SD Department of Environment & Natural Resources
Watershed Protection Program
Total Maximum Daily Load

Swan Lake Watershed, Turner County South Dakota
January, 1999

These TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the US Environmental Protection Agency. The 1998 303(d) Waterbody List identified Swan Lake as impaired by a measure of Trophic State Index (TSI), which serves as an indicator of the trophic condition of the lake, and accumulated sediment. TMDLs for total phosphorus and accumulated sediment have been developed and are supported below.

TMDL Summary

Waterbody Name	**Swan Lake**
Lake ID/HUC	10170102
TMDL Pollutant	**Total phosphorus**
Water Quality Target	Total Phosphorus Trophic State Index <65 (yearly average)
TMDL Goal	60% reduction in phosphorus
303(d) Status	1998 303(d) Waterbody List, Priority 1, Page 23, 30, 34
Impaired Uses	Warmwater semi-permanent fish propagation; immersion recreation; limited contact recreation
Reference Documents	Swan Lake Restoration Project Implementation Plan, 1995 Diagnostic/Feasibility Study Swan Lake Turner County South Dakota, (SD DENR, 1993)

TMDL Summary

Waterbody Name	**Swan Lake**
Lake ID/HUC	10170102
TMDL Pollutant	**Accumulated Sediment**
Water Quality Target	Secchi depth Trophic State Index <65 (yearly average)
TMDL Goal	50% increase in secchi disk depth
303(d) Status	1998 303(d) Waterbody List, Priority 1, Page 23, 30, 34
Impaired Uses	Warmwater semi-permanent fish propagation; immersion recreation; limited contact recreation
Reference Documents	Swan Lake Restoration Project Implementation Plan, 1995 Diagnostic/Feasibility Study Swan Lake Turner County South Dakota, (SD DENR, 1993)

I. Executive Summary:

- ***Waterbody Description and Impairments***

Swan Lake is a 180-acre natural lake located 3 miles north and 1 mile west of Viborg, South Dakota. Swan Lake assumed characteristics of a reservoir in 1914 when an inlet channel was excavated from Turkey Ridge Creek into the lake. When the inlet was completed, the Swan Lake watershed increased from approximately 1000 acres to approximately 81,600 acres.

Swan Lake water outlets to Turkey Ridge Creek which flows into the Vermillion River. The elevation of the lake inlet is below that of the outlet. During periods when the water level of Turkey Ridge Creek is lower than the lake level, water backs out the inlet and back into the creek. At other times, the water flows into the lake when the water levels of the creek are higher than that of the lake.

By eliminating the water flowing to the lake after spring thaw, an estimated 60 percent of the nutrient load could be eliminated. It also appears that Swan Lake is storing the majority of nutrients it receives. These nutrients appear to recycled throughout the year.

Sediment deposition has occurred over the years. It is estimated that a 50% increase in secchi depth should result with the removal of approximately 300,000 cubic yards.

- ***Stakeholders***

Swan Lake Improvement Association
Turner Conservation District
East Dakota Water Development District
Natural Resources Conservation Service
SD Game, Fish and Parks
SD DENR

- ***Intent to Submit as a Clean Water Act Section 303(d) TMDL***

In accordance with Section 303(d) of the Clean Water Act, the South Dakota Department of Environment and Natural Resources submits for EPA, Region VIII review and approval, the phosphorus and accumulated sediment total maximum daily loads (TMDLs) for Swan Lake as provided in this summary and attached document(s). These TMDLs have been established at levels necessary to meet the applicable water quality standards for nutrients and sediment with consideration of seasonal variation and a margin of safety. The following designated use classifications will be protected through implementation of this TMDL: warmwater semi-permanent fish life propagation, immersion recreation and limited contact recreation.

