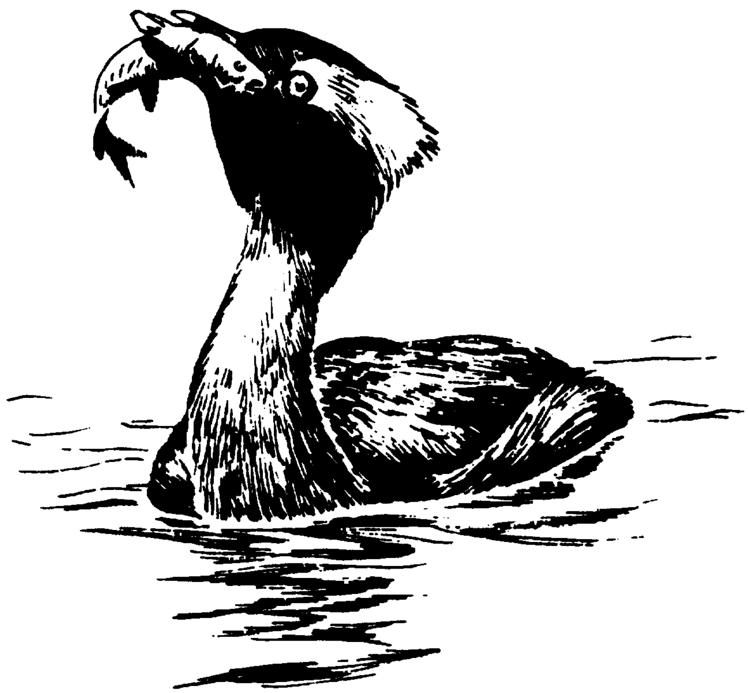
PHASE I
WATERSHED ASSESSMENT AND TMDL
FINAL REPORT

FISH LAKE,
DEUEL COUNTY, SOUTH DAKOTA



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

January, 2004
SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

ASSESSMENT/PLANNING PROJECT FINAL REPORT

FISH LAKE WATERSHED ASSESSMENT AND TMDL FINAL REPORT

By

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Deuel County Conservation District

1/26/04

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Abbreviations

AFOs	Animal Feeding Operations
ANC	Acid Neutralizing Capacity
AnnAGNPS	Annualized Agricultural Non-Point Source
BMPs	Best Management Practices
CV	Coefficient of Variance
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
GPS	Global Positioning System
GLS	Great Little Sampler
IJC	International Joint Commission
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Units
Q WTD C	Flow Weighted Concentration
SD DENR	South Dakota Department of Environment and Natural Resources
SD GF&P	South Dakota Department of Game, Fish & Parks
SU	Standard Units
TKN	Total Kjeldahl Nitrogen
TSI	Trophic State Index
µmhos/cm	micromhos/centimeter
USGS	United States Geologic Survey

Executive Summary

PROJECT TITLE: Fish Lake/ Lake Alice Watershed Assessment

PROJECT START DATE: 6/1/01 PROJECT COMPLETION DATE: 6/1/02

FUNDING: TOTAL BUDGET: $80,375

TOTAL EPA GRANT:	$64,325
TOTAL EXPENDITURES OF EPA FUNDS:	$46,365.45
TOTAL SECTION 106 MATCH ACCRUED:	$14,545.65
BUDGET REVISIONS:	None
TOTAL EXPENDITURES:	$60,911.10

SUMMARY ACCOMPLISHMENTS

The Fish Lake Watershed Assessment was completed as a portion of a larger assessment in Deuel County South Dakota which covered both Fish Lake and Lake Alice, including their associated drainages. The project commenced in June of 2001 as a result of these waterbodies inclusion on the 1998 State 303(d) list, when a coordinator was hired and data collection began. Collection of data continued through June of 2002 at that point the process of preparing the final reports began; the Fish Lake Watershed Assessment was postponed until the completion of the Lake Alice Assessment Final Report. All milestones were accomplished in an acceptable and timely manner, with the exception of the final report, which was postponed until the completion of the Lake Alice Report and as a result of unanticipated difficulties encountered while executing the watershed model.

The primary funding source for the project was provided through federal 106 funds. Additional funding was provided by local sources such as Deuel County, East Dakota Water Development District, and the Deuel County Conservation District.

The major findings of this study include the following points:

- The presence of significant amounts of internal loading may mask improvements in water quality as a result of watershed work for at least 10 to 20 years.
- Immediate improvements dealing with the internal loading issues will likely prove to be cost prohibitive.
- Sediment accumulation during the project was not found to be a significant problem, but subwatershed FLT3 may benefit from mitigation practices as it accounted for 92% of the watershed load.
- Mitigation practices should be completed in the most critical areas to reduce nutrients when possible the lake in its current state.
- Implementation practice may slightly reduce the lake TSI to protect the lake from further degradation.

Introduction

Purpose

The long term goal of the Fish Lake Assessment Project is to locate and document sources of nonpoint source pollution in the watershed. Feasible restoration recommendations will be produced in order to provide adequate background information needed to drive a watershed implementation project to reduce sedimentation and nutrients impacting the lake and its tributaries, and to produce a TMDL report for Fish Lake.

General Lake Description

Fish Lake is a 738 acre natural impoundment located in southern Deuel County, South Dakota (see Figures 1and 2). The primary tributaries and receiving water body are unnamed, however the discharge from the Fish Lake watershed ultimately reach the Minnesota River. The impoundment receives runoff from agricultural operations. The creeks in the watershed and the lake have experienced declining water quality according to the state 303(d) report. The Fish Lake Watershed is approximately 25,000 acres in size. The land use in the watershed is predominately agricultural consisting of cropland and grazing.

Lake Identification and Location

Lake Name: Fish Lake	State: South Dakota
County: Deuel	Township: 113N
Range: 47W	Sections: 8,9,16,17
Nearest Municipality:	Latitude: 44.881898
Longitude: -96.637657	EPA Region: VIII
Primary Tributaries: 3 unnamed creeks	Receiving Body of Water: unnamed creek
HUC Code: 7020003	HUC Name: Lac Qui Parle

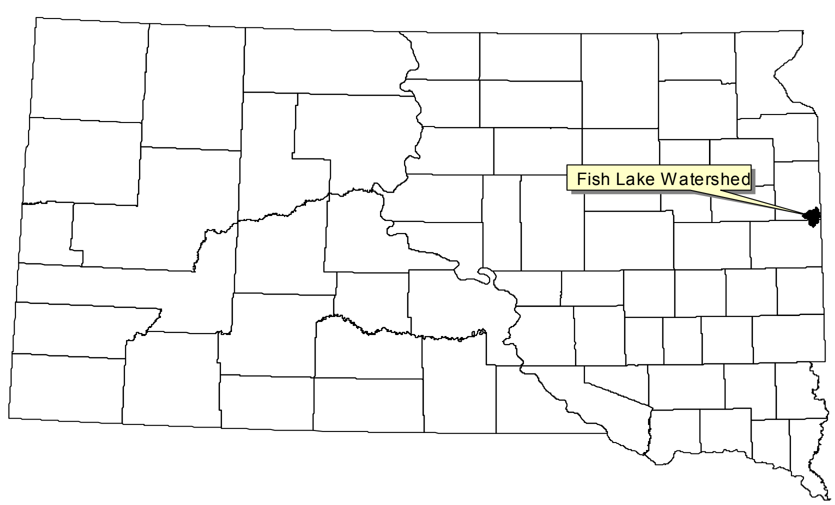


Figure 1. Fish Lake Watershed

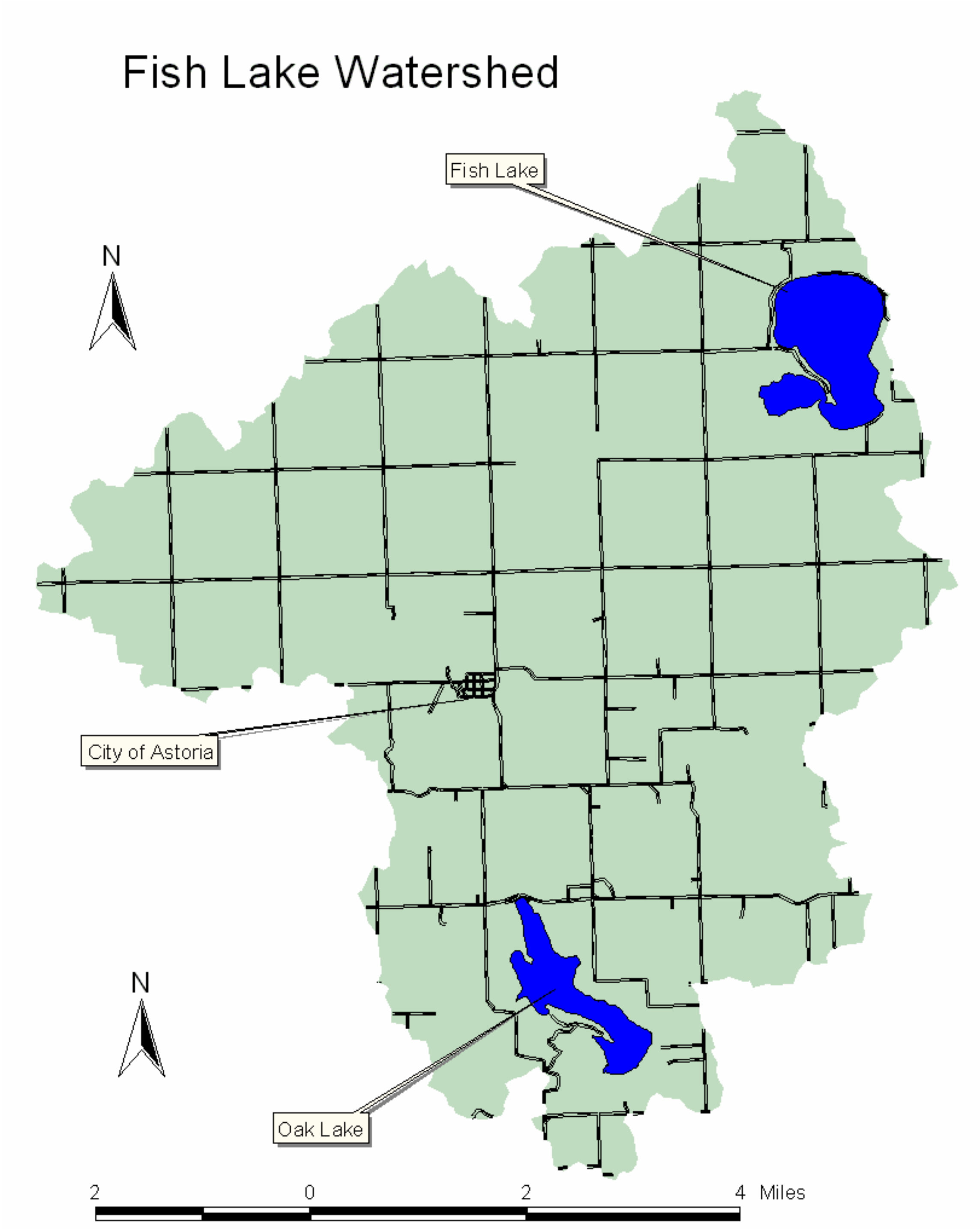


Figure 2. Fish Lake, Deuel County, South Dakota

Trophic State Comparison

The trophic state of a lake is a numerical value that ranks its relative productivity. Developed by Carlson (1977), the Trophic State Index (TSI) allows a lake's productivity to be easily quantified and compared to other lakes. Higher TSI values correlate with higher levels of primary productivity. A comparison of Fish Lake to other impoundments in the Northern Glaciated Plains Ecoregion (Table 1) shows a wide range of productivity in the ecoregion. Fish Lake has higher than average mean TSI value for its ecoregion. The values provided in Table 1 were generated from the most recent statewide lake assessment final report (Stueven and Stewart, 1996). The TSI for Fish Lake will vary slightly in this report due to the use of new data gathered during this assessment.

Table 1. Comparison of Mean Trophic States for Lakes Located in the Northern Glaciated Plains Ecoregion

Lake	County	TSI	Mean Trophic State
Cochrane	Deuel	51.88	Eutrophic
Oliver	Deuel	56.99	Eutrophic
Alice	Deuel	60.56	Eutrophic
Bullhead	Deuel	61.84	Eutrophic
Hendricks	Brookings	69.80	Hyper-eutrophic
Pelican	Codington	70.02	Hyper-eutrophic
East Oakwood	Brookings	70.85	Hyper-eutrophic
Clear	Deuel	71.55	Hyper-eutrophic
Kampeska	Codington	71.66	Hyper-eutrophic
School	Deuel	72.99	Hyper-eutrophic
Fish	**Deuel**	**73.01**	**Hyper-eutrophic**

Beneficial Uses

The State of South Dakota has assigned all of the water bodies that lie within its borders a set of beneficial uses. Along with these assigned uses are sets of standards for the chemical properties of the lake. These standards must be maintained for the lake to fully support its assigned beneficial uses. All bodies of water in the state receive the beneficial uses of fish and wildlife propagation, recreation, and stock watering. The following beneficial uses are assigned to Fish Lake.

(6) Warmwater marginal fish life propagation
(7) Immersion recreation
(8) Limited contact recreation
(9) Fish and wildlife propagation, recreation, and stock watering

Individual parameters as well as the lake's TSI value determine the support of these beneficial uses. Fish Lake is identified in *Ecoregion Targeting for Impaired Lakes in*

South Dakota (Stueven et al. 2000) as not supporting its beneficial uses. As a result of this, it was listed in the 1998 and 2002 303(d) list of impaired waterbodies.

Recreational Use

The South Dakota Department of Game, Fish, and Parks provides a list of existing public facilities that are maintained at area lakes (Table 2). Fish Lake has a small recreation area developed on the north side of the lake including a boat ramp, public dock, and shore fishing. There is one permanent lake residence and a couple of farm sites located within view of the lake.

Table 2. Comparison of Recreational Uses and Facilities for Area Lakes

Lake	Beach	Boat Ramp	Camp Ground	Public Docks	Handicapped Access	Shore Fishing	Public Toilets	County
Alice		X		X		X	X	Deuel
Briggs						X		Deuel
Bullhead		X		X		X	X	Deuel
Cochrane	X	X		X		X	X	Deuel
South Coteau		X				X		Deuel
Fish Lake		**X**		**X**		**X**		Deuel
Ketchum		X						Deuel
Oliver		X						Deuel
School		X		X		X		Deuel

Project Goals, Objectives, and Activities

Planned and Actual Milestones, Products, and Completion Dates

Objective 1. Lake Sampling

Sampling of Fish Lake was to begin in April 2001. The first samples were not collected until June, 2001 when sampling equipment arrived and the coordinator began work. Sampling of nutrient and solids parameters continued at the two scheduled sites through October as planned. Safe ice conditions only allowed one winter sample to be collected in January. Spring samples were gathered in April and May.

Objective 2. Tributary Sampling

The project coordinator began tributary monitoring and sampling at the end of May, 2001. Sufficient runoff was present for several months to facilitate sample collection. An Isco Flowmeter was installed at each site at the start of the project and used to take automatic samples and stage recordings of the water level going into and out of Fish Lake. Detailed level and flow data were entered into a database that was used to assess the nutrient and solids loading to the lake.

Objective 3. Quality Assurance/ Quality Control (QA/QC)

Duplicate and blank samples were collected during the course of the project to provide defendable proof that sample data were collected in a scientific and reproducible manner. QA/QC data collection began in May of 2001 and was completed on the last sampling date in June of 2002. Fewer than planned samples were collected, however it appears that the quality of the data is sufficient to complete a TMDL for this waterbody.

Objective 4. Watershed Modeling

Information regarding cropping history and hydrology of the watershed were collected throughout the project. Analysis of the data was completed during the fall of 2003, well after the proposed date. This is a result of attempts to also complete the Lake Alice TMDL under the same grant application as the Fish Lake study, and some unanticipated difficulties involved with the model.

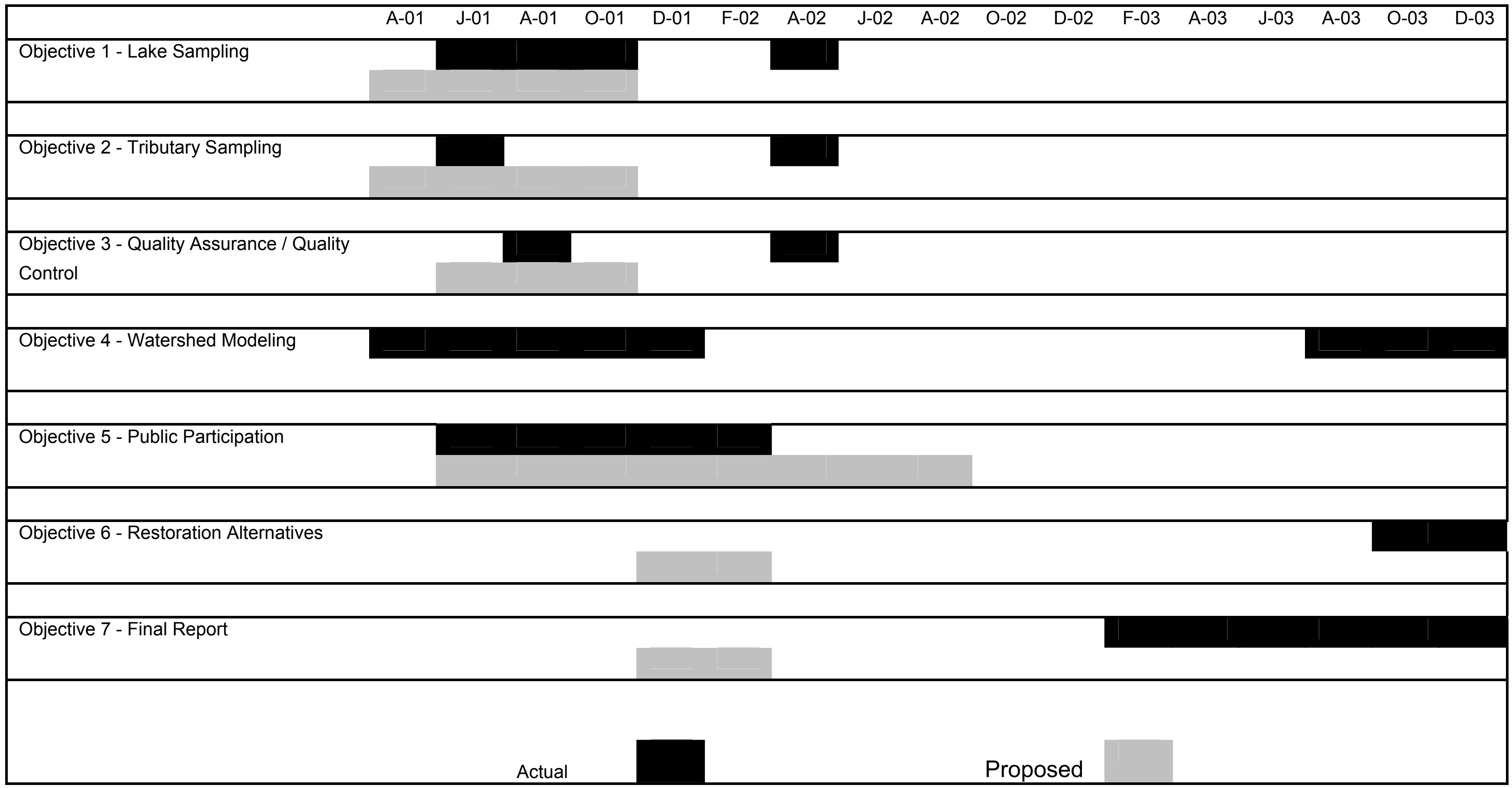
Objective 5. Public Participation

All of the landowners were contacted individually to assess the land use in the watershed and the condition of animal feeding operations in the project area. Further information was also provided to the project coordinator during routine trips to the watershed and public meetings for the local Lakes and Streams meetings, Deuel County Conservation District Meetings, and the newly formed Fish Lake Association.

