Re: 6-7-95
MPCA - Bill Thorp
Rochester WQ

PROJECT WORK PLAN

FOR THE

LAKE VOLNEY WATER QUALITY IMPROVEMENT PROJECT

SPONSORED BY: LE SUEUR COUNTY BOARD OF COMMISSIONERS

Clean water Partnership through the Minnesota Pollution Control Agency

CONTRIBUTING SPONSORS:

LESUEUR COUNTY PLANNING AND ZONING
LAKE VOLNEY IMPROVEMENT ASSOCIATION
LE SUEUR COUNTY COMMUNITY HEALTH
MINNESOTA EXTENSION SERVICE
LE SUEUR COUNTY SOIL AND WATER CONSERVATION DISTRICT
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
ISAAC WALTON LEAGUE
MONTGOMERY SPORTSMAN'S CLUB
US NATURAL RESOURCE CONSERVATION SERVICE

Prepared April 24, 1995

TABLE OF CONTENTS

Number	*Description*	*Page*

LIST OF TABLES

LIST OF FIGURES

SECTION 1: Statement of the Problem and Existing Conditions

Name and Physical Characteristics of the Waters and Project Area- The project area of concern is Lake Volney (40-0033) and the associated watershed. This system lies about 4 miles southeast of Le Center, Minnesota. The lake morphometric, watershed and fisheries characteristics are presented in Table 1 on the following page. The watershed lies in the North Central Hardwood Forest ecoregion but has land use patterns typical for this and the Western Corn Belt Plains ecoregion (Table 2). Soils in the watershed are defined as the Lester, LeSueur, Cordova complex. The lake basin has one primary and two secondary inlets (creeks), and a single outlet to the Cannon River. Topographical maps showing the watershed boundaries, major inlets, and outlet are enclosed. In addition, a map depicting the major and minor inlets/outflow with a description of each site is enclosed.

Description of Local Interests, Historical Uses, and Previous Water Quality Studies- There is an active and diverse local interest in improving the aesthetic and recreation value of Lake Volney. The Lake Volney Improvement Association (LVIC) is an active 60 member group association that participates in the Citizens Lake Monitoring Program (CLMP). The deterioration of water quality (i.e., noxious algae blooms) has been the major force stimulating the organization and planning necessary to submit this Clean Water Partnership application. In addition, the LVIC has sought to go beyond the Clean Water Partnership by initiating fund raising activities (charitable gambling) to support the cost of future water quality improvement and maintenance projects.

The lake system has been a major recreational focal area in the county for many years. In the summer and winter there is heavy recreational use of the lake. The Le Sueur County public swimming beach lies on the southern shore of Lake Volney which includes a public boat landing. Over 75% of the shoreline is developed with seasonal and year round residents. The primary historical uses include boating, swimming, water skiing, and fishing.

Several studies have been conducted on Lake Volney in the recent past including: 1) the Citizen's Lake Monitoring Program (CLMP); 2) MPCA Lake Assessment Program (LAP) study conducted in 1987; 3) an Agricultural Non-point Source Pollution model (AGNPS) developed during the period 1991-92; 4) an additional MPCA in-lake water quality sampling conducted in 1992; 5) a Minnesota Department of Natural Resources (DNR) fisheries survey conducted in 1992; and 6) a septic survey conducted by residents during 1991. The studies indicate that the lake has been subject to extreme water quality deterioration processes in the recent past. Nutrient, chlorophyll-a, and dissolved oxygen data suggest the lake is receiving excessive loadings from its watershed and, quite 1

TABLE 1: LAKE VOLNEY MORPHOMETRIC, WATERSHED AND FISHERY CHARACTERISTICS

MNDNR ID	40-0033
AREA (ac)	277
MEAN DEPTH (ft)	22.7
MAXIMUM DEPTH(ft)	67
VOLUME (ac-ft)	6,156.7
LITTORAL AREA (%)	46
SHORELINE LENGTH (mi)	2.5
FETCH (mi)	0.94
WATERSHED AREA (ac)	1,906
WATERSHED AREA: LAKE SURFACE AREA	6.9:1
FISHERIES-ECOLOGICAL CLASSIFICATION:	Centrarchid-Walleye
MANAGEMENT CLASSIFICATION:	Game fish, Walleye
WETLANDS CLASSIFICATION:	Not Applicable
MIXIS:	Dimictic

TABLE 2: LAND USE SUMMARY, LAKE VOLNEY WATERSHED VERSUS REGIONAL AVERAGE VALUES BY PERCENTS

LAKE	VOLNEY	REGIONAL AVERAGE
FORESTED	0	15.9
WATER	11.9	8.1*
WETLAND	4.0	
URBAN	0	5.3**
RESIDENTIAL	1.4	
PASTURE	8.9	21.4
CULTIVATED	73.9	49.3

* WATER AND WETLAND
** URBAN AND RESIDENTIAL

possibly, internal nutrient recycling as well. These loading have created severe nucience algal blooms that persist for the majority of the warm water season that have halted recreational activity at the public beach. The MPCA mean summer water chemistry data from the LAP study (1986-1987) is enclosed as Appendix A. Based on these data, the MPCA technical staff estimates the average Trophic State Index (TSI) as 63. This is above the average for the North Central Hardwood Forests (59) and below for lakes in the Western Corn Belt Plains (72).