II. Problem Characterization:

- ***Maps***

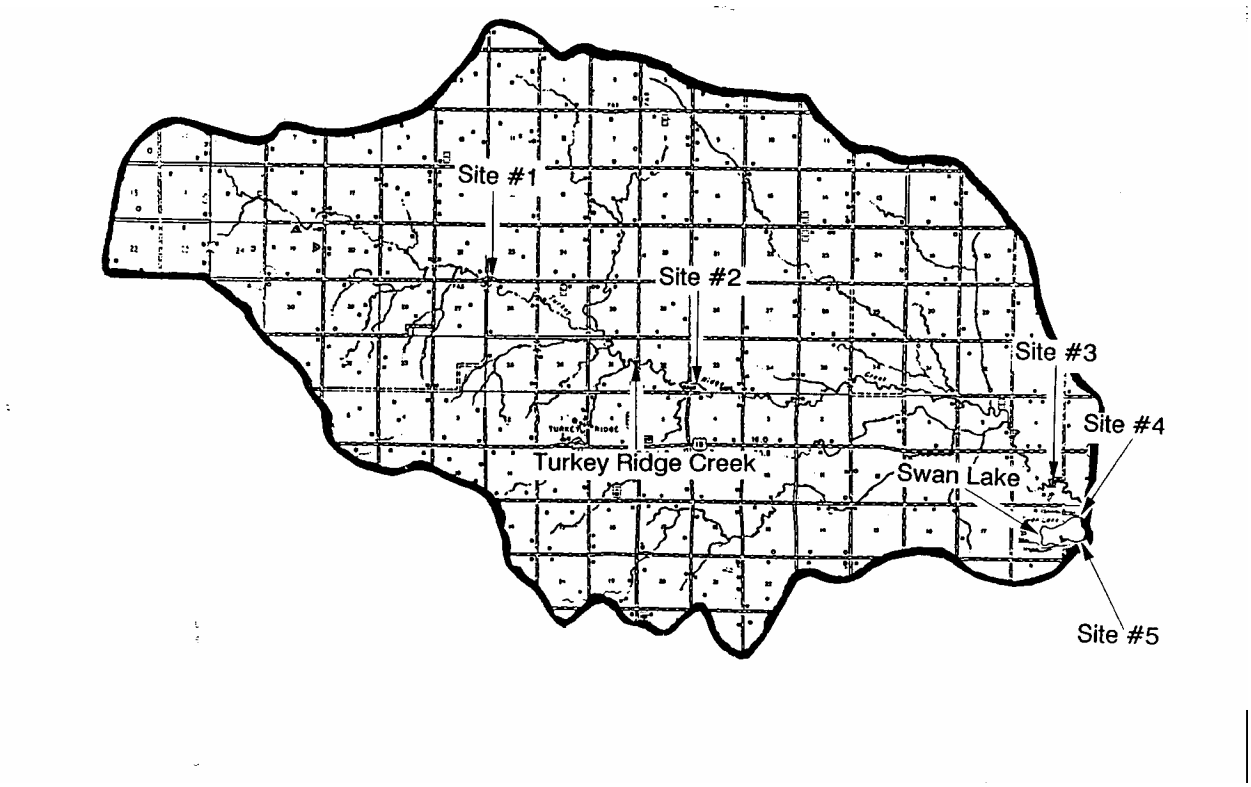


Figure 1 Swan Lake Watershed

- ***Waters Covered by TMDL***

Swan Lake

- ***Rationale for Geographic Coverage***

The entire watershed for Swan Lake was considered in the development of this TMDL. The watershed is made up of Turkey Ridge on the far west boundary and gently rolling land from the base of the ridge to Swan Lake. Approximately 70 percent of the watershed is gently rolling glacial plain with slopes less than 3 percent. Turkey Ridge makes up approximately 30 percent of the watershed with slopes ranging from 0 to 25 percent in a few ravines.

The two largest land use categories within the watershed are non-highly erodible cropland (77%) and pasture (13.7)

- ***Pollutant(s) of Concern***

Total phosphorus
Accumulated sediment

- ***Use Impairments or Threats***

The overall water quality of the tributaries in the watershed is poor due to high nutrient levels during runoff events. Water quality is relatively good when ground water recharge of the Turkey Ridge Creek aquifer occurs. Total phosphorus and nitrogen concentrations increase during runoff events

Swan Lake is considered hypereutrophic as it has an over abundance of nutrients. Inlake nutrients are stored and are available to be recycled to degrade water quality. The average depth of Swan Lake in 1993 was 4 foot and as a result, turbidity in the lake was high. With a decrease in total phosphorus releases from the watershed, in time, Swan Lake will see a decline on algal blooms, and experience better water quality for fish life propagation and recreational uses.

Lack of adequate water depth, due to large historical floods prior to the raising of a road adjacent to the lake, diminishes the recreational, fishery and aesthetic enjoyment of the lake. With an increase in water depth, in time, the fishery and recreational uses of Swan Lake will drastically improve.

III. TMDL Endpoint:

- ***Description***

The TMDL goal for Swan Lake is to improve the trophic status of the lake from hypereutrophic to eutrophic. This goal requires the increase in secchi depths by 50 % and tributary phosphorus loads by 60%. This change is trophic state would allow the restoration of the recreational and fish life propagation beneficial uses of the lake.

- ***Probable Sources***

Total phosphorus

The major source of total phosphorus to Swan Lake is Turkey Ridge Creek which receives high loads from agricultural practices within the drainage. The number of feedlots directly on Turkey Ridge Creek are the most probably source of these high nutrient levels during runoff events. Two control structures were constructed with the intention to divert poor quality runoff water away from the lake. Improper operation and maintenance of the control structures eventually led to high levels of nutrient and sediment being released into the lake.

Another possible source of phosphorus is nutrient recycling and releases within the lake itself. Loadings stored by the lake are relatively small in comparison to the inflow; however, the lake can not effectively release the nutrients through the outlet. This inability causes a reservoir of nutrients that can be released and recycled throughout the year.

Accumulated sediment

Three possible sources of the accumulated sediment in Swan Lake are erosion from the watershed, historic floods that passed over the land separating the lake and Turkey

Ridge Creek, and in-lake shoreline erosion. At least 50 percent of the shoreline has been riprapped. Higher sediment loads are typical of runoff events.

- ***Endpoint Link to Surface Water Quality Standards***

Total Phosphorus

The TMDL goal of a 60% reduction in phosphorus inputs will be defined by obtaining an in-lake total phosphorus TSI < 65 as a yearly average.

Accumulated sediment

The TMDL goal of a 50% increase is secchi depths will be defined by obtaining an in-lake secchi depth TSI < 65 as a yearly average.

IV. TMDL Analysis and Development:

- ***Data Sources***

The Swan Lake study was designed to: identify, monitor, and evaluate pollutants (sediment - nutrients) entering Swan Lake from Turkey Ridge Creek watershed, and assess the current in-lake water quality conditions and the status of the watershed.

The data collection phase of the project consisted of water quality sampling under the best possible conditions to obtain the most accurate data and information possible. Data collection was the responsibility of the Swan Lake Improvement Association. The sample collection, preservation and analysis was conducted in accordance with the Quality Assurance Program of the DENR. Chemical analysis was conducted by the EPA-Certified State Health Laboratory in accordance with their approved Quality Assurance Program. Raw data was analyzed and evaluated by DENR.

Data evaluation consisted of a thorough analysis of all data including computer modeling and statistical testing. Products included: current trophic status, nutrient loading from the watershed, in-lake water quality analysis, and sources of nutrients.

