PHASE I
WATERSHED ASSESSMENT
AND TMDL
FINAL REPORT

LAKE ALICE
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

1889

JULY, 2002

SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM ASSESSMENT/PLANNING PROJECT FINAL REPORT

LAKE ALICE WATERSHED ASSESSMENT AND TMDL
FINAL REPORT

By

Sean Kruger, Environmental Project Scientist

Brad Kniss, Project Coordinator

Sponsor

Deuel County Conservation District

7/31/02

This project was conducted in cooperation with the State of South Dakota and the United States Environmental Protection Agency, Region 8.

Grant #
I-98-8727-03-0

Acknowledgements

The cooperation of the following organizations and individuals is gratefully appreciated. The assessment of Lake Alice and its watershed could not have been completed without their assistance.

Dave Bartling, SD Department of Game Fish and Parks

Deanne Balaster, Natural Resource Conservation Service

Deuel County Conservation District

Deuel County Farm Service Agency

Deuel County Lakes and Streams Association

Dr. Nels Troelsrtup, South Dakota State University

East Dakota Water Development District

Elois Redlin, Deuel County Conservation District Manager

Kevin Luoma, Natural Resource Conservation Service

Leroy Stohr, Clear Lake Restoration Project

SD DENR-Watershed Resource Assistance Program

Natural Resource Conservation Service

Table of Contents

Abbreviations

AFOs	Animal Feeding Operations
AGNPS	Agricultural Non-Point Source
BMPs	Best Management Practices
CRP	Conservation Reserve Program
CV	Coefficient of Variance
DC	District Conservationist
DO	Dissolved Oxygen
GPS	Global Positioning System
GLS	Great Little Sampler
MSL	Mean Sea Level
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Units
OHWM	Ordinary High Water Mark
OLWM	Ordinary Low Water Mark
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: 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 Lake Alice Watershed Assessment was completed as a portion of a larger assessment in Deuel County South Dakota which covered both Fish Lake and Lake Alice and their associated drainages. The project commenced in June of 2001 as a result of these water bodies inclusion on the 1998 State 303d list, at which point 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 first covering the Lake Alice Watershed. All milestones were accomplished in an acceptable and timely manner.

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

Water quality monitoring identified this lake as fully supporting its beneficial uses without watershed or in-lake treatments to control nutrient loading. Modeling indicated that the watershed is composed primarily of grass and pastureland with approximately 96% of the total acres accounted for in either hay, CRP, or pasture. Prior to the inception of the CRP Program, this watershed was composed of 30% to 40% cropland. The cropland component is now less than 2% of the total watershed acres.

The primary goal of this project was to identify sources of impairment to Lake Alice and provide sufficient background data to drive a section 319 implementation project. Because no sources of impairment in the watershed were identified, this goal was accomplished, and it is recommended that this water body be removed from the state 303d list.

Introduction

Purpose

The purpose of this pre-implementation assessment is to determine the sources of impairment to Lake Alice in Duel County, South Dakota and the tributary in its watershed. The only tributary to Lake Alice runs only during substantial snowmelt and rain events. The discharge from this watershed ultimately reaches the Minnesota River. The only tributary to Lake Alice is located at the western reach of the lake.

General Lake Description

Lake Alice is a 974-acre glacial lake located in sections 5, 6, 7, 8, 17, and 18, T116N R48W; Sections 1 and 12, T116N R49W; and Section 36, T117N R49W. Lake Alice is approximately 2 miles north and 3 miles east of Altamont, Deuel County. Lake Alice has an average depth of 12 feet (3.76 m) and over 9.5 miles (10.2 km) of shoreline. The lake has a maximum depth of 15 feet (4.6 m), holds, 4,286 acre-feet of water at pool elevation. The recommended the ordinary high water mark (OHWM) for Lake Alice was was established at 1691.8 feet above mean sea level (MSL), and the ordinary low water mark (OLWM) established at 1687.2 feet above sea level, set forth by the Department of Environment and Natural Resource, Division of Water Rights. The outlet to Lake Alice is on the northwest corner and drains into Conner Slough, which eventually reaches the Minnesota River, the outlet elevation is set at 1689.4 feet MSL.

Lake Identification and Location

Lake Name: Lake Alice
County: Deuel
Range: 48W & 49W

Nearest Municipality: Altamont
HUC Code: 07020001
EPA Region: VIII
HUC Name: Upper Minnesota

State: South Dakota
Township: 116N & 117N
Sections: T116N, R48W; 5,6,7,8,17, & 18: T116N, R49W; 1 & 12: T117N, R49W; 36
Longitude: -96.637657
Latitude: 44.881898
Receiving Bodies of Water: Conner Slough Caine Creek, Yellow Bank Creek, Minnesota River

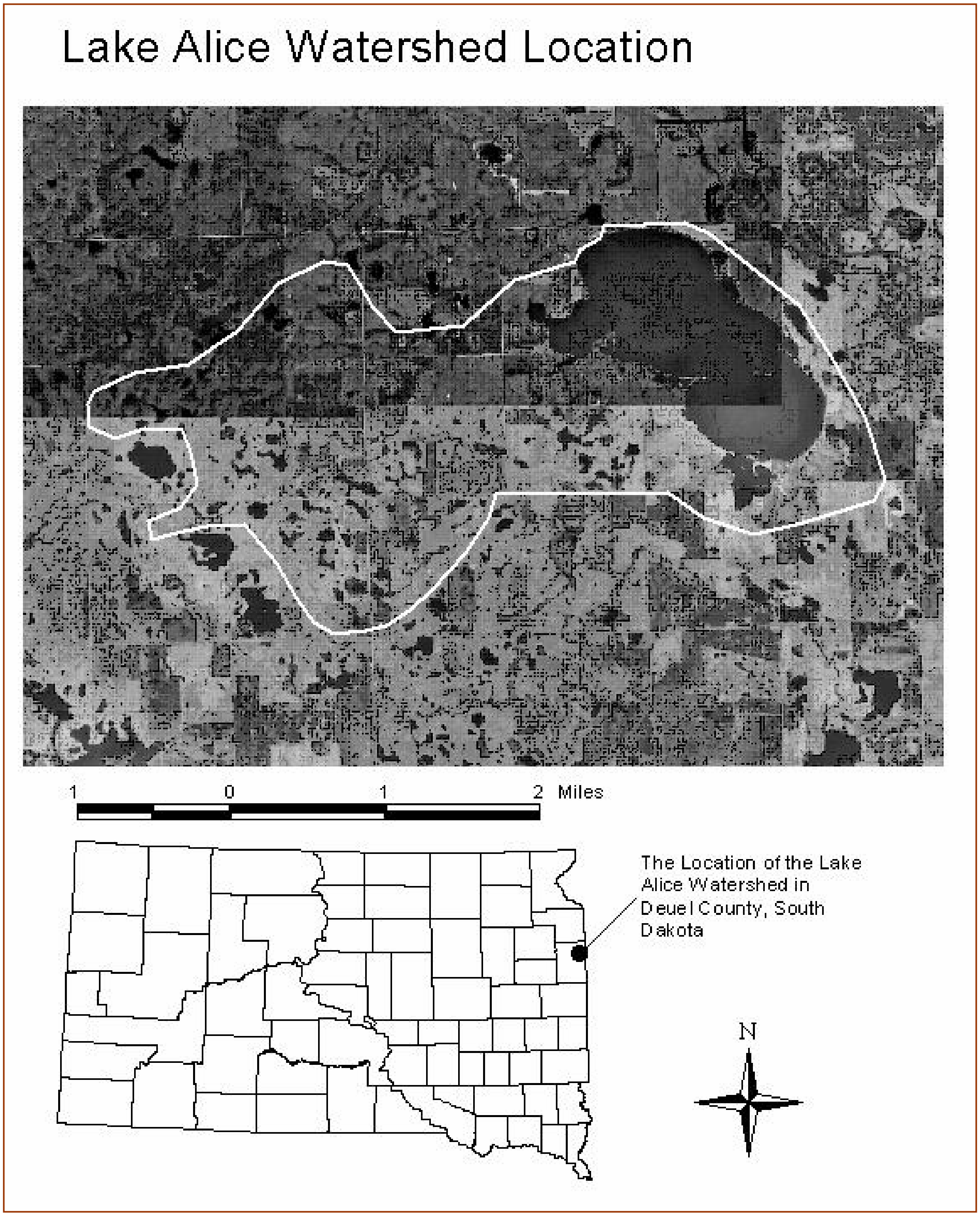


Figure 1. Lake Alice Watershed, Deuel County, South Dakota

Trophic Status Comparison

The trophic state of a lake is a numerical value that ranks its relative productivity. Developed by Carlson (1977), the Trophic State Index, or TSI, allows the lakes productivity to be easily quantified and compared to other lakes. Higher TSI values correlate with higher levels of primary productivity. A comparison of Lake Alice to other lakes in the area (Table 1) shows that a medium to high rate of productivity is common for lakes in the region. The values provided in Table 1 were generated from the most recent statewide lake assessment data, and for this reason, there will be some variation between the TSI reported here and in the rest of the report. The TSI for Lake Alice will show that it is a eutrophic lake from the data gathered from this report.

Table 1. TSI Comparison to other Lakes in the Northen Plains Glaciated Ecoregion

Lake	Nearest Municipality	TSI	Mean Trophic State
West Oakwood	Bruce	75.84	Hypereutrophic
Lake Campbell	Nunda	75.56	Hypereutrophic
Lake Poinsett	Lake Norden	69.25	Hypereutrophic
Pelican	Watertown	68.32	Hypereutrophic
Brandt Lake	Chester	67.22	Hypereutrophic
Punished Woman	South Shore	65.51	Hypereutrophic
Nine Mile	Lake City	65.44	Hypereutrophic
Lake Alice	**Altamont**	**64.64**	Eutrophic
Bullhead Lake	Goodwin	63.34	Eutrophic
South Buffalo Lake	Lake City	61.78	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 waterbody. 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 list of beneficial uses is assigned to Lake Alice.

(5) Warmwater semi-permanent 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. Lake Alice is identified in Ecoregion Targeting for Impaired Lakes in South Dakota and in the 1998 South Dakota 303d Waterbody List as not fully supporting its beneficial uses.

Recreational Use

The South Dakota Department of Game Fish and Parks provide a list of public facilities that are maintained at area lakes (Table 2). Lake Alice has a boat ramp and restroom facilities located at the north side of the lake. There is state ground located at the north and southeast of the lake for public shore fishing and hunting.

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

Lake	Parks	Boat Ramp	Camping	Toilets	Shore Fishing	Picknicking	Swimming	Nearest municipality
Bullhead Lake		x			x			Goodwin
Clear Lake	city	x	x	x	x	x	x	Clear Lake
Fish Lake		x			x		x	Astoria
Lake Chochrane	state	x	x	x	x	x	x	Gary
South Coteau Lake		x			x		x	Altamont
Lake Oliver		x			x		x	Gary
Lake Alice		**x**		**x**	**x**		**x**	**Altamont**
Round Lake		x			x		x	Goodwin
West Oakwood	state	x	x	x	x	x	x	Bruce
Oak Lake		x			x		x	White

Geology and Soils

Lake Alice is in the region known as Coteau des Prairies, a high plateau that extends across Deuel County in a southeasterly direction. (Flint, 1955) The Prairie Coteau (Coteau des Prairies) region was subjected to glaciation of the late Wisconsin age. Most of the soils derived from pre-glacial formations of granite, gneiss, limestone, sandstone, siltstone and shale. The glacial deposits of the late Wisconsin age can be several hundred feet thick overlying the Cretaceous bedrock. The late Wisconsin deposits consist of glacial till, stratified glacial outwash, and alluvial sediment. The landscape of the watershed consists of morainic ridges, rolling hills, some steep slopes, and small wetlands.

Deuel County is cold during the winter and relatively hot during the summer with occasional cool spells. The total annual precipitation is about 24 inches. 75 percent of this precipitation usually falls in April through September. The average seasonal snowfall is 50 inches and a maximum snowfall at any one time on record is 87 inches.

The project area contains both bedrock aquifers and glacial-deposit aquifers. The quality of the water in the bedrock aquifers is variable due to the high content of soluble salts that are associated with material the aquifer is found in. The water found in the glacial-deposits aquifers is usually of better quality. For the most part the rural water system is used for residential home use. There are a few dugouts in the watershed for livestock watering.

History

Deuel County was established in 1862 by an act of the first Dakota Territorial legislature. It was named in honor of the pioneer legislator, Jacob S. Deuel. The original county consisted of Grant county, the southern half of Roberts county, and the eastern halves of Codington and Hamilin Counties. The present boundaries of the county were established in 1873. (South Dakota Crop and Livestock Reporting Service, 1968) Clear Lake is presently the county seat after it was moved from Gary S.D. in 1890.

Like many other lakes in the area, Lake Alice was farmed during the years of the great depression. Millet and other grain crops were grown with great success in what is now the lake basin.

Lake Alice was named after Alice Mosher, daughter of John Mosher, an engineer on the Winona and St. Petersburg Railroad. She was considered to be the first white woman to visit the lake.

At one time, a bathhouse was located on the Northwest side of the lake where area residents took swimming lessons. It is no longer present at the lake.

Project Goals, Objectives, and Activities

Planned and Actual Milestones, Products, and Completion Dates

Objective 1. Lake Sampling

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

Objective 2. Tributary Sampling

The project coordinator began tributary monitoring and sampling at the start of the project at the end of May of 2001. Sufficient runoff was present only in the months of June 2001 and May 2002. An Isco Flowmeter was installed at the start of the project and used to take automatic samples and stage recordings of the water level going into Lake Alice. 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 sample date of June of 2002.

Objective 4. Watershed Modeling

Information regarding cropping history and hydrology of the watershed were collected throughout the project. Due to the small size of the watershed and the amount of CRP ground found in the watershed an AGNPS model was consider as to be insignificant towards implementation of BMP’s. This can be in question, but do to the fact that there are currently only two crop fields, five hay fields and the rest is CRP or wetland in nature, an AGNPS model would be to extensive to actually be used on such a small scale watershed.

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. Futher information was also provided to the project coordinator during routine trips to the watershed and public meetings for the local Lakes and Streams meetings and Deuel County Conservation District Meetings

Objective 6 and 7 Restoration Alternatives and Final Report

Completion of the restoration alternatives and final report for Lake Alice was delayed due to a later than scheduled start of the project and the corresponding project of Fish Lake watershed that was also completed under the same.

