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

Legion Lake
Custer County, SD

By

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Water Resources Assistance Program

Sponsor

Black Hills Resource Conservation and Development Association, Inc.

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

Executive Summary

Legion Lake was initially included in the 1998 South Dakota 303(d) list as an impairment-related TMDL water body (SD DENR 1998). Information supporting this listing was derived from statewide lake assessment data (Stueven and Stewart 1996) and the 1996 305(b) report (SD DENR 1996). More recently, Legion Lake was also identified in the 2006 South Dakota 303(d) list as impaired because it exceeds Trophic State Index (TSI) and pH criteria. Legion Lake is listed as high priority water body in terms of Total Maximum Daily Load (TMDL) development (SD DENR 2002, 2004, 2006). Potential sources of nutrients include silviculture, highway maintenance and runoff, recreational activities, and natural sources.

The listing of Legion Lake on the impaired waterbodies list in the 2006 Integrated Report (SD DENR 2006) was determined to be an error, as several measurements from this study were not included in the impairment listing analysis. Considering all available data, Legion Lake falls within the ranges of a mesotrophic to eutrophic waterbody and is currently meeting TSI criteria. Nonetheless, it was determined that a TMDL for the TSI impairment was needed to maintain or improve the current trophic state by implementing Best Management Practices (BMPs).

A watershed assessment project was initiated with the following primary objectives (1) evaluate current physical, chemical, and biological integrity of Legion Lake and its watershed (2) determine non-point source critical areas within the watershed, (3) define management practices to improve the water quality, and (4) develop a Trophic State Index TMDL for Legion Lake.

Physical, chemical, and biological data for this project was collected over a one-year period. Scott Environmental, a local consultant, conducted monthly and event-based water quality sampling at four stream sites (three sites above the reservoir and one site below the reservoir) and two lake sites from August 2001 to August 2002. Continuous discharge data was collected at stream sites during the same time period. South Dakota Department of Environment and Natural Resources (SD DENR) has also collected water quality samples as well as temperature and dissolved oxygen profiles from Legion Lake.

Almost 95% of samples collected in Legion Lake were considered phosphorus-limited. Only samples collected from the epilimnion during winter and spring months revealed cases of nitrogen limitation. Since a majority of samples were phosphorus limited, phosphorus loads to Legion Lake will be targeted for reduction to decrease the likelihood of algae blooms and allow the lake to support its designated beneficial uses.

Approximately 7.3 kg of total phosphorus is delivered to Legion Lake from its watershed annually. Modeling results indicate an accumulation of approximately 1 kg of total phosphorus in Legion Lake per year. Since Legion Lake is currently meeting TSI criteria, the total phosphorus load allocation assigned in the TDML is equal to the current loading rate (7.3 kg/year) in order to maintain the current trophic state. Nonetheless, BMPs are recommended to reduce phosphorus loads and improve trophic state, because Legion Lake is only narrowly meeting TSI criteria.

It is assumed that internal phosphorus loading from the lake sediment is a source of phosphorus. As the oxygen content of the water near the sediment interface declines and becomes anoxic, phosphorus and other nutrients can be released into the water. Dissolved oxygen and temperature profiles taken in the deeper embayment displayed seasonal stratification and oxygen depletion in the lower depths of the lake. During summer stratification, dissolved oxygen concentrations begin to decrease drastically at depths of approximately 3 m until concentrations reach anoxia at approximately 5 m of water depth. Based on sediment survey data collected during this study, Legion Lake has accumulated approximately 22,000 cubic yards of sediment. The majority of the accumulated sediment is shown to have been deposited in the deeper embayment. This source of phosphorus could be managed using lake management techniques, including alum treatment and aeration/circulation.

To slow sedimentation rates and reduce nutrient loads, the construction of artificial wetlands and improved riparian buffers are recommended. Wetland areas can be designed to reduce the total phosphorus load by up to 90% (USEPA, 2001). Riparian re-vegetation and enhancement in the watershed is also recommended to reduce the total phosphorus load.

It should be noted that water quality data presented in this report may not be representative of a typical year, as the study period was during a time of drought. Nonetheless, lake and watershed management recommendations presented in this report will improve water quality. To evaluate the level of improvement, water quality monitoring is recommended following the implementation of management activities.

Acknowledgements

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

South Dakota Department of Environment and Natural Resources – Water Resource Assistance Program

South Dakota Department of Game, Fish, and Parks – Wildlife Division Regional Office in Rapid City, SD

South Dakota Department of Game, Fish, and Parks – Custer State Park

United States Environmental Protection Agency – Non-Point Source Program

Table of Contents

List of Figures

List of Tables

Introduction

The purpose of the Custer State Park Lakes Assessment was to determine sources of impairment for three water bodies, Legion Lake, Center Lake, and Legion Lake. This report discusses the current condition, possible restoration alternatives, and a Total Maximum Daily Load (TMDL) summary for one of the three lakes, Legion Lake, and its watershed.

Lake and Watershed Description

The Legion Lake watershed is located in north central Custer County, South Dakota (Figure 1). The watershed consists of approximately 2,050 acres of primarily quartzite and granite outcrop covered by dense pine forest; predominately Ponderosa Pine with some Black Hills Spruce and Aspen. The Legion Lake watershed falls within the Black Hills Plateau Level IV Ecoregion, which is part of the Middle Rockies Level III Ecoregion. The Black Hills Plateau is characterized by plateau topography with broad ridges and entrenched canyons.

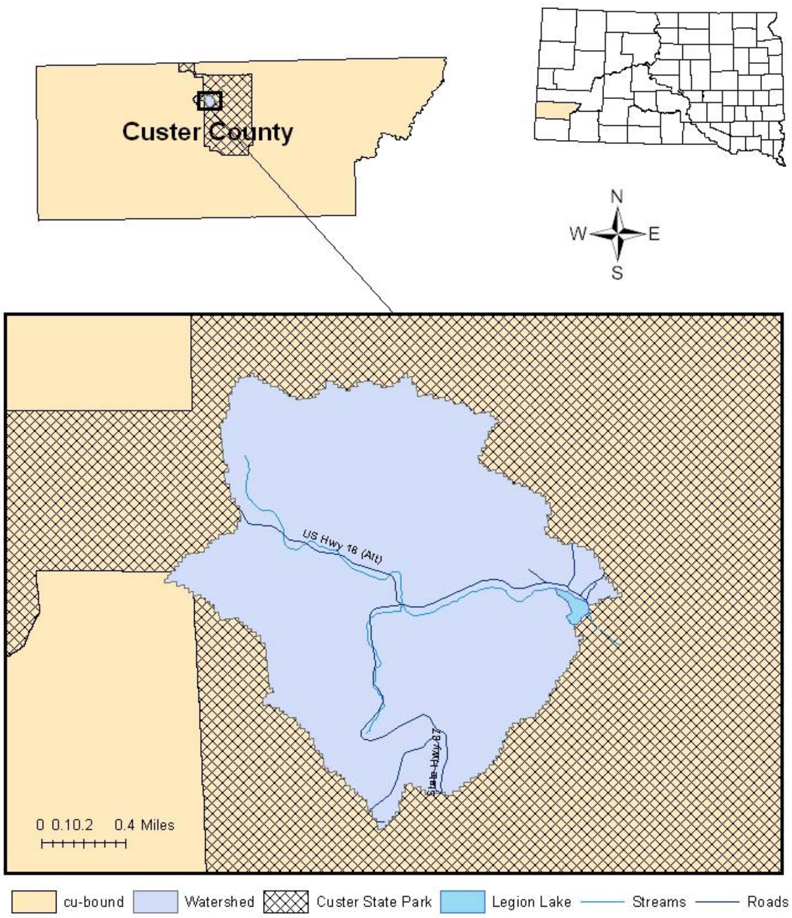

Figure 1. Location of the Legion Lake watershed in Custer County, SD.

The lake is recharged by natural precipitation, which is quite variable in the study area. Average annual precipitation for the Black Hills of South Dakota is approximately 19 inches (Driscoll et al. 2000). Typically, most precipitation falls from early spring to late summer (Figure 2).

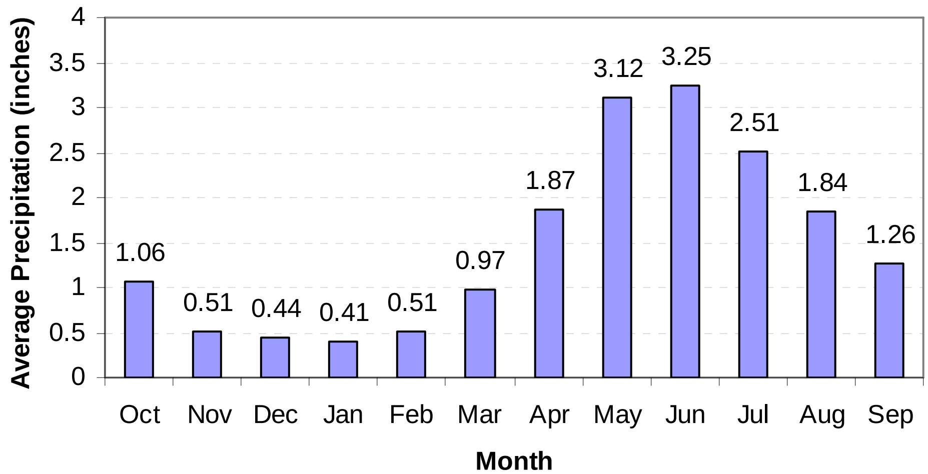

Figure 2. Average monthly precipitation for Custer County, SD (water years 1931-1998). (source: Driscoll et al., 2000)

The lake has a surface area of approximately 9 acres and volume of approximately 90 acre feet. The mean and maximum depths of the lake are 10 feet and 22 feet, respectively.

Beneficial Use Assignment and Water Quality Standards

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

Legion Lake has been assigned the following beneficial uses: coldwater marginal fish life propagation (category 3), immersion recreation (category 7), limited contact recreation (category 8), and wildlife propagation, recreation, and stock watering (category 9). Table 1 lists the criteria that must be met to maintain the above beneficial uses. When multiple standards exist for a particular parameter, the most stringent standard is used.

Table 1. State surface water quality standards for Legion Lake, SD.

Parameter	Criteria	Beneficial Use Requiring Criteria
Nitrate	≤ 88 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
Total Ammonia Nitrogen[1]	Equal to or less than the result from Equation 1 in Appendix A (SDCL§74:51:01)	Coldwater marginal fish propagation
Alkalinity ($CaCO_3$)	≤ 750 mg/L, 30-day average[2] ≤ 1,313 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
pH	6.5 – 8.8 (standard units)	Coldwater marginal fish propagation
Conductivity	≤ 4,000 umhos/cm, 30-day average; ≤ 7,000 umhos/cm, daily maximum	Wildlife propagation, recreation, and stock watering
Total Dissolved Solids	≤2,500 mg/L, 30-day average; ≤4,375 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
Total Suspended Solids	≤ 90 mg/L, 30-day average; ≤ 158 mg/L, daily maximum	Coldwater marginal fish propagation
Temperature	≤ 75 º F	Coldwater marginal fish propagation
Dissolved Oxygen	≥ 5.0 mg/L; per sample	Coldwater marginal fish propagation
Fecal Coliform Bacteria[3]	≤ 200 colonies/100mL, based on geometric mean of 5 samples; ≤ 400 colonies/100mL, per sample	Immersion recreation
Undisassociated Hydrogen Sulfide[4]	≤ 0.002 mg/L, per sample	Coldwater marginal fish propagation

[1] Daily maximum criterion. Criteria also established for 30-day average and early life stage periods.
[2] "30-day average" is the arithmetic mean of a minimum of 3 consecutive samples taken on separate weeks in a 30-day period.
[3] The fecal coliform standard is in effect from May 1 to September 30.
[4] Parameter not measured during this project.

All South Dakota streams are assigned the beneficial uses of irrigation, fish and wildlife propagation, recreation, and stock watering. No additional beneficial uses have been assigned to the streams for Legion Lake. Table 2 lists the criteria that must be met to support the above beneficial uses.

Table 2. Surface water quality criteria and designated beneficial uses for streams in the Legion Lake watershed study area, Custer State Park, SD.

Parameter	Criteria	Beneficial Use Requiring Criteria
Alkalinity ($CaCO_3$)	≤ 750 mg/L, 30-day average[3]; ≤ 1,313 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
pH	6.0 – 9.5 (standard units)	Wildlife propagation, recreation, and stock watering
Conductivity	≤ 2,500 umhos/cm, 30-day average; ≤ 4,375 umhos/cm, daily maximum	Irrigation
Total Dissolved Solids	≤ 2,500 mg/L, 30-day average; ≤ 4,375 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
Nitrate-N	≤ 50 mg/L, 30-day average; ≤ 88 mg/L, daily maximum	Wildlife propagation, recreation, and stock watering
Total Petroleum Hydrocarbons[1]	≤ 10 mg/L, per sample	Wildlife propagation, recreation, and stock watering
Oil and grease[1]	≤ 10 mg/L, per sample	Wildlife propagation, recreation, and stock watering
Sodium adsorption ration[1,2]	≤ 10	Irrigation

[1] Parameters not measured during this project.
[2] The SAR is used to evaluate the sodium hazard of irrigation water based on the Gapon equation.
[3] "30-day average" is the arithmetic mean of a minimum of 3 consecutive samples taken on separate weeks in a 30-day period.

Threatened and Endangered Species

No threatened or endangered species (Table 3) were observed in the Legion Lake watershed during this study period. However, care should be taken when considering management activities in this watershed to avoid any potential disturbance of these species.

Table 3. Threatened, endangered and candidate species of South Dakota.

NAME	SCIENTIFIC NAME	FEDERAL STATUS	STATE STATUS
Invertebrates:			
American burying beetle	*Nicrophorus americanus*	LE	
Scaleshell	*Leptodea leptodon*	LE	
Higgins Eye	*Lampsilis higginsii*	LE	
Dakota skipper	*Hesperia dacotae*	C	
Fishes:			
Banded killifish	*Fundulus diaphanus*		SE
Blacknose shiner	*Notropis heterolepis*		SE
Central mudminnow	*Umbra limi*		SE
Finescale dace	*Phoxinus neogaeus*		SE
Longnose sucker	*Catostomus catostomus*		ST
Northern redbelly dace	*Phoxinus eos*		ST
Pallid sturgeon	*Scaphirhynchus albus*	LE	SE
Pearl dace	*Margariscus margarita*		ST
Sicklefin chub	*Macrhybopsis meeki*		ST
Sturgeon chub	*Macrhybopsis gelida*		ST
Topeka shiner	*Notropis topeka*	LE	
Trout-perch	*Percopsis omiscomaycus*		ST
Reptiles and amphibians:			
Blanding's turtle	*Emydoidea blandingii*		SE
Eastern hognose snake	*Heterodon platirhinos*		ST
False map turtle	*Graptemys pseudogeographica*		ST
Lined snake	*Tropidoclonion lineatum*		SE
Birds:			
American dipper	*Cinclus mexicanus*		ST
Bald eagle	*Haliaeetus leucocephalus*	LT	ST
Eskimo curlew	*Numenius borealis*	LE	SE
Interior least tern	*Sterna antillarum athalassos*	LE	SE
Osprey	*Pandion haliaetus*		ST
Peregrine falcon	*Falco peregrinus*		SE
Piping plover	*Charadrius melodus*	LT	ST
Whooping crane	*Grus americana*	LE	SE
Mammals:			
Black bear	*Ursus americanus*		ST
Black-footed ferret	*Mustela nigripes*	LE	SE
Gray wolf	*Canis lupus*	LE	
River otter	*Lutra canadensis*		ST
Swift fox	*Vulpes velox*		ST
Plants:			
Western prairie fringed orchid	*Platanthera praeclara*	LT	
KEY TO CODES:			
LE = Federal Endangered	PE = Proposed Endangered	SE = State Endangered	
LT = Federal Threatened	PT= Proposed Threatened	ST = State Threatened	
C = Federal Candidate			

Source: http://www.sdgfp.info/Wildlife/Diversity/TES.htm

Project Goals, Objectives, and Activities

Project Goals

The purpose of this assessment project was to determine and document sources of impairments to Legion Lake and the watershed and to develop feasible alternatives for restoration. The primary goal of this project was to complete a phosphorus TMDL for Legion Lake.

Project Objectives

Objective 1: Lake Sampling

The first objective was to determine current water quality conditions in the lake and calculate the lake's trophic state. This information was used to determine the amount of nutrient trapping, the amount of phosphorus released from the hypolimnion, and the amount of nutrient reduction required to improve the trophic condition of the lake.

Physical, chemical, and biological parameters were examined for Legion Lake on a monthly basis, excluding the months October 2001 and March and April 2002. Samples were collected from surface and bottom depths at two sites (Figure 3). All samples were analyzed by Energy Laboratories in Rapid City, SD. Air and water temperature, dissolved oxygen, conductivity, field pH, and water depth were measured using a Yellow Springs Instruments (YSI) meter. As with stream sampling, all samples and measurements were collected using methods described in *Standard Operating Procedures for Field Samplers* for the South Dakota Water Resources Assistance Program (Stueven et al. 2000a). Table 4 lists all parameters measured for Legion Lake.

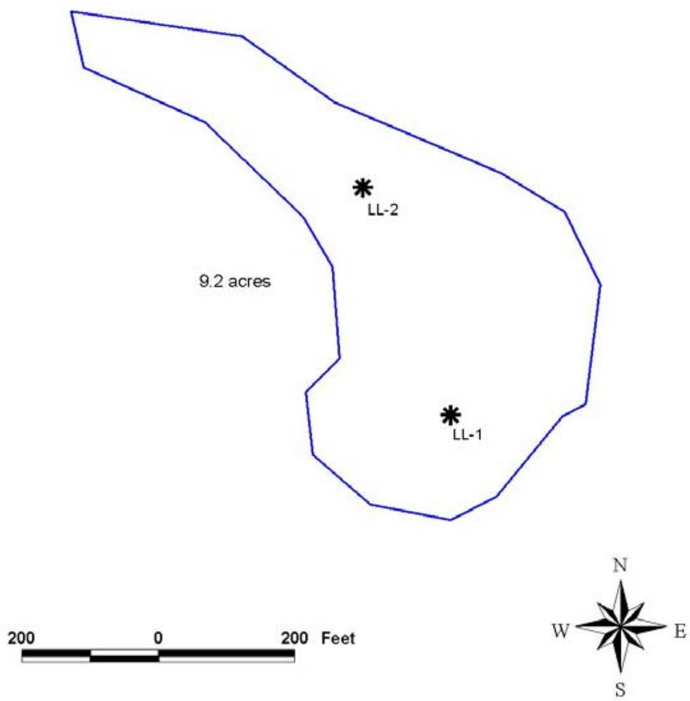

Figure 3. Location of inlake sampling sites for Legion Lake, Custer County, SD.

Table 4. Parameters measured at lake sites.

Physical	Chemical	Biological
Air temperature	Total alkalinity	Fecal coliform bacteria
Water temperature	Un-ionized ammonia	E. coli
Secchi transparency	Total Kjeldahl Nitrogen	
Visual observations	Nitrate+Nitrite	
Total solids	Total Phosphorus	
Total suspended solids	Total Dissolved Phosphorus	
Depth	Dissolved oxygen	
	Conductivity	
	Field pH	

Objective 2: Stream Sampling

The second objective was to estimate the sediment and nutrient loadings from streams in the watershed through hydrologic and chemical monitoring. The information was used to locate critical areas in the watershed to be targeted for implementation.

OTT Thalimedes water level recorders were installed on four streams sites (LLT-3, LLT-4, LLT-5 and LLO-6) to maintain a continuous stage record for those streams for a period of one year. Figure 4 shows the location of the stream monitoring sites.

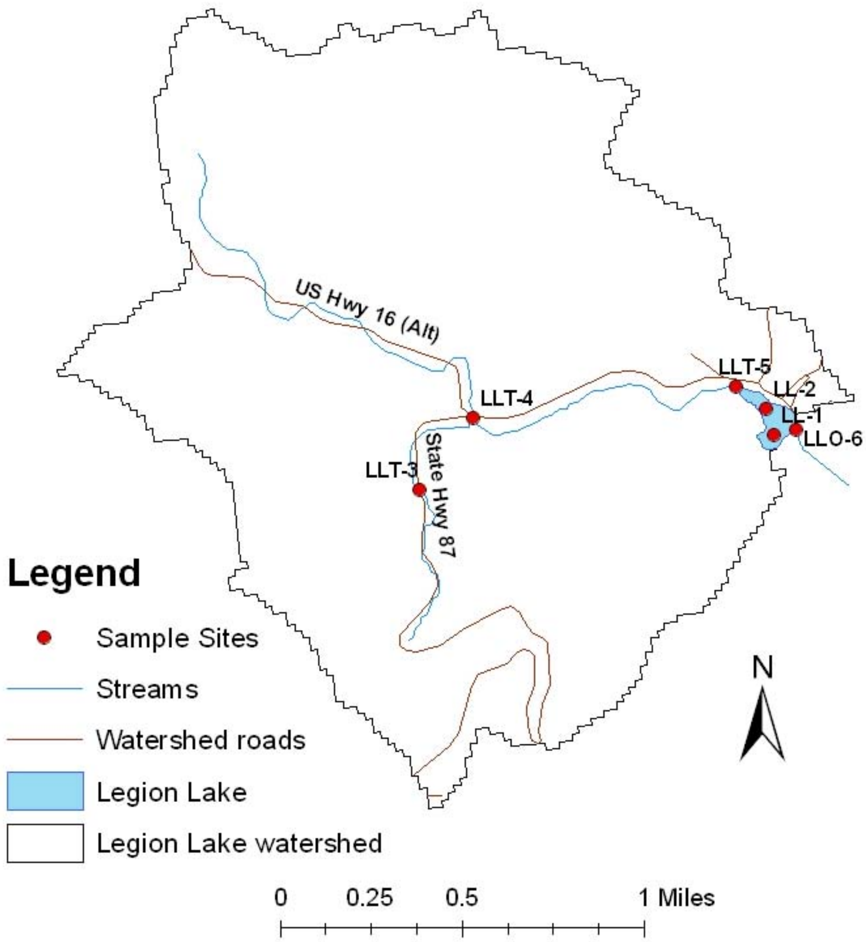

Figure 4. Location of stream sampling sites for the Legion Lake watershed assessment, Custer County, SD.

Instantaneous discharge measurements were taken with a hand-held current velocity meter. A regression equation was developed from the relationship between instantaneous discharge measurements and stage data to estimate continuous discharge and a hydrologic budget for the drainage system. Watershed loads were determined from discharge measurements and sample concentrations of sediment and nutrients. FLUX, a eutrophication model developed by the Army Corps of Engineers (US ACOE 1999) was used to estimate nutrient and sediment loading.

All stream samples and measurements were collected using methods described in *Standard Operating Procedures for Field Samplers* for the South Dakota Water Resources Assistance Program (Stueven et al. 2000a). Grab samples were collected mid-stream from the same location with same method at each visit. After each water sample was collected, water and air temperature, pH, conductivity, and dissolved oxygen measurements were taken using a YSI meter. Table 5 lists all parameters assessed at stream sites.

Table 5. Parameters measured at stream sites.

Physical	Chemical	Biological
Air temperature	Dissolved oxygen	Fecal coliform bacteria
Water temperature	Ammonia	E. coli
Discharge	Un-ionized ammonia	Benthic macroinvertebrates
Depth	Nitrate+Nitrite	
Visual observations	TKN	
Water level	Total phosphate	
Total solids	Total dissolved phosphate	
Total suspended solids	Field pH	
Conductivity		

Benthic macroinvertebrate samples were collected from sites LLT-3 and LLT-5 in November 2001. All benthic samples were collected in accordance with the *Standard Operating Procedures for Field Samplers* for the South Dakota Water Resources Assistance Program (Stueven et al. 2000a).

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

All QA/QC activities were conducted in accordance with the Water Resource Assistance Program Quality Assurance Project Plan. QA/QC samples consisted of field blanks and field duplicate samples. The activities involved with QA/QC procedures and the results of QA/QC monitoring are reported in a subsequent section of this report.

Objective 4: Watershed Modeling

Legion Lake and its streams were modeled using the BATHTUB and FLUX models. FLUX is a program used to estimate loadings of nutrients or other water quality constituents passing a stream sampling station over a period of time.

The BATHTUB program was used to estimate water and nutrient balances and identify factors controlling algal production. The model was also used to determine the nutrient load reduction required for Legion Lake to support its beneficial uses. The model performs calculations on a steady state, spatially segmented hydraulic network and accounts for advective transport, diffusive transport, and nutrient sedimentation.

Results

Stream Physical and Chemical Parameters

Annual Loading

FLUX, a eutrophication model developed by the Army Corps of Engineers (US ACOE 1999), was used to determine hydrologic, nutrient, and sediment loadings at monitoring sites based on the flow and water quality parameter concentration data collected at the site. FLUX can calculate loadings using several available models (e.g. average flow, flow-weighted, etc.).

Two subwatershed were delineated within the larger watershed (Figure 5) and represent the area from which sites LLT-3 and LLT-4 receive runoff. The larger delineated watershed is the area from which Legion Lake receives runoff. Hydrologic and parameter loads were calculated for each of these areas. Site LLT-5 was used to represent the load from the entire Legion Lake watershed, and sites LLT-3 and LLT-4 represent the loads from their respective subwatersheds.

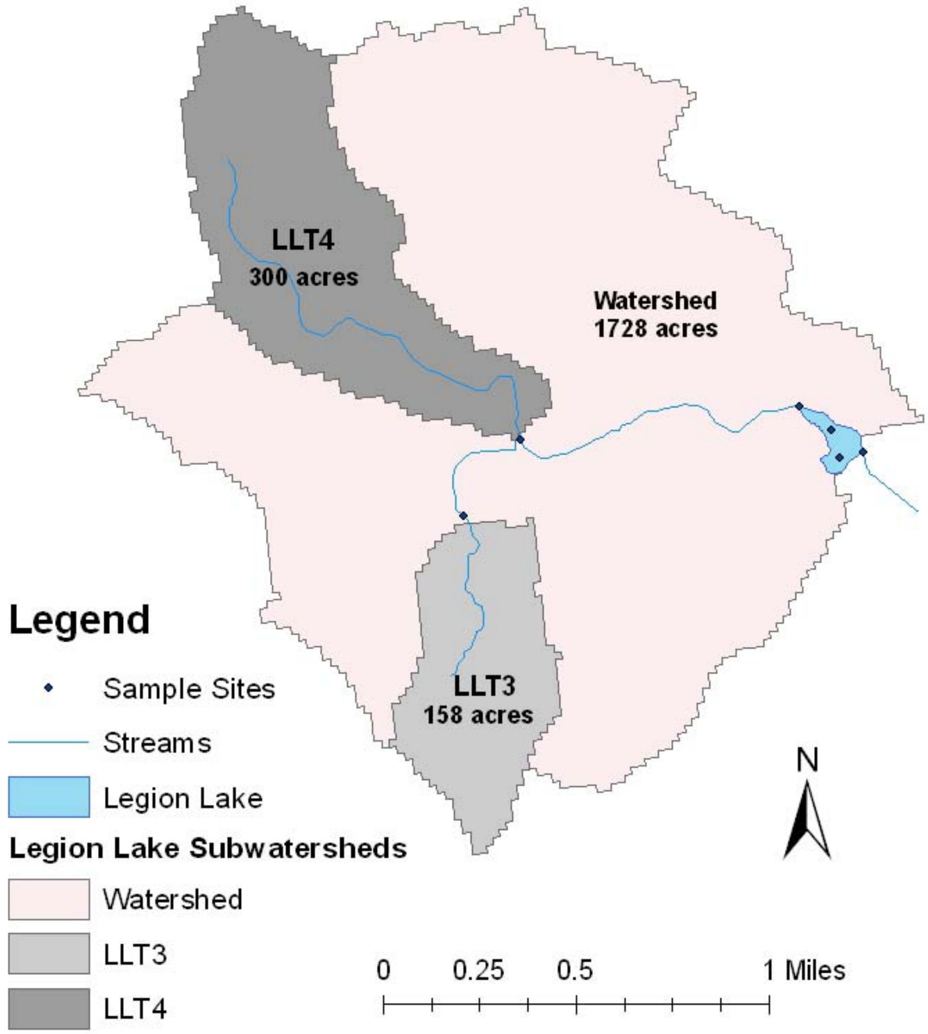

Figure 5. Delineation of subwatershed areas for the Legion Lake watershed assessment.

Monthly hydrologic contributions from each gauged subwatershed area were calculated by the FLUX modeling program. Estimates of hydrologic load were calculated for each season by summing three months of hydrologic load per season (i.e. the winter season was the total of December, January, and February monthly loads; spring was the total of March, April, and May monthly loads; summer was the total of June, July, and August monthly loads; and fall was the total of September, October, and November monthly loads).

Generally, estimated flow volumes were highest during the spring and fall seasons. Flow volume was highest during the fall at the inlet site (LLT-5) and during the spring at sites LLT-4 and LLO-6. Estimated volumes were approximately equal during the spring and fall seasons at site LLT-3. At all gauged sites, zero flow was recorded during winter months (Table 6).

Table 6. The following table lists the FLUX-modeled seasonal and total hydrologic contributions for each site/subwatershed in the Legion Lake watershed.

	Site	Season	Volume (acre-ft)	Percent of Annual (%)	Subwatershed area (acres)	Hydraulic Export Coefficient (acre-ft / acre)
INLETS	LLT3	Winter	0.00	0%	158	0.000
		Spring	4.86	7%	158	0.031
		Summer	3.24	5%	158	0.021
		Fall	4.86	7%	158	0.031
		Total	**12.97**	**18%**	158	**0.082**
	LLT4	Winter	0.00	0%	300	0.000
		Spring	8.11	11%	300	0.027
		Summer	4.86	7%	300	0.016
		Fall	9.73	14%	300	0.032
		Total	**22.70**	**32%**	300	**0.076**
	LLT5	Winter	0.00	0%	1728	0.000
		Spring	29.19	41%	1728	0.017
		Summer	20.27	28%	1728	0.012
		Fall	21.89	31%	1728	0.013
INLET TOTAL		Total	**71.35**	**100%**	1728	**0.041**
OUTLET	LLO6	Winter	0.00	0.0%	1728	0.000
		Spring	29.19	37.9%	1728	0.017
		Summer	5.67	7.4%	1728	0.003
		Fall	21.89	28.4%	1728	0.013
		Total	**56.75**	**100.0%**	1728	**0.033**

Water quality parameter loadings were also calculated for each gauged subwatershed using the FLUX modeling program. As expected, sites with larger drainage areas experienced higher annual loads for all parameters. Alkalinity and dissolved and total solids loads were higher at the inlet than at the outlet of the lake (Table 7).

Table 7. Parameter annual loads (kg) for each monitoring site.

Parameter	LLT-3	LLT-4	LLT-5	LLO-6
Alkalinity	967	1630	5687	4719
TKN	6.9	7.6	28.6	34.5
Nitrate+Nitrite	1.6	1.6	2.7	13.3
Ammonia	0.8	1.3	5.9	3.6
Organic Nitrogen	6.0	6.3	24.3	30.8
Inorganic Nitrogen	2.4	2.9	7.9	17.3
Total Nitrogen	7.0	9.3	25.2	48.0
Total Phosphorus	1.9	2.7	7.3	6.3
Total Dissolved Phosphorus	0.5	1.2	4.8	2.6
Total Suspended Solids	421	154	300	312
Total Dissolved Solids	3021	3565	12134	9640
Total Solids	3461	3735	12689	9894

After the hydrologic and parameter loadings for all sites were calculated, export coefficients were developed for each of the subwatershed water quality parameters. Export coefficients were calculated by taking the annual nutrient and sediment loads (kg) at a particular site and dividing by the total area of the sub-watershed (in acres) for that site. This calculation resulted in the determination of the kilograms of sediment and nutrient per acre per year (kg/acre/year) delivered from the respective subwatershed area. Similar to the hydrologic export coefficient, these values represent a fraction of the parameter mass that might be expected from each acre in the watershed annually. Higher values indicate higher export potentials, and are signs that priority problems exist within the subwatershed.

In general, export coefficients for the LLT-3 subwatershed were greater than those for the LLT-4 subwatershed and the entire watershed (LLT-5). The total dissolved phosphorus export coefficient for subwatershed LLT-4 was only slightly higher than LLT-3. Based on these results, the LLT-3 subwatershed should be given highest priority for the implementation of management practices (Table 8).

Table 8. Export coefficients (kg/acre/year) for gauged subwatersheds (LLT-3 and LLT-4) and total watershed (LLT-5) areas.

Parameter	LLT-3	LLT-4	LLT-5
Alkalinity	6.1	5.4	3.3
TKN	0.044	0.025	0.017
Nitrite/Nitrate	0.010	0.005	0.002
Ammonia	0.005	0.004	0.003
Organic Nitrogen	0.038	0.021	0.014
Inorganic Nitrogen	0.015	0.010	0.005
Total Nitrogen	0.044	0.031	0.015
Total Phosphorus	0.012	0.009	0.004
Total Dissolved Phosphorus	0.003	0.004	0.003
Total Suspended Solids	2.66	0.51	0.17
Total Dissolved Solids	19.12	11.88	7.02
Total Solids	21.91	12.45	7.34

Water Temperature

Water temperature is an influential variable in biological, chemical, and physical processes. Temperature can influence metabolic rates of aquatic organisms, toxicity of pollutants, and levels of dissolved oxygen. Stream water temperature is influenced by natural environmental conditions/events, including atmospheric temperatures, precipitation, and vegetation (shade). The greatest source of heat in freshwaters is solar radiation, especially water bodies that are directly exposed to the sun (Hauer and Lamberti 1996); however, the streams that flow into Legion Lake drain heavily forested areas.

As expected, temperature measurements were extremely variable due to seasonal atmospheric temperature differences (Table 9 and Figure 6). Temperatures at the inlet site (LLT-5) ranged from 1.5 to 17.1 degrees Celsius (mean = 11.1), while the outlet site (LLO-6) ranged from 8.8 to 19.2 degrees Celsius (mean = 14.49). Lower mean water temperatures at inlet sites could be attributed to the water source, which is predominantly rain and snow-melt runoff. Spring snow-melt water can keep stream water temperatures below air temperatures for several days (Hynes 1970).

Table 9. Descriptive statistics of water temperature (degrees Celsius) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	9.23	1.70	16.30	5.33	5.20	9.35	14.50
LLT-4	10	10.42	2.20	16.10	4.59	7.50	10.05	15.60
LLT-5	10	11.11	1.50	17.10	5.11	8.50	11.70	16.80
LLO-6	8	14.49	8.80	19.20	4.29	10.30	15.25	18.40

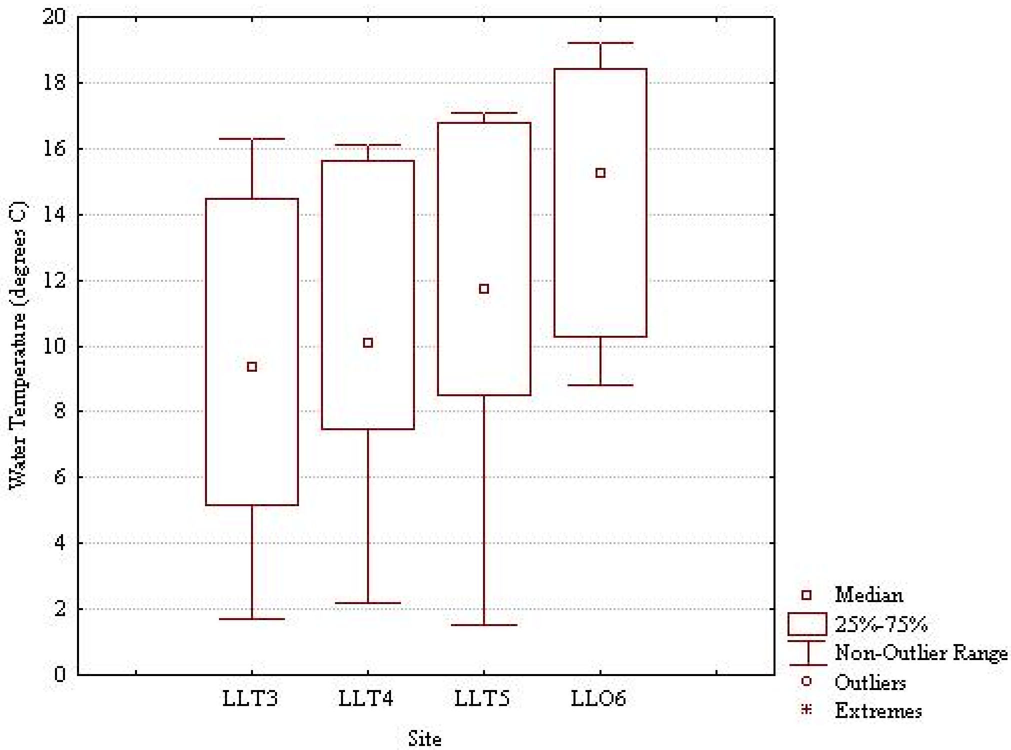

Figure 6. Box plot of temperature by site for Legion Lake stream sites. LLT-3, LLT-4, and LLT-5 are inlet stream sampling sites, and LLO-6 is the outlet stream sampling site.

Dissolved Oxygen

Concentrations of dissolved oxygen (DO) often vary both spatially and temporally. Seasonal loadings of organic matter greatly influence DO concentrations (Wetzel 2001). Physical factors, such as temperature and pressure, also influence concentrations of DO. Atmospheric oxygen solubility is most affected by temperature; DO increases considerably in colder water.

Concentrations of DO at all inlet stream sites were similar. Average DO concentrations were 8.61 mg/L, 8.22 mg/L, and 8.34 mg/L for sites LLT-3, LLT-4, and LLT-5, respectively. Average DO concentration was 6.82 mg/L at the outlet site (Table 10 and Figure 7). Lower DO concentrations at the outlet are probably due to warmer water temperatures and the water source at this sampling site. Typically, water flows from the reservoir over the spillway to the outlet site during spring and summer months. During low flow periods, which include this study period, very little water is discharged from the reservoir.

Table 10. Descriptive statistics of dissolved oxygen (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	8.61	5.60	10.50	1.59	7.34	9.21	9.74
LLT-4	10	8.22	5.57	10.30	1.42	7.19	8.55	9.39
LLT-5	10	8.34	5.57	11.21	1.61	7.25	8.43	9.40
LLO-6	8	6.82	4.64	8.56	1.33	5.99	6.75	7.97

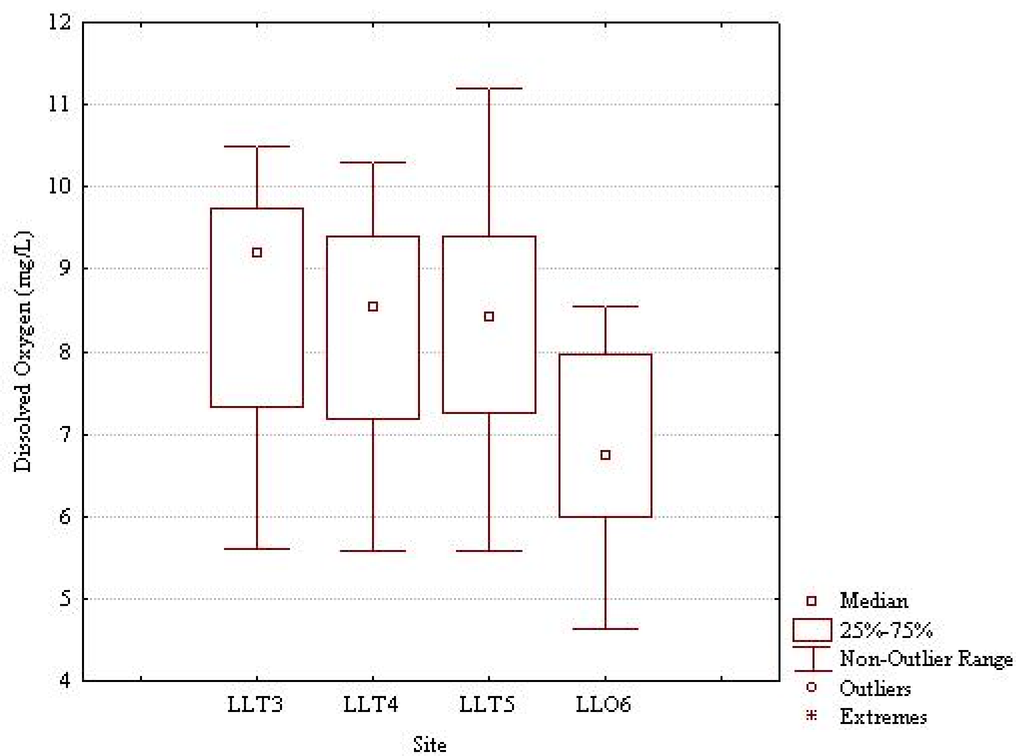

Figure 7. Box plot of dissolved oxygen by site for Legion Lake streams sites.

Acidification and Alkalinity

The primary measurements of acidification are alkalinity and pH. The pH scale ranges from 0 to 14, with 7 being neutral. Water with pH < 7 is considered acidic, while water with pH > 7 is considered basic. The pH of water is regulated mostly by the interaction of H+ ions. Natural waters exhibit wide variations in acidity and alkalinity. The pH of natural waters ranges between the extremes of 2 and 12 (Wetzel 2001), yet most forms of aquatic life require an environment with a pH of 6.5 to 9.0.

Streams in the Legion Lake watershed are designated with the beneficial use of fish and wildlife propagation and stock watering, which requires pH levels to be maintained between 6.0 and 9.5. All but 3 samples (8%) were within this range, and all 3 exceptions were basic, ranging from 9.5-11.0. Average field pH values among all sites were within 0.2 standard units (Table 11). Little variability in pH values was observed among sites (Figure 8).

Table 11. Descriptive statistics of field pH (standard units) for the Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	8.2	7.7	10.0	0.7	7.9	8.0	8.2
LLT-4	10	8.1	7.5	9.9	0.7	7.6	7.9	8.2
LLT-5	10	8.0	7.8	8.5	0.2	7.9	8.0	8.0
LLO-6	8	8.2	7.6	11.0	1.1	7.8	7.9	8.1

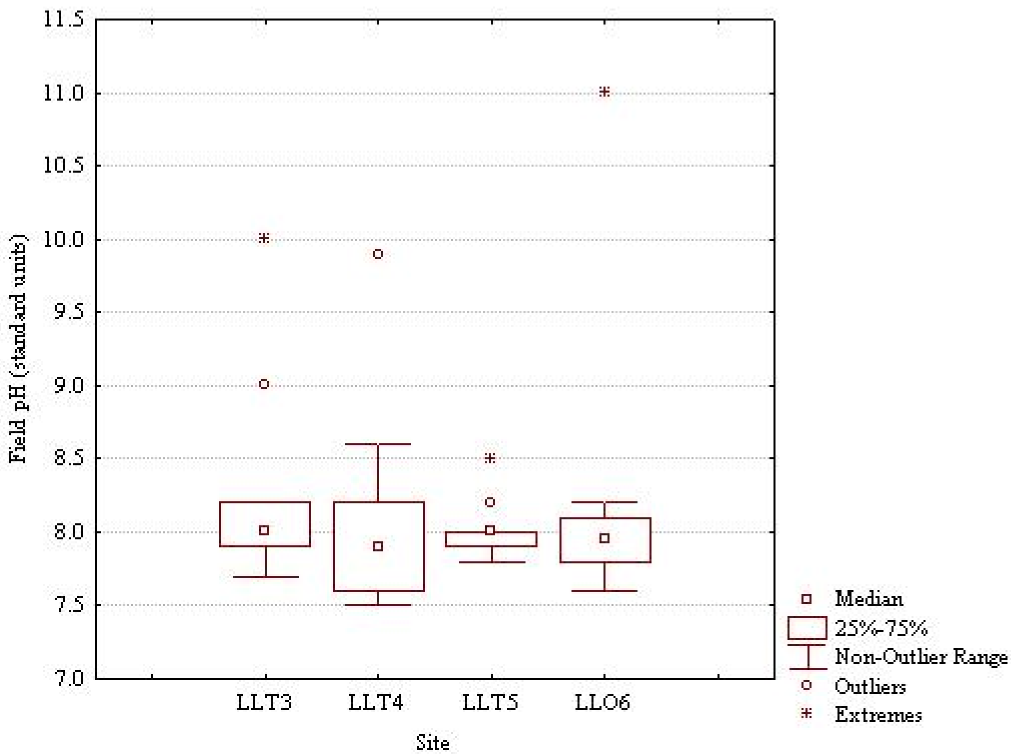

Figure 8. Box plot of field pH by site for Legion Lake stream sites.

Alkalinity is a term that refers to the buffering ability of the carbonate system in water. The term is also used interchangeably with 'acid neutralizing capacity' (ANC), which is the capacity to neutralize strong inorganic acids (Wetzel 2001). Alkalinity is a product of geological setting. Soils rich in carbonate rock, such as limestone, provide a source of high alkalinity (Monson 2000). In general, increased alkalinity inhibits drastic pH changes. Alkalinity typically ranges from 20 to 200 mg/L in natural environments (Lind 1985). However, in a setting of entirely igneous rock such as the study area, little neutralizing capacity can be expected from the soils and surrounding rock.

Inlet and outlet samples were similar, although somewhat higher concentrations were observed at the outlet site (Table 11). Average alkalinity concentrations were 60.6 mg/L, 61.6 mg/L, and 58.2 mg/L for sites LLT-3, LLT-4, and LLT-5, respectively. Average alkalinity concentration was 76.3 mg/L at the outlet site (Table 12 and Figure 9). Greatest variability in alkalinity concentrations was observed at the outlet stream site. The alkalinity standard of ≤ 1313 mg/L was not exceeded.