Five tributary monitoring sites were strategically placed within the watershed for the best comprehensive coverage. Since the flow of Turkey Ridge Creek is intermittent, especially during dry periods, sampling was modified according to flow volume. Sample collection were taken as close to peak run-off events as possible and also included base flows once a month.

In-lake sampling included 3 sites sampled monthly from October through March and twice monthly from April to September. Grab samples depths ranged from 0.4 - 0.6 meters.

A sediment and elutriate sample was obtained to assess nutrient and toxic levels of heavy metals. The results indicated that toxics were of no concern.

A sediment survey was conducted as the lake mean depth equaled 1.4 meters. The survey quantified the amount of sediment needed for removal.

Landuse data was obtained, including a feedlot survey of the watershed. A total of 32 feedlots were located with sixteen adjacent to Turkey Ridge Creek. An additional 16 feedlots were located within three-quarters of a mile of the creek.

Biological assessment included monitoring and literature searches on algae, aquatic plants, an aquatic plant inventory, terrestrial plants, fish, reptiles and amphibians, birds, and mammal populations.

- ***Analysis Techniques or Models***

Watershed losses were estimated by a watershed model. Water quality samples and flows were collected to calculate loadings from the watershed. The Universal Soil Loss Equation was used to estimate the soil loss on specific sections. This served as a way to compare areas of highest soil loss but does not calculate how much of the loss as sediment delivered to the lake.

Reduction Response Model

Inlake total phosphorus concentrations are a function of the total phosphorus load delivered to the lake by the watershed. Vollenweider and Kerekes (1980) developed a mathematical relationship for inflow of total phosphorus and the inlake total phosphorus concentration. They assumed that if you change the inflow of total phosphorus you change inlake phosphorus concentration a relative but steady amount. The variables used in the relationship are:

$[\overline{P}]\lambda$ = Average inlake total phosphorus concentration

$[\overline{P}]i$ = Average concentration of total phosphorus that flow into the lake

$\overline{T}p$ = Average residence time of inlake total phosphorus

$\overline{T}w$ = Average residence time of lake water

Data collected from 1991 to 1992 provided enough information to estimate $[\overline{P}]\lambda$, $[\overline{P}]i$, and $\overline{T}w$. In order to estimate the residence time of total phosphorus ($\overline{T}p$) it was necessary to back calculate Equation 2 below, and solve for $\overline{T}p$ by forming Equation 3 (Wittmuss, 1996):

{Equation 2} $$\left[\overline{P}\right]\lambda = \left[\frac{\overline{T}p}{\overline{T}w}\right]\left[\overline{P}\right]i$$

{Equation 3} $$\left(\overline{T}p\right) = \frac{[\overline{P}]\lambda}{[\overline{P}]i}\left(\overline{T}w\right)$$

Values for $[\overline{P}]\lambda$, $[\overline{P}]i$, and $\overline{T}w$ were determined in the following manner:

$[\overline{P}]\lambda$ was determined by averaging all of the surface total phosphorus samples.

$[\overline{P}]i$ was determined by adding all of the input loadings for total phosphorus in milligrams and dividing that number by the total number of liters that entered the lake. The values for both of these numbers came from tributaries, storm sewers, groundwater, and the atmosphere.

$\overline{T}w$ was determined by dividing the total volume of Swan Lake (719 acre-feet) by the total outputs of water (60 acre-feet/days of discharge measurements).

$$Tw = 716/60 = 11.9\ years$$

The final values for $[\overline{P}]\lambda$ and $[\overline{P}]i$ are:

$[\overline{P}]\lambda$ = 0.168 mg/L $\qquad$ $[\overline{P}]i$ = 0.232 mg/L

By placing the numbers in the proper places as discussed in Equation 3, $\overline{T}p$ would be:

$$Tp = \left[\frac{.168}{.232}\right](11.9) = 8.69\ years$$

Referring back to Equation 2, reducing the inputs of total phosphorus, the equation would estimate the reduction of inlake total phosphorus. This is assuming constant inputs of water. Theoretically the retention time for total phosphorus should also be reduced. With only one year of sampling, there is no way to estimate the reduction in the retention time of total phosphorus. The $\overline{T}p$ constant (8.69) derived from the data will be used in Equation 2. As can be seen in Table 1, a reduction in phosphorus inputs to Swan Lake by 60% will reduce the inlake phosphorus to concentrations less than hyper eutrophic.

Table 1. % Reduction in total phosphorus to Swan Lake

% Reduction	TSI	Inlake Concentration	Inflow Concentration
0%	78.1	0.168	0.232
10%	76.6	0.151	0.209
20%	74.9	0.134	0.186
30%	72.9	0.118	0.162
40%	70.7	0.101	0.139
50%	68.1	0.084	0.116
60%	64.9	0.067	0.093
70%	60.7	0.050	0.070
80%	54.9	0.034	0.046

% Reduction	TSI	Inlake Concentration	Inflow Concentration
90%	44.9	0.017	0.023

Since well over 60% of the inputs to Swan Lake come from the Turkey Ridge Creek inlet, discontinued use of the inlet should remove a sufficient amount of phosphorus inputs to lower the phosphorus TSI to the eutrophic level. To make sure the reduction is met, continued long term sampling should be implemented on Swan Lake. Information from the South Dakota's Statewide Lake Assessment (sampled every fourth year) should be sufficient to develop long-term trends.