Table 3. Proposed and Actual Objective Completion Dates

	A-01	M-01	J-01	J-01	A-01	S-01	O-01	N-01	D-01	J-02	F-02	M-02	A-02	M-02	J-02	J-02	A-02
Objective 1 - Lake Sampling	■	■	■	■	■	■	■										
		▒	▒	▒	▒	▒	▒			▒				▒	▒		
Objective 2 - Tributary Sampling	■	■	■	■	■	■	■										
			▒										▒				
Objective 3 - Quality Assurance / Quality control	■	■	■	■	■	■	■	■	■								
		▒	▒	▒	▒	▒	▒	▒		▒			▒	▒	▒		
Objective 4 - Watershed Modeling	■	■	■	■	■	■	■	■	■	■							
	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒							
Objective 5 - Public Participation		■			■			■			■						
		▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Objective 6 - Restoration Alternatives									■	■	■	■					
															▒	▒	▒
Objective 7 - Final Report									■	■	■	■					
															▒	▒	▒

▒ Actual ■ Proposed

Monitoring Results

Surface Water Chemistry (Unnamed Tributary)

Flow Calculations

A single inlet site on an unnamed tributary to Lake Alice was monitored. This site was selected to determine the sediment and nutrient loadings to Lake Alice. The site was equipped with an ISCO model 4230 Flow meters attached to a GLS auto-sampling unit. Water stages were monitored and recorded to the nearest 1/100th of a foot during times of discharge. A Marsh-McBirney velocity meter was used to determine flows at various stages. The stages and flows were then used to create a stage/discharge table for the site, which 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 at the inlet to Lake Alice may be found in Appendix B.

Tributary Sampling Schedule

Samples were collected at the sites during the spring of 2001 through the spring of 2002. All of the samples were collected using a suspended sediment sampler. Water samples were then 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
E. coli Bacteria Counts

Alkalinity
Total Dissolved Solids
Ammonia
Total Kjeldahl Nitrogen (TKN)
Volatile Total Suspended Solids
Ammonia

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

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

Parameters measured in the field by sampling personnel were:

Water Temperature
Conductivity
Field pH
Air Temperature
Dissolved Oxygen

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 unnamed tributary located within the Lake Alice watershed must maintain the criteria that support these uses. In order for the creek to maintain 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. There were no violations of water quality standards during the project.

Table 4. State Water Quality Standards

Nitrate	≤50 (mean) ≤88 (single sample)
Alkalinity	≤750 (mean) ≤1,313 (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 drab 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

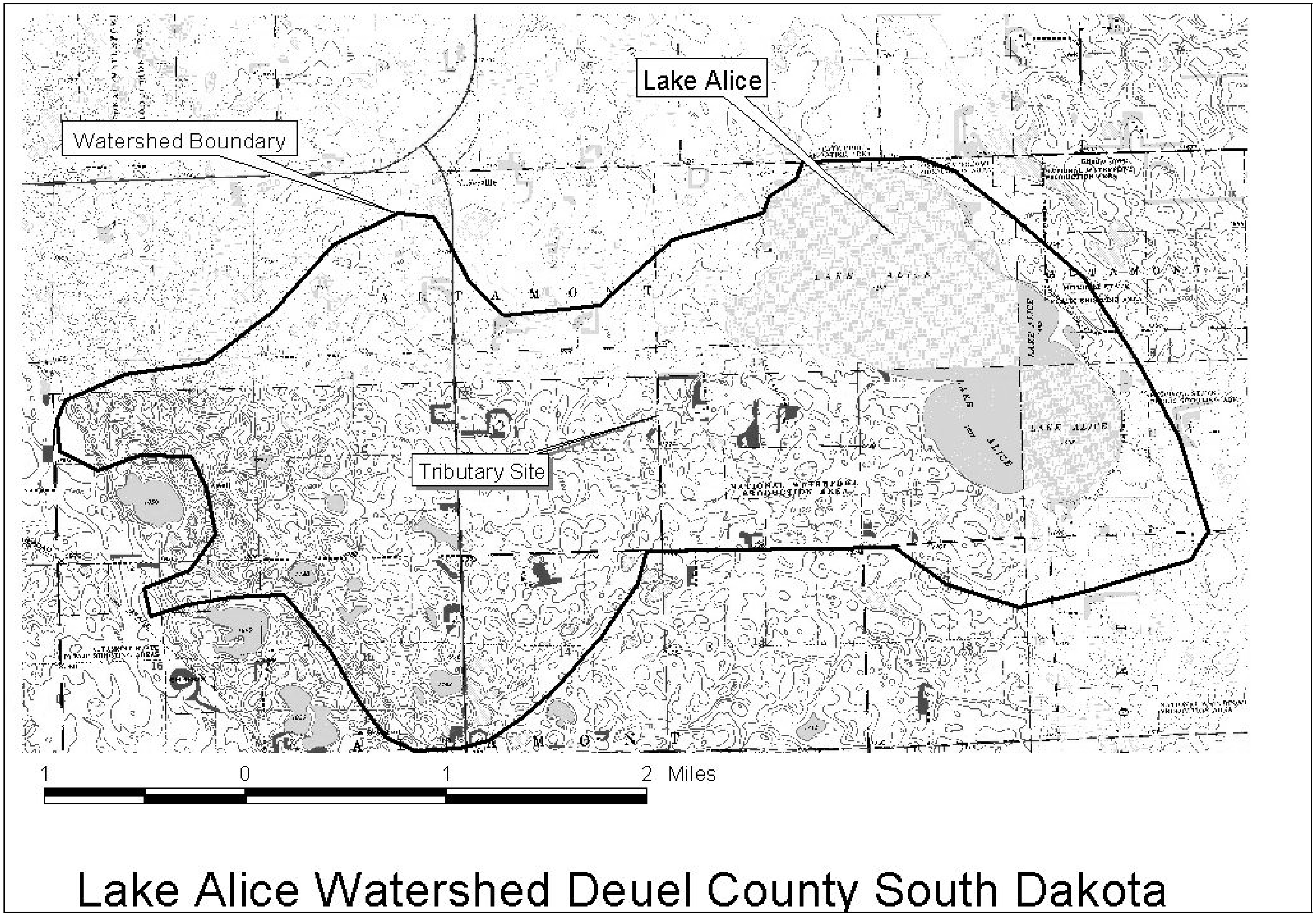


Figure 2. Lake Alice Watershed Monitoring Station

Water and Nutrient Budgets

The official outlet elevation for Lake Alice is set at 1689.4 feet Mean Sea Level (MSL). The outlet to the lake is located in the northwest corner of the lake. Ice heaves in the winter have pushed up the sand along this shore resulting in some blockage of the outlet. This, in combination with above average rainfall in recent years has kept the lake at or above its official high water mark of 1691.8 feet MSL and above the spillway elevation. Appendix C contains historic water levels for Lake Alice.

The elevation of the lake at the start of the project was 1693.9 feet MSL. At the end of the first growing season, the level of the lake had dropped to 1692.55 feet. Evaporation rates for this area average approximately 27 inches from May through October or .0125 feet/ day. Using this figure, corrected for precipitation, the lake should have dropped to 1692.66 feet MSL. The difference of .1 feet or 100 acre feet of volume may be attributed to any number of things, but most likely is due to calculation errors as a result of variations in precipitation and evaporation. It appears that ground water has very little influence on Lake Alice.

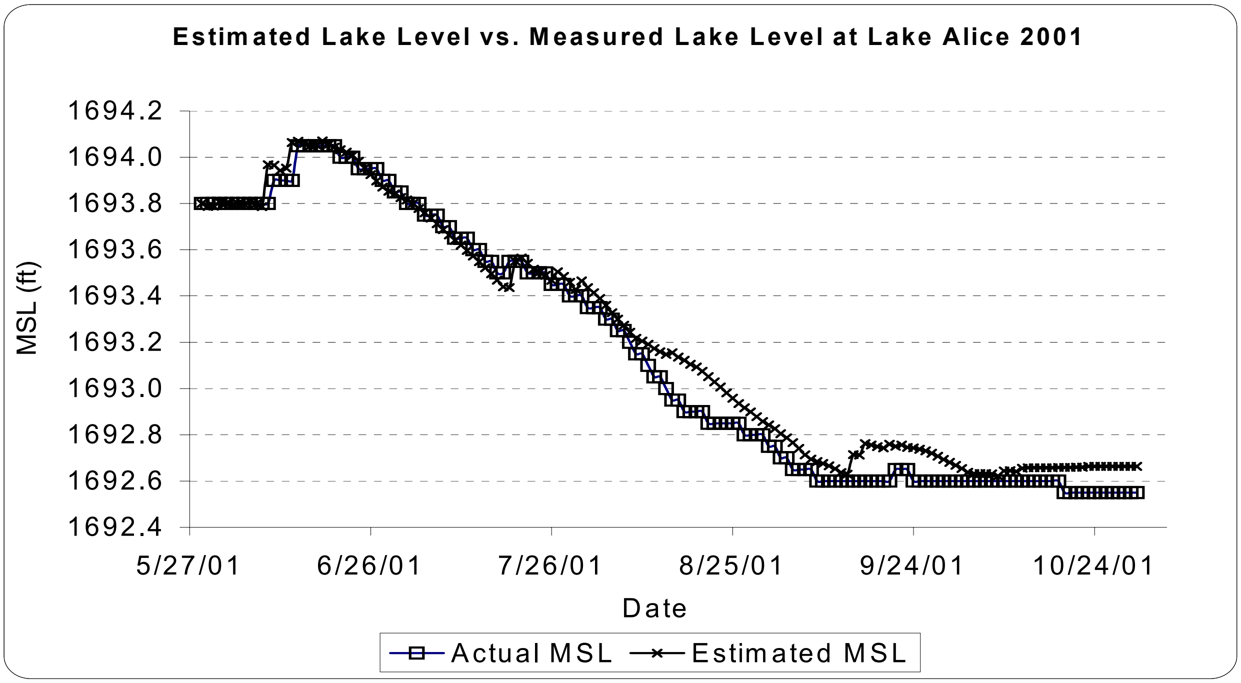


Figure 3. Estimated Lake Level vs. Measured Lake Level at Lake Alice 2001

Seasonal Loading

Seasonal loadings to Lake Alice are heavily influenced by snowmelt and spring rainstorm events. Table 6 depicts the seasonal percentage of phosphorus loading entering the lake. The spring months of March, April, and May only accounted for 1% of the loading that occurred to the lake during the project. This may differ from year to year as early June accounted for the rest of the loading to the lake. It is likely that 25 year storm events will result in late season loading, but the infrequency of these events results in little impact to the lake. All BMPs implemented within the watershed should be designed with maximum protection to the lake provided during the spring and early summer. Even though 99% of the loading occurred during the summer season, it is likely that the spring months are more frequently the season during which loadings occur.

Table 5. Monthly and Seasonal Loading for Lake Alice

Month	Mass (kg) Phosphorus	Concentration (ppb)	Seasonal percentage
Mach	0	0	1%
April	0	0	
May	.1	83	
June	86.6	106.49	99%
July	0	0	
August	0	0	
September	0	0	0%
October	0	0	
November	0	0	
December	0	0	0%
January	0	0	
Febuary	0	0	

Annual Loading

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. Located in Table 7, these loads and their standard errors (CV) are calculated through the use of FLUX (Army Corps of Engineers loading model) for the two primary inlets to the lake. It is important to note that a large portion of the phosphorus and nitrogen load entering Lake Alice comes from atmospheric deposition. Estimates range from 40% to 65% of the total phosphorus load (based on estimates from atmospheric loads between .01 mg/L to .028 mg/L from the BATHTUB model as well as from Wetzel).

Table 6. Annual Loading to Lake Alice from its Primary Tributary

	Inlet to Lake Alice		
	Concentration (ug/L)	FLUX Load (kg/yr)	CV
Total Phosphorus	111	86.1	.142
Total Dissolved Phosphorus	103	79.7	.294
Total Alkalinity	245,562	189,506	.035
Total Suspended Solids	1,104	852	2.567
Total Nitrogen	1,148	886.7	.1
Area Drained (km^2)	33.48		
Annual Discharge (hm^3)	.772		
Discharge Coeff. (hm^3/km^2)	..0231		

Fecal Coliform Bacteria

Fecal coliform are bacteria that are found in the digestive tract of warm-blooded animals. One of the most common types of fecal coliform is *E. coli*, which is associated with livestock, wildlife, and human waste (Novotny, 1994). Major sources in the Lake Alice tributary are most likely livestock and wildlife. The human population in the Lake Alice watershed is approximately 20-30 individuals, making human waste an unlikely potential source.

Sample data for the Lake Alice watershed proved fecal coliform present in the inlet during runoff events. These numbers are relatively low considering the mean during the assessment was 227 colonies/100ml for fecal and 170 colonies/100ml for E-coli. Since high nutrient concentrations usually accompany the fecal bacteria and *E. coli* counts, controlling animal waste may reduce fecal/ E-coli counts and nutrient concentrations. The only potential agricultural source of bacteria identified in the watershed was a small lot that is used for feeding buffalo during portions of the year. While the number of animal units is very low, the possible presence of animals during runoff events may contribute some bacterial contamination to the lake.

Fecal Coliform and E.Coli (Colonies/100ml)			
Date	Time	Fecal	*E.coli*
6/11/01	10:30	200	89
6/13/02	16:33	770	470
6/18/02	9:00	100	146
6/18/02	9:00	60	145
4/4/02	16:00	5	2
Mean		227	170

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.

The alkalinity in Lake Alice ranged from a low of 95 mg/ L on April 4, 2002 to a maximum value of 280 mg/L on June 12, 2001. The numeric mean is 188 mg/L and the FLUX calculated mean load concentration is 245 mg/L. All of these values fall well within the state standard of 1,313 mg/ L for a single sample or 750 mg/L mean.

Nitrate/Nitrite

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 50mg/L mean over any 30 day period of time and 88 mg/L for any single sample.

Nitrate levels in the tributary to Lake Alice were consistently below the minimum detection limit of 0.10 mg/L. The only sample with a detectable amount of nitrate/nitrite was collected on April 4, 2002, with a concentration of .4 mg/L. The consistent low to undetectable limits of nitrate/nitrite found at this site indicate that there is not impairment as a result of this parameter.

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. pH 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 basic (more OH^- ions).

The short duration of flow in combination with equipment breakdowns resulted in a very limited data set. The only accurate pH reading recorded the water at approximately 8.0 su, well within the standards for this waterbody.

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 maximum dissolved solids concentration found at this site was 858 mg/L which falls well within the state standard of 4,375 mg/L for a single sample or a mean of 2,500 mg/L.

Nitrogen and Phosphorus

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.

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. External loading refers to surface runoff, dust, and precipitation. Internal loading refers to the transfer 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 water.

The primary reason for examining the nitrogen and phosphorus loads to Lake Alice is to determine the impact that nutrient loading had on the lakes plant and algae communities. The tributary load to Lake Alice is exceptionally small for a lake of this size. At its maximum level during 2001, it covered an estimated 1,200 acres. The phosphorus load from the watershed was approximately 108 kg.

The nitrogen load to Lake Alice is substantially higher than the phosphorus load. The FLUX calculated annual load is approximately 900 kg, or roughly ten times the phosphorus load. While this load is larger, it likely has very little impact on the overall condition of the lake as nitrogen is readily available in atmospheric loads. Measured concentrations were slightly over 1 mg/L, which is relatively low when compared with many tributaries in eastern South Dakota. These low nutrient concentrations are likely attributed to the large percentage of land in the watershed that has grass cover and does not experience tillage.

Tributary Site Summary

As was discussed in the in earlier sections of this report the effects of atmospheric loading in combination with the exceptionally small loadings occurring from the tributary indicate that only 40% to 65% of the nutrient load to Lake Alice actually occurs from its watershed. There were also no standards violations detected in any of the water quality samples collected at the inlet to the lake.