Table 12. Descriptive statistics of alkalinity (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	61	26	72	15.0	52	67	70
LLT-4	10	62	46	72	9.7	50	66	68
LLT-5	10	58	48	64	5.8	52	61	62
LLO-6	8	76	60	110	18.5	61	70	89

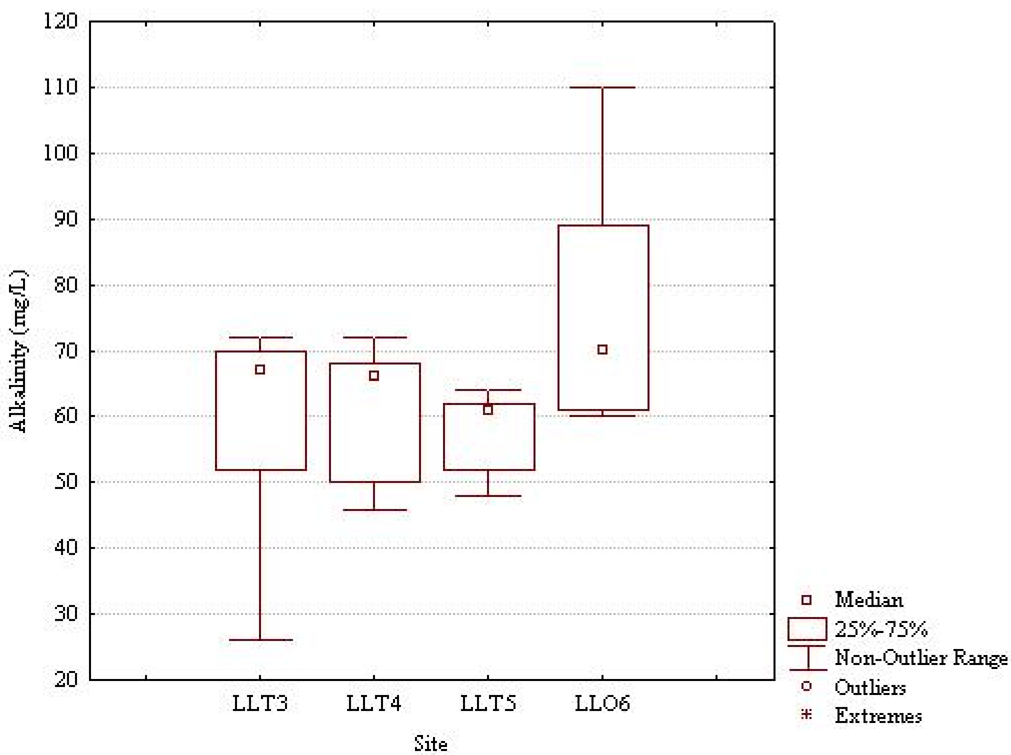

Figure 9. Box plot of alkalinity by site for Legion Lake stream sites.

Solids

"Solids" is a general term that refers to suspended or dissolved materials that are present in the waterway. Two solids parameters were examined in this assessment: total solids and total suspended solids. Total solids include the sum of dissolved and suspended solids. Suspended solids consist of larger materials that do not pass through the filter; this material is also referred to as the residue. These materials include both organic and inorganic forms.

Concentrations of total solids were comparable at two inlet sites (LLT-4 and LLT-5), while LLT-3 showed a much higher concentration. Average total solids concentrations were 218 mg/L, 146, mg/L and 145 mg/L for sites LLT-3, LLT-4, and LLT-5, respectively. Average total solids concentration was 153.8 mg/L at the outlet site (Table 13 and Figure 10).

Annual total solids load from the Legion Lake watershed is approximately 12,689 kg/year. Total solids export coefficient for the watershed was 7.34 kg/acre/year. The export coefficients for subwatersheds LLT-3 and LLT-4 were comparable at 12.91 and 12.45 kg/acre/year, respectively.

Table 13. Descriptive statistics of total solids (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	218	180	270	27.4	200	210	220
LLT-4	10	146	120	200	23.2	130	140	150
LLT-5	10	145	120	220	31.7	130	130	150
LLO-6	8	154	120	190	26.2	135	145	180

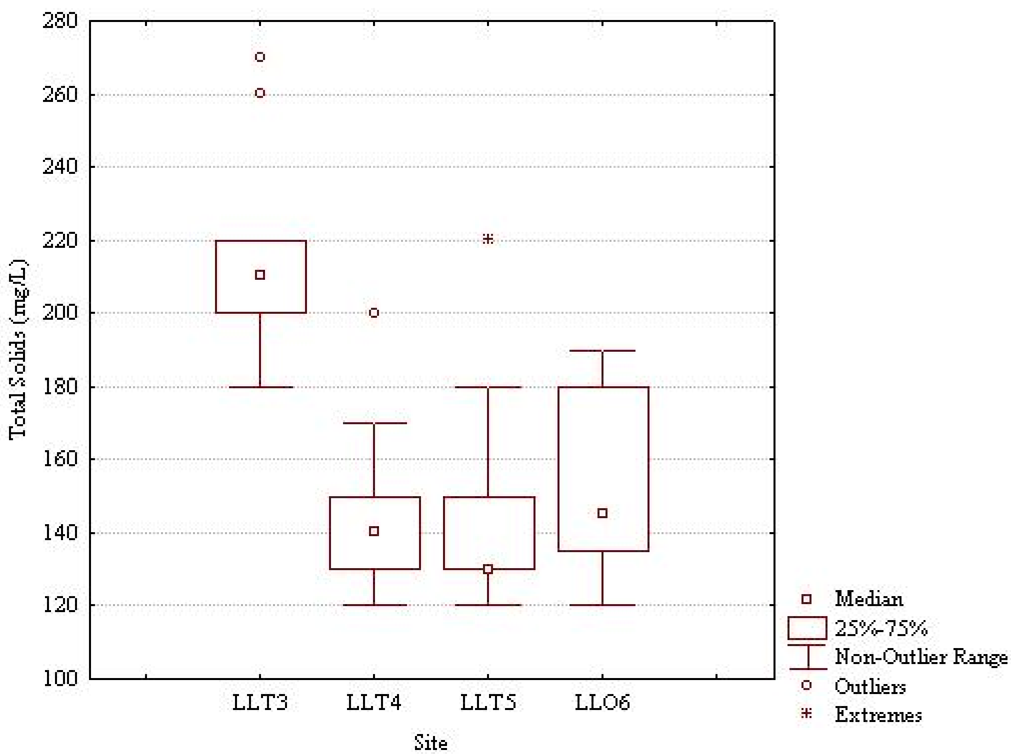

Figure 10. Box plot of total solids by site for Legion Lake stream sites.

Concentrations of total suspended solids (TSS) were slightly higher at LLT-3 than at LLT-4. Samples taken at LLT-5 were never above the reporting limit (5 mg/L), except during a rain event when the concentration reached 51 mg/L. (Table 14 and Figure 11).

LLO-6 concentration was slightly higher than LLT-4, but not as high as LLT-3. Average TSS concentrations were 22.7 mg/L, 6.9 mg/L, and 7.4 mg/L for sites LLT-3, LLT-4, and LLT-5, respectively. Average TSS concentration was 8.9 mg/L at the outlet site. Higher TSS concentrations at the outlet site are possibly due to contributions from algae die-off.

Annual TSS load from the Legion Lake watershed is approximately 300 kg/year. TSS export coefficient for the watershed was 0.17 kg/acre/year. The TSS export coefficient was markedly higher for LLT-3 subwatershed (2.66 kg/acre/year) than for SLT-4 subwatershed (0.51 kg/acre/year).

Table 14. Descriptive statistics of total suspended solids (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	22.7	2.5	84.0	24.3	6.0	15.0	31.0
LLT-4	10	6.9	2.5	18.0	5.9	2.5	4.3	9.0
LLT-5	10	7.4	2.5	51.0	15.3	2.5	2.5	2.5
LLO-6	8	8.9	2.5	26.0	10.0	2.5	2.5	16.5

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. TSS concentrations < 5.0 mg/L were assigned a value of 2.5 mg/L).

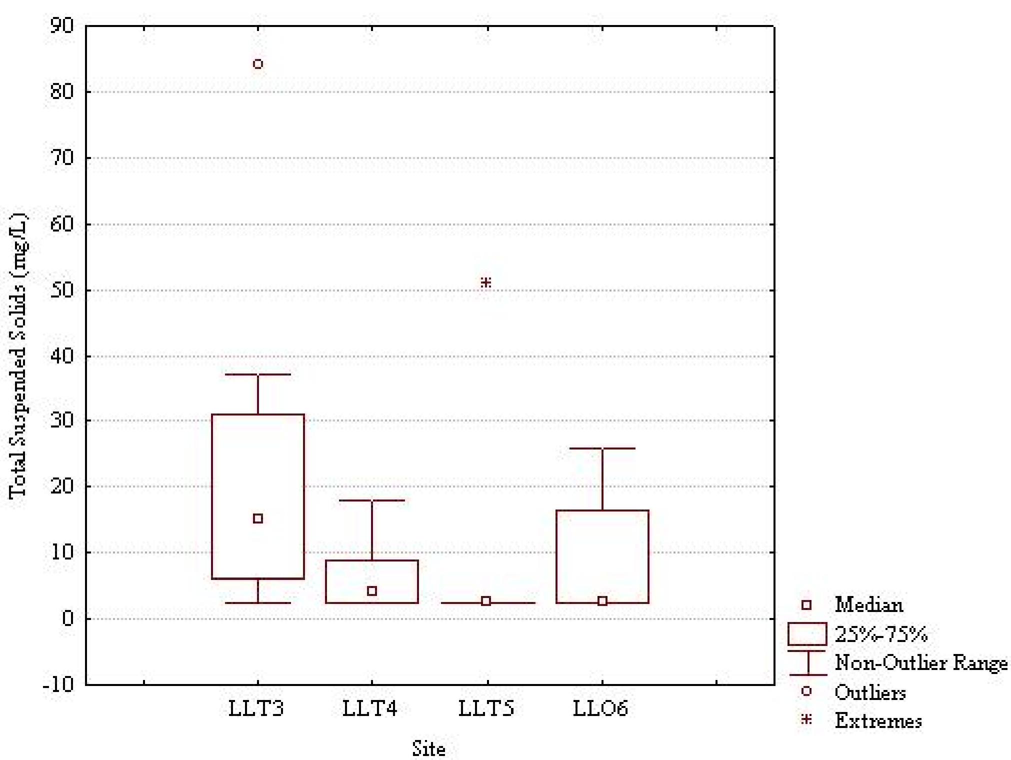

Figure 11. Box plot of total suspended solids (TSS) by site for Legion Lake stream sites.

Nitrogen

Three types of nitrogen were assessed in stream samples: (1) nitrate/nitrite, (2) ammonia, and (3) Total Kjeldahl Nitrogen (TKN). With these three parameters, relative concentrations of organic and inorganic nitrogen can be determined, as well as total nitrogen concentrations. Organic nitrogen was calculated as TKN minus ammonia. Inorganic nitrogen was calculated as the sum of ammonia and nitrate/nitrite. Total nitrogen was calculated by totaling inorganic and organic nitrogen.

Concentrations of all forms of nitrogen were highest at LLO-6. Average total nitrogen concentrations were 0.49 mg/L, 0.41 mg/L, and 0.55 mg/L for sites LLT-3, LLT-4, and LLT-5, respectively, while average total nitrogen concentration was 0.87 mg/L at LLO-6 (Table 15 and Figure 12). Annual loads for all assessed forms of nitrogen are listed in Table 7.

Table 15. Descriptive statistics of total nitrogen (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.49	0.26	0.74	0.20	0.30	0.46	0.68
LLT-4	10	0.41	0.28	1.33	0.32	0.30	0.31	0.34
LLT-5	10	0.55	0.28	1.93	0.58	0.28	0.28	0.33
LLO-6	8	0.87	0.28	2.70	0.82	0.30	0.63	1.09

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. TKN concentrations < 0.50 mg/L were assigned a value of 0.25 mg/L).

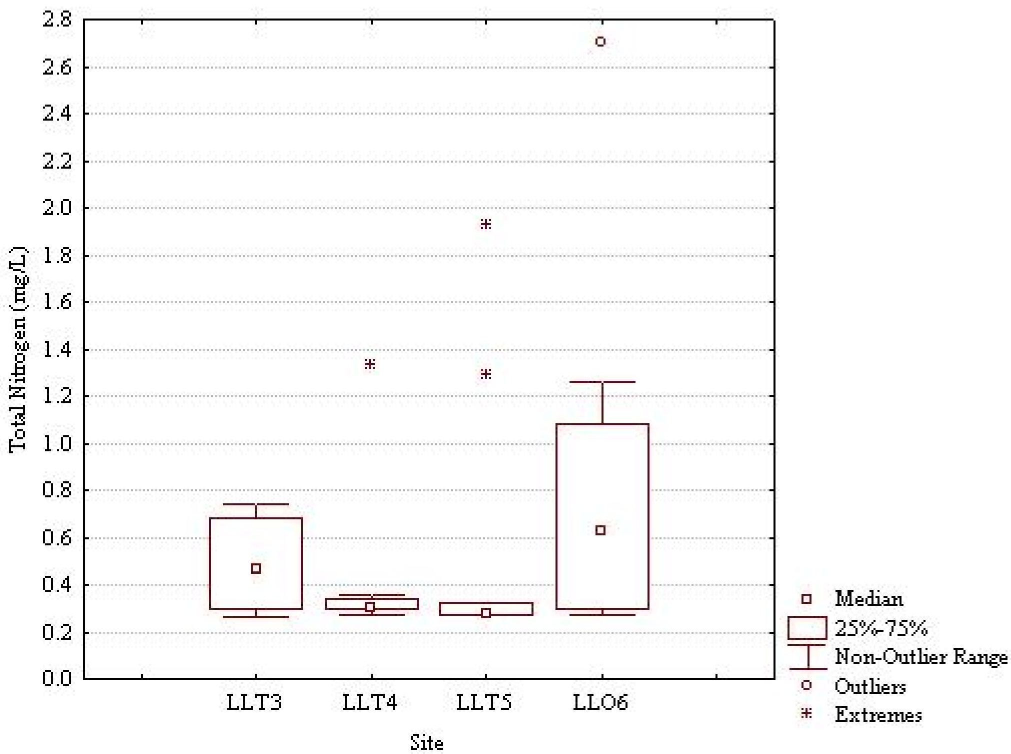

Figure 12. Box plot of total nitrogen by site for Legion Lake stream sites.

Quantities of inorganic (nitrate, nitrite, and ammonia) and organic nitrogen compounds in streams are highly diverse and variable due to the variety of inputs from natural and anthropogenic sources. Ammonia is usually the dominant constituent of inorganic nitrogen, and nitrate and nitrite concentrations are typically low in unpolluted waters. Organic nitrogen concentrations usually constitute a large portion of the total nitrogen in river systems (Wetzel 2001).

Average concentrations of organic nitrogen were 0.38, 0.30, 0.46, and 0.49 mg/L at sites LLT-3, LLT-4, LLT-5, and LLO-6, respectively (Table 16). Average concentrations of inorganic nitrogen were 0.15, 0.12, 0.14, and 0.39 mg/L at sites LLT-3, LLT-4, LLT-5, and LLO-6, respectively (Table 17). As expected, concentrations of organic nitrogen were higher than inorganic nitrogen (Figure 13).

Table 16. Descriptive statistics of organic nitrogen (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	9	0.38	0.20	0.55	0.18	0.20	0.45	0.55
LLT-4	10	0.30	0.20	1.15	0.30	0.20	0.20	0.20
LLT-5	9	0.46	0.20	1.85	0.57	0.20	0.20	0.20
LLO-6	8	0.49	0.20	1.15	0.36	0.20	0.38	0.70

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. TKN concentrations < 0.50 mg/L were assigned a value of 0.25 mg/L).

Table 17. Descriptive statistics of inorganic nitrogen (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.15	0.08	0.26	0.06	0.10	0.14	0.19
LLT-4	10	0.12	0.08	0.18	0.03	0.10	0.11	0.14
LLT-5	10	0.14	0.08	0.44	0.13	0.08	0.08	0.08
LLO-6	8	0.39	0.08	1.55	0.49	0.10	0.25	0.39

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. ammonia concentrations < 0.10 mg/L were assigned a value of 0.05 mg/L).

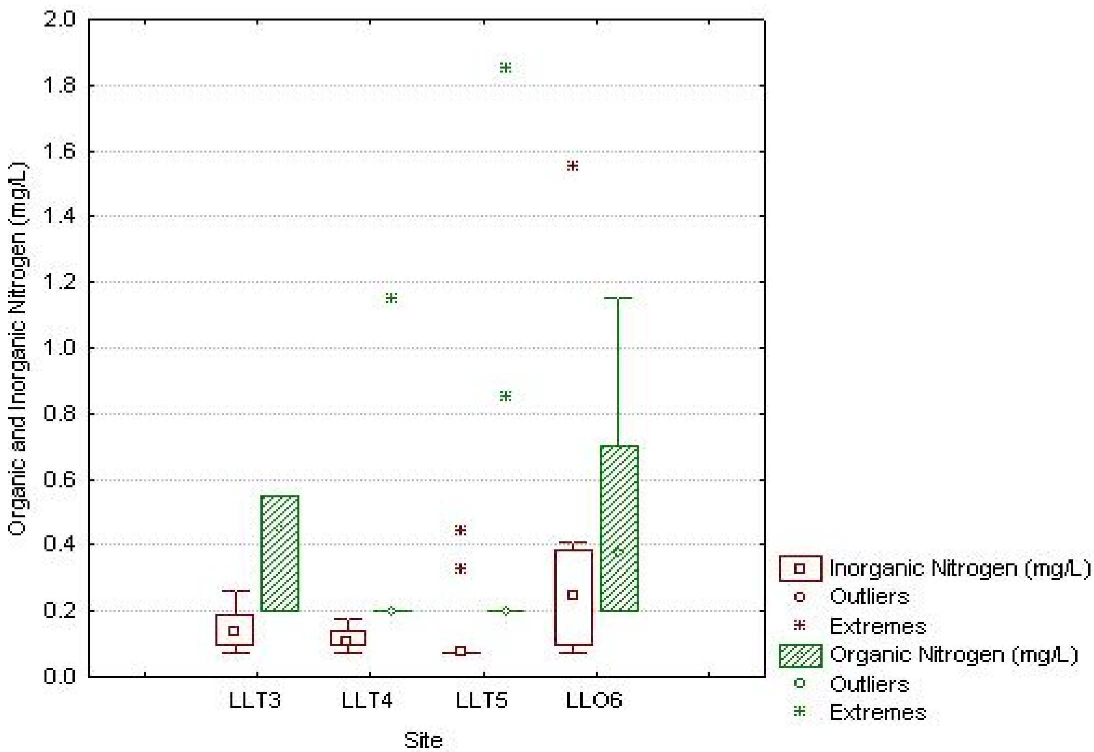

Figure 13. Box plot of organic and inorganic nitrogen by site for Legion Lake stream sites.

Ammonia is the nitrogen end-product of bacterial decomposition of organic matter. This form of nitrogen is most readily available to algae and aquatic plants for uptake and growth. Concentrations of ammonia in fresh water are highly variable. In unpolluted surface waters, ammonia concentrations can range from 0-5 mg/L. Ammonia levels in streams and lakes are primarily influenced by the amount of primary productivity and the extent of pollution from organic matter. In general, concentrations of ammonia in well-oxygenated waters are low due to rapid utilization by the algae community (Wetzel 2001).

Concentrations of ammonia observed in stream samples were extremely low. Average ammonia levels at all sites were less than the detection limit of 0.1 mg/L (Table 18).

Table 18. Descriptive statistics of ammonia (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.05	0.05	0.05	0.00	0.05	0.05	0.05
LLT-4	10	0.05	0.05	0.05	0.00	0.05	0.05	0.05
LLT-5	10	0.08	0.05	0.30	0.08	0.05	0.05	0.05
LLO-6	8	0.05	0.05	0.05	0.00	0.05	0.05	0.05

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. ammonia concentrations < 0.1 mg/L were assigned a value of 0.05 mg/L).

Nitrate/nitrite concentrations were similar among all stream sites above the lake, ranging from less than detection to 0.39 mg/L. Higher concentrations were observed at LLO-6 with a maximum concentration of 1.50 mg/L (Table 19). To protect the beneficial use of fish and wildlife propagation and stock watering, the state water quality standard for nitrates is ≤ 88 mg/L. All samples were well below this limit.

Table 19. Descriptive statistics of nitrate/nitrite (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.10	0.03	0.21	0.06	0.05	0.09	0.14
LLT-4	10	0.07	0.03	0.13	0.03	0.05	0.06	0.09
LLT-5	10	0.06	0.03	0.39	0.12	0.03	0.03	0.03
LLO-6	8	0.34	0.03	1.50	0.49	0.05	0.20	0.34

*Note: For statistical purposes, half of the reporting limit was used for sample results less than the reporting limit (e.g. nitrate/nitrite concentrations < 0.05 mg/L were assigned a value of 0.025 mg/L).

Phosphorous

Phosphorus is present in all aquatic systems. Natural sources include the leaching of phosphate-bearing rocks and organic matter decomposition. Potential anthropogenic sources of phosphorus include fertilizers and sewage.

Effects of the reservoir are apparent when comparing inlet and outlet phosphorus concentrations. Average total phosphorus concentrations were 0.11 mg/L at site LLT-3 and 0.10 mg/L at the remaining three sites (Table 20 and Figure 14). Total phosphorus annual load from the watershed was 7.3 kg, which is equivalent to 0.004 kg per watershed acre. Total phosphorus annual load measured at the outlet site was 6.3 kg. Based on these loading estimates, roughly 1 kg of phosphorus is stored in Legion Lake each year. It is expected that much of the external phosphorus load is either incorporated into aquatic plant and algal biomass or attached to suspended solids that eventually settles to the bottom of the lake.

Table 20. Descriptive statistics of total phosphorus (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.11	0.03	0.22	0.06	0.06	0.10	0.16
LLT-4	10	0.10	0.04	0.20	0.05	0.07	0.09	0.11
LLT-5	10	0.10	0.05	0.25	0.06	0.07	0.08	0.09
LLO-6	8	0.10	0.04	0.20	0.06	0.06	0.09	0.15

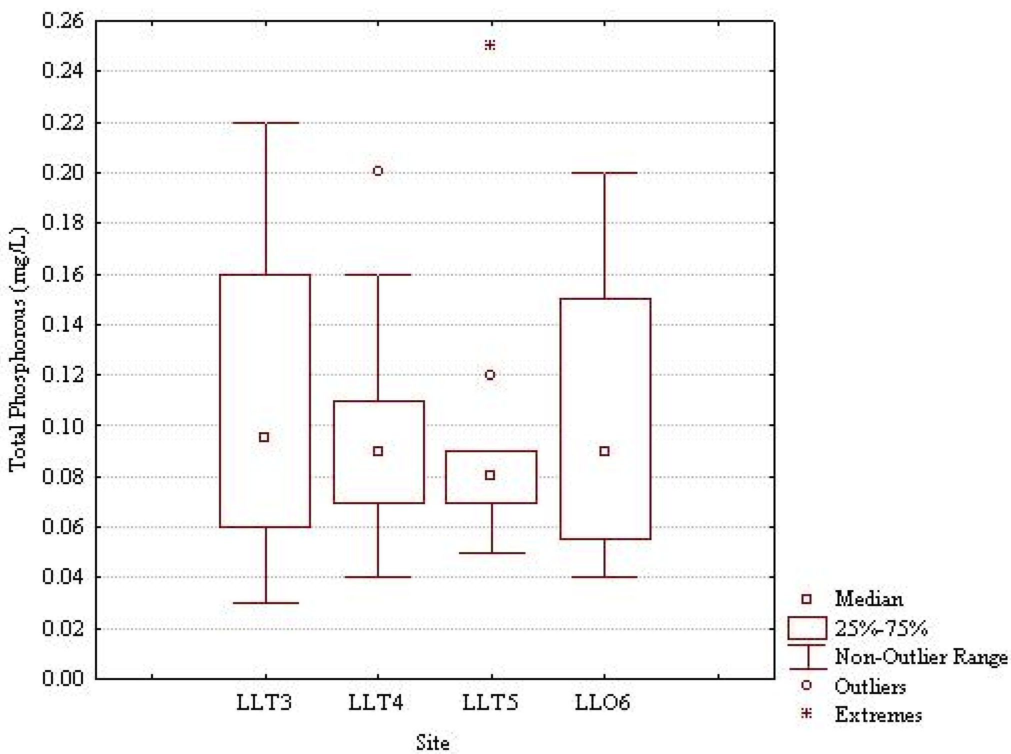

Figure 14. Box plot of total phosphorus by site for Legion Lake stream sites.

Slightly higher phosphorus loads are delivered from subwatershed LLT-3, than from subwatershed LLT-4 and the entire watershed (LLT-5). Approximately 0.012 kg/acre/year of total phosphorus is delivered from SLT-3 subwatershed, 0.009 kg/acre/year from SLT-4 subwatershed, and 0.004 kg/acre/year from the entire watershed (LLT-5).

Total dissolved phosphorus (TDP) concentration at LLT-5 was the highest and the outlet (LLO-6) was the most variable. Average TDP concentrations were 0.03, 0.04, 0.06, and 0.04 mg/L at sites LLT-3, LLT-4, LLT-5, and LLO-6, respectively (Table 21 and Figure 15).

Table 21. Descriptive statistics of total dissolved phosphorus (mg/L) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	0.03	0.01	0.08	0.02	0.02	0.03	0.04
LLT-4	10	0.04	0.02	0.07	0.01	0.03	0.04	0.04
LLT-5	10	0.06	0.01	0.08	0.02	0.05	0.06	0.07
LLO-6	8	0.04	0.01	0.07	0.02	0.02	0.03	0.06

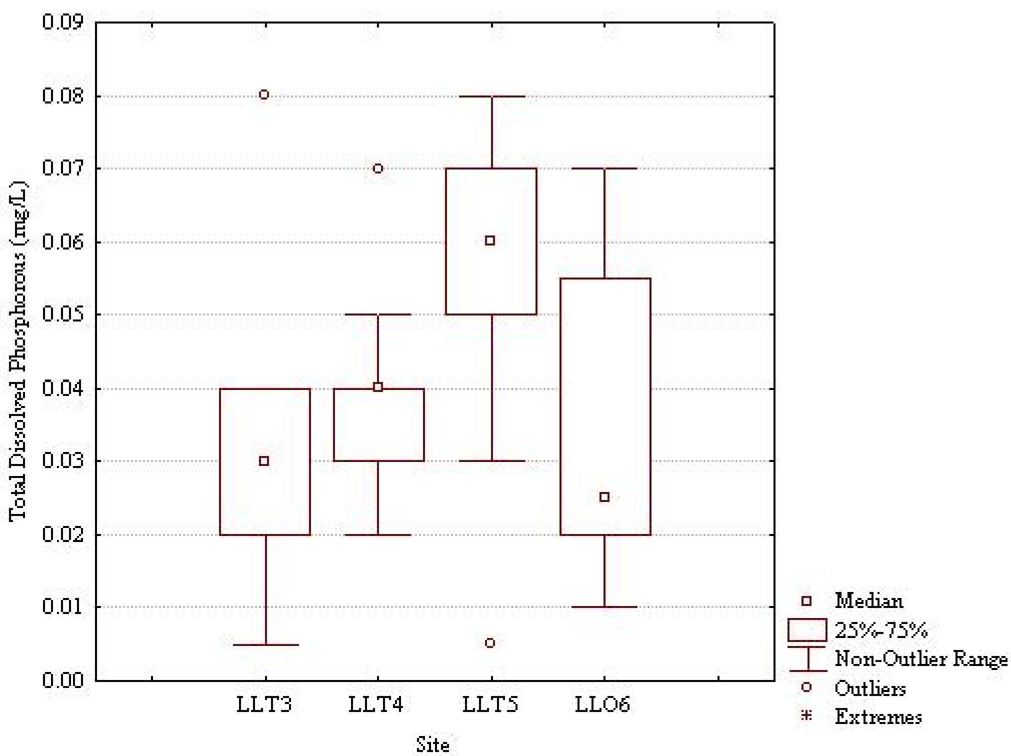

Figure 15. Box plot of total dissolved phosphorus by site for Legion Lake stream sites.

Stream Biological Parameters

Benthic Macroinvertebrate Survey

Three benthic macroinvertebrate samples were collected at two monitored stream sites (LLT-3 and LLT-5). A D-framed net (500 µm mesh size) was used to collect composite samples at three locations in a 100 m reach immediately upstream of the water quality sampling site.

Chironomidae was the most abundant family in all stream samples. Approximately 22% of all individuals were chironomids. Chironomidae (order: Diptera) is an ecologically important group of aquatic insects and often occur in high densities and diversity.

In general, Diptera taxa are considered moderately tolerant of pollution in comparison to other aquatic insect groups. The orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are considered to be more sensitive or intolerant to pollution. These more sensitive orders are often combined and measured as total "EPT" taxa. Higher numbers of EPT taxa indicate good water quality, while higher numbers of Diptera can indicate poorer water quality. A common measure or metric used to examine the relative abundances of these indicator groups is the ratio of EPT:Chironomidae. Good biological health is reflected in communities with an even distribution among all four major groups and with substantial representation in the sensitive groups (i.e. Ephemeroptera, Plecoptera, and Trichoptera).

The EPT:Chironomidae metric was one of many used to compare sites LLT-3 and LLT-4. Higher values for this metric were observed at site LLT-5, indicating larger numbers of more sensitive groups and potentially better water quality than site LLT-3 (Figure 16). The difference between the two sites was statistically significant (Kruskal-Wallis test, $p < 0.05$).

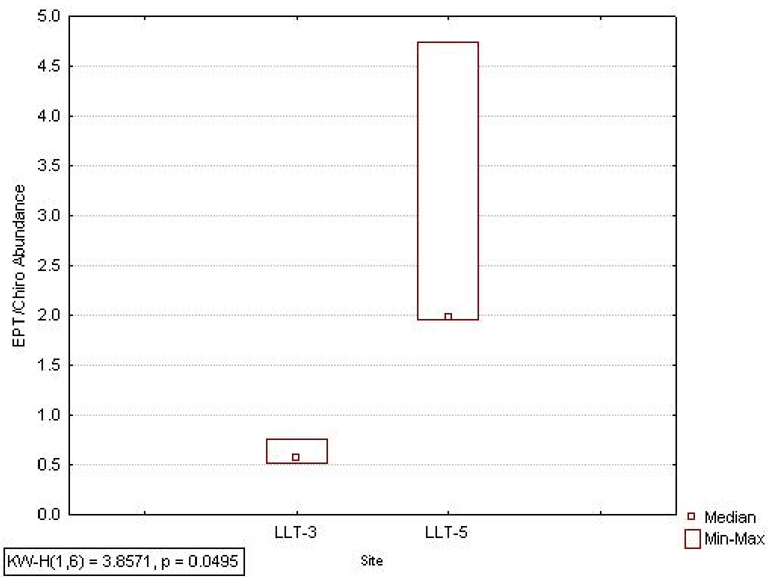

Figure 16. Ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) to Chironomidae abundances for stream sites LLT-3 and LLT-5. Box represents minimum and maximum values, and point represents median value (three samples per site).

The relative abundance of Ephemeroptera, one of the sensitive groups, was also calculated. No Ephemeroptera were collected at site LLT-3, while up to 13% of the organisms in one of the samples collected at site LLT-5 were Ephemeroptera (Figure 17). For this metric, the difference between the two sites was statistically significant (Kruskal-Wallis test, $p < 0.05$).

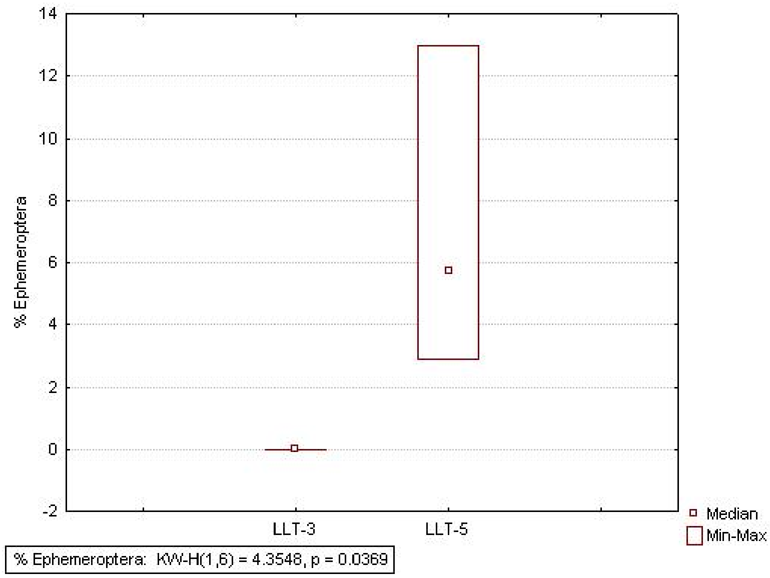

Figure 17. Ephemeroptera abundances for stream sites LLT-3 and LLT-5. This metric displayed a statistically significant difference between the two sites (Kruskal-Wallis, p < 0.05).

The relative percent of sediment tolerant taxa was calculated for each site. Sediment tolerant taxa metric was calculated by summing the relative percent abundance of taxa belonging to the following groups: oligochaetes, burrowers, gastropods, non-insects, and one tribe of chironomids (Orthocladinae). Higher numbers of sediment tolerant individuals were observed at LLT-3 (Figure 18). However, the difference between the two sites was not statistically significant (Kruskal-Wallis test, p > 0.05).

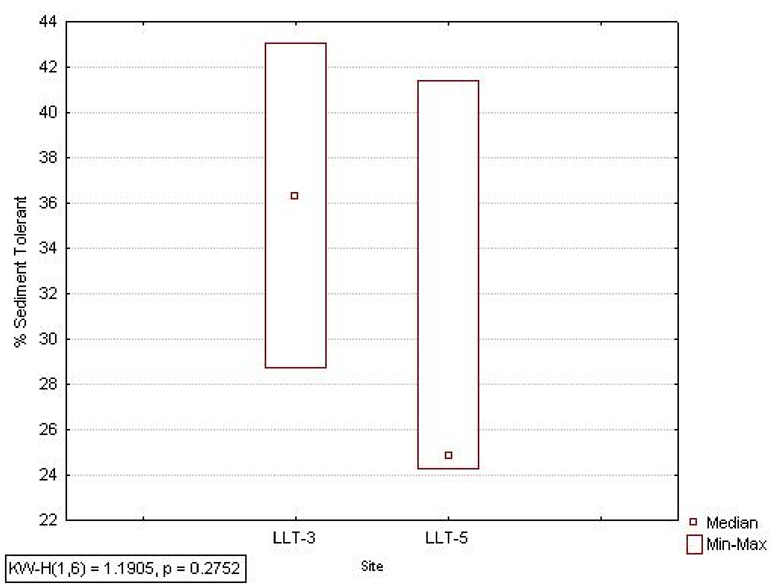

Figure 18. Percent sediment tolerant organisms for stream sites LLT-3 and LLT-5.

The Hilsenhoff Biotic Index (HBI) metric was used to examine the average tolerance to organic pollution of macroinvertebrates sampled at each site. The scale of tolerance values range from 0 to 10 and increase as water quality decreases (i.e. higher values indicate more tolerant biological communities). Samples from both sites indicate moderate tolerance to pollution. Slightly higher HBI values were observed at site LLT-5 (Figure 19), however the range of values for both sites was relatively small and the difference between the two sites was not, in this case, statistically significant (Kruskal-Wallis test, $p > 0.05$).

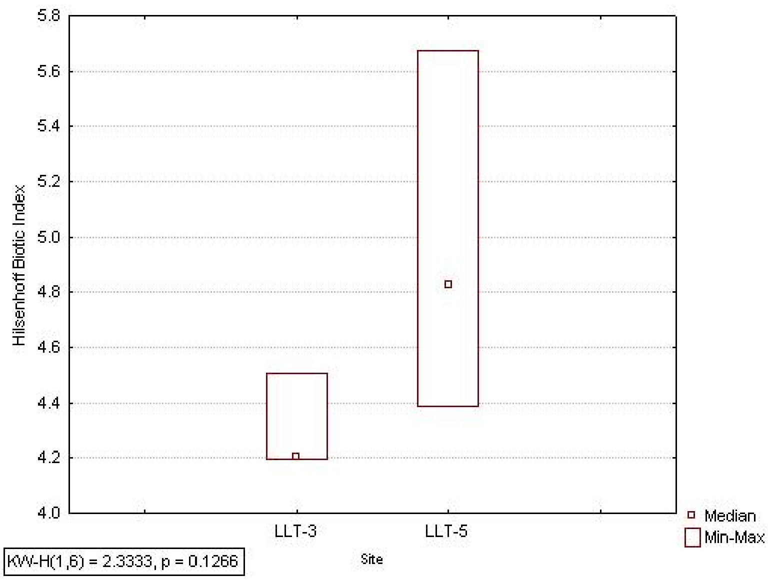

Figure 19. Hilsenhoff Biotic Index (HBI) abundances for stream sites LLT-3 and LLT-5.

Overall, macroinvertebrate data indicates average water quality at both stream sites based on the number and tolerance to pollution of organisms found in samples. However, differences between the two sites for some metrics were statistically significant. Thus, a judgment may be made concerning which of the two sites is more biologically impaired.

Sources of the biological impairment at site LLT-3 may include nutrient enrichment, sedimentation, poor stream habitat quality, and low stream flow. Most metric values indicate a healthier invertebrate community at site LLT-5. Higher numbers of sediment tolerant taxa and lower numbers of sensitive taxa were observed at site LLT-3. The biological impairments observed at site LLT-3 correlate with higher total suspended solids and nutrient concentrations and lower stream flow measured at site LLT-3. All results, including metrics and taxa list, are presented in Appendix E.

Fecal Coliform Bacteria

Fecal coliform bacteria are found in the intestinal tract of all warm-blooded animals. Although these organisms are not disease-causing organisms themselves, their presence indicates fecal contamination and a higher probability of infectious, water-borne disease.

Fecal bacteria concentrations are often highly variable. Environmental factors (e.g. sunlight exposure and water temperature) can influence concentrations of fecal bacteria in a waterway. The lifespan of fecal bacteria is relatively short compared to the associated animal waste, so the absence of fecal bacteria does not necessarily equate to the absence of animal waste.

Average fecal coliform bacteria concentrations were 38, 55, 279, and 34 colony forming units per 100 mL (CFU/100 mL) at sites LLT-3, LLT-4, LLT-5, and LLO-6, respectively (Table 22). Highest bacteria concentrations were sampled at all stream sites in July 2002. The streams in the study watershed do not have a water quality standard for fecal coliform bacteria. However, Legion Lake has a fecal coliform bacteria standard of ≤ 400 CFU/100 ml.

Concentrations of *E. coli* were also analyzed. Concentrations were minimal (<20 CFU/100 mL) or undetectable in all samples except for two. The two highest concentrations were in June at LLO-6 (120 CFU/100 mL) and July at LLT-5 (130 CFU/100 mL). Detectable concentrations of *E. coli* and higher concentration of fecal coliform bacteria during the summer months may be an indicator of the seasonal human activity in the watershed.

Table 22. Descriptive statistics of fecal coliform bacteria (CFU/100 ml) for Legion Lake stream sites.

Site	Samples	Mean	Min	Max	Stan. Dev.	Lower Quartile	Median	Upper Quartile
LLT-3	10	38	1	350	110	1	3	10
LLT-4	10	55	1	490	153	1	4	14
LLT-5	10	279	1	2700	851	1	7	30
LLO-6	8	34	1	140	54	1	8	57

Lake Physical and Chemical Parameters

Water Temperature

Water temperature in Legion Lake ranged from 1.5 to 23.5 (mean = 12.7) degrees Celsius (Figure 20). Maximum temperature was reached in July. State standards require water temperatures to be maintained below 23.9 degrees Celsius to support the beneficial use of coldwater marginal fish life propagation. This temperature limit was not exceeded.

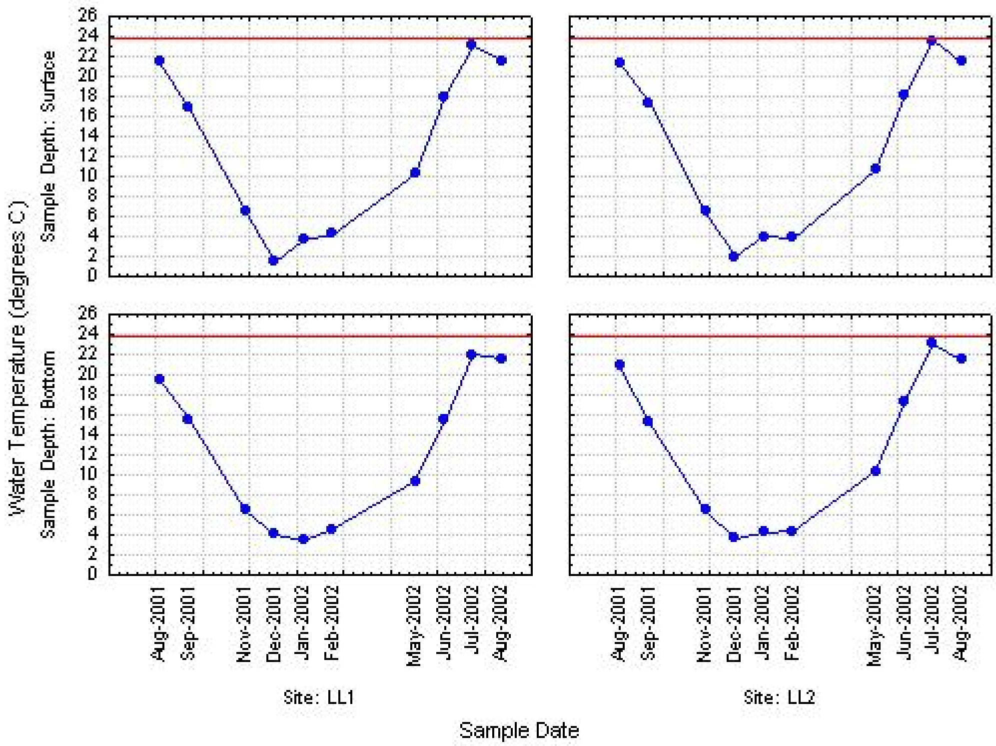

Figure 20. Water temperature by month for Legion Lake categorized by site and sample depth. Water quality standards require water temperatures to be maintained at or below 75 degrees Celsius (23.9 degrees Fahrenheit); this criterion is represented in the graph by the solid horizontal line. Temperature measurements were collected from August 2001-August 2003 (no samples were collected during October, March, or April).

Dissolved Oxygen

Dissolved oxygen (DO) is made available, in part, by photosynthetic inputs from algae and aquatic plants. Conversely, microbial degradation of dead algae and aquatic plants consumes oxygen. In eutrophic lakes (i.e. high in nutrient loading with high organic production), an elevated rate of production and subsequent decomposition of organic matter can result in low or no oxygen in the lower depths of the lake (i.e. hypolimnion) (Monson 2000). The hypolimnion can become anoxic as quickly as a few weeks after the onset of summer stratification and can remain anaerobic throughout this stratification period (Wetzel 2001).

During the summer months, DO deficient and anoxic conditions occur at bottom depths of Legion Lake. DO levels at near-surface depths were sufficient to support coldwater fish populations throughout most of the sampling season. However, levels significantly decreased during the summer months when sunlight penetration was impeded by algae growth and oxygen demand was higher in the hypolimnion (Figure 21).

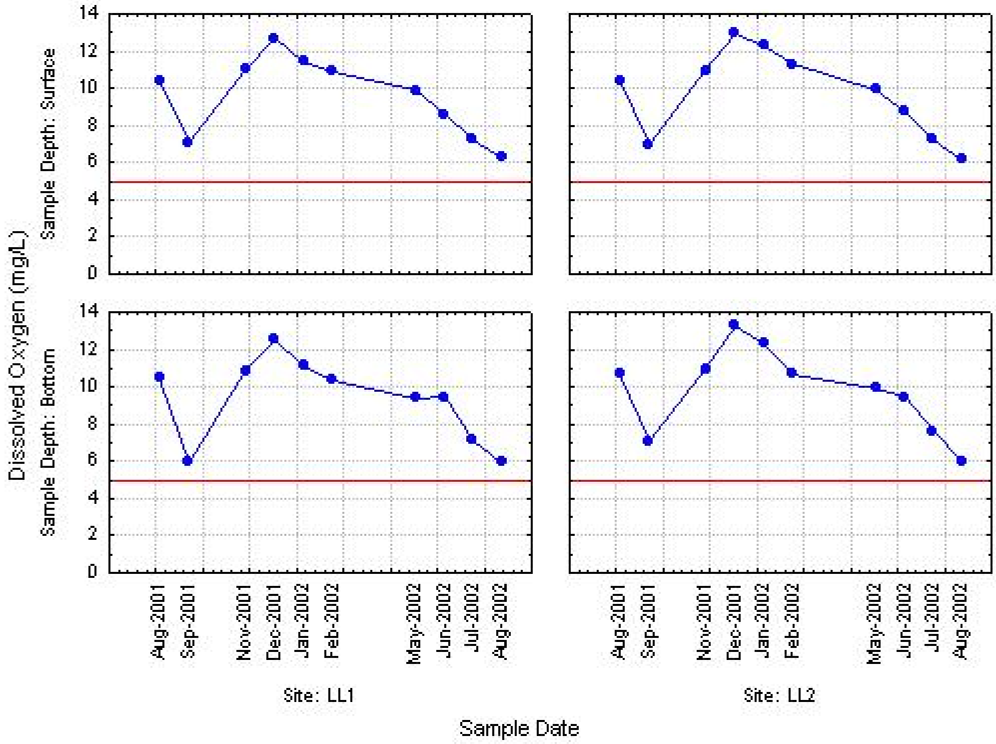

Figure 21. Dissolved oxygen by month for Legion Lake categorized by site and sample depth. Water quality standards require dissolved oxygen levels to be maintained at or above 5 mg/L; this criterion is represented in the graph by the solid horizontal line. No samples were collected during October, March, or April.