Objectives 6 and 7. Restoration Alternatives and Final Report

Completion of the restoration alternatives and final report were completed during 2003, after the work on the Lake Alice TMDL, conducted under the same grant as the Fish Lake study, was completed.

Table 3. Proposed and Actual Objective Completion Dates



Monitoring Results

Surface Water Chemistry (Tributaries)

Flow Calculations

A total of four (three tributary and one outlet) monitoring sites were selected on the tributaries to Fish Lake. The sites were selected to determine which portions of the watershed were contributing the greatest amount of nutrient and sediment load to the lake. All of the sites were equipped with ISCO 4230 flow meters connected to ISCO GLS auto samplers. Water stages were monitored and recorded to the nearest 1/100th of a foot for each of the four sites. A Marsh-McBirney Model 2000 velocity meter was used to determine flows at various stages. The stages and flows were then used to create a stage-to-discharge table for each site. Stage-to-discharge tables may be found in Appendix A.

Load Calculations

Total nutrient and sediment loads were calculated with the use of the Army Corps of Engineers eutrophication model known as FLUX. FLUX uses individual sample data in correlation with daily average discharges to develop six loading calculations for each parameter. As recommended in the application sequence, a stratification scheme and method of calculation was determined using the total phosphorus load. This stratification scheme is then used for each of the additional parameters. Sample data collected from the tributaries may be found in Appendix B.

Tributary Sampling Schedule

Samples were collected at selected sites during the spring of 2001 through the spring of 2002. Most samples were collected using a suspended sediment sampler while some were collected with the automatic samplers. Water samples were filtered, preserved, and packed in ice for shipping to the State Health Lab in Pierre, SD. The laboratory then assessed the following parameters:

Fecal Coliform Counts
Total Solids
Total Suspended Solids
Nitrate
Total Phosphorus
Total Dissolved Phosphorus
Alkalinity
Total Dissolved Solids
Ammonia
Total Kjeldahl Nitrogen (TKN)
Volatile Total Suspended Solids
E. coli Bacteria Counts

Personnel conducting the sampling at each of the sites recorded visual observations of weather and stream characteristics.

Precipitation	Wind
Odor	Septic Conditions
Dead Fish	Film
Turbidity	Width
Water Depth	Ice Cover
Water Color	

Parameters measured in the field by sampling personnel were:

Water Temperature	Air Temperature
Dissolved Oxygen	Field pH
Conductivity	

South Dakota Water Quality Standards

The State of South Dakota assigns at least two of the eleven beneficial uses to all bodies of water in the state. Fish and wildlife propagation, recreation and stock watering as well as irrigation are assigned to all streams and rivers. All portions of the tributaries located within the Fish Lake watershed must maintain the criteria that support these uses. In order for the creeks to support these uses, there are seven standards that must be maintained. These standards, as well as the water quality values that must be met, are listed in Table 4.

Table 4. State Water Quality Standards

Parameter	Criterion
Nitrate	≤ 50 mg/L (mean) ≤ 88 mg/L (single sample)
Alkalinity	≤ 750 mg/L (mean) ≤ 1,313 mg/L (single sample)
pH	≥ 6.0 and ≤ 9.5 su
Total Dissolved Solids	≤ 2,500 mg/L for a 30-day geometric mean ≤ 4,375 mg/L daily maximum for a grab sample
Conductivity	≤ 2,500µmhos (mean) ≤ 4,375µmhos (single sample)
Total Petroleum Hydrocarbon Oil and Grease	≤ 10 mg/L ≤ 10 mg/L
Sodium Adsorption Ratio	≤ 10 mg/L

Watershed Overview and Water Budget

The Fish Lake drainage was divided into three individual subwatersheds with a gauging station located at the outlet to each one, with an additional station located at the outlet to the lake (See Figure 3). Stage and discharge data were collected from each subwatershed was combined with water chemistry samples to calculate a load from each of these subwatersheds.

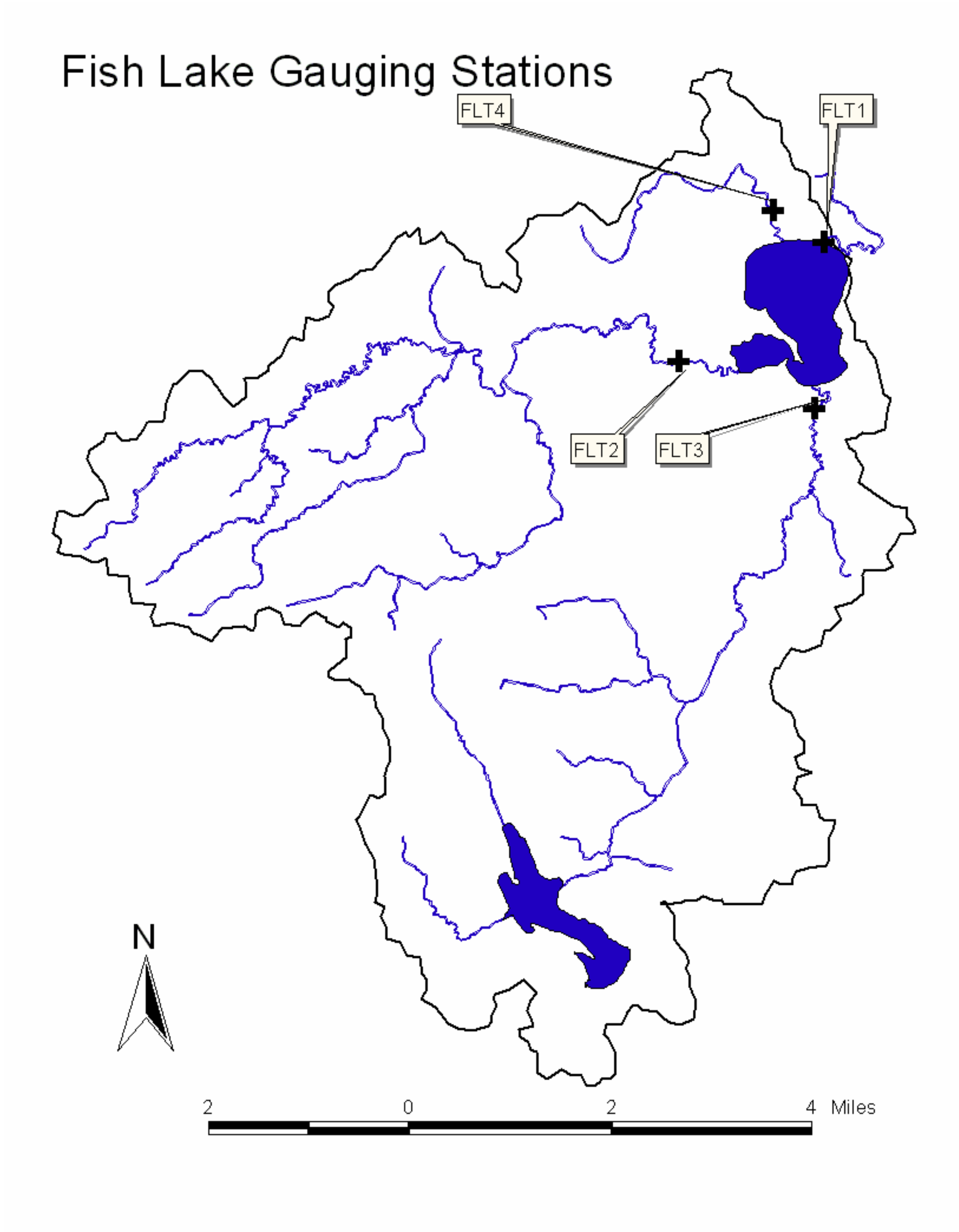


Figure 3. Fish Lake Monitoring Stations

Annual and Seasonal Loadings

To calculate the current and future water quality in an impoundment, BATHTUB (Army Corps of Engineers eutrophication model) utilizes phosphorus and nitrogen loads entering the impoundment. These loads and their standard errors (CV) are calculated through the use of FLUX (Army Corps of Engineers loading model) for the primary inlets and the outlet to the lake. Table 5 contains the annual loadings calculated during the project. Seasonal loadings are heavily influenced by runoff events that primarily occur in the spring of the year. While some years may experience summer or fall runoff events that are significant, most of the runoff during a normal year occurs in the spring.

Table 5. Annual Loadings to Fish Lake

All Loads Reported in Kilograms					
	FLT-2	FLT-3	FLT-4	Total Load	Outlet
TP	879	1,471	135	2,485	1,434
TDP	733	743	91	1,567	474
Talka	774,449	857,514	153,957	1,785,920	1,611,173
Tsol	2,039,345	2,558,263	314,945	4,912,553	5,066,394
Tssol	22,472	407,464	13,025	442,961	258,202
Vtss	6,935	47,236	2,295	56,466	97,381
Tnit	6,420	13,879	1,028	21,327	16,203
OrgNit	4,705	6,434	786	11,925	15,208
InorgNit	1,714	7,444	242	9,400	994
Mean Flow (CFS)	3.68	4.61	0.67	9	9
Acreage	12,481	11,929	1,410	25,820	27,479

An important comparison of watershed conditions can be made through the use of the discharge coefficients. These are the loads that enter the lake divided by or corrected for the number of acres that a particular inlet drains. The data in Table 6 reflects some of the more important comparisons that will be made through the tributaries section of this report. It is important to note that site FLT-3 is frequently found to contribute a significant amount of the nutrients and sediments that enter the lake.

Table 6. Loading Coefficients for Fish Lake (Kg/acre)

	FLT-2	FLT-3	FLT-4
TP	0.07	0.12	0.10
TDP	0.06	0.06	0.06
Tssol	1.80	34.16	9.24
Vtss	0.56	3.96	1.63
Tnit	0.51	1.16	0.73
InorgNit	0.14	0.62	0.17

An additional component in a lake's loading is the hydraulic budget, which is the source(s) of the water that enters the lake comes from and where it goes. Figure 4 depicts the sources of the water entering Fish Lake.

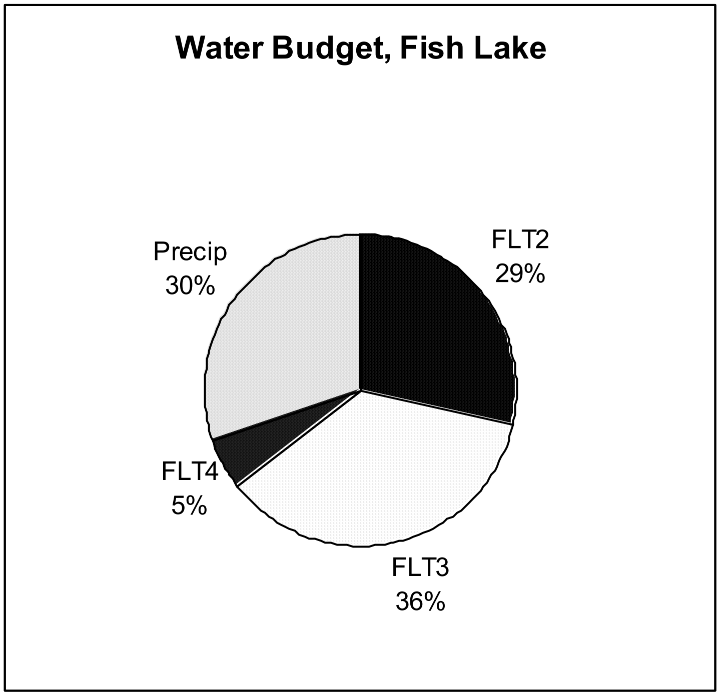


Figure 4. Fish Lake Water Budget

Subwatersheds FLT-2 and FLT-3 are similar in size and each accounted for roughly 1/3 of the water load to the lake. Approximately 1/3 can be attributed to precipitation falling directly into the lake.

Site FLT-4 accounts for only 5% of the annual water budget. The exact boundary of this portion of the watershed appears to vary depending on the amount of moisture present each year. During very high water years, Fox Lake (located several miles north and west of Fish Lake) appears to discharge surplus water through a series of wetlands that eventually reaches Fish Lake. Since this is not a frequent occurrence, it is unlikely that the drainages around Fox Lake have a significant impact on the condition of Fish Lake. For this reason, no mitigation activities installed for the benefit of Fish Lake should be implemented in this portion of the watershed.

Fecal Coliform Bacteria

Fecal coliform bacteria are found in the waste of warm-blooded animals. Some common types of bacteria are *E. coli*, S*almonella,* and *Streptococcus,* which are associated with livestock, wildlife, and human waste (Novotny, 1994). Most of the samples indicated the presence of *E. coli* at levels higher than the total fecal coliform count (Table 7). This is the result of standard lab testing procedures. Fecal coliform tests are conducted with an incubation temperature of 45°C while *E. coli* tests are conducted with an incubation temperature of 35°C. The higher incubation temperature for the fecal test inhibits the growth of some *E. coli,* resulting in the lower counts for total fecal coliform.

Table 7. Fecal Coliform Counts in Fish Lake Tributaries

Site	Date	Fecal	*E.coli*	Site	Date	Fecal	*E.coli*
FLT-2	05/31/01	100	119	FLT-2	04/04/02	5	2
FLT-2	06/05/01	80	184	FLT-2	04/18/02	20	28.8
FLT-2	06/13/01	16000	2400	FLT-3	04/03/02	20	30.5
FLT-2	06/30/01	270	308	FLT-3	04/18/02	50	65.1
FLT-2	07/09/01	2500	> 2420	FLT-4	06/05/01	5	24.6
FLT-3	05/31/01	1100	1990	FLT-4	04/04/02	5	0.5
FLT-3	06/07/01	2200	2400	FLT-4	04/18/02	5	0.5
FLT-3	06/13/01	3000	> 2420	FLO1	05/31/01	5	6.3
FLT-3	07/09/01	2700	1990	FLO1	06/05/01	5	1
FLT-3	05/09/02	700	121	FLO1	08/01/01	5	3
FLT-4	05/30/01	280	435	FLO1	08/28/01	5	1
FLT-4	06/13/01	570	687	FLO1	04/04/02	5	3.1
FLT-4	06/13/01	140	107	FLO1	04/18/02	5	1
FLT-4	07/16/01	160	98.4				
FLT-4	07/16/01	120	67.6				

There are no fecal coliform standards for the tributaries entering Fish Lake. As a result of this, there can be no impairments as a result of fecal contamination in the tributaries. Samples collected from the lake did not indicate any impairment; however, some of the larger concentrations, such as those from FLT-2 on 6/13/01, likely result in higher counts then were measured in the lake during the assessment.

Fecal contamination may also be an indicator of the source of nutrient enrichment that the streams and lake are experiencing. Fecal counts were exceptionally high at sites FLT-2 and FLT-3, with multiple dates in excess of 1,000 colonies/ 100 mL. This suggests that mitigation practices targeting livestock in these watersheds may result in the greatest immediate benefits to the lake through the reduction of fecal loads in addition to nutrient loads.

Alkalinity

Historically, the term alkalinity referred to the buffering capacity of the carbonate system in water. Today, alkalinity is used interchangeably with acid neutralizing capacity (ANC), which refers to the capacity to neutralize strong acids such as HCL, H_2SO_4 and HNO_3. Alkalinity in water is due to any dissolved species (usually weak acid anions) with the ability to accept and neutralize protons (Wetzel, 2000). Due to the abundance of carbon dioxide (CO_2) and carbonates, most freshwater contains bicarbonates as its primary source of alkalinity. Alkalinity is commonly found in concentrations as high as 200 mg/L.

Alkalinity concentrations in the streams draining into Fish Lake ranged from a low of 101 mg/L collected at site FLT-2 on 4/4/02 to a maximum of 318 mg/L collected at site FLT-2 on 7/9/01. These values remained well within the state standards of a mean of 750 mg/L and a single sample maximum of 1,313 mg/L indicating that the tributaries are not impaired as a result of excessive alkalinities.

pH

pH is a measure of free hydrogen ions (H^+) or potential hydrogen. More simply it indicates the balance between acids and bases in water. It is measured on a logarithmic scale between 0 and 14 and is recorded as standard units (su). At neutral (pH of 7) acid ions (H^+) equal the base ions (OH^-). Values less than 7 are considered acidic (more H^+ ions) and greater than 7 are basic (more OH^- ions).

pH values collected from the project streams had pH values that ranged from 6.77 su to 9.1 su, all within the state standards of 6.0 su to 9.5 su indicating no impairment as a result of high or low pH values.

Solids

Total solids are the sum of all dissolved and suspended as well as all organic and inorganic materials. Dissolved solids are typically found at higher concentrations in ground water, and typically constitute the majority of the total solids concentration. The total solids loadings most closely depict the dissolved portion of the solids load.

Dissolved solids standards for the tributaries in the project area are a maximum of 2,500 mg/L for a mean or a single sample maximum of 4,375 mg/L. The highest recorded value came from site FLT-2 on July 9, 2001 with a concentration of 791mg/L, indicating full support of the state standards.

Suspended solids are of some concern in the Fish Lake watershed. The tributaries do not have a suspended solids standard, however, a significant volume of Fish Lake has been lost through sedimentation (see the sediment survey section of this report), making suspended solids loads in the tributaries a potential concern.