Surface Water Chemistry (Lake Alice)

Inlake Sampling Schedule

Sampling began in June 2000 and was conducted on a monthly basis from the surface of the lake until project completion in June 2001 at the two pre-selected sites (See Figure 4). Water samples were filtered, preserved, and packed in ice for shipping to the State Health Lab in Pierre, SD. Sample data collected at Lake Alice may be found in Appendix D. The laboratory then assessed the following parameters:

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

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

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

Parameters measured in the field by sampling personnel were:

Water Temperature
Conductivity
Field pH
Secchi Depth
Air Temperature
Dissolved Oxygen
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. Lake Alice has been assigned the beneficial uses of:

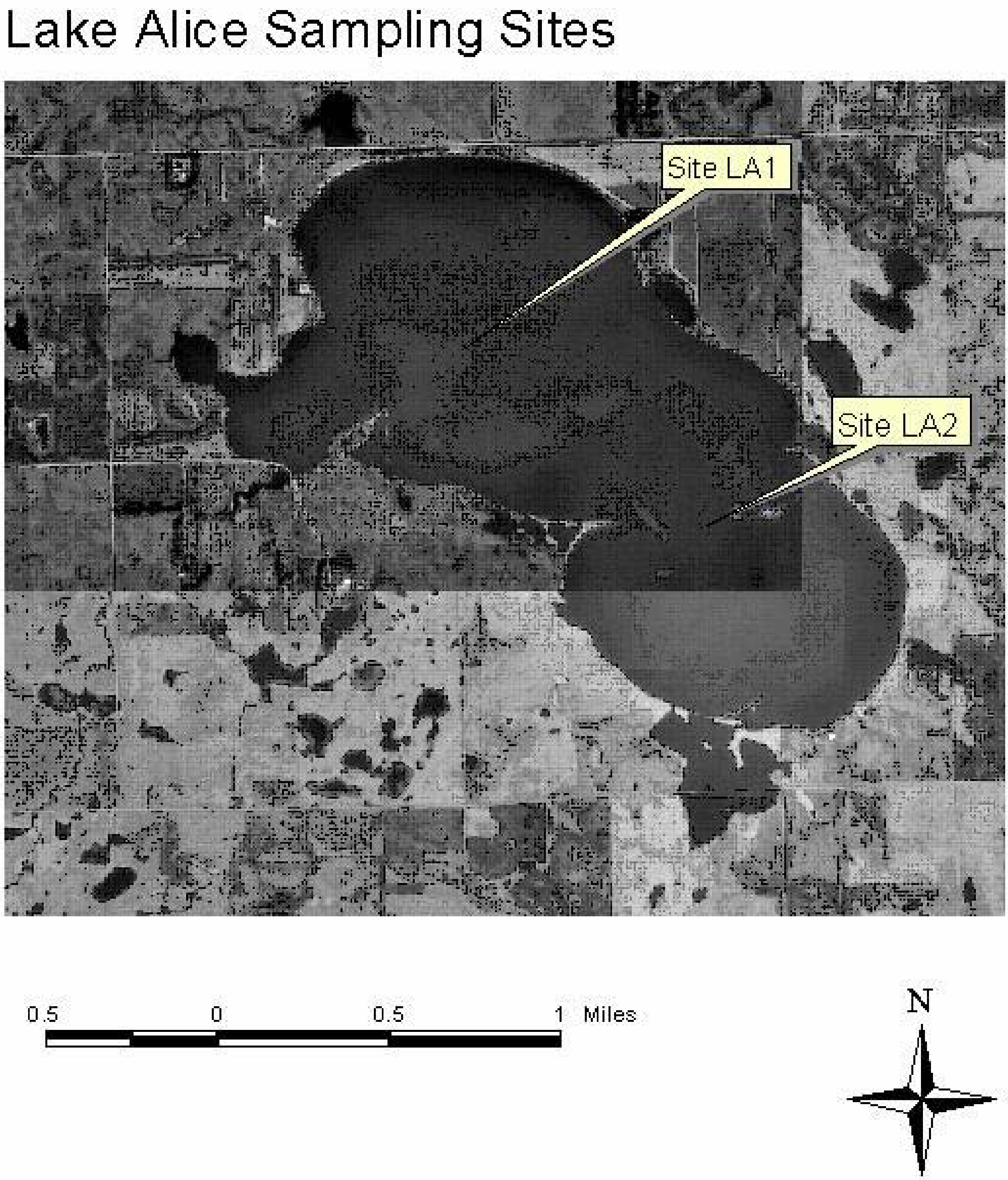
(6) Warmwater semi-permanent fish life propagation
(7) Immersion recreation
(8) Limited contact recreation
(9) Fish and wildlife propagation, recreation and stock watering

The following table lists the parameters 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 7. State Beneficial Use Standards for Lake Alice

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° *C)*	≤4,000 *(mean)* ≤7,000 *(single sample)*	Wildlife Propagation and Stock Watering
Nitrogen, unionized ammonia as N	≤.04 *(mean)* ≤1.75 times the applicable limit *(single sample)*	Warmwater Semi-permanent Fish Propagation
Nitrogen, nitrate as N	≤50 *(mean)* ≤88 *(single sample)*	Wildlife Propagation and Stock Watering
Oxygen, dissolved	≥5.0	Immersion and Limited Contact Recreation
pH *(standard units)*	6.5 - 9.0	Warmwater Semi-permanent Fish Propagation
Solids, suspended	≤90 *(mean)* ≤158 *(single sample)*	Warmwater Semi-permanent Fish Propagation
Solids, total dissolved	≤2,500 *(mean)* ≤4,375 *(single sample)*	Wildlife Propagation and Stock Watering
Temperature	≤32° C	Warmwater Semi-permanent Fish Propagation
Total Petroleum Hydrocarbon Oil and Grease	≤10 mg/L ≤10 mg/L	Wildlife Propagation and Stock Watering

Figure 4. Lake Alice Sampling Locations



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 is more abundant in cooler water. Water temperature also plays a key role in physical conditions. Oxygen dissolves in higher concentration in cooler water. The toxicity of un-ionized ammonia is also related directly to warmer temperatures.

There are many factors that influence the concentration of dissolved oxygen (DO) in a water body. Temperature is the most important of these factors. As the temperature of the 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 that the 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 result to a fish kill.

The water temperature in Lake Alice exhibited little variation from site LA-1 to site LA-2 see Figures 5 and 6. Temperatures showed seasonal variations that are consistent with its geographic location, steadily increasing in the spring and summer and consistently decreasing in the fall and winter. It can be expected that during most years the inlake temperatures would be within a few degrees of the project data at their respective dates.

The lowest water temperatures were recorded in January, this is the only sample that was taken while the lake was completely covered in ice. There were several periods of freezing and thawing in the lake throughout the winter. This may have allowed for some increases in water temperature. The peak annual temperatures were reached during July at 25.9C, which is below the state standards that require it to maintain a maximum temperature under 32.2C.

Oxygen levels in Lake Alice were sufficient to maintain requirements for the fishery of the lake. The lowest level was 9.1 mg/L and was recorded during the month of August 2001, and the highest in January 2002 was recorded at 15.8 mg/L.

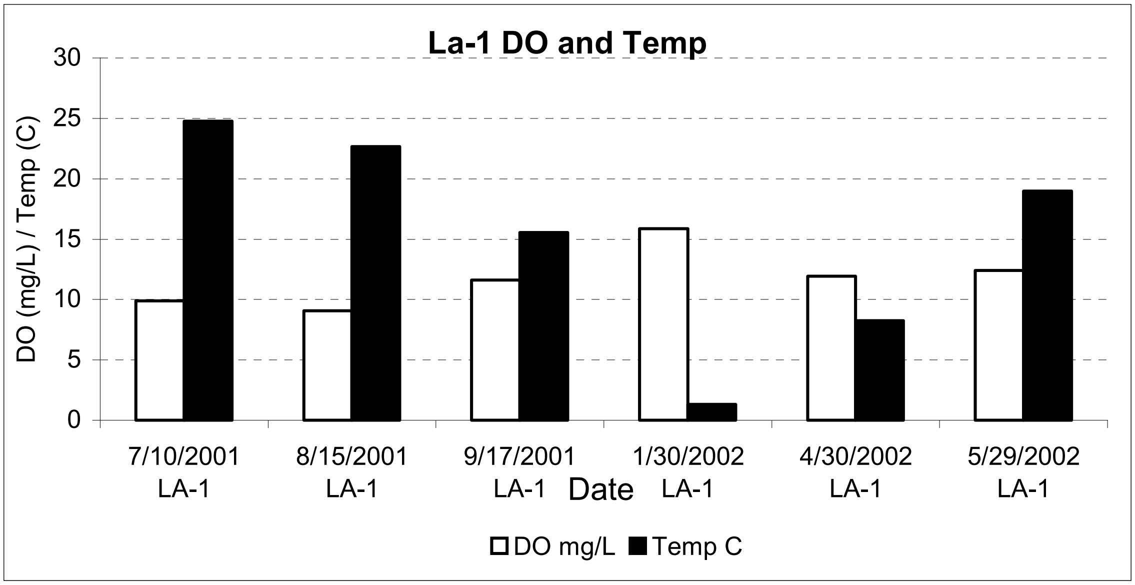


Figure 5. Site LA1 Dissolved Oxygen and Temperature

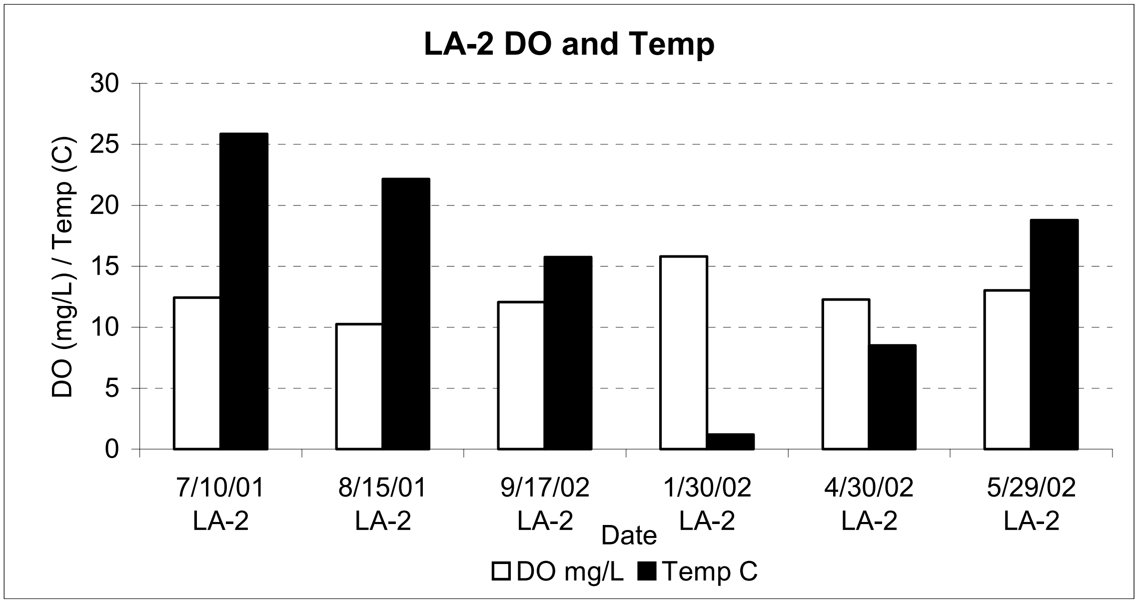


Figure 6. Site LA2 Dissolved Oxygen and Temperature.

Conductivity

Conductivity is a measure of water's ability to conduct electricity, which is a function of the total number of ions present. Conductivity increases reflect an increase in the concentration of dissolved ions in the waterbody. This may also be used to indicate hardness. It is measured in μmhos/cm, and is sensitive to changes in temperature.

Surface conductivity remained relatively constant during the duration of the lake sampling. Conductivity showed to be relatively low when compared to other lakes in the region. The state standard for fish and wildlife propagation requires that conductivity not to exceed 4,000 umhos for a 30-day average or 7,000 umhos any single day. The values measured in Lake Alice did not exceed these levels during the sampling period.

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. It is commonly found in concentrations as high as 200 mg/L or greater.

The alkalinity in Lake Alice varied from a low of 159 mg/L in the summer to a high value of 265 mg/L in the winter. The increase during the winter and early spring may be attributed to lower amounts of photosynthesis occurring during those months. During the spring and summer months, photosynthesis carried on by algae and macrophytes utilize a portion of the alkalinity. The ice cover and cold temperatures reduced this action during the winter months allowing decomposition on the lake bottom to release more carbonates, which in turn increased the 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 are considered acidic (more H^+ ions) and greater than 7 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 the pH. The extent to which this occurs is affected by the lake's ability to buffer against changes in pH. The presence of a 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.

pH values in Lake Alice ranged from a low of 7.98 su to a high of 9.09 su. There were two samples collected above the state standard of 9.00 su. Both were collected during an algae bloom on September 17, 2001. Comparing pH to chlorophyll *a* concentrations (Figure 7) indicates that there is a correlation between them. As the chlorophyll *a*, and photosynthesis, increase, so does the pH in the lake. This suggests that a reduction in the frequency and intensity of algae blooms such as the one that occurred in September will reduce the frequency of pH values above the state standard.

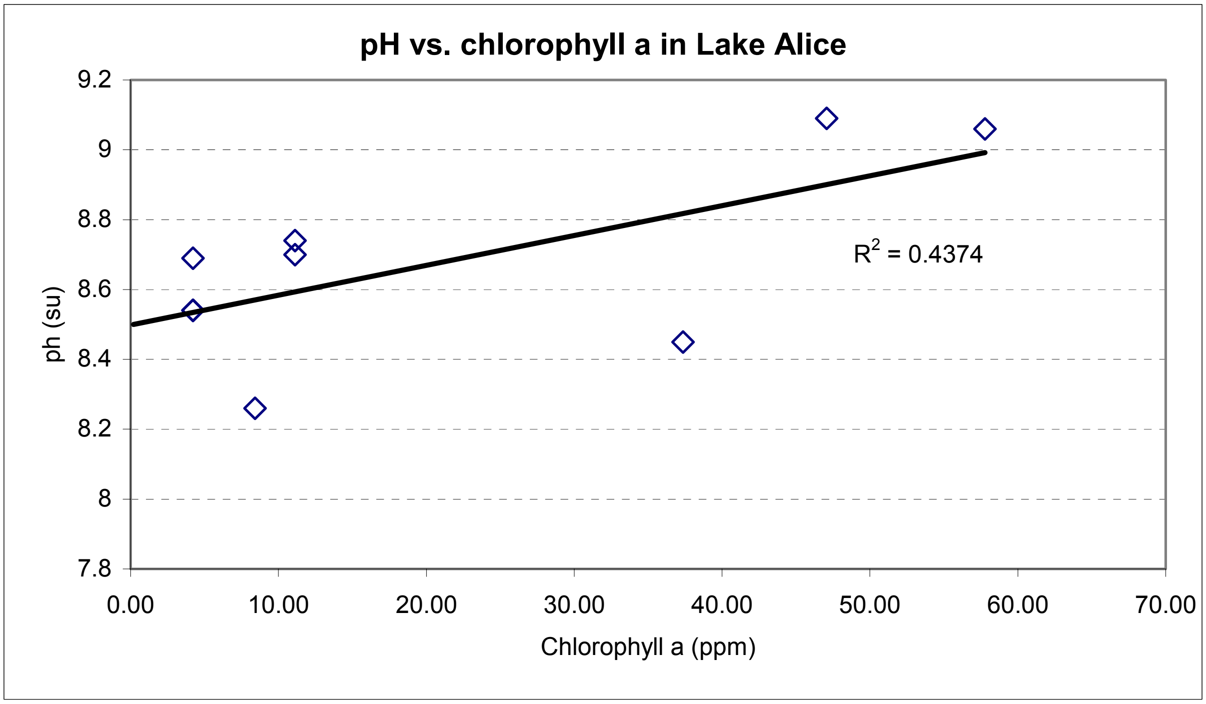


Figure 7. pH to Chlorophyll a Relationship in Lake Alice

Chlorophyll a/ Secchi Depth

Chlorophyll *a* is the primary photosynthetic pigment found in oxygen producing organisms (Wetzel, 1982). Chlorophyll *a* is a good indicator of a lakes productivity as well as its state of eutrophication. Chlorophyll *a* is also used in the development of lake TSI values. Chlorophyll *a* concentrations ranged from .2 ppb to 57 ppb in Lake Alice.