State water quality standards require DO concentrations to be maintained at or above 5.0 mg/L to support the coldwater marginal fish propagation use. All DO measurements collected during the study period were above this criterion. Surface DO values ranged from 6.2 to 13.0 mg/L (mean = 9.6). Bottom DO measurements ranged from 5.9 to 13.3 mg/L (mean = 9.6). However, it is possible that bottom measurements may not have been collected at a sufficient depth required to show a significant difference between surface and bottom DO levels. Standard operating procedures require bottom DO measurements to be collected approximately 0.5 to 1.0 ft above the lake bottom.

Temperature and DO profiles were not measured during the assessment period to determine oxygen availability and temperature conditions throughout the water column and to detect stratification. Though, summer stratification occurs annually in Legion Lake and has been observed in more recent visits. Figure 22 is a temperature and DO profile near site LL-1 collected in July 2003. This graph demonstrates summer stratification, observed in the deeper bay of Legion Lake. At the time this profile was collected, DO concentrations were less than 0.3 mg/L (i.e. anoxic) at or below a depth of 5 meters. Still, sufficient refuge for fish was available at more shallow depths, where oxygen concentrations remained above the water quality criterion.

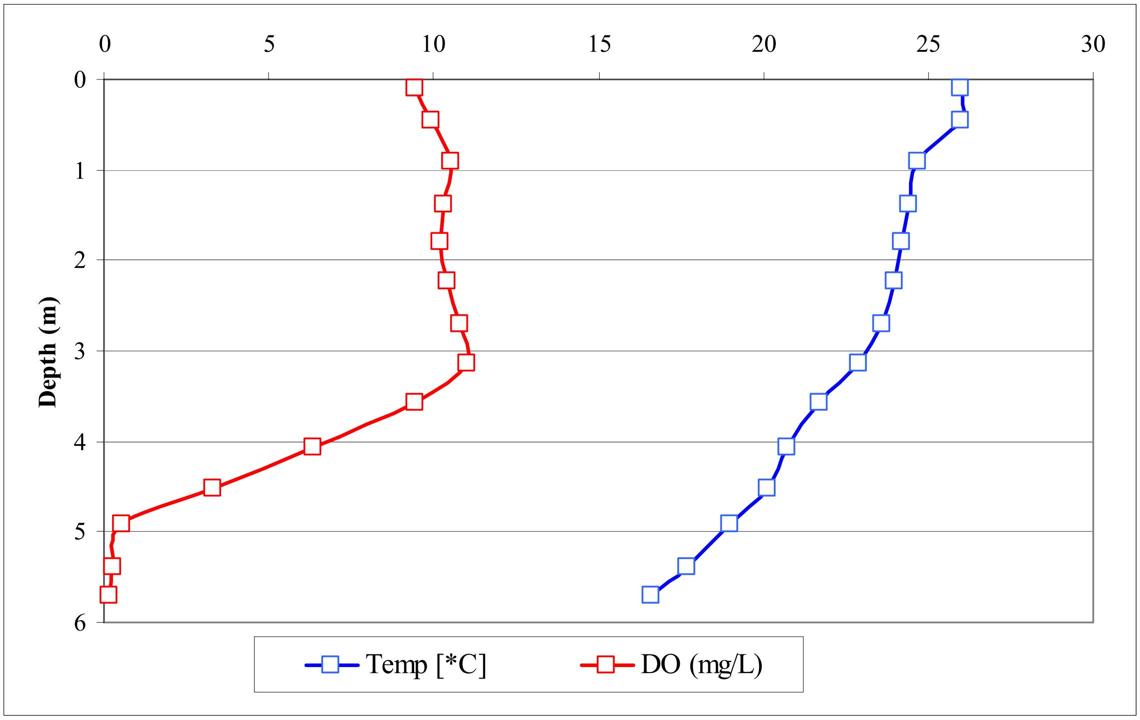

Figure 22. Temperature and dissolved oxygen profile for Legion Lake near site LL-1 on July 21, 2003.

Acidification and Alkalinity

As previously stated, the primary measurements of acidification are alkalinity and pH. In Legion Lake, pH values ranged from 7.6 to 9.3 (mean = 8.6). The pH water quality criterion for Legion Lake is a range of 6.5 to 8.8. The upper limit of this standard was exceeded during the months of May, June, July, August, and September. Seventeen of 40 pH measurements (43%) exceeded the upper limit of the pH standard (Figure 24).

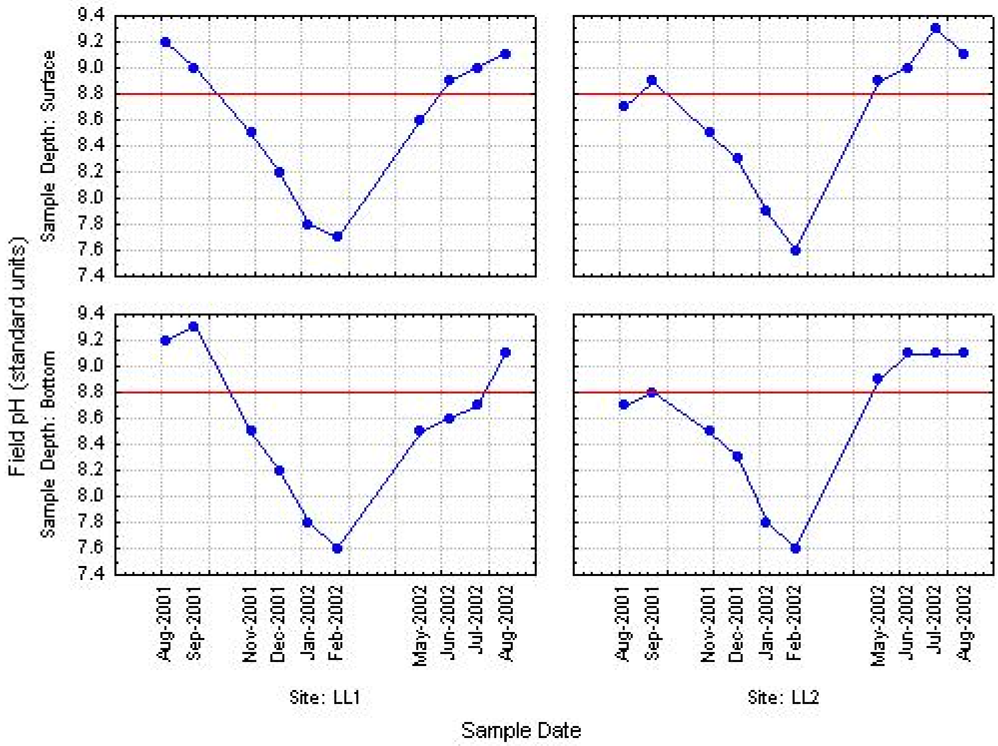

Figure 23. pH by month for Legion Lake categorized by site and sample depth. Water quality standards require pH levels to be maintained 6.5 and 8.8 standard units; this criterion is represented in the graph by the solid horizontal line. Approximately 43% of all pH measurements exceeded the upper limit of the pH standard.

This increase in pH is attributed to the photosynthetic utilization of CO_2 by algae and aquatic plants. Management practices recommended to reduce phosphorus loads, thereby reducing algae growth, are expected to also reduce the pH of Legion Lake to a level that meets criteria established to protect the coldwater permanent fish life propagation use.

High pH in Legion Lake is also attributed, in part, to natural background sources. Because natural sources are considered uncontrollable, this report does not address a strategy to control these sources. The pH impairment will be addressed in a future report and/or TMDL.

Alkalinity concentrations ranged from 36 to 110 mg/L (mean = 63.2). The alkalinity concentrations in Legion Lake are well below the water quality standard, which is ≤1,313 mg/L. Concentrations were low throughout the sampling period, with the highest concentrations recorded during the winter months (Figure 24).

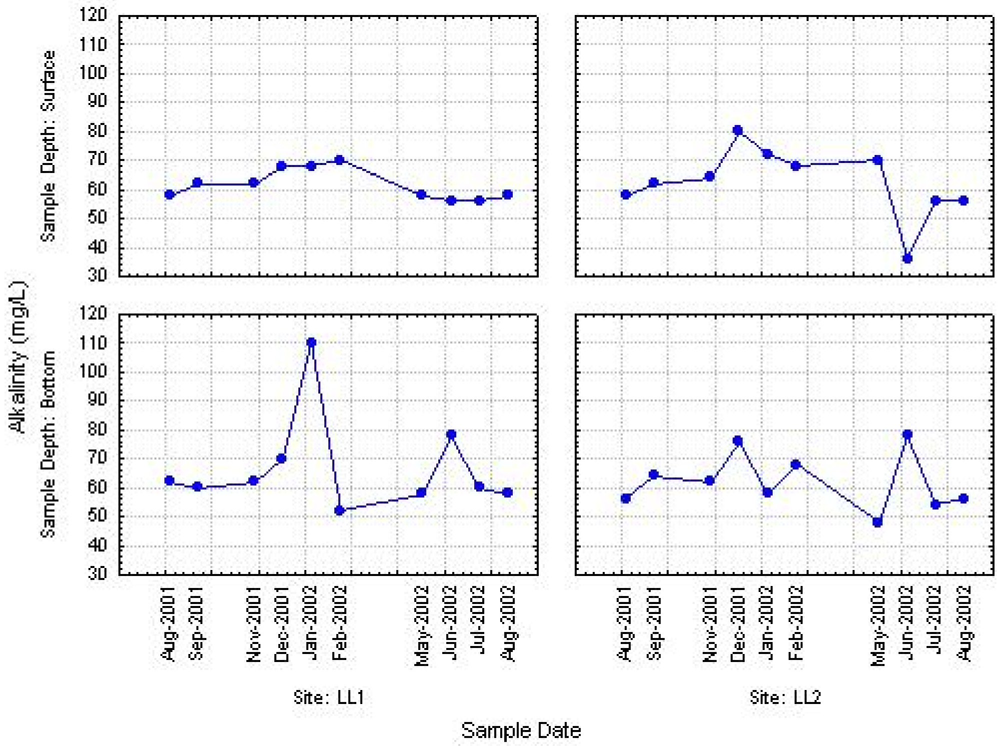

Figure 24. Alkalinity concentrations by month for Legion Lake categorized by site and sample depth.

Solids

Total solids concentrations in Legion Lake ranged from 94 to 350 mg/L (mean = 136). In general, concentrations were lower during the summer months. Ice contamination is suspected to be the cause of the elevated surface sample concentrations in January (Figure 25). The surface sample concentration taken from site LL-2 during July 2002 (350 mg/L) was determined to be an error in sampling or laboratory testing, and was omitted from Figure 25.

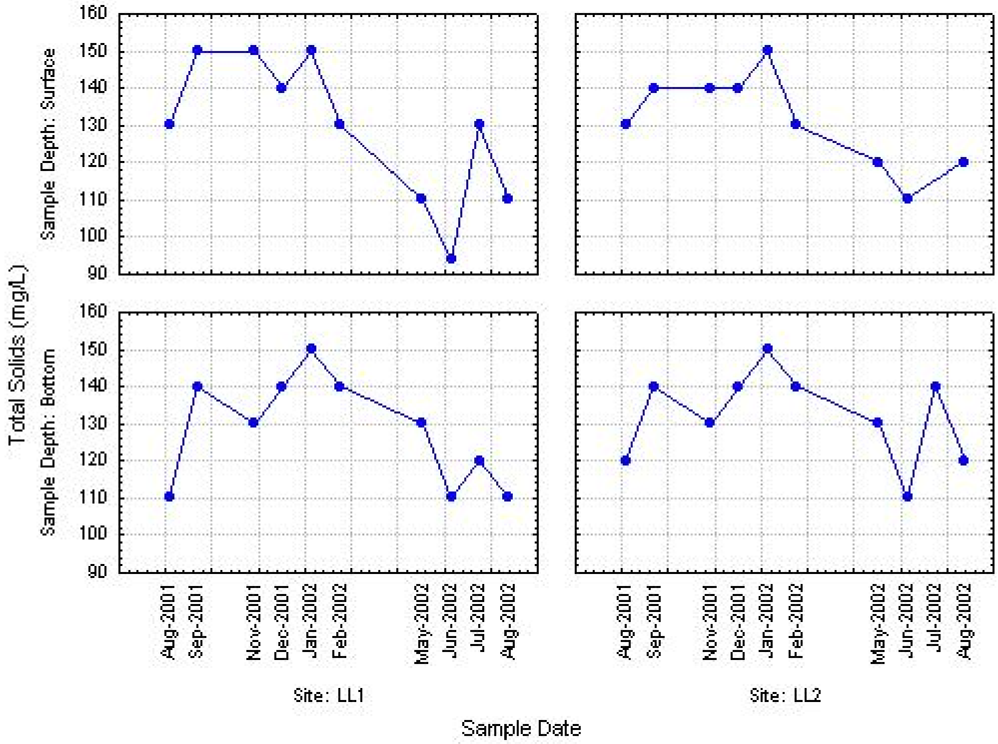

Figure 25. Total solids concentrations (outlier removed) by month for Legion Lake categorized by site and sample depth.

Typical of most waterways, total solids were mostly comprised of dissolved solids. Concentrations of dissolved solids were calculated by subtracting suspended solids from total solids and ranged from 92 to 348 mg/L (mean = 132). Minimum concentrations of dissolved solids were observed in June at all lake sampling locations (Figure 26). The sample collected from site LL-2 during July 2002 (348 mg/L) was omitted from Figure 27 due to sampling or laboratory error.

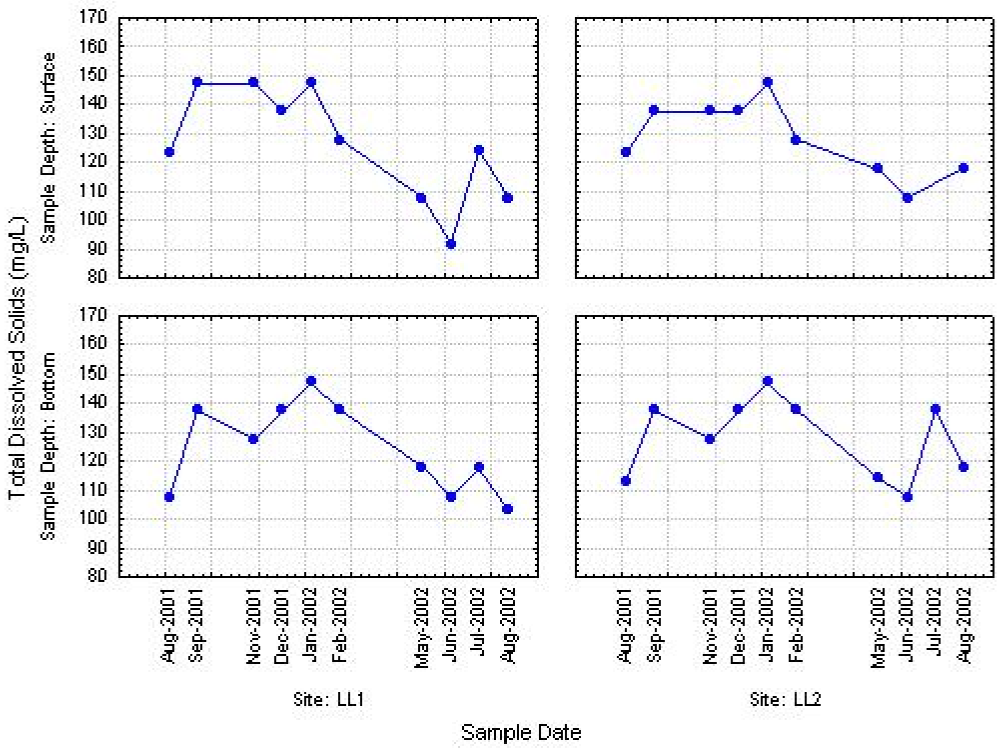

Figure 26. Total dissolved solids concentrations (outlier removed) by month for Legion Lake categorized by site and sample depth.

Total suspended solids (TSS) concentrations ranged from non-detectable levels to 16 mg/L (mean = 4). TSS concentrations displayed seasonality at all sampling locations. Concentrations only reached detectable levels during spring and summer months (Figure 28).

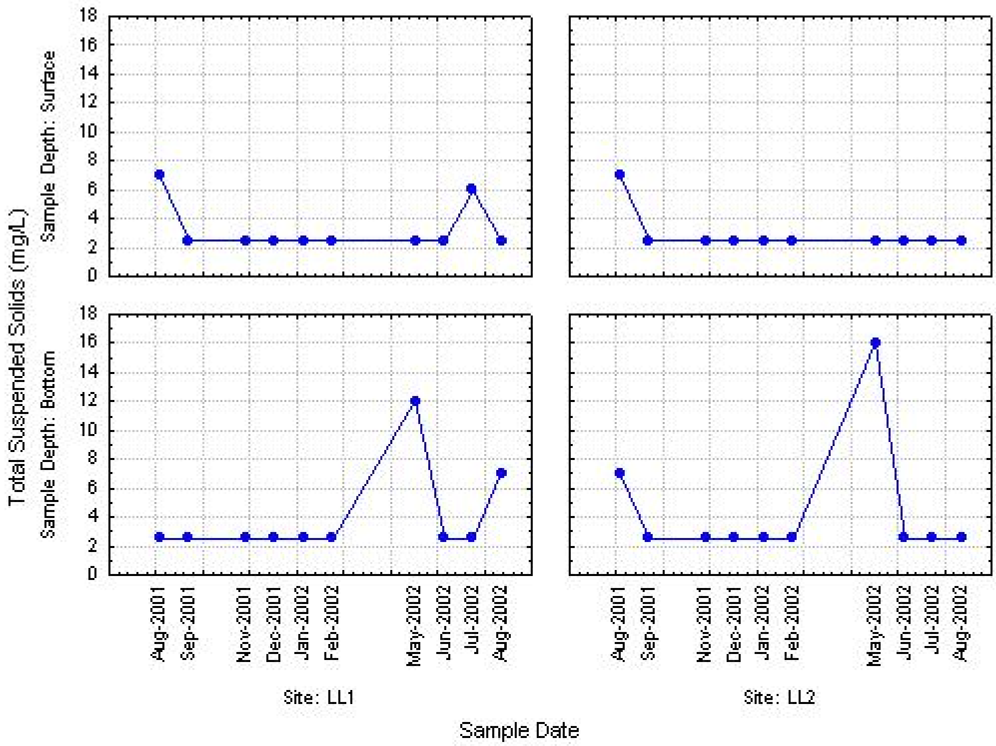

Figure 27. Total suspended solids concentrations by month for Legion Lake categorized by site and sample depth.

Nitrogen

Several forms of nitrogen can be found in a water body. Natural sources of nitrogen include precipitation, biological processes (i.e. nitrogen fixation), wildlife waste, and surface and groundwater drainage. Anthropogenic nitrogen sources include sewage inputs of organic nitrogen, fertilizer applications, and livestock waste.

Ammonia levels were below the detection limit (0.01 mg/L) during all but one of the sampling events. All values below detection limits were assigned half of the limit to allow calculation of statistics. Concentrations were above the detection limit in September 2001 at a maximum concentration of 0.20 mg/L. All ammonia concentrations were below the water quality standard.

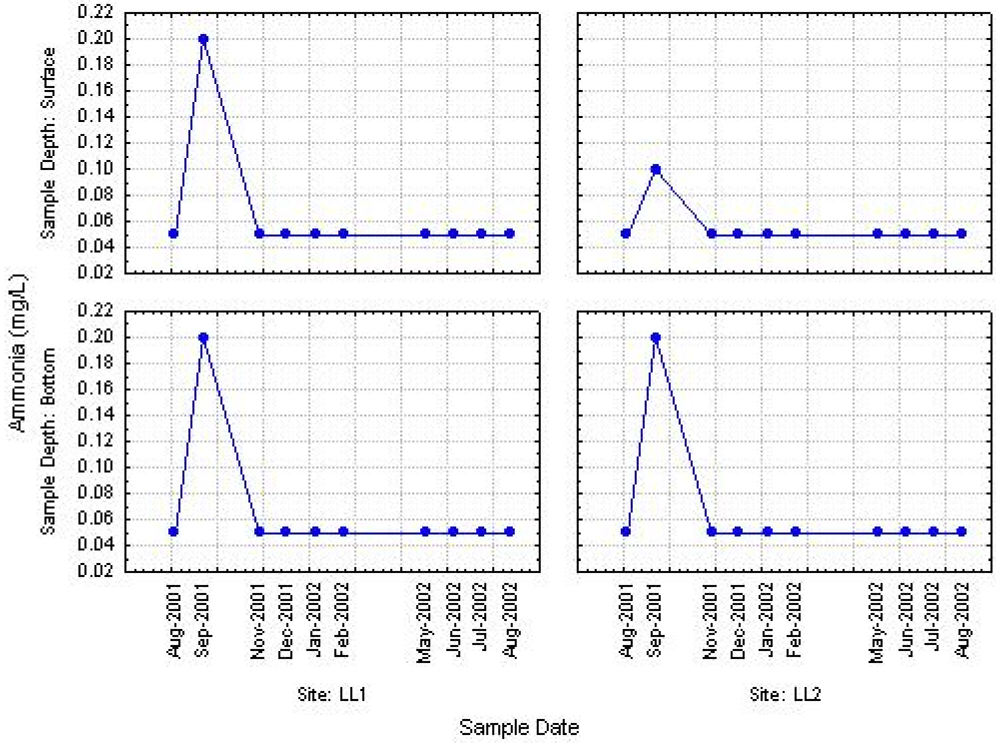

Figure 28. Ammonia concentrations by month for Legion Lake categorized by site and sample depth.

Nitrate is usually present in low concentrations in natural waters, yet it is often the most abundant inorganic form of nitrogen. Natural concentrations rarely exceed 10 mg/L and are normally less than 1 mg/L (Lind 1985). Nitrate/nitrite concentrations of all samples collected from Legion Lake were below detection limits (0.05 mg/L).

Total nitrogen was calculated by adding Total Kjeldahl Nitrogen (TKN) and nitrate/nitrite concentrations. Because no nitrate/nitrite was detected in Legion Lake samples, total nitrogen is equivalent to TKN. Total nitrogen values were used to determine whether nitrogen is a limiting nutrient in Legion Lake (see limiting nutrient section). Total nitrogen in Legion Lake ranged from 0.28 to 1.23 mg/L (mean = 0.66) (Figure 29).

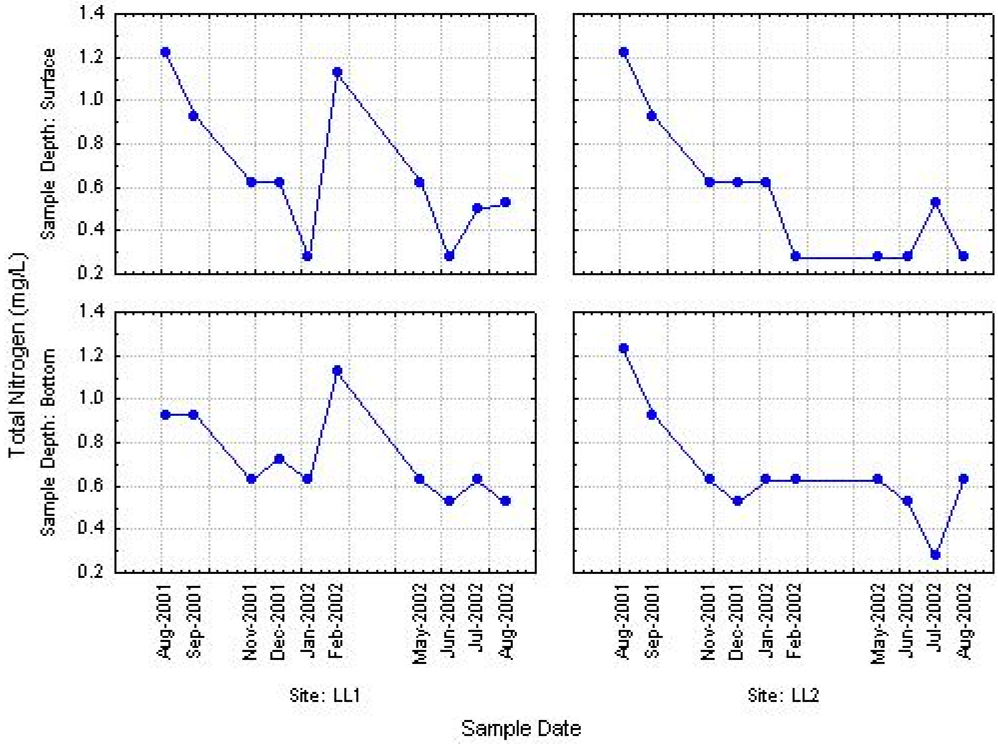

Figure 29. Total nitrogen concentrations by month for Legion Lake categorized by site and sample depth.

Phosphorus

Like nitrogen, phosphorus is a biologically active element. It cycles through different states in the aquatic environment, and its concentration in any one state depends on the degree of biological assimilation or decomposition occurring in that system. The predominant inorganic form of phosphorus in lake systems is orthophosphate. Concentrations of orthophosphate were measured as total dissolved phosphorus (TDP) in this study. Phosphorus is often a limiting nutrient to algae and macrophyte production within many aquatic systems. Loading of this nutrient presents an increased eutrophication (primary production) risk.

Total phosphorus concentrations of non-polluted waters are usually less than 0.1 mg/L (Lind 1985). Total phosphorus values in Legion Lake ranged from less than detection to 0.06 mg/L (mean = 0.03). Samples with the highest concentrations were collected in September of 2001. Bottom sampling depth of site LL-2 experienced the lowest total phosphorus concentrations of all sampling locations during May through August (Figure 30).

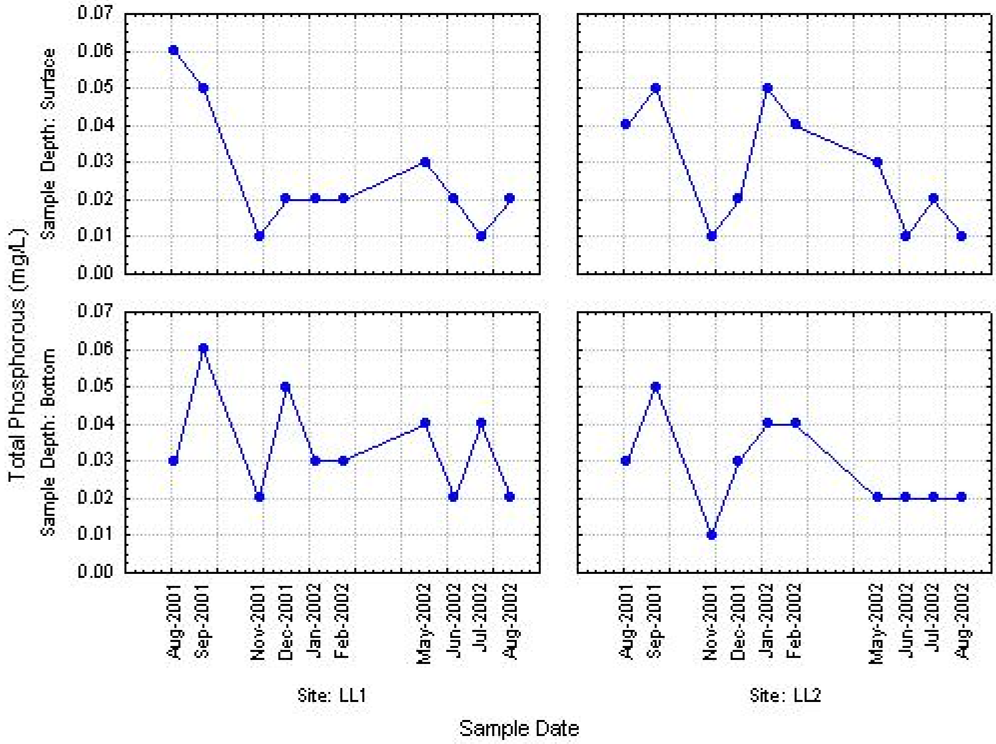

Figure 30. Total phosphorus concentrations by month for Legion Lake categorized by site and sample depth.

TDP is the portion of total phosphorus that is readily available for plant and algae utilization. TDP concentrations in non-polluted waters are usually less than 0.01 mg/L (Lind 1985). TDP concentrations in Legion Lake ranged from below detection limits to 0.04 mg/L (mean = 0.01). Surface concentrations were at or above the minimum amount for rapid algal growth during August and September 2001 and May 2002, which typically requires only 0.02 mg/L (Figure 31).

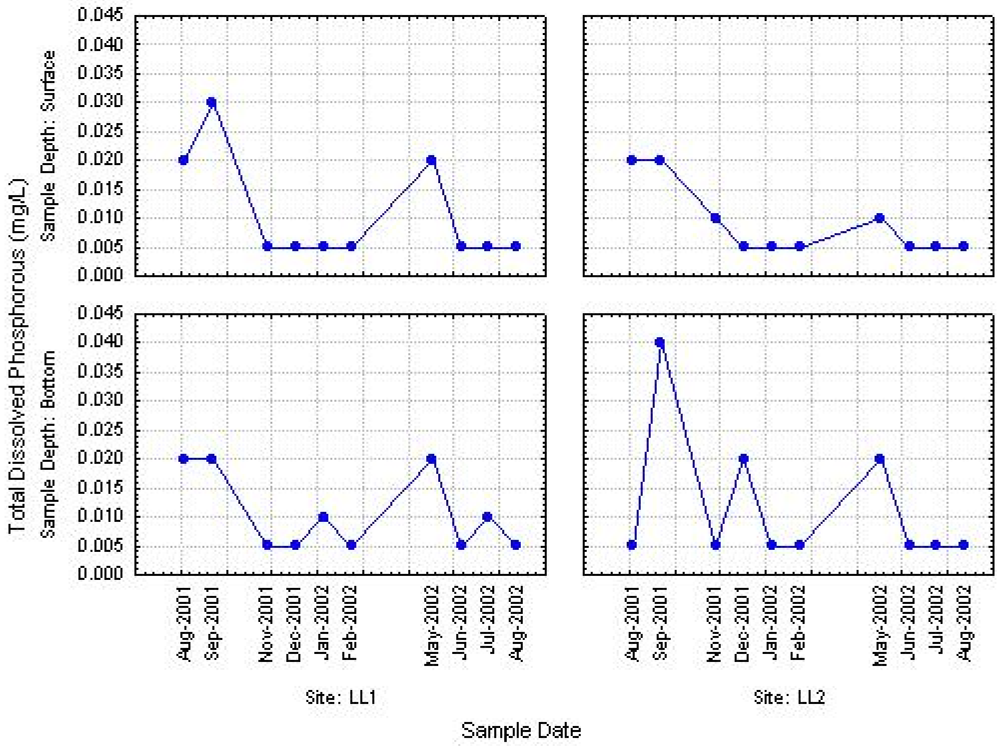

Figure 31. Total dissolved phosphorus concentrations by month for Legion Lake categorized by site and sample depth.

Limiting Nutrients

Great emphasis is placed on regulating nutrient loading to water bodies to control aquatic productivity (i.e. eutrophication). In aquatic systems, the most significant nutrient factors causing the shift from a lesser to a more productive state are phosphorus and nitrogen. Nitrogen is difficult to control because of its highly soluble nature, but phosphorus is easier to manipulate from a management perspective. Consequently, it is most often the nutrient targeted for reduction when attempting to control lake eutrophication.

When either nitrogen or phosphorus reduces the potential for algal growth and reproduction, it is considered the limiting nutrient. Optimal nitrogen and phosphorus concentrations for aquatic plant growth occur at a ratio of 10:1 (N:P ratio). N:P ratios greater than 10:1 indicate a phosphorus limited system, while N:P ratios less than 10:1 indicate a nitrogen-limited system (USEPA, 1990).

N:P ratios of all Legion Lake samples ranged from approximately 6.9 to 62.5 (mean = 26.8). 95% of samples collected in Legion Lake were considered phosphorus-limited. N:P ratios were generally lower in the winter and increased throughout the spring and summer months (Figure 32). The sample collected in November revealed the highest case of phosphorus limitation (N:P = 62.5). The ratios varied fairly substantially from month to month, but only became nitrogen-limited during the February and May samples at LL-2A.

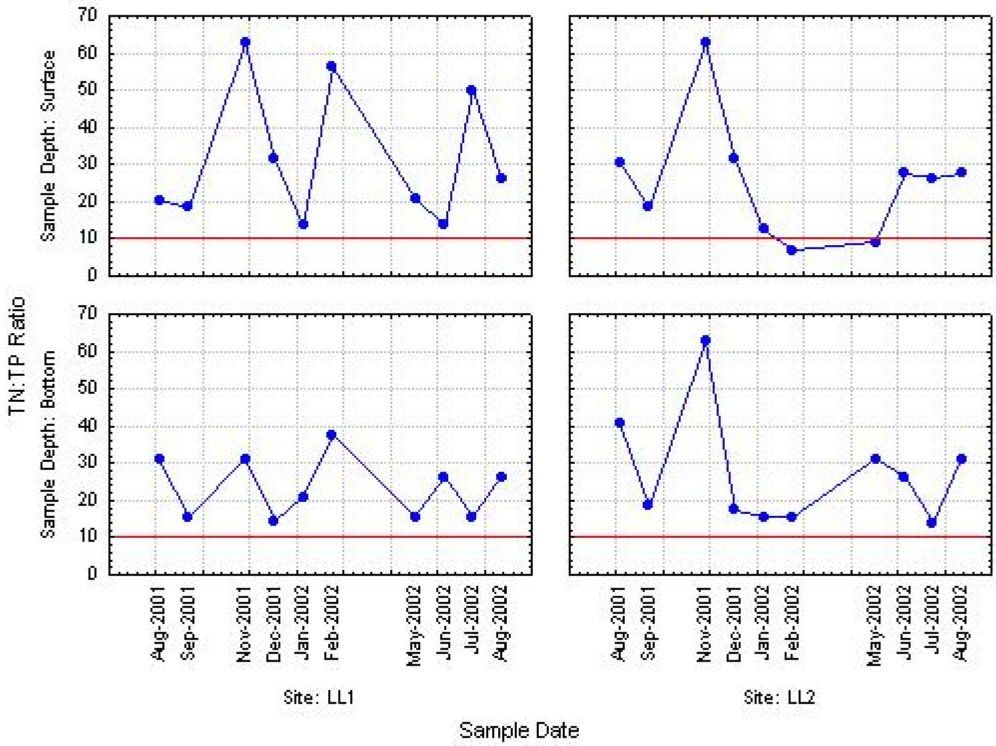

Figure 32. Nitrogen:phosphorus ratios by month for Legion Lake categorized by site and sample depth. The solid horizontal line represents the optimal nitrogen and phosphorus concentrations for aquatic plant growth (ratio of 10:1). Ratios greater than 10:1 indicate a phosphorus limited system, while ratios less than 10:1 indicate a nitrogen-limited system.

Trophic State

Wetzel (2001) defines 'trophy' of a lake as "the rate at which organic matter is supplied by or to a lake per unit time." Trophic state is often measured as the amount of algal production in a lake, one source of organic material. Determinations of trophic state can be made from several different measures including oxygen levels, species composition of lake biota, concentrations of nutrients, and various measures of biomass or production. An index incorporating several of these parameters is best suited to determine trophic state.

Carlson's (1977) Trophic State Index (TSI) was used to determine the approximate trophic state of Legion Lake. This index incorporates measures of Secchi disk transparency, chlorophyll *a*, and total phosphorus into scores ranging from 0 to 100 with each 10-unit increase representing a doubling in algal biomass. Four ranges of index values (Table 23) define Carlson's trophic levels, which include oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic (in order of increasing productivity).

Table 23. Carlson's trophic levels and index ranges for each level.

Trophic Level	TSI Range
Oligotrophic	0 – 35
Mesotrophic	36 – 50
Eutrophic	51 – 65
Hyper-eutrophic	66 – 100

TSI values were calculated for each of the index parameters individually. The number of samples/measurements used to calculate individual TSI values varied by parameter and year. Only surface samples/measurements from sites LL-1A and LL-2A of this study, as well as historical and more recent data, were used for TSI calculations. Phosphorus samples were collected during the SD DENR Statewide Lakes Assessment (SWLA) program twice per year during the years 1989, 1991, 1992, 1999; semi-monthly during this study from August 2001 to August 2002; and again during SWLA in June and July of 2003. Secchi depth measurements were collected at the same time as phosphorous samples, except during ice cover in December and January. Chlorophyll *a* samples were collected only during June and July 1991, August 1993, and June and July 1999 and 2003 (note that chlorophyll samples were collected as part of SD DENR statewide lakes assessment program, not during the study period).

Phosphorus TSI values ranged from 37.4 to 69.8 (mean = 52.4), chlorophyll *a* TSI values ranged from 47.0 to 71.2 (mean = 54.4), and Secchi depth TSI values ranged from 36.8 to 68.7 (mean = 48.7). Approximately 54% of phosphorus TSI values indicate eutrophic conditions, and 46% were in the mesotrophic range. Approximately 38% of the Secchi depth measurements indicated eutrophic conditions, and 62% were in the mesotrophic range. Of the seven chlorophyll samples, three were mesotrophic, three were eutrophic, and one was recorded as hyper-eutrophic in July of 1999. See Table 24 for descriptive statistics of available TSI data for Legion Lake.

Table 24. Descriptive statistics for trophic state index (TSI) values calculated from direct measurements and samples collected from Legion Lake from 1989-2003.

Statistic	Phosphorus TSI	Chlorophyll TSI	Secchi TSI
Number of Samples	28	7	24
Average	52.4	54.4	48.7
Median	53.2	51.3	47.6
Minimum	37.4	47.0	36.8
Maximum	69.8	71.2	68.7
Standard Deviation	9.6	8.3	8.6

Beneficial use attainment for Legion Lake was also assessed using TSI values. SD DENR currently uses fishery-based TSI criteria to evaluate beneficial use attainment. TSI criteria are established for each fishery classification for samples collected during the index period May 15 to September 15. Legion Lake is classified as a cold water marginal fishery, and the applicable TSI criterion is a median chlorophyll and Secchi depth TSI ≤ 53 (Lorenzen, 2005). While several individual measurements exceeded the criterion, median TSI values for chlorophyll, Secchi depth, and combined chlorophyll and Secchi depth are all below the criterion (Figure 33).

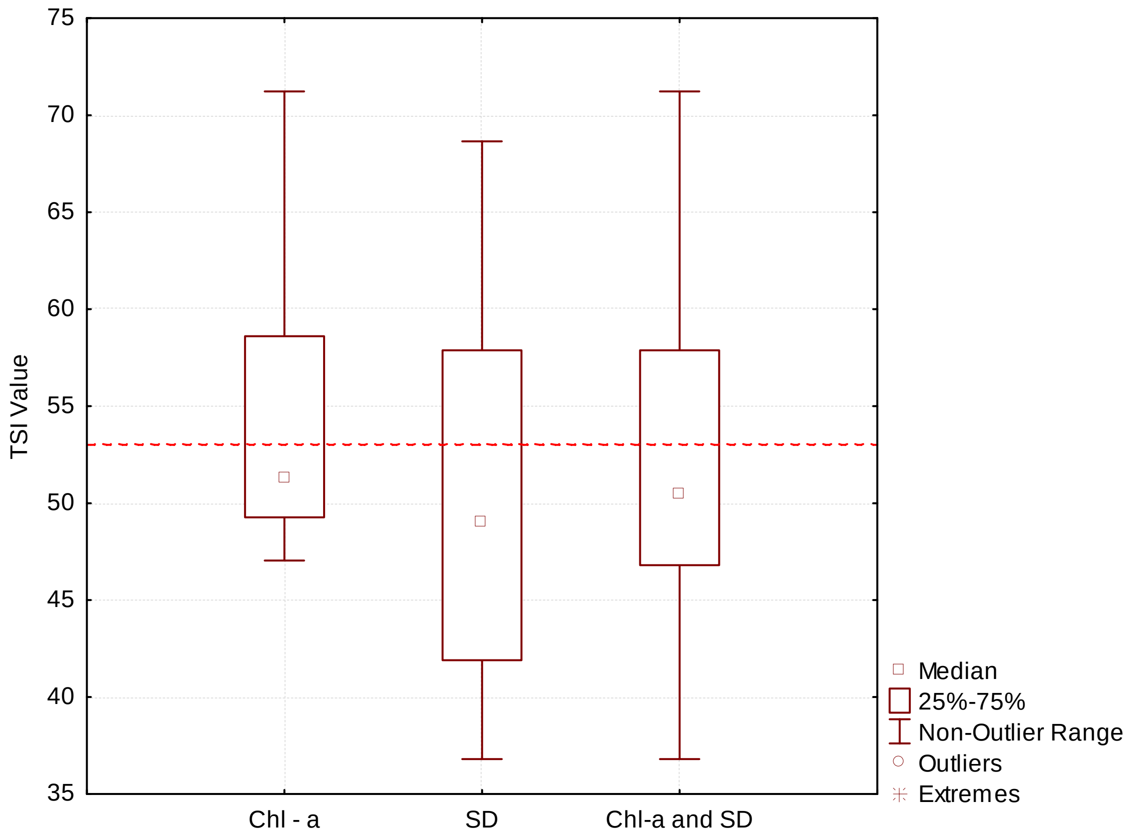

Figure 33. Chlorophyll-*a* and Secchi depth TSI values for samples collected during 1989-2003. Horizontal, dashed line represents TSI criterion (≤ 53 for coldwater marginal fishery). Note the median TSI value for combine chlorophyll-*a* and Secchi data is less than 53, indicating fully supporting status.

Historic TSI data was compiled to examine trends in trophic state. The limited historical chlorophyll TSI data did not correlate well with the phosphorus and Secchi TSI data. Annual average phosphorus and Secchi TSI values were significantly correlated (Spearman Rank *rho*=0.96) and appear to be declining (Table 25 and Figure 34).

Table 25. Historic TSI values for Legion Lake. Values represent averages for each year.

Year	Total Phosphorus	Chlorophyll *a*	Secchi Depth
1989	65.6	m	58.9
1991	69.8	47.0	57.9
1992	58.4	56.2	55.6
1999	59.0	60.3	56.4
2001	51.4	m	50.6
2002	48.7	m	43.0
2003	41.7	50.4	39.8

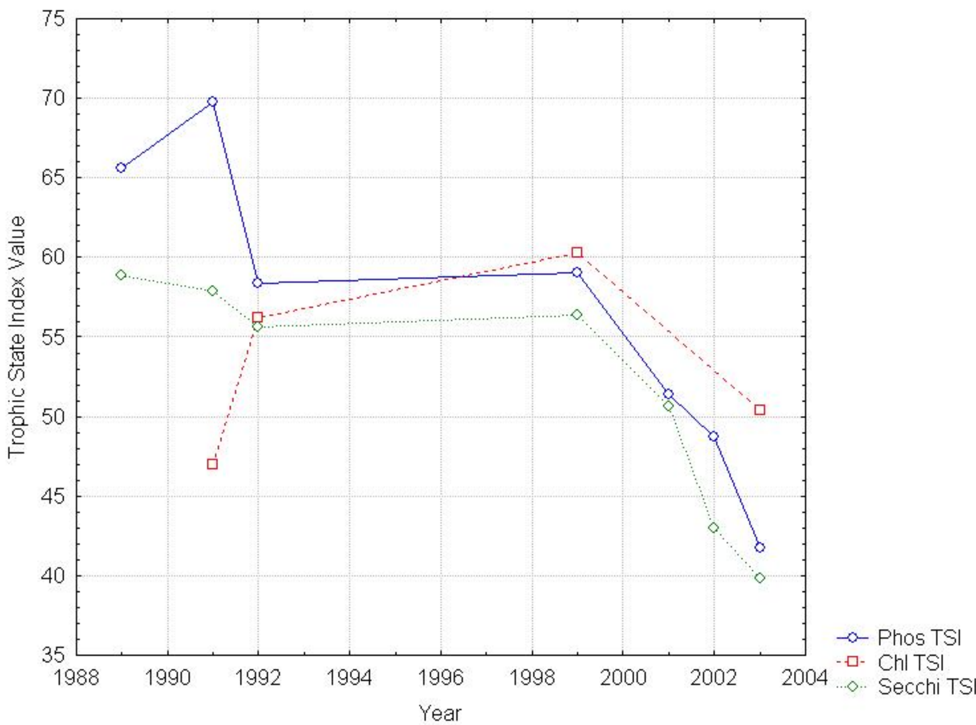

Figure 34. Historic Trophic State Index Values for Legion Lake (1989-2003).

Lake Biological Parameters

Fishery

The South Dakota Department of Game, Fish, and Parks (SDGF&P) last conducted a fishery survey in May of 1996. The survey consisted of one 1/4" (baby) frame net set, two 3/4" frame net sets, and four 150' experimental sinking gill net sets.