Suspended solids load from the watershed are represented in Figure 5. It is apparent that subwatershed FLT-3 is more impaired when compared with the other subwatersheds. Site FLT-3 drains a slightly smaller area than site FLT-2, but it accounted for over 18 times the suspended solids load of site FLT-2. The load at site FLT-3 was 407,464 kg/yr.

Sediment accumulation in the lake is occurring at a rate of approximately 204 tons on an average annual basis. This is based on the calculated load from the inlets compared to the calculated load at the outlet to the lake. The annual load to the lake is 488 tons, while the outlet discharges 284 tons annually. A reduction in the sediment loading in excess of 40% would be required to keep the lake from losing additional volume as a result of sedimentation. Although the lake has lost a considerable amount of its volume as a result of sedimentation, the current sediment accumulation may be considered negligible as it accounts for less than 1 mm of depth loss in 20 years.

When these loadings are converted to a loading per acre for each of the subwatersheds, FLT-3 had a load of 34.1 kg/acre, site FLT-4 had a load of 9.2 kg/acre, and site FLT-2 had a load of 1.8 kg/acre. Erosion control activities conducted in the Fish Lake watershed should be targeted primarily towards the FLT-3 drainage.

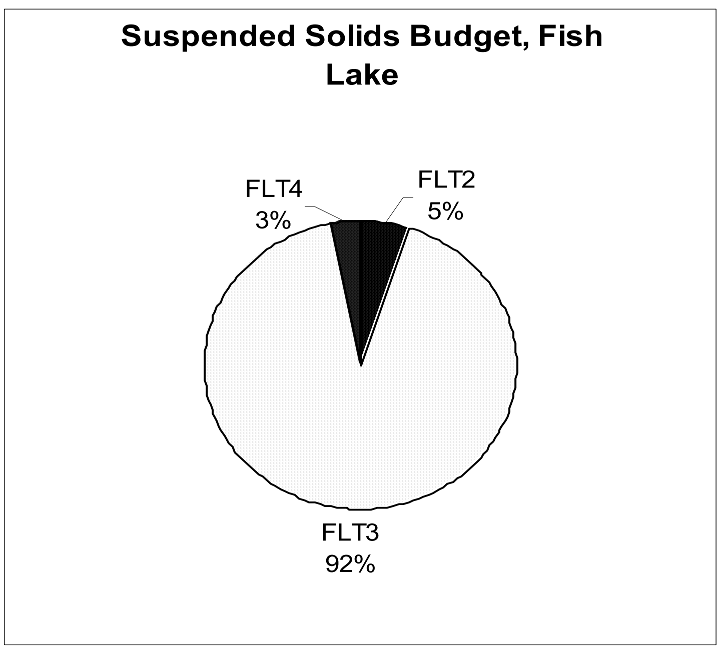


Figure 5. Fish Lake Subwatershed Suspended Solids Loads

Nitrate/Nitrite and Ammonia

Nitrogen is assessed in four forms: nitrate/nitrite, ammonia, and Total Kjeldahl Nitrogen (TKN). From these four forms, total, organic, and inorganic nitrogen may be calculated. Nitrogen compounds are major cellular components of organisms. Because its availability may be less than the biological demand, environmental sources may limit productivity in freshwater ecosystems. Nitrogen is difficult to manage because it is highly soluble and very mobile in water.

As a standard testing procedure, nitrates and nitrites are measured and recorded together. This form of nitrogen is inorganic and readily available for plant use. The water quality standards for wildlife propagation, recreation, and stock watering require that nitrate concentrations remain below 50 mg/L mean over any 30-day period of time and 88 mg/L for any single sample.

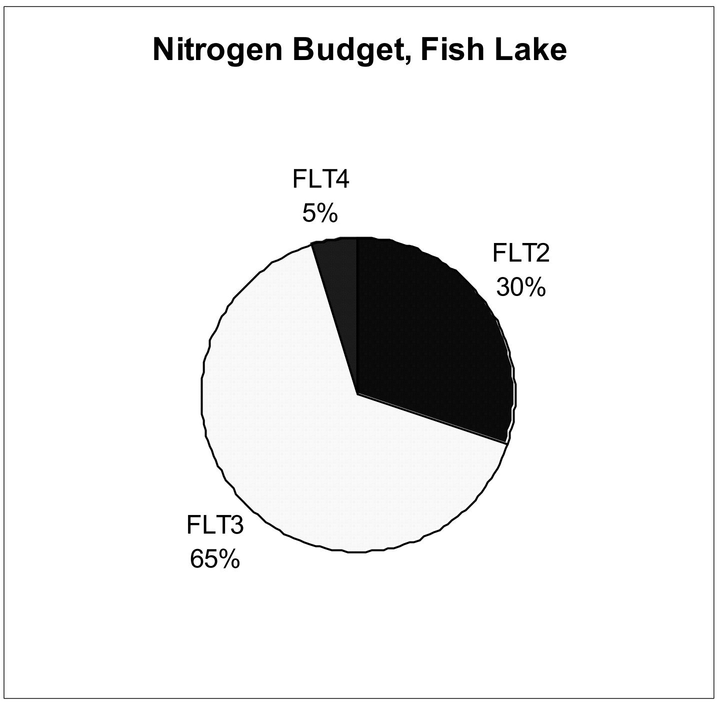


Figure 6. Nitrogen Budget for Fish Lake

The total nitrogen budget calculated for the tributaries entering Fish Lake (see Figure 6) indicates that site FLT-3 accounts for 65% of the nitrogen load entering the lake. When individual sample concentrations are compared, there are no violations of state standards. The highest nitrate concentration recorded during the project was at site FLT-3 on April 3, 2002 at a concentration of 5.2 mg/L. It is likely that mitigation practices in this watershed will reduce the loadings to Fish Lake.

Phosphorus

Phosphorus is one of the macronutrients required for primary production. In comparison to carbon, nitrogen, and oxygen, it is often the least abundant in natural systems (Wetzel, 2000). Phosphorus loading to lakes can be of an internal or external nature. Total phosphorus is the sum of all attached and dissolved phosphorus in the lake.

Figure 7 depicts the percentage of the annual phosphorus load that enters Fish Lake from each of its subwatersheds as well as from rainfall. The greatest impact to Fish Lake comes from site FLT-3, where 58% of the phosphorus load originates. Accounting for only 36% of the water budget and 26% of the drainage area, this site has the greatest discharge coefficient of 0.12 kg/ acre annually. In comparison, sites FLT-4 and FLT-2 have discharge coefficients of 0.10 kg/acre and 0.07 kg/ acre respectively.

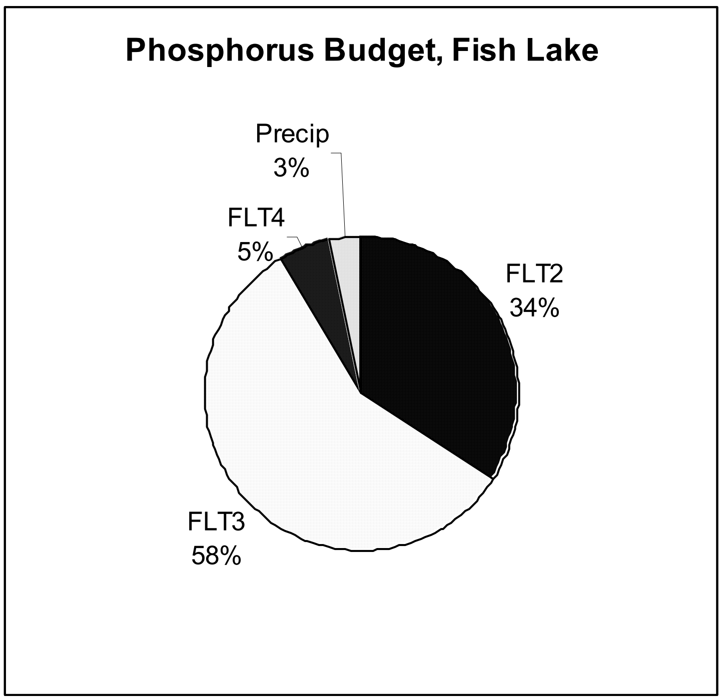


Figure 7. Fish Lake Subwatershed Phosphorus Loads

The dissolved phosphorus discharge coefficients are all 0.06 kg/acre, indicating that the increase in phosphorus measured at site FLT-3 is the result of attached phosphorus, likely from erosion problems in this portion of the watershed. This is reinforced in the suspended solids discussion for the tributaries earlier in this report.

Mitigation processes targeting the reduction of phosphorus will likely have the greatest impact on subwatershed FLT-3. Priority should be given to this subwatershed over the others for the implementation of mitigation activities.

Tributary Site Summary

When observing both the annual water budget and the loadings of individual nutrients from the various watersheds, it appears that site FLT-3 is the most impaired portion of the watershed. According to the data collected during the assessment site FLT-3 contributes approximately twice as much nitrogen and phosphorus per acre than the other portions of the watershed.

The large sediment load occurring from site FLT-3 suggests that the increase in the nutrient load may be a result of soil erosion problems in this portion of the watershed. The fecal coliform concentrations measured at sites FLT-2 and FLT-3 suggest that there may be some impacts from livestock, either located in feeding areas adjacent to the stream or pastured animals that frequent the stream as a water source or for pest relief.

Mitigation practices should target the soil erosion in subwatershed FLT-3 and livestock operations in both subwatersheds FLT-2 and FLT-3. It is unlikely that Best Management Practices in subwatershed FLT 4 would have a significant impact on the lake and BMPs scheduled for FLT-4 should be assessed individually prior to implementation. Similarly, mitigation practices targeting erosion in subwatershed FLT-2 may not result in significant benefits to the lake and should be assessed individually prior to their construction.

Surface Water Chemistry (Fish Lake)

Inlake Sampling Schedule

Sampling began in June 2001 and was conducted on a monthly basis until project completion in June 2002. Two sites were selected for sample collection. Water samples were filtered, preserved, and packed in ice for shipping to the State Health Lab in Pierre, SD. Sample data collected at Fish Lake may be found in Appendix C. The laboratory assessed the following parameters:

Fecal Coliform Counts	Alkalinity
Total Solids	*E coli* Counts
Total Suspended Solids	Ammonia
Nitrate	Total Kjeldahl Nitrogen (TKN)
Total Phosphorus	Volatile Total Suspended Solids
Total Dissolved Phosphorus	Chlorophyll *a* *

** Chlorophyll a analysis completed by DENR staff @ Mathews Training Center Laboratory*

Personnel conducting the sampling at each of the sites recorded visual observations of weather and lake characteristics.

Precipitation	Wind
Odor	Septic
Dead Fish	Film
Water Depth	Ice Cover
Water Color	

Parameters measured in the field by sampling personnel were:

Water Temperature	Air Temperature
Secchi Depth	Dissolved Oxygen
Field pH	Turbidity

South Dakota Water Quality Standards

All public waters within the State of South Dakota have been assigned beneficial uses. All designated waters are assigned the use of fish and wildlife propagation, recreation, and stock watering. Along with each of these uses are sets of water quality standards that must not be exceeded in order to support these uses. Fish Lake has been assigned the beneficial uses of:

(6) Warmwater marginal fish life propagation
(7) Immersion recreation
(8) Limited contact recreation
(9) Fish and wildlife propagation, recreation and stock watering

The parameters and their associated values listed in Table 8 are those that must be considered when maintaining beneficial uses as well as the concentrations for each. When multiple standards for a parameter exist, the most restrictive standard is used.

Table 8. State Water Quality Standards for Fish Lake

Parameters	mg/L (except where noted)	Beneficial Use Requiring this Standard
Alkalinity *($CaCO_3$)*	≤ 750 *(mean)* ≤ 1,313 *(single sample)*	Wildlife Propagation and Stock Watering
Coliform, fecal *(per 100 mL)* May 1 to Sept 30	≤ 200 *(mean)* ≤ 400 *(single sample)*	Immersion Recreation
Conductivity *(μmhos / cm @ 25^o C)*	≤ 4,000 *(mean)* ≤ 7,000 *(single sample)*	Wildlife Propagation and Stock Watering
Nitrogen, unionized ammonia as N	≤ 0.05 *(mean)* ≤ 1.75 times the applicable limit *(single sample)*	Warmwater Marginal Fish Propagation
Nitrogen, nitrate as N	≤ 50 mg/L *(mean)* ≤ 88 mg/L *(single sample)*	Wildlife Propagation and Stock Watering
Oxygen, dissolved	≥ 5.0 mg/L	Immersion and Limited Contact Recreation
pH *(standard units)*	6.0 - 9.0	Warmwater Marginal Fish Propagation
Solids, suspended	≤ 150 mg/L *(mean)* ≤ 263 mg/L *(single sample)*	Warmwater Marginal Fish Propagation
Solids, total dissolved	≤ 2,500 mg/L *(mean)* ≤ 4,375 mg/L *(single sample)*	Wildlife Propagation and Stock Watering
Temperature	≤ 32.22 C	Warmwater Marginal Fish Propagation
Total Petroleum Hydrocarbon Oil and Grease	≤ 10 mg/L ≤ 10 mg/L	Wildlife Propagation and Stock Watering

Inlake Water Quality Parameters

Water Temperature and Dissolved Oxygen

Water temperature is of great importance to any aquatic ecosystem. Many organisms and biological processes are temperature sensitive. Blue-green algae tend to dominate warmer waters while green algae and diatoms generally do better under cooler conditions. Water temperature also plays an important role in physical conditions. Oxygen dissolves in higher concentrations in cooler water. Higher toxicity of un-ionized ammonia is also related directly to warmer temperatures.

Many factors influence the concentration of dissolved oxygen (DO) in a waterbody. Temperature is one of the most important of these factors. As the temperature of water increases, its ability to hold DO decreases. Daily and seasonal fluctuations in DO may occur in response to algal and bacterial action (Bowler, 1998). As algae photosynthesize during the day, they produce oxygen, which raises the concentration in the epilimnion. As photosynthesis ceases at night, respiration utilizes available oxygen causing a decrease in concentration. During winters with heavy snowfall, light penetration may be reduced to the point where algae and aquatic macrophytes in the lake cannot produce enough oxygen to keep up with consumption (respiration) rates. This results in oxygen depletion and may ultimately lead to a fish kill.

Water temperatures and dissolved oxygen concentrations remained well within state standards for these two parameters. Water temperatures varied from a low of 16.2^{o} C to a high of 20.6^{o} C during the growing season.

Due to some equipment difficulties, there were only four inlake dissolved oxygen readings were collected during the project. All of these were within state standards for DO concentrations. Fish Lake is a warmwater marginal fishery, indicating that the lake is subject to occasional fish kills, likely as a result of diminished dissolved oxygen concentrations. This study found that Fish Lake was not impaired as a result of low dissolved oxygen concentrations or high temperatures.

Alkalinity

A lake's total alkalinity affects its ability to buffer against changes in pH. Total alkalinity consists of all dissolved electrolytes (ions) with the ability to accept and neutralize protons (Wetzel, 2000). Due to the abundance of carbon dioxide (CO_2) and carbonates, most freshwater contains bicarbonates as their primary source of alkalinity. Bicarbonates are commonly found in concentrations as high as 200 mg/L or greater.

Alkalinity concentrations in Fish Lake ranged from a low of 151 mg/L recorded during April of 2002 to a maximum concentration of 206 mg/L recorded during August of 2001. These values are well within state standards (< 750 mg/L for a mean) indicating that Fish Lake is not impaired as a result of excessive concentrations of alkalinity.

pH

pH is a measure of free hydrogen ions (H^+) or potential hydrogen. More simply, it indicates the balance between acids and bases in water. It is measured on a logarithmic scale between 0 and 14 and is recorded as standard units (su). At neutral (pH of 7) acid ions (H^+) equal the base ions (OH^-). Values less than 7 su are considered acidic (more H^+ ions) and greater than 7 su are basic (more OH^- ions). Algal and macrophyte photosynthesis act to increase a lake's pH. Respiration and the decomposition of organic matter will reduce pH. The extent to which this occurs is affected by the lake's ability to buffer against changes in pH. The presence of high alkalinity (>200 mg/L) represents considerable buffering capacity and will reduce the effects of both photosynthesis and decay in producing large fluctuations in pH.

Recorded pH values for Fish Lake ranged from a low of 8.47 su to a maximum of 9.18 su. The values recorded on September 13, 2001 were both greater than state standards (Table 9). This is likely due to the large algae bloom which occurred in early September of 2001 and most likely resulted in the temporary exceedence of the state standard. It is likely that this occurs during or immediately following large algae blooms in the lake. The effects of these blooms are often short in duration and do not result in long term impairments of the lake. Mitigation activities reducing the nutrient load will likely reduce the frequency and intensity of algae blooms also reducing the occurrence of pH values above the state standards.

Table 9. Fish Lake pH Values

Site	Date	pH
FL-1	8/15/2001	8.66
FL-1	9/13/2001	9.08
FL-1	4/29/2002	8.64
FL-1	05/30/02	8.62
FL-2	8/15/2001	8.47
FL-2	9/13/2001	9.18
FL-2	4/29/2002	8.64
FL-2	05/30/02	8.63
	Max.	9.18
	Min.	8.47

Secchi Depth and Chlorophyll *a*

Secchi depth visibility is the most commonly used measurement to determine water clarity. No regulatory standards for this parameter exist, however the Secchi reading is an important tool used for determining the trophic state of a lake. The two primary causes for low Secchi readings are suspended solids and algae. Deeper Secchi readings are found in lakes that have clearer water, which is often associated with lower nutrient levels and "cleaner" water.

Chlorophyll *a* is the primary photosynthetic pigment found in oxygen producing organisms (Wetzel, 1982). Chlorophyll *a* is a good indicator of a lake's productivity as well as its state of eutrophication. The total concentration of chlorophyll *a* is measured in mg/m^3 (ppb) and is used in Carlson's Trophic State Index to rank a lake's state of eutrophication.

In the comparison made in Figure 8, a strong relationship is seen between the Secchi depth and the concentration of chlorophyll *a* in the lake. As algae blooms occur, resulting in the elevated chlorophyll a levels, the Secchi depth of the lake decreases. It can be expected that reduced nutrient concentrations and subsequent reductions in algae blooms would result in greater water clarity for the lake.