Secchi depth is the most commonly used method to determine water clarity. There are currently no regulatory standards that exist for this parameter. The Secchi reading is an important tool for determining the trophic state of a lake. The two primary causes for low Secchi readings are suspended solids and high algae counts. Larger Secchi readings are found in lakes that have clearer water, which is often associated with lower nutrient levels and “cleaner” water. Secchi readings ranged from .3 meters to 1.75 meters during the growing season.

Secchi depth is used for the development of lake TSI values. In the case of Lake Alice, suspended solids were not a major contributor to the low Secchi readings found. Chlorophyll *a* significantly affected the Secchi readings during algae blooms. Figure 8 indicates that as chlorophyll *a* concentrations decreased, the average Secchi depth reading increased. Reducing the frequency and severity of algae blooms will improve the clarity of the lake. There was also a good relationship between the suspended solids and the chlorophyll *a,* most of the suspended solids were volatile in nature which correlated with changing chlorophyll *a* concentrations very well.

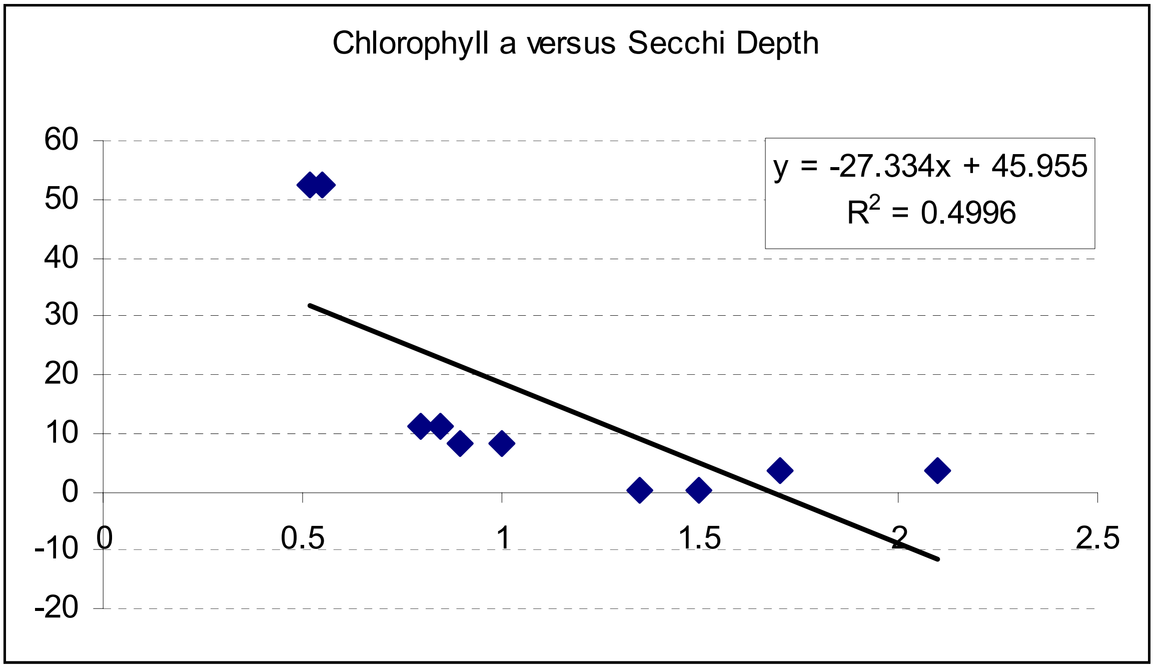


Figure 8. Chlorophyll *a* to Secchi Depth Relationship

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 into a stream bottom buries 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.

Lake Alice exhibited very little variation in total solids and dissolved solids concentrations through the course of the year. Peak values were observed during periods of ice cover in January of 2001. The lowest values were observed during the month of June 2001. Suspended solids concentrations in Lake Alice remained fairly low throughout the course of the year. The lowest values were observed during the January sample and the highest during the September sample. Volatile suspended solids followed the same trend as the suspended solids.

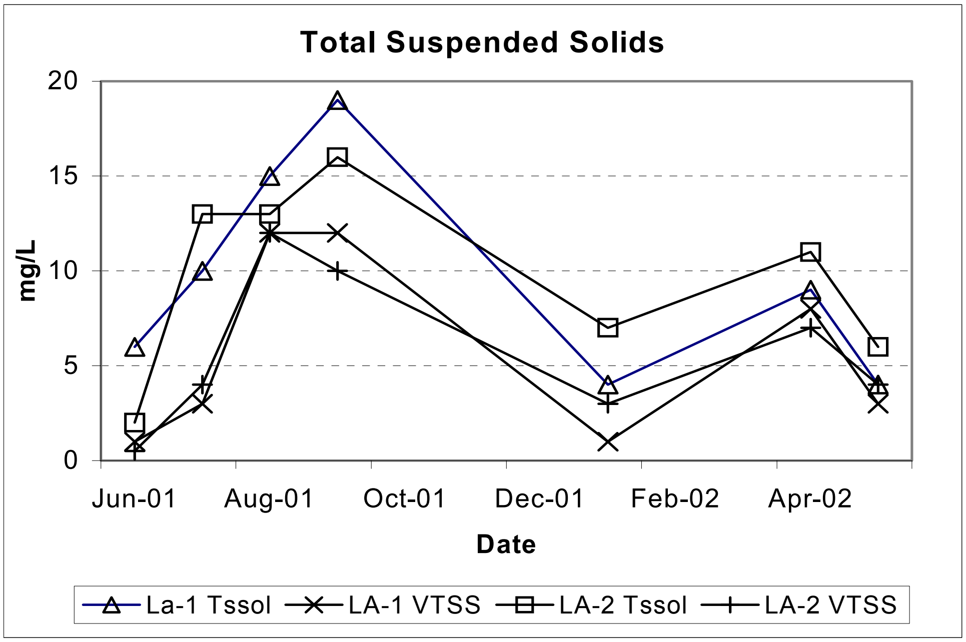


Figure 9. Total and Volatile Suspended Solids for Lake Alice

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 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.

At no time during the project were nitrate/nitrites levels recorded at or above the detection limit. Ammonia was recorded above the detection limit one time in the month of July at the south end of Lake Alice. This is of no great concern due to the fact that the other site on the lake did not show a significant increase in ammonia. Ammonia and nitrate/nitrite are the most readily available forms of nitrogen for plant growth. Lake Alice has a dense population of aquatic macrophytes in its shallow areas. These plants, along with algae, consume almost all of the nitrates and ammonia as fast as they become available. The sum of ammonia and the organic nitrogen present in the water body is measured as TKN. For Lake Alice, it may be assumed that the TKN essentially represents the organic nitrogen in the lake.

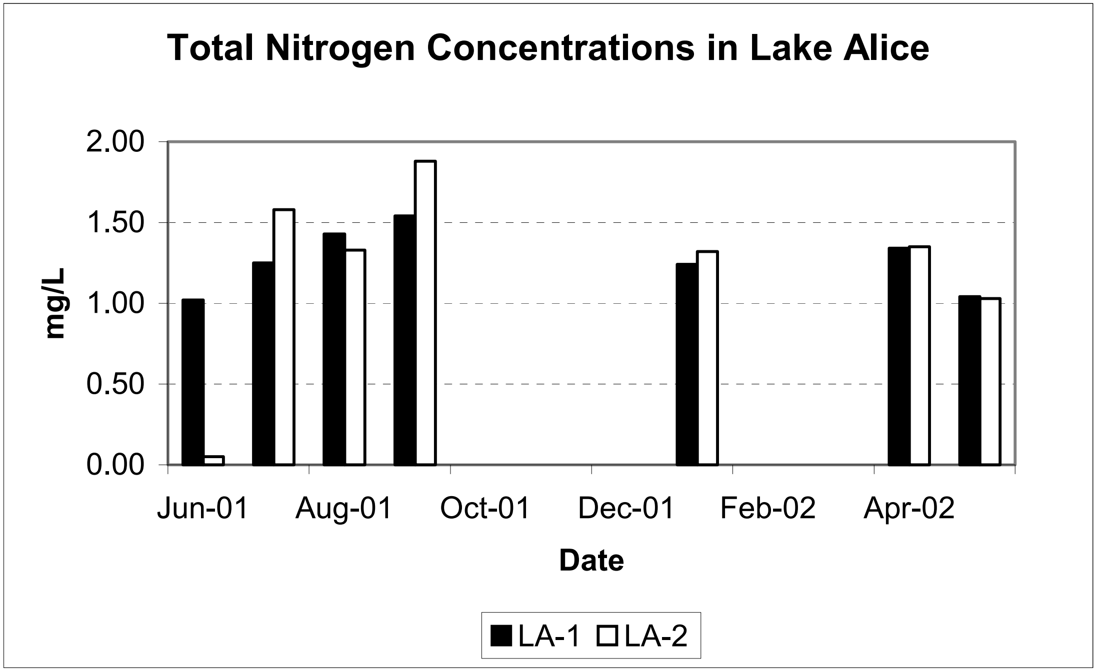


Figure 10. Total Nitrogen Concentrations in Lake Alice

Total 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. The attached phosphorus is directly related to the amount of total suspended solids present. An increase in the amount of suspended solids increases the fraction of attached phosphorus.

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 average in-lake total phosphorus during the assessment was .066 mg/L. Algae requires only 0.02 mg/L of phosphorus to start causing nuisance algae blooms. This means that Lake Alice has over three times the minimal requirements for algal growth. The dissolved portion of phosphorus accounts for about 30% of the total concentration in the lake. The average dissolved phosphorus concentration was 0.018 mg/L, which is at the minimum level needed to create nuisance algae blooms. Reducing these concentrations would likely result in less frequent and less intense algae blooms.

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.

There were no detectable fecal samples collected from Lake Alice during the project period. This is likely due in part to the very small number of livestock in the watershed. With no fecal coliform colonies detected during the project, it is unlikely that Lake Alice ever experiences impairments as a result of bacteria levels.

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 indicate a phosphorus-limited system. Those that are less than 10:1 represent nitrogen-limited systems.

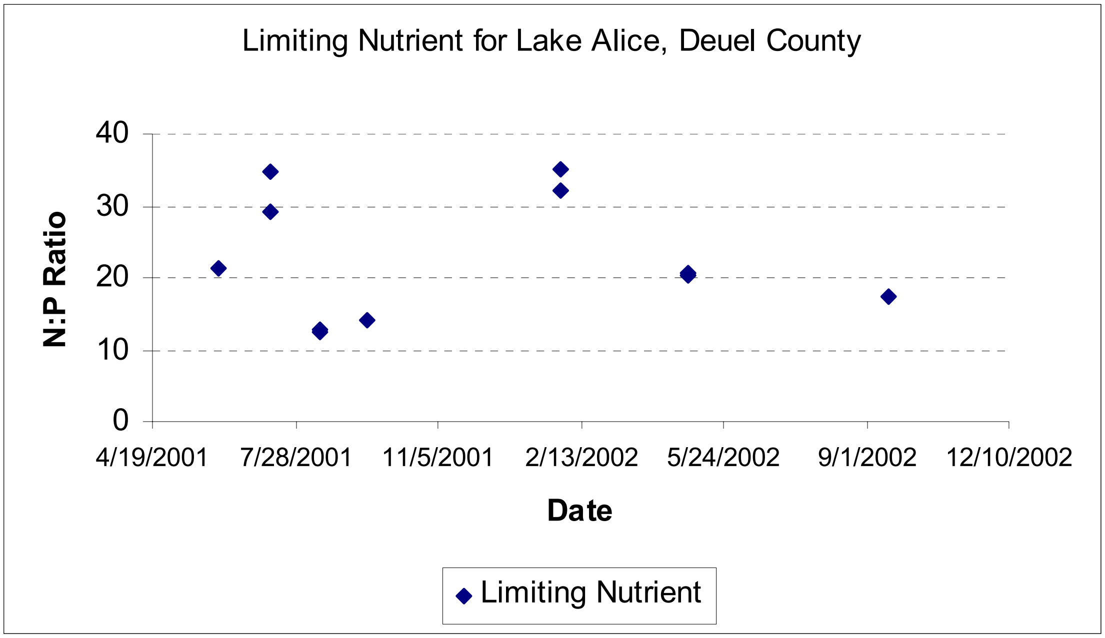


Figure 11. Limiting Nutrients for Lake Alice

The nitrogen to phosphorus ratio for Lake Alice ranged from 12 to 32 placing it within the phosphorus-limited category. This indicates that reductions in the total phosphorus concentration in the lake will likely result in positive responses in the trophic state.

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 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 nuisance 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 8. Carlson's Trophic State Index

TROPHIC STATE	COMBINED TSI NUMERIC RANGE
OLIGOTROPHIC	0-35
MESOTROPHIC	36-50
EUTROPHIC	51-64
HYPER-EUTROPHIC	65-100

The mean growing season TSI calculated for Lake Alice is 61.5 which places it within the eutrophic lakes category and classifies it as fully supporting its beneficial uses. As is discussed in other sections of this report, it is likely that this lake is benefiting from conservation practices in its watershed and will continue to see improved water quality for years to come.

Reduction Responses and Long Term Trends

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 Unnamed Tributary. Loading data for Unnamed Tributary was taken directly from the results obtained from the FLUX modeling data calculated for the inlet to the lake. Atmospheric loads were provided by SDDENR.

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.