Secchi disk TSI levels in Swan Lake are also hyper-eutrophic (average depth 0.46 meters or 71.17 TSI in the motorized part of the lake). Data collected in the most recent study (Stueven, 1993) suggested shallow depths were largely responsible for the resuspension of sediments by wave action and boat motors. Data also showed that the Turkey Ridge Creek inlet was responsible for the majority of the inputs to the lake. Closing of the inlet or controlling the inlet to eliminate the sediment-laden flows would effectively remove most inputs of sediment to Swan Lake. Once the inlet sediment inputs are controlled, accompanied by the increased depth in Swan Lake, resuspension of sediments from waves and boat motors will be reduced, resulting in increased Secchi depths.

The combined elimination of Turkey Ridge Creek inputs, along with the removal of approximately 300,000 cubic yards of sediment from the most motorized part of the lake, should increase Secchi depth an additional 50% resulting in eutrophic TSI levels (0.71 meter average Secchi depth). After these restoration activities are completed, long-term sampling should be continued to make sure the predicted results were achieved. The graphs below show the expected decreased TSI levels for both phosphorus and Secchi depth.

- ***Seasonality***

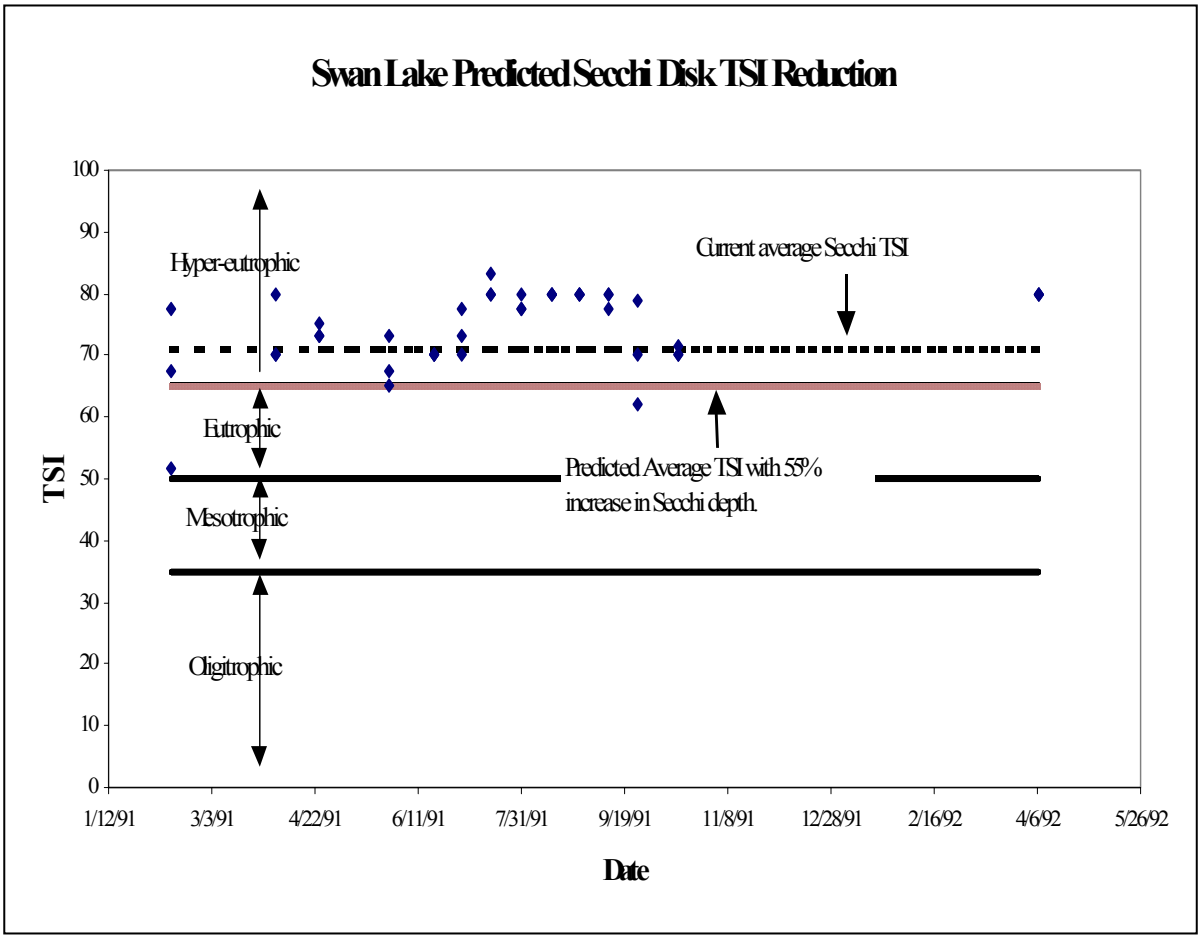
Different seasons of the year can yield differences in water quality due to changes in precipitation and agricultural practices. To determine seasonal differences, Swan Lake samples were separated into spring (February through April), summer (May through July), fall (August through October) and winter (November through February) collection periods. Loadings to the lake during times when the ground was frozen and when the ground was thawed were compared