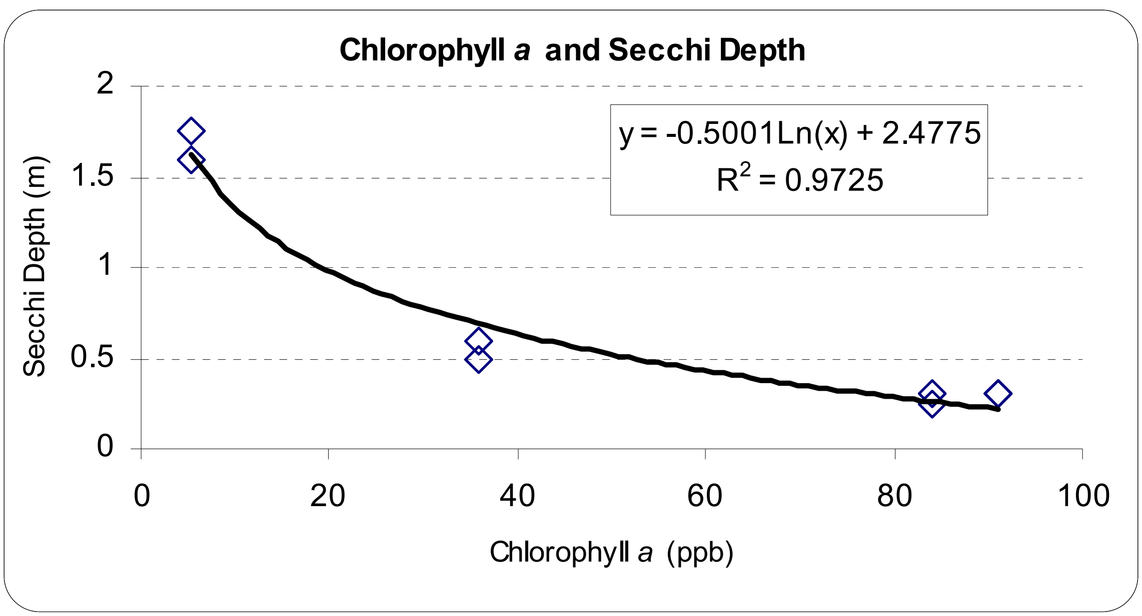


Figure 8. Chlorophyll *a* and Secchi Depth in Fish Lake

Solids

Solids are addressed as four separate parts in the assessment; total solids, dissolved solids, suspended solids, and volatile suspended solids. Total solids are the sum of all forms of material including suspended and dissolved as well as organic and inorganic materials that are found in a given volume of water.

Suspended solids consist of particles of soil and organic matter that may be eventually deposited in stream channels and lakes in the form of silt. Silt deposition to a stream bottom buries and destroys the complex bottom habitat. This habitat destruction reduces the diversity of aquatic insect, snail, and crustacean species. In addition to reducing stream habitat, large amounts of silt may also fill-in lake basins. As silt deposition reduces the water depth in a lake, several things occur. Wind-induced wave action increases turbidity levels by suspending solids from the bottom that had previously settled out. Shallow water increases and maintains higher temperatures. Shallow water also allows for the establishment of beds of aquatic macrophytes.

State standards for suspended solids are set at a mean of 90 mg/L and a maximum single sample value of 158 mg/L. Samples collected at Fish Lake were all well within the state standards with a maximum recorded concentration of 57 mg/L recorded on August 15, 2001 at site FL-1. The high suspended solids concentration in August and September of 2001 occurred after runoff in the lake had ceased indicating the most likely source of suspended solids is a result of wind action mobilizing material that had previously settled to the bottom.

Dissolved solids concentrations were also well within the state standards of 2,500 mg/L mean and 4,375 mg/L for a single sample. The maximum recorded value of 685 mg/L was recorded at site FL-1 on January 21, 2001. Fish Lake is not impaired as a result of suspended or dissolved solids concentrations.

Table 10. Solids Concentrations in Fish Lake

Site	Date	Suspended Solids	Dissolved Solids	Volatile Suspended Solids
FL-1	06/05/01	3	488	0.05
FL-1	7/10/2001	7	614	1
FL-1	8/15/2001	57	600	18
FL-1	9/13/2001	38	533	10
FL-1	1/21/2002	6	685	3
FL-1	4/29/2002	26	455	15
FL-1	05/30/02	24	487	17
FL-2	6/5/2001	2	493	0.5
FL-2	7/10/2001	7	603	2
FL-2	8/15/2001	46	597	20
FL-2	9/13/2001	31	535	9
FL-2	1/21/2002	6	684	3
FL-2	4/29/2002	23	457	13
FL-2	05/30/02	23	489	13

Nitrogen

Nitrogen is analyzed in four forms: nitrate/nitrite, ammonia, and Total Kjeldahl Nitrogen (TKN). From these four forms, total, organic, and inorganic nitrogen may be calculated. Nitrogen compounds are major cellular components of organisms. Because its availability may be less than the biological demand, environmental sources of nitrogen may limit productivity in freshwater ecosystems. Nitrogen is difficult to manage because it is highly soluble and very mobile. In addition, there are bacterial species capable of fixing atmospheric nitrogen for use by algae resulting in a virtually limitless supply of nitrogen.

Nitrogen concentrations (Table 11) are important for several reasons, the first of which is in the determining the limiting nutrients. If nitrogen is the limiting nutrient, reductions in the phosphorus load to the lake may not result improvements in water quality. This will be discussed in greater detail in later portions of this report.

Ammonia can be toxic to fish life, particularly in its unionized form which is dependent on water temperature and pH. The highest ammonia concentration recorded during the project was 0.23 mg/L recorded June 5, 2001 which for the pH and temperature for that day was within the allowable limits. Ammonia is typically more toxic during the summer as a result of warm water temperatures. Since summer fish kills are not a frequent problem on this lake, it is unlikely that ammonia levels impair this waterbody.

Maximum allowable limits for nitrogen in the form of nitrates are 50 mg/L for a mean or a single sample of 88 mg/L. The maximum concentration observed in Fish Lake during the project was 0.2 mg/L recorded on July 10, 2001. This is well within state standards indicating no impairment as a result of nitrogen in the form of nitrates.

Table 11. Nitrogen Concentrations in Fish Lake

Site	Date	ammonia	Nitrate	TKN	Total Nitrogen	Organic Nitrogen	Inorganic Nitrogen
FL-1	06/05/01	0.23	0.05	1.32	1.37	1.09	0.28
FL-1	7/10/2001	0.09	0.20	1.28	1.48	1.19	0.29
FL-1	8/15/2001	0.01	0.05	1.58	1.63	1.57	0.06
FL-1	9/13/2001	0.01	0.05	2.17	2.22	2.16	0.06
FL-1	1/21/2002	0.04	0.06	1.74	1.80	1.70	0.10
FL-1	4/29/2002	0.01	0.01	1.43	1.44	1.42	0.02
FL-1	05/30/02	0.01	0.05	1.56	1.61	1.55	0.06
FL-2	6/5/2001	0.21	0.05	1.48	1.53	1.27	0.26
FL-2	7/10/2001	0.09	0.10	1.33	1.43	1.24	0.19
FL-2	8/15/2001	0.01	0.05	1.60	1.65	1.59	0.06
FL-2	9/13/2001	0.01	0.05	2.04	2.09	2.03	0.06
FL-2	1/21/2002	0.02	0.05	1.56	1.61	1.54	0.07
FL-2	4/29/2002	0.02	0.05	1.59	1.64	1.57	0.07
FL-2	05/30/02	0.01	0.05	1.77	1.82	1.76	0.06

Phosphorus

Phosphorus is one of the macronutrients required for primary production. When compared with carbon, nitrogen, and oxygen, it is often the least abundant (Wetzel, 2000). Phosphorus loading to lakes can be of an internal or external nature. External loading refers to surface runoff, dust, and precipitation. Internal loading refers to the release of phosphorus from the bottom sediments to the water column of the lake. Total phosphorus is the sum of all attached and dissolved phosphorus in the lake.

Total dissolved phosphorus is the unattached portion of the total phosphorus load. It is found in solution, but readily binds to soil particles when they are present. Total dissolved phosphorus, including soluble reactive phosphorus, is more readily available to plant life than attached phosphorus.

The total phosphorus concentrations in Fish Lake are directly related to the amount of suspended material in the water. Figure 9 shows that as the amount of suspended solids increases, so does the concentration of phosphorus in the water. A similar relationship was found to exist between total phosphorus and chlorophyll *a* (R^2 of .55) but not with volatile suspended solids (R^2 of .18). Internal loading appears to be an issue, likely through suspension of bottom sediments through wind and wave action. Concentrations ranged from a low of 0.075 mg/L in the winter to a high of 0.24 mg/L during the growing season. The most effective solutions to the high phosphorus concentrations in Fish Lake are cost prohibitive, dredging followed by alum treatment. Reducing watershed loads may reduce long term concentrations, but would likely show little influence for many years.

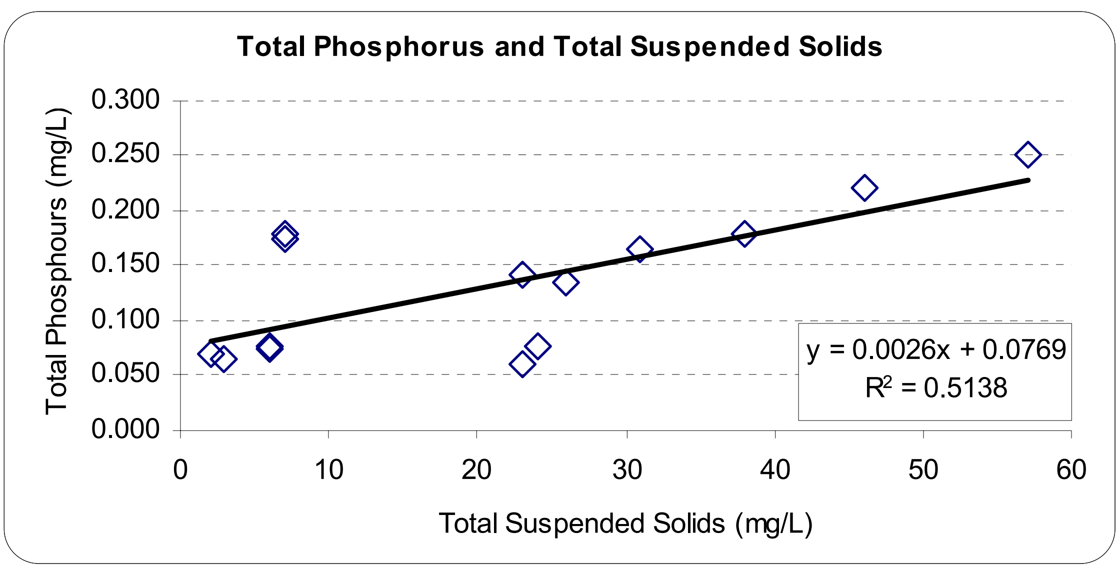


Figure 9. Total Phosphorus vs. Total Suspended Solids in Fish Lake

Fecal Coliform Bacteria

Fecal coliform are bacteria that are found in the waste of warm-blooded animals. Some common types of bacteria are *E. coli*, Salmonella, and Streptococcus, which are associated with livestock, wildlife, and human waste. (Novotny, 1994).

The state standard for fecal coliform between May 1 and September 30 is less than 400 colonies/ 100mL in any one sample. The geometric mean must remain less than 200 colonies/ 100mL based on samples collected during a minimum of five separate 24 hour periods for any 30-day period, and they may not exceed this value in more than 20 % of the samples examined in this same 30-day period.

Samples collected from Fish Lake were well within state standards with a maximum recorded fecal coliform count of 30 colonies/100mL. The same sample had an *E. coli* count of 63 colonies/100mL, both of which are well within the state standards. Current data does not indicate impairment to Fish Lake as a result of bacterial contamination.

Table 12. Fish Lake Fecal Coliform Counts

Date	Site	Fecal	E.Coli
6/5/01	FL-1	5	1
	FL-2	5	1
8/15/01	FL-1	5	14.6
	FL-2	5	2
9/13/01	FL-1	40	49.6
	FL-2	5	3.1
1/21/02	FL-1	1	0.5
	FL-2	1	0.5
4/29/02	FL-1	30	63.1
	FL-2	20	49.6
5/30/02	FL-1	5	0.50
	FL-2	5	4.10

Limiting Nutrients

Two primary nutrients are required for cellular growth in organisms, phosphorus and nitrogen. Nitrogen is difficult to limit in aquatic environments due to its highly soluble nature. Phosphorus is easier to control, making it the primary nutrient targeted for reduction when attempting to control lake eutrophication. The ideal ratio of nitrogen to phosphorus for aquatic plant growth is 10:1 (EPA, 1990). Ratios higher than 10:1 indicate a phosphorus-limited system. Those that are less than 10:1 represent nitrogen-limited systems.

Fish Lake remained phosphorus limited for the majority of the project with a mean ratio of 15.4:1. The exception was during the late summer of 2001 when the ratio dropped to 7.6:1. This represents the period of time during which a severe algae bloom occurred resulting in higher than normal pH levels and diminished water clarity. Fish Lake is too shallow for extended periods of stratification; however, there were no significant watershed loads which occurred during this period of time suggesting that bottom sediments did release nutrients which resulted in the increase in phosphorus and ultimately the algae bloom.

If the shallow waters of Fish Lake did release nutrients from the sediment, it suggests a very difficult mitigation process. The lake is too large to effectively dredge and too shallow to treat with alum. A large amount of green filamentous algae (*Cladophora fracta*) was found during the macrophyte survey in early July, on the bottom of the lake. It is possible that it was utilizing nutrients from the sediments and then released them during a die off which occurred during early July.

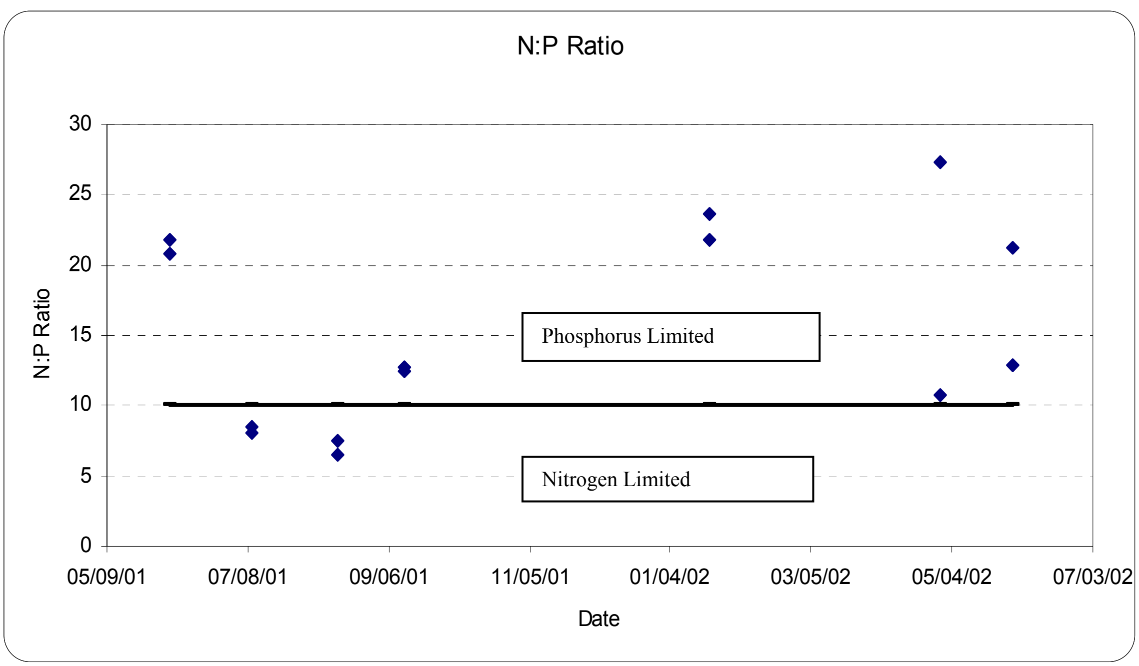


Figure 10. Limiting Nutrients in Fish Lake

Trophic State

Trophic state relates to the degree of nutrient enrichment of a lake and its ability to produce aquatic macrophytes and algae. The most widely used and commonly accepted method for determining the trophic state of a lake is the Trophic State Index (TSI) (Carlson, 1977). It is based on Secchi depth, total phosphorus, and chlorophyll *a* in surface waters. The values in a combined TSI number of the aforementioned parameters are averaged to give the lake's trophic state.

Lakes with TSI values less than 35 (Table 13) are generally considered to be oligotrophic and contain very small amounts of nutrients, little plant life, and are generally very clear. Lakes that obtain a score of 35 to 50 are considered to be mesotrophic and have more nutrients and primary production than oligotrophic lakes. Eutrophic lakes have a score between 50 and 65 and are subject to algal blooms and have large amounts of primary production. Hyper-eutrophic lakes receive scores greater than 65 and are subject to frequent and massive blooms of algae that severely impair their beneficial uses and aesthetic beauty.

Table 13. Carlson's Trophic State Index

TROPHIC STATE	COMBINED TSI NUMERIC RANGE
OLIGOTROPHIC	0-35
MESOTROPHIC	36-50
EUTROPHIC	51-65
HYPER-EUTROPHIC	> 65

TSI values for Fish Lake (Figure 11) ranged from a low of 54.7 recorded at site FL-1 on June 5, 2001 to a high of 79.3 recorded at site FL-1 on August 15, 2001. TSI values calculated for January samples were fairly close to the mean for the lake recorded at 63.6. This is somewhat unusual, as samples collected through the ice are frequently the clearest and have some of the lowest phosphorus concentrations of all samples collected from a lake.

The low TSI on June 5th 2001 reflects the lowest recorded total phosphorus measured in the lake. As was mentioned in the limiting nutrients section on the previous page, a large mat of filamentous green algae was found on the bottom of the lake. It is possible that this mat had begun growth at this point and had tied up many of the available nutrients resulting in "cleaner" than normal water.

The mean TSI for all samples collected was calculated to be at a trophic state of 68.8, placing this lake in the hyper-eutrophic category of lakes. This number does take into account samples that do not fall within the growing season of May 1 through September 30, also the period of peak recreational use. Disregauding these samples as well as phosphorus TSI values for those dates in which the lake was not phosphorus limited (Carlson, 1977) resulted in a mean TSI Value of 67.5 for Fish Lake. All loading based reductions should be completed using this as the starting point as it most accurately reflects the trophic state of Fish Lake.