The BATHTUB calculated TSI for Lake Alice is between 60 and 62 depending on the atmospheric loading simulated for the lake. Estimates for phosphorus concentrations in rainfall range from 0.01 to 0.028 mg/L. Phosphorus residence times in the lake range from 3 to 5 years depending on the concentration used. With the use of the most conservative estimate (0.01 mg/L), approximately 40% (75 Kg) of the phosphorus load entering the lake is a direct result of atmospheric deposition. Stream loadings represent the remaining 60%.

As a result of this large portion of the load entering from the atmosphere, reductions of 50% from the watershed yield a shift in the mean TSI value for the lake of 2 to 4 points (2 points when atmospheric loads are assumed to contain 0.028 mg/L of phosphorus and 4 points when atmospheric loads are assumed to contain 0.01 mg/L of phosphorus). Modeling unrealistic 95% reductions in phosphorus loading results in mean TSI levels between 55 and 58.

The long term trend for Lake Alice will likely be stable to improving. There has been a large amount of conservation work done in its small watershed. As the affects of these BMPs take place on Lake Alice, the condition of the lake should improve. The TSI recorded during the study is lower than what was previously reported in the 1995 South Dakota Lakes Assessment Final Report (Stewart and Stueven, 1995). This may represent the first stages of recovery.

Biological Monitoring

Aquatic Macrophyte Survey

DENR staff and the project coordinator conducted an aquatic macrophyte survey during late July, 2001. Submerged and emergent aquatic vegetation was located, sampled, identified, and recorded at 25 of the 31 sampling transects. Thirty one transects were located at approximately 300 meter intervals along the shoreline of the lake.

The primary focus of the survey was to document the existence of invasive species, such as Eurasian Water Milfoil, in the lake. At no point during the survey were any of these invaders encountered. Secchi depth readings were also recorded at each of the transects. Table 9 identifies the primary species encountered during the survey as well as the percentage of sites that it occurred at.

Table 9. Submerged Macrophyte Species and Occurence in Lake Alice

Species	Frequency of Occurrence
Najas Guadalupensis	87%
Sago pondweed	94%
Unidentified Moss	87%
Coontail	16%
Northern Water Milfoil	10%
Clasping Leaf Pondweed	48%
Carex species	10%

Phytoplankton

A detailed study of the algae species present in Lake Alice was not conducted during the project. It is important to note that during early fall of 2001, two hunting dogs along with various wildlife died after entering the water in Lake Alice. Autopsies were not performed, however algae was sampled and identified resulting in consensus among staff at SDDENR that the most likely cause of the fatalities was due to a die-off of a species of *Anabeana* (several of which have been proven to be toxic) found in the sample at high concentrations. Reduction of nutrient concentrations in the lake would likely reduce the chances of such blooms and prevent future problems.

Threatened and Endangered Species

There are no federally threatened or endangered species documented in the Lake Alice 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 Unnamed Tributary 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 Lake Alice 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

Agricultural Non-Point Source Model (AGNPS)

The Lake Alice watershed is composed primarily of grass and pastureland with approximately 96% of the total acres accounted for in either hay, CRP, or pasture. Prior to the inception of the CRP Program, this watershed was composed of 30% to 40% cropland. Many of these cropland acres were located on land that was conducive to high amounts of erosion, particularly during periods prior to conservation tillage. The cropland component is now less than 2% of the total watershed acres. Continued use of conservation practices is very likely in this watershed for several reasons. Many of the CRP acres (particularly those close to the lake) are used primarily for paid hunting. The owner/ operator of this ground has put a great deal of effort into the restoration of wildlife habitat including the maintenance of wetlands. Many of the remaining CRP acres not currently used for paid hunting are maintained due to their erosive nature.

Completion of the AGNPS model on this watershed would be relatively meaningless, as there is very little that could be changed within the boundaries to reduce the already small nutrient load to the lake. The presence of one feeding area that is used periodically for buffalo management may have a small impact on the lake, however the trophic state appears to have improved to a fully supporting condition indicating little need for an in depth assessment of this source.

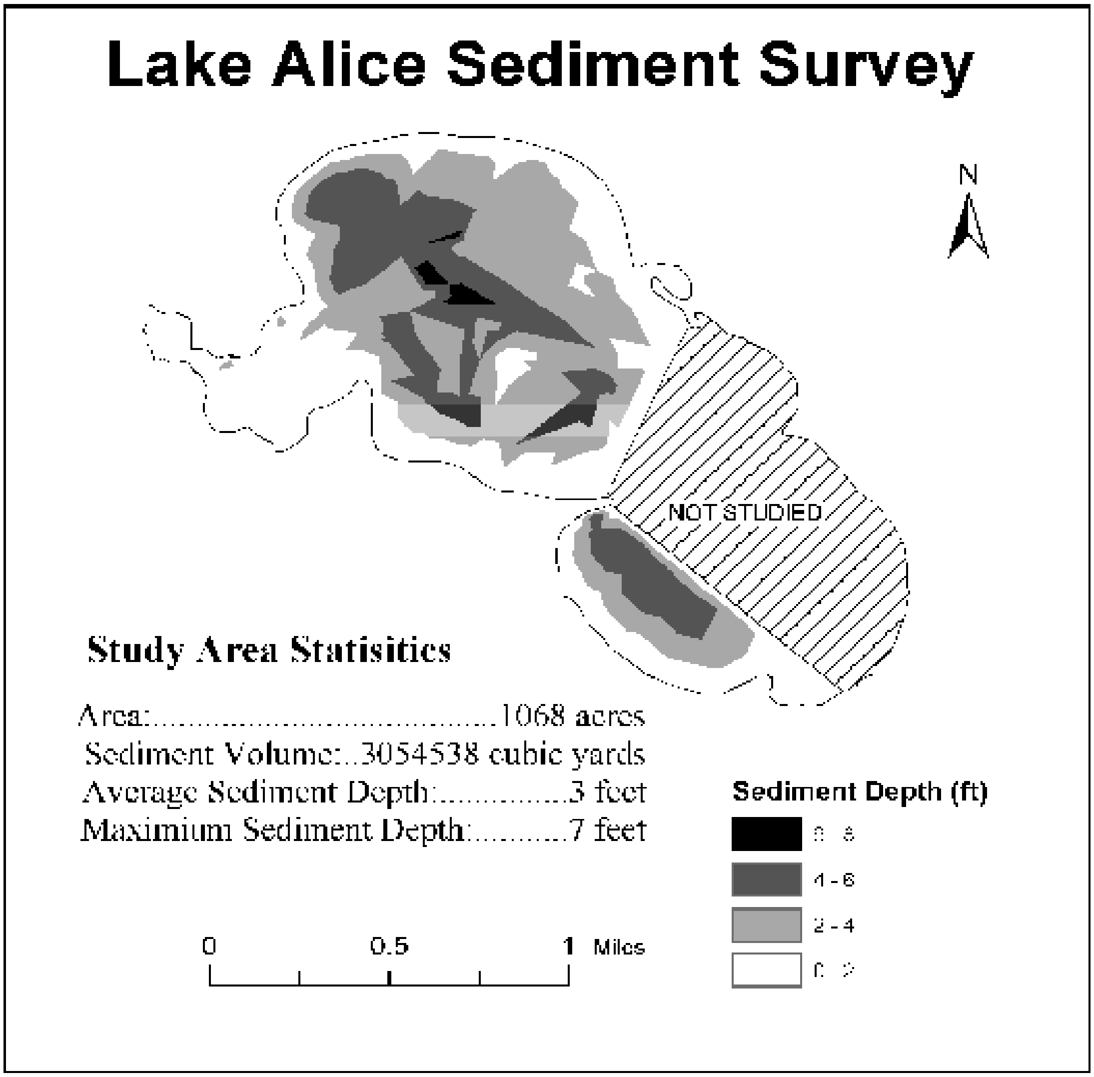
Table 10. Lake Alice Watershed Land Uses

Land Use	Acres
Alfalfa and Grass Hay	475
Cropland (Winter Wheat, Beans, and Corn)	138
Conservation Reserve Program Land	2516
Forested (Usually Building sites and tree strips)	98
Other (including Roads and wetlands)	79
Pasture Land	4969
Water	1195

Sediment Survey

A sediment survey of Lake Alice was completed during the winter of 2001 and 2002. Unseasonably warm temperatures did not provide sufficient ice cover to complete an assessment of the entire lake. The portions completed may be considered representative of the entire basin. Average sediment depths were calculated to be approximately 3 feet and totaling over 3.0 million cubic yards of sediment in the portion of the lake assessed. Extending this average depth to the entire lake would yield a sediment volume of 5.1 million cubic yards or 3,204 acre feet.

Figure 12. Lake Alice Sediment Survey Map



Quality Assurance Reporting (QA/QC)

Only two duplicate samples were collected on Lake Alice and its tributary (results are located in Table 11). Both samples were very close to the duplicate with the greatest difference being recorded for the dissolved phosphorus at 14%. This is still minimal and should not be considered great enough to skew the data.

Field Blanks were not conducted on Lake Alice but were performed on the Fish Lake portion of the project, which was conducted during the same time frame. The blank had some traces of total solids detected at 15 mg/L. This could be due to inadequate rinsing of bottles or low quality distilled water. Regardless of the cause, this concentration is low enough to not significantly affect the results.

Table 11. Quality Assurance Sampling Results

Sampler	Site	Date	Alka-M	Tsol	Tssol	VTSS	ammonia	nitrat	TKN	TP	TDP	Fecal	E.Coli
Kniss	LA-2	7/10/2001	216	1008	13	4.00	0.03	0.050	1.550	0.046	0.022		
Kniss	LA-2d	7/10/2001	214	1005	8	4.00	0.01	0.050	1.510	0.043	0.006		
Industrial Differnce			0%	0%	6%	0%	13%	0%	0%	1%	14%		
Kniss	LAT-2	6/18/2002	246	615	0.50	0.50	0.010	0.050	1.12	0.113	0.11	100.00	146.00
Kniss	LAT-2d	6/18/2002	243	611	1.00	0.50	0.010	0.050	1.05	0.114	0.11	60.00	145.00
Industrial Differnce			0%	0%	8%	0%	0%	0%	1%	0%	0%	6%	0%

Public Involvement and Coordination

State Agencies

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

The South Dakota Department of Game, Fish and Parks also aided in the completion of the assessment by providing historical information.

Federal Agencies

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

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

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

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

The Deuel County Lakes and Streams Association provided sponsorship and was also a major contributor to public involvement in the project. They provided local matching funds and public input to the care, concerns and local history of the lake that helped complete the assessment.

The Deuel County Conservation District provided work space, equipment storage and financial assistance for the project.

The East Dakota Water Development District also provided financial assistance for the project.

Public involvement consisted of individual meetings with landowners that provided a great deal of historic perspective on the watershed and the lake itself. Public involvement was also developed with the Deuel County Conservation District Board meetings, Deuel County Lakes and Streams Association meetings and East Dakota Water Development District Meetings.

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 8). The number of tributary samples collected was less than purposed due to the fact that the watershed of Lake Alice is relatively small in comparison to other watersheds in the area, and the 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.

An outlet was discovered across the county road to the north of the lake in a wetland area that Lake Alice drains into. A sampling unit might have been beneficial to collect data on the water leaving Lake Alice, however very little discharge occurred out of the lake.

Future Activities Recommendations

The watershed to Lake Alice has undergone changes as a result of the farm program that would resemble the end result of a successful implementation project. Most of the cropland has been converted to CRP and is managed for hunting. The remaining cropland is maintained with conservation tillage. Improvements to the buffalo feeding area may also result in further improvements and additional protection of this waterbody. Many of these changes have not had a chance to take their full affect on the lake and continued improvement in the water quality should be expected.

Future activities in the watershed should be directed towards the maintenance of the current conservation practices. The impacts of bank erosion may also become an issue in the future. As the lake continues to experience higher than average water levels, it may continue to plug its outlet with sand. To prevent bank erosion from rising water levels and provide limited flushing of phosphorus from the lake, construction and maintenance of a spillway at the official high water mark might be beneficial. The cost of an outlet is unknown at this time.

Other activities may include rip rapping shoreline to prevent erosion. The cost of this practice would likely exceed $7,000,000 and provide limited loading reductions and do nothing for the nutrients which have already accumulated in the lake.

Treatment of the lake with alum would likely have long term effects as a result of the minimal loadings, however costs for this could exceed $700,000.

Total dredging of a like this size is beyond the financial means of the region. Sediment volumes exceed 3.0 million cubic yards and costs would likely exceed $9.0 million dollars.

Literature Cited

Bowler, P., 1998. Ecology Resources, Bio 179L – Water Chemistry Notes. http://www.wmrs.edu/supercourse/1998yearbook/glossary.htmL

Carlson, R. E., 1977. A Trophic State Index for Lakes. Limnology and Oceanography. 22:361-369

Claffy, 1955. Oklahoma Ponds and Reservoirs

Fenneman, N. M., 1931, Physiography of Western United States: New York, McGraw Hill Book Co., 534 p.

Heidepriem, S., 1978, Bring on the Pioneers! History of Hand County: The State Publishing Company, Pierre SD.

Larson, G., Aquatic and Wetlands Plants of South Dakota

Minnesota, University of Web Site, 2001, Wackett, Dr. L., Atrazine Pathway Map. http://umbbd.ahc.umn.edu/index.html

Missouri, State of Web Site, 2001. www.conservation.state.mo.us/nathis/endangered/endanger/orchid/index.htm

Novotny and Olem, V. and H., 1994. Water Quality, Prevention, Identification, and Management of Diffuse Pollution, Van Nostrand Reinhold, New York

Prescott, G.W. 1962. Algae of the Western Great Lakes Area. Wm. C. Brown Publ., Dubuque, Iowa. 977 pp.

Round, F.E., 1965. The biology of the algae. Edward Arnold, Ltd. London. 269 pp.

Reid, G.K., 1961. Ecology of inland waters and estuaries. Van Nostrand Reinhold Co.New York. 375 pp.

Shapiro J., 1973. Blue-green algae : why they become dominant. Science. Vol. 179. pp. 382-384.

Stewart, W.C., Stueven, E. H., Smith, R. L., Repsys, A. J., 2000., Ecoregion Targeting For Impaired Lakes in South Dakota. South Dakota Department of Enviornment and Natural Resources, Division of Financial and Technical Assistance, Pierre, South Dakota.

Stewart, W.C., Stueven, E. H., 1995., 1995 South Dakota Lakes Assessment Final Report. South Dakota Department of Enviornment and Natural Resources, Division of Financial and Technical Assistance, Pierre, South Dakota

U.S Department of Interior, Fish, and Wildlife Service and U.S. Department of Commerce, Bureau of Census 1997.

U.S. Environmental Protection Agency, 1990. Clean Lakes Program Guidance Manual. EPA-44/4-90-0006. Washington D.C.

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

Wetzel, R.G. 1983. Limnology 2rd Edition. Saunders Publishing Company, Philadelphia, Pennsylvania.

Wetzel, R.G. 2000. Limnological Analyses 3rd Edition. Springer-Verlag New York Inc., New York.

Wetzel, R.G. 2001. Limnology 3rd Edition. Saunders Publishing Company, Philadelphia, Pennsylvania.