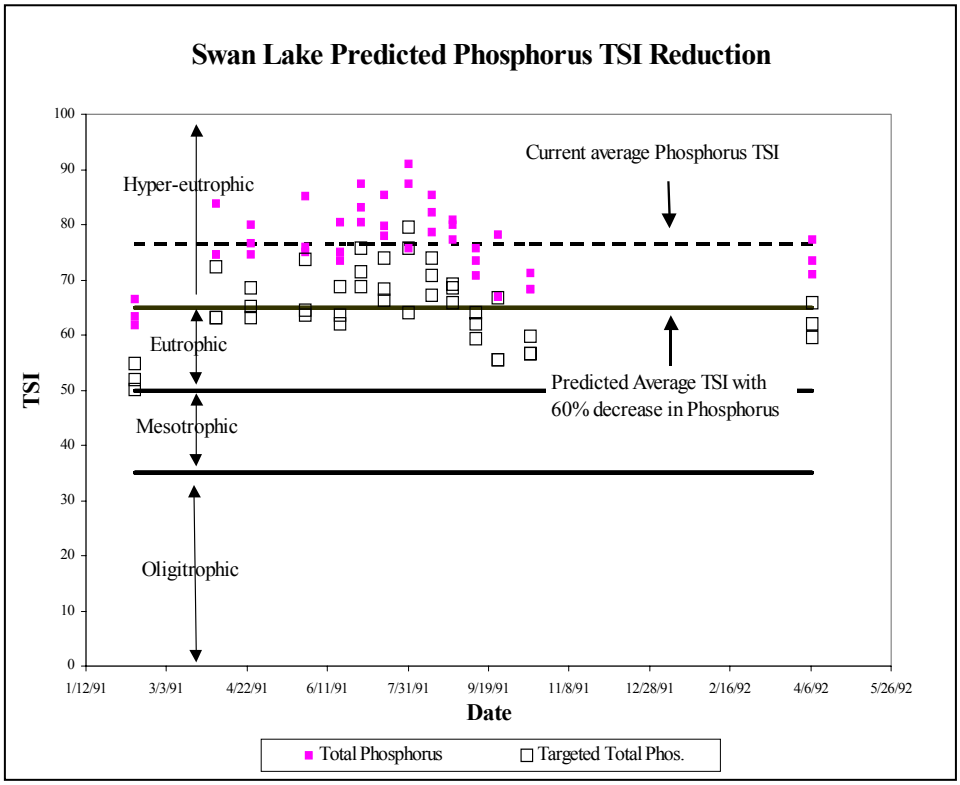
- ***Margin of Safety***

The greatest margin of safety is contained within the implemented restoration alternatives. The removal of the accumulated sediment should result in increased water depths and limited nutrient recycling. Bank stabilization should remove the additional

risk of deposition. The elimination of inflow from Turkey Ridge Creek will eliminate future deposition of sediment as well as high inflow nutrient loads.

Future monitoring will also provide a margin of safety for obtaining the TMDL goal. Monitoring occurred during the implementation of the recommendations of the assessment project. This monitoring allowed the opportunity for a mid-course correction to the TMDL goal, but indicated that the goal was obtainable. Post-implementation monitoring is recommended to observe if the implemented controls are continuing to meet the water quality target. In addition, Swan Lake will be routinely sampled every 3 - 4 years as part of the South Dakota Statewide Lakes Assessment program. The combination of these various monitoring activities will indicate if the TMDL is achievable or if other controls will be needed.





V. Allocation of TMDL Loads or Responsibilities:

- ***Wasteload Allocation***

There are no point sources of pollutants that are of concern in this watershed, therefore the "wasteload allocation" component of the TMDL is considered a zero value. The TMDL is considered wholly included in the "load allocation" component of the TMDL.

- ***Load Allocation***

The major phosphorus and sediment pollutant loads are directly the result of runoff from the false watershed of the Turkey Ridge Creek inlet. The inlake sediment is also a problem as it contributes to nutrient recycling and shallow water depths.

- ***Allocation of Responsibility***

The following controls were recommended in the 1993 Diagnostic/Feasibility study report:

Primary Activities:

1). Control structure repair on valve nest to Turkey Ridge Creek;
2). Dam structure repair downstream of the inlet channel;
3). In-lake sediment removal
4). Bank stabilization;
5). Sediment dike;
6). Buffer strips or CRP in original watershed;
7) Rough fish control; and

8). Sanitary district development.

Secondary Activities:

9). Animal waste management systems; and

10). Dugouts and wells.

VI. Schedule of Implementation:

Control actions for this project have already been implemented. In 1995, the Swan Lake Association received Section 319 grant funds to implement a nonpoint source pollution control project. Phase I was completed in 1998 and consisted of the following:

1). Removal of 300,000 cubic yards of inlake sediment by dredging;
2). Closure of the Turkey Ridge Creek inlet structure;
3). Stabilization of 3000 - 5000 feet of lake shoreline;
4). Implementation of BMP's in original 1000 acre lake watershed;
5). Control of rough fish and restock lake; and
6). Water quality monitoring during and after project.

Phase II is dependent on the completion of a feasibility analysis and water quality monitoring to determine if an additional 120,000 - 240,000 cubic yards of inlake sediment should be removed. No Section 319 funds will be used in the implementation of Phase II.

VII. Post-Implementation Monitoring:

Post implementation monitoring is needed to verify that the removal of 300,000 cubic yards of sediment was adequate to increase water depth and secchi disk depth readings. This is to be verified by an increase in inlake depths > 2 - 2.5 feet. Inlake and tributary monitoring will determine if the elimination of the Turkey Ridge Creek inlet and removal of accumulated sediment was adequate to change the trophic status from a hypereutrophic to eutrophic state. This is to be verified by average inlake TSI <65.

VIII. Public Participation:

- ***Summary of Public Review***

The water quality assessment was initiated after the State of South Dakota received EPA Section 314 Clean Lakes grant funds, as Swan Lake was on the priority list for Section 319 Nonpoint Pollution Control projects. The Turner Conservation District agreed to sponsor the project and secured additional match funds from Turner County, and the Swan Lake Improvement Association. The 314 grant was a 70% federal and 30% local match.