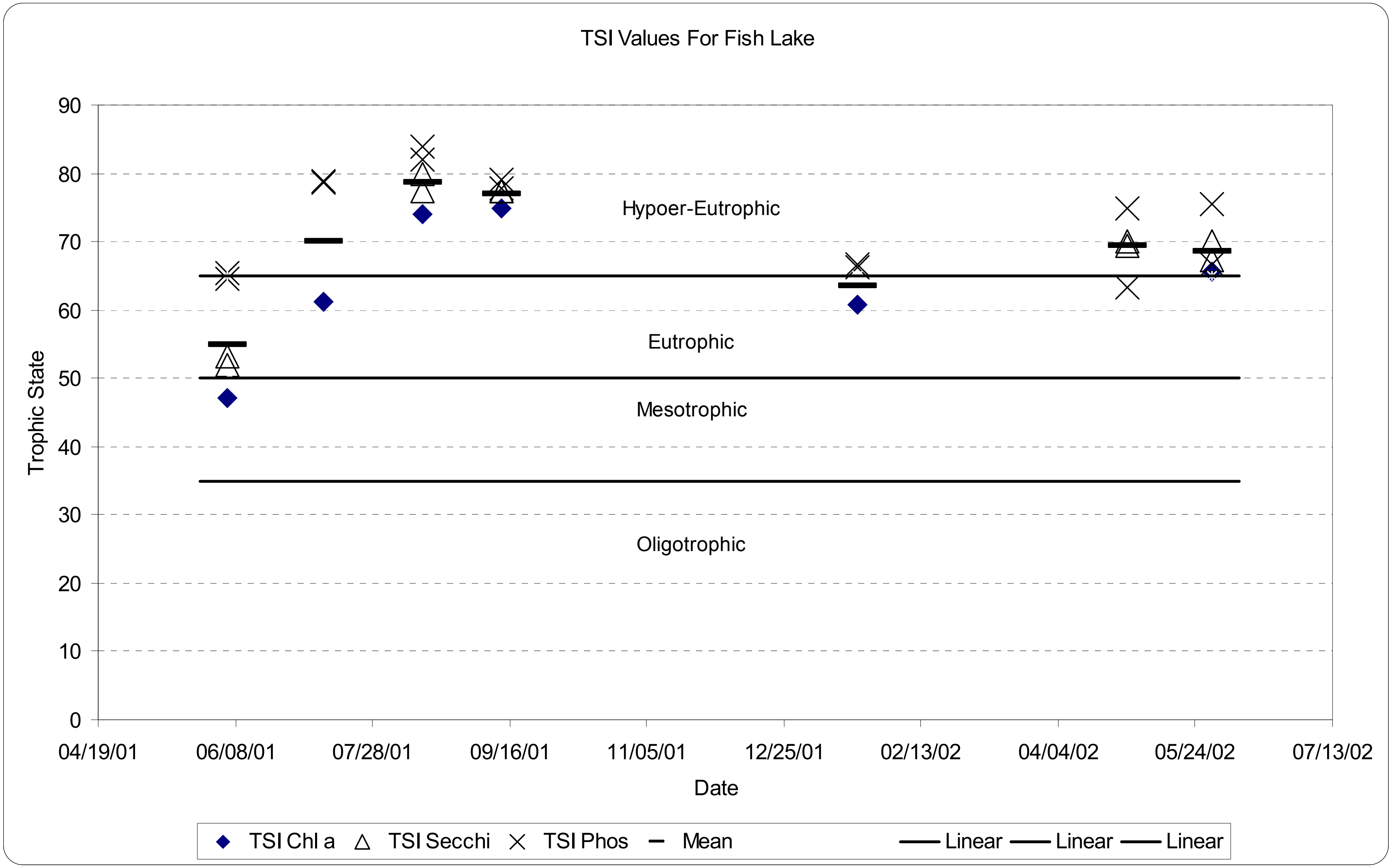


Figure 11. Measured Trophic State by Date for Fish Lake

Reduction Response Modeling

Inlake reduction response modeling was conducted with BATHTUB, an Army Corps of Engineers eutrophication response model (Walker, 1999). System responses were calculated using reductions in the loading of phosphorus to the lake from the creeks. Loading data for the creeks was taken directly from the results obtained from the FLUX modeling data calculated for the inlets to the lake. Atmospheric loads were provided by SDDENR. A summary of the data is listed in Table 5.

BATHTUB provides numerous models for the calculation of inlake concentrations of phosphorus, nitrogen, chlorophyll *a*, and Secchi depth. Models are selected that most closely predict current inlake conditions from the loading data provided. As reductions in the phosphorus load are predicted in the loading data, the selected models will closely mimic the response of the lake to these reductions. Due to differences in calculation methods, the TSI values in the BATHTUB model outputs will be slightly different from those calculated in the report

BATHTUB not only predicts the inlake concentrations of nutrients; it also produces a number of diagnostic variables that help to explain the lake responses. Table 13 shows the response to reductions in the phosphorus load. The observed and predicted mean TSI values for Fish Lake had less than 1% difference between them indicating that model responses should closely represent actual changes in the lakes condition.

The variables (N-150)/P and INORGANIC N/P are both indicators of phosphorus and nitrogen limitation. The first, (N-150)/P, is a ratio of total nitrogen to total phosphorus. Values less than 10 are indicators of a nitrogen-limited system. The second variable, INORGANIC N/P, is an inorganic nitrogen to ortho-phosphorus ratio. Values less than 7 are nitrogen-limited. The models prediction suggests that the lake is phosphorus limited, but close enough to the line that it may at times experience periods of nitrogen limitation. This is reinforced by the data in the limiting nutrients section of this report.

The variables FREQ (CHL-a)% represent the predicted algal nuisance frequencies or bloom frequencies. Blooms are often associated with concentrations of 30 to 40 ppb of total phosphorus. These frequencies are the percentage of days during the growing season that algal concentrations may be expected to exceed the respective values.

The calculated TSI from the trophic state section of this report is 67.5. Basing reductions from this value, a loading reduction of 45% would be required to shift the trophic state of Fish Lake to Eutrophic (< 65). This shift will likely be unnoticeable to users of this waterbody as nuisance algal blooms will continue to occur at nearly the same frequency as they did during and prior to the assessment.

Table 14. BATHTUB Calculations for Fish Lake

VARIABLE	Observed Values calculated using BATHTUB OBSERVED	Condition of the Lake based on current loadings ESTIMATED	Reduction of concentrations to mimic the cleanest subwatershed ESTIMATED	Equal Reductions assumed in all subwatersheds, percentages are for total lake load. 10% Est	20% Est	30% Est	40% Est	50% Est	60% Est
TOTAL P	130	123.8	104.92	116.79	109.38	101.61	93.13	84.29	74.38
TOTAL N	1700	1588.23	1588.23	1588.23	1588.23	1588.23	1588.23	1588.23	1588.23
CHL-A	43	43.12	40.3	42.17	41.05	39.72	38.05	36.05	33.41
SECCHI	0.66	0.66	0.69	0.67	0.68	0.7	0.72	0.75	0.79
ORGANIC N	1550	1173.01	1108.73	1151.38	1125.73	1095.31	1057.33	1011.63	951.64
ANTILOG PC-1	1901.28	1663.34	1459.17	1592.64	1511.44	1418.73	1308.27	1182.75	1029.64
ANTILOG PC-2	13.15	12.74	12.67	12.72	12.69	12.65	12.59	12.51	12.39
(N - 150) / P	11.92	11.62	13.71	12.31	13.15	14.15	15.44	17.06	19.34
INORGANIC N / P	3.19	10.17	17.79	12.31	15.37	19.96	27.69	41.46	73.36
FREQ(CHL-a>10) %	97.94	97.97	97.37	97.79	97.54	97.22	96.75	96.06	94.91
FREQ(CHL-a>20) %	82.25	82.37	79.4	81.42	80.23	78.71	76.65	73.9	69.77
FREQ(CHL-a>30) %	60.67	60.85	56.61	59.47	57.77	55.67	52.93	49.44	44.58
FREQ(CHL-a>40) %	42.33	42.51	38.29	41.11	39.42	37.38	34.8	31.63	27.42
FREQ(CHL-a>50) %	29	29.16	25.53	27.94	26.49	24.78	22.64	20.1	16.85
FREQ(CHL-a>60) %	19.84	19.97	17.06	18.98	17.82	16.46	14.81	12.88	10.49
TSI-P	74.34	73.64	71.25	72.79	71.85	70.79	69.53	68.09	66.29
TSI-CHLA	67.5	67.53	66.86	67.31	67.04	66.72	66.3	65.77	65.02
TSI-SEC	65.94	65.97	65.29	65.75	65.47	65.14	64.71	64.18	63.45
Mean TSI	69.3	69.0	67.8	68.6	68.1	67.6	66.8	66.0	64.9
TSI Shift	0	0	1.2	0.4	0.9	1.5	2.2	3.0	4.1

Table 15. BATHTUB Calculations Legend

TOTAL P MG/M3	Pool Mean Phosphorus Concentration
TOTAL N MG/M3	Pool Mean Nitrogen Concentration
CHL-A MG/M3	Pool Mean Chlorophyll *a* Concentration
SECCHI M	Pool Mean Secchi depth
ORGANIC N MG/M3	Pool Mean Organic Nitrogen Concentration
ANTILOG PC-1	First principal component of reservoir response. Measure of nutrient supply. < 50 = Low Nutrient Supply and Low Eutrophication potential // >500 = High nutrient supply and high Eutrophication potential
ANTILOG PC-2	Second principal component of reservoir response variables. Nutrient association with organic vs. inorganic forms; related to light-limited areal productivity. Low: PC-2 < 4 = turbidity-dominated, light-limited, low nutrient response. High: PC-2 >10 = algae-dominated, light unimportant, high nutrient response.
(N - 150) / P	(Total N - 150)/ Total P ratio. Indicator of limiting nutrient. Low: (n-150)/P < 10-12 + nitrogen-limited High: (n-150)/P > 12-15 phosphorus-limited
INORGANIC N / P	Inorganic Nitrogen/ ortho-phosphorus ratio. Indicator of limiting nutrient Low: N/P < 7-10 Nitrogen- limited High: N/P > 7-10 phosphorus limited
FREQ(CHL-a>10) %	Algal nuisance frequencies or bloom frequencies. Estimated from mean chlorophyll *a*. Percent of time during growing season that Chl *a* exceeds 10, 20, 30, 40, 50, 60 ppb. Related to risk or frequency of use impairment.
TSI	Trophic State Indices (Carlson 1977)

Biological Monitoring

Aquatic Macrophyte Survey

DENR staff conducted an aquatic macrophyte survey on July 10 and 11, 2001. Twenty eight transects were located at approximately 300 meter intervals along the shoreline of the lake. Aquatic emergent or submerged vegetation were encountered and recorded at all of the transects. Secchi readings were also recorded at each site.

There were only three submerged species encountered during the survey, a green filamentous algae identified as *Cladophora fracta,* coontail (*Ceratophyllum demersum*), and sago pondweed (*Potamogeton pectinatus*). The algal species was encountered at every site and was usually detected in heavy concentrations matted to the bottom substrates of the lake. Sago pondweed was the second most frequently encountered macrophyte and was found at 25 of the 28 transects. Coontail was recovered at 9 of the 28 transects. At no point during the study were any non-native aquatic species encountered.

Secchi readings during the survey ranged from a low of 0.42 meters to a high of 1.6 meters. The average Secchi reading was 0.92 meters and the median was 0.85 meters.

Threatened and Endangered Species

There are no federally threatened or endangered species documented in the Fish Lake watershed. The US Fish and Wildlife Service lists the whooping crane, bald eagle, and western prairie fringed orchid as species that could potentially be found in the area. None of these species were encountered during this study; however, care should be taken when conducting mitigation projects in the watershed.

A search of the South Dakota Natural Heritage Database indicated that there had been sightings of the green backed heron (*Butorides virescens*) and the black crowned night heron (*Nycticorax nycticorax*) around the lake, which are both listed as rare species in the state of South Dakota.

Bald eagles typically prefer large trees for perching and roosting. As there are no confirmed documentation of bald eagles within the Fish Lake watershed, little impact to the species should occur. Any mitigation processes that take place should avoid the destruction of large trees that may be used as eagle perches, particularly if an eagle is observed using the tree as a perch or roost.

Whooping cranes have never been documented in the Fish Lake watershed. Sightings in this area are likely only during fall and spring migration. When roosting, cranes prefer wide, shallow, open water areas such as flooded fields, marshes, artificial ponds, reservoirs, and rivers. Their preference for isolation and avoidance of areas that are surrounded by tall trees or other visual obstructions makes it unlikely that they will be present in the project area to be negatively impacted as a result of the implementation of BMPs. If whooping cranes are sighted during the implementation of mitigation practices, all disruptive activities should cease until the bird(s) leave of their own volition.

Although there have never been any confirmed documentations of the western prairie fringed orchid in this watershed, habitat suitable for its survival does exist. Western prairie fringed orchid grows in tall grass prairies and meadows. Wetland draining and the conversion of rich soil prairies to agricultural cropland threaten the orchid's survival. Overgrazing, improper use of pesticides, and collecting also threaten its survival (Missouri, 2001).

Other Monitoring

Annualized Agricultural Non-Point Source Model (AnnAGNPS)

AnnAGNPS is a data intensive watershed model that routes sediment and nutrients through a watershed by utilizing land uses and topography. The watershed is broken up into cells of varying sizes based on topography. Each cell is then assigned a primary land use and soil type. Best Management Practices (BMPs) are then simulated by altering the land use in the individual cells and reductions are calculated at the outlet to the watershed.

The input data set for AnnAGNPS Pollutant Loading Model consists of 33 sections of data, which can be supplied by the user in a number of ways. This model execution utilized; digital elevation maps (DEM's) to determine cell and reach geometry, SSURGO soil layers to determine primary soil types and the associated NASIS data tables for each soils properties, and primary land use based on the Digital Ortho Quads (DOQ's). The DOQ was digitized and many land uses were determined directly from it. Additional detail on cropping rotations and grass conditions were added through utilizing Farm Service Agency (FSA) records, using some data from the Oak Lake Field Station, and through some ground truthing. Impoundment data was obtained from analysis of the National Wetlands Inventory (NWI). Weather data was generated using a synthetic weather generator based on climate information from the two closest stations, Huron and Sioux Falls. Mean annual precipitation for this watershed is about 21 inches.

It is important to note that these model results are based on 25 simulated years of data with precipitation ranging from 15 to 27 inches per year. None of these represent the project period, they are instead representations of what may typically occur on any given year, and when analyzed as a group provides a risk analysis for practices in the watershed.

Part of the modeling process includes the assessment of animal feeding operations (AFOs) located in the watershed. This assessment was completed through direct contact with the operators who provided information on the number of animal units and duration of use. Execution of the stand alone feedlot assessment model as well as analysis using the annualized version of the model indicated that nutrient production in the assessed lots does have some impact on the lake.

There are four notable animal feeding operations located in the Fish Lake watershed. (See Figure 12) According to model analysis, they account for approximately 5.5% of the total phosphorus load to Fish Lake. The operation located on the west side of the lake accounts for approximately 4 % of the phosphorus load while the remaining three combine for the other 1.3%. Reductions in loadings from the 3 operations closest to the lake would likely be the most beneficial and cost effective. The fourth lot located in the upper portion of the watershed likely has a minimal impact due to the number of wetlands between it and the lake.

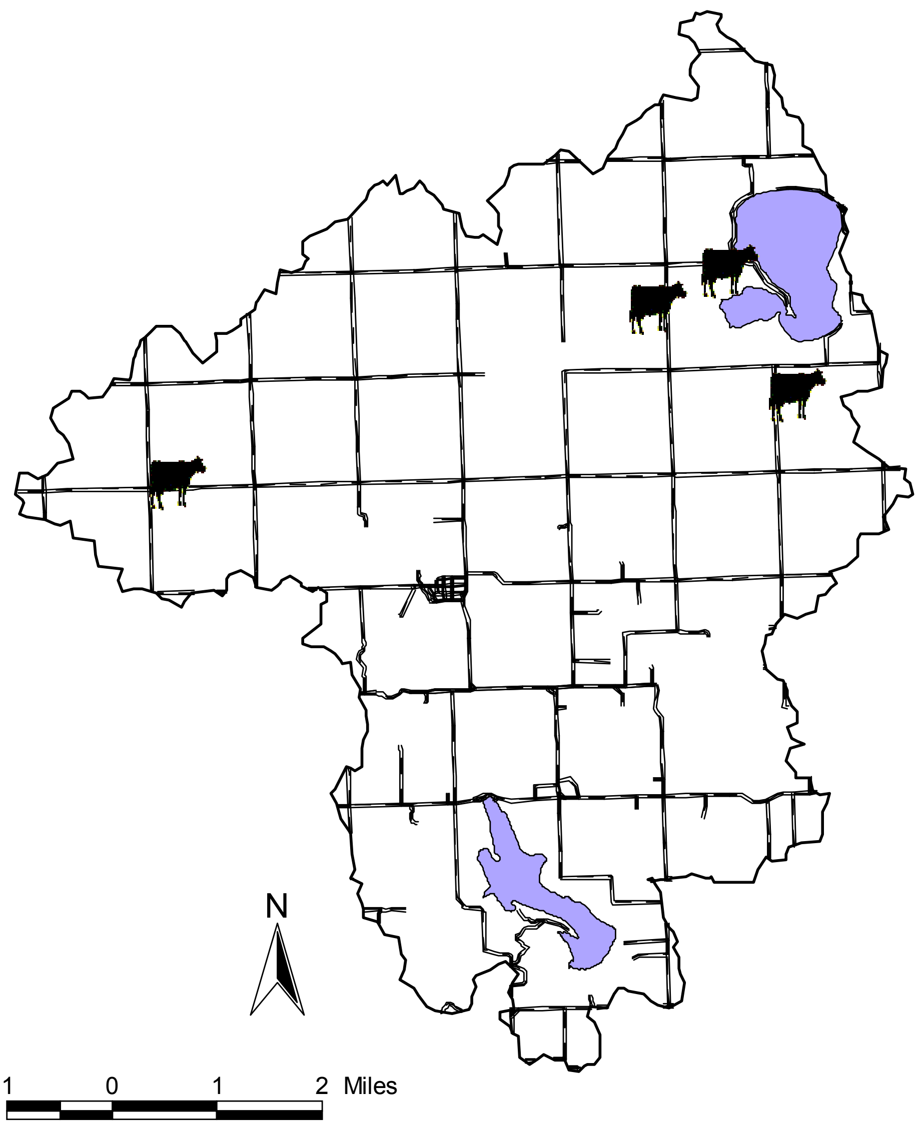


Figure 12. Fish Lake Animal Feeding Operations

A number of management scenarios were completed for the Fish Lake watershed. A comparison of the phosphorus loads at the outlet to the watershed is available in Figure 13. The model did indicate that loadings from the portion of the watershed draining from the south through site FLT-3 were greater per acre than the rest of the watershed, similar to what the water quality data indicated. Targeting this portion of the watershed, particularly those areas located downstream of Oak Lake, will be the most effective for improving Fish Lake water quality.