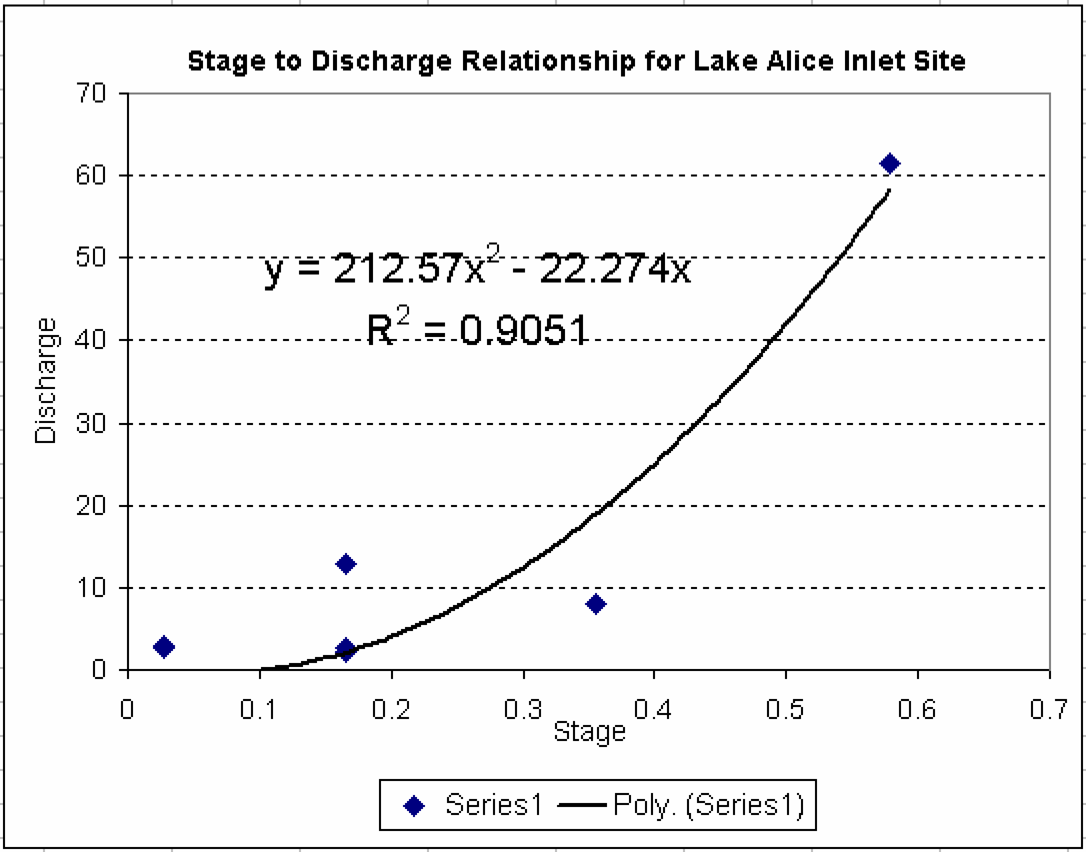
List of Tables

List of Figures

List of Appendices

Appendix A. Stage to Discharge Tables

	Stage	Discharge
0.627	0.027	2.688
0.627	0.027	2.97
0.766	0.166	2.688
0.766	0.166	2.169
0.765	0.165	12.854
1.179	0.579	61.57
0.956	0.356	8.075



Appendix B. Tributary Sample Data

E number	Sampler	Site	Date	Time	DO	DO%	Doc	pH	Cond	Temp	Alka-M	Tsol	Tssol	Tdsol	VTSS	ammonia	nitrat	TKN	TP	TDP	Fecal	E.Coli
E01EC004294	Kniss	LAT-2	06/10/01	13:26							216	746	10	736	0.5	0.01						
E01EC004295	Kniss	LAT-2	6/11/2001	10:30							279	858	0.50	857.5	0.50	0.040	0.050	1.12	0.083	0.06	200.00	88.60
E01EC004429	Kniss	LAT-2	6/12/2001	10:30							280	648	2.00	646	1.00	0.010	0.050	1.19	0.096	0.07		
E01EC004512	Kniss	LAT-2	6/13/2002	16:33							217	582	10.00	572	3.00	0.010	0.050	1.44	0.094	0.06	770.00	470.00
E01EC004575	Kniss	LAT-2	6/18/2002	9:00							246	615	0.50	614.5	0.50	0.010	0.050	1.12	0.113	0.11	100.00	146.00
E01EC004574	Kniss	LAT-2d	6/18/2002	9:00							243	611	1.00	610	0.50	0.010	0.050	1.05	0.114	0.11	60.00	145.00
E02EC001593	Kniss	LAT-2	4/4/2002	16:00	14.26	100.5	53.3	8.03		0.59	95	255	1.00	254	1.00	0.010	0.400	0.81	0.125	0.10	5.00	2.00

Appendix C. Historic Water Levels

OHWM	1691.8	Mean Sea Level for project dates were backcalculated from the measurement recorded on 9/11/01 of 1692.6 feet MSL							
Date	MSL	Date	MSL	Date	MSL	Date	MSL	Date	MSL
09/27/84	1686.3	05/29/01	1692.5	07/18/01	1692.5	09/06/01	1692.5	10/26/01	1692.5
05/08/85	1688.4	05/30/01	1692.5	07/19/01	1692.5	09/07/01	1692.5	10/27/01	1692.5
10/10/85	1688.3	05/31/01	1692.5	07/20/01	1692.5	09/08/01	1692.5	10/28/01	1692.5
05/08/86	1691.4	06/01/01	1692.5	07/21/01	1692.5	09/09/01	1692.5	10/29/01	1692.5
10/08/86	1692.0	06/02/01	1692.5	07/22/01	1692.5	09/10/01	1692.5	10/30/01	1692.5
04/28/87	1691.9	06/03/01	1692.5	07/23/01	1692.5	09/11/01	1692.5	10/31/01	1692.5
10/08/87	1690.3	06/04/01	1692.5	07/24/01	1692.5	09/12/01	1692.5	11/01/01	1692.5
04/20/88	1690.2	06/05/01	1692.5	07/25/01	1692.5	09/13/01	1692.5	11/02/01	1692.5
09/22/88	1688.1	06/06/01	1692.5	07/26/01	1692.5	09/14/01	1692.5	11/03/01	1692.5
04/26/89	1688.2	06/07/01	1692.5	07/27/01	1692.5	09/15/01	1692.5	11/04/01	1692.5
10/18/89	1687.2	06/08/01	1692.5	07/28/01	1692.5	09/16/01	1692.5	11/05/01	1692.5
05/02/90	1686.9	06/09/01	1692.5	07/29/01	1692.5	09/17/01	1692.5	11/06/01	1692.5
09/19/90	1686.6	06/10/01	1692.5	07/30/01	1692.5	09/18/01	1692.5	11/07/01	1692.5
05/01/91	1686.7	06/11/01	1692.5	07/31/01	1692.5	09/19/01	1692.5	11/08/01	1692.5
10/02/91	1686.7	06/12/01	1692.5	08/01/01	1692.5	09/20/01	1692.5	11/09/01	1692.5
04/29/92	1687.2	06/13/01	1692.5	08/02/01	1692.5	09/21/01	1692.5	11/10/01	1692.5
09/16/92	1690.0	06/14/01	1692.5	08/03/01	1692.5	09/22/01	1692.5	11/11/01	1692.5
05/12/93	1692.2	06/15/01	1692.5	08/04/01	1692.5	09/23/01	1692.5	11/12/01	1692.5
09/22/93	1693.0	06/16/01	1692.5	08/05/01	1692.5	09/24/01	1692.5	11/13/01	1692.5
05/04/94	1693.3	06/17/01	1692.5	08/06/01	1692.5	09/25/01	1692.5	11/14/01	1692.5
09/14/94	1693.0	06/18/01	1692.5	08/07/01	1692.5	09/26/01	1692.5	11/15/01	1692.5
05/10/95	1693.7	06/19/01	1692.5	08/08/01	1692.5	09/27/01	1692.5	11/16/01	1692.5
10/11/95	1693.5	06/20/01	1692.5	08/09/01	1692.5	09/28/01	1692.5	11/17/01	1692.5
05/01/96	1693.1	06/21/01	1692.5	08/10/01	1692.5	09/29/01	1692.5	11/18/01	1692.5
10/02/96	1692.2	06/22/01	1692.5	08/11/01	1692.5	09/30/01	1692.5	11/19/01	1692.5
05/13/97	1693.2	06/23/01	1692.5	08/12/01	1692.5	10/01/01	1692.5	11/20/01	1692.5
10/08/97	1692.4	06/24/01	1692.5	08/13/01	1692.5	10/02/01	1692.5	11/21/01	1692.5
04/29/98	1693.5	06/25/01	1692.5	08/14/01	1692.5	10/03/01	1692.5	11/22/01	1692.5
09/29/98	1692.2	06/26/01	1692.5	08/15/01	1692.5	10/04/01	1692.5	11/23/01	1692.5
05/04/99	1692.9	06/27/01	1692.5	08/16/01	1692.5	10/05/01	1692.5	11/24/01	1692.5
09/29/99	1692.8	06/28/01	1692.5	08/17/01	1692.5	10/06/01	1692.5		
04/25/00	1692.2	06/29/01	1692.5	08/18/01	1692.5	10/07/01	1692.5		
09/26/00	1691.1	06/30/01	1692.5	08/19/01	1692.5	10/08/01	1692.5		
05/02/01	1693.5	07/01/01	1692.5	08/20/01	1692.5	10/09/01	1692.5		
09/11/01	1692.6	07/02/01	1692.5	08/21/01	1692.5	10/10/01	1692.5		
04/24/02	1692.8	07/03/01	1692.5	08/22/01	1692.5	10/11/01	1692.5		
		07/04/01	1692.5	08/23/01	1692.5	10/12/01	1692.5		
		07/05/01	1692.5	08/24/01	1692.5	10/13/01	1692.5		
		07/06/01	1692.5	08/25/01	1692.5	10/14/01	1692.5		
		07/07/01	1692.5	08/26/01	1692.5	10/15/01	1692.5		
		07/08/01	1692.5	08/27/01	1692.5	10/16/01	1692.5		
		07/09/01	1692.5	08/28/01	1692.5	10/17/01	1692.5		
		07/10/01	1692.5	08/29/01	1692.5	10/18/01	1692.5		
		07/11/01	1692.5	08/30/01	1692.5	10/19/01	1692.5		
		07/12/01	1692.5	08/31/01	1692.5	10/20/01	1692.5		
		07/13/01	1692.5	09/01/01	1692.5	10/21/01	1692.5		
		07/14/01	1692.5	09/02/01	1692.5	10/22/01	1692.5		
		07/15/01	1692.5	09/03/01	1692.5	10/23/01	1692.5		
		07/16/01	1692.5	09/04/01	1692.5	10/24/01	1692.5		
		07/17/01	1692.5	09/05/01	1692.5	10/25/01	1692.5		

Appendix D. Lake Sample Data

E number	Site	Date	Secchi	DO	DO%	Doc	pH	Cond	Temp	Alka-M	Tsol	Tssol	VTSS	ammonia	nitrat	TKN	TP	TDP	Fecal	E.Coli
E01EC004207	LA-1	06/05/01	1.35							200	971	6	1	0.01	0.05	1.01	0.050	0.013	5	0.5
E01EC005303	LA-1	7/10/2001		9.89		56.3	8.5		24.8	159	1010	10	3.00	0.01	0.050	1.240	0.04	0.007		
E01EC006474	LA-1	8/15/2001	0.8	9.08		44.1	8.7		22.7	225	1051	15	12.00	0.01	0.050	1.420	0.12	0.026	5.00	1.00
E01EC007221	LA-1	9/17/2001	0.55	11.61		42	9.1		15.6	214	1072	19	12.00	0.01	0.050	1.530	0.11	.029	5.00	5.20
E02EC000424	LA-1	1/30/2002		15.9	114	55.3	8		1.33	265	1215	4	1.00	0.01	0.100	1.230	0.04	0.018	5.00	0.50
E02EC002199	LA-1	4/30/2002	1	11.9	101	54.3	8.3	832	8.24	221	1019	9	8.00	0.01	0.005	1.330	0.07	0.014	5.00	0.50
E01EC004206	LA-2	6/5/2001	1.5							200	963	2	0.50	0.01	0.005	0.041	0.04	0.012	5.00	0.50
E01EC005304	LA-2	7/10/2001		12.43		89.4	8.7		25.9	216	1008	13	4.00	0.03	0.050	1.550	0.05	0.022		
E01EC005305	LA-2d	7/10/2001		12.43		89.4	8.5		24.8	214	1005	8	4.00	0.01	0.050	1.510	0.04	0.006		
E01EC006473	LA-2	8/15/2001	0.85	10.25		45.1	8.7		22.1	227	1037	13	12.00	0.01	0.050	1.320	0.11	0.027	5.00	1.00
E01EC007222	LA-2	9/17/2002	0.52	12.06		42	9.1		15.8	215	1071	16	10.00	0.01	0.050	1.870	0.11	0.028	5.00	5.20
E02EC000425	LA-2	1/30/2002		15.8	113	55.3	8.2		1.2	260	1197	7	3.00	0.01	0.100	1.310	0.04	0.023	5.00	0.50
E02EC002200	LA-2	4/30/2002	0.9	12.3	104	55.3	8.5	8.37	8.52	223	1017	11	7.00	0.01	0.050	1.340	0.07	0.013	5.00	0.05

Appendix E. Total Maximum Daily Load Summary (TMDL)

TOTAL MAXIMUM DAILY LOAD EVALUATION

For

LAKE ALICE

(HUC 10160009)

DEUEL COUNTY, SOUTH DAKOTA

SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

JULY, 2002

Lake Alice Total Maximum Daily Load

Waterbody Type:	**Lake (Natural)**
303(d) Listing Parameter:	**TSI**
Designated Uses:	**Recreation, Warmwater Semi permanent aquatic life**
Size of Waterbody:	**1,200 acres**
Size of Watershed :	**8,275 acres**
Water Quality Standards:	**Narrative and Numeric**
Indicators:	**Average TSI,**
Analytical Approach:	**AGNPS, BATHTUB, FLUX**
Location:	**HUC Code: 07020001**
Goal:	**Maintain TSI of less than 65**
Target:	**Reduce bank Erosion on Lake**

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.