Rainbow trout, largemouth bass, creek chub, and fathead minnows were collected during the fish survey. Minimal populations of creek chub and fathead minnows were sampled. A total of 1 fathead minnow and 2 creek chub were collected.

Legion Lake is managed as a "put and take" rainbow trout fishery. Twenty-six hatchery rainbow trout were captured by gill nets. Annual scheduled stocking of catchable rainbow trout and occasional supplemental stocking of adult rainbow trout maintains a viable trout fishery. On average, approximately 10,400 rainbow trout (catchable size) are stocked annually. It is expected that very little trout reproduction is occurring in the lake or inlet streams. The complete SD GF&P fish survey report can be found in Appendix B.

Fecal Coliform Bacteria

The beneficial use of immersion recreation is assigned to Legion Lake. Fecal coliform bacteria concentrations must be ≤ 400 CFU/100 ml in any single sample to support this use. Legion Lake samples did not show detectable fecal coliform bacteria concentrations.

Concentrations of *E. coli* bacteria in lake samples were also analyzed, and were not detected.

Quality Assurance/Quality Control

Proper laboratory and field sampling methods require that quality assurance and quality control (QA/QC) samples be collected. Ten QA/QC samples were taken during the project period, during which a total of 88 samples were collected. The QA/QC samples represent 11.4% of the total samples collected, exceeding the minimum requirement of 10%. The ten QA/QC samples were all replicate samples collected on randomly chosen dates from Legion Lake or one of its tributaries. No blank samples were collected/submitted. Standard chemical analysis was completed on each sample.

Replicate samples were compared to the routine samples using the industrial statistic (%I). The value given is the absolute difference between the routine and the replicate sample in percent, as follows:

Equation 1. Industrial statistic equation.

$$\%I = ABS[(A-B)/(A+B)*100]$$

%I = Industrial Statistic
ABS = Absolute Value
A = Parameter value for replicate sample
B = Parameter value for routine sample

The average percent differences for analyzed parameters ranged from 0.0% to 14.5%. The following three parameters had an average percent difference greater that 10%: total Kjeldahl nitrogen, total solids, and fecal coliform. The difference between replicate and routine samples for these parameters may be due to contamination of the sample bottles/distilled water by the field sampler, natural variability, or a laboratory error. Overall, approximately 77% of all sample pair difference estimates were less than 10%. See Appendix E for all QA/QC data.

Other Monitoring

Sediment Survey

Sedimentation continues to be one of the most destructive pollutants of lakes and streams. This impairment can increase phosphorus concentrations, decrease habitat availability for invertebrates and fish, and decrease the depth of the water body.

A sediment survey was conducted for Legion Lake in December 2003. Water depth and sediment depth was measured with a steel probe through holes drilled in the ice. Water depth and sediment depth was recorded at each site (166 sampling locations) with Global Positioning System (GPS) equipment.

Sediment depths in Legion Lake ranged from 0.4 to 4 feet (mean = 1.6). Using survey data, a sediment depth contour map was produced and total sediment volume was calculated (Figure 35). Sediment volume is approximately 22,000 cubic yards.

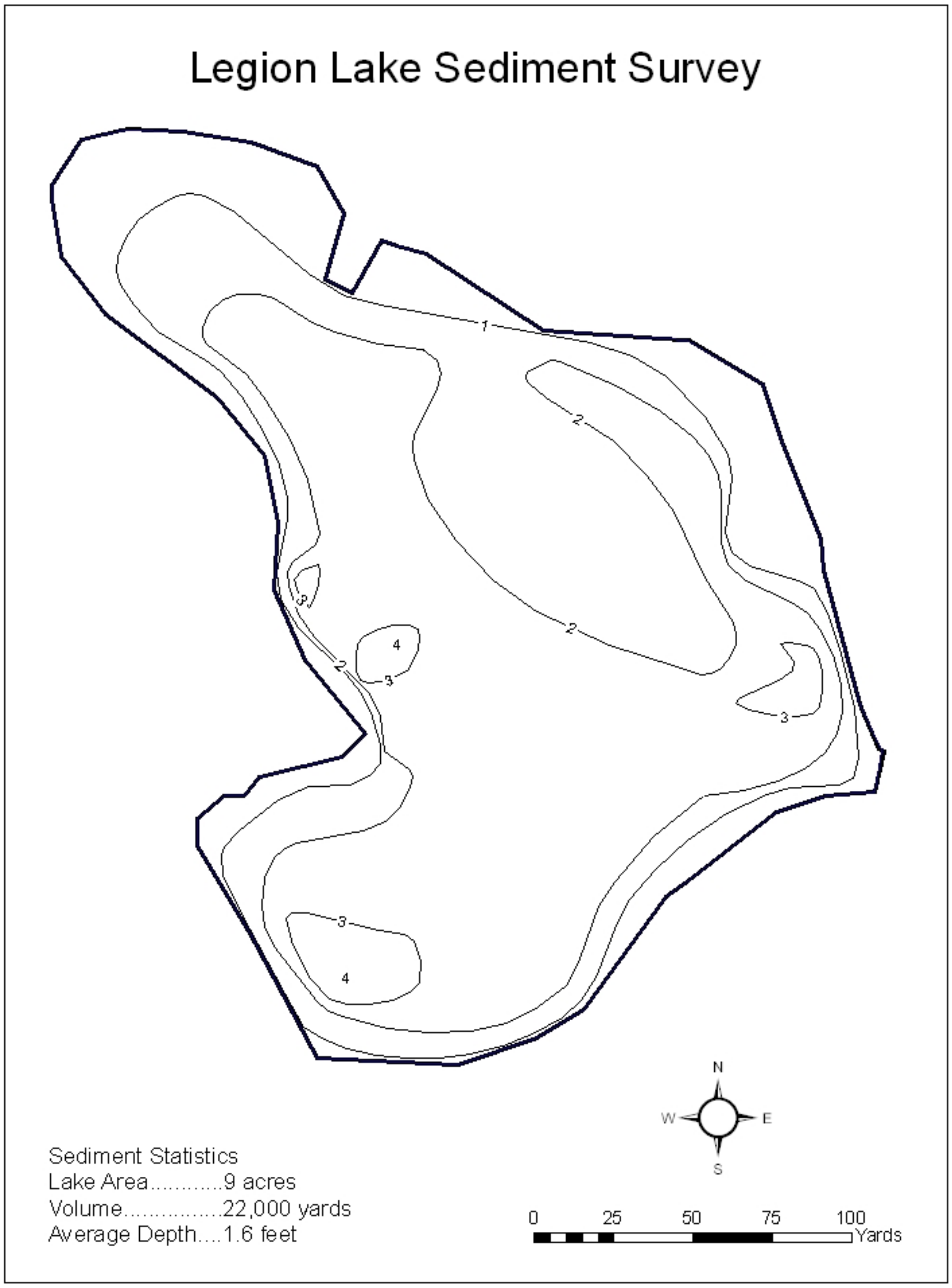

Figure 35. Estimated sediment depth contours (feet) for Legion Lake based on sediment survey data collected on December 24, 2003.

Conclusions and Recommendations

Watershed and Lake Management

Several possible sources of phosphorus may exist in the Legion Lake watershed, including domestic sewage, detergents, fertilizers, and animal waste. Phosphorus makes its way to streams as a result of erosion and associated runoff occurring in the watershed. Riparian buffer improvements and artificial wetland construction are recommended to reduce phosphorus loads carried by streams in the Legion Lake watershed.

A portion of the total phosphorus load is assumed to originate from lake bottom sediment. Thus, installation of practices to control phosphorus loading from the watershed may not be sufficient in maintaining the trophic state of the lake unless the internal load is also controlled. Four in-lake treatment options were considered to reduce phosphorus loadings from the bottom sediments of Legion Lake, including a chemical treatment (alum application), dredging, aeration in combination with circulation, and bioremediation. Of the four treatment alternatives evaluated, alum treatment and aeration/circulation are recommended to maintain or improve the trophic state. However, additional phosphorus load reductions could be achieved by implementing other lake management options described below.

Riparian Zone Management

Stream bank stability is directly related to the species composition of the riparian vegetation and the distribution and density of these species. Properly functioning riparian areas can significantly reduce non-point source pollution by intercepting surface runoff and by settling, filtering and storing sediment and associated pollutants. Riparian re-vegetation and enhancement of streams in the Legion Lake watershed are recommended to reduce total phosphorus loads.

Artificial Wetlands

Artificial wetlands are typically engineered systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist in treating an effluent or other source of water. Wetland plants assimilate nutrients, reducing concentrations in receiving waters. Numerous studies have demonstrated the non-point source pollutant removal capabilities of wetland systems. It is recommended that artificial wetland(s) be constructed on the inlet stream to reduce phosphorus loads from the watershed.

Aluminum Sulfate (Alum) Treatment

Sediment-bound phosphorus loads from upland erosion accumulates at the lake bottom. Low oxygen concentrations allow this sediment-bound phosphorus to be released and available for algal growth. So even when external sources of phosphorus are eliminated, this nutrient remains in oversupply. For this reason, controlling phosphorus concentrations in lakes is a two-part process: keeping phosphorus out of the lake and reducing the availability of phosphorus from lake sediments.

Alum treatment involves the addition of aluminum sulfate slurry that produces an aluminum hydroxide precipitate. This precipitate removes phosphorus and suspended solids from the water column and settles to the bottom of the lake to form a phosphorus-binding blanket on the sediment surface. Alum has been used for centuries for clarification of drinking water, but only recently has it moved into the mainstream of lake management. It is a safe, effective, and economical means of controlling internal phosphorus loading (Welch 1995).

If external phosphorus loads are reduced, an alum treatment will control phosphorus levels and eliminate algae blooms for up to ten years. The longevity of the treatment depends on the amount of alum applied and level of external phosphorus loading (Conover 1988).

Lake Aeration and Circulation

The purpose of aeration and circulation techniques in lake management is to increase the dissolved oxygen content of the water. Various systems are available including aeration by air/oxygen injection or circulation by mechanical mixing.

Lake aeration can have multiple benefits to water quality and lake biota. Aeration can increase aquatic habitat for fish and other lake organisms. In some cases, nuisance algal blooms can be reduced or algae populations can be shifted to more desirable taxa.

The use of air injection (diffuser) systems is the most common destratification method. This system uses a compressor on shore to deliver air through lines connected to a perforated pipe(s) or other simple diffuser(s) placed near the bottom, typically in the deep area of the lake. The use of a diffuser system not only adds oxygen to the water, but also encourages mixing. The rising air bubbles cause water in the hypolimnion to rise, pulling this water into the epilimnion. When the colder, hypolimnetic water reaches the lake surface, it flows across the surface and eventually sinks, mixing with the warmer epilimnetic water.

A circulator could be used to mix the oxygen- rich surface waters with oxygen-depleted waters in the lower depths and could be supplemented with an air injection (diffuser) system. Additional oxygen delivered by an aeration system, in conjunction with the mixing action provided by circulator, may allow the lake to become completely aerated.

Dredging

Lake sediments contain much higher phosphorus concentrations than the water. Excavating the sediment in Legion Lake could reduce a significant source of phosphorus.

Hydraulic dredging could be considered to remove phosphorus-laden sediments. Hydraulic dredging typically involves a rotating cutter head and a suction pump to remove sediments. The cutter head cuts into sediment layers and churns them into a slurry. The pump vacuums the slurry through floating pipe to an on-shore dewatering facility. One disadvantage of this option is the amount of time and cost involved in dewatering the excavated sediments.

Dry dredging could also be considered. This option would require draining the lake and dewatering the removed sediment. While more sediment could be removed by dry dredging than hydraulic dredging, Custer State Park may experience a greater loss of revenue if the dry dredging option is pursued due to the amount of time required to drain, dredge, and refill the lake. In addition, the quality and volume of drained water, as well as surface waters downstream of draining or dewatering activities, should be considered before water is discharged downstream.

Bioremediation

Biofiltration is lake treatment technique based on the controlled use of the ecological characteristics of common mollusk species. Freshwater mussels are natural filter feeders, which effectively and efficiently filter organic and inorganic matter from the water.

The biofiltration technology has very low costs. Most construction, including the preparation of the bedding, can be accomplished with minimal labor and materials costs. The filtration capacity is a characteristic feature of every mollusk species. On average, a single freshwater mussel (about 3 cm in diameter) can filter approximately 100 ml/hour. The volume of water filtered can be very large. Freshwater mussel populations in an area of 100 m^2 can filter a volume up to 28,000 m^3/day and absorb up to 5.5 g of phosphorus and 11.5 g of nitrogen (United Nations Environment Programme 2004).

It should be noted that this treatment method is considered experimental. Further research may be required before this technique is widely implemented. Consideration should also be given to the species of mollusk selected; non-native species should not be used.

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Appendix A

Total Maximum Daily Load (TMDL) Summary

TOTAL MAXIMUM DAILY LOAD EVALUATION

For

Legion Lake

(HUC 10120109)

Custer County, South Dakota

South Dakota Department of Environment and Natural Resources

April 08

Legion Lake Total Maximum Daily Load

Waterbody Type:	Lake (Impoundment)
ABD Entity ID	SD-CH-L-LEGION_01
303(d) Listing Parameter:	Trophic State Index (TSI)
Designated Uses:	Recreation, Coldwater Permanent Fish Life Propagation Water
Size of Impaired Waterbody:	9 acres
Size of Watershed:	2,050 acres
Water Quality Standards:	Narrative and Numeric
Indicators:	Trophic State Index
Location:	HUC Code: 101201090804
Goal:	Maintain or improve current trophic state by managing phosphorus loads
Target:	Chlorophyll and Secchi depth TSI ≤53

Objective

The intent of this summary is to clearly identify the components of the TMDL, support adequate public participation, and facilitate the US Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by US EPA.

Introduction

Legion Lake is a 9-acre impoundment located north-central Custer County, South Dakota (Figure 1). Galena Creek is the major inflow stream. The lake reaches a maximum depth of 22 feet (6.7 m) and holds a total water volume of 90.3 acre-ft (at spillway elevation). Portions of the lake exhibit thermal stratification during summer months. The 2006 South Dakota Impaired Waterbody List identified Legion Lake for TMDL development due to elevated trophic state index (TSI) and pH. Information supporting this listing was derived from statewide lake assessment data and the study conducted in August 2000 – August 2001.

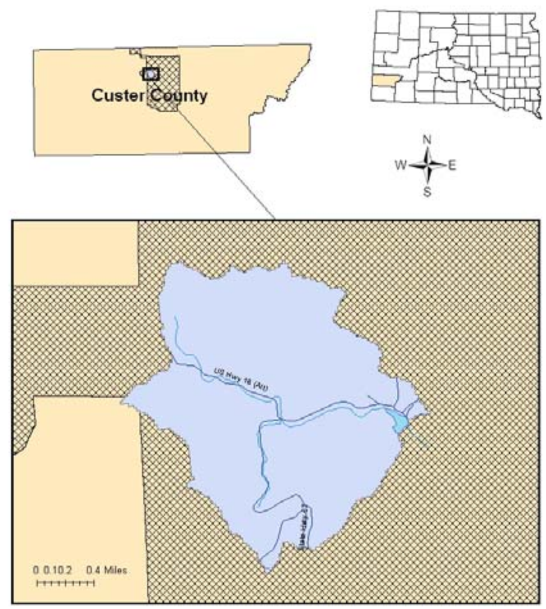

Figure 1. Location of Legion Lake and watershed in Custer County, South Dakota. Hatched area is Custer State Park.

Problem Identification

Streams above Legion Lake drains a watershed of 2,052 acres that predominantly consists of evergreen forest and state park recreational areas. Nearly the entire watershed lies within Custer State Park.

Streams within this watershed carry sediment and nutrient loads that degrade water quality and have caused increased eutrophication in the lake. An estimated 7.3 kg/year of phosphorus enter Legion Lake from watershed runoff. In addition to the watershed phosphorus loads, Legion Lake also experiences internal phosphorus loading from lake-bottom sediment.

Description of Applicable Water Quality Standards & Numeric Water Quality Targets

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

- Coldwater marginal fish life propagation (category 3)
- Immersion recreation (category 7)
- Limited contact recreation (category 8)
- Fish and wildlife propagation, recreation and stock watering (category 9)

Individual parameters, including the lake's TSI value, determine the support of these beneficial uses. Legion Lake experiences internal phosphorus loading from its sediments and external phosphorus loading from its watershed, which has caused increasing eutrophication. Legion Lake is identified in the 1998, 2002, and 2004 South Dakota Waterbody Lists as impaired due to its eutrophic state. The 2002 and 2004 lists identify Legion Lake as a high priority water body in terms of TMDL development.

South Dakota has 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 indicate impairment. SD DENR has developed a protocol that establishes desired TSI levels for lakes based on the fishery use classification (Lorenzen, 2005). Legion Lake is classified as a coldwater marginal fishery. The TSI criterion established for coldwater marginal fisheries is a median chlorophyll and Secchi TSI ≤ 53.

This protocol was used to assess impairment and determine a numeric target for Legion Lake. Legion Lake is currently meeting the TSI criteria with a median chlorophyll and Secchi TSI of 50.4. BMPs are recommended in this report to ensure that lake phosphorus concentrations at a level that allow the lake to maintain or improve its trophic state.

Pollutant Assessment

Point Sources

There are no point sources of pollutants in this watershed.

Non-point Sources

Since phosphorus was identified as a limiting nutrient for algae growth, watershed or external phosphorus loads should be maintained or reduced using management practices recommended in the assessment report. External loads could be reduced with the implementation of riparian zone management and construction of wetlands on the inlet stream.

Non-point sources of phosphorus from the watershed (external load) are only a portion of the total phosphorus load to Legion Lake. Internal phosphorus loading from lake bottom sediment is another source of phosphorus and can also be controlled. Alum treatment and aeration/ circulation methods are recommended to remove phosphorus from the lake water column.

The TMDL target can be maintained with the implementation of the above recommended management practices.

Linkage Analysis

Water quality data was collected at two lake sites and four stream sites, including the lake's inlet and outlet. 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 Energy Laboratories, Inc. in Rapid City, SD for analysis. Quality Assurance/Quality Control samples were collected on 10% of the samples according to South Dakota's EPA approved Non-point Source Quality Assurance/ Quality Control Plan. Details concerning water sampling techniques, analysis, and quality control are addressed in the assessment final report.

Phosphorus export coefficients were calculated for each subwatershed and were used to define critical non-point source (NPS) pollution areas within the watershed (those with higher sediment and phosphorus loads). The LLT-3 subwatershed displayed a higher total phosphorus export coefficient than the LLT-4 subwatershed and the entire watershed. When considering locations for implementation of BMPs to control erosion and nutrient runoff, especially riparian buffer improvements, the LLT-3 subwatershed should be given higher priority than the LLT-4 subwatershed.

TMDL Allocations

Wasteload Allocation

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

Load Allocation (LA)

Current total phosphorus loads from the watershed are approximately 7.3 kg/yr. Phosphorus loads can be maintained or reduced through the implementation of constructed wetlands and riparian zone enhancements. However, no reduction of current loads is required. Thus, the phosphorus average annual load allocation for Legion Lake is 7.3 kg/yr.

To identify a maximum daily limit, a method from EPA's "Technical Support Document For Water Quality-Based Toxics Control," referred to as the TSD method, was used. This method, which is based on a long-term average load that considers variation in a dataset, is a recommended method in EPA's technical guidance "Options for expressing Daily Loads in TMDLs"(USEPA 1991). The TSD method is represented by the following equation:

$$MDL = LTA \times e^{[z\sigma - 0.5\sigma 2]}$$

where,

MDL = maximum daily limit
LTA = long-term average
z = z statistic of the probability of occurrence
$\sigma^2 = \ln(CV2+1)$
CV = coefficient of variation

The daily load expression is identified as a static daily maximum load. A static daily load expression was deemed suitable because of the small watershed size, relatively constant loadings from nonpoint sources (e.g., septics, roads, in-stream sources), and the fact that a steady-state analysis was used. Assuming a probability of occurrence of 95% and a CV of 0.1 (based on available data), the maximum daily load corresponding to an average annual load of 7.3 kg/yr is 0.022 kg/day.

Table A1. Load allocation (kg/yr) summary for Legion Lake.

TMDL Component	Maximum Daily Allocation (kg/day)	Long-term Average Allocation (kg/year)
Wasteload Allocation	0	0
Load Allocation	0.022	7.3
Margin of Safety	Implicit	Implicit
TMDL	**0.022**	**7.3**

Seasonal Variation

Different seasons of the year can yield differences in water quality due to changes in precipitation and land use. To determine seasonal differences, Legion Lake sample data was graphed by sampling date to facilitate viewing seasonal differences. Nearly all parameters assessed in this study displayed seasonal variation. For example, lake total phosphorus concentrations were highest during winter months in Legion Lake. Because much of the biologically available phosphorus is assimilated by algae during the growing season, concentrations increase during the winter.

Seasonal hydrologic loadings from the watershed were also calculated. Highest hydrologic loads were observed during the spring and fall, while no measurable flow was observed during the winter.

Margin of Safety

The margin of safety is implicit based on conservative estimations of model coefficients.

Critical Conditions

The TSI impairment observed in Legion Lake is most severe during the summer. This may be the result of warm water temperatures and peak algal growth.

Follow-Up Monitoring

During future implementation of BMPs, monitoring and evaluation efforts should be targeted toward the effectiveness of implemented BMPs. Monitoring locations should be selected based on locations of BMPs.

Once the implementation project is completed, post-implementation monitoring will be necessary to assure that the TMDL has been reached and improvement to the beneficial uses occurs. This will be achieved through statewide lake assessment.

Public Participation

Efforts taken to gain public education, review, and comment during development of the TMDL included presentations to local groups on the findings of the Legion Lake assessment and a 30-day public notice period for public review and comment.

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

Implementation Plan

Funds to implement lake and watershed water quality improvements can be obtained through the SD DENR. SD DENR administers funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota, including the Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Non-point Source Grants program.

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Appendix B

Legion Lake Fishery Survey Report
Prepared by South Dakota Department of Game, Fish, and Parks

SOUTH DAKOTA STATEWIDE FISHERIES SURVEY

Name: Legion Lake County(ies): Custer
Legal description: T3S, R5E, Sec 25

Location from nearest town: 8 Miles East of Custer, SD
Dates of present survey: 28-30 May 1996
Date last surveyed: 8-10 June 1988
Most recent lake management plan: F21-R-28 Date: NA
Management classification: Coldwater Permanent
Contour mapped: Yes Date: 1987

Primary Species: (game and forage) Secondary and other species:
1. Rainbow trout 1. Largemouth Bass
2. ________ 2. Creek Chub

PHYSICAL CHARACTERISTICS

Surface Area: 9.2 ac. (3.7 ha); Watershed: 1,408 acres (570.0 ha.)
Maximum depth: 22.0 (6.7 m) ; Mean depth: 9.7 ft. (3.0 m)
Lake elevation at survey (from known benchmark): Full Pool

1. Describe ownership of lake and adjacent lakeshore property:

Legion Lake, located in Custer State Park, is owned and managed by the South Dakota Department of Game, Fish and Parks (SDGFP).

2. Describe watershed condition and percentages of land use:

The watershed is largely mature ponderosa pine forest administered by SDGFP. The lake and its watershed are used exclusively for recreation and wildlife propagation.

3. Describe aquatic vegetative condition:

Emergent vegetation in the form of cattail lined the inlet area of shoreline. Submergent forms were not noted to be excessive.

4. Describe pollution problems:

No pollution problems were evident during the 1996 survey.

5. Describe condition of all structures, i.e. spillway, level regulators, boat ramps, etc.:

No apparent structural defects exist with the dam or outlet structure. No boat ramps exist on Legion Lake. A fishing pier and store are located on the northwest shoreline. Several rental cabins are available for visitors a short distance above the lake to the northeast.

CHEMICAL DATA

1. Describe general water quality characteristics.

Conductivity was relatively low in Legion Lake on the sample date, with a surface reading of 125 umhos (Table 1). Granitic soils in this area of the Black Hills generally result in waters with low conductivity readings.

2. Thermocline: Yes_ No__; location from surface NA ft.

A temperature profile was not performed. Only surface readings were collected. However, lake stratification generally does not occur in this region until mid June.

3. Secchi disc reading: 4.9 ft. (1.5 m)

4. Stations for water chemistry located on attached lake map: Yes X No _ See APPENDIX Figure 1.

Table 1. Water chemistry results for Legion Lake, Custer County, 28 May, 1996.

Depth Meters	Temp °C	pH	DO ppm	Conductivity umhos/cm
0.0 (Surface)	9.0	8.6	9.0	125

Trophic State Indices (TSI) for Secchi disc transparency, chlorophyll a and total phosphorus were calculated according to criteria developed by Carlson (1977). TSI rankings are from 1-100. Lakes with TSI values <40 are considered oligotrophic, while those with values exceeding 50 are considered eutrophic. Secchi disc TSI was calculated at 54, Chlorophyll a TSI was 57 and a total phosphorus index of 47 was derived during the present survey. All indices indicate moderate productivity or mesotrophic to slightly eutrophic conditions. Table 2 compares 1996 TSI values with data collected since 1979 by Koth (1981) and Stewart and Stueven (1994), respectively.

Table 2. Trophic State Indices (TSI) for Legion Lake 1979-1980, 1989, 1991, 1992 and 1996. Indices include Secchi disk transparency (SD), chlorophyll a (Chl a) and Total Phosphorus (TP).

TSI Values	1979-1980	1989	1991	1992	1996
SD	61*	53	61	56	54
Chl a	51*	-	59	56	57
TP	55*	69	70	64	47

* Mean Value - Data unavailable

BIOLOGICAL DATA

1. Describe fish collection methods:

(1) 24 hr 1/4" (Baby) Frame net set with 25' lead.
(2) 24 hr 3/4" Frame net sets with 75' leads.
(4) 1 hr 150' Experimental, sinking gill net sets.

Table 3. Total catch of one 1/4" frame net set at Legion Lake, Custer County, 29 May 1996.

Species	Total Number	%	Total Weight (grams)	%	Mean Weight (grams)	Mean Length (mm)	Catch per Effort
Fathead Minnow	1	50.0	5.0	2.5	5.0	73.0	1.0
Creek Chub	1	50.0	197.0	97.5	197.0	263.0	1.0
Totals	2	100.0	202.0	100.0			

Table 4. Total catch of two 3/4" frame net sets at Legion Lake, Custer County, 29 May 1996.

Species	Total Number	%	Total Weight (grams)	%	Mean Weight (grams)	Mean Length (mm)	Catch per Effort
Largemouth Bass	1	100.0	6.0	100.0	6.0	90.0	0.5
Totals	1	100.0	6.0	100.0			

Table 5. Total catch of four, one hour experimental gill net sets at Legion Lake, Custer County, 30 May 1996.

Species	Total Number	%	Total Weight (grams)	%	Mean Weight (grams)	Mean Length (mm)	Catch per Effort
Rainbow Trout	26	96.3	5,205.0	96.1	200.2	272.5	*156.0
Creek Chub	1	3.7	211.0	3.9	211.0	261.0	*6.0
Totals	27	100.0	5,416.0	100.0			

* CPUE adjusted for 24 hr netting effort.

2. Brief narrative describing status of fish sampled.

Legion Lake has historically been managed as a rainbow trout fishery by the annual stocking of approximately 10,200 catchables (Appendix Table 1). Current management consists of six plants of from 1,200 to 2,200 rainbow trout each, beginning in April and continuing through mid August.

One yearling largemouth bass, two creek chub and one fathead minnow were captured during the present survey in addition to rainbow trout, which comprised over 86 percent of the total catch by combined gear types (Tables 3-5).

A chemical renovation was performed on Legion Lake in 1985 to eradicate overabundant populations of black bullhead, white sucker and yellow perch. Prior to the 1996 survey, the most recent Legion Lake survey conducted in 1988, recorded one yellow perch caught by trap netting. However, none of the species targeted for eradication in 1985 were found in the 1996 survey.

Length-frequency for the 1996 Legion Lake rainbow trout catch is shown in Appendix Figure 2.

Recommendations

1. Continue to manage as a rainbow trout fishery by the stocking of approximately 6,375 catchables at 4.1/kg annually beginning in 1997, in accordance with the annual coldwater fish stocking schedule.

2. Survey in 2005 to determine species composition, trend of fish population and monitor water quality.

Literature cited

Carlson, Robert E. 1977. A trophic state index for lakes. Limnology and Oceanography 22 (2): 361-369.

Koth, Ronald M. 1981. South Dakota Lakes Classification and Inventory. South Dakota Department of Environment and Natural Resources, Final Report, Pierre.

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Appendix

Appendix Table 1. Stocking record for Legion Lake, Custer County, 1986-1996.

Species	Year	Number	Size
Rainbow trout	1986	10,200	Catchable
Rainbow trout	1986	80	Adult
Rainbow trout	1987	10,200	Catchable
Rainbow trout	1987	30	Adult
Rainbow trout	1988	11,800	Catchable
Rainbow trout	1988	3,780	Fingerling
Rainbow trout	1989	10,350	Catchable
Rainbow trout	1989	200	Adult
Rainbow trout	1990	10,034	Catchable
Rainbow trout	1990	175	Adult
Brown trout	1991	39	Adult
Rainbow trout	1991	11,600	Catchable
Rainbow trout	1991	75	Adult
Rainbow trout	1992	10,200	Catchable
Rainbow trout	1992	220	Adult
Rainbow trout	1993	10,200	Catchable
Rainbow trout	1994	10,200	Catchable
Rainbow trout	1995	10,600	Catchable
Rainbow trout	1995	25	Adult
Rainbow trout	1996	10,090	Catchable

Appendix C

Assessment Data

Legion Lake Chemical Data

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
LL1	8/22/2001	15:43	Surface	Scott Alan	5		<2	58	130	7	<0.1	<0.1	<0.05	1.2	0.02	0.06	63.2	1	60.0
LL1	9/26/2001	13:10	Surface	Scott Alan	5		<2	62	150	<5	0.2	<0.1	<0.05	0.9	0.03	0.05	60.6	2	50.0
LL1	11/1/2001	11:10	Surface	Scott Alan	5	<2	<2	62	150	<5	<0.1	<0.1	<0.05	0.6	<0.01	0.01	37.4	5	36.8
LL1	12/27/2001	9:50	Surface	Scott Alan	4.75	ND	ND	68	140	ND	ND	ND	ND	0.6	ND	0.02	47.4		
LL1	1/31/2002	10:20	Surface	Scott Alan	5.5	ND	ND	68	150	ND	ND	ND	ND	ND	ND	0.02	47.4		
LL1	2/27/2002	10:05	Surface	Scott Alan	5	ND	ND	70	130	ND	ND	ND	ND	1.1	ND	0.02	47.4	3	44.2
LL1	5/13/2002	12:49	Surface	Scott Alan	6	ND	ND	58	110	ND	ND	ND	ND	0.6	0.02	0.03	53.2	4.5	38.3
LL1	6/6/2002		Surface	Scott Alan	5	ND	ND	56	94	ND	ND	ND	ND	ND	ND	0.02	47.4	5	36.8
LL1	7/1/2002	11:00	Surface	Scott Alan	5	ND	ND	56	130	6	ND	ND		0.5	ND	0.01	37.4	4.5	38.3
LL1	8/5/2002	12:35	Surface	Scott Alan	5	ND	ND	58	110	ND	ND	ND	ND	0.5	ND	0.02	47.4	3.5	41.9
LL1	8/22/2001	15:43	Bottom	Scott Alan	5		<2	62	110	<5	<0.1	<0.1	<0.05	0.9	0.02	0.03	53.2	1	60.0
LL1	9/26/2001	13:17	Bottom	Scott Alan	5.25		<2	60	140	<5	0.2	<0.1	<0.05	0.9	0.02	0.06	63.2	2	50.0
LL1	11/1/2001	11:30	Bottom	Scott Alan	5.25	<2	<2	62	130	<5	<0.1	<0.1	<0.05	0.6	<0.01	0.02	47.4	5	36.8
LL1	12/27/2001	10:35	Bottom	Scott Alan	4.75	ND	ND	70	140	ND	ND	ND	ND	0.7	ND	0.05	60.6		
LL1	1/31/2002	10:50	Bottom	Scott Alan	5.5	ND	ND	110	150	ND	ND	ND	ND	0.6	0.01	0.03	53.2		
LL1	2/27/2002	10:48	Bottom	Scott Alan	5.5	ND	ND	52	140	ND	ND	ND	ND	1.1	ND	0.03	53.2	3	44.2
LL1	5/13/2002	12:49	Bottom	Scott Alan	6	ND	ND	58	130	12	ND	ND	ND	0.6	0.02	0.04	57.4	4.5	38.3
LL1	6/6/2002	10:39	Bottom	Scott Alan	5	ND	ND	78	110	ND	ND	ND	ND	0.5	ND	0.02	47.4	5	36.8
LL1	7/1/2002	11:00	Bottom	Scott Alan	5	ND	ND	60	120	ND	ND	ND	ND	0.6	0.01	0.04	57.4	4.5	38.3
LL1	8/5/2002	12:35	Bottom	Scott Alan	5	ND	ND	58	110	7	ND	ND	ND	0.5	ND	0.02	47.4	3.5	41.9
LL2	8/22/2001	17:57	Surface	Scott Alan	3		<2	58	130	7	<0.1	<0.1	<0.05	1.2	0.02	0.04	57.4	1	60.0
LL2	9/26/2001	13:23	Surface	Scott Alan	2.25		<2	62	140	<5	0.1	<0.1	<0.05	0.9	0.02	0.05	60.6	2.25	48.3
LL2	11/1/2001	10:42	Surface	Scott Alan	2.25	<2	<2	64	140	<5	<0.1	<0.1	<0.05	0.6	0.01	0.01	37.4	2.25	48.3
LL2	12/27/2001	11:10	Surface	Scott Alan	3	ND	ND	80	140	ND	ND	ND	ND	0.6	ND	0.02	47.4		
LL2	1/31/2002	11:18	Surface	Scott Alan	2.5	ND	ND	72	150	ND	ND	ND	ND	0.6	ND	0.05	60.6		
LL2	2/27/2002	11:20	Surface	Scott Alan	2.5	ND	ND	68	130	ND	ND	ND	ND	ND	ND	0.04	57.4		
LL2	5/13/2002	12:41	Surface	Scott Alan	2.5	ND	ND	70	120	ND	ND	ND	ND	ND	0.01	0.03	53.2	2.5	46.8
LL2	6/6/2002	11:15	Surface	Scott Alan	2.5	ND	ND	36	110	ND	ND	ND	ND	ND	ND	ND		2.5	46.8
LL2	7/1/2002	11:00	Surface	Scott Alan	2.5	ND	ND	56	350	ND	ND	ND	ND	0.5	ND	0.02	47.4	2.5	46.8
LL2	8/5/2002	12:20	Surface	Scott Alan	2.5	ND	ND	56	120	ND	ND	ND	ND	ND	ND	0.01	37.4	2.5	46.8
LL2	8/22/2001	15:57	Bottom	Scott Alan	3		<2	56	120	7	<0.1	<0.1	<0.05	1.2	<0.01	0.03	53.2	1	60.0
LL2	9/26/2001	13:30	Bottom	Scott Alan	2.25		<2	64	140	<5	0.2	<0.1	<0.05	0.9	0.04	0.05	60.6	2.25	48.3
LL2	11/1/2001	11:05	Bottom	Scott Alan	2.25	<2	<2	62	130	<5	<0.1	<0.1	<0.05	0.6	<0.01	0.01	37.4	2.25	48.3
LL2	12/27/2001	11:48	Bottom	Scott Alan	3	ND	ND	76	140	ND	ND	ND	ND	0.5	0.02	0.03	53.2		
LL2	1/31/2002	11:50	Bottom	Scott Alan	2.5	ND	ND	58	150	ND	ND	ND	ND	0.6	ND	0.04	57.4		
LL2	2/27/2002	11:55	Bottom	Scott Alan	2.5	ND	ND	68	140	ND	ND	ND	ND	0.6	ND	0.04	57.4		
LL2	5/13/2002	12:41	Bottom	Scott Alan	2.5	ND	ND	48	130	16	ND	ND	ND	0.6	0.02	0.02	47.4	2.5	46.8
LL2	6/6/2002	12:00	Bottom	Scott Alan	2.5	ND	ND	78	110	ND	ND	ND	ND	0.5	ND	0.02	47.4	2.5	46.8
LL2	7/1/2002	11:00	Bottom	Scott Alan	2.5	ND	ND	54	140	ND	ND	ND	ND	ND	ND	0.02	47.4	2.5	46.8
LL2	8/5/2002	12:20	Bottom	Scott Alan	2.5	ND	ND	56	120	ND	ND	ND	ND	0.6	ND	0.02	47.4	2.5	46.8
LLT3	8/22/2001	12:32	Surface	Scott Alan	0.2		4	70	210	31	<0.1	<0.1	<0.05	<0.5	0.03	0.09			
LLT3	9/26/2001	12:04	Surface	Scott Alan	0.1		<2	66	200	15	<0.1	<0.1	0.08	0.6	0.03	0.17			
LLT3	10/10/2001	17:05	Surface	Scott Alan	0.1		3	70	210	15	<0.1	<0.1	0.1	<0.5	<0.01	0.08			
LLT3	10/31/2001	17:16	Surface	Scott Alan	0.1	<5	2	72	260	84	<0.1	<0.1	0.07	0.6	0.02	0.22			
LLT3	4/18/2002	11:40	Surface	Scott Alan	0.1	ND	ND	46	210	37	ND	ND	0.21	0	0.08	0.11			
LLT3	4/24/2002	9:58	Surface	Scott Alan	0.1	ND	ND	26	180	20	ND	ND	0.14	0.6	ND	0.06			
LLT3	5/2/2002	9:15	Surface	Scott Alan	0.1	ND	ND	52	270	ND	ND	ND	0.15	ND	0.02	0.03			
LLT3	6/26/2002	10:18	Surface	Scott Alan	0.1	4	10	68	200	ND	ND	ND	0.05	ND	0.04	0.04			
LLT3	7/21/2002	11:57	Surface	Scott Alan	0.25	10	350	64	220	6	ND	ND	0.11	0.6	0.04	0.1			
LLT3	8/12/2002	13:19	Surface	Scott Alan	0.15	ND	10	72	220	14	ND	ND	ND	0.5	0.03	0.16			

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
LLT4	8/22/2001	13:11	Surface	Scott Alan	0.2		30	68	140	18	<0.1	<0.1	<0.05	<0.5	0.04	0.08			
LLT4	9/26/2001	12:17	Surface	Scott Alan	0.2		<2	68	140	<5	<0.1	<0.1	0.05	<0.5	0.04	0.09			
LLT4	10/10/2001	16:56	Surface	Scott Alan	0.3		7	64	130	9	<0.1	<0.1	0.06	<0.5	0.04	0.09			
LLT4	10/31/2001	16:57	Surface	Scott Alan	0.2	5	<2	64	140	6	<0.1	<0.1	<0.05	<0.5	0.04	0.11			
LLT4	4/18/2002	11:59	Surface	Scott Alan	0.2	ND	ND	48	130	ND	ND	ND	0.11	ND	0.07	0.2			
LLT4	4/23/2002	10:26	Surface	Scott Alan	0.2	ND	ND	46	140	ND	ND	ND	0.06	ND	0.02	0.05			
LLT4	5/2/2002	10:01	Surface	Scott Alan	0.2	ND	ND	50	170	ND	ND	ND	0.09	ND	0.02	0.04			
LLT4	6/26/2002	10:45	Surface	Scott Alan	0.2	8	14	68	120	7	ND	ND	0.05	ND	0.03	0.07			
LLT4	7/21/2002	0:06	Surface	Scott Alan	0.2	20	490	68	200	16	ND	ND	0.13	1.2	0.05	0.16			
LLT4	8/12/2002	13:31	Surface	Scott Alan	0.18	ND	6	72	150	ND	ND	ND	0.05	ND	0.03	0.11			
LLT5	8/22/2001	13:43	Surface	Scott Alan	0.35		30	60	120	<5	<0.1	<0.1	<0.05	<0.5	0.07	0.08			
LLT5	9/26/2001	12:35	Surface	Scott Alan	0.2		13	62	130	<5	0.3	<0.1	<0.05	<0.5	0.08	0.12			
LLT5	10/10/2001	16:45	Surface	Scott Alan	0.4		<2	64	130	<5	<0.1	<0.1	<0.05	<0.5	0.06	0.08			
LLT5	10/31/2001	16:34	Surface	Scott Alan	0.4	<2	<2	62	140	<5	<0.1	<0.1	<0.05	<0.5	0.05	0.08			
LLT5	4/18/2002	12:12	Surface	Scott Alan	0.35	ND	ND	52	130	ND	ND	ND	ND	ND	0.08	0.08			
LLT5	4/23/2002	10:55	Surface	Scott Alan	0.4	ND	ND	50	150	ND	ND	ND	ND	ND	0.03	0.06			
LLT5	5/2/2002	10:56	Surface	Scott Alan	0.48	2	ND	56	180	ND	ND	ND	ND	ND	ND	0.05			
LLT5	6/26/2002	10:55	Surface	Scott Alan	0.2	10	30	64	130	ND	ND	ND	ND	ND	0.06	0.09			
LLT5	7/21/2002	0:17	Surface	Scott Alan	0.6	130	2700	48	220	51	ND	ND	0.39	0.9	0.07	0.25			
LLT5	8/12/2002	13:42	Surface	Scott Alan	0.35	ND	12	64	120	ND	ND	ND	ND	ND	0.05	0.09			
LLO6	8/22/2001	16:40	Surface	Scott Alan	0.2		8	64	130	<5	<0.1	<0.1	0.21	0.6	0.02	0.08			
LLO6	9/26/2001	13:56	Surface	Scott Alan	0.2		8	76	150	<5	0.1	<0.1	0.36	0.9	0.03	0.12			
LLO6	4/18/2002	12:27	Surface	Scott Alan	0.25	ND	ND	60	120	ND	ND	ND	0.05	ND	0.06	0.07			
LLO6	4/24/2002	11:27	Surface	Scott Alan	0.25	ND	ND	62	140	ND	ND	ND	0.05	ND	0.02	0.04			
LLO6	5/2/2002	11:23	Surface	Scott Alan	0.3	ND	ND	60	140	ND	ND	ND	ND	ND	0.01	0.04			
LLO6	6/26/2002	11:15	Surface	Scott Alan	0.2	120	100	94	180	23	ND	ND	0.31	0.6	0.07	0.18			
LLO6	7/21/2002	0:29	Surface	Scott Alan	0.2	ND	140	84	180	10	ND	ND	1.5	1.2	0.05	0.2			
LLO6	8/12/2002	14:07	Surface	Scott Alan	0.2	ND	14	110	190	26	ND	ND	0.19	ND	0.02	0.1			
UnK	7/11/1989		BOTTOM					71	140	11	0.43		0.1	1.43	0.047	0.129	74.3		
UnK	7/11/1989		BOTTOM																
UnK	7/11/1989		SURFACE					71	153	9	0.15		0.1	1.66	0.014	0.078	67.0		
UnK	7/11/1989		SURFACE															0.54864	68.7
UnK	8/15/1989		BOTTOM					67	147	4	0.25		0.1	1.1	0.011	0.092	69.4		
UnK	8/15/1989		BOTTOM																
UnK	8/15/1989		SURFACE					67	144	2	0.23		0.1	0.94	0.013	0.064	64.2		
UnK	8/15/1989		SURFACE															2.1336	49.1
UnK	6/19/1991		BOTTOM					53	149	10	0		0.6	0.32		0.122	73.5		
UnK	6/19/1991		BOTTOM																
UnK	6/19/1991		SURFACE					51	138	12	0		0.6	0.48		0.095	69.8		
UnK	6/19/1991		SURFACE															1.15824	57.9
UnK	7/22/1992		BOTTOM					92	139	4	0.04		0.1	0.56		0.08	67.4		
UnK	7/22/1992		BOTTOM																
UnK	7/22/1992		SURFACE					70	128	1	0		0.1	0.55		0.04	57.4		
UnK	7/22/1992		SURFACE															1.35	55.7
UnK	8/18/1992		BOTTOM					74	136	8	0		0.1	0.67		0.086	68.4		
UnK	8/18/1992		BOTTOM																
UnK	8/18/1992		SURFACE					72	143	7	0		0.1	0.74		0.046	59.4		
UnK	8/18/1992		SURFACE															1.37	55.5
UnK	6/7/1999		BOTTOM					44	141	5	0.01		0.05	0.56		0.062	63.7		
UnK	6/7/1999		BOTTOM																

