC over time.

However, the available data indicate elevated concentrations of TDS and SC in water flowing from seeps and flow pathways from seeps south of I90 to the lake.

The TDS and SC data from lake, tributary, and monitoring well sampling events are summarized in Appendix A.

Comments: *No comments.*

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ 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:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- 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…;
- 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);
- 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:

Important Assumptions Used in the Technical Analysis

Freeman Lake receives flow from a 3,409 acre watershed, approximately 3.5 miles wide and 2.5 miles deep with gently rolling to steep topography. The watershed is predominately cropland producing wheat and some alfalfa/grass for hay. The land producing wheat is usually fallowed every other year. There are no active farmsteads in the watershed and the only livestock are 30 to 40 head of cattle grazed in the area east of the lake.

TDS is the pollutant of concern for this TMDL. Section 2.1, "Pollutants of Concern" (page 10) provides the rationale for selecting a TDS concentration of <2,500 mg/L as the water quality target for both the TDS TMDL and the SC TMDL.

TDS is the measure of dissolved salts in the water. TDS and SC are closely related because many dissolved solids are ions and act as electrical conductors. Based on a regression analysis of the concentration of TDS and SC measured in 17samples collected from Freeman Lake from 1989 -2011, the average TDS (mg/L) to SC (µmho/cm) ratio of 0.87 was observed in Freeman Lake (i.e., TDS = 0.87 SC).

The ratio of the water quality criteria for TDS (<2,500 mg/L) to SC (<4,000 µmho/cm) is 0.63. Therefore, if the TDS water quality criterion of 2,500 mg/L is achieved in Freeman Lake, it's expected that the SC concentration will be (0.87) x (2,500) or 2,175 µmho/cm, thus the SC standard of <4,000 will be achieved. For this reason and because TDS is a direct laboratory measurement of particles that cause electrical conductivity in water, TDS was selected as the pollutant of concern in regard to both water quality parameters for this TMDL.

Methodology

The TDS loading capacity of Freeman Lake is based on reduction response modeling performed using BATHTUB, a US Army Corps of Engineers Eutrophication Response Model. The model calculates reductions in TDS concentrations in Freeman Lake for various percent reductions in TDS loading from tributaries. The loading reduction that is predicted to result in Freeman Lake achieving the WQC for TDS becomes the basis for the loading capacity.

Inputs to the BATHTUB model include:

- *TDS loading to Freeman Lake from tributaries was developed from results of sampling at nine locations in 1997 and 1999 combined with flow measurements at these same seep areas, averaged over a calendar year. The flow measurements appear to be from a single seep sampling event.*
- *Internal conditions of Freeman Lake are based on results of lake sampling. Sample results from 2006 were used to calibrate the model. The year 2006 was selected because the most recent in-lake sampling results (from 2011) indicate the TDS concentrations meet the WQC for TDS. The lake did not achieve*

WQC for TDS in 2006. Results from 2006 are considered to best represent the impaired condition of the lake.

- *Atmospheric loads were provided by SD DENR.*

Documentation and Data

An inventory of the water quality data used to support the development of the TMDL is provided in Appendix A. There are four tables of data:

***Table 7** summarizes TDS sample results from in- lake sampling of Freeman Lake conducted by SD DENR from 1989 – 1997 as part of the South Dakota Statewide Lakes Assessment Program. Lake surface and lake bottom sample results are presented for site SWLAZZZ3907, a composite of 3 in-lake locations, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C. Concentrations of TDS range from 625 mg/L (in surface sample collected in July 2007) to 8549 mg/l (in a bottom sample collected in July 2004). The most recent sample result is for surface sample collected on August 23, 2007: 1929 mg/L. Another two samples were collected near the east shoreline at site FREEMANL10 in 1997 and 1999 as part of the selenium and nitrate TMDL study. A single grab sample was collected by SD DENR staff in October 2011 at the sample site located in the center of the lake.*

***Table 8** summarizes SC sample results from vertical profile sampling at sample sites SWLAZZZ3907, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C, conducted by SD DENR from 1989 -2006. An additional four SC measurements were taken along the east shoreline at site FREEMANL10 in 1997 and 1999, and one SC measurement was collected from the center of the lake by SD DENR staff in October 2011. Concentrations of SC range from 1644 umhos/cm (in June 1989) to 9007 umhos/cm (in July 2004).*