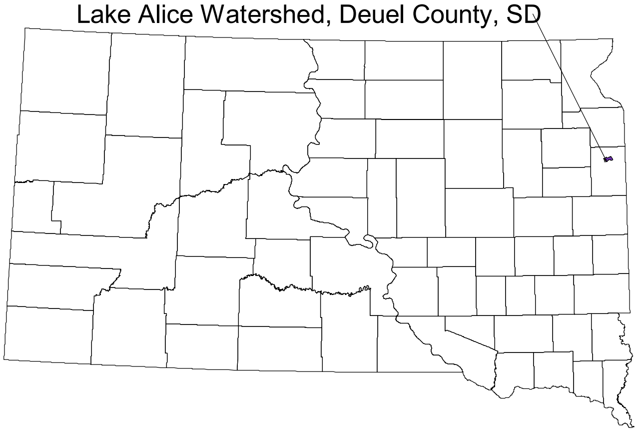


Figure 13. Watershed Location in South Dakota

Introduction

Lake Alice is a 974 acre (394 ha) natural impoundment located in north central Deuel County, South Dakota. The lake has a maximum depth of 16 feet (4.9 m) and a pool elevation capacity of 752 acre-feet of water. Lake Alice does not appear to stratify during the growing season. The outlet for the lake empties into an unnamed Tributary, which eventually reaches the Minnesota River. The Lake Alice watershed comprises a small portion of Upper Minnesota hydrologic unit, which has a priority rank of 24 in the South Dakota Unified Watershed Assessment.

Problem Identification

The unnamed tributary is the primary tributary to Lake Alice and drains a mixture of primarily grazing lands and conservation reserve program acres with only a few acres of cropland. The only feeding area in the watershed is a small lot used periodically for

buffalo. The stream carries small nutrient loads, which minimally impact the water quality in the lake but do cause some increase in the trophic state. Higher than normal water levels in the lake (maintaining a level at or above the official high water mark) may be contributing to the eutrophication of the lake through bank erosion.

Description of Applicable Water Quality Standards & Numeric Water Quality Targets

Lake Alice 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 semipermanent fish life propagation; Immersion recreation; Limited contact recreation; and Fish and wildlife propagation, recreation and stock watering.
Other indicators, 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. Lake Alice is identified in both the 1998 South Dakota Waterbody List and "Ecoregion Targeting for Impaired Lakes in South Dakota" as partially supporting its aquatic life beneficial use.

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 status 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 Lake Alice.

Lake Alice currently has a mean TSI of 61.5, which places it in the eutrophic lakes category and is indicative of high levels of primary productivity. Assessment monitoring indicates that the primary cause of the high productivity is phosphorus loads from a combination of atmospheric loading bank erosion and the watershed. There does not appear to be a significant impact on nutrient concentrations as a result of sediment released phosphorus.

The numeric target, established for Lake Alice in "Ecoregion Targeting for Impaired Lakes in South Dakota" is a TSI of less than 65. This TSI has already been reached, likely due to the large participation in the CRP program and the use of best management practices in the watershed.

Pollutant Assessment

Point Sources

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

Nonpoint Sources/ Background Sources

Of the 180 to 300 kg of phosphorus (variance due to atmospheric loading) that enter the lake on an average annual basis, approximately 108 kg or 35% to 60% may be attributed to the watershed. The remaining 40% to 65% is attributed to atmospheric deposition. To simplify the loadings, it may be assumed that approximately 50% of the load to Lake Alice may be attributed to the atmosphere as well as the tributary.

Linkage Analysis

Water quality data was collected from the primary tributary to Lake Alice near its inlet to the lake as well as within the lake itself. 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 collected on 10% of the samples according to South Dakota's EPA approved Nonpoint Source Quality Assurance/Quality Control Plan. Details concerning water sampling techniques, analysis, and quality control are addressed on pages 9-29 and 35 of the assessment final report.

In addition to water quality monitoring, land use data was collected in anticipation of using a watershed landuse model. The Agriculture Nonpoint Pollution Source (AGNPS) model was not completed due to the current landuse in the watershed and the fully supporting TSI measured during the study.

The impacts of phosphorus reductions on the condition of Lake Alice were calculated using BATHTUB, an Army Corps of Engineers model. The model predicted that by reducing phosphorus from the watershed, very little impact would result in the lake. Modeling unrealistic 95% reductions in the phosphorus load resulted in TSI values of 55 to 58 (3 to 6 TSI points lower than current conditions)

Maintaining current landuse practices may result in continued improvement in the water quality at Lake Alice. Further protection to the lake may be achieved through the stabilization of failing banks along the lake either through lower water levels (at or below the official high water mark) or through mechanical stabilization of the banks.

TMDL and Allocations

TMDL

	0 kg/yr	(WLA)
+	108 kg/yr	(LA)
+	240 kg/yr	(Atmospheric)
	Implicit	(MOS)
	348 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)

Maintenance of current BMPs in addition to bank stabilization will insure that the lake continues to fully support its beneficial uses and may result in additional improvements in water quality.

Seasonal Variation

Different seasons of the year can yield differences in water quality due to changes in precipitation and agricultural practices. To determine seasonal differences, Lake Alice samples were separated into spring (March-May), summer (June-August), fall (September-November), and winter (December-February) collection periods. Seasonalized data may be found on page 12-13.

Margin of Safety

Conservative estimates were used throughout the modeling process. These estimates produced an implicit margin of safety. In addition to the implicit margin of safety, stabilization of the shoreline will increase the margin of safety that the lake will maintain its current state of full support of its beneficial uses.

Critical Conditions

The impairments to Lake Alice are most severe during the late summer. This is the result of warm water temperatures and peak algal growth impacting periods of peak recreational use of the lake.

Follow-Up Monitoring

Continued monitoring of Lake Alice will be completed by the South Dakota Department of Environment and Natural Resources State Wide Lakes Assessment program.

Public Participation

Efforts taken to gain public education, review, and comment during development of the TMDL involved (numbers reflect contacts concerning both the Fish Lake and the Lake Alice Assessments):

Meetings attended by the project coordinator include:

Lakes and Streams Association	3
East Dakota Water Development	1
Fish Lake Association	2
Deuel Conservation District	5

And Over 70 contacts with individual land owners

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

Implementation Plan

The recommendation for implementation of work activities in the Lake Alice watershed are to complete best management practices which will reduce phosphorus concentrations and stabilize eroding shorelines providing further protection to the lake insuring it maintains full support of its beneficial uses.

Appendix F. Public Comments, Correspondence, and Response to Comments

August 27, 2003

Vern Berry, 8 EPR-EP
US Environmental Protection Agency Region VIII
999 18th Street Suite 300
Denver CO 80202-2466

Dear Vern:

The South Dakota Department of Environment and Natural Resources (DENR) submits the attached Lake Alice Assessment and Total Maximum Daily Load (TMDL) for US EPA final approval. This TMDL was developed by the department with public input in accordance with section 303(d) of the federal Clean Water Act. The TMDL has been established at levels necessary to meet applicable water quality standards with consideration of seasonal variation, margin of safety, and all sources of pollution. The waters addressed by these TMDLs are listed within the 2002 South Dakota 303(d) Waterbody List.

Based on comments received, it was not revised. The comments and the DENR response to comments are included with the report as an appendix.

We look forward to receiving your final approval of this TMDL. If you have questions or require additional information, please let me know.

Sincerely,

Leland Baron
Watershed Protection Program
(605) 773-4254
Leland.Baron@state.sd.us

Attachments:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 300
DENVER, CO 80202-2466
http://www.epa.gov/region08

June 3, 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
Lake Alice
Byre Lake
Lake Hanson

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

Enclosure

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)
Lake Alice*	phosphorus	TSI mean < 65	216 kg/yr total phosphorous load to the lake	Section 303(d)(1)	■ Phase I Watershed Assessment and TMDL Final Report, Lake Alice, Deuel County, South Dakota (SD DENR, July 2002)
Byre Lake	phosphorus	TSI mean ≤ 65	7,550 kg/yr total phosphorous load to the lake (19.6% reduction in average annual total phosphorus load)	Section 303(d)(1)	■ Phase I Watershed Assessment Final Report and TMDL, Byre Lake / Grouse Creek, Lyman County, South Dakota (SD DENR, April 2003)
Lake Hanson*	phosphorus	TSI mean < 65 Increase boatable acres in the lake (add 8 acres)	2,612 kg/yr total phosphorous load to the lake (5% reduction of in average annual total phosphorus load)	Section 303(d)(1)	■ Phase I Watershed Assessment and TMDL Final Report, Lake Hanson / Pierre Creek, Hanson County, South Dakota (SD DENR, December 2002)

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

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Alice, Deuel County
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: May 17, 2004 Date Review completed: May 25, 2004 VEB

Review Criteria (All criteria must be met for approval)	**Approved** (check if yes)	**Comments**
■ **TMDLs result in maintaining and attaining water quality standards**	X	The waterbody classification uses which are addressed by this TMDL are warmwater semipermanent fish life propagation, immersion recreation, limited contact recreation, and criteria for fish and wildlife propagation, recreation and stock watering.
■ **Water Quality Standards Target**	X	Water quality target was established based on the targets in the document "Ecoregion Targeting for Impaired Lakes in South Dakota." These targets meet the fully support beneficial uses of identified lakes. This is a reasonable approach because the trophic status of the waterbody relates to the uses of concern.
■ **TMDL**	X	The TMDL is expressed in terms of annual phosphorus load to the lake. This is a reasonable way to express the TMDL for this lake because it provides an effective surrogate that reflects both aquatic life and recreational needs, and reflects the long response time of lakes of this type to pollutant controls within the watershed.
■ **Significant Sources Identified**	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified.
■ **Technical Analysis**	X	Monitoring, empirical relationships, BATHTUB and FLUX modeling, and best professional judgement were used in identifying pollutant sources, and in identifying acceptable levels of pollutant control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and the waterbody type.
■ **Margin of Safety and Seasonality**	X	An appropriate margin of safety is included through conservative assumptions in the derivation of the target and in the modeling. Additionally, ongoing monitoring has been proposed to assure water quality goals are achieved. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by proposing BMPs that can be tailored to seasonal needs.
■ **Allocation**	X	The allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to range and cropland management practices, and internal loading.
■ **Public Review**	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.
■ **EPA approved Water Quality Standards**	X	Standards upon which this TMDL was based have been formally approved by the EPA. No tribal waters were involved in this TMDL.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Byre Lake, Lyman County
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: May 17, 2004 Date Review completed: May 25, 2004 VEB

A. Water Quality Standards - **Approved**	The State's submittal provides a good description of the geographic scope of the TMDL as well as information on the watershed and land use characteristics of Byre Lake. The South Dakota Department of Environment and Natural Resources (SD DENR) has identified Byre Lake as a water that is intended to support a range of designated uses including: domestic water supply, warmwater permanent fish life propagation, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation, stock watering, and irrigation. The narrative standards being implemented in this TMDL are: "*Materials which produce nuisance aquatic life may not be discharged or caused to be discharged into surface waters of the state in concentrations that impair a beneficial use or create a human health problem.*" (See ARSD §74:51:01:09) "*All waters of the state must be free from substances, whether attributable to human-induced point source discharges or nonpoint source activities, in concentration or combinations which will adversely impact the structure and function of indigenous or intentionally introduced aquatic communities.*" (See ARSD §74:51:01:12)
B. Water Quality Standards Targets - **Approved**	Water quality targets for this TMDL are based on interpretation of narrative provisions found in State water quality standards. In May 2000, SD DENR published *Ecoregion Targeting for Impaired Lakes in South Dakota*. This document proposed ecoregion-specific targeted Trophic State Index (TSI) values based on beneficial uses. EPA approved the use of these ecoregion-specific targets to evaluate lakes using beneficial use categories. In South Dakota algal blooms can limit contact and immersion recreation beneficial uses. Also algal blooms can deplete oxygen levels which can affect aquatic life uses. SD DENR considers several algal species to be nuisance aquatic species. TSI measurements can be used to estimate how much algal production may occur in lakes. Therefore, TSI is used as a measure of the narrative standard in order to determine whether beneficial uses are being met. The overall mean TSI for Byre Lake during the period of the assessment (April 2000 through May 2001) was 66.2. Nutrient reduction response modeling was conducted with BATHTUB, an Army Corps of Engineers eutrophication response model. The results of the modeling show that 80% or more reduction in the total phosphorous loading from the watershed would be necessary to meet the ecoregion-based beneficial use TSI target of 55 or less. However, Byre Lake does not appear to fit the ecoregion-based beneficial use criteria due to legacy phosphorous loading to the lake and the technical and financial inability to fully treat new loading to the lake. Therefore, an alternative watershed specific TSI target has been established, which will fully support the beneficial uses for Byre Lake. The target used in this TMDL is: ■ TSI mean $\leq$ 65 (growing season average)

C. Significant Sources - **Approved**	The TMDL identifies the major sources of phosphorous as coming from nonpoint source agricultural landuses within the watershed and internal loading from bottom sediments within the lake. In particular, a loading analysis was done for nutrients and sediment considering various agricultural land use and land management factors.
D. Technical Analysis - **Approved**	The technical analysis addresses the needed phosphorous reduction to achieve the desired water quality. The TMDL recommends a 19.6% reduction in average annual total phosphorous loads to Byre Lake. Based on the loads measured during the period of the assessment the total phosphorous load should be 7,550 kg/yr to achieve the desired TSI target. This reduction is based in large part on the BATHTUB mathematical modeling of the Lake and its predicted response to nutrient load reductions. The Annualized Agricultural Non-Point Source Model (AnnAGNPS) model was used to simulate alterations in land use practices and the resulting nutrient reduction response. The nutrient loading source analysis, that was used to identify necessary controls in the watershed, was based on the identification of targeted or "critical" cells. Cell priority was assigned based on average nutrient and sediment loads produced that ultimately reach the outlet of the watershed. Cells that produce nitrogen, sediment *and* phosphorous loads greater than one standard deviation over the mean for the watershed were given a priority ranking of 1. Cells that produce loads for 2 out of the 3 pollutants greater than one standard deviation over the mean were given a priority ranking of 2. Cells that produce loads for 1 out of the 3 pollutants greater than one standard deviation over the mean were given a priority ranking of 3. The initial load reductions under this TMDL will be achieved through controls on the priority 1 and 2 cells within the watershed combined with modification of grazing practices.
E. Margin of Safety & Seasonality - **Approved**	An appropriate margin of safety is included through conservative assumptions in the derivation of the target and in the modeling. Additionally, BMPs were specified that go beyond what is necessary to achieve the target, and ongoing monitoring has been proposed to assure water quality goals are achieved. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by proposing BMPs that can be tailored to seasonal needs.
F. TMDL - **Approved**	The TMDL established for Byre Lake is a 7,550 kg/yr total phosphorus load to the lake (19.6% reduction in annual total phosphorus load). Since the annual loading varies from year-to-year, this TMDL is considered a long term average percent reduction in phosphorous loading.
G. Allocation - **Approved**	This TMDL addresses the need to achieve further reductions in nutrients to attain water quality goals in Byre Lake. The allocation for the TMDL was a "load allocation" attributed to nonpoint sources. The allocation for phosphorous was attributed to such sources as runoff from cropland, rangeland and pastureland. There is a desire to move forward with controls in the areas of the basin where there is confidence that phosphorous reductions can be achieved through modifications to priority cells within the watershed combined with modification of grazing practices. Additional phosphorous load reductions are possible from streambank stabilization, conversion highly erodible cropland to rangeland, riparian management, and shoreline stabilization. Reduction percentages were not calculated for these additional BMPs.