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	6/7/1999		SURFACE					46	134	1	0.01		0.05	0.49		0.048	60.0		
UnK	6/7/1999		SURFACE															1.45	54.6
UnK	7/27/1999		BOTTOM					51	141	8	0.01		0.05	0.49		0.066	64.6		
UnK	7/27/1999		BOTTOM																
UnK	7/27/1999		SURFACE					53	142	6	0.01		0.05	0.74		0.042	58.1		
UnK	7/27/1999		SURFACE															1.14	58.1
Comp	6/19/2003		Bottom					56	154	6	<.02		<.1	0.37	0.019	0.02	47.4	3.9	40.4
Comp	6/19/2003		Surface					46	161	5	<.02		<.1	0.37	0.01	0.013	41.2	3.9	40.4
Comp	7/21/2003		Bottom					53	171	2	<.02		<.1	0.18	0.017	0.026	51.2	4.23	39.2
Comp	7/21/2003		Surface					49	151	3	<.02		<.1	0.35	0.013	0.014	42.2	4.23	39.2
UnK	8/22/2001		surface					58	130	7	0.05		0.025	1.2	0.04	0.02	47.4	1	60.0
UnK	6/6/2002		surface					36	110									2.5	46.8
UnK	7/1/2002		surface					56	350					0.5	0.02			2.5	46.8
UnK	8/5/2002		surface					56	120						0.01			2.5	46.8
UnK	10/14/1986	10:40 AM	Surface	Goebel Greg	5			58	128	4	.04			.51	.031	.065	64.4		
UnK	10/14/1986	10:30 AM	Surface	Goebel Greg	4			62	132	4	.03			.63	.021	.069	65.2		
UnK	10/14/1986	10:20 AM	Surface	Goebel Greg	3			54	132	2	.04			.70	.015	.054	61.7		
UnK	10/14/1986	10:10 AM	Surface	Goebel Greg	2			58	130	4	.03			.86	.018	.072	65.8		
UnK	10/14/1986	10:00 AM	Surface	Goebel Greg	1			61	127	3	.04			.81	.011	.070	65.4		
UnK	10/14/1986	9:45 AM	Surface	Goebel Greg			5	59	127	3	.03			.48	.018	.079	67.2	1.91	50.7
UnK	10/14/1986	11:50 AM	Surface	Goebel Greg	2			57	134	4	.03			.66	.018	.070	65.4		
UnK	10/14/1986	11:40 AM	Surface	Goebel Greg	1			58	124	4	0.015			.56	.018	.067	64.8		
UnK	10/14/1986	11:30 AM	Surface	Goebel Greg			5	58	121	5	0.015			.51	.017	.068	65.0	1.83	51.3
UnK	10/14/1986	10:50 AM	Surface	Goebel Greg	6			57	131	3	0.015			.54	.018	.065	64.4		
UnK	9/23/1986	11:40 AM	Surface	Goebel Greg	1			56	97	3	.04			.82	.010	.044	58.7		
UnK	9/23/1986	11:50 AM	Surface	Goebel Greg	1.8			55	71	1	.04			1.12	.021	.040	57.4	2.13	49.1
UnK	9/23/1986	11:30 AM	Surface	Goebel Greg			5	56	93	1	.05			.8	.018	.028	52.2	2.13	49.1
UnK	9/23/1986	10:10 AM	Surface	Goebel Greg				56	111	1	.11			.84	.010	.040	57.4		
UnK	9/23/1986	10:00 AM	Surface	Goebel Greg			5	54	98	2	.12			.74	.018	.034	55.0	2.13	49.1
UnK	9/23/1986	10:50 AM	Surface	Goebel Greg	5.8			62	83	3	.56			1.20	.188	.196	80.3		
UnK	9/23/1986	10:40 AM	Surface	Goebel Greg	5			56	116	2	.17			.90	0.005	.034	55.0		
UnK	9/23/1986	10:15 AM	Surface	Goebel Greg	2			54	112	2	.12			.76	.012	.032	54.2		
UnK	9/23/1986	10:20 AM	Surface	Goebel Greg	3			55	112	0.5	.13			.84	.011	.035	55.4		
UnK	9/23/1986	10:30 AM	Surface	Goebel Greg	4			53	106	2	.14			.89	.017	.032	54.2		
UnK	8/26/1986	10:45 AM	Surface	Goebel Greg	5			58	92	2	.32			.92	.032	.115	72.6		
UnK	8/26/1986	11:40 AM	Surface	Goebel Greg	2			59	90	0.5	.04			1.43	0.005	.055	62.0		
UnK	8/26/1986	9:45 AM	Surface	Goebel Greg			5	66	98	8	.048			1.64	.019	.031	53.7	0.46	71.3
UnK	8/26/1986	10:00 AM	Surface	Goebel Greg	1			60	99	1	.03			1.48	.011	.042	58.1		
UnK	8/26/1986	10:15 AM	Surface	Goebel Greg	2			56	90		.037			1.50	.010	.063	63.9		
UnK	8/26/1986	10:30 AM	Surface	Goebel Greg	3			56	96	0.5	.06			.86	.013	.031	53.7		
UnK	8/26/1986	10:40 AM	Surface	Goebel Greg	4			59	97	2	.14			.58	.010	.042	58.1		
UnK	8/26/1986	10:55 AM	Surface	Goebel Greg	5.7			85	131	15	.55			1.22	.383	.393	90.3		
UnK	8/26/1986	11:25 AM	Surface	Goebel Greg			5	60	103	5	0.015			1.45	.018	.032	54.2		
UnK	8/26/1986	11:35 AM	Surface	Goebel Greg	1			56	94	4	.04			1.67	0.005	.055	62.0		
UnK	8/12/1986	11:10 AM	Surface	Goebel Greg	6			66	96	2	1.14			1.59	.159	.308	86.8		
UnK	8/12/1986	10:10 AM	Surface	Goebel Greg			5	53	114	4	0.015			1.37	.020	.037	56.2	0.84	62.5
UnK	8/12/1986	10:20 AM	Surface	Goebel Greg	1			54	107	7	0.015			1.12	.017	.047	59.7		
UnK	8/12/1986	10:30 AM	Surface	Goebel Greg	2			54	103	3	0.015			1.14	.012	.035	55.4		
UnK	8/12/1986	10:40 AM	Surface	Goebel Greg	3			52	101	7	.05			.92	0.005	.046	59.4		
UnK	8/12/1986	11:00 AM	Surface	Goebel Greg	5			54	104	4	.07			.80	0.005	.055	62.0		
UnK	8/12/1986	12:30 PM	Surface	Goebel Greg	2			52	114	0.5	0.015			.60	.011	.034	55.0		

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	8/12/1986	12:20 PM	Surface	Goebel Greg	1			54	92	0.5	0.015			.98	.012	.034	55.0		
UnK	8/12/1986	12:10 PM	Surface	Goebel Greg			5	54	121	1	0.015			.96	.011	.034	55.0	0.84	62.5
UnK	8/12/1986	10:50 AM	Surface	Goebel Greg	4			55	101	5	.07			.72	.010	.045	59.1		
UnK	7/23/1986	12:30 PM	Surface	Goebel Greg	5			58	90	3	.04			.49	.025	.080	67.4		
UnK	7/23/1986	11:40 AM	Surface	Goebel Greg			5	54	102	2	0.015			.41	.021	.050	60.6	3.05	43.9
UnK	7/23/1986	12:50 PM	Surface	Goebel Greg			5	54	90	2	0.015			.49	.012	.030	53.2	2.80	45.1
UnK	7/23/1986	1:10 PM	Surface	Goebel Greg	2.1			60	87	1	0.015			.3	.017	.03	53.2		
UnK	7/23/1986	11:50 AM	Surface	Goebel Greg	a			52	161	3	0.015			.43	.011	.020	47.4		
UnK	7/23/1986	12:00 PM	Surface	Goebel Greg	2			53	81	1	.03			.30	.010	.030	53.2		
UnK	7/23/1986	12:10 PM	Surface	Goebel Greg	3			54	102	2	0.015			.47	0.005	.030	53.2		
UnK	7/23/1986	1:00 PM	Surface	Goebel Greg	1			50	121	1	0.015			.37	.022	.030	53.2		
UnK	7/23/1986	12:20 PM	Surface	Goebel Greg	4			56	89	3	0.015			.42	.013	.030	53.2		
UnK	7/23/1986	12:40 PM	Surface	Goebel Greg	6			78	94	6	.66			1.31	.084	.230	82.6		
UnK	7/9/1986	11:00 AM	Surface	Goebel Greg	3			56	99	3	.10			.52	.013	.022	48.7		
UnK	7/9/1986	1:15 PM	Surface	Goebel Greg	2.2			60	103	5	.17			.91	.018	.022	48.7		
UnK	7/9/1986	12:45 PM	Surface	Goebel Greg			5	62	102	4	.94			.49	.020	.020	47.4	2.90	44.6
UnK	7/9/1986	1:00 PM	Surface	Goebel Greg	1			57	112	4	.16			.45	.019	.015	43.2		
UnK	7/9/1986	10:45 AM	Surface	Goebel Greg	2			57	80	4	0.015			.52	.017	.030	53.2		
UnK	7/9/1986	10:15 AM	Surface	Goebel Greg			5	58	82	0.5	0.015			.50	.013	.015	43.2	2.36	47.6
UnK	7/9/1986	11:15 AM	Surface	Goebel Greg	4			64	94	6	.06			.74	.019	.040	57.4		
UnK	7/9/1986	11:30 AM	Surface	Goebel Greg	5			58	98	8	.10			.68	.022	.045	59.1		
UnK	7/9/1986	11:45 AM	Surface	Goebel Greg	6			66	108	10	.82			1.07	.035	.260	84.4		
UnK	7/9/1986	10:30 AM	Surface	Goebel Greg	1			60	80	2	.18			.56	.015	.045	59.1		
UnK	6/25/1986	12:00 PM	Surface	Goebel Greg	6			58	73	5	.28			.64	.067	.167	78.0		
UnK	6/25/1986	10:45 AM	Surface	Goebel Greg	1			46	97	9	.20			.98	.015	.082	67.7		
UnK	6/25/1986	10:30 AM	Surface	Goebel Greg			5	48	88	6	.2			.94	.024	.094	69.7	1.14	58.1
UnK	6/25/1986	11:00 AM	Surface	Goebel Greg	2			54	97	7	.20			.73	.013	.076	66.6		
UnK	6/25/1986	11:15 AM	Surface	Goebel Greg	3			52	91	11	.17			.84	.014	.072	65.8		
UnK	6/25/1986	11:30 AM	Surface	Goebel Greg	4			50	76	6	.77			.44	.015	.114	72.5		
UnK	6/25/1986	11:45 AM	Surface	Goebel Greg	5			54	83	7	.12			.61	.039	.109	71.8		
UnK	6/25/1986	12:45 PM	Surface	Goebel Greg	1			53	84	4	.13			.62	.049	.119	73.1		
UnK	6/25/1986	1:00 PM	Surface	Goebel Greg	2			45	77	8	.13			.86	.021	.077	66.8		
UnK	6/25/1986	12:30 PM	Surface	Goebel Greg			5	49	85	4	.18			.56	.027	.042	58.1	1.07	59.1
UnK	6/11/1986	11:45 AM	Surface	Goebel Greg	6.2			66	98	4	.163			.66	.038	.117	72.9		
UnK	6/11/1986	11:30 AM	Surface	Goebel Greg	5			58	80	4	.038			.48	.024	.078	67.0		
UnK	6/11/1986	11:15 AM	Surface	Goebel Greg	4			54	88	2	0.015			.16	.033	.057	62.5		
UnK	6/11/1986	11:05 AM	Surface	Goebel Greg	3			52	81	3	0.015			.72	.020	.059	63.0		
UnK	6/11/1986	11:00 AM	Surface	Goebel Greg	2			52	82	4	.032			.43	.011	.081	67.5		
UnK	6/11/1986	10:45 AM	Surface	Goebel Greg	1			52	92	2	.056			.80	.013	.05	60.6		
UnK	6/11/1986	10:30 AM	Surface	Goebel Greg			5	56	92	4	.048			.56	.012	.046	59.4	1.60	53.2
UnK	6/11/1986	12:50 PM	Surface	Goebel Greg	2			52	81	3	0.015			.31	.016	.054	61.7		
UnK	6/11/1986	12:50 PM	Surface	Goebel Greg	1			55	89	3	0.015			.33	.013	.045	59.1		
UnK	6/11/1986	12:30 PM	Surface	Goebel Greg			5	56	96	4	0.015			.41	.034	.054	61.7	1.60	53.2
UnK	5/28/1986	2:30 PM	Surface	Goebel Greg	2			52	100	2	0.015			.21	.015	.025	50.6		
UnK	5/28/1986	12:30 PM	Surface	Goebel Greg	5			56	100	4	.05			.33	.020	.032	54.2		
UnK	5/28/1986	2:15 PM	Surface	Goebel Greg			5	58	90	3	0.015			.18	.010	.025	50.6		
UnK	5/28/1986	12:15 PM	Surface	Goebel Greg	4			62	105	3	.03			.25	.04	.03	53.2		
UnK	5/28/1986	12:00 PM	Surface	Goebel Greg	3			58	110	4	.05			.44	.020	.020	47.4		
UnK	5/28/1986	11:30 AM	Surface	Goebel Greg	1			54	107	5	.51			.27	.011	.022	48.7		
UnK	5/28/1986	11:15 AM	Surface	Goebel Greg			5	54	117	5	1			.47	.015	.02	47.4	2.44	47.1
UnK	5/28/1986	11:45 AM	Surface	Goebel Greg	2			52	117	5	.19			.18	.015	.028	52.2		

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	5/28/1986	2:00 PM	Surface	Goebel Greg				56	104	4	0.015			.50	.020	.032	54.2	2.44	47.1
UnK	5/28/1986	1:00 PM	Surface	Goebel Greg	6.2			62	105	9	0.015			.50	.045	.070	65.4		
UnK	5/6/1986	2:30 PM	Surface	Goebel Greg	5.8			64	304	8	0.015			.52	.01	.095	69.8		
UnK	5/6/1986	2:15 PM	Surface	Goebel Greg	5			62	158	6	0.015			.42	.015	.07	65.4		
UnK	5/6/1986	2:00 PM	Surface	Goebel Greg	4			64	130	6	0.015			.34	.021	.055	62.0		
UnK	5/6/1986	1:45 PM	Surface	Goebel Greg	3			64	112	10	0.015			.38	.021	.05	60.6		
UnK	5/6/1986	1:30 PM	Surface	Goebel Greg	2			66	85	1	0.015			.32	.013	.045	59.1		
UnK	5/6/1986	1:15 PM	Surface	Goebel Greg	1			67	107	3	0.015			.29	.018	.038	56.6		
UnK	5/6/1986	1:00 PM	Surface	Goebel Greg			5	60	84	6	0.015			.5	.02	.04	57.4	1.75	51.9
UnK	5/6/1986	3:00 PM	Surface	Goebel Greg			5	57	132	6	0.015			.22	.017	.060	63.2	1.68	52.5
UnK	5/6/1986	3:15 PM	Surface	Goebel Greg				65	129	9	.49			.22	.016	.105	71.3		
UnK	4/16/1986	11:30 AM	Surface	Goebel Greg	5.1			62	93	7	0.015			.46	.026	.07	65.4		
UnK	4/16/1986	11:50 AM	Surface	Goebel Greg			5	60	67	1	0.015			.95	.025	.095	69.8	0.84	62.5
UnK	4/16/1986	12:00 PM	Surface	Goebel Greg	1			62	76	4	0.015			.66	.026	.062	63.7		
UnK	4/16/1986	10:30 AM	Surface	Goebel Greg			5	66	54	0.5	.09			.68	.031	.098	70.3	0.84	62.5
UnK	4/16/1986	11:00 AM	Surface	Goebel Greg				68	80		0.015			1.15	.026	.095	69.8		
UnK	4/16/1986	10:45 AM	Surface	Goebel Greg	1			60	78	4	0.015			1.12	.025	.07	65.4		
UnK	3/31/1986	10:50 AM	Surface	Goebel Greg	1			52	107	7	0.015			.83	.014	.109	71.8		
UnK	3/31/1986	11:15 AM	Surface	Goebel Greg	3			58	97	7	0.015			.83	.011	.065	64.4		
UnK	3/31/1986	11:30 AM	Surface	Goebel Greg	4			60	99	7	0.015			.74	.011	.067	64.8		
UnK	3/31/1986	11:00 AM	Surface	Goebel Greg	2			58	103	7	0.015			.73	.02	.063	63.9		
UnK	3/31/1986	11:45 AM	Surface	Goebel Greg	4.7			82	114	8	.82			1.61	.103	.181	79.1		
UnK	3/31/1986	10:30 AM	Surface	Goebel Greg			5	56	101	7	0.015			.13	.02	.062	63.7	0.90	61.5
UnK	3/31/1986	12:30 PM	Surface	Goebel Greg			5	56	106	8	0.015			2	.016	.065	64.4	0.91	61.4
UnK	2/18/1986	11:00 AM	Surface	Goebel Greg	3			97	120	0.5	.35			.51	.027	.060	63.2		
UnK	2/18/1986	11:10 AM	Surface	Goebel Greg	3.8			94	124	0.5	.64			1.54	.045	.127	74.0		
UnK	2/18/1986	10:10 AM	Surface	Goebel Greg			5	86	125	5	1.22			1.09	.045	.137	75.1	0.76	64.0
UnK	2/18/1986	10:40 AM	Surface	Goebel Greg	2			94	125	1	.18			.41	.025	.060	63.2		
UnK	1/6/1986	11:30 AM	Surface	Goebel Greg	3.6			102	112	4	.56			.81	.084	.1	70.6		
UnK	1/6/1986	11:00 AM	Surface	Goebel Greg	2			102	116	0.5	.23			.81	.022	.063	63.9		
UnK	1/6/1986	10:40 AM	Surface	Goebel Greg			5	100	110	0.5	.21			.79	.032	.067	64.8	1.10	58.6
UnK	12/3/1985	12:20 PM	Surface	Goebel Greg	1			84	142	2	.12			.84	.020	.053	61.4		
UnK	12/3/1985	11:50 AM	Surface	Goebel Greg	1		5	72	146	3	.09			.84	.020	.081	67.5	1.22	57.1
UnK	12/3/1985	12:40 PM	Surface	Goebel Greg	2			99	123	3	.16			.96	.021	.052	61.2		
UnK	12/3/1985	1:00 PM	Surface	Goebel Greg	3.3			102	151	5	.66			1.39	.022	.111	72.1		
UnK	10/16/1985	1:00 PM	Surface	Goebel Greg	1			76	151	9	.21			1.05	.060	.092	69.4		
UnK	10/16/1985	12:30 PM	Surface	Goebel Greg			5	87	162	10	.21			.86	.064	.085	68.2	0.80	63.2
UnK	10/16/1985	1:15 PM	Surface	Goebel Greg	2			80	149	11	0.015			1	.060	.093	69.5		
UnK	10/16/1985	1:30 PM	Surface	Goebel Greg	2.9			82	126	10	.21			1.03	.060	.093	69.5		
UnK	9/23/1985	12:30 PM	Surface	Goebel Greg			5	72	145	45	0.015			1.75	.015	.114	72.5	0.30	77.4
UnK	9/23/1985	1:10 PM	Surface	Goebel Greg	3			71	147	41	0.015			1.35	0.005	.112	72.2		
UnK	9/23/1985	12:40 PM	Surface	Goebel Greg	1			84	141	41	0.015			1.68	.020	.120	73.2		
UnK	9/23/1985	12:50 PM	Surface	Goebel Greg	2			78	131	44	0.015			1.74	.060	.124	73.7		
UnK	8/21/1985	9:30 AM	Surface	Goebel Greg	2			70	79	7	0.015			1.30	.022	.062	63.7		
UnK	8/21/1985	10:45 AM	Surface	Goebel Greg			5	66	91	1	.1			1.08	.060	.062	63.7	0.70	65.1
UnK	8/21/1985	11:00 AM	Surface	Goebel Greg	1			70	111	3	.03			1.11	.050	.075	66.4		
UnK	8/21/1985	11:10 AM	Surface	Goebel Greg	1.7			68	79	1	0.015			1.10	.028	.08	67.4		
UnK	8/21/1985	9:00 AM	Surface	Goebel Greg			5	71	88	2	0.015			1.25	.025	.060	63.2	0.60	67.4
UnK	8/21/1985	10:00 AM	Surface	Goebel Greg	5.5			82	192	92	1			1.78	.105	.155	76.9		
UnK	8/21/1985	9:50 AM	Surface	Goebel Greg	4			72	115	3	.08			.80	.030	.062	63.7		
UnK	8/21/1985	9:40 AM	Surface	Goebel Greg	3			70	94	2	0.015			1.00	.027	.063	63.9		

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	8/21/1985	9:15 AM	Surface	Goebel Greg	1			66	97	11	0.015			1.17	.049	.070	65.4		
UnK	8/7/1985	9:50 AM	Surface	Goebel Greg	3			70	102	10	.03			.93	.018	.090	69.1		
UnK	8/7/1985	10:00 AM	Surface	Goebel Greg	4			70	109	5	.06			.91	.014	.071	65.6		
UnK	8/7/1985	10:15 AM	Surface	Goebel Greg	5.5			86	162	50	2.36			2.85	.105	.308	86.8		
UnK	8/7/1985	11:15 AM	Surface	Goebel Greg	1.7			66	108	4	.04			1.05	.020	.077	66.8		
UnK	8/7/1985	9:15 AM	Surface	Goebel Greg			5	66	112	4	0.015			1.22	.013	.060	63.2	0.80	63.2
UnK	8/7/1985	11:00 AM	Surface	Goebel Greg	1			72	122	8	.05			1.08	.018	.07	65.4		
UnK	8/7/1985	10:45 AM	Surface	Goebel Greg			5	65	110	8	.07			1.02	.048	.07	65.4	0.80	63.2
UnK	8/7/1985	9:30 AM	Surface	Goebel Greg	1			71	110	4	.06			1.24	.016	.064	64.2		
UnK	8/7/1985	9:40 AM	Surface	Goebel Greg	2			69	92	4	.05			1.29	.02	.062	63.7		
UnK	7/18/1985	10:00 AM	Surface	Goebel Greg	4			78	95	5	.07			.9	.015	.075	66.4		
UnK	7/18/1985	10:10 AM	Surface	Goebel Greg	5.5			86	117	27	.86			2.13	.058	0.205	80.9		
UnK	7/18/1985	9:30 AM	Surface	Goebel Greg	1			70	125	5	0.015			.785	.020	.040	57.4		
UnK	7/18/1985	11:10 AM	Surface	Goebel Greg	1.7			70	84	4	0.015			.88	.010	.075	66.4		
UnK	7/18/1985	10:45 AM	Surface	Goebel Greg			20	66	63	3	.04			.91	.015	.048	60.0	1.20	57.4
UnK	7/18/1985	11:00 AM	Surface	Goebel Greg	1			69	53	3	0.015			1.02	.01	.045	59.1		
UnK	7/18/1985	9:10 AM	Surface	Goebel Greg			160	74	59	1	0.015			.86	.010	.040	57.4	1.30	56.2
UnK	7/18/1985	9:35 AM	Surface	Goebel Greg	2			70	94	10	0.015			.89	.010	.050	60.6		
UnK	7/18/1985	9:45 AM	Surface	Goebel Greg	3			72	7	6.5	0.015			.67	.01	.053	61.4		
UnK	6/19/1985	12:40 PM	Surface	Goebel Greg	4			75	137	6	0.015			.9	.055	.065	64.4		
UnK	6/19/1985	10:45 AM	Surface	Goebel Greg	1			76	100	6	0.015			.8	.028	.034	55.0		
UnK	6/19/1985	11:00 AM	Surface	Goebel Greg	1.8			76	90	4	0.015			.82	.036	.045	59.1	0.91	61.3
UnK	6/19/1985	12:30 PM	Surface	Goebel Greg	3			71	103	5	0.015			.84	.061	.063	63.9		
UnK	6/19/1985	12:20 PM	Surface	Goebel Greg	2			78	136	4	0.015			.80	.064	.07	65.4		
UnK	6/19/1985	12:15 PM	Surface	Goebel Greg	1			80	142	8	0.015			.77	.072	.077	66.8		
UnK	6/19/1985	12:00 PM	Surface	Goebel Greg			5	74	102	4	0.015			.76	.043	.046	59.4		
UnK	6/19/1985	12:50 PM	Surface	Goebel Greg	5.6			76	92	14	.14			1.05	.037	.1	70.6		
UnK	6/19/1985	10:30 AM	Surface	Goebel Greg			5	76	106	4				.84	.012	.033	54.6	0.91	61.4
UnK	6/5/1985	9:45 AM	Surface	Goebel Greg			1	90	182	90	0.015			1.26	.024	.05	60.6	0.91	61.3
UnK	6/5/1985	11:00 AM	Surface	Goebel Greg	5.6			114	110	30	.23			1.08	.030	.172	78.4		
UnK	6/5/1985	10:15 AM	Surface	Goebel Greg	2			82	97	9	0.015			1.01	.024	.058	62.7		
UnK	6/5/1985	10:10 AM	Surface	Goebel Greg	1			98	86	10	0.015			1.47	.026	.065	64.4		
UnK	6/5/1985	10:45 AM	Surface	Goebel Greg	4			100	95	8	.05			.90	.012	.049	60.3		
UnK	6/5/1985	11:45 AM	Surface	Goebel Greg			1	88	86	10	0.015			1.10	.013	.050	60.6	0.91	61.4
UnK	6/5/1985	12:00 PM	Surface	Goebel Greg	1			88	71	7	0.015			1.16	.038	.060	63.2		
UnK	6/5/1985	12:15 PM	Surface	Goebel Greg	1.8			94	76	10	0.015			1.27	.012	.060	63.2		
UnK	6/5/1985	10:30 AM	Surface	Goebel Greg	3			96	87	7	.04			.93	.012	.047	59.7		
UnK	5/22/1985	10:10 AM	Surface	Goebel Greg	3			70	99	11	.39			.24	.026	.061	63.5		
UnK	5/22/1985	10:00 AM	Surface	Goebel Greg	2			69	111	7	.22			.71	.027	.055	62.0		
UnK	5/22/1985	9:30 AM	Surface	Goebel Greg			1	68	248	12	.04			.34	.036	.055	62.0	1.37	55.5
UnK	5/22/1985	10:30 AM	Surface	Goebel Greg	5.6			68	123	29	.55			.85	.033	.114	72.5		
UnK	5/22/1985	9:45 AM	Surface	Goebel Greg	1			70	102	10	.08			.65	.040	.036	55.8		
UnK	5/22/1985	10:20 AM	Surface	Goebel Greg	4			72	105	7	.19			.63	.02	.07	65.4		
UnK	5/8/1985	11:45 AM	Surface	Goebel Greg	1			64	23	1	0.015			.59	.020	.031	53.7		
UnK	5/8/1985	11:30 AM	Surface	Goebel Greg			1	70	40	2	0.015			.51	0.005	.033	54.6	1.68	52.5
UnK	5/8/1985	12:00 PM	Surface	Goebel Greg	1.8			68	42	4	0.015			.51	.020	.040	57.4		
UnK	5/8/1985	9:30 AM	Surface	Goebel Greg			1	70	111	1	0.015			.51	.021	.030	53.2	1.68	52.5
UnK	5/8/1985	10:20 AM	Surface	Goebel Greg	3.00			65	24	4	0.015			.54	.010	.035	55.4		
UnK	5/8/1985	10:00 AM	Surface	Goebel Greg	1.00			72	33	1	.039			.78	.035	.039	57.0		
UnK	5/8/1985	10:10 AM	Surface	Goebel Greg	2.00			76	88	2	0.015			.6	.029	.055	62.0		
UnK	5/8/1985	10:45 AM	Surface	Goebel Greg	5.60			73	58	10	0.015			.8	.029	.064	64.2		

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	5/8/1985	10:30 AM	Surface	Goebel Greg	4.00			68	33	7	0.015			.77	.030	.068	65.0		
UnK	4/15/1985	11:50 AM	Surface	Goebel Greg	1			60	96	0.5	0.015			1.7	.010	.047	59.7		
UnK	4/15/1985	11:30 AM	Surface	Goebel Greg	1.68		1	58	50	4	0.015			.61	.035	.050	60.6		
UnK	4/15/1985	10:30 AM	Surface	Goebel Greg	2.99			58	99	5	0.015			.84	.010	.075	66.4		
UnK	4/15/1985	9:30 AM	Surface	Goebel Greg	1.83		1	52	26	4	.04			.56	.01	.045	59.1		
UnK	4/15/1985	10:50 AM	Surface	Goebel Greg	5.61			66	72	8	0.015			.9	.04	.085	68.2		
UnK	4/15/1985	12:10 PM	Surface	Goebel Greg	1.8			64	105	3	0.015			.69	.012	.050	60.6		
UnK	4/15/1985	10:00 AM	Surface	Goebel Greg	1.01			60	69	6	0.015			.87	0.005	.05	60.6		
UnK	4/15/1985	10:15 AM	Surface	Goebel Greg				60	88	4	0.015			.98	0.005	.05	60.6		
UnK	4/15/1985	10:40 AM	Surface	Goebel Greg	3.99			61	98	6	0.015			.83	.01	.075	66.4		
UnK	3/13/1985	12:20 PM	Surface	Goebel Greg	2			66	61	5	.04			.69		.078	67.0		
UnK	3/13/1985	9:45 AM	Surface	Goebel Greg			1	75	64	4	.15			1.8	.029	.080	67.4	0.23	81.2
UnK	3/13/1985	10:10 AM	Surface	Goebel Greg	2.01			74	61	3	.13			1.45	.025	.066	64.6		
UnK	3/13/1985	10:25 AM	Surface	Goebel Greg	2.99			96	68	2	.15			2.10	.021	.055	62.0		
UnK	3/13/1985	10:50 AM	Surface	Goebel Greg	5.6			86	64	4	.19			1.03	.031	.059	63.0		
UnK	3/13/1985	10:35 AM	Surface	Goebel Greg	3.99			72	56	0.5	.16			.78	.021	.046	59.4		
UnK	3/13/1985	12:00 PM	Surface	Goebel Greg			1	74	71	5	.07			.90	.032	.065	64.4	0.46	71.2
UnK	2/13/1985	11:50 AM	Surface	Goebel Greg			1	77	82	0.5	.07			.64	.028	.053	61.4	0.68	65.6
UnK	2/13/1985	12:15 PM	Surface	Goebel Greg	2			92	88	2	.11			.76	.020	.060	63.2		
UnK	2/13/1985	10:50 AM	Surface	Goebel Greg	3.99			88	92	0.5	.23			.74	.021	.044	58.7		
UnK	2/13/1985	10:40 AM	Surface	Goebel Greg	2.99			80	90	2	.23			0.015	.021	.055	62.0		
UnK	2/13/1985	10:20 AM	Surface	Goebel Greg	2.01			78	100	2	.21			.80	.026	.035	55.4		
UnK	2/13/1985	10:00 AM	Surface	Goebel Greg	0.61		12	82	94	2	.2			1.09	.030	.097	70.1	0.76	64.0
UnK	2/13/1985	11:00 AM	Surface	Goebel Greg	5.61			76	77	5	.31			.78	.020	.050	60.6		
UnK	1/14/1985	12:30 PM	Surface	Goebel Greg			1	78	71	5	.07			.53	.095	.095	69.8	1.22	57.1
UnK	1/14/1985	11:15 AM	Surface	Goebel Greg	3.99			64	105	5	.25			.79	.033	.033	54.6		
UnK	1/14/1985	11:00 AM	Surface	Goebel Greg	2.99			68	108	4	.225			1.25	.027	.045	59.1		
UnK	1/14/1985	10:30 AM	Surface	Goebel Greg	2.01			72	106	6	.17			.90	.027	.050	60.6		
UnK	1/14/1985	10:10 AM	Surface	Goebel Greg			1	84	94	6	.24			.92	.027	.054	61.7	0.99	60.1
UnK	1/14/1985	1:00 PM	Surface	Goebel Greg	2			74	45	5	.14			.82	.045	.045	59.1		
UnK	1/14/1985	11:30 AM	Surface	Goebel Greg	5.61			80	101	13	.34			.96	.03	.045	59.1		
UnK	12/19/1984	11:50 AM	Surface	Goebel Greg	2.01			64	116	8	.14			1.22	.02	.060	63.2		
UnK	12/19/1984	12:10 PM	Surface	Goebel Greg	2.99			62	138	6	.16			.94	.01	.063	63.9		
UnK	12/19/1984	12:40 PM	Surface	Goebel Greg	5.6			84	179	25	.23			1.07	.042	.060	63.2		
UnK	12/19/1984	11:30 AM	Surface	Goebel Greg	1.01			66	102	6	.16			1.08	.012	.070	65.4		
UnK	12/19/1984	11:15 AM	Surface	Goebel Greg	0.46		1	70	107	7	.17			1.13	.01	.070	65.4	0.76	64.0
UnK	12/19/1984	2:15 PM	Surface	Goebel Greg	2			76	152	6	.1			.81	.012	.080	67.4		
UnK	12/19/1984	2:00 PM	Surface	Goebel Greg	1			64	140	4	.08			.9	.010	.060	63.2		
UnK	12/19/1984	1:45 PM	Surface	Goebel Greg	.5		1	69	125	5	.1			.99	.015	.082	67.7	0.76	64.0
UnK	12/19/1984	12:30 PM	Surface	Goebel Greg	3.99			60	128	6	.16			.98	.01	.060	63.2		
UnK	7/12/1984	9:20 AM	Surface	Goebel Greg	5.64			62	138	24	.16			.69	.085	.154	76.8		
UnK	7/12/1984	9:05 AM	Surface	Goebel Greg	0.46		64	56	128	6	.09			.69	.031	.084	68.1	1.07	59.0
UnK	7/12/1984	9:50 AM	Surface	Goebel Greg	1.68			58	104	4	.06			59	.031	.058	62.7		
UnK	7/12/1984	9:40 AM	Surface	Goebel Greg	0.46		22	56	92	3	.07			.68	.031	.075	66.4		
UnK	7/12/1984	9:15 AM	Surface	Goebel Greg	3.28			64	114	10	.07			.62	.032	.120	73.2		
UnK	6/13/1984	9:10 AM	Surface	Goebel Greg	3.35			54	116	1	.04			.57	.030	.036	55.8		
UnK	6/13/1984	9:35 AM	Surface	Goebel Greg	5.79			66	136	24	.21			.79	.067	.134	74.8		
UnK	6/13/1984	8:50 AM	Surface	Goebel Greg	0.46			54		122	.04			.96	.057	.057	62.5	0.68	65.6
UnK	6/13/1984	10:15 AM	Surface	Goebel Greg	1.68			56	108	1	.03			.82	.030	.042	58.1		
UnK	6/13/1984	10:00 AM	Surface	Goebel Greg	0.46		12	52	116	4	.05			.95	.024	.050	60.6	0.61	67.1
UnK	5/22/1984	10:10 AM	Surface	Goebel Greg	5.79			60	150	13	.05			.4	.010	.055	62.0		

Site	Date	Time	RelDepth	Personnel	Depth	E Coli	Fecal	Alka	Tot Sol	TSS	Ammo	Un-Ion Ammo	N/N	TKN	TDP	TP	TSI TP	Secchi	TSI SD
UnK	5/22/1984	10:05 AM	Surface	Goebel Greg	3.35			54	106	7	0.015			.42	.010	.056	62.2		
UnK	5/22/1984	10:50 AM	Surface	Goebel Greg	1.68			48	126	8	0.015			.40	.015	.062	63.7		
UnK	5/22/1984	10:35 AM	Surface	Goebel Greg	0.46		2	52	122	5	.04			.41	.020	.056	62.2	0.99	60.1
UnK	5/22/1984	10:00 AM	Surface	Goebel Greg	0.46			50	123	8	0.015			.37	.011	.056	62.2	1.07	59.0
UnK	4/17/1984	1:15 PM	Surface	Goebel Greg	0.46		1	62	104	6	0.015			.44	.010	.026	51.2	1.29	56.3
UnK	4/17/1984	1:35 PM	Surface	Goebel Greg	3.28			64	106	9	0.015			.48	0.005	.036	55.8		
UnK	4/17/1984	2:05 PM	Surface	Goebel Greg	1.68			64	112	12	0.015			.36	0.005	.025	50.6		
UnK	4/17/1984	1:55 PM	Surface	Goebel Greg	0.46		1	62	98	6	0.015			.35	.010	.025	50.6	1.29	56.3
UnK	4/17/1984	1:40 PM	Surface	Goebel Greg	5.64			62	118	12	0.015			.48	.010	.048	60.0		
UnK	3/19/1984	10:25 AM	Surface	Goebel Greg	1.68			62	152	7	.03			.41	.010	.044	58.7		
UnK	3/19/1984	9:55 AM	Surface	Goebel Greg	5.49			66	158	16	.05			.76	.010	.044	58.7		
UnK	3/19/1984	9:30 AM	Surface	Goebel Greg	3.20			68	152	11	0.015			.79	.015	.066	64.6		
UnK	3/19/1984	9:00 AM	Surface	Goebel Greg	0.46		1	68	146	8	0.015			.65	.01	.038	56.6	0.91	61.4
UnK	3/19/1984	10:15 AM	Surface	Goebel Greg	0.46		1	64	138	9	0.015			.36	.010	.044	58.7	1.37	55.5
UnK	2/21/1984	9:30 AM	Surface	Goebel Greg	0.46		1	70	115	5	0.015			.86	.010	.065	64.4	0.61	67.1
UnK	2/21/1984	10:10 AM	Surface	Goebel Greg	0.46			66	108	2	0.015			.33	0.005	.043	58.4	1.22	57.1
UnK	2/21/1984	10:30 AM	Surface	Goebel Greg	1.68			72	122	2	0.015			.43	.010	.050	60.6		
UnK	2/21/1984	9:45 AM	Surface	Goebel Greg	3.20			72	118	4	.04			.57	0.005	.050	60.6		
UnK	2/21/1984	9:50 AM	Surface	Goebel Greg	5.49			70	122	5	.13			.53	.010	.032	54.2		
UnK	1/23/1984	9:50 AM	Surface	Goebel Greg	0.46		1	79	106	4	.09			.41	.026	.059	63.0	1.14	58.1
UnK	1/23/1984	10:00 AM	Surface	Goebel Greg	1.68			74	108	3	.19			.5	.02	.05	60.6		
UnK	1/23/1984	11:00 AM	Surface	Goebel Greg	5.49			84	100	4	.43			.70	.018	.043	58.4		
UnK	1/23/1984	10:45 AM	Surface	Goebel Greg	3.20			80	116	2	.33			.65	.019	.039	57.0		
UnK	1/23/1984	10:20 AM	Surface	Goebel Greg	0.46		1	79	132	1	.3			.66	.020	.041	57.7	1.37	55.5
UnK	1/3/1984	10:55 AM	Surface	Goebel Greg	0.46		1	68	136	2	.14			.45	.035	.066	64.6	1.07	59.0
UnK	1/3/1984	11:15 AM	Surface	Goebel Greg	1.52			68	126	2	.20			.58	.033	.056	62.2		
UnK	1/3/1984	10:20 AM	Surface	Goebel Greg	3.20			70	112	4	.29			.65	.022	.040	57.4		
UnK	1/3/1984	10:30 AM	Surface	Goebel Greg	5.49			68	120	8	.41			.91	.022	.061	63.5		
UnK	1/3/1984	10:05 AM	Surface	Goebel Greg	0.46		1	74	136	3	.26			.61	.022	.045	59.1	1.52	54.0
UnK	12/6/1983	9:30 AM	Surface	Goebel Greg	5.49			66	138	20	.24			.85	.040	.060	63.2		
UnK	12/6/1983	9:20 AM	Surface	Goebel Greg	3.20			68	130	4	.19			.62	.025	.048	60.0		
UnK	12/6/1983	10:40 AM	Surface	Goebel Greg	0.46		4	68	112	7	.08			.89	.040	.090	69.1	0.91	61.4
UnK	12/6/1983	10:50 AM	Surface	Goebel Greg	1.68			68	108	6	.12			.76	.040	.065	64.4		
UnK	12/6/1983	8:50 AM	Surface	Goebel Greg	1.5		1	75	132	5	.16			.97	.020	.090	69.1	0.84	62.5
UnK	10/25/1983	12:20 PM	Surface	Goebel Greg	1.52			66	122	11	.26			.93	.010	.075	66.4		
UnK	10/25/1983	1:10 PM	Surface	Goebel Greg	4.88			66	124	20	.29			.92	.018	.020	47.4	0.76	63.9
UnK	10/25/1983	1:00 PM	Surface	Goebel Greg	2.90			64	122	12	.27			.99	.018	.062	63.7		
UnK	10/25/1983	12:45 PM	Surface	Goebel Greg	0.46		1	64	122	11	.27			.82	.018	.075	66.4	0.76	64.0
UnK	10/25/1983	11:50 AM	Surface	Goebel Greg	0.46		2	66	126	11	.26			.88	.018	.055	62.0	0.84	62.5
UnK	10/5/1983	10:45 AM	Surface	Goebel Greg	0.46		4	64	116	9	.04			1.13	.012	.058	62.7	1.07	59.0
UnK	10/5/1983	10:50 AM	Surface	Goebel Greg	1.68			70	102	10	.03			.97	.012	.058	62.7		
UnK	10/5/1983	10:10 AM	Surface	Goebel Greg	3.35			72	114	10	.08			.94	.014	.052	61.2		
UnK	10/5/1983	9:30 AM	Surface	Goebel Greg	0.46		2	66	108	5	.04			.92	.014	.055	62.0	1.22	57.1
UnK	10/5/1983	10:20 AM	Surface	Goebel Greg	5.79			70	124	24	.22			1.12	.019	.058	62.7		
UnK	8/23/1983	9:10 AM	Surface	Goebel Greg	0.46			62	114	9	.05			1.57	.010	.065	64.4	0.76	64.0
UnK	8/23/1983	9:20 AM	Surface	Goebel Greg	1.68			62	114	4	.03			1.05	.010	.070	65.4		
UnK	8/23/1983	10:05 AM	Surface	Goebel Greg	3.20	1		62	110	7	.06			.82	.010	.065	64.4		
UnK	8/23/1983	10:15 AM	Surface	Goebel Greg	5.49	1		82	120	19	.96			1.01	.130	.225	82.3		
UnK	8/23/1983	9:50 AM	Surface	Goebel Greg	0.46	1	1	62	104	10	0.015			.95	.010	.050	60.6	0.91	61.4
UnK	7/27/1983	9:45 AM	Surface	Goebel Greg	5.79	1		74	122	32	.28			1.31	.100	.132	74.6		
UnK	7/27/1983	10:05 AM	Surface	Goebel Greg	0.46	1	1	62	92	8	0.015			.77	.010	.050	60.6	1.29	56.3
UnK	7/27/1983	10:15 AM	Surface	Goebel Greg	5.5	1		62	116	11	0.015			.77	.015	.050	60.6		
UnK	7/27/1983	9:30 AM	Surface	Goebel Greg	3.35			64	92	11	0.015			.88	.015	.050	60.6		
UnK	7/27/1983	9:15 AM	Surface	Goebel Greg	0.46		4	60	110	6	.04			.79	.010	.035	55.4	1.29	56.3
UnK	6/29/1983	10:45 AM	Surface	Goebel Greg	0.46	1	5	50.8	112	15	0.01			.42	.009	.058	62.7	1.37	55.5
UnK	6/29/1983	10:00 AM	Surface	Goebel Greg	5.64	1		55.4	124	18	.08			.14	.012	.068	65.0		
UnK	6/29/1983	9:30 AM	Surface	Goebel Greg	0.46	1	5	51.4	117	9	0.01			.25	.009	.047	59.7	1.52	54.0
UnK	6/29/1983	9:50 AM	Surface	Goebel Greg	3.28	1		51.6	114	19	0.01			.29	.008	.054	61.7		
UnK	6/29/1983	11:00 AM	Surface	Goebel Greg	1.52			50.8	125	14	0.01			0.65	.008	.064	64.2		