***Table 9** summarizes TDS and SC sample results from samples collected at tributary sites during the development of the TMDL for nitrates and selenium. Note that during this time, lake samples were only collected during 2 tributary sampling events and only analyzed for TDS. Tributary sampling occurred in 1997 at three locations and in 1999 at numerous locations. As summarized above, only one lake sampling event occurred in 1997 and one lake sampling event occurred in 1999 and samples were analyzed for TDS only.*

***Table 10** summarizes monitoring well and seep sample data collected by the South Dakota Geological Survey in 1997. Groundwater concentrations of TDS in two wells ranged from 7352 mg/L to 11644 mg/L. Seep concentrations of TDS ranged from 14196 mg/L to 17, 075 mg/L. Groundwater levels of SC in two wells ranged from 7770 umhos/cm to 11,000 umhos/cm. Seep levels of SC ranged from 13,200 umhos/cm to 15,300 umhos/cm.*

The data in Appendix A were used to:

- *Establish a Freeman Lake-specific ratio of TDS to SC.*
- *Establish the time trend relationship of TDS concentrations in Freeman Lake.*
- *As inputs to the BATHTUB model to predict reductions in loading from tributaries that are necessary to achieve the water quality target.*
- *To calibrate the BATHTUB model. Data from lake sampling events in 2006 were used to calibrate the BATHTUB model.*

Results

The TDS loading capacity for Freeman Lake (based on the water quality target of 2,500 mg/L TDS) is 4.37 kg/day TDS. The BATHTUB model predicts that a 68% reduction in loading from the tributaries is necessary to achieve the WQC for TDS in Freeman Lake.

Section 5.0, "TMDL and Allocations" (page 26) and Table 6, "TMDL and allocations for Freeman Lake regarding TDS" provide a balanced TMDL equation for TDS, the pollutant of concern for this TMDL as follows:

Current TDS Load =	*13.53 kg/day*
TDS Loading Capacity (TMDL) =	*4.37 kg/day*
Load allocation =	*3.93 kg/day*
WLA =	*0*
Margin of Safety (10%) =	*0.44 kg/day*
Load Reduction =	*68%*

Comments: *No comments.*

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…).

Review Elements:

☒ 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:

An inventory of the water quality data used to support the development of the TMDL is provided in Appendix A. There are three tables of data:

Table 7 *summarizes TDS sample results from in- lake sampling of Freeman Lake conducted by SD DENR from 1989 – 1997 as part of the South Dakota Statewide Lakes Assessment Program. Lake Surface and lake bottom sample results are presented for site SWLAZZZ3907, a composite of 3 in-lake locations, SWLAZZZ3907A,* *SWLAZZZ3907B, and SWLAZZZ3907C. Concentrations of TDS range from 625 mg/L (in surface sample collected in July 2007) to 8549 mg/l (in a bottom sample collected in July 2004). The most recent sample result is for surface sample collected on August 23, 2007: 1929 mg/L. Another two samples were collected near the east shoreline at site FREEMANL10 in 1997 and 1999 as part of the selenium and nitrate TMDL study. A single grab sample was collected by SD DENR staff in October 2011 at the sample site located in the center of the lake.*

***Table 8** summarizes SC sample results from vertical profile sampling at sample sites SWLAZZZ3907, SWLAZZZ3907A, SWLAZZZ3907B, and SWLAZZZ3907C, conducted by SD DENR from 1989 -2006. An additional four SC measurements were taken along the east shoreline at site FREEMANL10 in 1997 and 1999, and one SC measurement was collected from the center of the lake by SD DENR staff in October 2011. Concentrations of SC range from 1644 umhos/cm (in June 1989) to 9007 umhos/cm (in July 2004).*

***Table 9** summarizes TDS and SC sample results from tributary samples collected during the development of the TMDL for nitrates and selenium. Note that during this time, lake samples were only collected during 2 tributary sampling events and only analyzed for TDS. Tributary sampling occurred in 1997 at three locations and in 1999 at numerous locations. As summarized above, only one lake sampling event occurred in 1997 and one lake sampling event occurred in 1999 and samples were analyzed for TDS only.*