There are a number of possibilities for this area generating higher nutrient loads. The dataset for the model lacked the detail needed to include fertilizer applications on these acres, providing the first possibility for nutrient loading. Other possibilities include degraded pasture conditions, excessive livestock use of riparian areas, a lack of buffers in crop ground, and nutrient loading as a result of drained crop ground. Implementation activities in this area should take all of these possibilities into account prior to funding.

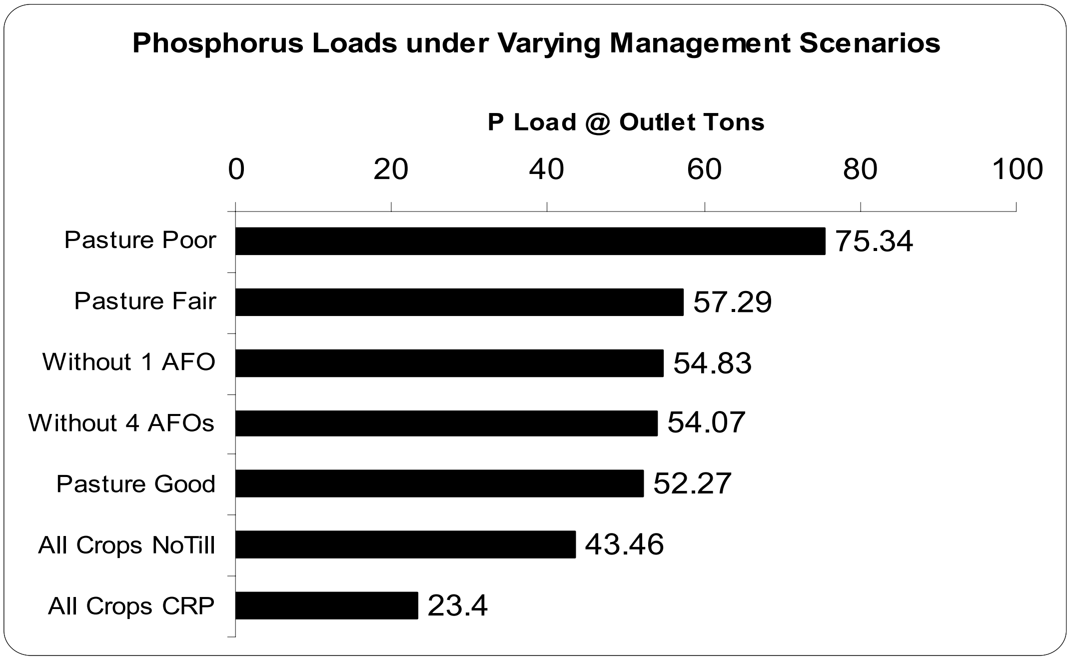


Figure 13. Phosphorus Loads under Varying Management Scenarios

The management scenario *pasture fair* listed in Figure 13 may be considered the present condition of the watershed. This scenario incorporates all of the fields as they are currently managed and considers the pastures throughout the watershed to be in fair condition. With an accumulation of 57.29 tons, this equals an average annual load of 2,078 kg, which is similar to what the water quality data indicated at 2,485 kg.

The *pasture poor* scenario reduced the root mass by 25% and the ground cover by 10%. The dramatic increase (30%) in phosphorus loading (associated with increased sediment loss) indicate that many of the grazing areas may be located on sensitive slopes that may experience significant increases or decreases in erosion with minimal disturbances or improvements. As it is unclear what the condition of each tract of pasture is, improvements made to those found to be in poor condition will likely result in reductions to the nutrient loading to Fish Lake.

The scenarios simulating the removal of animal feeding operations were conducted with the watershed managed under its current conditions with the complete containment of the feeding operations. The removal of the operation located on the western shores of the lake had the largest impact on the lake. Additional reductions were accomplished through containment of 3 additional lots. The lot located in the far western edge of the watershed is not close enough to be a potential source of fecal contamination and had the least impact on the nutrient load to the lake. Reduction in runoff from the three operations located within 1 mile of the lake would be the most effective use of management efforts.

The scenario *pasture good* increased the root mass by 25% and the ground cover by 10% resulting in a 9% reduction in phosphorus loading. This reinforces the importance of sound management practices on critical slopes and in the riparian zones.

The *no till* scenario simulated switching the management of all crop fields in the watershed to a no till system. It is unlikely that all the producers in a given area would switch to no till and be able to sustain yields without occasionally breaking ground. This scenario helps show the importance of reducing the frequency of tillage practices. Converting all of the cropland in the watershed to a no till rotation will result in a 24% reduction in phosphorus loading to the lake.

The final scenario was run to simulate what conditions might be found if the landscape were in a pre-settlement condition. Crop ground was changed to CRP and rangeland was rated at fair to good condition with no animal feeding operations. Under these "pristine" conditions, 59% of the phosphorus load was reduced.

The Fish Lake watershed may be broken down into 5 categories of landuse. Grass, hay, CRP and alfalfa cover approximately 39% of the watershed. Crops that are grown through no till practices cover 1% of the watershed. Crops grown with some conservation tillage cover 36% of the watershed. Crops grown without conservation tillage, those with fall and spring tillage practices cover 12% of the watershed. The remaining 12% of the watershed is composed of wetlands, farmsteads, roads, and other uses that do not fit into the first four categories.

Priority should be given to cropland areas with the following criteria:

- Draining directly to the Lake
- Intersected by a stream segment
- Steep slopes (fields with C, D, or E soils)
- Non-conservation tillage fields

Priority should be given to pastureland with the following criteria:

- Draining directly to the Lake
- Intersected by a stream segment
- Steep slopes (pastures with C, D, or E soils)
- Pastures in the poorest range condition class

It could be possible for the loadings to this lake to be reduced by as much as 25% assuming a high rate of participation (based on estimated participation rates from local resource professionals) at 50% for both crop and range land BMPs in the watershed. Containment of three of the animal feeding operations will result in a 5% reduction. Improved grass and range conditions on 2,700 acre of pasture lands may result in an additional 10% reduction. The final 10% may be attained from reduced tillage practices, grassed waterways or other buffer areas along 6,400 acres of cropland.

Sediment Survey

Elutriate samples were collected with a Petite Ponar and shipped to the State Health Lab for analysis. In addition to sediment, a volume of 3 gallons of water was collected at each of the testing sites and were analyzed for the same chemicals as the sediment. Table 15 indicates the various parameters that were tested for in the elutriate sample.

Results from the elutriate and receiving water tests yielded many concentrations below the detection limit. Those metals and chemicals that were detected were not at concentrations high enough to generate any concern.

Table 16. Elutriate and Receiving Water Test Results

Parameter	Elutriate	Receiving Water	Units	Parameter		Elutriate	Receiving Water	Units
COD	41.9	32.5	mg/L	Alachlor		<0.100	<0.100	ug/L
Total Phosphorus	.074	.012	mg/L	Chlordane		<0.500	<0.500	ug/L
TKN	2.63	.81	mg/L	Endrin		<0.500	<0.500	ug/L
Ammonia	1.7	<0.02	mg/L	Heptachlor		<0.400	<0.400	ug/L
Hardness	380	380	mg/L	Heptachlor Epoxide		<0.500	<0.500	ug/L
Nitrate	0.1	<0.1	mg/L	Methoxychlor		<0.500	<0.500	ug/L
Aluminum	24.7	2.5	ug/L	Toxaphene		NonDetect	NonDetect	
Zinc	<3.0	800	ug/L	Aldrin		<0.500	<0.500	ug/L
Silver	<0.2	<0.2	ug/L	Dieldrin		<0.500	<0.500	ug/L
Selenium	1.8	1.4	ug/L	PCB Screen	Aroclor 1016	<0.100	<0.100	ug/L
Nickel	2.4	2.2	ug/L		Aroclor 1221	<0.100	<0.100	ug/L
Total Mercury	<0.2	<0.2	ug/L		Aroclor 1232	<0.100	<0.100	ug/L
Lead	<0.1	<0.1	ug/L		Aroclor 1242	<0.100	<0.100	ug/L
Copper	2.3	1.8	ug/L		Aroclor 1248	<0.100	<0.100	ug/L
Cadmium	<0.2	<0.2	ug/L		Aroclor 1254	<0.100	<0.100	ug/L
Arsenic	11.5	11.5	ug/L		Aroclor 1260	<0.100	<0.100	ug/L
Nitrite	<0.02	<0.02	mg/L	Diazinon		<0.500	<0.500	ug/L
Endosulfan II	<0.500	<0.500	ug/L	DDD		<0.500	<0.500	ug/L
Atrazine	<0.100	<0.100	ug/L	DDT		<0.500	<0.500	ug/L
				DDE		<0.800	<0.800	ug/L
				Beta BHC		<0.500	<0.500	ug/L
				Gamma BHC		<0.500	<0.500	ug/L
				Alpha BHC		<0.500	<0.500	ug/L

A sediment survey was completed during the winter of 2002 through the ice. Water and sediment depths were recorded at over 260 sites throughout the lake to determine the total amount of deposited material in the lake. An average sediment depth of 3.2 feet and an average water depth of 5.2 feet were recorded during the assessment. The total sediment volume in the lake is 3.8 million cubic yards. Figure 14 shows the sediment depths at the sampling locations in the lake.

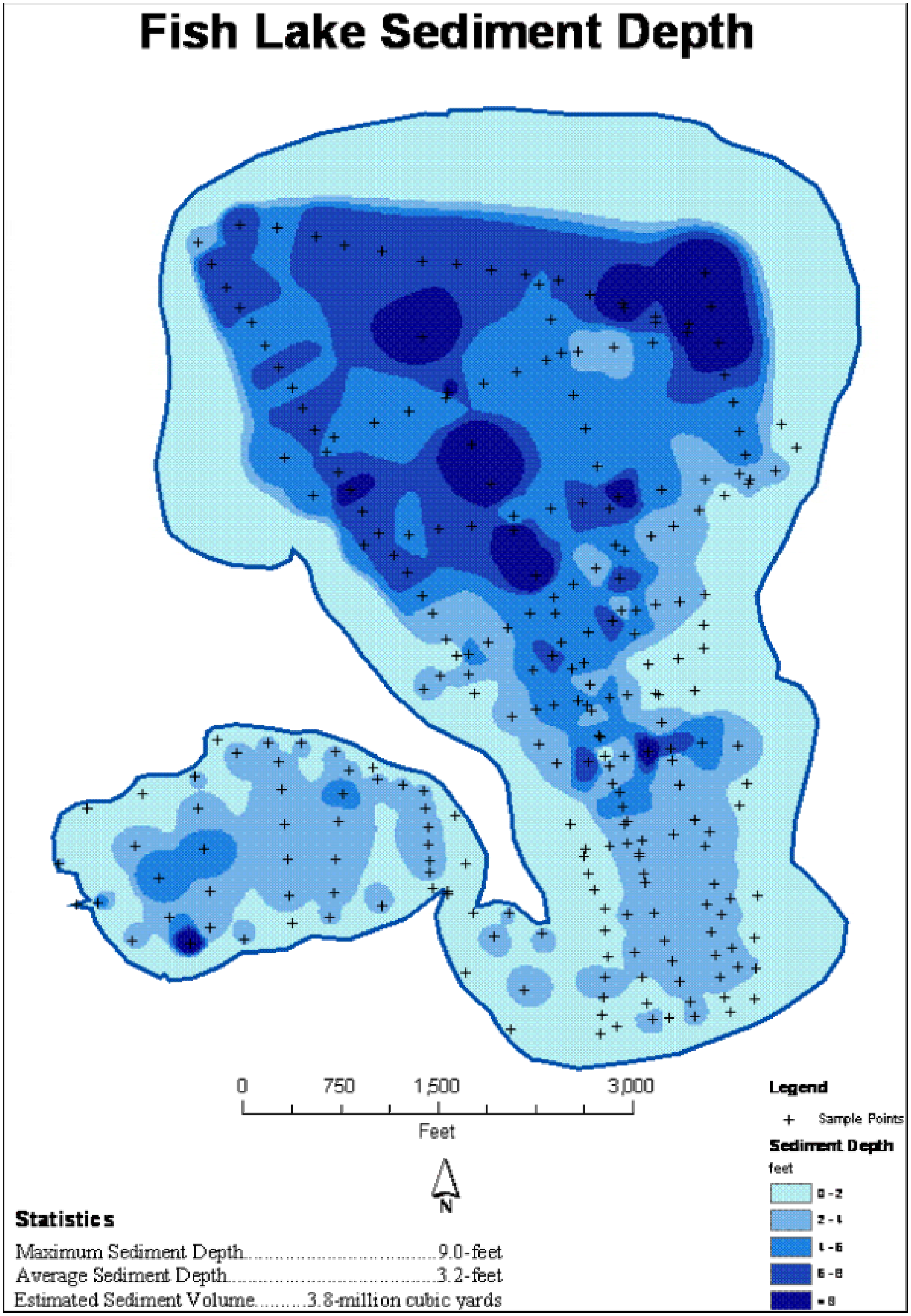


Figure 14. Fish Lake Sediment Map

Quality Assurance Reporting (QA/QC)

Quality assurance and quality control or QA/QC samples were supposed to be collected for 10% of the inlake and tributary samples taken. There were 33 tributary samples and 14 lake samples collected for a total of 47 samples. Two of the three duplicate samples were collected for a second lake in this project but may be considered applicable as they were completed by the same personnel in the same manner. All together, an additional four replicate and four blank samples should have been collected. All QA/QC samples may be found in Table 16.

Replicate samples were within the ranges expected for the varying parameters. Typically suspended solids have a greater amount of difference than other parameters. Considering the low amount of variation in most of the parameters, the samples are likely representative of the water quality in the lake and its tributaries.

The blank sample was clean with the exception of total suspended solids, which were slightly above the detection limit. If this level of contamination was consistent throughout the project, it would minimally affect the results altering them by less than 10% in all cases and less than 5% in most cases.

Table 17. QA/QC Results

E number	Site	Date	Alka-M	Tsol	Tssol	VTSS	Amm	nitrat	TKN	TP	TDP	Fecal	E.Coli
E01EC005304	LA-2	7/10/2001	216	1008	13	4.00	0.03	0.050	1.550	0.046	0.022		
E01EC005305	LA-2d	7/10/2001	214	1005	8	4.00	0.01	0.050	1.510	0.043	0.006		
Percent Difference			1%	0%	48%	0%	100%	0%	3%	7%	114%		
E01EC005532	FLT-4	07/16/01	277	456	1	0.5	0.07	0.10	1.32	0.512	0.452	160	98.4
E01EC005533	FLT-4d	07/16/01	275	465	4	0.5	0.08	0.10	1.55	0.505	0.463	120	67.6
Percent Difference			1%	2%	120%	0%	13%	0%	16%	1%	2%	29%	37%
E01EC004575	LAT-2	6/18/2002	246	615	0.50	0.50	0.010	0.050	1.12	0.113	0.11	100	146
E01EC004574	LAT-2d	6/18/2002	243	611	1.00	0.50	0.010	0.050	1.05	0.114	0.11	60	145
Percent Difference			1%	1%	67%	0%	0%	0%	6%	1%	0%	50%	1%
Blank Sample													
E01EC004002	FLT-3b	05/31/02	<6	15	<1	<1	<.02	<.1	<.36	<.002	<.002	<10	<1

Public Involvement and Coordination

State Agencies

The South Dakota Department of Environment and Natural Resources (SD DENR) was the primary state agency involved in the completion of this assessment. SD DENR provided equipment as well as technical assistance throughout the course of the project.

The South Dakota Department of Game Fish and Parks (SD GF&P) provided threatened and endangered species information in addition to local information provided to the coordinator by the areas conservation officer.

Federal Agencies

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

Natural Resource Conservation Service (NRCS) provided technical assistance, particularly in the collection of soils data for the AnnAGNPS portion of the report.

The Farm Service Agency provided a great deal of information that was utilized in the completion of the AnnAGNPS modeling portion of the assessment.

Local Governments, Industry, Environmental, and Other Groups; and Public at Large

The Deuel County Conservation District provided work space, financial assistance, and aided in the completion of the AnnAGNPS portion of the report. The district also provided personnel for the collection of the field data.

Public involvement consisted of some individual meetings with landowners that provided a great deal of historic perspective on the watershed. Additionally, landowners were contacted through mailings to which most responded with information needed to complete the AnnAGNPS model.

Other local groups that were involved financially or provided assistance in this assessment include Deuel County Lakes and Streams, East Dakota Water Development District, and South Dakota Lakes and Streams.

Dr. Nels Troelstrup, South Dakota State University, provided valuable input on the condition of Oak Lake and its watershed from the Oak Lake Field Station.

Aspects of the Project that did Not Work Well

All of the objectives for the project were met in an acceptable fashion and in a reasonable time frame (see the milestone table on page 6). The number of tributary samples collected was less than purposed due to the fact that spring run-off was less than expected. The number of lake samples collected was less than planned because of the unseasonably warm winter, which made the ice cover unsafe for gathering samples. Sample collection was sufficient to produce a TMDL for this waterbody.

Additional QA/QC samples should have been collected for this project. There was a misunderstanding by the coordinator as to the number of samples required to meet the QA/QC requirements for the project. Steps to correct this include regular data dumps to DENR and analysis of the data to see that requirements are being met.

Future Activities Recommendations

There are a number of concerns that need to be addressed in the Fish Lake watershed. Mitigation processes in this watershed should take into consideration the following items:

Considering the effects of internal loading on this lake, implementation practices in the watershed will not likely result in noticeable changes in water quality for a considerable length of time. Taking into account the lake's location to considerably "cleaner" and more popular bodies of water, large expenditures in this watershed may not be economically feasible as a result of a lack of local interest.

To achieve immediate improvements in water quality (under 10 years) a large scale dredge project accompanied by alum treatment and watershed work would be required. The size of this water body and the amount of accumulated sediment would require a significant source of funds approaching or exceeding $10 million to implement a dredge project that would result in a noticeable change in water quality.

Sediment accumulation in the lake was estimated at 200 tons per year. This accounts for approximately 1 mm of depth loss over a 20 year period, indicating sediment from the watershed is not a large concern for this waterbody. The load entering from subwatershed FLT-3 was considerably higher than the rest of the drainage suggesting mitigation activities for this portion of the watershed should be strongly considered.

Taking into consideration the economics of creating a noticeable change in the water quality of Fish Lake in conjunction with the immediate availability of other waterbodies in the area that fully support their beneficial uses of immersion and limited contact recreation, it is recommended that the lake be slightly improved from its current state which does adequately support its designated fish life use. Watershed work should be completed as follows to ensure that the fishery is protected in its current condition.