Legion Lake Field Data

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
LL1	8/22/2001	15:43	Surface	Scott Alan	5	17	213.5	10.45	9.2	22	1		Rainy
LL1	9/26/2001	13:10	Surface	Scott Alan	5	25	218.6	7.11	9	17	2		Sunny
LL1	11/1/2001	11:10	Surface	Scott Alan	5	8	218.2	11.02	8.5	7	5		Sunny
LL1	12/27/2001	9:50	Surface	Scott Alan	4.75	3	131.7	12.67	8.2	2		18	Overcast
LL1	1/31/2002	10:20	Surface	Scott Alan	5.5	-3	247	11.47	7.8	4		18	Overcast
LL1	2/27/2002	10:05	Surface	Scott Alan	5	-7	244.2	10.93	7.7	4	3	18	Sunny
LL1	5/13/2002	12:49	Surface	Scott Alan	6	11	211.8	9.9	8.6	10	4.5		Sunny
LL1	6/6/2002		Surface	Scott Alan	5	23	212.1	8.58	8.9	18	5		Sunny
LL1	7/1/2002	11:00	Surface	Scott Alan	5	26	216.1	7.24	9	23	4.5		Sunny
LL1	8/5/2002	12:35	Surface	Scott Alan	5	21	219.4	6.3	9.1	22	3.5		Overcast
LL1	8/22/2001	15:43	Bottom	Scott Alan	5	17	213.5	10.45	9.2	20	1		Rainy
LL1	9/26/2001	13:17	Bottom	Scott Alan	5	25	217.9	5.94	9.3	16	2		Sunny
LL1	11/1/2001	11:30	Bottom	Scott Alan	5	8	218.4	10.88	8.5	7	5		Sunny
LL1	12/27/2001	10:35	Bottom	Scott Alan	4.75	3	233.1	12.53	8.2	4		18	Overcast
LL1	1/31/2002	10:50	Bottom	Scott Alan	5.5	-3	243.2	11.15	7.8	4		18	Overcast
LL1	2/27/2002	10:48	Bottom	Scott Alan	5		244.3	10.37	7.6	5	3	18	Sunny
LL1	5/13/2002	12:49	Bottom	Scott Alan	6	11	212.3	9.42	8.5	9	4.5		Sunny
LL1	6/6/2002	10:39	Bottom	Scott Alan	5	23	212.7	9.43	8.6	16	5		Sunny
LL1	7/1/2002	11:00	Bottom	Scott Alan	5	26	215.9	7.12	8.7	22	4.5		Sunny
LL1	8/5/2002	12:35	Bottom	Scott Alan	5	21	219.5	5.97	9.1	22	3.5		Overcast
LL2	8/22/2001	17:57	Surface	Scott Alan	3	17	212.8	10.44	8.7	21.4	1		Rainy
LL2	9/26/2001	13:23	Surface	Scott Alan	2.25	25	218.4	7	8.9	17.4	2.25		Sunny
LL2	11/1/2001	10:42	Surface	Scott Alan	2.25	8	212.2	10.96	8.5	6.5	2.25		Sunny
LL2	12/27/2001	11:10	Surface	Scott Alan	3	3	132.4	12.95	8.3	2		12	Overcast
LL2	1/31/2002	11:18	Surface	Scott Alan	2.5	-3	245.2	12.3	7.9	4		18	Overcast
LL2	2/27/2002	11:20	Surface	Scott Alan	2.5	-7	239.5	11.29	7.6	3.9		18	Sunny
LL2	5/13/2002	12:41	Surface	Scott Alan	2.5	8	207.2	9.95	8.9	10.7	2.5		Sunny
LL2	6/6/2002	11:15	Surface	Scott Alan	2.5	22	209	8.73	9	18.2	2.5		Sunny
LL2	7/1/2002	11:00	Surface	Scott Alan	2.5	26	214.4	7.26	9.3	23.5	2.5		Sunny
LL2	8/5/2002	12:20	Surface	Scott Alan	2.5	21	218.3	6.16	9.1	21.5	2.5		Overcast
LL2	8/22/2001	15:57	Bottom	Scott Alan	3	17	213.8	10.67	8.7	20.9	1		Rainy
LL2	9/26/2001	13:30	Bottom	Scott Alan	2.25	25	217.6	7.09	8.8	15.3	2.25		Sunny
LL2	11/1/2001	11:05	Bottom	Scott Alan	2.25	8	213.2	10.98	8.5	6.5	2.25		Sunny
LL2	12/27/2001	11:48	Bottom	Scott Alan	3	3	233.8	13.26	8.3	3.7			Overcast
LL2	1/31/2002	11:50	Bottom	Scott Alan	2.5	-3	283	12.3	7.8	4.3			Overcast
LL2	2/27/2002	11:55	Bottom	Scott Alan	2.5	-7	244.1	10.68	7.6	4.4			Sunny
LL2	5/13/2002	12:41	Bottom	Scott Alan	2.5	8	210.8	9.95	8.9	10.3	2.5		Sunny
LL2	6/6/2002	12:00	Bottom	Scott Alan	2.5	22	209.8	9.45	9.1	17.4	2.5		Sunny
LL2	7/1/2002	11:00	Bottom	Scott Alan	2.5	26	215.8	7.62	9.1	23.1	2.5		Sunny
LL2	8/5/2002	12:20	Bottom	Scott Alan	2.5	21	219.5	6.02	9.1	21.5	2.5		Overcast
LLT3	8/22/2001	12:32	Surface	Scott Alan	0.3	26	270.3	7.72	7.7	15			Rainy
LLT3	9/26/2001	12:04	Surface	Scott Alan	0.36	28	275.8	8.86	10.0	11			Sunny
LLT3	10/10/2001	17:05	Surface	Scott Alan	0.37	14	298.8	9.69	7.9	7			Sunny
LLT3	10/31/2001	17:16	Surface	Scott Alan	0.35	8	273.1	9.55	7.7	7			Sunny
LLT3	4/18/2002	11:40	Surface	Scott Alan	0.25	8	285.6	9.97	8.0	2			Sunny
LLT3	4/24/2002	9:58	Surface	Scott Alan	0.23	21	252.5	9.74	7.9	5			Sunny
LLT3	5/2/2002	9:15	Surface	Scott Alan	0.24	17	373.5	10.50	8.0	2			Sunny
LLT3	6/26/2002	10:18	Surface	Scott Alan	0.18	28	289.6	7.34	8.2	15			Sunny
LLT3	7/21/2002	11:57	Surface	Scott Alan	0.31	20	147.1	5.60	9.0	16			Rainy
LLT3	8/12/2002	13:19	Surface	Scott Alan	0.2	12	288.3	7.08	8.2	12			Overcast

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
LLT4	8/22/2001	13:11	Surface	Scott Alan	0.35	22	207.4	7.19	7.6	16			Rainy
LLT4	9/26/2001	12:17	Surface	Scott Alan	0.36	24	193.8	8.87	9.9	12			Sunny
LLT4	10/10/2001	16:56	Surface	Scott Alan	0.39	14	196.7	8.62	7.5	8			Sunny
LLT4	10/31/2001	16:57	Surface	Scott Alan	0.39	8	178.2	9.41	7.9	8			Sunny
LLT4	4/18/2002	11:59	Surface	Scott Alan	0.36	8	210.9	9.39	7.9	7			Sunny
LLT4	4/23/2002	10:26	Surface	Scott Alan	0.23	21	190.7	8.47	7.6	9			Sunny
LLT4	5/2/2002	10:01	Surface	Scott Alan	0.24	16	243.8	10.30	8.1	2			Sunny
LLT4	6/26/2002	10:45	Surface	Scott Alan	0.36	30	190.4	6.92	7.8	16			Sunny
LLT4	7/21/2002	0:06	Surface	Scott Alan	0.29	18	272.3	5.57	8.6	16			Rainy
LLT4	8/12/2002	13:31	Surface	Scott Alan	0.2	12	208.2	7.49	8.2	11			Overcast
LLT5	8/22/2001	13:43	Surface	Scott Alan	0.66	21	189.2	7.25	7.9	17			Rainy
LLT5	9/26/2001	12:35	Surface	Scott Alan	0.6	24	185.9	8.74	8.0	12			Sunny
LLT5	10/10/2001	16:45	Surface	Scott Alan	0.65	16	200.1	9.66	7.9	9			Sunny
LLT5	10/31/2001	16:34	Surface	Scott Alan	0.66	9	176.1	8.99	8.0	9			Sunny
LLT5	4/18/2002	12:12	Surface	Scott Alan	0.66	8	195.9	9.40	8.0	6			Sunny
LLT5	4/23/2002	10:55	Surface	Scott Alan	0.66	-14	202.6	8.11	7.9	11			Sunny
LLT5	5/2/2002	10:56	Surface	Scott Alan	0.69	19	253.9	11.21	8.0	2			Sunny
LLT5	6/26/2002	10:55	Surface	Scott Alan	0.2	30	206.1	6.90	7.8	17			Sunny
LLT5	7/21/2002	0:17	Surface	Scott Alan	1.1	18	247.0	5.57	8.5	17			Rainy
LLT5	8/12/2002	13:42	Surface	Scott Alan	0.6	13	195.6	7.53	8.2	12			Overcast
LLO6	8/22/2001	16:40	Surface	Scott Alan	0.35	20	226.6	6.32	7.6	19			Rainy
LLO6	9/26/2001	13:56	Surface	Scott Alan	0.34	26	243.3	6.72	11.0	17			Sunny
LLO6	4/18/2002	12:27	Surface	Scott Alan	0.4	8	213.5	8.56	8.0	9			Sunny
LLO6	4/24/2002	11:27	Surface	Scott Alan	0.41	20	216.2	7.52	7.9	12			Sunny
LLO6	5/2/2002	11:23	Surface	Scott Alan	0.46	17	211.6	8.41	8.2	9			Sunny
LLO6	6/26/2002	11:15	Surface	Scott Alan	0.21	28	275.5	6.77	7.7	19			Sunny
LLO6	7/21/2002	0:29	Surface	Scott Alan	0.2	18	260.6	4.64	8.0	18			Rainy
LLO6	8/12/2002	14:07	Surface	Scott Alan	0.21	13	292.8	5.65	7.9	14			Overcast
UnK	7/11/1989		BOTTOM						7.51				
UnK	7/11/1989		BOTTOM				190	9		23.6			
UnK	7/11/1989		SURFACE						7.65				
UnK	7/11/1989		SURFACE				180	5.3		24	0.54864		
UnK	8/15/1989		BOTTOM						7.53				
UnK	8/15/1989		BOTTOM				177	1.6	7.5	18.8			
UnK	8/15/1989		SURFACE						7.72				
UnK	8/15/1989		SURFACE				184	6.1	7.7	20.7	2.1336		
UnK	6/19/1991		BOTTOM						7.17				
UnK	6/19/1991		BOTTOM					0.1	7.6	9.25			
UnK	6/19/1991		SURFACE						7.49				
UnK	6/19/1991		SURFACE					8.05	7.95	19	1.15824		
UnK	7/22/1992		BOTTOM										
UnK	7/22/1992		BOTTOM					2.67	7.44	14.67			
UnK	7/22/1992		SURFACE										
UnK	7/22/1992		SURFACE					6.33	7.44	17	1.35		
UnK	8/18/1992		BOTTOM										
UnK	8/18/1992		BOTTOM					2.367	7.72	16.33			
UnK	8/18/1992		SURFACE										
UnK	8/18/1992		SURFACE					7.7	8.58	19	1.37		
UnK	6/7/1999		BOTTOM										
UnK	6/7/1999		BOTTOM				111.6667	4.48		8.846666			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	6/7/1999		SURFACE										
UnK	6/7/1999		SURFACE				151.3333	6.983333		20.54667	1.45		
UnK	7/27/1999		BOTTOM										
UnK	7/27/1999		BOTTOM				111.3333	3.816667	8.083333	13.14			
UnK	7/27/1999		SURFACE										
UnK	7/27/1999		SURFACE				353	8.043333	8.953333	25.57667	1.14		
Comp	6/19/2003		Bottom				273	2.66	7.98	15.1	3.9		
Comp	6/19/2003		Surface				241	10	8.27	19.7	3.9		
Comp	7/21/2003		Bottom				317	1.31	8.06	19	4.23		
Comp	7/21/2003		Surface				252	10.3	9.07	25.8	4.23		
UnK	8/22/2001		surface				212.8	10.44	8.7	21.4	1		
UnK	6/6/2002		surface				209	8.73	9	18.2	2.5		
UnK	7/1/2002		surface				214.4	7.26	9.3	23.5	2.5		
UnK	8/5/2002		surface				218.3	6.16	9.1	21.5	2.5		
UnK	10/14/1986	10:40	Surface	Goebel Greg	5	10.00		9.4	7.3	7.22			
UnK	10/14/1986	10:30	Surface	Goebel Greg	4	10.00		9.4	7.1	7.22			
UnK	10/14/1986	10:20	Surface	Goebel Greg	3	10.00		9.4	7.2	6.67			
UnK	10/14/1986	10:10	Surface	Goebel Greg	2	10.00		9.4	7.2	6.67			
UnK	10/14/1986	10:00	Surface	Goebel Greg	1	10.00		9.4	7.1	6.67			
UnK	10/14/1986	9:45	Surface	Goebel Greg		10.00		9.4	6.9	5.56	1.91		
UnK	10/14/1986	11:50	Surface	Goebel Greg	2	9.44		9.8	7.3	6.67			
UnK	10/14/1986	11:40	Surface	Goebel Greg	1	9.44		9.8	7.3	7.22			
UnK	10/14/1986	11:30	Surface	Goebel Greg		9.44		9.8	7.2	6.67	1.83		
UnK	10/14/1986	10:50	Surface	Goebel Greg	6	10.00		9.4	7.3	7.22			
UnK	9/23/1986	11:40	Surface	Goebel Greg	1	17.22		7	7	12.22			
UnK	9/23/1986	11:50	Surface	Goebel Greg	1.8	17.22		7	7	12.22	2.13		
UnK	9/23/1986	11:30	Surface	Goebel Greg		17.22		7.1	7.0	13.33	2.13		
UnK	9/23/1986	10:10	Surface	Goebel Greg		12.78		5.6		13.33			
UnK	9/23/1986	10:00	Surface	Goebel Greg		12.78		6.1		13.33	2.13		
UnK	9/23/1986	10:50	Surface	Goebel Greg	5.8	16.67		4.0		11.67			
UnK	9/23/1986	10:40	Surface	Goebel Greg	5	17.22		5.2		12.22			
UnK	9/23/1986	10:15	Surface	Goebel Greg	2	12.78		5.5		13.33			
UnK	9/23/1986	10:20	Surface	Goebel Greg	3	16.67		5.8		13.33			
UnK	9/23/1986	10:30	Surface	Goebel Greg	4	17.22		5.1		12.22			
UnK	8/26/1986	10:45	Surface	Goebel Greg	5	21.11		3.0	7.9	17.78			
UnK	8/26/1986	11:40	Surface	Goebel Greg	2	21.11		12.6	9.3	19.44			
UnK	8/26/1986	9:45	Surface	Goebel Greg		18.33		12.4	9.3	19.44	0.46		
UnK	8/26/1986	10:00	Surface	Goebel Greg	1	18.33		12.4	9.3	20.00			
UnK	8/26/1986	10:15	Surface	Goebel Greg	2	18.33		12.1	9.2	19.44			
UnK	8/26/1986	10:30	Surface	Goebel Greg	3	21.11		7.7	8.9	18.89			
UnK	8/26/1986	10:40	Surface	Goebel Greg	4	21.11		6.7	8.7	18.89			
UnK	8/26/1986	10:55	Surface	Goebel Greg	5.7	21.11		0	6.7	13.33			
UnK	8/26/1986	11:25	Surface	Goebel Greg		21.11		12.7	9.3	20.00			
UnK	8/26/1986	11:35	Surface	Goebel Greg	1	21.11		12.7	9.3	19.44			
UnK	8/12/1986	11:10	Surface	Goebel Greg	6	24.44		0.2	6.9	15.56			
UnK	8/12/1986	10:10	Surface	Goebel Greg		24.44		11.2	9.1	21.11	0.84		
UnK	8/12/1986	10:20	Surface	Goebel Greg	1	24.44		11.8	9.1	20.56			
UnK	8/12/1986	10:30	Surface	Goebel Greg	2	24.44		11.7	9.1	20.56			
UnK	8/12/1986	10:40	Surface	Goebel Greg	3	24.44		9.7	9.0	20.00			
UnK	8/12/1986	11:00	Surface	Goebel Greg	5	24.44		2.9	7.3	18.33			
UnK	8/12/1986	12:30	Surface	Goebel Greg	2	26.67		12.0	9.1	21.67			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	8/12/1986	12:20	Surface	Goebel Greg	1	26.67		11.8	9.1	22.22			
UnK	8/12/1986	12:10	Surface	Goebel Greg		26.67		11.6	9.1	22.78	0.84		
UnK	8/12/1986	10:50	Surface	Goebel Greg	4	24.44		6.1	8.6	19.44			
UnK	7/23/1986	12:30	Surface	Goebel Greg	5	24.44		3.0	7.0	17.78			
UnK	7/23/1986	11:40	Surface	Goebel Greg		22.22		8.0	7.9	22.78	3.05		
UnK	7/23/1986	12:50	Surface	Goebel Greg		28.33		8.1	8.0	22.78	2.80		
UnK	7/23/1986	13:10	Surface	Goebel Greg	2.1	28.33		8.1	8.0	22.78			
UnK	7/23/1986	11:50	Surface	Goebel Greg	a	22.22		8.1	7.9	22.78			
UnK	7/23/1986	12:00	Surface	Goebel Greg	2	24.44		8.1	7.9	22.78			
UnK	7/23/1986	12:10	Surface	Goebel Greg	3	24.44		8.1	7.9	21.67			
UnK	7/23/1986	13:00	Surface	Goebel Greg	1	28.33		8.1	8.0	23.89			
UnK	7/23/1986	12:20	Surface	Goebel Greg	4	24.44		6.6	7.5	20.56			
UnK	7/23/1986	12:40	Surface	Goebel Greg	6	24.44		1.0	6.8	15.00			
UnK	7/9/1986	11:00	Surface	Goebel Greg	3	17.22		8.2	8.2	20.56			
UnK	7/9/1986	13:15	Surface	Goebel Greg	2.2	23.89		7.5	8.4	21.67			
UnK	7/9/1986	12:45	Surface	Goebel Greg		23.89		7.2	8.2	22.22	2.90		
UnK	7/9/1986	13:00	Surface	Goebel Greg	1	23.89		7.5	8.3	22.22			
UnK	7/9/1986	10:45	Surface	Goebel Greg	2	17.22		7.9	8.2	20.56			
UnK	7/9/1986	10:15	Surface	Goebel Greg		17.22		7.2	8.1	21.11	2.36		
UnK	7/9/1986	11:15	Surface	Goebel Greg	4	17.22		7.8	8.0	17.78			
UnK	7/9/1986	11:30	Surface	Goebel Greg	5	17.22		1.9	6.9	13.89			
UnK	7/9/1986	11:45	Surface	Goebel Greg	6	17.22		0	6.8	12.22			
UnK	7/9/1986	10:30	Surface	Goebel Greg	1	17.22		7.3	8.1	20.56			
UnK	6/25/1986	12:00	Surface	Goebel Greg	6	30.00		1.5	6.9	13.33			
UnK	6/25/1986	10:45	Surface	Goebel Greg	1	30.00		11.4	9.0	22.22			
UnK	6/25/1986	10:30	Surface	Goebel Greg		30.00		11.2	9.1	22.22	1.14		
UnK	6/25/1986	11:00	Surface	Goebel Greg	2	30.00		13.0	9.0	21.11			
UnK	6/25/1986	11:15	Surface	Goebel Greg	3	30.00		9.0	8.1	21.11			
UnK	6/25/1986	11:30	Surface	Goebel Greg	4	30.00		4.6	7.1	16.67			
UnK	6/25/1986	11:45	Surface	Goebel Greg	5	30.00		4.9	7.2	15.56			
UnK	6/25/1986	12:45	Surface	Goebel Greg	1	32.78		11.4	9.0	22.78			
UnK	6/25/1986	13:00	Surface	Goebel Greg	2	32.78		11.9	8.8	21.67			
UnK	6/25/1986	12:30	Surface	Goebel Greg		32.78		10.8	9.1	24.44	1.07		
UnK	6/11/1986	11:45	Surface	Goebel Greg	6.2	21.67		1.3	6.8	11.11			
UnK	6/11/1986	11:30	Surface	Goebel Greg	5	18.89		3.8	7.1	13.33			
UnK	6/11/1986	11:15	Surface	Goebel Greg	4	18.89		7.6	7.4	14.44			
UnK	6/11/1986	11:05	Surface	Goebel Greg	3	18.89		8.3	7.4	15.00			
UnK	6/11/1986	11:00	Surface	Goebel Greg	2	18.89		8.9	8.1	15.00			
UnK	6/11/1986	10:45	Surface	Goebel Greg	1	18.89		9.0	8.1	15.56			
UnK	6/11/1986	10:30	Surface	Goebel Greg		18.89		8.8	8.1	16.11	1.60		
UnK	6/11/1986	12:50	Surface	Goebel Greg	2	22.78		9.1	8.0	15.00			
UnK	6/11/1986	12:50	Surface	Goebel Greg	1	22.78		8.8	8.2	15.56			
UnK	6/11/1986	12:30	Surface	Goebel Greg		22.78		8.8	8.0	17.22	1.60		
UnK	5/28/1986	14:30	Surface	Goebel Greg	2	20.00		9.3	7.7	15.56			
UnK	5/28/1986	12:30	Surface	Goebel Greg	5	20.00		6.6	7.4	11.67			
UnK	5/28/1986	14:15	Surface	Goebel Greg		20.00		9.3	7.8	16.11			
UnK	5/28/1986	12:15	Surface	Goebel Greg	4	20.00		7.5	7.5	11.67			
UnK	5/28/1986	12:00	Surface	Goebel Greg	3	20.00		8.8	7.6	14.44			
UnK	5/28/1986	11:30	Surface	Goebel Greg	1	20.00		9	7.6	16.67			
UnK	5/28/1986	11:15	Surface	Goebel Greg		20.00		9.0	7.6	16.67	2.44		
UnK	5/28/1986	11:45	Surface	Goebel Greg	2	20.00		9.0	7.7	16.11			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	5/28/1986	14:00	Surface	Goebel Greg		20.00		9.1	7.8	17.78	2.44		
UnK	5/28/1986	13:00	Surface	Goebel Greg	6.2	18.89		4.2	7.2	10.56			
UnK	5/6/1986	14:30	Surface	Goebel Greg	5.8	12.78		6.2	7.7	8.33			
UnK	5/6/1986	14:15	Surface	Goebel Greg	5	12.78		7.6	7.7	10.56			
UnK	5/6/1986	14:00	Surface	Goebel Greg	4	12.78		8.0	7.7	12.22			
UnK	5/6/1986	13:45	Surface	Goebel Greg	3	12.78		8.1	7.7	12.78			
UnK	5/6/1986	13:30	Surface	Goebel Greg	2	12.78		8.2	7.7	13.33			
UnK	5/6/1986	13:15	Surface	Goebel Greg	1	12.78		8.1	7.7	13.33			
UnK	5/6/1986	13:00	Surface	Goebel Greg		12.78		8.1	7.7	13.33	1.75		
UnK	5/6/1986	15:00	Surface	Goebel Greg		11.67		8.2	7.3	13.33	1.68		
UnK	5/6/1986	15:15	Surface	Goebel Greg		11.67		8.2	7.4	13.33			
UnK	4/16/1986	11:30	Surface	Goebel Greg	5.1	6.67		12	9	4.44			
UnK	4/16/1986	11:50	Surface	Goebel Greg		10.56		12.1	9.0	7.22	0.84		
UnK	4/16/1986	12:00	Surface	Goebel Greg	1	10.56		12.2	9.1	6.67			
UnK	4/16/1986	10:30	Surface	Goebel Greg		6.67		12.1	9.1	5.56	0.84		
UnK	4/16/1986	11:00	Surface	Goebel Greg		6.67		12.4	9.0	5.00			
UnK	4/16/1986	10:45	Surface	Goebel Greg	1	6.67		12.1	9.0	6.11			
UnK	3/31/1986	10:50	Surface	Goebel Greg	1	6.11		13.8	8.3	7.78			
UnK	3/31/1986	11:15	Surface	Goebel Greg	3	6.11		14.3	8.4	7.78			
UnK	3/31/1986	11:30	Surface	Goebel Greg	4	6.11		14.1	7.9	5.56			
UnK	3/31/1986	11:00	Surface	Goebel Greg	2	6.11		13.9	8.4	7.78			
UnK	3/31/1986	11:45	Surface	Goebel Greg	4.7	6.11		12.7	7.0	5.56			
UnK	3/31/1986	10:30	Surface	Goebel Greg		6.11		13.7	8.0	7.78	0.90		
UnK	3/31/1986	12:30	Surface	Goebel Greg		6.11		14.1	8.3	6.11	0.91		
UnK	2/18/1986	11:00	Surface	Goebel Greg	3	9.44		3.8	6.5	3.33			
UnK	2/18/1986	11:10	Surface	Goebel Greg	3.8	9.44		2.5	6.6	3.33			
UnK	2/18/1986	10:10	Surface	Goebel Greg		9.44		2.9	7.0	.56	0.76		
UnK	2/18/1986	10:40	Surface	Goebel Greg	2	9.44		4.6	6.6	1.67			
UnK	1/6/1986	11:30	Surface	Goebel Greg	3.6	-.56		3.4	7.4	2.22			
UnK	1/6/1986	11:00	Surface	Goebel Greg	2	-0.56		6.2	7.6	1.11			
UnK	1/6/1986	10:40	Surface	Goebel Greg		-0.56		6.2	7.9	.56	1.10		
UnK	12/3/1985	12:20	Surface	Goebel Greg	1	4.44		11.4	8.2	.56			
UnK	12/3/1985	11:50	Surface	Goebel Greg	1	4.44		11.9	8.2	.56	1.22		
UnK	12/3/1985	12:40	Surface	Goebel Greg	2	4.44		11.3	8.2	1.11			
UnK	12/3/1985	13:00	Surface	Goebel Greg	3.3	40		6.7	7.1	37			
UnK	10/16/1985	13:00	Surface	Goebel Greg	1	15.6		5	6.8	5.56			
UnK	10/16/1985	12:30	Surface	Goebel Greg		15.6		5	6.8	5.56	0.80		
UnK	10/16/1985	13:15	Surface	Goebel Greg	2	15.6		5	6.8	5.56			
UnK	10/16/1985	13:30	Surface	Goebel Greg	2.9	15.6		4.8	6.9	5.56			
UnK	9/23/1985	12:30	Surface	Goebel Greg		4.44		6.3	7.3	10.6	0.30		
UnK	9/23/1985	13:10	Surface	Goebel Greg	3	4.44		5.6	7.2	10			
UnK	9/23/1985	12:40	Surface	Goebel Greg	1	4.44		6.4	7.3	10.6			
UnK	9/23/1985	12:50	Surface	Goebel Greg	2	4.44		6	7.3	10			
UnK	8/21/1985	9:30	Surface	Goebel Greg	2	20		10.1	9.1	19.4			
UnK	8/21/1985	10:45	Surface	Goebel Greg		22.2		10.5	9.2	21.1	0.70		
UnK	8/21/1985	11:00	Surface	Goebel Greg	1	22.2		10.5	9.1	21.1			
UnK	8/21/1985	11:10	Surface	Goebel Greg	1.7	22.2		10.4	9.1	20.6			
UnK	8/21/1985	9:00	Surface	Goebel Greg		20		11	9.2	20	0.60		
UnK	8/21/1985	10:00	Surface	Goebel Greg	5.5	22.2		0	6.6	16.1			
UnK	8/21/1985	9:50	Surface	Goebel Greg	4	22.2		1.6	7.7	17.8			
UnK	8/21/1985	9:40	Surface	Goebel Greg	3	20		6.5	9.0	18.9			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	8/21/1985	9:15	Surface	Goebel Greg	1	20		11.1	9.2	20			
UnK	8/7/1985	9:50	Surface	Goebel Greg	3	24.4		5.8	8.6	20			
UnK	8/7/1985	10:00	Surface	Goebel Greg	4	24.4		3.2	7.5	18.9			
UnK	8/7/1985	10:15	Surface	Goebel Greg	5.5	23.3		0.3	6.6	15.6			
UnK	8/7/1985	11:15	Surface	Goebel Greg	1.7	22.2		10.6	8.8	21.1			
UnK	8/7/1985	9:15	Surface	Goebel Greg		24.4		10.6	9.2	21.1	0.80		
UnK	8/7/1985	11:00	Surface	Goebel Greg	1	22.2		10.7	9.0	21.1			
UnK	8/7/1985	10:45	Surface	Goebel Greg		22.2		10.5	9.0	21.1	0.80		
UnK	8/7/1985	9:30	Surface	Goebel Greg	1	24.4		10.6	9.2	21.1			
UnK	8/7/1985	9:40	Surface	Goebel Greg	2	24.4		8.0	8.8	20.6			
UnK	7/18/1985	10:00	Surface	Goebel Greg	4	21.7		4	7.5	20			
UnK	7/18/1985	10:10	Surface	Goebel Greg	5.5	21.7		0	6.7	15			
UnK	7/18/1985	9:30	Surface	Goebel Greg	1	22.2		9.2	8.9	21.1			
UnK	7/18/1985	11:10	Surface	Goebel Greg	1.7	21.7		9.2	8.9	21.1			
UnK	7/18/1985	10:45	Surface	Goebel Greg		21.7		9.2	8.9	21.1	1.20		
UnK	7/18/1985	11:00	Surface	Goebel Greg	1	21.7		9.2	8.9	21.1			
UnK	7/18/1985	9:10	Surface	Goebel Greg		22.2		9.2	9.0	21.1	1.30		
UnK	7/18/1985	9:35	Surface	Goebel Greg	2	22.2		9.2	8.9	21.1			
UnK	7/18/1985	9:45	Surface	Goebel Greg	3	21.7		6.3	8.3	20.6			
UnK	6/19/1985	12:40	Surface	Goebel Greg	4	22.2		5.3	8.5	17.2			
UnK	6/19/1985	10:45	Surface	Goebel Greg	1	21.1		9.1	8.9	17.2			
UnK	6/19/1985	11:00	Surface	Goebel Greg	1.8	26.7		9.1	8.9	17.2	0.91		
UnK	6/19/1985	12:30	Surface	Goebel Greg	3	22.2		8.6	9.0	17.8			
UnK	6/19/1985	12:20	Surface	Goebel Greg	2	23.9		9.3	9.0	17.8			
UnK	6/19/1985	12:15	Surface	Goebel Greg	1	23.9		9.4	9.0	17.8			
UnK	6/19/1985	12:00	Surface	Goebel Greg		23.9		9.1	9.0	17.8			
UnK	6/19/1985	12:50	Surface	Goebel Greg	5.6	22.2		.7	6.8	10.6			
UnK	6/19/1985	10:30	Surface	Goebel Greg		21.1		9.1	8.9	16.7	0.91		
UnK	6/5/1985	9:45	Surface	Goebel Greg		15.6		10.2	8.9	16.7	0.91		
UnK	6/5/1985	11:00	Surface	Goebel Greg	5.6	21.7		.9	6.9	11.1			
UnK	6/5/1985	10:15	Surface	Goebel Greg	2	21.1		10.8	8.9	16.1			
UnK	6/5/1985	10:10	Surface	Goebel Greg	1	15.6		10.3	8.9	16.7			
UnK	6/5/1985	10:45	Surface	Goebel Greg	4	21.7		4.7	8.6	15.6			
UnK	6/5/1985	11:45	Surface	Goebel Greg		20.6		10.4	9.0	17.8	0.91		
UnK	6/5/1985	12:00	Surface	Goebel Greg	1	20.6		10.5	9	18.3			
UnK	6/5/1985	12:15	Surface	Goebel Greg	1.8	21.1		10.3	9	17.8			
UnK	6/5/1985	10:30	Surface	Goebel Greg	3	21.1		9.4	8.9	16.1			
UnK	5/22/1985	10:10	Surface	Goebel Greg	3	25		9.8	8.5	16.1			
UnK	5/22/1985	10:00	Surface	Goebel Greg	2	25		9.9	8.6	16.7			
UnK	5/22/1985	9:30	Surface	Goebel Greg		22.2		9.6	8.4	16.7	1.37		
UnK	5/22/1985	10:30	Surface	Goebel Greg	5.6	26.7		.8	6.9	10.6			
UnK	5/22/1985	9:45	Surface	Goebel Greg	1	22.2		9.6	8.6	17.2			
UnK	5/22/1985	10:20	Surface	Goebel Greg	4	26.7		6	7.3	13.9			
UnK	5/8/1985	11:45	Surface	Goebel Greg	1	27.8		8.9	8.0	16.7			
UnK	5/8/1985	11:30	Surface	Goebel Greg		27.8		8.8	8.1	16.7	1.68		
UnK	5/8/1985	12:00	Surface	Goebel Greg	1.8	27.8		8.9	7.9	16.7			
UnK	5/8/1985	9:30	Surface	Goebel Greg		23.3		8.7	7.6	15.6	1.68		
UnK	5/8/1985	10:20	Surface	Goebel Greg	3.00	25.6		10.1	7.7	13.3			
UnK	5/8/1985	10:00	Surface	Goebel Greg	1.00	23.3		8.8	7.6	16.1			
UnK	5/8/1985	10:10	Surface	Goebel Greg	2.00	25.6		8.9	7.8	15.6			
UnK	5/8/1985	10:45	Surface	Goebel Greg	5.60	27.2		.6	6.8	10			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	5/8/1985	10:30	Surface	Goebel Greg	4.00	27.2		6.9	7.4	13.3			
UnK	4/15/1985	11:50	Surface	Goebel Greg	1	22.2		9.2	7.3	12.2			
UnK	4/15/1985	11:30	Surface	Goebel Greg	1.68	22.2		9.2	7.3	12.2			
UnK	4/15/1985	10:30	Surface	Goebel Greg	2.99	22.2		9.1	7.3	8.89			
UnK	4/15/1985	9:30	Surface	Goebel Greg	1.83	20		9	7.5	7.22			
UnK	4/15/1985	10:50	Surface	Goebel Greg	5.61	22.2		5.2	7.0	7.78			
UnK	4/15/1985	12:10	Surface	Goebel Greg	1.8	22.2		9.2	7.4	10			
UnK	4/15/1985	10:00	Surface	Goebel Greg	1.01	21.1		9.1	7.4	10			
UnK	4/15/1985	10:15	Surface	Goebel Greg		21.1		9.2	7.4	10			
UnK	4/15/1985	10:40	Surface	Goebel Greg	3.99	22.2		7.8	7.2	7.78			
UnK	3/13/1985	12:20	Surface	Goebel Greg	2	5		5.4	7.1	2.78			
UnK	3/13/1985	9:45	Surface	Goebel Greg		4.44		6.2	7.2	.56	0.23		
UnK	3/13/1985	10:10	Surface	Goebel Greg	2.01	4.44		4.0	7.0	3.33			
UnK	3/13/1985	10:25	Surface	Goebel Greg	2.99	4.44		2.5	7.0	3.33			
UnK	3/13/1985	10:50	Surface	Goebel Greg	5.6	4.44		1.3	7.0	3.33			
UnK	3/13/1985	10:35	Surface	Goebel Greg	3.99	4.44		1.8	6.9	3.33			
UnK	3/13/1985	12:00	Surface	Goebel Greg		5		9.6	7.1	1.11	0.46		
UnK	2/13/1985	11:50	Surface	Goebel Greg		-2.22		10.8	7.2	0	0.68		
UnK	2/13/1985	12:15	Surface	Goebel Greg	2	-2.22		5.8	7.1	2.22			
UnK	2/13/1985	10:50	Surface	Goebel Greg	3.99	-2.22		2.8	6.9	2.22			
UnK	2/13/1985	10:40	Surface	Goebel Greg	2.99	-2.22		3	6.9	1.67			
UnK	2/13/1985	10:20	Surface	Goebel Greg	2.01	-2.22		3.3	7.0	1.67			
UnK	2/13/1985	10:00	Surface	Goebel Greg	0.61	-2.22		5.5	7.3	0	0.76		
UnK	2/13/1985	11:00	Surface	Goebel Greg	5.61	-2.22		1.9	7.0	2.78			
UnK	1/14/1985	12:30	Surface	Goebel Greg		3.33		9.6	6.9	.56	1.22		
UnK	1/14/1985	11:15	Surface	Goebel Greg	3.99	-3.89		3.1	6.8	2.78			
UnK	1/14/1985	11:00	Surface	Goebel Greg	2.99	-3.89		3.4	6.8	2.22			
UnK	1/14/1985	10:30	Surface	Goebel Greg	2.01	-3.89		3.6	6.8	1.67			
UnK	1/14/1985	10:10	Surface	Goebel Greg				5.2	7.2	.56	0.99		
UnK	1/14/1985	13:00	Surface	Goebel Greg	2	3.33		6.6	6.9	1.67			
UnK	1/14/1985	11:30	Surface	Goebel Greg	5.61	-3.89		2.2	6.8	2.78			
UnK	12/19/1984	11:50	Surface	Goebel Greg	2.01			7.4	7.1	1.67			
UnK	12/19/1984	12:10	Surface	Goebel Greg	2.99			7.5	7.1	1.67			
UnK	12/19/1984	12:40	Surface	Goebel Greg	5.6	-4.44		4.4	6.9	2.78			
UnK	12/19/1984	11:30	Surface	Goebel Greg	1.01	-2.22		7.4	7.0	1.11			
UnK	12/19/1984	11:15	Surface	Goebel Greg	0.46	-2.22		7.5	7.0	.56	0.76		
UnK	12/19/1984	14:15	Surface	Goebel Greg	2	2.22		7.4	7.0	1.67			
UnK	12/19/1984	14:00	Surface	Goebel Greg	1			8.2	7.0	1.67			
UnK	12/19/1984	13:45	Surface	Goebel Greg	.5	3.33		9.9	7.0	0	0.76		
UnK	12/19/1984	12:30	Surface	Goebel Greg	3.99			7.1	7.0	1.67			
UnK	7/12/1984	9:20	Surface	Goebel Greg	5.64	25		0	7.0	10			
UnK	7/12/1984	9:05	Surface	Goebel Greg	0.46	25		9.4	8.7	21.1	1.07		
UnK	7/12/1984	9:50	Surface	Goebel Greg	1.68	28.9		9.2	8.2	20.6			
UnK	7/12/1984	9:40	Surface	Goebel Greg	0.46	28.9		9.5	8.8	21.1			
UnK	7/12/1984	9:15	Surface	Goebel Greg	3.28	25		4.8	7.1	15.6			
UnK	6/13/1984	9:10	Surface	Goebel Greg	3.35	17.2		5.9	7.1	10			
UnK	6/13/1984	9:35	Surface	Goebel Greg	5.79	17.2		0	7.0	7.22			
UnK	6/13/1984	8:50	Surface	Goebel Greg	0.46	17.2		10.8	9	15.6	0.68		
UnK	6/13/1984	10:15	Surface	Goebel Greg	1.68	15.6		8.7	7.6	11.7			
UnK	6/13/1984	10:00	Surface	Goebel Greg	0.46	15.6		10.7	9.0	15.6	0.61		
UnK	5/22/1984	10:10	Surface	Goebel Greg	5.79	11.1		.4	7.3	6.11			

Site	Date	Time	RelDepth	Personnel	Depth	A Temp	Conduct	DO	F pH	W Temp	Secchi	Ice	Weather
UnK	5/22/1984	10:05	Surface	Goebel Greg	3.35	11.1		7.7	7.6	7.78			
UnK	5/22/1984	10:50	Surface	Goebel Greg	1.68	13.3		9.9	7.7	11.1			
UnK	5/22/1984	10:35	Surface	Goebel Greg	0.46	13.3		9.0	7.7	13.3	0.99		
UnK	5/22/1984	10:00	Surface	Goebel Greg	0.46	11.1		8.9	7.9	13.9	1.07		
UnK	4/17/1984	13:15	Surface	Goebel Greg	0.46	17.2		10.9	7.6	9.44	1.29		
UnK	4/17/1984	13:35	Surface	Goebel Greg	3.28	17.2		11	7.6	6.67			
UnK	4/17/1984	14:05	Surface	Goebel Greg	1.68	17.8		10.8	7.8	9.44			
UnK	4/17/1984	13:55	Surface	Goebel Greg	0.46	18.9		10.8	7.6	9.44	1.29		
UnK	4/17/1984	13:40	Surface	Goebel Greg	5.64	17.8		8.2	7.4	5			
UnK	3/19/1984	10:25	Surface	Goebel Greg	1.68	2.78		8.8	7.1	3.33			
UnK	3/19/1984	9:55	Surface	Goebel Greg	5.49	3.89		6.9	7.3	2.22			
UnK	3/19/1984	9:30	Surface	Goebel Greg	3.20	3.89		10.6	7.4	3.33			
UnK	3/19/1984	9:00	Surface	Goebel Greg	0.46	3.89		11.8	7.7	2.22	0.91		
UnK	3/19/1984	10:15	Surface	Goebel Greg	0.46			10.1	7.1	2.78	1.37		
UnK	2/21/1984	9:30	Surface	Goebel Greg	0.46	8.33		9.9	7.2	1.67	0.61		
UnK	2/21/1984	10:10	Surface	Goebel Greg	0.46	11.1		9.4	7.5	1.67	1.22		
UnK	2/21/1984	10:30	Surface	Goebel Greg	1.68	13.3		7.1	7.4	3.33			
UnK	2/21/1984	9:45	Surface	Goebel Greg	3.20	9.44		7.3	7.2	2.78			
UnK	2/21/1984	9:50	Surface	Goebel Greg	5.49	10		3.7	7.2	3.33			
UnK	1/23/1984	9:50	Surface	Goebel Greg	0.46	-.56		8.3	6.9	.56	1.14		
UnK	1/23/1984	10:00	Surface	Goebel Greg	1.68	.56		5.9	6.9	.56			
UnK	1/23/1984	11:00	Surface	Goebel Greg	5.49	0		1.8	7.0	2.78			
UnK	1/23/1984	10:45	Surface	Goebel Greg	3.20	.56		2.1	6.9	1.67			
UnK	1/23/1984	10:20	Surface	Goebel Greg	0.46	0		5	6.9	0	1.37		
UnK	1/3/1984	10:55	Surface	Goebel Greg	0.46	5.56		6.4	6.9	.56	1.07		
UnK	1/3/1984	11:15	Surface	Goebel Greg	1.52	5.56		5.4	7.0	.56			
UnK	1/3/1984	10:20	Surface	Goebel Greg	3.20	3.33		4.2	7.1	2.78			
UnK	1/3/1984	10:30	Surface	Goebel Greg	5.49	3.33		2.8	6.9	3.33			
UnK	1/3/1984	10:05	Surface	Goebel Greg	0.46	2.78		6.7	7.1	1.11	1.52		
UnK	12/6/1983	9:30	Surface	Goebel Greg	5.49	-10		6.3	7.6	1.11			
UnK	12/6/1983	9:20	Surface	Goebel Greg	3.20	-11.7		8.2	7.9	1.11			
UnK	12/6/1983	10:40	Surface	Goebel Greg	0.46	-4.44		10.8	7.8	.56	0.91		
UnK	12/6/1983	10:50	Surface	Goebel Greg	1.68	-5.56		9.7	8	.56			
UnK	12/6/1983	8:50	Surface	Goebel Greg	1.5	-10.6		12.6	8.0	0	0.84		
UnK	10/25/1983	12:20	Surface	Goebel Greg	1.52	16.7		6.8	7.4	7.22			
UnK	10/25/1983	13:10	Surface	Goebel Greg	4.88	15.6		6.1	7.4	6.11	0.76		
UnK	10/25/1983	13:00	Surface	Goebel Greg	2.90	15.6		6.8	7.4	7.22			
UnK	10/25/1983	12:45	Surface	Goebel Greg	0.46	15.6		6.9	7.4	6.67	0.76		
UnK	10/25/1983	11:50	Surface	Goebel Greg	0.46	15.6		7.1	7.5	7.78	0.84		
UnK	10/5/1983	10:45	Surface	Goebel Greg	0.46	12.2		6.4	7.4	10.6	1.07		
UnK	10/5/1983	10:50	Surface	Goebel Greg	1.68	12.2		6.3	7.4	10.6			
UnK	10/5/1983	10:10	Surface	Goebel Greg	3.35	8.33		5	7.4	10.6			
UnK	10/5/1983	9:30	Surface	Goebel Greg	0.46	8.33		6.9	7.5	10.6	1.22		
UnK	10/5/1983	10:20	Surface	Goebel Greg	5.79	10.6		1.0	6.9	12.2			
UnK	8/23/1983	9:10	Surface	Goebel Greg	0.46	20.6		7.4	9.3	21.1	0.76		
UnK	8/23/1983	9:20	Surface	Goebel Greg	1.68	20.6		7.2	9.3	21.1			
UnK	8/23/1983	10:05	Surface	Goebel Greg	3.20	21.7		4	9	19.4			
UnK	8/23/1983	10:15	Surface	Goebel Greg	5.49	21.7		0	7.0	11.1			
UnK	8/23/1983	9:50	Surface	Goebel Greg	0.46	21.7		7.2	9.3	21.7	0.91		
UnK	7/27/1983	9:45	Surface	Goebel Greg	5.79	23.3		0	7.1	12.2			
UnK	7/27/1983	10:05	Surface	Goebel Greg	0.46	25		9.4	9.0	23.3	1.29		
UnK	7/27/1983	10:15	Surface	Goebel Greg	5.5	25		8.9	8.9	23.3			
UnK	7/27/1983	9:30	Surface	Goebel Greg	3.35	23.3		6	7.5	20			
UnK	7/27/1983	9:15	Surface	Goebel Greg	0.46	23.3		9.0	9.1	23.3	1.29		
UnK	6/29/1983	10:45	Surface	Goebel Greg	0.46	20		9.4	8.9	18.3	1.37		
UnK	6/29/1983	10:00	Surface	Goebel Greg	5.64	21.7		2.3	7.2	10			
UnK	6/29/1983	9:30	Surface	Goebel Greg	0.46	22.2		9.7	9.1	18.3	1.52		
UnK	6/29/1983	9:50	Surface	Goebel Greg	3.28	22.2		9.2	9.0	17.2			
UnK	6/29/1983	11:00	Surface	Goebel Greg	1.52	20		9.5	8.9	18.9			

DO and Temperature Data

Date	Depth (m)	W Temp (*C)	DO (mg/L)
7/11/1989	1	23	4.1
	3	22	3
	6	22	1.1
	9	21	1
	12	23.2	2.3
	15	11	0.25

Date	Depth (m)	W Temp (*C)	DO (mg/L)
8/15/1989	1	20.5	6
	4	19.3	5.4
	7	19.1	4.8
	10	18.75	3.5
	13	18.75	1.75

Date	Depth (m)	W Temp (*C)	DO (mg/L)
6/19/1991	0	19	8.1
	2	18.66	8
	4	16	7.9
	6	13.2	5.7
	8	11	3.1
	10	10	1.95
	12	9.5	0.4
	14	9	0.02
	15	9	0.02

Date	Depth (m)	W Temp (*C)	DO (mg/L)
10/1/1991	0	13.3	11.8
	2	13.3	11.8
	4	13.3	11.4
	6	13.2	11
	8	12	6.55
	10	11.8	5.8
	12	11.4	4.8
	14	11.2	2.75
	16	11.1	1.75
	17	11.1	0.5

Date	Depth (m)	W Temp (*C)	DO (mg/L)
7/22/1992	0	16.9	6.4
	3	16.9	6.2
	6	16.9	6
	9	16.9	5
	12	16.9	5
	15	14.6	0.15
	18	12.5	0.3

Date	Depth (m)	W Temp (*C)	DO (mg/L)
8/18/1992	0	19.1	8.3
	3	19.1	7.25
	6	19.1	7.2
	9	19	6.66
	12	18.2	0.02
	15	15	0.05

Date	Depth (m)	W Temp (*C)	DO (mg/L)
6/19/2003	0.03	19.67	10.08
	0.26	19.6	10.1
	0.54	19.6	10.1
	0.78	19.6	10.1
	1.06	19.6	10.1
	1.29	19.6	10.1
	1.62	19.6	10.2
	1.79	19.3	11.5
	2.05	18.7	16.2
	2.27	18.3	17.5
	2.53	17.7	17.8
	2.78	17.5	17.3
	3.11	16.6	1.72
	3.28	15.9	1.1
	0.08	19.7	9.88
	0.3	19.7	9.99
	0.61	19.7	10
	0.99	19.7	10
	1.2	19.7	10
	1.48	19.7	10
	1.83	19.4	10
	2.13	18.7	12
	2.47	18.2	13
	2.86	17.2	14.5
	3.22	16.7	12.2
	3.54	16	8.35
	3.86	15.6	5.8
	4.12	15.4	3.69

Date	Depth (m)	W Temp (*C)	DO (mg/L)
7/21/2003	0.07	25.6	11.2
	0.3	25.5	11.1
	0.63	25.1	11.6
	0.89	24.6	11.8
	1.15	24.5	11.6
	1.52	24.4	11.6
	1.81	24.2	11.7
	2.13	24	11.6
	2.43	23.8	11.5
	2.76	23.5	12.9
	3.04	23	12.3
	3.32	22.5	11.1
	3.65	21.6	6.65
	3.92	21	3.33
	0.15	25.9	10.4
	0.44	25.5	10.7
	0.81	24.7	10.6
	1.24	24.4	10.7
	1.63	24.3	10.6
	2	24.1	10.6
	2.42	23.9	10.5
	2.85	23.4	11.6
	3.2	22.7	12.3
	3.59	21.8	10.3
	4.03	20.8	6.79
	4.42	20.2	2.1
	4.81	19.4	0.45
	4.96	19.3	0.43

Date	Depth (m)	W Temp (*C)	DO (mg/L)
6/19/2003	0.09	19.7	10.1
	0.4	19.6	10.3
	0.801	19.6	10.2
	1.25	19.5	10.3
	1.55	19.3	10.6
	1.97	19.1	10.9
	2.42	18.5	12.8
	2.83	17.5	13.1
	3.27	16.6	12.4
	3.61	15.9	10.3
	4.04	15.3	9.23
	4.47	14.8	7.4
	4.97	14.2	4.69
	5.26	13.9	3.2

Date	Depth (m)	W Temp (*C)	DO (mg/L)
7/21/2003	0.092	26	9.45
	0.45	26	9.93
	0.91	24.7	10.5
	1.38	24.4	10.3
	1.8	24.2	10.2
	2.23	24	10.4
	2.7	23.6	10.8
	3.13	22.9	11
	3.58	21.7	9.45
	4.07	20.7	6.37
	4.51	20.1	3.31
	4.92	19	0.52
	5.38	17.7	0.25
	5.71	16.6	0.18

Table of Abbreviations and Units

Abbreviation	Parameter	Units
A Temp	Air Temperature	°C
Alka	Alkalinity	mg/L
Ammo	Ammonia	mg/L
Chlorophyll a	Chlorophyll a - corrected for Phaeophytin	mg/m^3
Comp	Composite	
Cond	Conductivity	µmhos/cm
D Fish	Dead Fish	
DC	Discharge	cfs
Depth	Total Water Depth	ft
DO	Dissolved Oxygen	mg/L
E Coli	E Coli Coliform	Colony Forming Units (CFU)/100 mL
Ext	Extreme	
F pH	Field pH	su
Fecal	Fecal Coliform	Colony Forming Units (CFU)/100 mL
Ice	Ice Cover	
Mod	Moderate	
NO3+NO4	Nitrate + Nitrite	mg/L
Precip	Precipitation	
RelDepth	Relative Depth	
Rep	Replicate Sample	
S Depth	Sample Depth	ft
S Type	Sample Type	
Secchi	Secchi Depth	m
TDP	Total Dissolved Phosphorous	mg/L
TDS	Total Dissolved Solids	mg/L
TKN	Total Kjeldahl Nitrogen	mg/L
Tot N	Total Nitrogen	mg/L
Tot P	Total Phosphorous	mg/L
Tot Sol	Total Solids	mg/L
TSI Chl a	Trophic State Index - Chlorophyll a	Chl a in mg/m^3
TSI Mean	Trophic State Index Mean	
TSI N	Trophic State Index - Nitrogen	N in mg/L
TSI Secchi	Trophic State Index - Secchi Depth	Secchi Depth in m
TSI Tot P	Trophic State Index - Total Phosphorous	Tot P in mg/L
TSS	Total Suspended Solids	mg/L
Turb	Turbidity	Nephelometric Turbidity Units (NTU)
TVSS	Total Volatile Suspended Solids	mg/L
UnK	Unknown	
W Temp	Water Temperature	°C
Weather	Weather Conditions and/or Field Comments	
	Nitrate	mg/L

Appendix D

Benthic Macroinvertebrate Data

Client: Scott Environmental, Custer, SD Phone: 605-673-3353

Project: Benthic Macroinvertebrate Samples collected from Center, Legion and Sylvan Lake Tributaries within Custer State Park, SD. Samples collected November 9, 2001.