***Table 10** summarizes monitoring well and seep sample data collected by the South Dakota Geological Survey in 1997. Groundwater concentrations of TDS in two wells ranged from 7352 mg/L to 11644 mg/L. Seep concentrations of TDS ranged from 14196 mg/L to 17, 075 mg/L. Groundwater levels of SC in two wells ranged from 7770 umhos/cm to 11,000 umhos/cm. Seep levels of SC ranged from 13,200 umhos/cm to 15,300 umhos/cm.*

The data in Appendix A were used to:

- *Establish a Freeman Lake-specific ratio of TDS to SC.*
- *Establish the time trend relationship of TDS concentrations in Freeman Lake.*
- *As inputs to the BATHTUB model to predict reductions in loading from tributaries that are necessary to achieve the water quality target. Limitations in the data are not discussed in the TMDL document.*
- *Calibrate the BATHTUB model. Lake water quality data from 2006 sampling events were used to calibrate the BATHTUB model.*

Comments: *No comments.*

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☐ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

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

Summary:

There are no point sources of TDS or SC discharging to Freeman Lake. The only permitted point source in the watershed is 1880 Town which routes wastewater to a lagoon located north of the facility. The permit does not authorize discharges from the lagoon. The permit number is SD0028100. The wasteload allocation is zero.

Comments: *No Comments.*

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.

Review Elements:

☒ 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 the 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:

Section 5.2, "Load Allocation" (page 27) identifies the nonpoint source load as flow from saline seeps that contribute TDS to tributary drainages that feed Freeman Lake. Increase in seep flow occurs due to land use practices. Table 6, "TMDL and allocations for Freeman Lake regarding TDS" (page 26) identifies the load allocation as 3.93 kg/day TDS.

Comments: *No comments.*

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).

Review Elements:

☒ 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:

Section 6.1, "Margin of Safety" (page 27) describes the selected MOS. A total of 10% of the load capacity or TMDL was set aside as an explicit margin of safety to account for uncertainty in tributary loadings and in-lake conditions.

Table 6, "TMDL and allocations for Freeman Lake regarding TDS" (page 26) identifies the explicit MOS as 0.44 kg/day TDS. This value is 10% of the TMDL for TDS of 4.37 kg/day.

Comments*: No comments.*

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.

Review Elements:

☒ 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:

Seeps occur when there is free moisture in the soil and an impervious layer causes the free water to flow out on the soil surface. The amount of flow depends on the amount of free water available, the size of the recharge area, and the time of the year. Seeps are more likely to flow when vegetation is dormant or growing slowly and at times of heaviest precipitation; therefore, flow is usually heaviest in the spring. The flow may be reduced or stop altogether during the late spring and summer and start again after frost has occurred in the fall.

Field trips conducted during the TMDL study for selenium and nitrate indicated that seepage yield approaches zero in July, August, and September. Flow begins to increase as vegetative growth decreases and reaches a constant flow by the beginning of December. This flow will continue throughout the winter and may even increase after the spring thaw. Flow starts to diminish in late April and usually approaches zero by July. A field trip to the seep areas in late October of 2011 showed that one of the seeps in the eastern tributary was currently active and contributing flow to the lake.

Modeling performed to support the development of the TMDL assumed that seeps flow for 305 days per year, based on the assumption that flow ceases in July, August, and September. Flow data from seeps collected during periods when the seeps were flowing were used in the model. The flow data were multiplied by the number of days of seep activity during one year (305 days) divided by 365 days to provide a yearly average flow estimate. This factor accounts for the temporal variation in tributary loading from seep areas and mathematically accounts for seasonality.

Comments: *No comments.*

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.

Review Elements:

☒ 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 TMDL document is written in clear language that explains the impairment, the technical analysis, the loading capacity, the load allocation and margin of safety in terms understandable to the general public and scientific community. Section 7.0, "Public Participation" (page 27) describes the public participation process followed during the development of the TMDL.

SD DENR was the lead state agency involved in the completion of this assessment. Also contributing to the assessment were the South Dakota Game, Fish, and Parks Department, the South Dakota Geological Survey, and the South Dakota Department of Agriculture.

The Jackson County Conservation District provided assistance in collecting data as part of the selenium and nitrate TMDL study.

The draft TMDL was made available to the public for review and comment. In March 2012, public notices were placed in the Murdo Coyote, the Kadoka Press, and the Pioneer Review. A copy of the public notices was provided to EPA. The public notices included information about how to obtain a copy of the document and how to submit comments to SDDENR. Comments were requested by April 22, 2012. All comments received are taken into consideration in the final document.