State/Tribe: South Dakota
Waterbody Name: Byre Lake, Lyman County
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: May 17, 2004 Date Review completed: May 25, 2004 VEB

H. Public Participation - **Approved**	The State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process. In particular, the State has encouraged participation through public meetings in the watershed, articles in local newspapers, individual contact with the residents in the watershed, and widespread solicitation of comments on the draft TMDL. The State also employed the Internet to post the draft TMDL and to solicit comments. The level of public participation is found to be adequate.

■ TMDL Checklist ■

EPA Region VIII

State/Tribe: South Dakota
Waterbody Name: Lake Hanson, Hanson County
Point Source-control TMDL: Nonpoint Source-control TMDL: X (check one or both)
Date Received: May 17, 2004 Date Review completed: May 25, 2004 VEB

Review Criteria (All criteria must be met for approval)	**Approved** (check if yes)	**Comments**
■ **TMDLs result in maintaining and attaining water quality standards**	X	The waterbody classification uses which are addressed by this TMDL are warmwater semipermanent fish life propagation, immersion recreation, limited contact recreation and fish and wildlife propagation, recreation and stock watering.
■ **Water Quality Standards Target**	X	Water quality target was established based on the targets in the document "Ecoregion Targeting for Impaired Lakes in South Dakota." These targets meet the fully support beneficial uses of identified lakes. This is a reasonable approach because the trophic status of the waterbody relates to the uses of concern.
■ **TMDL**	X	The TMDL is expressed in terms of total phosphorus load to the lake, and the corresponding average annual percent reduction in phosphorous load. This is a reasonable way to express the TMDL for this lake because it provides an effective surrogate that reflects both aquatic life and recreational needs.
■ **Significant Sources Identified**	X	Significant sources were adequately identified in a categorical and/or individual source-by-source basis. All sources that need to be addressed through controls were identified as grazing lands, animal feeding operations and septic systems near the lake.
■ **Technical Analysis**	X	Monitoring, empirical relationships, AnnAGNPS, FLUX and BATHTUB modeling , and best professional judgement were used in identifying pollutant sources, and in identifying acceptable levels of pollutant control. This level of technical analysis is reasonable and appropriate because of the character of the pollutants, the type of land use practices, and the waterbody type.
■ **Margin of Safety and Seasonality**	X	An appropriate margin of safety is included through conservative assumptions in the derivation of the target and in the modeling. Additionally, BMPs were specified that go beyond what is necessary to achieve the target, and ongoing monitoring has been proposed to assure water quality goals are achieved. Seasonality was adequately considered by evaluating the cumulative impacts of the various seasons on water quality and by proposing BMPs that can be tailored to seasonal needs.
■ **Allocation**	X	The allocation for the TMDL was a "load allocation" attributed to nonpoint sources. Allocation was attributed to range and cropland management practices, and internal loading.
■ **Public Review**	X	Public review and participation was conducted through meetings, electronic media, and mailings. The extent of public review is acceptable. Further, the review process sponsored by the State was adequate for purposes of developing a TMDL that will be implemented because of public acceptance.
■ **EPA approved Water Quality Standards**	X	Standards upon which this TMDL was based have been formally approved by the EPA. No tribal waters were involved in this TMDL.

Public Comment and DENR Response to Comments

Lake Alice Public Comment

From: Berry.Vern@epamail.epa.gov [mailto:Berry.Vern@epamail.epa.gov]
Sent: Monday, March 03, 2003 6:31 PM
To: Leland.Baron@state.sd.us
Cc: Lofstedt.Doug@epamail.epa.gov
Subject: EPA Comments on TMDLs for Lake Alice and Cresbard Lake

Leland,

Thanks for the opportunity to comment on these TMDLs. We have the following comments on the TMDLs for Lake Alice and Cresbard Lake.

Lake Alice - no comments. Based on the current data, and as indicated in the draft TMDL, this waterbody seems to be meeting the TSI goals established by SD DENR, and is eligible for de-listing.

Cresbard Lake
* The TMDL target is a mean TSI of 74.8, which requires a 40% reduction in phosphorous load. Based on SD DENR's ecoregion TSI criteria this would meet the partially supporting beneficial use classification. The modeling done for the Lake assessment report shows that a 95% reduction in phosphorous is necessary to achieve fully supporting status. The assessment report explains why the 95% reduction in phosphorous is not technically or economically achievable, however this explanation is not included in the TMDL. This explanation should be included in the TMDL write-up.

Vern Berry
US EPA Region 8
Denver, CO
303-312-6234

-----Original Message-----
From: James J. Dailey
Sent: Monday, March 03, 2003 2:21 AM
To: Leland.Baron@state.sd.us
Subject: Lake Alice Project, Deuel Co., SD

Dear Leland Baron:

My name is James Dailey, a farmer-rancher in Deuel County, and have lived within a mile of Lake Alice all my life. I have owned property adjacent to Lake Alice in Section 1 and Section 12 since 1987. I would like to take this opportunity to comment on the total maximum daily load evaluation for Lake Alice (HUC10160009) Deuel County, South Dakota.

It is my understanding that this lake as well as over 100 other lakes in South Dakota were identified by the EPA as having high levels of contaminants and it was the responsibility of the department of Environment and Natural Resources to study these lakes and find a solution to the problem. In this particular case I feel this agency is grossly negligent in their responsibility to the overall public and the citizens of Deuel County. I will direct my comments to various aspects of the study to substantiate my position.

INTRODUCTION:
You have indicated that the water shed for Lake Alice is 8,275 acres. This is grossly incorrect. The lake itself encompasses at least 1,200 acres and the water shed is only slightly more than that, approximately 1,300 to 1,600 acres. You have indicated that the lake outlet empties into an un-named tributary which in reality, the lake has no outlet, and only empties out after becoming approximately 2 1/2 feet above the high water mark. The lake will flood into the un-named tributary. The Department of Game, Fish & Parks, and the South Dakota Department of Environment and Natural Resources have resisted the establishment of a permanent outlet on the lake which would prevent this flooding if established within a close proximity of the ordinary high water mark. The ordinary high water mark was established several years ago through efforts of Deuel County Lakes & Streams, Gene Stohr and myself.

PROBLEM IDENTIFICATION:
There is definitely, at times, a water quality problem with the lake. This problem was addressed by the young man implementing the study but it seems Mr. Leland Baron chose to disregard it in his final report. Assuming it is true, the primary tributary to Lake Alice carries only a small nutrient load. There has to be another source which is at times grossly deteriorating the water quality causing it to be listed by the EPA as a lake needing to be improved. The activity on the above watershed has not changed measurably in the last twenty-five years. There are very, very few acres within the watershed being cultivated and those acres are no-tilled. The thing that has changed since 1992, with the exception of 2002, is that the area has received excessive rainfall and in some years as much as twice the normal annual rainfall. With the high rainfall and some winters of excessive snow since June of 1992, the lake has been in a state of flooding. In most cases, the lake has been from 2 - 3 feet over full, causing massive shoreline erosion killing the entire tree line of the lake and totally redefining the boundaries of the water basin. While this has gone on, the Department of Environment and Natural Resources and the South Dakota Game, Fish & Parks, the very agencies entrusted to protect this

precious community resource, have failed to act even after repeated requests by concerned individuals. After the tax payers of Deuel County, the Deuel County Conservation District, and several members of the study group came together to provide the resources and the mechanism to implement the study which was done on the lake, still Mr. Leland Baron chooses not to address the problem.

DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGETS: Stock watering is listed as one of the beneficial uses of the lake. At this time and for the past several years no domestic livestock have had access to the lake. The study states a gradual increase in fertility of the water is due to nutrients washing into the lake from external sources is a sign of the eutrophication. It is my belief and the belief of others that this problem basically comes from shoreline erosion, as the minimal amount of water that enters the lake comes from predominantly native grass land. In the last paragraph under this heading the study indicates that the TSI has already been reached likely due to large participation in the CRP program and the use of best management practices in the watershed. It is ironic that anyone should believe that there is no longer a problem with water quality or that it is going to get better on it's own because the reality of it is, while there is only approximately 200 acres of tilled ground within the watershed it is still considerably more than there was in previous years. The CRP program has had almost no impact on the watershed because nearly 100% of the CRP acres that are now enrolled had a grass cover for many years prior to being enrolled in the CRP program.

NONPOINT SOURCES/BACKGROUND SOURCES:
(Quote) "To simplify the loadings, it may be assumed that approximately 50% of the load to Lake Alice maybe attributed to the atmosphere as well as the tributary." Given this scenario to problem simplification, it might be better to assume that all the phosphorus comes from the atmosphere thus there is nothing we can do and we have neatly solved the problem and addressed the concern of the EPA. In reality we have done nothing more than play with numbers and reallocate the blame.

LINKAGE ANALYSIS:
(Quote) "Maintaining current land use practices may result in continued improvement in the water quality at Lake Alice." Once again, it is hard to believe that by doing nothing things will get better given the fact that the land use practices which must have, according to your assessment, caused the lake to be identified by EPA as a problem lake when the land use practices have not measurably changed over the years.

CRITICAL CONDITIONS:
You indicate that impairments to the lake are due to warm water temperatures, peak algae growth and peak recreational uses. The degree to which the lake is used for recreation can have almost no measurable adverse impact on the lake. Given the best weekend of the summer when fish are biting, and it is warm enough to jet ski or boat, the maximum number of watercraft that I have ever seen on that 1,200 acres of water is 23, and I am there every weekend of the summer. It is ironic that the South Dakota Department of Environment and Natural Resources feel that there is no problem or if there is one, time

will solve it by itself. In September of 2001, the algae bloom on the lake reached a degree of severity that when an individual exercising his hunting dogs allowed them to drink from the water, it resulted in the near immediate death of both dogs. The individual's name is Richard Puthoff of Watertown, South Dakota and his phone number is 605-886-9319. Following this incident, the Civil Defense Officer, and Game, Fish & Parks were notified and they came out and inspected the lake and found that there were waterfowl, shorebirds, and some fish dead in the bay on the west side of the lake. Consequently, signs were posted that no one was to use the lake for swimming and no pets were allowed access to the lake. I apologize if I sound negative but it appears to me after all the time has been spent in finding a solution to preserve the water quality and recreational uses of this lake by countless individuals, this agency has chosen to merely sweep the problem down stream. I believe that far too long and far too often this is the approach taken by government agencies whose sole purpose is to protect and preserve our natural resources. I find it unfortunate that people in governmental positions worthy of public respect can do this kind of work and in good conscience take their paycheck.

Sincerely Yours,

James J. Dailey

Cc: EPA - Region 8
South Dakota Lakes & Streams
Deuel County Lakes & Streams
Deuel County Conservation District
Deuel County Commissioners

DENR Response to Comments

August 25, 2003

James Dailey
47618 173rd Street
Clear Lake, South Dakota 57226

Re: Response to Comments on Draft Lake Alice Assessment

Dear Mr. Dailey:

Thank you for your March 3, 2003 e-mail comments on the draft Lake Alice water quality assessment.

In addition to this e-mail response, I am sending you a CD containing a file of the full report for your information and use. If you want a hard copy instead, let us know. The full report has more information relating to the facts and conclusions stated in the summary document that you reviewed previously. I have also responded to your concerns in the order you listed them in your March 3, 2003 e-mail.

Watershed Acreage - You stated the watershed acreage was not correct. The assessment report identifies the watershed as encompassing 8,275 acres, which includes the roughly 1,000 acre Lake Alice. Reexamination of the USGS topography maps (page 2 of the assessment) indicates that this estimation of watershed acreage is correct.

Lake Outlet - The assessment indicates that Lake Alice has an outlet that discharges to an un-named tributary. Your comment the lake "has no outlet" appears to be the result of using a different definition for the term outlet. Lake Alice does not have a man made outlet in the traditional sense. The report defined an outlet as the first point of discharge when the water level in the lake rises to an elevation that results in a discharge of water. For Lake Alice, the outlet elevation has been set by the Board of Water Management at 1689.4 feet Mean Sea Level (MSL) while the ordinary high water mark has been set at 1691.8 feet MSL (page 12).

I am not familiar with past efforts to establish a man made outlet so I cannot comment on what may or may not have taken place in the past. However, it is my understanding in talking with the Department of Environment and Natural Resources (DENR) Water Rights Program, that they would not oppose the construction of a man made outlet as long as the outlet elevation was set at 1689.4 feet MSL. However, we cannot speak for Game, Fish & Parks or the downstream landowners who may not want to see the additional water from Lake Alice.

Water Quality Standards – Lake Alice is listed for the following beneficial uses: Warm water semi-permanent, immersion recreation, limited contact recreation, and fish, wildlife, recreation and stock watering. The beneficial uses state what a water body may be used for regardless of whether that activity is actually taking place or not.

Water Quality – Lake Alice was originally listed in the department's 1998 303(d) list of water bodies requiring the completion of a Total Maximum Daily Load (TMDL). The department used a Trophic

Status Index (TSI) value of greater than 55.5 as being an indication of possible impairment for lakes. Unfortunately, this resulted in Black Hills lakes being compared equally with shallow, eastern South Dakota prairie lakes, and vice versa. For the preparation of the 2002 303(d) list, the department refined the impairment criteria by comparing all the lakes in the same ecoregion against each other. Lake Alice is in the Northern Glaciated Plains Ecoregion. The TSI break for fully supporting beneficial uses of lakes in this ecoregion is equal to or less than a 65.0 TSI. The TSI for Lake Alice has been decreasing and was determined to 61.5 (page 29) during the study. However, the study started in 2001 so the department continued with the project since Lake Alice was near the impairment threshold.

The assessment report indicates that there are only small loadings of nutrients entering the lake from the watershed and that the largest single source of nutrients is atmospheric deposition. Since there is no water leaving Lake Alice, the nutrients have accumulated in the sediment over time. These nutrients can be released occasionally which can result in nuisance algal blooms. We see seasonal algal blooms in most if not all of our prairie lakes during the summer. The severity of the blooms is influenced by many factors, not all of which controlled.

Since the watershed is in good shape and no longer contributing significant amounts of pollution to Lake Alice, the options to improve water quality are limited to potential work in or on Lake Alice itself.

Shoreline erosion is a problem that is very visual but hard to quantify. The estimated cost to riprap the entire shoreline of Lake Alice to reduce shoreline erosion is estimated to cost over \$7,000,000.$^{\underline{00}}$.

Alum treatment is a temporary (about 10 years) solution which locks up the phosphorus in the sediments and makes them unavailable for aquatic life. The estimated cost to treat Lake Alice is \$700,000.$^{\underline{00}}$.

Lake dredging is a third option. There is an estimated 3.0 million cubic yards of sediment in Lake Alice. The estimated cost to dredge all of this sediment out of Lake Alice is \$9.0 million.

We do not have an estimate of what a manmade outlet would cost. A manmade outlet would allow high water to drain from Lake Alice and would accomplish some flushing of the phosphorus from the lake. The outlet would help correct the erosion.

Recommendations Section – The recommendations section is being re-written to clarify what we believe is feasible given local support and available funding.

Thanks for your interest in protecting Lake Alice. With EPA approval, a final copy of the report should be available on the DENR web site.

Sincerely,

Leland Baron
Water Resources Assistance Program
(605) 773-4254

STATE OF SOUTH DAKOTA

GREAT SEAL

1889

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