Public meetings were held throughout the Diagnostic/Feasibility study period. Technical assistance was received by SD Department of Game, Fish and Parks, Natural

Resources Conservation Service, Turner Conservation District, Turner County and the Swan Lake Association.

- ***Project Information and Education Efforts***

The following table summarizes the efforts taken to gain public education, review and comment during TMDL development:

Public Meetings/ Personal Contact	***Articles/ Fact Sheets***	***Document Distribution***
Pre-project meeting Funding meeting Mid-project meeting Near-end project meeting Final summary meeting		SD Dept. GF&P NRCS Turner Conservation District Turner County Swan Lake Improvement Association US EPA - Region VIII
Electronic media	***Mailings***	***Public Comments Received***
January 1998 Diagnostic/Feasibility Summary added to department website **February, 1999** TMDL Summary advertised on department website	Interested parties Stakeholders Daily Newspapers	Comments received during project meetings and review of the draft report and findings were considered

IX. Supporting Development Document(s) (attached):

Stueven, G. H., January, 1993. DIAGNOSTIC/FEASIBILITY STUDY SWAN LAKE TURNER COUNTY SOUTH DAKOTA. South Dakota Clean Lakes Program, Division of Water Resources Management, South Dakota Department of Environment and Natural Resources, Pierre, South Dakota.

Swan Lake Restoration Project Implementation Plan (Phase I), Swan Lake Improvement Association; 1995.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 500
DENVER, CO 80202-2466

APR 13 1999

Ref: Ref: 8EPR-EP

Nettie Myers, Secretary
Department of Environment and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

Re: TMDL Approvals
Lake Bryon
Elm Lake
Lake Faulkton
Lake Hendricks
Lake Hiddenwood
Lake Madison/Brant
McCook Lake
Ravine Lake
Redfield Lake
Swan Lake

Dear Ms. Myers:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the subject waterbodies. In accordance with the Clean Water Act (33 U.S.C. 1251 et. seq.), we approve all aspects of the TMDLs as developed for these water quality limited waterbodies as described in Section 303(d)(1). We acknowledge that these particular TMDLs for the various lakes are based primarily on a voluntary and incentive-based approach to implementation.

Based on our review, we feel the separate TMDL elements listed in the enclosed checklists adequately address the pollutants of concern, taking into consideration seasonal variation and a margin of safety.

For years, the State has sponsored an extensive clean lakes program. Through the lakes assessment and monitoring efforts associated with this program, priority waterbodies have been identified for clean up. It is reasonable that these same priority waters have been a focus of the Section 319 nonpoint source projects as well as one of the priorities under the State's Section 303(d) TMDL efforts.

In the course of developing TMDLs for impaired waters, EPA has recognized that not all impairments are linked to water chemistry alone. Rather, EPA recognizes that "*Section 303(d) requires the States to identify all impaired waters regardless of whether the impairment is due to toxic pollutants, other chemical, heat, habitat, or other problems.*" (see 57 Fed. Reg.

Printed on Recycled Paper

33040 for July 24, 1992). Further, EPA states that "*...in some situations water quality standards -- particularly designated uses and biocriteria -- can only be attained if nonchemical factors such as hydrology, channel morphology, and habitat are also addressed. EPA recognizes that it is appropriate to use the TMDL process to establish control measures for quantifiable non-chemical parameters that are preventing the attainment of water quality standards.*" (see Guidance for Water Quality-based Decisions: The TMDL Process; USEPA; EPA 440/4-91-001, April 1991; pg.4). We feel the State has developed TMDLs that are consistent with this guidance, taking a comprehensive view of the sources and causes of water quality impairment within each of the watersheds. For example, in several of the TMDLs, the State considered nonchemical factors such as lake depth and its relationship to the impaired uses. Further, we feel it is reasonable to use factors such as lake depth as surrogates to express the final endpoint of the TMDL.

Thank you for your submittal. If you have any questions concerning this approval, feel free to contact Bruce Zander of my staff at 303/312-6846.

Sincerely,

Max H. Dodson
Assistant Regional Administrator
Office of Ecosystems Protection and
Remediation

Enclosures

Enclosure

APPROVED TMDLS

Waterbody Name*	TMDL Parameter / Pollutant	Water Quality Goal/Endpoint	TMDL	Section 303(d)1 or (d)3 TMDL	Supporting Documentation
Lake Bryon*	phosphorus	TSI < 70	50% reduction in phosphorus loads	§303(d)(1)	Lake Assessment Project Report, (Lake Byron excerpt) (SD DENR, August 1996) Lake Assessment Project Report, Lake Byron, Beadle County, SD (SD DENR, December 1992) Section 319 Nonpoint Source Control Program Watershed Project Final Report, Lake Byron Watershed Project (Beadle CD, December 31, 1997) Lake Byron Watershed Project Section 319 Project Implementation Plan (SD DENR, July 1993)
	sediment	Decrease annual inlake sediment accumulation by 1200 tons/year	50% reduction in sediment loads	§303(d)(1)	
Elm Lake*	phosphorus	N:TDP ratio > 7.5 averaged over growing season	60% reduction in phosphorus loads	§303(d)(1)	Phase I Watershed Assessment Final Report, Elm Lake, Brown Country, South Dakota (SDDENR, September1998)
Lake Faulkton*	phosphorus	TSI < 90	35% reduction in phosphorus loads	§303(d)(1)	Lake Assessment Project, Lake Faulkton, Faulk County, South Dakota (SD DENR, 1996)
	sediment	Increased average lake depth by 6 feet over 15.5 acres	Remove 150,000 cubic yards of lake sediment	§303(d)(1)	
Lake Hendricks*	phosphorus	TSI < 65	50% reduction in phosphorus loads	§303(d)(1)	Diagnostic/Feasibility Study Report, Lake Hendricks/Deer Creek Watershed, Brookings County, South Dakota; Lincoln County, Minnesota (SD DENR, February 1993)
	sediment	Increased average lake depth by 6 feet over 100 acres	Remove 1 million cubic yards of lake sediment	§303(d)(1)	