Data collected and compiled by: ***Natural Resource Solutions***

Contact Information:
Natural Resource Solutions
Attn: Rebecca Spawn-Stroup
511 East Wye Mesa
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Email: stroup@itctel.com

Benthic Macroinvertebrate Data - Custer State Park, SD

(Complete Data Set, 21 samples)

		Site:	CLT	CLT	CLT	CLT	CLT	CLT	CLT	LLT	LLT	LLT	LLT	LLT	LLT	SLT	SLT	SLT	SLT	SLT	SLT	SLT	SLT
CLASS/ORDER	**FAMILY**	**FINAL DETERMINATION**	Life Stage	3-A	3-A (dup)	3-B	3-C	5-A	5-B	5-C	3-A	3-B	3-C	5-A	5-B	5-C	4-A	4-A (dup)	4-B	4-C	5-A	5-A (dup)	5-B	5-C
Amphipoda	Crangonyctidae	*Crangonyx* sp.	NA	0	0	0	0	0	0	0	34	6	29	6	6	2	0	0	0	0	0	0	0	0
Amphipoda	Gammaridae	*Gammarus* sp.	NA	0	0	0	0	3	0	0	59	37	78	17	34	4	0	0	0	0	0	0	0	0
Coleoptera	Dytiscidae	*Hydaticus* sp.	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Coleoptera	Dytiscidae	*Hydaticus* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Coleoptera	Dytiscidae	*Laccophilus* sp.	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Coleoptera	Dytiscidae	*Uvarus* sp.	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Coleoptera	Elmidae	*Dubiraphia* sp.	L	0	0	0	0	1	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Heterlimnius corpulentus*	L	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Optioservus* sp.	L	0	2	41	22	16	34	9	0	0	0	65	77	59	1	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Optioservus* sp.	A	0	0	1	4	0	3	0	0	1	0	0	9	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Stenelmis* sp.	A	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Zaitzevia parvula*	L	2	1	5	5	13	59	3	0	0	5	1	9	7	1	0	0	0	0	0	0	0
Coleoptera	Elmidae	*Zaitzevia parvula*	A	0	0	0	0	0	1	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0
Coleoptera	Hydraenidae	*Hydraena* sp.	A	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Hydrophilidae	*Anacaena* sp.	A	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Diptera	Ceratopogonidae	Ceratopogoninae	L	4	3	4	0	22	1	4	20	12	36	5	2	10	36	48	58	29	8	3	26	4
Diptera	Chironomidae	*Ablabesmyia* sp.	L	0	0	0	0	0	1	14	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Brillia* sp.	L	0	0	0	0	0	0	0	0	1	0	0	0	0	3	1	2	1	0	0	0	1
Diptera	Chironomidae	*Chaetocladius* sp.	L	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Chironominae (imm.)	L	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Corynoneura* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1
Diptera	Chironomidae	*Cricotopus/Orthocladius* sp.	L	0	0	1	0	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Cryptochironomus* sp.	L	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Eukiefferiella* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0
Diptera	Chironomidae	*Harnischia* complex	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Diptera	Chironomidae	*Heleniella* sp.	L	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Heterotrissocladius* sp.	L	0	0	0	0	1	0	1	0	0	0	0	0	0	14	5	0	0	8	6	2	0
Diptera	Chironomidae	*Krenopelopia* sp.	L	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Larsia* sp.	L	110	79	85	0	0	0	0	0	0	1	1	0	2	0	0	0	5	0	0	10	17
Diptera	Chironomidae	*Limnophyes* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Diptera	Chironomidae	*Metriocnemus* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Diptera	Chironomidae	*Micropsectra* sp.	L	25	20	1	4	42	0	36	6	0	0	2	1	26	5	2	0	4	0	3	0	0
Diptera	Chironomidae	*Microtendipes pedellus* gp.	L	43	57	1	0	52	2	13	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Odontomesa* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Diptera	Chironomidae	Orthocladiinae (imm.)	L	0	0	0	1	13	0	0	0	0	0	0	0	1	0	3	14	0	0	0	0	0
Diptera	Chironomidae	*Pagastia* sp.	L	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	2	0
Diptera	Chironomidae	*Parachaetocladius* sp.	L	0	0	0	0	0	0	0	36	39	27	2	2	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Parakiefferiella* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Diptera	Chironomidae	*Parametriocnemus* sp.	L	0	0	0	1	2	2	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Pentaneura* sp.	L	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Polypedilum* sp.	L	23	30	23	1	18	28	64	25	20	26	1	0	16	89	110	43	53	149	182	77	120
Diptera	Chironomidae	*Procladius* sp.	L	6	6	1	0	1	0	18	0	0	0	0	4	3	0	0	0	0	0	0	0	0
Diptera	Chironomidae	*Prodiamesa* sp.	L	0	0	0	0	0	0	0	7	4	1	0	0	0	3	4	1	3	2	0	0	4
Diptera	Chironomidae	*Radotanypus* sp.	L	0	0	0	0	0	0	2	9	3	1	21	1	18	37	38	15	12	15	11	13	29
Diptera	Chironomidae	*Rheocricotopus* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Diptera	Chironomidae	Tanypodinae (imm.)	L	0	0	0	14	4	0	3	0	0	2	0	0	0	12	0	0	0	0	0	0	0
Diptera	Chironomidae	*Tanytarsus* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Diptera	Chironomidae	*Thienemanniella* sp.	L	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Diptera	Chironomidae	*Thienemannimyia* gp.	L	56	51	27	50	19	2	6	8	1	3	18	11	2	0	0	6	1	0	2	2	0
Diptera	Chironomidae	*Tvetenia* sp.	L	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Diptera	Psychodidae	*Pericoma/Telmatoscopus* sp.	L	0	0	0	0	0	0	0	0	9	7	0	0	0	0	0	0	0	0	0	0	0
Diptera	Ptychopteridae	*Ptychoptera* sp.	L	0	0	0	0	0	0	0	12	3	1	0	0	5	2	1	0	0	0	0	0	0
Diptera	Simuliidae	*Simulium* sp.	L	0	0	0	1	0	1	0	0	0	0	14	21	4	0	1	0	0	0	0	0	1
Diptera	Tabanidae	*Chrysops* sp.	L	2	1	0	0	0	0	2	4	0	0	1	0	0	0	0	0	0	0	0	0	0

			Site:	CLT	CLT	CLT	CLT	CLT	CLT	CLT	LLT	LLT	LLT	LLT	LLT	LLT	SLT	SLT	SLT	SLT	SLT	SLT	SLT	SLT
CLASS/ORDER	**FAMILY**	**FINAL DETERMINATION**	Life Stage	3-A	3-A (dup)	3-B	3-C	5-A	5-B	5-C	3-A	3-B	3-C	5-A	5-B	5-C	4-A	4-A (dup)	4-B	4-C	5-A	5-A (dup)	5-B	5-C
Diptera	Tipulidae	*Antocha* sp.	L	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Tipulidae	*Dicranota* sp.	L	0	0	0	0	0	0	0	1	2	2	0	0	0	5	0	14	4	0	0	0	1
Diptera	Tipulidae	*Hexatoma* sp.	L	1	2	4	2	1	1	1	0	0	0	2	1	2	0	0	0	0	0	0	0	0
Diptera	Tipulidae	*Tipula* sp.	L	0	0	0	5	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Tipulidae	Tipulidae (imm.)	L	0	0	0	0	0	0	0	6	7	4	4	2	4	0	0	0	0	0	0	0	0
Ephemeroptera	Baetidae	Baetidae (imm./damaged)	L	2	2	23	17	3	14	4	0	0	0	7	0	5	6	4	2	1	1	0	63	58
Ephemeroptera	Baetidae	*Baetis* sp.	L	0	0	0	0	0	8	0	0	0	0	5	0	5	5	13	8	0	0	0	0	0
Ephemeroptera	Baetidae	*Paracloeodes minutus*	L	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0
Ephemeroptera	Ephemerellidae	Ephemerellidae (imm.)	L	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Leptohyphidae	*Tricorythodes* sp.	L	0	0	0	0	2	0	11	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia* sp.	L	4	2	20	50	11	11	8	0	0	0	4	38	0	0	0	0	0	0	0	0	0
Gastropoda	Ancylidae	*Ferrissia* sp.	NA	0	0	0	0	3	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	Planorbidae	*Gyraulus* sp.	NA	0	0	0	4	10	0	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Gastropoda	Physellidae	*Physella* sp.	NA	2	4	2	18	2	2	0	3	1	0	0	9	4	0	0	0	0	1	0	2	1
Hirudinea	Glossiphoniidae	*Glossiphonia complanata*	NA	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	*Helobdella stagnalis*	NA	7	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera	Sialidae	*Sialis* sp.	L	4	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Aeshnidae	*Anax* sp.	L	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Corduliidae	*Epitheca (Tetragoneuria)* sp.	L	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Gomphidae	Gomphidae (imm.)	L	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Odonata	Gomphidae	*Gomphus* sp.	L	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Gomphidae	*Ophiogomphus* sp.	L	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	Oligochaeta	Oligochaeta	NA	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0	8	20
Oligochaeta	Naididae	*Slavina appendiculata*	NA	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligochaeta	Tubificidae	Tubificidae (imm. w/o cc)	NA	1	1	3	0	4	10	20	0	0	0	0	0	0	49	13	8	0	2	48	7	0
Oligochaeta	Tubificidae	Tubificidae (imm. w/ cc)	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	23	12	2	0	1	2	1	0
Pelecypoda	Sphaeriidae	*Pisidium* sp.	NA	0	0	0	0	0	0	4	1	0	0	2	3	6	0	0	2	0	3	0	0	0
Pelecypoda	Sphaeriidae	Sphaeriidae (imm.)	NA	43	25	6	11	8	67	49	2	6	11	35	3	96	19	5	30	0	44	28	16	22
Pelecypoda	Sphaeriidae	Sphaerium sp.	NA	0	0	0	0	0	0	0	0	0	1	0	0	0	0	31	8	3	17	0	0	0
Plecoptera	NA	Plecoptera (imm./damaged)	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	74
Plecoptera	Capniidae	*Paracapnia* sp.	L	2	2	4	27	0	3	0	1	0	0	4	0	0	0	0	8	4	0	0	0	0
Plecoptera	Chloroperlidae	Chloroperlidae (imm.)	L	4	6	4	7	10	6	4	9	2	5	23	12	17	5	6	1	3	21	6	29	12
Plecoptera	Chloroperlidae	*Sweltsa* sp.	L	3	5	4	29	2	5	4	1	0	12	4	0	0	0	0	0	1	0	0	0	0
Plecoptera	Nemouridae	Nemouridae (imm.)	L	0	0	0	0	0	0	0	23	13	0	1	0	0	1	0	1	2	7	4	2	3
Plecoptera	Nemouridae	*Zapada cinctipes*	L	0	0	12	6	0	5	0	0	0	0	5	8	4	0	1	0	0	0	0	0	0
Plecoptera	Perlodidae	*Skwala* sp.	L	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	NA	Trichoptera (imm.)	L	1	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Trichoptera	Apataniidae	*Allomyia* sp.	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Trichoptera	Brachycentridae	*Brachycentrus* sp.	L	0	0	1	0	0	2	1	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Trichoptera	Brachycentridae	*Micrasema* sp.	L	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Glossosomatidae	*Glossosoma* sp.	L	0	0	0	1	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	*Ceratopsyche morosa* gp. (imm.)	L	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	*Ceratopsyche slossonae*	L	0	0	11	1	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	*Cheumatopsyche* sp.	L	0	0	9	2	0	28	0	0	0	0	16	28	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	*Hydropsyche* sp.	L	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydroptilidae	Hydroptilidae (damaged)	P	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Leptoceridae	Leptoceridae (imm.)	L	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Leptoceridae	*Mystacides* sp.	L	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Leptoceridae	*Oecetis* sp.	L	2	4	1	0	6	0	0	1	1	1	7	6	6	2	0	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	*Lepidostoma* sp.	L	1	3	1	18	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Limnephilidae	Limnephilidae (imm.)	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0
Trichoptera	Limnephilidae	*Limnephilus* sp.	L	2	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Trichoptera	Limnephilidae	*Hesperophylax* sp.	L	0	0	0	0	0	0	0	18	20	28	7	5	6	33	35	38	31	6	4	19	4
Trichoptera	Phryganeidae	*Ptilostomis* sp.	L	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
Trichoptera	Polycentropodidae	*Polycentropus* sp.	L	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Acari	NA	0	0	0	2	10	2	0	5	5	10	2	8	1	3	0	0	0	2	0	0	6
		Ostracoda	NA	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0
		Turbellaria	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	13	10	1	0	0	0	0	0
			ttl:	**352**	**319**	**300**	**311**	**311**	**328**	**301**	**295**	**195**	**304**	**296**	**323**	**344**	**371**	**347**	**267**	**157**	**297**	**304**	**311**	**379**

Metrics Analysis Results for Legion, Center and Sylvan Lake Tributary samples,
Custer State Park, SD

Metrics compiled analyzed by:
Natural Resource Solutions
Phone: 605-693-6767
Email: stroup@itctel.com

Metric 1	
StationID	Taxa Richness
CLT 3-A	25
CLT 3-A (dup)	27
CLT 3-B	28
CLT 3-C	28
CLT 5-A	39
CLT 5-B	37
CLT 5-C	34
LLT 3-A	25
LLT 3-B	23
LLT 3-C	26
LLT 5-A	37
LLT 5-B	33
LLT 5-C	32
SLT 4-A	26
SLT 4-A (dup)	21
SLT 4-B	21
SLT 4-C	16
SLT 5-A	22
SLT 5-A (dup)	13
SLT 5-B	25
SLT 5-C	19

Metric 2	
StationID	EPT Taxa
CLT 3-A	9
CLT 3-A (dup)	8
CLT 3-B	12
CLT 3-C	13
CLT 5-A	11
CLT 5-B	15
CLT 5-C	9
LLT 3-A	6
LLT 3-B	4
LLT 3-C	4
LLT 5-A	14
LLT 5-B	11
LLT 5-C	7
SLT 4-A	6
SLT 4-A (dup)	6
SLT 4-B	6
SLT 4-C	6
SLT 5-A	6
SLT 5-A (dup)	4
SLT 5-B	6
SLT 5-C	5

Metric 3	
StationID	Ephemeroptera Taxa
CLT 3-A	2
CLT 3-A (dup)	2
CLT 3-B	3
CLT 3-C	3
CLT 5-A	3
CLT 5-B	4
CLT 5-C	3
LLT 3-A	0
LLT 3-B	0
LLT 3-C	0
LLT 5-A	4
LLT 5-B	2
LLT 5-C	2
SLT 4-A	2
SLT 4-A (dup)	2
SLT 4-B	2
SLT 4-C	1
SLT 5-A	1
SLT 5-A (dup)	0
SLT 5-B	2
SLT 5-C	1

Metric 4	
StationID	Trichoptera Taxa
CLT 3-A	4
CLT 3-A (dup)	3
CLT 3-B	5
CLT 3-C	6
CLT 5-A	5
CLT 5-B	6
CLT 5-C	4
LLT 3-A	2
LLT 3-B	2
LLT 3-C	2
LLT 5-A	5
LLT 5-B	7
LLT 5-C	3
SLT 4-A	2
SLT 4-A (dup)	2
SLT 4-B	1
SLT 4-C	1
SLT 5-A	3
SLT 5-A (dup)	2
SLT 5-B	1
SLT 5-C	1

Metric 5	
StationID	Plecoptera Taxa
CLT 3-A	3
CLT 3-A (dup)	3
CLT 3-B	4
CLT 3-C	4
CLT 5-A	3
CLT 5-B	5
CLT 5-C	2
LLT 3-A	4
LLT 3-B	2
LLT 3-C	2
LLT 5-A	5
LLT 5-B	2
LLT 5-C	2
SLT 4-A	2
SLT 4-A (dup)	2
SLT 4-B	3
SLT 4-C	4
SLT 5-A	2
SLT 5-A (dup)	2
SLT 5-B	3
SLT 5-C	3

Metrics compiled analyzed by:
Natural Resource Solutions
Phone: 605-693-6767
Email: stroup@itctel.com

Metric 6	
StationID	Diptera Taxa
CLT 3-A	9
CLT 3-A (dup)	10
CLT 3-B	9
CLT 3-C	9
CLT 5-A	16
CLT 5-B	12
CLT 5-C	16
LLT 3-A	12
LLT 3-B	12
LLT 3-C	12
LLT 5-A	12
LLT 5-B	12
LLT 5-C	15
SLT 4-A	14
SLT 4-A (dup)	11
SLT 4-B	9
SLT 4-C	9
SLT 5-A	9
SLT 5-A (dup)	7
SLT 5-B	11
SLT 5-C	9

Metric 7	
StationID	Chironomidae Taxa
CLT 3-A	6
CLT 3-A (dup)	7
CLT 3-B	7
CLT 3-C	6
CLT 5-A	13
CLT 5-B	8
CLT 5-C	12
LLT 3-A	7
LLT 3-B	7
LLT 3-C	7
LLT 5-A	7
LLT 5-B	8
LLT 5-C	10
SLT 4-A	11
SLT 4-A (dup)	8
SLT 4-B	7
SLT 4-C	7
SLT 5-A	8
SLT 5-A (dup)	6
SLT 5-B	10
SLT 5-C	6

Metric 8			
StationID	EPT Abund	Chiro Abund	EPT/Chiro Abundance
CLT 3-A	21	263	0.08
CLT 3-A (dup)	25	244	0.10
CLT 3-B	91	139	0.65
CLT 3-C	166	71	2.34
CLT 5-A	57	156	0.37
CLT 5-B	97	41	2.37
CLT 5-C	36	160	0.23
LLT 3-A	53	93	0.57
LLT 3-B	36	69	0.52
LLT 3-C	46	61	0.75
LLT 5-A	90	46	1.96
LLT 5-B	109	23	4.74
LLT 5-C	184	93	1.98
SLT 4-A	52	167	0.31
SLT 4-A (dup)	61	165	0.37
SLT 4-B	58	84	0.69
SLT 4-C	42	79	0.53
SLT 5-A	40	178	0.22
SLT 5-A (dup)	17	206	0.08
SLT 5-B	137	111	1.23
SLT 5-C	151	172	0.88

Metric 9	
StationID	% EPT
CLT 3-A	5.97
CLT 3-A (dup)	7.84
CLT 3-B	30.33
CLT 3-C	53.38
CLT 5-A	18.33
CLT 5-B	29.57
CLT 5-C	11.96
LLT 3-A	17.97
LLT 3-B	18.46
LLT 3-C	15.13
LLT 5-A	30.41
LLT 5-B	33.75
LLT 5-C	13.08
SLT 4-A	14.02
SLT 4-A (dup)	17.58
SLT 4-B	21.72
SLT 4-C	26.75
SLT 5-A	13.47
SLT 5-A (dup)	5.59
SLT 5-B	44.05
SLT 5-C	39.84

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Metric 10	
StationID	% Ephemeroptera
CLT 3-A	1.70
CLT 3-A (dup)	1.25
CLT 3-B	14.67
CLT 3-C	22.83
CLT 5-A	5.14
CLT 5-B	10.37
CLT 5-C	7.64
LLT 3-A	0.00
LLT 3-B	0.00
LLT 3-C	0.00
LLT 5-A	5.74
LLT 5-B	13.00
LLT 5-C	2.91
SLT 4-A	2.96
SLT 4-A (dup)	4.90
SLT 4-B	3.75
SLT 4-C	0.64
SLT 5-A	0.34
SLT 5-A (dup)	0.00
SLT 5-B	21.54
SLT 5-C	15.30

Metric 11	
StationID	% Plecoptera
CLT 3-A	2.56
CLT 3-A (dup)	4.08
CLT 3-B	8.00
CLT 3-C	22.19
CLT 5-A	4.18
CLT 5-B	6.10
CLT 5-C	2.66
LLT 3-A	11.53
LLT 3-B	7.69
LLT 3-C	5.59
LLT 5-A	12.50
LLT 5-B	6.19
LLT 5-C	6.10
SLT 4-A	1.62
SLT 4-A (dup)	2.02
SLT 4-B	3.75
SLT 4-C	6.37
SLT 5-A	9.43
SLT 5-A (dup)	3.29
SLT 5-B	16.40
SLT 5-C	23.48

Metric 12	
StationID	% Trichoptera
CLT 3-A	1.70
CLT 3-A (dup)	2.51
CLT 3-B	7.67
CLT 3-C	8.36
CLT 5-A	9.00
CLT 5-B	13.11
CLT 5-C	1.66
LLT 3-A	6.44
LLT 3-B	10.77
LLT 3-C	9.54
LLT 5-A	12.16
LLT 5-B	14.55
LLT 5-C	4.07
SLT 4-A	9.43
SLT 4-A (dup)	10.66
SLT 4-B	14.23
SLT 4-C	19.75
SLT 5-A	3.70
SLT 5-A (dup)	2.30
SLT 5-B	6.11
SLT 5-C	1.06

Metric 13	
StationID	% Chironomidae
CLT 3-A	74.72
CLT 3-A (dup)	76.49
CLT 3-B	46.33
CLT 3-C	22.83
CLT 5-A	50.16
CLT 5-B	12.50
CLT 5-C	53.16
LLT 3-A	31.53
LLT 3-B	35.38
LLT 3-C	20.07
LLT 5-A	15.54
LLT 5-B	7.12
LLT 5-C	27.03
SLT 4-A	45.01
SLT 4-A (dup)	47.55
SLT 4-B	31.46
SLT 4-C	50.32
SLT 5-A	59.93
SLT 5-A (dup)	67.76
SLT 5-B	35.69
SLT 5-C	45.38

Metric 14	
StationID	% Tanytarsini
CLT 3-A	0.00
CLT 3-A (dup)	0.00
CLT 3-B	0.00
CLT 3-C	0.00
CLT 5-A	0.00
CLT 5-B	0.00
CLT 5-C	0.00
LLT 3-A	0.00
LLT 3-B	0.00
LLT 3-C	0.00
LLT 5-A	0.00
LLT 5-B	0.00
LLT 5-C	0.00
SLT 4-A	0.00
SLT 4-A (dup)	0.00
SLT 4-B	0.00
SLT 4-C	0.00
SLT 5-A	0.00
SLT 5-A (dup)	0.00
SLT 5-B	0.00
SLT 5-C	0.00

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Metric 15		Metric -- extra, not required		Metric 16		Metric 17		Metric 18	
StationID	**% Diptera**	StationID	**% Hydropsychidae/EPT**	StationID	**% Non-Insects**	StationID	**% Oligochaeta**	StationID	**Pinkham-Pearson***
CLT 3-A	76.70	CLT 3-A	0.00	CLT 3-A	15.34	CLT 3-A	0.57	CLT 3-A	
CLT 3-A (dup)	78.37	CLT 3-A (dup)	0.00	CLT 3-A (dup)	10.34	CLT 3-A (dup)	0.63	CLT 3-A (dup)	Reference Conditions
CLT 3-B	49.00	CLT 3-B	21.98	CLT 3-B	4.33	CLT 3-B	1.00	CLT 3-B	Required.
CLT 3-C	25.40	CLT 3-C	1.81	CLT 3-C	11.25	CLT 3-C	0.00	CLT 3-C	See Note* on
CLT 5-A	58.52	CLT 5-A	8.77	CLT 5-A	12.86	CLT 5-A	1.29	CLT 5-A	last page.
CLT 5-B	14.02	CLT 5-B	38.14	CLT 5-B	25.91	CLT 5-B	3.35	CLT 5-B	
CLT 5-C	55.81	CLT 5-C	2.78	CLT 5-C	26.91	CLT 5-C	6.64	CLT 5-C	
LLT 3-A	46.10	LLT 3-A	0.00	LLT 3-A	35.25	LLT 3-A	0.00	LLT 3-A	
LLT 3-B	52.31	LLT 3-B	0.00	LLT 3-B	28.21	LLT 3-B	0.00	LLT 3-B	
LLT 3-C	36.51	LLT 3-C	0.00	LLT 3-C	42.76	LLT 3-C	0.00	LLT 3-C	
LLT 5-A	24.32	LLT 5-A	21.11	LLT 5-A	22.64	LLT 5-A	0.96	LLT 5-A	
LLT 5-B	15.17	LLT 5-B	25.69	LLT 5-B	20.74	LLT 5-B	1.01	LLT 5-B	
LLT 5-C	34.30	LLT 5-C	0.00	LLT 5-C	33.14	LLT 5-C	4.87	LLT 5-C	
SLT 4-A	56.60	SLT 4-A	0.00	SLT 4-A	28.84	SLT 4-A	19.41	SLT 4-A	
SLT 4-A (dup)	61.96	SLT 4-A (dup)	0.00	SLT 4-A (dup)	20.46	SLT 4-A (dup)	7.20	SLT 4-A (dup)	
SLT 4-B	58.43	SLT 4-B	0.00	SLT 4-B	19.85	SLT 4-B	3.75	SLT 4-B	
SLT 4-C	71.34	SLT 4-C	0.00	SLT 4-C	1.91	SLT 4-C	0.00	SLT 4-C	
SLT 5-A	62.63	SLT 5-A	0.00	SLT 5-A	23.91	SLT 5-A	1.01	SLT 5-A	
SLT 5-A (dup)	68.75	SLT 5-A (dup)	0.00	SLT 5-A (dup)	25.66	SLT 5-A (dup)	16.45	SLT 5-A (dup)	
SLT 5-B	44.05	SLT 5-B	0.00	SLT 5-B	10.93	SLT 5-B	5.14	SLT 5-B	
SLT 5-C	46.97	SLT 5-C	0.00	SLT 5-C	12.93	SLT 5-C	5.28	SLT 5-C	

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Metric 19

Jaccard Similarity Index**	C_{ij}	U_i	U_j	S_{ij}

Note:**

Due to the complexity of this metric and the amount of time it would take to compute this metric for all samples, it cannot be run at this time. I have provided information below on how to compute this metric so you may compute combinations of interest yourselves, or, if you have certain comparison combinations you would like computed, let me know which specific ones and I would be happy to compute them for you.

Formula: $S_{ij} = C_{ij} / (C_{ij} + U_i + U_j)$

C_{ij} = Number of organisms common to both i & j.
U_i = Number of organisms unique to i.
U_j = Number of organisms unique to j.

Metric 20

StationID	ShanWeaver (log e)	ShanWeaver (log 2)	ShanWeaver (log 10)
CLT 3-A			
CLT 3-A (dup)	The EDAS program would not run this metric.		
CLT 3-B	If needed, this metric can be calculated by hand		
CLT 3-C	at a later time.		
CLT 5-A			
CLT 5-B			
CLT 5-C			
LLT 3-A			
LLT 3-B			
LLT 3-C			
LLT 5-A			
LLT 5-B			
LLT 5-C			
SLT 4-A			
SLT 4-A (dup)			
SLT 4-B			
SLT 4-C			
SLT 5-A			
SLT 5-A (dup)			
SLT 5-B			
SLT 5-C			

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Metric 21	
StationID	Invert. Community Index***
CLT 3-A	See Note***
CLT 3-A (dup)	on last page
CLT 3-B	
CLT 3-C	
CLT 5-A	
CLT 5-B	
CLT 5-C	
LLT 3-A	
LLT 3-B	
LLT 3-C	
LLT 5-A	
LLT 5-B	
LLT 5-C	
SLT 4-A	
SLT 4-A (dup)	
SLT 4-B	
SLT 4-C	
SLT 5-A	
SLT 5-A (dup)	
SLT 5-B	
SLT 5-C	

Metric 22	
StationID	% Similarity[+]
CLT 3-A	See Note[+]
CLT 3-A (dup)	on last page
CLT 3-B	
CLT 3-C	
CLT 5-A	
CLT 5-B	
CLT 5-C	
LLT 3-A	
LLT 3-B	
LLT 3-C	
LLT 5-A	
LLT 5-B	
LLT 5-C	
SLT 4-A	
SLT 4-A (dup)	
SLT 4-B	
SLT 4-C	
SLT 5-A	
SLT 5-A (dup)	
SLT 5-B	
SLT 5-C	

Metric 23	
StationID	No. Intolerant Taxa
CLT 3-A	6
CLT 3-A (dup)	6
CLT 3-B	8
CLT 3-C	9
CLT 5-A	7
CLT 5-B	13
CLT 5-C	9
LLT 3-A	8
LLT 3-B	6
LLT 3-C	5
LLT 5-A	7
LLT 5-B	7
LLT 5-C	5
SLT 4-A	4
SLT 4-A (dup)	4
SLT 4-B	5
SLT 4-C	6
SLT 5-A	4
SLT 5-A (dup)	3
SLT 5-B	3
SLT 5-C	4

Metric -- extra, not required			
StationID	Intolerant Individuals	Total Ind.	% Intolerant
CLT 3-A	16	352	4.55
CLT 3-A (dup)	19	319	5.96
CLT 3-B	47	300	15.67
CLT 3-C	141	311	45.34
CLT 5-A	28	311	9.00
CLT 5-B	47	328	14.33
CLT 5-C	23	301	7.64
LLT 3-A	80	295	27.12
LLT 3-B	61	195	31.28
LLT 3-C	47	304	15.46
LLT 5-A	43	296	14.53
LLT 5-B	66	323	20.43
LLT 5-C	26	344	7.56
SLT 4-A	14	371	3.77
SLT 4-A (dup)	13	347	3.75
SLT 4-B	25	267	9.36
SLT 4-C	17	157	10.83
SLT 5-A	31	297	10.44
SLT 5-A (dup)	12	304	3.95
SLT 5-B	33	311	10.61
SLT 5-C	20	379	5.28

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Metric 24	
StationID	**Sediment Intolerant Taxa**[++]
CLT 3-A	See Note[++]
CLT 3-A (dup)	on last page
CLT 3-B	
CLT 3-C	
CLT 5-A	
CLT 5-B	
CLT 5-C	
LLT 3-A	
LLT 3-B	
LLT 3-C	
LLT 5-A	
LLT 5-B	
LLT 5-C	
SLT 4-A	
SLT 4-A (dup)	
SLT 4-B	
SLT 4-C	
SLT 5-A	
SLT 5-A (dup)	
SLT 5-B	
SLT 5-C	

Metric 25			
StationID	Tolerant Individuals	Total Ind.	**% Tolerant Organisms**
CLT 3-A	100	352	28.41
CLT 3-A (dup)	99	319	31.03
CLT 3-B	15	300	5.00
CLT 3-C	57	311	18.33
CLT 5-A	94	311	30.23
CLT 5-B	90	328	27.44
CLT 5-C	133	301	44.19
LLT 3-A	23	295	7.80
LLT 3-B	11	195	5.64
LLT 3-C	17	304	5.59
LLT 5-A	63	296	21.28
LLT 5-B	54	323	16.72
LLT 5-C	124	344	36.05
SLT 4-A	108	371	29.11
SLT 4-A (dup)	65	347	18.73
SLT 4-B	52	267	19.48
SLT 4-C	3	157	1.91
SLT 5-A	70	297	23.57
SLT 5-A (dup)	78	304	25.66
SLT 5-B	34	311	10.93
SLT 5-C	25	379	6.60

Metric 26						
StationID	Orth/Chi	Gastr	Nonln	Oligo	Burrwr	**% Sediment Tolerant**
CLT 3-A	0.0	0.6	15.3	0.6	1.4	17.90
CLT 3-A (dup)	0.0	1.3	10.3	0.6	2.8	15.05
CLT 3-B	0.0	0.7	4.3	1.0	1.3	7.33
CLT 3-C	1.4	7.1	11.3	0.0	1.0	20.70
CLT 5-A	8.3	4.8	12.9	1.3	4.8	32.13
CLT 5-B	0.0	1.5	25.9	3.4	0.6	31.40
CLT 5-C	0.0	2.7	26.9	6.6	1.0	37.21
LLT 3-A	0.0	1.0	35.3	0.0	0.0	36.27
LLT 3-B	0.0	0.5	28.2	0.0	0.0	28.72
LLT 3-C	0.0	0.3	42.8	0.0	0.0	43.09
LLT 5-A	0.0	0.0	22.6	1.0	0.7	24.28
LLT 5-B	0.0	2.8	20.7	1.0	0.3	24.85
LLT 5-C	1.1	1.2	33.1	4.9	1.2	41.41
SLT 4-A	0.0	0.0	28.8	19.4	0.0	48.25
SLT 4-A (dup)	1.8	0.0	20.5	7.2	0.9	30.35
SLT 4-B	16.7	0.0	19.9	3.7	5.2	45.51
SLT 4-C	0.0	0.0	1.9	0.0	0.0	1.91
SLT 5-A	0.0	0.7	23.9	1.0	0.0	25.59
SLT 5-A (dup)	0.0	0.0	25.7	16.4	0.0	42.11
SLT 5-B	0.0	0.6	10.9	5.1	0.0	16.72
SLT 5-C	0.0	0.3	12.9	5.3	0.0	18.47

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Metric 27	
StationID	% 1st Dominant Taxon
CLT 3-A	31.25
CLT 3-A (dup)	24.76
CLT 3-B	28.33
CLT 3-C	16.08
CLT 5-A	16.72
CLT 5-B	20.43
CLT 5-C	21.26
LLT 3-A	20.00
LLT 3-B	20.00
LLT 3-C	25.66
LLT 5-A	21.96
LLT 5-B	26.63
LLT 5-C	27.91
SLT 4-A	23.99
SLT 4-A (dup)	31.70
SLT 4-B	21.72
SLT 4-C	33.76
SLT 5-A	50.17
SLT 5-A (dup)	59.87
SLT 5-B	24.76
SLT 5-C	31.66

Metric 28	
StationID	Hilsenhoff Biotic Index
CLT 3-A	6.07
CLT 3-A (dup)	5.97
CLT 3-B	4.84
CLT 3-C	3.99
CLT 5-A	5.37
CLT 5-B	5.12
CLT 5-C	6.24
LLT 3-A	4.20
LLT 3-B	4.21
LLT 3-C	4.51
LLT 5-A	4.83
LLT 5-B	4.39
LLT 5-C	5.67
SLT 4-A	6.45
SLT 4-A (dup)	6.08
SLT 4-B	5.91
SLT 4-C	5.33
SLT 5-A	5.87
SLT 5-A (dup)	6.58
SLT 5-B	5.18
SLT 5-C	5.39

Metric 29	
StationID	Biotic Index
CLT 3-A	16
CLT 3-A (dup)	16
CLT 3-B	19
CLT 3-C	19
CLT 5-A	22
CLT 5-B	25
CLT 5-C	22
LLT 3-A	17
LLT 3-B	12
LLT 3-C	11
LLT 5-A	21
LLT 5-B	17
LLT 5-C	16
SLT 4-A	12
SLT 4-A (dup)	10
SLT 4-B	9
SLT 4-C	11
SLT 5-A	11
SLT 5-A (dup)	7
SLT 5-B	7
SLT 5-C	6

Metric 30	
StationID	Biotic Condition Index+++
CLT 3-A	See Note+++
CLT 3-A (dup)	on last page
CLT 3-B	
CLT 3-C	
CLT 5-A	
CLT 5-B	
CLT 5-C	
LLT 3-A	
LLT 3-B	
LLT 3-C	
LLT 5-A	
LLT 5-B	
LLT 5-C	
SLT 4-A	
SLT 4-A (dup)	
SLT 4-B	
SLT 4-C	
SLT 5-A	
SLT 5-A (dup)	
SLT 5-B	
SLT 5-C	

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Metric 31	
StationID	% Hydropsychidae/Trichoptera
CLT 3-A	0.00
CLT 3-A (dup)	0.00
CLT 3-B	86.96
CLT 3-C	11.54
CLT 5-A	17.86
CLT 5-B	86.05
CLT 5-C	20.00
LLT 3-A	0.00
LLT 3-B	0.00
LLT 3-C	0.00
LLT 5-A	52.78
LLT 5-B	59.57
LLT 5-C	0.00
SLT 4-A	0.00
SLT 4-A (dup)	0.00
SLT 4-B	0.00
SLT 4-C	0.00
SLT 5-A	0.00
SLT 5-A (dup)	0.00
SLT 5-B	0.00
SLT 5-C	0.00

Metric 32	
StationID	Total Abundance
CLT 3-A	352
CLT 3-A (dup)	319
CLT 3-B	300
CLT 3-C	311
CLT 5-A	311
CLT 5-B	328
CLT 5-C	301
LLT 3-A	295
LLT 3-B	195
LLT 3-C	304
LLT 5-A	296
LLT 5-B	323
LLT 5-C	344
SLT 4-A	371
SLT 4-A (dup)	347
SLT 4-B	267
SLT 4-C	157
SLT 5-A	297
SLT 5-A (dup)	304
SLT 5-B	311
SLT 5-C	379

Metric 33	
StationID	No. Predator Taxa
CLT 3-A	11
CLT 3-A (dup)	11
CLT 3-B	10
CLT 3-C	7
CLT 5-A	14
CLT 5-B	8
CLT 5-C	10
LLT 3-A	7
LLT 3-B	6
LLT 3-C	11
LLT 5-A	9
LLT 5-B	8
LLT 5-C	9
SLT 4-A	7
SLT 4-A (dup)	3
SLT 4-B	5
SLT 4-C	6
SLT 5-A	3
SLT 5-A (dup)	3
SLT 5-B	9
SLT 5-C	7

Metric 34	
StationID	% Omnivores+Scavengers
CLT 3-A	43.75
CLT 3-A (dup)	47.96
CLT 3-B	55.33
CLT 3-C	65.92
CLT 5-A	73.31
CLT 5-B	94.21
CLT 5-C	85.71
LLT 3-A	64.75
LLT 3-B	69.23
LLT 3-C	47.04
LLT 5-A	72.97
LLT 5-B	75.54
LLT 5-C	86.05
SLT 4-A	79.51
SLT 4-A (dup)	81.56
SLT 4-B	70.04
SLT 4-C	72.61
SLT 5-A	89.56
SLT 5-A (dup)	96.38
SLT 5-B	71.06
SLT 5-C	69.66

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Metric 35				
StationID	Ind.Gather	Ind.Filter	Total Abund	% Ind. Gatherers+Filterers
CLT 3-A	37	86	352	34.94
CLT 3-A (dup)	29	82	319	34.80
CLT 3-B	53	28	300	27.00
CLT 3-C	78	15	311	29.90
CLT 5-A	109	65	311	55.95
CLT 5-B	116	109	328	68.60
CLT 5-C	104	68	301	57.14
LLT 3-A	112	3	295	38.98
LLT 3-B	66	6	195	36.92
LLT 3-C	72	11	304	27.30
LLT 5-A	55	70	296	42.23
LLT 5-B	66	57	323	38.08
LLT 5-C	95	108	344	59.01
SLT 4-A	148	20	371	45.28
SLT 4-A (dup)	128	6	347	38.62
SLT 4-B	63	32	267	35.58
SLT 4-C	23	0	157	14.65
SLT 5-A	50	47	297	32.66
SLT 5-A (dup)	72	28	304	32.89
SLT 5-B	101	16	311	37.62
SLT 5-C	112	23	379	35.62

Metric 36	
StationID	% Gatherers
CLT 3-A	10.51
CLT 3-A (dup)	9.09
CLT 3-B	17.67
CLT 3-C	25.08
CLT 5-A	35.05
CLT 5-B	35.37
CLT 5-C	34.55
LLT 3-A	37.97
LLT 3-B	33.85
LLT 3-C	23.68
LLT 5-A	18.58
LLT 5-B	20.43
LLT 5-C	27.62
SLT 4-A	39.89
SLT 4-A (dup)	36.89
SLT 4-B	23.60
SLT 4-C	14.65
SLT 5-A	16.84
SLT 5-A (dup)	23.68
SLT 5-B	32.48
SLT 5-C	29.55

Metric 37	
StationID	% Filterers
CLT 3-A	24.43
CLT 3-A (dup)	25.71
CLT 3-B	9.33
CLT 3-C	4.82
CLT 5-A	20.90
CLT 5-B	33.23
CLT 5-C	22.59
LLT 3-A	1.02
LLT 3-B	3.08
LLT 3-C	3.62
LLT 5-A	23.65
LLT 5-B	17.65
LLT 5-C	31.40
SLT 4-A	5.39
SLT 4-A (dup)	1.73
SLT 4-B	11.99
SLT 4-C	0.00
SLT 5-A	15.82
SLT 5-A (dup)	9.21
SLT 5-B	5.14
SLT 5-C	6.07

Metric 38	
StationID	% Grazers+Scrapers
CLT 3-A	0.57
CLT 3-A (dup)	1.88
CLT 3-B	14.67
CLT 3-C	17.04
CLT 5-A	10.29
CLT 5-B	13.11
CLT 5-C	5.65
LLT 3-A	1.02
LLT 3-B	1.03
LLT 3-C	0.66
LLT 5-A	21.96
LLT 5-B	31.89
LLT 5-C	18.31
SLT 4-A	0.27
SLT 4-A (dup)	0.58
SLT 4-B	0.00
SLT 4-C	0.00
SLT 5-A	0.67
SLT 5-A (dup)	0.00
SLT 5-B	1.93
SLT 5-C	0.26

Metrics compiled analyzed by:
Natural Resource Solutions
Phone: 605-693-6767
Email: stroup@itctel.com

Metric 39		Metric 40		Metric 41		Metric 42	
StationID	Scrapers / Filterers	StationID	% Scrapers / (Scrapers+Filterers)	StationID	% Predators	StationID	% Shredders
CLT 3-A	0	CLT 3-A	2.27	CLT 3-A	56.25	CLT 3-A	8.24
CLT 3-A (dup)	0	CLT 3-A (dup)	6.82	CLT 3-A (dup)	52.04	CLT 3-A (dup)	11.29
CLT 3-B	2	CLT 3-B	61.11	CLT 3-B	44.67	CLT 3-B	13.67
CLT 3-C	4	CLT 3-C	77.94	CLT 3-C	34.08	CLT 3-C	18.97
CLT 5-A	0	CLT 5-A	32.99	CLT 5-A	25.72	CLT 5-A	7.07
CLT 5-B	0	CLT 5-B	28.29	CLT 5-B	5.79	CLT 5-B	12.50
CLT 5-C	0	CLT 5-C	20.00	CLT 5-C	14.29	CLT 5-C	22.92
LLT 3-A	1	LLT 3-A	50.00	LLT 3-A	15.25	LLT 3-A	24.75
LLT 3-B	0	LLT 3-B	25.00	LLT 3-B	11.79	LLT 3-B	31.28
LLT 3-C	0	LLT 3-C	15.38	LLT 3-C	27.30	LLT 3-C	19.08
LLT 5-A	1	LLT 5-A	48.15	LLT 5-A	21.28	LLT 5-A	8.78
LLT 5-B	2	LLT 5-B	64.38	LLT 5-B	13.93	LLT 5-B	5.57
LLT 5-C	1	LLT 5-C	36.84	LLT 5-C	12.79	LLT 5-C	8.72
SLT 4-A	0	SLT 4-A	4.76	SLT 4-A	20.49	SLT 4-A	33.96
SLT 4-A (dup)	0	SLT 4-A (dup)	25.00	SLT 4-A (dup)	18.44	SLT 4-A (dup)	42.36
SLT 4-B	0	SLT 4-B	0.00	SLT 4-B	29.96	SLT 4-B	34.46
SLT 4-C	0	SLT 4-C	0.00	SLT 4-C	27.39	SLT 4-C	57.96
SLT 5-A	0	SLT 5-A	4.08	SLT 5-A	10.44	SLT 5-A	56.23
SLT 5-A (dup)	0	SLT 5-A (dup)	0.00	SLT 5-A (dup)	3.62	SLT 5-A (dup)	63.49
SLT 5-B	0	SLT 5-B	27.27	SLT 5-B	28.94	SLT 5-B	31.51
SLT 5-C	0	SLT 5-C	4.17	SLT 5-C	30.34	SLT 5-C	33.77

Metrics compiled analyzed by:
Natural Resource Solutions
Phone: 605-693-6767
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NOTES:

Pinkham-Pearson* : This metric is a measure of functional feeding group similarity to a reference stream, or reference conditions for a given stream type based on a model. You must first have a reference stream/model before this metric can be computed.