Why the Project is Taking Place

Over the past 10 years, watershed residents have observed a continual degradation of water quality as evidence by extremely algal blooms, unsightly shoreline scum's, and in general, a diminishing water clarity. The current perception, documented in a 1992 survey (MPCA), is that agricultural run-off, coupled with internal nutrient recycling are responsible for the excessive algal blooms, and sedimentation occurring in the lake. The Clean Water Partnership application was initiated to identify and quantify nutrient and sediment loading so appropriate reduction methods can be initiated. Again, the Lake Association, the Montgomery Sportmans Club, the Isaac Walton League, and the DNR, have already begun to secure funding mechanisms in order to assist with the diagnostic study and future remediation plans.

Known, Suspected, or Potential Water Quality Problems

A swine operation located just upstream of the lake's main inlet has been identified as a suspect source of excessive nutrient loading by some local residents. No definitive data exists to clearly determine the source or the magnitude of the loading, however. There has been some stream sampling that have shown elevated concentrations at the outflow of this stream into the lake. No flow data exist to determine the magnitude or origin of the concentrations, and a MPCA site inspection of the feedlot failed to identify any probable source.

An additional feedlot above the northwest shoreline, that is currently not in operation, may have been a serious polluter in the past and the effects may still be reflected in the poor water quality of the lake. In addition, a series of drain tiles dominate the western watersheds and are responsible for large "plumes" that can be witnessed within the lake immediately following rainfall events. The septic system survey, conducted in 1991 , identified some systems that required upgrading, but it is extremely doubtful that nutrients delivered to the lake by these system could account for the massive problems within the lake itself.

Section 2: Statement of the Project Goals and Objectives

A. Overall Resource Goals

A. The focus and primary intent of this project is to advance the current understanding of the cause-effect mechanisms relating the watershed landuse practices to lake water quality. A mass balance approach will be taken quantifying the individual subwatershed discharges of water and nutrient mass, and relating these quantities to the lake storage and outflow mass. The sampling design will address the questions:

1) What is the nutrient mass entering the lake?
2) Where is it coming from?
3) How does the lake respond?
4) What can be done?

B. Water Quality Characterization Goals

The data gathered during the diagnostic study will enable the project manager and resource committee to develop an information-based management plan to:

1) Assess the magnitude of each pollution source.
2) Design realistic control measures.
3) Quantify the performance of the control measures implemented.
4) Prognosticate the net effect on the lake water quality.
5) Determine the benefit of lake improvement to the local economy.

C. Preliminary Quantitative Goals

At the present time there is insufficient information to establish quantitative goals. These goals will be established when more information on the sources of pollutants becomes available.

D. Information and Education Goals

1. To inform watershed residents of the impact of point source and non-point source (NPS) pollution and to educate individuals on methods to abate or prevent point source and NPS pollution.

2. To develop a sense of shared responsibility among property owners and resource users in the watershed.

3. To define and target sensitive watershed areas in which additional contact/information is necessary to improve the likelihood of implementing best management practices.

Section 3: Project Organization and Responsibility

A brief description of the responsibilities is provided below. A project organization chart and staff directory is provided on page 7.

A) Project Manager - The project manager is responsible for the overall coordination of the project activities and communications between the various groups. The project manager will be a part of and lead the Lake Volney Improvement Resource Committee. In addition to coordination activities, the project manager will also participate in the following program elements:

Program Element 1	Work Plan Development
Program Element 2	Water Quality Monitoring
Program Element 3	Watershed Assessment
Program Element 4	Sedimentigraphy
Program Element 5	Staff gage and Precipitation Monitoring
Program Element 6	Septic System Survey Update
Program Element 7	Data Analysis and Assessment
Program Element 8	Information and Education
Program Element 9	Implementation Plan Development
Program Element 10	Fiscal Management and Administration

B) Minnesota Department of Natural Resources - the DNR (waters) will participate in lake level and flow monitoring setup as well as the general hydrological aspects of the project. The department (fisheries) will also conduct a fishery survey in 1995 and closely monitor the project in terms of ultimate in-lake control selection for eutrophication reduction and subsequent fisheries enhancement.

C) Le Sueur County Soil and Water Conservation District - The SWCD will update the land use assessment and participate in the implementation plan development. They will also assist in identifying the minor drainage subsheds within the Lake Volney Watershed.

D) Minnesota Extension Service - The Extension Service will provide educational information to crop and livestock producers and lakeshore owners and participate in implementation plan development.