Waterbody Name*	TMDL Parameter / Pollutant	Water Quality Goal/Endpoint	TMDL	Section 303(d)1 or (d)3 TMDL	Supporting Documentation
Lake Hiddenwood*	phosphorus	Decreased winter fish kills and increased visitor days	Maintenance of increased depth regime plus 2% decrease in phosphorus loads	§303(d)(1)	Lake Hiddenwood Restoration and Protection Project Preproposal (North Central RC&D; August 1993) Lake Hiddenwood Restoration and Protection Project Implementation Plan for FY 94 (1994) Preliminary Report; Hiddenwood Recreation Damsite and Reservoir, North Central RC&D (RC-050-WA), Walworth County, SD (USDA, SCS; August 1978)
	sediment	Increased depth corresponding to increasing volume by 53 acre-feet	Maintenance of increased depth regime plus 5% decrease in sediment loads	§303(d)(1)	
Lake Madison*	phosphorus	TSI < 50	50% reduction in phosphorus loads	§303(d)(1)	Phase I Watershed Assessment Final Report - Madison Lake/Brant Lake, Lake County South Dakota (SD DENR, October 1998)
Lake Brant*	phosphorus	TSI < 50	50% reduction in phosphorus loads	§303(d)(1)	
McCook Lake*	sediment	Increased average lake depth by 4.5 feet over 183 acres	Remove 1.7 million cubic yards of lake sediment	§303(d)(1)	Diagnostic/Feasibility Study Report McCook Lake, Union County, South Dakota (SD DENR, March 1990)
Ravine Lake*	phosphorus	TSI of <84	70% reduction in phosphorus loads	§303(d)(1)	Diagnostic\Feasibility Study Report, Ravine Lake, Beadle County, SD (SD DENR, July 1990) AGNPS Modeling of the Ravine Lake Watershed, Huron, SD (SD DENR, July 1988)
	fecal coliform	< 400/100 mL fecal coliform counts	< 400/100 mL fecal coliform counts	§303(d)(1)	
Redfield Lake*	phosphorus	TSI < 90	45% reduction in total phosphorus load	§303(d)(1)	Lake Assessment Project Report, Lake Redfield, Spink County, SD (SD DENR, May 1993)
	sediment	Increased average lake depth by 5 feet over 31 acres	Remove 250,000 cubic yards of lake sediment	§303(d)(1)	

Waterbody Name*	TMDL Parameter / Pollutant	Water Quality Goal/Endpoint	TMDL	Section 303(d)1 or (d)3 TMDL	Supporting Documentation
Swan Lake*	phosphorus	TSI < 65	60% reduction in phosphorus loads	§303(d)(1)	Diagnostic/Feasibility Study Swan Lake; Turner County, South Dakota (SD DENR, January 1993)
	sediment	TSI (secchi depth) < 65	50% increase in secchi depth	§303(d)(1)	