Comments: *No Comments.* .

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.

Review Elements:

☐ 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:

Section 8.0, "Monitoring Strategy" (page 28) acknowledges that new information will be generated during implementation of the TMDL including monitoring data, best management practices effectiveness information, and land use information.

Additionally, SD DENR will continue to monitor Freeman Lake part of the South Dakota Statewide Lakes Assessment Program. Sampling will occur twice throughout the growing season to examine seasonal patterns. The results from this monitoring can be used to update the BATHTUB model and model outputs can be used to evaluate the project effectiveness or to determine TMDL adjustments.

The scope of the South Dakota Statewide Lakes Assessment Program is as follows:

- *Lakes are sampled on a 4-year rotation historically.*
- *Currently, lakes are selected annually for sampling according to the following criteria:*
  - *Annual sampling of the top 10-12 public high-profile lakes;*
  - *From the population of previously monitored lakes, 10-12 lakes are randomly selected annually; and*
  - *From the remaining population of classified lakes, 10-12 classified lakes are randomly selected annually.*
- *Sampling frequency is: 2 samples during the growing season*
- *Sample locations: 1-3 predetermined locations within the basin of each lake*
- *Sample methodology*

- *Samples collected 0.5 meters from the surface and in some instances 0.5 meters from the bottom*
- *Samples are either individual samples or are composited from multiple stations or depths throughout the water column*
- *For DO, T. pH, and SC, profile measurements are recorded at 1.0 meter increments throughout the water column. The entire population of data from profile sampling is used to make beneficial use support determinations.*

Comments: *No comments.*

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.

Review Elements:

☒ 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:

Since there are no point source discharges of TDS or SC in the Freeman Lake watershed, there is no WLA, thus no requirement that the TMDL document demonstrate reasonable assurance.

Section 9.0, "Implementation Strategy" (page 28) provides details about the primary approach that will be used to successfully implement this TMDL and achieve the necessary loading reductions of TDS and SC.

Saline seeps are the primary source of TDS and SC loading to Freeman Lake. Therefore, implementation of this TMDL should focus on reducing flow from the seep areas. There are four main seep areas identified in the TMDL document. To reduce flow from the seeps, implementation efforts must be directed toward recharge areas of these seeps.

The primary objective of implementation efforts should be planting deep rooted vegetation in seep recharge areas that will capture subsoil moisture via transpiration. Recharge areas should be seeded with alfalfa, which is the *most effective way to dry the deep subsoil and stop water flow to the saline seep. Recommended alfalfa cultivars include:*

Beaver alfalfa (likely to be the most effective)
Roamer, and
MS243

If these preferred cultivars are not available, other cultivars of alfalfa could also be used with favorable results.

It's imperative that alfalfa be planted over the majority of the recharge area. Halverson and Reule (1976, 1980) found that growing alfalfa on 80% of the recharge area effectively reduced flow from several saline seeps, while a narrow strip of alfalfa covering less than 20% of the recharge area on the immediate upslope of the discharge area did not effectively control flow from the saline seeps.

Planting grasses in the recharge areas is a secondary option for controlling flow from the seeps and could be employed during implementation. However, grasses are not as effective as alfalfa at capturing deep subsoil moisture.

Once flow to the recharge area of seeps has been controlled to the extent that the water table in the saline seep has been lowered or eliminated, the land in the discharge area may be reclaimed for agricultural purposes. More information on this process can be found in USDA ARS publication titled "Saline-Seep Diagnosis, Control, and Reclamation" which could be an important resource in developing implementation plans.

There is not an implementation project currently underway in the Freeman Lake watershed. The TMDL for nitrate and selenium impairments of Freeman Lake, approved by EPA in 2001, has an identical implementation strategy but to date, the strategy has not been implemented.

Comments: *No comments.*

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.

Review Elements:

☒ 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:
Section 5.0, "TMDL and Allocations" (page 26) and Table 6, "TMDL and allocations for Freeman Lake regarding TDS"(page 26) provide an expression of the TMDL as a daily load:

TDS Loading Capacity (TMDL) =	*4.37 kg/day*
Load allocation =	*3.93 kg/day*
WLA =	*0*
Margin of Safety (10%) =	*0.44 kg/day*

Current TDS Load =	*13.53 kg/day*
Load Reduction =	*68%*

Comments: *No comments.*