It could be possible for the loadings to this lake to be reduced by as much as 25% (621 pounds) assuming a high rate of participation at 50% for both crop and range land in the watershed. Containment of three of the animal feeding operations will result in a 5% (125 pounds) reduction. Improved grass and range conditions on 2,700 acres of pasture land may result in an additional 10% (250 pounds) reduction. The final 10% (250 pounds) may be attained from reduced tillage practices, grassed waterways or other buffer areas along 6,400 acres of cropland

Priority should be given to cropland areas with the following criteria:

- Close proximity to the lake
- Close proximity to a channelized stream
- Steep slopes
- Non-conservation tillage fields
- Fields located in subwatershed FLT-3

Priority should be given to pastureland with the following criteria:

- Close proximity to the lake
- Close proximity to a channelized stream
- Steep slopes
- Pastures in the poorest range condition class
- Pastures located in subwatersheds FLT-3 first, followed by those located in FLT-2

These reductions are based on the assumption that operators in the watershed will participate in an implementation project at a very high rate. Lower rates of participation or lack of participation on critical areas (steep slopes and close proximity to the lake) will result in a much lower reduction in phosphorus loadings to Fish Lake.

BMPs should not be targeted towards portions of the Fish Lake drainage coming through site FLT-4 or those portions draining into Fox Lake and entering Fish Lake from the north. Any mitigation activities in these areas should be closely examined for their impact on the lake prior to implementing.

In addition to "on the ground" management practices, the use of informational meetings and materials will also aid in local understanding and involvement in a project. Continued monitoring as well as a post-implementation assessment should be completed to determine the effectiveness of Best Management Practices completed.

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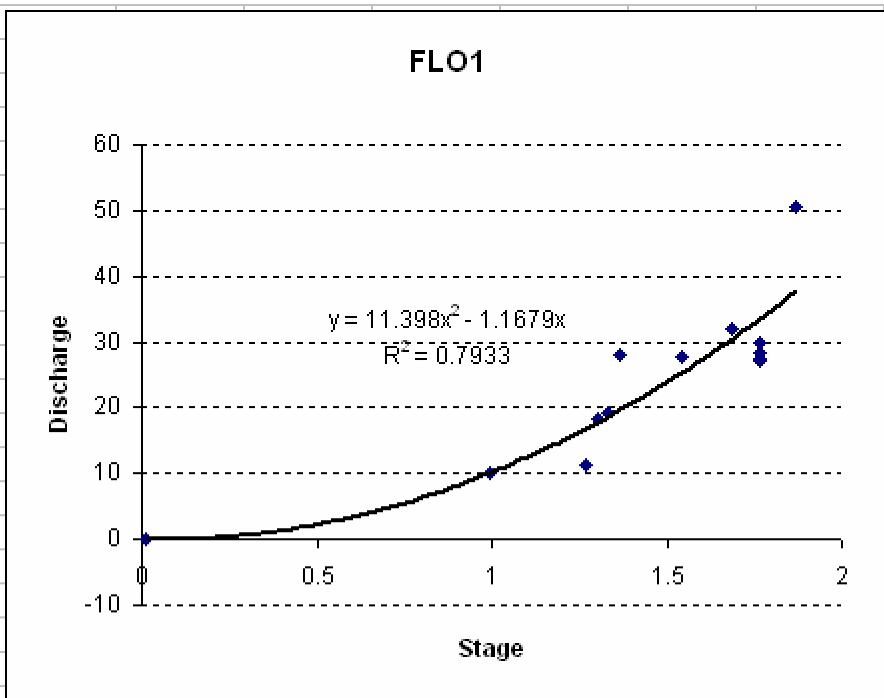
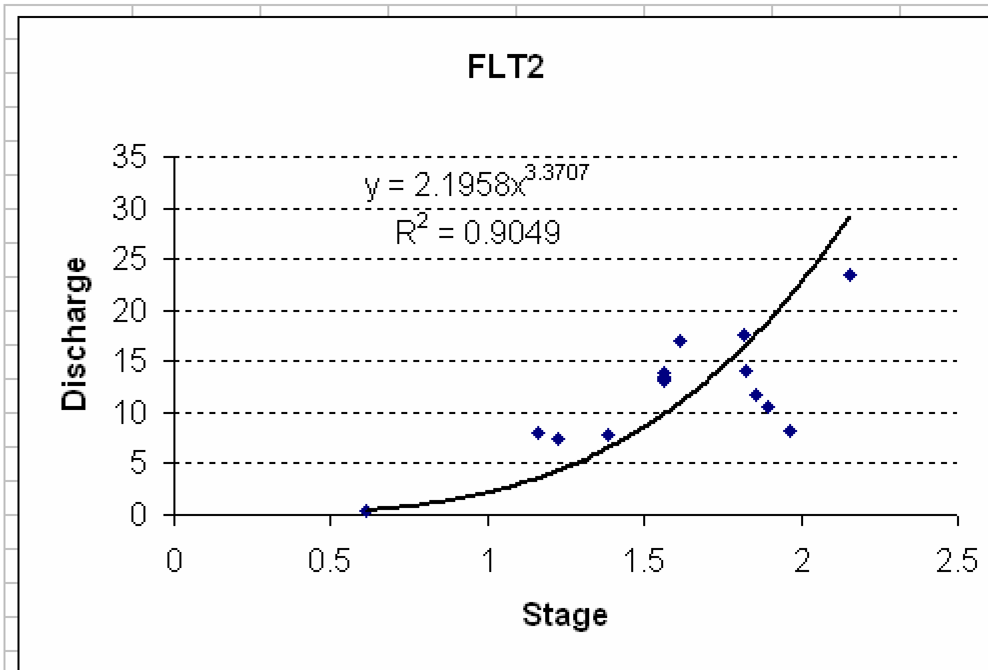
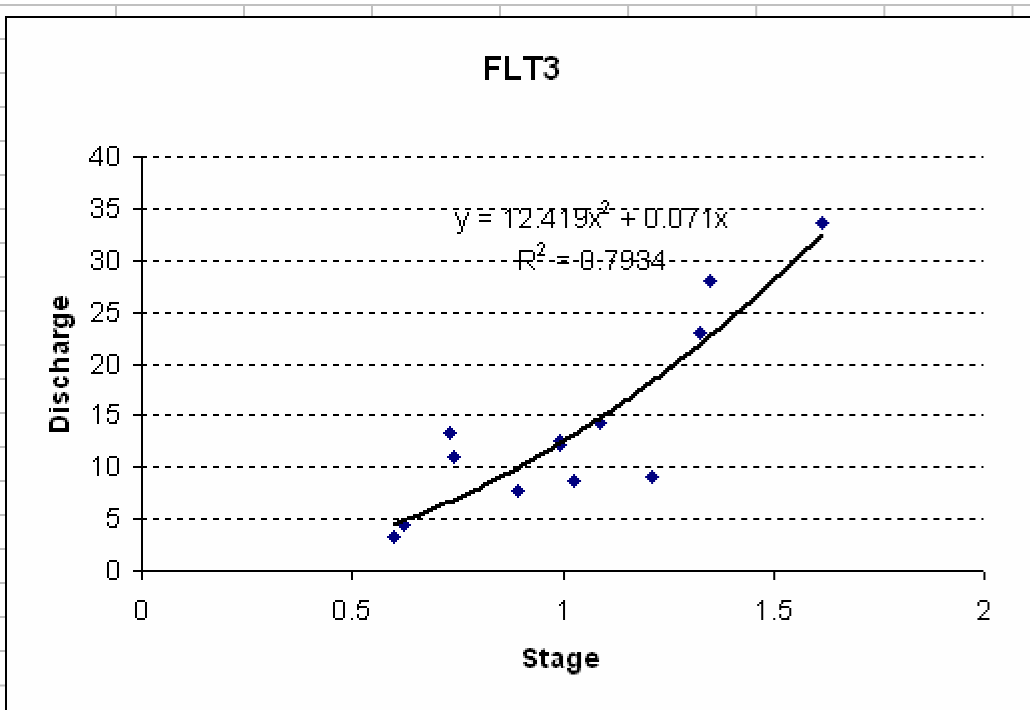
Appendix A. Stage to Discharge Tables



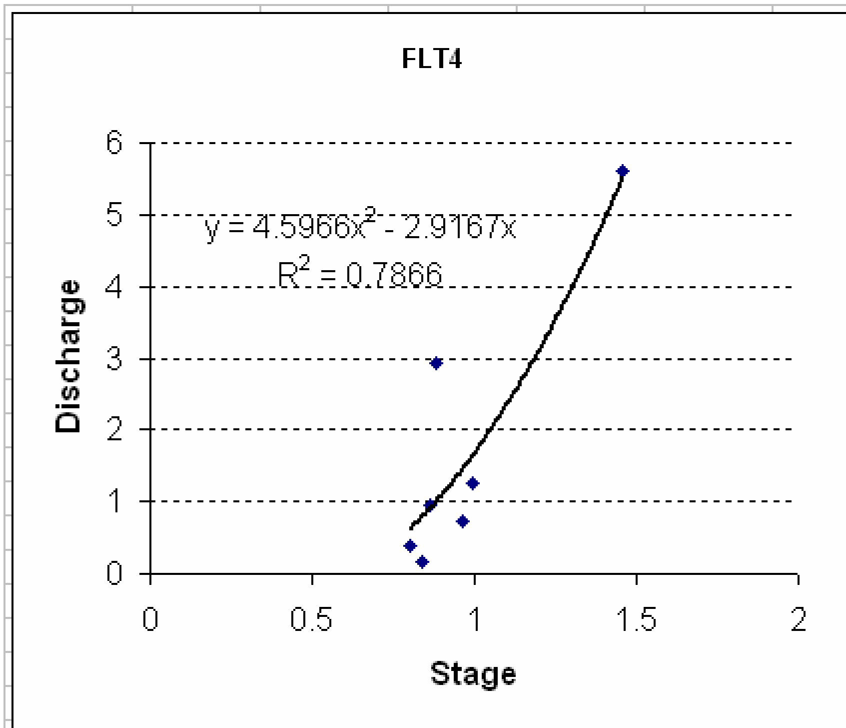
Stage	Discharge
0.01	0.01
1.33	19.12
1.367	27.95
1.683	31.99
1.54	27.87
1.3	18.1775
1.267	11.2125
0.993	9.996
1.87	50.58
1.7635	27.25
1.7635	29.84
1.7635	27.51
1.7635	28.34425



Stage	Discharge
1.226	7.452
1.386	7.7727
1.854	11.7675
1.817	17.541
1.163	8.04825
1.963	8.2507
1.896	10.48
0.614	0.3115
0.614	0.30158
0.614	0.3256
2.153	23.507
1.822	14.074
1.612	16.99
1.5615	13.878
1.5615	13.18313
1.5615	13.292
1.5615	13.54675



Stage	Discharge
0.739	10.93
0.733	13.349
0.892	7.812
1.615	33.68
1.35	28.0125
1.025	8.731
0.62	4.53
0.597	3.35
1.327	22.9455
1.213	9.1455
1.089	14.33625
0.9935	12.57263
0.9935	12.621
0.9935	12.628
0.9935	12.2245



Stage	Discharge
0.801	0.3852
0.84	0.164
0.883	2.9232
1.459	5.6052
0.996	1.24884
0.865	0.936
0.962	0.717

Appendix B. Tributary Data

E number	Site	Date	Time	DO	DO%	Doc	pH	Cond	Temp	Alka-M	Tsol	Tssol
E01EC003920	FLT-4	05/30/01	11:30							271	459	6
E01EC004210	FLT-4	06/05/01	10:00							270	485	3
E01EC004428	FLT-4	06/13/01	5:00							196	452	94
E01EC004513	FLT-4	06/13/01	15:30							209	429	7
E01EC005532	FLT-4	07/16/01	7:00							277	456	1
E01EC005533	FLT-4d	07/16/01	7:00							275	465	4
E02EC001596	FLT-4	04/04/02	12:30	10.4	89.6	51.2	6.89		1.22	146	289	5
E02EC001980	FLT-4	04/18/02	14:30	12.26	131.7	52.3	7.75	600	16.97	278	609	5
E01EC003999	FLT-2	05/31/01	12:15							261	671	1
E01EC004212	FLT-2	06/05/01	12:00							258	666	4
E01EC004425	FLT-2	06/13/01	15:00							273	652	5
E01EC004356	FLT-2	06/12/01	13:00							276	708	1
E01EC005059	FLT-2	06/30/01	13:30							295	722	5
E01EC005202	FLT-2	07/09/01	14:30			53.3	7.69	0.504	27.18	318	800	9
E02EC001595	FLT-2	04/04/02	13:30		95.5	51.2	7.37		0.48	101	280	9
E02EC001978	FLT-2	04/18/02	12:30	13.6	138.9	50.2	7.74	690	16.29	207	624	9
E01EC004001	FLT-3	05/31/01	15:00							242	461	11
E01EC004002	FLT-3b	05/31/02	15:00							3	15	0.5
E01EC004255	FLT-3	06/06/01	14:00							242	482	24
E01EC004256	FLT-3	06/07/01	3:38							233	484	13
E01EC004355	FLT-3	06/12/01	10:30							262	571	5
E01EC004427	FLT-3	06/12/01	19:30							260	564	11
E01EC004426	FLT-3	06/13/01	14:00							224	515	12
E01EC005203	FLT-3	07/09/01	15:30				8.01		29.71	294	545	84
E02EC001545	FLT-3	04/03/02	15:33	16.13	109.3	52.3	6.77		0.11	109	364	83
E02ED001979	FLT-3	04/18/02	13:00	11.73	125	48.2	7.75	756	19.4	210	562	46
E02EC002506	FLT-3	05/09/02	17:00							147	594	148
E01EC004000	FLO1	05/31/01	14:00							181	492	3
E01EC004211	FLO1	06/05/01	11:30							187	499	7
E01EC006009	FLO1	08/01/01	12:00							203	663	55
E01EC006794	FLO1	08/28/01	13:30				8.98	0.706	23.18	174	623	60
E02EC001594	FLO1	04/04/02	14:43		142.3	55.3	8.55		2.48	181	600	13
E02EC001977	FLO1	04/18/02	14:00	14.1	142.7	50.2	9.1	486	15.95	139	455	28

E number	Site	Date	Time	VTSS	ammonia	nitrat	TKN	TP	TDP	Fecal	E.Coli
E01EC003920	FLT-4	05/30/01	11:30	4	0.01	0.05	0.79	0.023	0.018	280	435
E01EC004210	FLT-4	06/05/01	10:00	1	0.01	0.05	1.14	0.035	0.023	0	24.6
E01EC004428	FLT-4	06/13/01	5:00	14	0.01	0.40	1.35	0.366	0.158	570	687
E01EC004513	FLT-4	06/13/01	15:30	1	0.01	0.30	1.49	0.200	0.100	140	107
E01EC005532	FLT-4	07/16/01	7:00	0.5	0.07	0.10	1.32	0.512	0.452	160	98.4
E01EC005533	FLT-4d	07/16/01	7:00	0.5	0.08	0.10	1.55	0.505	0.463	120	67.6
E02EC001596	FLT-4	04/04/02	12:30	2	0.19	1.10	1.48	0.316	0.265	5	0.5
E02EC001980	FLT-4	04/18/02	14:30	1	0.01	0.05	0.94	0.067	0.056	5	0.5
E01EC003999	FLT-2	05/31/01	12:15	1	0.01	0.05	1.14	0.154	0.143	100	119
E01EC004212	FLT-2	06/05/01	12:00	0.5	0.01	0.05	1.20	0.154	0.137	80	184
E01EC004425	FLT-2	06/13/01	15:00	1	0.01	0.10	1.42	0.291	0.265	16000	2400
E01EC004356	FLT-2	06/12/01	13:00	0.5	0.01	0.05	1.24	0.243	0.217		
E01EC005059	FLT-2	06/30/01	13:30	1	0.01	0.20	1.10	0.346	0.317	270	308
E01EC005202	FLT-2	07/09/01	14:30	2	0.05	0.10	1.58	0.404	0.372	2500	2420
E02EC001595	FLT-2	04/04/02	13:30	3	0.19	1.20	1.65	0.310	0.242	5	2
E02EC001978	FLT-2	04/18/02	12:30	3	0.01	0.10	1.03	0.107	0.068	20	28.8
E01EC004001	FLT-3	05/31/01	15:00	2	0.01	0.10	1.28	0.158	0.124	1100	1990
E01EC004002	FLT-3b	05/31/02	15:00	0.5	0.01	0.05	0.18	0.001	0.001	5	0.5
E01EC004255	FLT-3	06/06/01	14:00	0.5	0.01	0.05	1.21	0.177	0.136		
E01EC004256	FLT-3	06/07/01	3:38	2	0.01	0.10	1.00	0.183	0.145	2200	2400
E01EC004355	FLT-3	06/12/01	10:30	0.5	0.01	0.05	0.97	0.198	0.174		
E01EC004427	FLT-3	06/12/01	19:30	1							
E01EC004426	FLT-3	06/13/01	14:00	2	0.01	1.40	1.50	0.295	0.238	3000	2420
E01EC005203	FLT-3	07/09/01	15:30	16	0.01	0.10	1.34	0.481	0.366	2700	1990
E02EC001545	FLT-3	04/03/02	15:33	9	0.57	5.20	2.62	0.446	0.316	20	30.5
E02ED001979	FLT-3	04/18/02	13:00	10	0.01	0.20	1.06	0.116	0.049	50	65.1
E02EC002506	FLT-3	05/09/02	17:00	16	0.32	1.90	1.84	0.406	0.161	700	121
E01EC004000	FLO1	05/31/01	14:00	2	0.08	0.05	1.20	0.067	0.030	5	6.3
E01EC004211	FLO1	06/05/01	11:30	1	0.20	0.05	1.37	0.071	0.041	5	1
E01EC006009	FLO1	08/01/01	12:00	11	0.04	0.05	1.80	0.302	0.139	5	3
E01EC006794	FLO1	08/28/01	13:30	36	0.01	0.05	3.95	0.238	0.021	5	1
E02EC001594	FLO1	04/04/02	14:43	6	0.01	0.1	1.91	0.108	0.021	5	3.1
E02EC001977	FLO1	04/18/02	14:00	14	0.01	0.05	1.35	0.128	0.026	5	1