* An asterisk indicates the waterbody has been included on the State's Section 303(d) list of waterbodies in need of TMDLs.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Bryon
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and sediment loading rate. These are reasonable indicators to use in expressing the TMDL targets since they are quantifiable and relate to the use impairments.
■ TMDL	X	The TMDLs are expressed in terms of annual phosphorus and sediment load reductions. This is a reasonable way to express the TMDL for lakes since it takes lakes a period of time to respond to pollutant reductions.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved, by a high level of detailed monitoring and assessment, by further educational efforts throughout the watershed, by conservative assumptions regarding no-till or minimum till acreage, application of additional nutrient BMPs, and stabilization of more shoreline than recommended through the assessment Study. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas, shoreline areas, and croplands.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Elm Lake
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ **TMDLs result in maintaining and attaining water quality standards**	X	The waterbody classification uses which are addressed by this TMDL are drinking water and recreation.
■ **Water Quality Standards Target**	X	Targets were established based on nitrogen:phosphorus ratios. This is a reasonable approach since it relates to the trophic status of the waterbody which, in turn, relates to the uses of concern.
■ **TMDL**	X	The TMDL is expressed in terms of annual phosphorus load reduction. This is a reasonable way to express the TMDL for lakes since it takes lakes a period of time to respond to pollutant reductions.
■ **Significant sources identified**	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ **Technical analysis**	X	Monitoring, empirical relationships, AGNPS modeling, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ **Margin of safety and Seasonality**	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by application of additional nonpoint source BMPs. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ **Allocation**	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas, shoreline areas, and croplands.
■ **Public review**	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Since part of the Elm Lake watershed is in North Dakota, the state of North Dakota as well as local entities in that State have participated in the development of the TMDL and will be participating in the future through implementation of BMPks within the watershed. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Faulkton
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and lake depth. This is a reasonable approach since it relates to the trophic status of the waterbody as well as the physical nature of the lake which, in turn, relates to the uses of concern.
■ TMDL	X	The TMDL is expressed in terms of annual phosphorus load reduction and removal of lake sediment. This is a reasonable way to express the TMDL for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, AGNPS modeling, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by application of additional nonpoint source BMPs. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and croplands.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Hendricks
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and lake depth. This is a reasonable approach since it relates to the trophic status of the waterbody as well as the physical nature of the lake which, in turn, relates to the uses of concern.
■ TMDL	X	The TMDL is expressed in terms of annual phosphorus load reduction and removal of lake sediment. This is a reasonable way to express the TMDL for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by augmenting the watershed land use controls with in-lake dredging. The in-lake dredging will further reduce the amount of available nutrients into the lake because of increased depth as well as provide further aquatic life habitat. Additional margin of safety could be provided through addressing the failing wastewater on-site systems near the lake. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and croplands.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance. This TMDL involved cooperation between South Dakota and Minnesota since the watershed is in both states. Lincoln County, Minnesota participated in the process as a stakeholder.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Hiddenwood
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on lake depth, fish kill frequency, and visitor-days. These are reasonable targets for the TMDL since they relate to the impaired uses of concern.
■ TMDL	X	The TMDL are expressed in terms of annual phosphorus load reduction and removal of lake sediment. Also, the TMDL relates to the depth and volume of the Lake. Lake depth has a particularly important factor related to both the recreational use and fisheries use of the Lake. The emphasis at this point in time is to protect the improvements already made in the Lake as well as adding more controls on pollutant sources as a margin of safety.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, AGNPS modeling, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by application of additional nonpoint source BMPs. Additional BMPs include entrapment dams, construction of four agricultural waste systems, and cropland BMPs. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and croplands as well as to the bottom lake sediment.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Madison/Lake Brant
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ **TMDLs result in maintaining and attaining water quality standards**	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ **Water Quality Standards Target**	X	Targets were established based on trophic status. This is a reasonable approach since trophic status of the waterbody relates to the uses of concern.
■ **TMDL**	X	The TMDLs for each lake are expressed in terms of annual phosphorus load reduction. This is a reasonable way to express the TMDL for this lake since it takes a long period of time for a lake to respond to water quality controls, rather than on a daily basis.
■ **Significant sources identified**	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ **Technical analysis**	X	Monitoring, empirical relationships, AGNPS modeling, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ **Margin of safety and Seasonality**	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved, by increasing the target phosphorus reduction from 40% to 50%, and possibly by application of additional nonpoint source BMPs. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ **Allocation**	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and croplands.
■ **Public review**	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: McCook Lake
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ **TMDLs result in maintaining and attaining water quality standards**	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ **Water Quality Standards Target**	X	Targets were established based on lake depth. This is a reasonable approach since it relates to the trophic status of the waterbody as well as the physical nature of the lake which, in turn, relates to the uses of concern.
■ **TMDL**	X	The TMDL is expressed in terms of removal of lake sediment. This is a reasonable way to express the TMDL for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs.
■ **Significant sources identified**	X	There are no contemporary sources of sediment (the pollutant of concern). Rather, the current lake sediment that has been deposited over the years is the primary cause of impairment within the lake.
■ **Technical analysis**	X	Monitoring, empirical relationships, and best professional judgement were used in identifying acceptable levels of sediment removal from the Lake. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ **Margin of safety and Seasonality**	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by removal of more sediment than calculated to support inlake uses. Seasonality was adequately considered by evaluating the changes in lake conditions over the year, but seasonality has proven to be of very little concern related to the development of the TMDL and application of appropriate water quality controls.
■ **Allocation**	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to lake bottom sediments.
■ **Public review**	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Ravine Lake
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and fecal coliform concentration. This is a reasonable approach since these factors relate to the uses of concern.
■ TMDL	X	The TMDL is expressed in terms of annual phosphorus load reduction and fecal coliform concentration. This is a reasonable way to express the TMDLs for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs and reflects the long response time of lakes of this type to pollutant controls within the watershed.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, AGNPS modeling, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by application of additional nonpoint source BMPs including the stabilization of more shoreline than calculated and removal of more lake sediments than calculated. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and croplands.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Redfield Lake
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and lake depth. This is a reasonable approach since it relates to the trophic status of the waterbody as well as the physical nature of the lake which, in turn, relates to the uses of concern.
■ TMDL	X	The TMDL is expressed in terms of annual phosphorus load reduction and removal of lake sediment. This is a reasonable way to express the TMDL for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved, by application of additional nonpoint source BMPs, and by dredging more lake sediments than calculated. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as animal feeding areas and bottom sediments.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Swan Lake
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: March 30, 1999 Date Review completed: April 9, 1999 BAZ

Review Criteria (All criteria must be met for approval.)	Approved (check if yes)	Comments
■ TMDLs result in maintaining and attaining water quality standards	X	The waterbody classification uses which are addressed by this TMDL are aquatic life and recreation.
■ Water Quality Standards Target	X	Targets were established based on trophic status and secchi depth. This is a reasonable approach since it relates to the trophic status of the waterbody as well as the physical nature of the lake which is, in turn, related to the uses of concern.
■ TMDL	X	The TMDL is expressed in terms of annual phosphorus load reduction and increase in clarity (e.g., secchi depth). This is a reasonable way to express the TMDL for this lake since it provides an effective surrogate reflective of both the aquatic life and recreational needs.
■ Significant sources identified	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified (including the removal of lake bottom sediment, if needed.)
■ Technical analysis	X	Monitoring, empirical relationships, and best professional judgement were used in identifying pollutant sources and causes and in identifying acceptable levels of pollutant control, and in identifying appropriate levels of control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and watershed type.
■ Margin of safety and Seasonality	X	An appropriate margin of safety is included by performing ongoing monitoring to assure water quality goals are achieved and by application of additional nonpoint source BMPs including selective dredging, bank stabilization, and elimination of inflow from Turkey Ridge Creek. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by tailoring the BMPs to seasonal needs.
■ Allocation	X	All the allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to such sources as land uses in the Turkey Ridge Creek sub-watershed and in-lake sediments.
■ Public review	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.