Jaccard Similarity Index** : See note below the metric (# 19), on page 5.

Invertebrate Community Index (ICI)*** : This is not one metric. The ICI is a multimetric macroinvertebrate index, patterned after the IBI for Fish (Karr 1981). To perform this multimetric analysis would be a whole separate project/contract in itself.

% Similarity[+] : The information you want from this metric is not clear. Do you want a comparison between sites, averaging the replicates, or are you interested in the % Similarity between the replicates? The Jaccard Similarity Index will give you similar information.

No. Sediment-Intolerant Taxa[++] : Sediment intolerance information was not available for all taxa, therefore an accurate total number of sediment-intolerant taxa was not able to be provided.

Biotic Condition Index[+++] : A difference between the formulas for the Biotic Condition Index and the Biotic Index (See Metric # 29) was unable to be determined. If you can provide a Specific formula for this metric, I may be able to compute it for you.

Contact Information:
Natural Resource Solutions
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Brookings, SD 57006-4534

Phone/Fax: 605-693-6767
Cell: 605-690-2105 or 5549
Email: ***stroup@itctel.com***

Client: Allen Scott, Scott Environmental, Custer, SD
Methods, Equipment and Keys used for Benthic Macroinvertebrate samples collected in November, 2001 from Custer State Park, SD
Data collected and compiled by: ***Natural Resource Solutions***, *511 E. Wye Mesa, Brookings, SD 57006, Ph: 605-693-6767*

Sample Processing & Identification Methods:

For all laboratory sample processing and identification, the methods detailed in the SD-DENR's SOP, (attached to the contract under the heading, "Attachment A") were employed.

Processing/Sorting Equipment:

Olympus SZ60 Scientific Stereo Dissecting Microscope with Zoom, 10x-1200x
Various sizes of gridded sample trays, splitters and seives
Misc. forceps, petri dishes, etc.
Ethanol for preservation, Magnesium Sulfate (Epsom Salt, $MgSO_4$) for sample flotation, when needed.

Identification Equipment:

Olympus SZ60 Scientific Stereo Dissecting Microscope with Zoom, 10x-1200x
Misc. forceps, dissection utensils, petri dishes, etc.

Taxonomic Keys Used:

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14. McCafferty, W.P., R.D. Waltz 1995. Labiobaetis (Ephemeroptera:Baetidae): New status, new North American species and related new genus. Entomological News. 106: 19-28.
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17. Pennak, Robert W., 1989. Freshwater Invertebrates of the United States, 3rd Edition. John Wiley & Sons, Inc.
18. Schefter, P.W., G.B. Wiggins, 1986. A systematic study of the Nearctic larvae of the Hydropsyche morosa group (Trichoptera: Hydropsychidae). Life Sciences Misc. Publ. of the Royal Ontario Museum, 94 pp.
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20. Simpson, K. W., R. W. Bode and P. Albu. 1983. Keys for the genus *Cricotopus* adapted from "Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera, Chironomidae)" by M. Hirvenoja. Bull. N. Y. St. Mus. 450:1-13
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Appendix E

Quality Assurance/Quality Control (QA/QC) Data

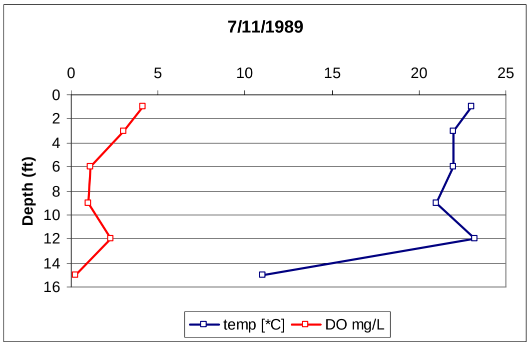
QA/QC data for replicate and routine sample pairs

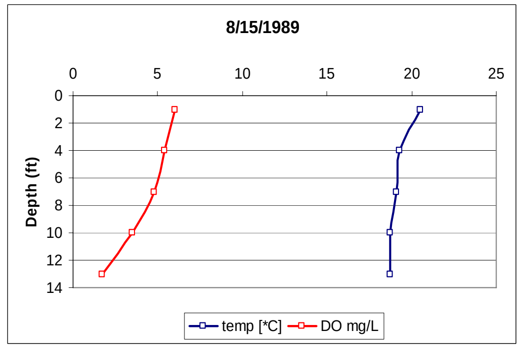
Site	Date	Alkalinity	Total Solids	TSS	Ammonia	NO3 + NO4	TKN	Total P	TDP	Fecal C	E. Coli
LLT4	12-Aug-02	72	150	2.5	0.05	0.05	0.25	0.11	0.030	6	5
LLT4	12-Aug-02	74	120	2.5	0.05	0.05	0.25	0.07	0.050	6	5
%I		**1.4**	**11.1**	**0.0**	**0.0**	**0.0**	**0.0**	**22.2**	**25.0**	**0.0**	**0.0**
LLT5	31-Oct-01	62	140	2.5	0.05	0.03	0.25	0.08	0.050	1	1
LLT5	31-Oct-01	60	120	2.5	0.05	0.03	0.25	0.08	0.020	2	2
%I		**1.6**	**7.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**42.9**	**33.3**	**33.3**
LLT5	23-Apr-02	52	150	2.5	0.05	0.03	1.90	0.05	0.030	1	1
LLT5	23-Apr-02	50	150	2.5	0.05	0.03	0.25	0.06	0.030	1	1
%I		**2.0**	**0.0**	**0.0**	**0.0**	**0.0**	**76.7**	**9.1**	**0.0**	**0.0**	**0.0**
LLT5	26-Jun-02	62	130	2.5	0.05	0.03	0.25	0.07	0.060	30	10
LLT5	26-Jun-02	64	130	2.5	0.05	0.03	0.25	0.09	0.060	34	14
%I		**1.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**12.5**	**0.0**	**6.3**	**16.7**
LLT5	21-Jul-02	48	220	51.0	0.05	0.39	0.90	0.25	0.070	2700	130
LLT5	21-Jul-02	48	230	48.0	0.05	0.37	0.80	0.25	0.080	3300	100
%I		**0.0**	**2.2**	**3.0**	**0.0**	**2.6**	**5.9**	**0.0**	**6.7**	**10.0**	**13.0**
LL1A	27-Feb-02	70	130	2.5	0.05	0.03	1.1	0.02	0.005	1	1
LL1A	27-Feb-02	66	130	2.5	0.05	0.03	0.6	0.03	0.005	1	1
%I		**2.9**	**0.0**	**0.0**	**0.0**	**0.0**	**29.4**	**20.0**	**0.0**	**0.0**	**0.0**
LL1A	5-Aug-02	58	110	2.5	0.05	0.025	0.5	0.02	0.005	1	1
LL1A	5-Aug-02	170	208	130	0.05	0.025	0.25	0.02	0.005	2	2
%I		**49.1**	**30.8**	**96.2**	**0.0**	**0.0**	**33.3**	**0.0**	**0.0**	**33.3**	**33.3**
LL2A	31-Jan-02	72	150	2.5	0.05	0.025	0.6	0.05	0.005	1	1
LL2A	31-Jan-02	68	160	2.5	0.05	0.025	0.6	0.06	0.005	1	1
%I		**2.9**	**3.2**	**0.0**	**0.0**	**0.0**	**0.0**	**9.1**	**0.0**	**0.0**	**0.0**
LL2A	6-Jun-02	36	110	2.5	0.05	0.025	0.25	0.01	0.005	1	1
LL2A	6-Jun-02	56	92	2.5	0.05	0.025	0.25	0.01	0.005	1	1
%I		**21.7**	**8.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
LL2A	1-Jul-02	56	350	2.5	0.05	0.025	0.5	0.02	0.005	1	1
LL2A	1-Jul-02	56	130	2.5	0.05	0.025	0.5	0.03	0.005	4	1
%I		**0.0**	**45.8**	**0.0**	**0.0**	**0.0**	**0.0**	**20.0**	**0.0**	**60.0**	**0.0**

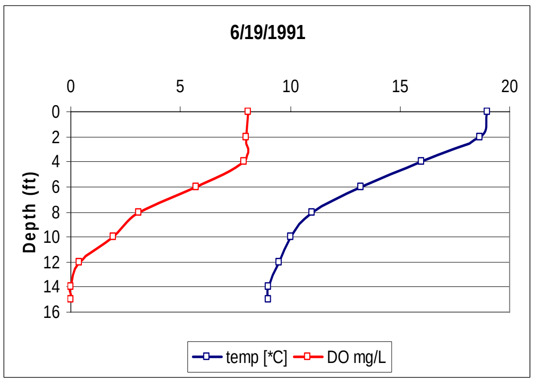
Average Percent Difference	**8.3**	**11.0**	**9.9**	**0.0**	**0.3**	**14.5**	**9.3**	**7.5**	**14.3**	**9.6**

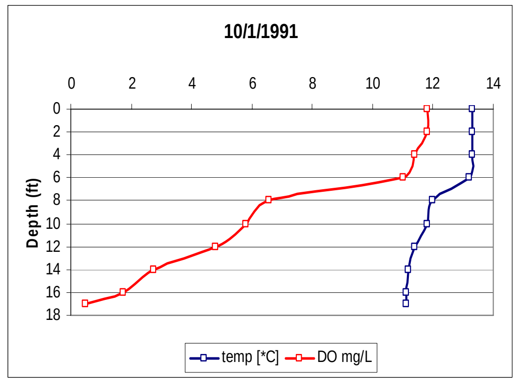
Appendix F

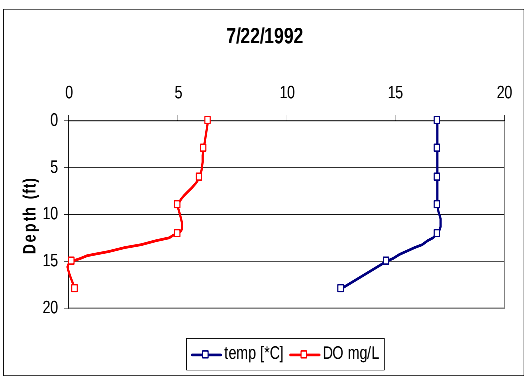
Water Temperature and Dissolved Oxygen Profiles

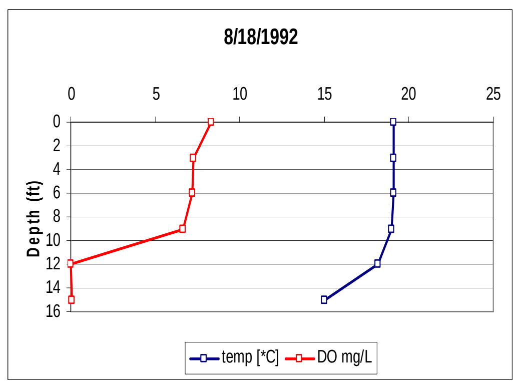

7/11/1989
Depth (ft)
temp [*C]
DO mg/L

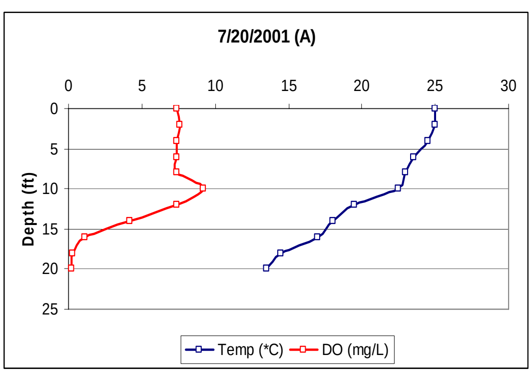

8/15/1989
Depth (ft)
temp [*C]
DO mg/L

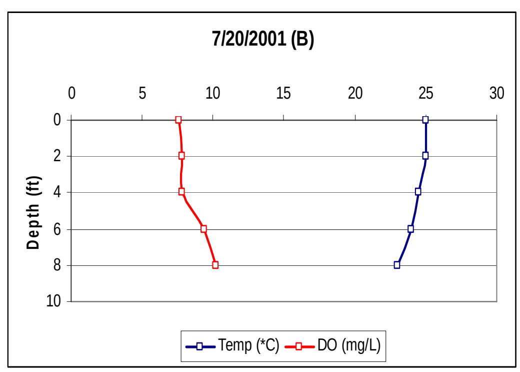

6/19/1991
Depth (ft)
temp [*C]
DO mg/L

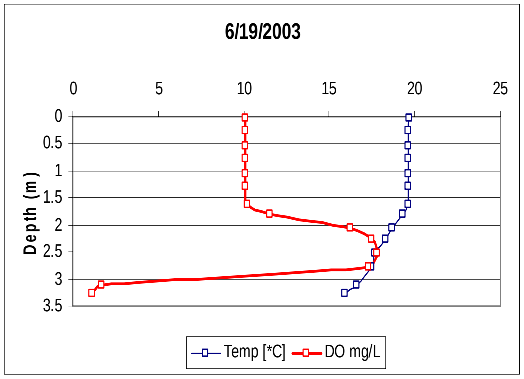

10/1/1991
Depth (ft)
temp [*C]
DO mg/L

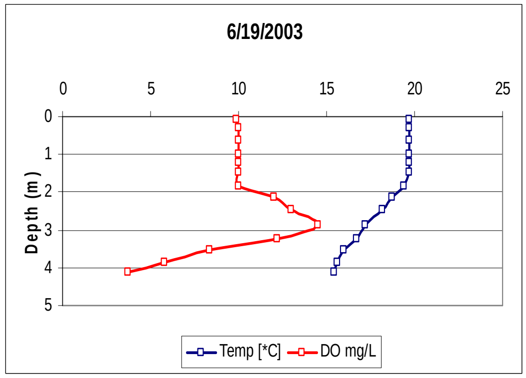

7/22/1992
Depth (ft)
temp [*C]
DO mg/L


8/18/1992
Depth (ft)
temp [*C]
DO mg/L


7/20/2001 (A)
Depth (ft)
Temp (*C)
DO (mg/L)


7/20/2001 (B)
Depth (ft)
Temp (*C)
DO (mg/L)


6/19/2003
Depth (m)
Temp [*C]
DO mg/L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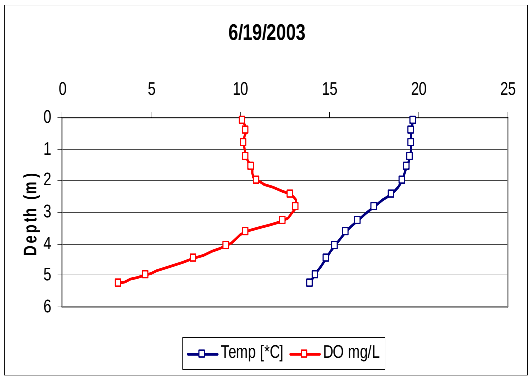
Temp [*C]
DO mg/L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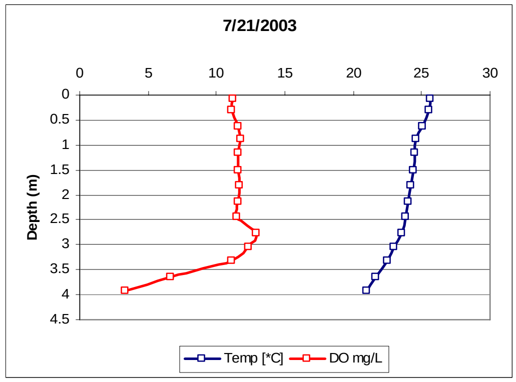
DO mg/L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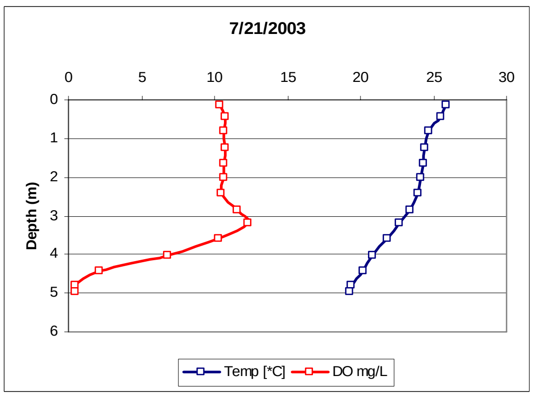
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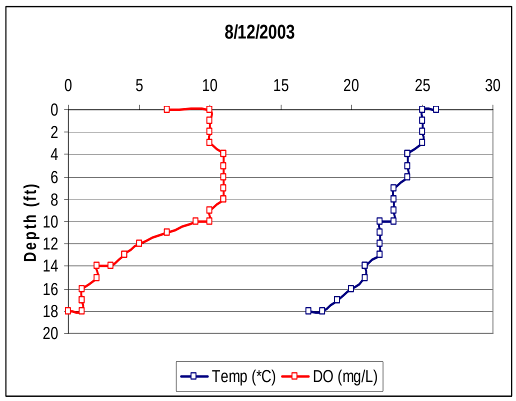
DO mg/L


8/12/2003
Depth (ft)
Temp (*C)
DO (mg/L)

Appendix G

Response to Public Comment

No comments were received from the general public during the 30-day public comment period. During the public comment period, the TMDL was reviewed by the Environmental Protection Agency (EPA), and their comments are provided below. The TMDL failed to completely meet one of EPA's review criteria (criterion #7: TMDL), as the load and wasteload allocations were not expressed using a daily time increment. In addition, an incorrect total load allocation was reported in the TMDL summary in the load allocation table. To address these comments, the load allocation value in the load allocation table was corrected (changed from 5.7 kg/yr to 7.3 kg/yr), and a daily load was reported along with the average annual load.

To identify a maximum daily limit, a method from EPA's "Technical Support Document For Water Quality-Based Toxics Control," referred to as the TSD method, was used. This method, which is based on a long-term average load that considers variation in a dataset, is a recommended method in EPA's technical guidance "Options for expressing Daily Loads in TMDLs"(USEPA 1991). The TSD method is represented by the following equation:

$$MDL = LTA \times e[z\sigma - 0.5\sigma^2]$$

where,

MDL = maximum daily limit
LTA = long-term average
z = z statistic of the probability of occurrence
$\sigma^2 = \ln(CV^2+1)$
CV = coefficient of variation

The daily load expression is identified as a static daily maximum load. A static daily load expression was deemed suitable because of the small watershed size, relatively constant loadings from nonpoint sources (e.g., septics, roads, in-stream sources), and the fact that a steady-state analysis was used. Assuming a probability of occurrence of 95% and a CV of 0.1 (based on available data), the maximum daily load corresponding to an average annual load of 7.3 kg/yr is 0.022 kg/day.

EPA REGION VIII TMDL REVIEW FORM

Document Name:	**Legion Lake Watershed Assessment Final Report**
Submitted by:	**Gene Stueven, SD DENR**
Date Received:	**December 27, 2007**
Review Date:	**January 23, 2008**
Reviewer:	**Vern Berry, EPA**
Formal or Informal Review?	**Informal – Public notice**

This document provides a standard format for EPA Region 8 to provide comments to the South Dakota Department of Environment and Natural Resources on TMDL documents provided to the EPA for either official formal or informal review. All TMDL documents are measured against the following 12 review criteria:

1. Water Quality Impairment Status
2. Water Quality Standards
3. Water Quality Targets
4. Significant Sources
5. Technical Analysis
6. Margin of Safety and Seasonality
7. Total Maximum Daily Load
8. Allocation
9. Public Participation
10. Monitoring Strategy
11. Restoration Strategy

Each of the 11 review criteria are described below to provide the rational for the review, followed by EPA's comments. This review is intended to ensure compliance with the Clean Water Act and also to ensure that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Water Quality Impairment Status

Criterion Description – Water Quality Impairment Status
TMDL documents must include a description of the listed water quality impairments. While the 303(d) list identifies probable causes and sources of water quality impairments, the information contained in the 303(d) list is generally not sufficiently detailed to provide the reader with an adequate understanding of the impairments. TMDL documents should include a thorough description/summary of all available water quality data such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and/or appropriate water quality standards.

☒ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☐ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – Legion Lake is a 9 acre man-made lake impoundment located in north-central Custer County, South Dakota. Galena Creek is the main tributary that flows into the reservoir and is located within the Middle Cheyenne-Spring sub-basin of the Cheyenne River Basin. It is listed on South Dakota's 2006 303(d) list as impaired (SD-CH-L-LEGION_01) for trophic state index (TSI) and pH due to nonpoint sources and is ranked as priority 1 (i.e., high priority) for TMDL development. The watershed is approximately 2,050 acres and drains predominantly evergreen forest and recreational areas. Legion Lake was included on South Dakota's 2006 303(d) list based on data collected prior to the Legion Lake assessment report being finalized (dated December 2007). When this recent data is added to the existing data Legion Lake is currently meeting the State's TSI target which corresponds with the coldwater marginal fish life propagation designated beneficial use of the lake. The pH impairment will be addressed in a future report and/or TMDL.

2. Water Quality Standards

Criterion Description – Water Quality Standards
The TMDL document must include a description of all applicable water quality standards for all affected jurisdictions. TMDLs result in maintaining and attaining water quality standards. Water quality standards are the basis from which TMDLs are established and the TMDL targets are derived, including the numeric, narrative, use classification, and antidegradation components of the standards.

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SUMMARY – Legion Lake was listed as impaired for TSI which is a surrogate measure used to determine whether the narrative standards are being met. South Dakota has applicable narrative standards that may be applied to the undesirable eutrophication of lakes. Data from Legion Lake indicates potential problems with nutrient enrichment and nuisance algal blooms, which are typical signs of the eutrophication process. 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)

Other applicable water quality standards are included on pages 2 - 4 of the assessment report.

3. Water Quality Targets

Criterion Description – Water Quality Targets

Quantified targets or endpoints must be provided to address each listed pollutant/water body combination. Target values must represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the TMDL target. For pollutants with narrative standards, the narrative standard must be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include targets representing water column sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

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SUMMARY – Water quality targets for this TMDL are based on interpretation of narrative provisions found in State water quality standards. In June 2005, SD DENR published *Targeting Impaired Lakes in South Dakota*. This document proposed targeted median growing season Secchi disk/chlorophyll *a* Trophic State Index (TSI) values for each beneficial use designation category. 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. Legion Lake is classified as a coldwater marginal fishery. The TSI target for coldwater marginal fisheries is a median Secchi disk/chlorophyll *a* $\leq$ 53.0

The actual Secchi disk / chlorophyll *a* TSI for Legion Lake during the period of the assessment was 50.4. However, Legion Lake continues to experience internal phosphorus loading from its sediments and external phosphorus loading from its watershed which has caused increasing eutrophication. The water quality data collected for the December 2007 assessment report was collected during a period of drought so the Secchi disk / chlorophyll *a* TSI of 50.4 may not be representative of a typical year. Therefore, the

TMDL recommends that BMPs be implemented to achieve lake phosphorus concentrations at a level that allows the lake to maintain or improve its trophic state.

The proposed water quality target for this TMDL is: **maintain a growing season median Secchi disk - chlorophyll *a* TSI at or below 53.0.**

4. Significant Sources

Criterion Description – Significant Sources

TMDLs must consider all significant sources of the stressor of concern. All sources or causes of the stressor must be identified or accounted for in some manner. The detail provided in the source assessment step drives the rigor of the allocation step. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source when the relative load contribution from each source has been estimated. Ideally, therefore, the pollutant load from each significant source should be quantified. This can be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach can be employed so long as the approach is clearly defined in the document.

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SUMMARY – The TMDL identifies the major sources of phosphorus as coming from nonpoint source forest and recreational landuses within the watershed. There are no known point source contributions in this watershed. Water quality loading was calculated for each gaged subwatershed using the FLUX modeling program to determine the approximate loading from the watershed. Possible sources include domestic sewage, detergents, fertilizers and animal waste. Also, a portion of the total phosphorus load originates from lake bottom sediment.

5. Technical Analysis

Criterion Description – Technical Analysis

*TMDLs must be supported by an appropriate level of technical analysis**.** It applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader. Of particular importance, the cause and effect relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and allocations needs to be supported by an appropriate level of technical analysis.*

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SUMMARY – The technical analysis addresses linkage between the water quality target and the identified sources of nutrients, and describes the models or methods used to derive the TMDL loads that will ensure that the water quality standards are met. To determine the cause and effect relationship between the water quality target and the identified sources various models and loading analysis were utilized.

The FLUX model was used to facilitate the analysis and reduction of tributary inflow and outflow nutrient and sediment loadings for Legion Lake. Phosphorus export coefficients were calculated for each subwatershed and were used to define critical nonpoint source pollution areas within the watershed.

The Acidification and Alkalinity section of the assessment report (pp. 35 – 36) discusses the pH data and impairment. Management practices recommended to reduce phosphorus loads, thereby reducing algae growth, are expected to also reduce the pH of Legion Lake to a level that meets the applicable water quality criteria. However, the high pH is also attributed, in part, to natural sources. This report does not include a strategy to control these natural sources, therefore the pH impairment will be addressed in a future report and/or TMDL.

6. Margin of Safety and Seasonality

Criterion Description – Margin of Safety and Seasonality

A margin of safety (MOS) is a required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (303(d)(1)(c)). The MOS can be implicitly expressed by incorporating a margin of safety into conservative assumptions used to develop the TMDL. In other cases, the MOS can be built in as a separate component of the TMDL (in this case, quantitatively, a TMDL = WLA + LA + MOS). In all cases, specific documentation describing the rational for the MOS is required.

Seasonal considerations, such as critical flow periods (high flow, low flow), also need to be considered when establishing TMDLs , targets, and allocations.

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SUMMARY – 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.

7. TMDL

Criterion Description – Total Maximum Daily Load

TMDLs include a quantified pollutant reduction target. According to EPA regulations (see 40 CFR 130.2(i)). TMDLs can be expressed as mass per unit of time, toxicity, % load reduction, or other measure. TMDLs must address, either singly or in combination, each listed pollutant/water body combination.

- ☐ Satisfies Criterion
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SUMMARY – The TMDL established for Legion Lake is a 7.3 kg/yr total phosphorus load to the lake. This is the "measured load" which is based on the flow and concentration data collected during the period of the assessment. Since the annual loading varies from year-to-year, this TMDL is considered a long term average percent reduction in phosphorus loading. Data collected for the assessment report indicate that Legion Lake is currently meeting the State's TSI target for coldwater marginal fish life propagation. Therefore the TMDL load for total phosphorus is equal to the current loading rate in order to maintain the current trophic state. However, BMPs are recommended to reduce phosphorus loads and improve or maintain the trophic state because Legion Lake is only narrowly meeting the TSI target.

COMMENTS – The TMDL table (Table A1, p. 61) says that the LA is 5.7 kg/yr whereas the LA discussion in the paragraph above the table says the LA is 7.3 kg/yr. Please correct the value in the table to match the 7.3 kg/yr TMDL load cited in the report and TMDL summary.

In November 2006 EPA issued the Memorandum "Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES permits," which recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. In June 2007 EPA made available a technical document "Options for the Expression of Daily Loads in TMDLs."

The Legion Lake TMDL needs to be revised to include a "daily" expression of load consistent with the Friends of the Earth decision and the technical guidance. The technical guidance is available at: http://www.epa.gov/owow/tmdl/draft_daily_loads_tech.pdf.

8. Allocation

Criterion Description – Allocation
TMDLs apportion responsibility for taking actions or allocate the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or dividing of responsibility. A performance based allocation approach, where a detailed strategy is articulated for the application of BMPs, may also be appropriate for nonpoint sources. Every effort should be made to be as detailed as possible and also, to base all conclusions on the best available scientific principles. *In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).*

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SUMMARY – This TMDL addresses the need to achieve reductions in nutrients to attain water quality goals in Legion Lake. The allocations in the TMDL include a “load allocation” attributed to recreational nonpoint sources. There are no known point source contributions in this watershed. Possible sources include domestic sewage, detergents, fertilizers and animal waste. Phosphorus loading reductions can be achieved by implementing the various BMPs that are outlined in the Conclusions and Recommendations section (pp. 52 – 54) of the report.

9. Public Participation

Criterion Description – Public Participation
The fundamental requirement for public participation is that all stakeholders have an opportunity to be part of the process. Notifications or solicitations for comments regarding the TMDL should clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for review, a copy of the comments received by the state should be also submitted to EPA..

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SUMMARY – 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 and has had individual contact with residents in the watershed. Also, the draft TMDL was posted on the State's internet site to solicit comments during the public notice period. The level of public participation is found to be adequate.

10. Monitoring Strategy

Criterion Description – Monitoring Strategy
TMDLs may have significant uncertainty associated with selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL documents to articulate the means by which the TMDL will be evaluated in the field, and to provide supplemental data in the future to address any uncertainties that may exist when the document is prepared.

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SUMMARY – Legion Lake will continue to be monitored through the statewide lake assessment project. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

11. Restoration Strategy

Criterion Description – Restoration Strategy
At a minimum, sufficient information should be provided in the TMDL document to demonstrate that if the TMDL were implemented, water quality standards would be attained or maintained. Adding additional detail regarding the proposed approach for the restoration of water quality <u>is not</u> currently a regulatory requirement, but is considered a value added component of a TMDL document.

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SUMMARY – The South Dakota DENR will work with a local watershed group to initiate BMP implementation in the Legion Lake watershed. Implementation of various best management practices will be necessary to meet or maintain the current water quality and TMDL targets/goals.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

RECEIVED

SEP 10 2008

DEPT. OF ENVIRONMENT AND NATURAL RESOURCES, SECRETARY'S OFFICE

SEP 2 2008

Ref: 8EPR-EP

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

Re: TMDL Approvals
School Lake; SD-BS-L-SCHOOL_01
Legion Lake; SD-CH-L-LEGION_01

Dear ~~Mr. Pirner~~ Steve:

We have completed our review of 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 elements of the TMDLs listed in the enclosed table adequately address the pollutants of concern as given in the table, taking into consideration seasonal variation and a margin of safety.

Some of the TMDLs listed in the enclosed table may be for waters not found on the State's current Section 303(d) waterbody list. The Environmental Protection Agency understands that such waters would have been included on the list had the State been aware, at the time the list was compiled, of the information developed in the context of calculating these TMDLs. This information demonstrates that the non-listed water is, in fact, a water quality limited segment in need of a TMDL. The State need not include these waters that have such TMDLs associated with them on its next Section 303(d) list for the pollutant covered by the TMDL.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Vern Berry and may be reached at 303-312-6234.

Sincerely,

Carol L. Campbell

Carol L. Campbell
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures

ENCLOSURE 1

APPROVED TMDLS

2 Pollutant TMDLs completed
1 cause addressed from the 2008 303(d) list
0 Determinations made that no pollutant TMDL was needed

Waterbody Name & AU ID	TMDL Parameter/ Pollutant (303(d) list cause)	Water Quality Goal/Endpoint	TMDL WLA / LA / MOS	Supporting Documentation (not an exhaustive list of supporting documents)
School Lake* SD-BS-L-SCHOOL_01	Phosphorus (TSI); pH impairment documented in the assessment report**	Secchi – chlorophyll-*a* TSI ≤ 68.4	LC = 87.2 kg/yr LA = 87.2 kg/yr WLA = 0 kg/yr MOS = Implicit	■ Watershed Assessment Final Report and TMDL, School Lake, Deuel County, South Dakota (SD DENR, August 2005)
Legion Lake* SD-CH-L-LEGION_01	Phosphorus	Secchi – chlorophyll-*a* TSI ≤ 53.0	LC = 7.3 kg/yr LA = 7.3 kg/yr WLA = 0 kg/yr MOS = Implicit	■ Section 319 Nonpoint Source Pollution Control Program Assessment/Planning Project Final Report, Legion Lake, Custer County, South Dakota (SD DENR, April 2008)
	pH	The pH impairment will be addressed in a future report and/or TMDL and Legion Lake will remain on the 303(d) list for pH. It is expected that the BMPs needed to control phosphorus loading will improve the pH readings in the lake, but natural sources are also suspected of contributing to high pH readings and will be investigated further.		

* Indicates that the waterbody has been included on the State's Section 303(d) list of waterbodies in need of TMDLs.
** Improvements in the pH readings in School Lake can be achieved through reduction of organic loading to the lake as a result of proposed BMP implementation. The TMDL contains a linkage analysis between phosphorous loading and pH in lakes and reservoirs.
LC = loading capacity; WLA = wasteload allocation; LA = load allocation; MOS = margin of safety
TMDL = LC = $\sum$ WLAs + $\sum$ LAs + MOS

ENCLOSURE 3

EPA REGION VIII TMDL REVIEW FORM

Document Name:	**Legion Lake Watershed Assessment Final Report**
Submitted by:	**Gene Stueven, SD DENR**
Date Received:	**June 19, 2008**
Review Date:	**July 15, 2008**
Reviewer:	**Vern Berry, EPA**
Formal or Informal Review?	**Formal – Final Approval**

This document provides a standard format for EPA Region 8 to provide comments to the South Dakota Department of Environment and Natural Resources on TMDL documents provided to the EPA for either official formal or informal review. All TMDL documents are measured against the following 11 review criteria:

1. Water Quality Impairment Status
2. Water Quality Standards
3. Water Quality Targets
4. Significant Sources
5. Technical Analysis
6. Margin of Safety and Seasonality
7. Total Maximum Daily Load
8. Allocation
9. Public Participation
10. Monitoring Strategy
11. Restoration Strategy

Each of the 11 review criteria are described below to provide the rational for the review, followed by EPA's comments. This review is intended to ensure compliance with the Clean Water Act and also to ensure that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Water Quality Impairment Status

Criterion Description – Water Quality Impairment Status
TMDL documents must include a description of the listed water quality impairments. While the 303(d) list identifies probable causes and sources of water quality impairments, the information contained in the 303(d) list is generally not sufficiently detailed to provide the reader with an adequate understanding of the impairments. TMDL documents should include a thorough description/summary of all available water quality data such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and/or appropriate water quality standards.

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SUMMARY – Legion Lake is a 9 acre man-made lake impoundment located in north-central Custer County, South Dakota. Galena Creek is the main tributary that flows into the reservoir and is located within the Middle Cheyenne-Spring sub-basin of the Cheyenne River Basin. It is listed on South Dakota's 2006 303(d) list as impaired (SD-CH-L-LEGION_01) for trophic state index (TSI) and pH, and on the 2008 303(d) list for pH, due to nonpoint sources and ranked as priority 1 (i.e., high priority) for TMDL development. The watershed is approximately 2,050 acres and drains predominantly evergreen forest and recreational areas. Legion Lake was included on South Dakota's 2006 303(d) list based on data collected prior to the Legion Lake assessment report being finalized (dated December 2007). When this recent data is added to the existing data Legion Lake is currently meeting the State's TSI target which corresponds with the coldwater marginal fish life propagation designated beneficial use of the lake. The pH impairment will be addressed in a future report and/or TMDL and Legion Lake will remain on the 303(d) list for pH. It is expected that the BMPs needed to control phosphorus loading will improve the pH readings in the lake, but natural sources are also suspected of contributing to high pH readings and will be investigated further.

2. Water Quality Standards

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SUMMARY – Legion Lake was listed as impaired for TSI which is a surrogate measure used to determine whether the narrative standards are being met. South Dakota has applicable narrative standards that may be applied to the undesirable eutrophication of lakes. Data from Legion Lake indicates potential problems with nutrient enrichment and nuisance algal blooms, which are typical signs of the eutrophication process. The narrative standards being implemented in this TMDL are:

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Other applicable water quality standards are included on pages 2 - 4 of the assessment report.

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The actual Secchi disk / chlorophyll *a* TSI for Legion Lake during the period of the assessment was 50.4. However, Legion Lake continues to experience internal phosphorus loading from its sediments and external phosphorus loading from its watershed which has caused increasing eutrophication. The water quality data collected for the December 2007 assessment report was collected during a period of drought so the Secchi disk / chlorophyll *a* TSI of 50.4 may not be representative of a typical year. Therefore, the TMDL recommends that BMPs be implemented to achieve lake phosphorus concentrations at a level that allows the lake to maintain or improve its trophic state.

The water quality target for this TMDL is: **maintain a growing season median Secchi disk -chlorophyll *a* TSI at or below 53.0.**

4. Significant Sources

Criterion Description – Significant Sources

TMDLs must consider all significant sources of the stressor of concern. All sources or causes of the stressor must be identified or accounted for in some manner. The detail provided in the source assessment step drives the rigor of the allocation step. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source when the relative load contribution from each source has been estimated. Ideally, therefore, the pollutant load from each significant source should be quantified. This can be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach can be employed so long as the approach is clearly defined in the document.

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*TMDLs must be supported by an appropriate level of technical analysis. It applies to **<u>all</u>** of the components of a TMDL document. It is vitally important that the technical basis for **<u>all</u>** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader. Of particular importance, the cause and effect relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and allocations needs to be supported by an appropriate level of technical analysis.*

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The FLUX model was used to facilitate the analysis and reduction of tributary inflow and outflow nutrient and sediment loadings for Legion Lake. Phosphorus export coefficients were calculated for each subwatershed and were used to define critical nonpoint source pollution areas within the watershed. The BATHTUB program was used to estimate water and nutrient balances and identify factors controlling algal production. The model was also used to determine the nutrient load reduction required for Legion Lake to support its beneficial uses.

The Acidification and Alkalinity section of the assessment report (pp. 35 – 36) discusses the pH data and impairment. Management practices recommended to reduce phosphorus loads, thereby reducing algae growth, are expected to also reduce the pH of Legion Lake to a level that meets the applicable water quality criteria. However, the high pH is also attributed, in part, to natural sources. This report does not include a strategy to control these natural sources; therefore the pH impairment will be addressed in a future report and/or TMDL.

6. Margin of Safety and Seasonality

Criterion Description – Margin of Safety and Seasonality

A margin of safety (MOS) is a required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (303(d)(1)(c)). The MOS can be implicitly expressed by incorporating a margin of safety into conservative assumptions used to develop the TMDL. In other cases, the MOS can be built in as a separate component of the TMDL (in this case, quantitatively, a TMDL = WLA + LA + MOS). In all cases, specific documentation describing the rational for the MOS is required.

Seasonal considerations, such as critical flow periods (high flow, low flow), also need to be considered when establishing TMDLs , targets, and allocations.

☒ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☐ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – 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.

7. TMDL

Criterion Description – Total Maximum Daily Load
TMDLs include a quantified pollutant reduction target. According to EPA regulations (see 40 CFR 130.2(i)). TMDLs can be expressed as mass per unit of time, toxicity, % load reduction, or other measure. TMDLs must address, either singly or in combination, each listed pollutant/water body combination.

- ☒ Satisfies Criterion
- ☐ Satisfies Criterion. Questions or comments provided below should be considered.
- ☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
- ☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
- ☐ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – The TMDL established for Legion Lake is a 7.3 kg/yr (0.022 kg/day) total phosphorus load to the lake. This is the "measured load" which is based on the flow and concentration data collected during the period of the assessment. Since the annual loading varies from year-to-year, this TMDL is considered a long term average percent reduction in phosphorus loading. Data collected for the assessment report indicate that Legion Lake is currently meeting the State's TSI target for coldwater marginal fish life propagation. Therefore the TMDL load for total phosphorus is equal to the current loading rate in order to maintain the current trophic state. However, BMPs are recommended to reduce phosphorus loads and improve or maintain the trophic state because Legion Lake is only narrowly meeting the TSI target.

The SD DENR believes that describing the load as an annual load is more realistic and protective of the waterbody. Most phosphorus based eutrophication models use annual phosphorus loads, and seasonality and unpredictable precipitation patterns make a daily load unrealistic. EPA recognizes that, under the specific circumstances, the state may deem the annual load the most appropriate timeframe (i.e., the TSI water quality target is based on an interpretation of narrative water quality standards which naturally does not include an averaging period). EPA notes that the Legion Lake TMDL calculations for phosphorus include an approximated daily load derived by EPA's method contained in the Technical Support Document for Water Quality-Based Toxics Control. The daily load expression is identified as a static daily maximum load, but will typically not match the actual phosphorus load reaching the lake on a given day.

8. Allocation

> ***Criterion Description – Allocation***
>
> *TMDLs apportion responsibility for taking actions or allocate the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or dividing of responsibility. A performance based allocation approach, where a detailed strategy is articulated for the application of BMPs, may also be appropriate for nonpoint sources. Every effort should be made to be as detailed as possible and also, to base all conclusions on the best available scientific principles.*
>
> *In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).*

☒ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☐ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – This TMDL addresses the need to achieve reductions in nutrients to attain water quality goals in Legion Lake. The allocations in the TMDL include a "load allocation" attributed to recreational nonpoint sources. There are no known point source contributions in this watershed. Possible sources include domestic sewage, detergents, fertilizers and animal waste. Phosphorus loading reductions can be achieved by implementing the various BMPs that are outlined in the Conclusions and Recommendations section (pp. 52 – 54) of the report.

9. Public Participation

> ***Criterion Description – Public Participation***
>
> *The fundamental requirement for public participation is that all stakeholders have an opportunity to be part of the process. Notifications or solicitations for comments regarding the TMDL should clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for review, a copy of the comments received by the state should be also submitted to EPA..*

☒ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☐ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – 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 and has had individual contact with residents in the watershed. Also, the draft TMDL was posted on the State's internet site to solicit comments during the public notice period. The level of public participation is found to be adequate.

10. Monitoring Strategy

Criterion Description – Monitoring Strategy
TMDLs may have significant uncertainty associated with selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL documents to articulate the means by which the TMDL will be evaluated in the field, and to provide supplemental data in the future to address any uncertainties that may exist when the document is prepared.

☐ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☒ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – Legion Lake will continue to be monitored through the statewide lake assessment project. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

11. Restoration Strategy

Criterion Description – Restoration Strategy
At a minimum, sufficient information should be provided in the TMDL document to demonstrate that if the TMDL were implemented, water quality standards would be attained or maintained. Adding additional detail regarding the proposed approach for the restoration of water quality <u>is not</u> currently a regulatory requirement, but is considered a value added component of a TMDL document.

☐ Satisfies Criterion
☐ Satisfies Criterion. Questions or comments provided below should be considered.
☐ Partially satisfies criterion. Questions or comments provided below need to be addressed.
☐ Criterion not satisfied. Questions or comments provided below need to be addressed.
☒ Not a required element in this case. Comments or questions provided for informational purposes.

SUMMARY – The South Dakota DENR will work with a local watershed group to initiate BMP implementation in the Legion Lake watershed. Implementation of various best management practices will be necessary to meet or maintain the current water quality and TMDL targets/goals.