Appendix C. Lake Data

E number	Site	Date	Time	ChlA	Secchi	DO	DO%	Doc	pH	Spc
E01EC004209	FL-1	06/05/01	18:45	5.45	1.75					
E01EC005306	FL-1	7/10/2001	6:00	22.52						
E01EC006468	FL-1	8/15/2001	10:30	84.15	0.25			41	8.66	
E01EC007168	FL-1	9/13/2001	13:00	91	0.3	12.74	134%	44.1	9.08	0.684
E02EC000318	FL-1	1/21/2002	15:30	21.74						
E02EC002165	FL-1	4/29/2002	14:30		0.5				8.64	0.609
E02EC002868	FL-1	05/30/02	11:00	35.76	0.5	10.05	109%	57.4	8.62	0.659
E01EC004208	FL-2	6/5/2001	18:15	5.45	1.6					
E01EC005307	FL-2	7/10/2001	5:30	22.52						
E01EC006467	FL-2	8/15/2001	10:30	84.15	0.3			0.42	8.47	
E01EC007167	FL-2	9/13/2001	13:00	91	0.3	13.87	147%	44.1	9.18	0.684
E02EC000317	FL-2	1/21/2002	16:00	21.74						
E02EC002166	FL-2	4/29/2002	14:30		0.52				8.64	0.617
E02EC002869	FL-2	05/30/02	11:30	35.76	0.6	9.52	104%	57.4	8.63	0.667

E number	Site	Date	Time	Cond	Temp	Alka-M	Tsol	Tssol	VTSS	ammonia
E01EC004209	FL-1	06/05/01	18:45		16.2	190	491	3	0.05	0.23
E01EC005306	FL-1	7/10/2001	6:00			201	621	7	1	0.09
E01EC006468	FL-1	8/15/2001	10:30		20.62	206	657	57	18	0.01
E01EC007168	FL-1	9/13/2001	13:00		18.16	164	571	38	10	0.01
E02EC000318	FL-1	1/21/2002	15:30			205	691	6	3	0.04
E02EC002165	FL-1	4/29/2002	14:30	404	7.43	152	481	26	15	0.01
E02EC002868	FL-1	05/30/02	11:00	586	19.21	165	511	24	17	0.01
E01EC004208	FL-2	6/5/2001	18:15		16.04	190	495	2	0.5	0.21
E01EC005307	FL-2	7/10/2001	5:30			202	610	7	2	0.09
E01EC006467	FL-2	8/15/2001	10:30	0.719	20.63	198	643	46	20	0.01
E01EC007167	FL-2	9/13/2001	13:00		18.07	162	566	31	9	0.01
E02EC000317	FL-2	1/21/2002	16:00			204	690	6	3	0.02
E02EC002166	FL-2	4/29/2002	14:30	414	7.7	151	480	23	13	0.02
E02EC002869	FL-2	05/30/02	11:30	599	19.68	166	512	23	13	0.01

E number	Site	Date	Time	nitrat	TKN	TP	TDP	Fecal	E.Coli
E01EC004209	FL-1	06/05/01	18:45	0.05	1.32	0.066	0.045	5	1
E01EC005306	FL-1	7/10/2001	6:00	0.20	1.28	0.174	0.151		
E01EC006468	FL-1	8/15/2001	10:30	0.05	1.58	0.252	0.105	5	14.6
E01EC007168	FL-1	9/13/2001	13:00	0.05	2.17	0.179	0.018	40	49.6
E02EC000318	FL-1	1/21/2002	15:30	0.06	1.74	0.076	0.024	1	0.5
E02EC002165	FL-1	4/29/2002	14:30	0.01	1.43	0.134	0.017	30	63.1
E02EC002868	FL-1	05/30/02	11:00	0.05	1.56	0.076	0.017	5	0.50
E01EC004208	FL-2	6/5/2001	18:15	0.05	1.48	0.070	0.046	5	1
E01EC005307	FL-2	7/10/2001	5:30	0.10	1.33	0.178	0.144		
E01EC006467	FL-2	8/15/2001	10:30	0.05	1.60	0.222	0.054	5	2
E01EC007167	FL-2	9/13/2001	13:00	0.05	2.04	0.165	0.019	5	3.1
E02EC000317	FL-2	1/21/2002	16:00	0.05	1.56	0.074	0.028	1	0.5
E02EC002166	FL-2	4/29/2002	14:30	0.05	1.59	0.060	0.016	20	49.6
E02EC002869	FL-2	05/30/02	11:30	0.05	1.77	0.141	0.017	5	4.10

Appendix D. Total Maximum Daily Load

TOTAL MAXIMUM DAILY LOAD EVALUATION

For

FISH LAKE

(HUC 7020003)

DEUEL COUNTY, SOUTH DAKOTA

SOUTH DAKOTA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

January, 2004

Fish Lake Total Maximum Daily Load

Waterbody Type:	**Natural Lake (Impounded)**
303(d) Listing Parameter:	**TSI**
Designated Uses:	**Recreation, Warmwater marginal aquatic life**
Size of Waterbody:	**738 acres**
Size of Watershed :	**25,000 acres**
Water Quality Standards:	**Narrative and Numeric**
Indicators:	**Trophic State Index (TSI)**
Analytical Approach:	**AnnAGNPS, BATHTUB, FLUX**
Location:	**HUC Code: 7020003**
Goal:	**Complete restoration activities to reduce phosphorus loads by 25%**
Target:	**TSI ≤ 66.3**

Objective:

The intent of this summary is to clearly identify the components of the TMDL submittal to support adequate public participation and facilitate the US 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.

Introduction

Fish Lake is a 738-acre natural impoundment located in Deuel County, South Dakota. The primary tributaries and receiving water body are unnamed, however the discharge from the Fish Lake watershed ultimately reach the Minnesota River. The 1998 South Dakota 303(d) Waterbody List (page 22) identified Fish Lake for TMDL development for trophic state index (TSI).

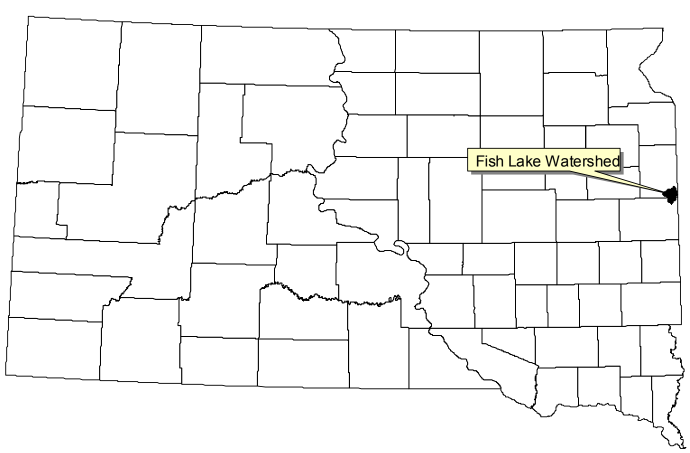


Figure 15. Location of Fish Lake Watershed in South Dakota

Problem Identification

The tributaries to Fish Lake drain a mixture of grazing and cropland acres. Feeding areas for livestock are present in the watershed. The stream carries nutrient loads, which degrade water quality in the lake and cause increased eutrophication. Internal nutrient loadings from shallow depths (resulting from re-suspension of nutrients from wind induced wave action) appear to be a primary source of nuisance algal blooms.

Description of Applicable Water Quality Standards & Numeric Water Quality Targets

Fish Lake has been assigned beneficial uses by the state of South Dakota Surface Water Quality Standards regulations. Along with these assigned uses are narrative and numeric criteria that define the desired water quality of the lake. These criteria must be maintained for the lake to satisfy its assigned beneficial uses, which are listed below:

Warmwater marginal fish life propagation
Immersion recreation
Limited contact recreation
Fish and wildlife propagation, recreation and stock watering

Individual parameters, including the lake's Trophic State Index (TSI) (Carlson, 1977) value, determine the support of beneficial uses and compliance with standards. A gradual increase in fertility of the water due to nutrients washing into the lake from external sources is a sign of the eutrophication process.

Fish Lake is identified in both the 1998 and 2002 South Dakota Waterbody List and "Ecoregion Targeting for Impaired Lakes in South Dakota" as partially supporting its aquatic life beneficial use. This support was determined through comparison of its trophic state to other lakes in its ecoregion.

South Dakota has several applicable narrative standards that may be applied to the undesired eutrophication of lakes and streams. Administrative Rules of South Dakota Article 74:51 contains language that prohibits the existence of materials causing pollutants to form, visible pollutants, taste and odor producing materials, and nuisance aquatic life.

If adequate numeric criteria are not available, the South Dakota Department of Environment and Natural Resources (SD DENR) uses surrogate measures. To assess the trophic state of a lake, SD DENR uses the mean TSI which incorporates secchi depth, chlorophyll *a* concentrations and phosphorus concentrations. SD DENR has developed a protocol that establishes desired TSI levels for lakes based on an ecoregion approach. This protocol was used to assess impairment and determine a numeric target for Fish Lake.

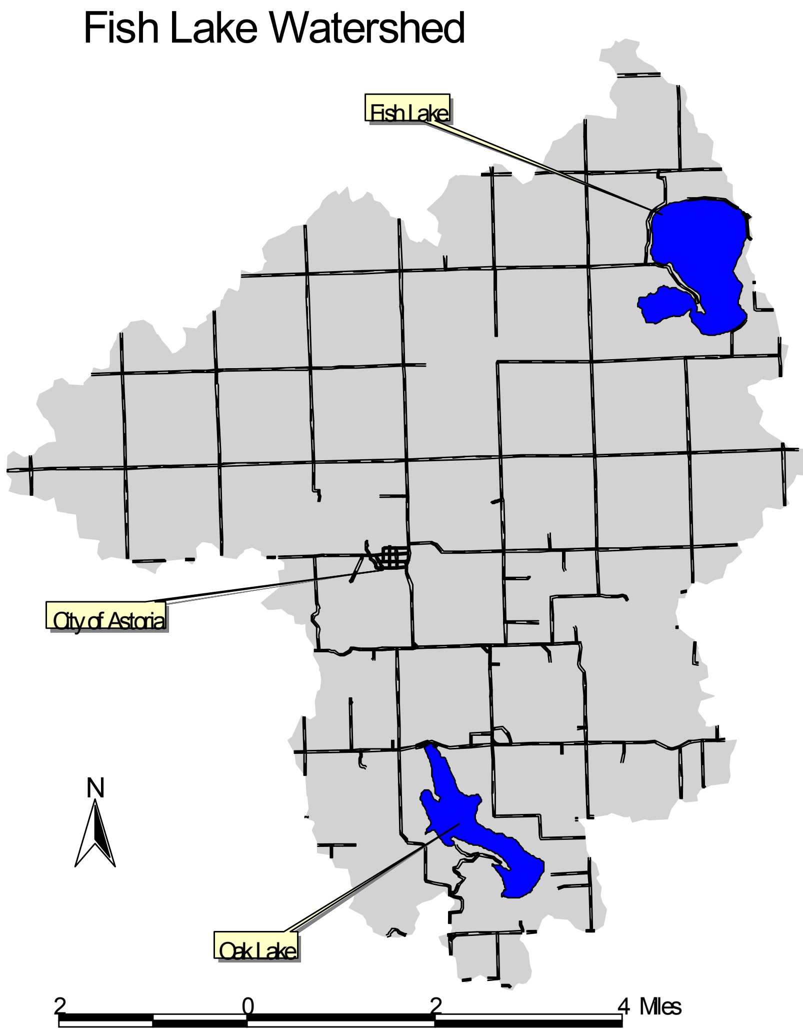


Figure 16. Fish Lake Watershed

Fish Lake currently has a mean TSI of 67.5, which is indicative of high levels of primary productivity. Assessment monitoring indicates that the primary cause of the high productivity is internal phosphorus loads which are supplemented by loads of nutrients from the watershed.

The numeric target, established to maintain the trophic state of Fish Lake, is a growing season average TSI of less than 66.3. Currently the lake maintains a TSI of less than 68, but continued loads from the watershed place it in jeopardy of degradation beyond this point. Attempting to reduce the TSI below 65 (full support for this ecoregion) is cost prohibitive and would not result in noticeable differences in the frequency or intensity of algal blooms to visitors at this water body.

Pollutant Assessment

Point Sources

There are no point sources of pollutants of concern in this watershed.

Nonpoint Sources/ Background Sources

Fish Lake receives a load of 2,485 kg of phosphorus on an annual basis. As a result of the high cost of achieving full support for this waterbody a more reasonable target of 66.3 (a 1.2 shift in TSI will be established). This is based on expected participation rates in an implementation program resulting in a 25% reduction in phosphorus loadings.

Linkage Analysis

Water quality data was collected from four monitoring sites within the Fish Lake watershed. Samples collected at each site were taken according to South Dakota's EPA approved Standard Operating Procedures for Field Samplers. Water samples were sent to the State Health Laboratory in Pierre for analysis. Quality Assurance/Quality Control samples were supposed to be collected on 10% of the samples according to South Dakota's EPA approved Clean Lakes Quality Assurance/Quality Control Plan. Replicate and blank samples were collected but not at the required 10%. The data is considered to be of sufficient quality through analysis of the samples collected to adequately develop this TMDL. Details concerning water sampling techniques, analysis, and quality control are addressed on pages 7-41 of the assessment final report.

In addition to water quality monitoring, data was collected to complete a watershed landuse model. The Annualized Agriculture Nonpoint Pollution Source (AnnAGNPS) model was used to provide comparative values for each of the land uses and animal feeding operations located in the watershed. See the AnnAGNPS section of the final report, pages 34-37.

The impacts of phosphorus reductions on the condition of Fish Lake were calculated using BATHTUB, an Army Corps of Engineers model. The model predicted that to achieve a TSI of less than 65, a 45% reduction in watershed loading would be necessary. Participation rates in the watershed restoration programs are expected to be insufficient to achieve this goal. The lake currently has a mean growing season TSI of less than 68. The fact that reaching full support (a 3 point TSI shift) will not noticeably improve the fishery, which does not appear to be impacted, implementing critical BMPs to slightly reduce the TSI value and keep the lake from further degradation is the most economically feasible approach.

TMDL and Allocations

TMDL for Phosphorus

	0	kg/yr	(WLA)
+	1,864	kg/yr	(LA)
+	,0	kg/yr	(Background)
	Implicit	(MOS)	
	1,864	kg/yr	(TMDL)

Wasteload Allocations (WLAs)

There are no point sources of pollutants of concern in this watershed. Therefore, the "wasteload allocation" component of these TMDLs is considered a zero value. The TMDLs are considered wholly included within the "load allocation" component.

Load Allocations (LAs)

A 25% reduction in phosphorus is possible assuming a high rate of participation for 50% of both crop and range land in the watershed. Containment of three of the animal feeding operations will result in a 5% reduction. Improved grass and range conditions on 2,700

acre of pasture lands may result in an additional 10% reduction. The final 10% may be attained from reduced tillage practices, grassed waterways and buffer areas impacting 6,400 acres of cropland. These BMPs are expected to result in a load of 1,863 kg/year and result in a positive TSI shift of 1.2 points.

Seasonal Variation
Different seasons of the year can yield differences in water quality due to changes in precipitation and agricultural practices. The growing season (late spring through late summer) is the most important time to maintain support of beneficial uses. Not only is this the period of peak recreational use, but it is also the period during which most impairments occur to this lake. This TMDL targets this period of time assuming support during the growing season will result in year round support of all beneficial uses.

Margin of Safety
Implementation of best management practices on the Fish Lake watershed will result in an implicit margin of safety for the loading reductions.

Critical Conditions
The impairments to Fish Lake are most severe during the late summer. This is the result of warm water temperatures and peak algal growth as well as peak recreational use of the lake.

Follow-Up Monitoring
Once the implementation project is completed, post-implementation monitoring will be necessary to assure that the TMDL has been reached and maintenance of the beneficial uses occurs. Fish Lake will also be monitored continually as a part of the South Dakota Statewide Lakes Assessment program to ensure that the lake continues to support its beneficial uses in its current state.

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

1. Deuel County Conservation District Board Meetings
2. Individual contact with residents in the watershed
3. Meeting with a newly formed Fish Lake Association
4. South Dakota Lakes and Streams Meetings

The findings from these public meetings and comments have been taken into consideration in development of the Fish Lake TMDL.

Implementation Plan
The South Dakota DENR is working with the Deuel County Conservation District to develop an implementation project. Currently there is no time schedule for its completion or for the start of the an implementation project.

Fifty copies of this document were printed by the Department of Environment and Natural Resources at a cost of $2.06 per copy.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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http://www.epa.gov/region08

September 29, 2004

Ref: 8EPR-EP

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

Re: TMDL Approvals
Brakke Dam
Fish Lake
Hayes Lake
Lake Herman

Dear Mr. Pirner:

We have completed our review, and have received Endangered Species Act Section 7 concurrence from the U.S. Fish and Wildlife Service, on the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq.*), we approve all aspects of the TMDLs as developed for the water quality limited waterbodies as described in Section 303(d)(1).

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

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 cleanup. 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. 33040 for July 24, 1992). Further, EPA states that "*...in some situations water quality standards –*

particulary 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 trophic state index (TSI) and its relationship to the impaired uses. Further, we feel it is reasonable to use factors such as TSI 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 Vernon Berry of my staff at 303-312-6234.

Sincerely,

/s/ by Max H. Dodson

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

Enclosures

Enclosure 1

APPROVED TMDLS

Waterbody Name*	**TMDL Parameter/ Pollutant**	**Water Quality Goal/Endpoint**	**TMDL**	**Section 303(d)1 or 303(d)3 TMDL**	**Supporting Documentation** (not an exhaustive list of supporting documents)
Brakke Dam*	phosphorus	TSI mean < 64.51	501 kg/yr total phosphorous load to the lake (18.9% reduction in average annual total phosphorus load)	Section 303(d)(1)	# Phase I Watershed Assessment and TMDL Final Report, Brakke Dam, Lyman County, South Dakota (SD DENR, April 2004)
Fish Lake*	phosphorus	TSI mean ≤ 66.3	1,864 kg/yr total phosphorous load to the lake (25% reduction in average annual total phosphorus load)	Section 303(d)(1)	# Phase I Watershed Assessment Final Report and TMDL, Fish Lake, Deuel County, South Dakota (SD DENR, January 2004)
Hayes Lake*	phosphorus	TSI mean ≤ 64.8	25,264 kg/yr total phosphorous load to the lake (24% reduction of average annual watershed load, and 25% reduction of internal load)	Section 303(d)(1)	# Watershed Assessment and TMDL Final Report, Hayes Lake / Frozen Man Creek, Stanley County, South Dakota (SD DENR, March 2004)
Lake Herman*	phosphorus	TSI mean ≤ 73.93	3,417 kg/yr total phosphorous load to the lake (45% reduction in average annual total phosphorus load)	Section 303(d)(1)	# Total Maximum Daily Load for Total Phosphorous in Lake Herman, Lake County, South Dakota (SD DENR, September 2004)

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