E) Lake Volney Lake Improvement Association and other interested watershed citizens - Watershed citizens will assist in water quality monitoring especially with inlet flow, precipitation, and lake level monitoring. They will participate in updating the septic system survey. The group will be responsible for reading staff gages, on a continuous basis, that will be placed at non-automated stream sites throughout the watershed , lake, and lake outlet. The association will locate, erect, and keep records for the precipitation monitoring network, and will receive training for and be expected to conduct the in-lake sampling and measurement gathering. They will also be involved in the construction of the hydrological monitoring network and be involved in the implementation plan development. They will work directly with the project manager and serve on the Resource Committee.

F) Mankato State University Water Resources Center - MSU will be responsible for the chemical, biological analysis of the water samples collected during the study including the necessary quality control and quality assurance protocols.

Section 4: Identification and Summary of Program Elements

Program Element 1: Development and Revision of the Project Work and Monitoring Plans

The Project Sponsor, the project consultant, and the Project Resource Committee will develop and revise the work and monitoring plans as required or warranted. Drafting the plan will be the responsibility of the project consultant and the project sponsors.

Program Element 2: Water Quality Monitoring

The watershed hydrologic and water quality monitoring (creeks, ditches, and tile lines) and the single lake out-flow will be sampled and flow rated from March - September 1995. In-Lake monitoring will be conducted from May - September 1995. Sample collection/analysis will be the responsibility of the project sponsors, the lake association, and project consultant.

A sampling design has been created describing the site locations and sampling series, the sampling frequency of each sampling series, and the analytes to be measured for each sampling series (see Tables 3-5). This computerized sampling design has built in flexibility and automatically computes costs associated with sampling series and total analytical costs The information obtained from water quality monitoring will be used to calculate nutrient and water budgets for the lake/watershed system; estimate specific contributions of water, nutrient mass, and suspended solids from each subwatershed; estimate ground water contributions; determine net sediment mass contributions; and provide inputs to the watershed loading/ lake response models required to fully understand cause-effect mechanisms, form realistic water quality goals, and identify/quantify implementation measures.

Program Element 3: Watershed Assessment

Land use information compiled in 1991 for the AGNEPS model will be updated to current land uses by county and SWCD staff members. All available land use, soils, wetlands, and the MPCA ecoregion data will be collected and compiled. Maps and data bases developed by this process will provide a viable means to identify areas within the watershed for possible implementation actions based on inflow nutrient data.

Program Element 4: Sedimentigraphy

Dr. Daniel Engstrom of the Limnological Research Center, University of Minnesota will conduct a sediment survey to determine the spatial and temporal distribution of phosphorus forms within the upper 5cm of sediment deposits with Lake Volney (see Table 6 for details). The focus of this study will be to determine the availability of phosphorus in the sediments and the potential for recycling. A deeper core analysis (>1meter) will reveal a chronology of the lake's history in terms of water quality. The survey will also provide an independent estimate of sediment phosphorus loading to the lake that will greatly increase the certainty associated with the final study results. The information gathered from the survey will be crucial in the assessment of possible in-lake control strategies that will be reviewed by Hugh Valiant of the DNR Fisheries in Waterville, and

Table 3

Site Description and sampling series - 1995

Station Description	Site #	Average: Samples/Round/Station Trib 100	Trib 101	Lake 200	Event 300
West Branch Ditch 1 at State Hwy 99	1		1		
East Branch Ditch 1 at State Hwy 99	2	1			1
Wetland Outlet Ditch 1 - above hoglot	3	1			1
Tile Outlet Ditch 1 - below hoglot	4		1		
Ditch 1 Outlet - northeast shore	5	1			1
East Shore Drainage Pump	6		1		
Ditch 2 Outlet - northwest shore	7	1			
Draintile Upstream of Ditch 2	8		1		
Ditch 3 Outlet- west shore	9	1			1
Tile Outlet at Ditch 3 Outlet	10		1		
Tile Outlet Ditch 3 - upstream	11		1		
Ditch 4 Outlet - southwest shore	12		1		
Lake Outlet	13	1			
Lake Station - deepest portion of the lake	14			4	
Total Stations		6	7	1	4
Total Samples/Round		6	7	4	4

NOTE: Lake 200 Series 3m, 6m, 10m, and 16m depths

Table 4
Sampling Schedule - 1995

Week Starting Monday	Sample Series Trib 100	Trib 101	Lake 200	Event 300	
Snow Melt	1				
Apr-10					*note: try to collect 8 storm events
Apr-17	1	1			
Apr-24					
May-1	1		1		
May-8					
May-15	1	1			
May-22					
May-29	1		1		
Jun-5					
June-12	1	1	1		
Jun-19					
Jun-26	1		1		
Jul-3					
Jul-10	1	1	1		
Jul-17					
Jul-24	1		1		
Jul-31					
Aug-7	1	1			
Aug-14					
Aug-21	1		1		
Aug-28					
Sep-4	1	1	1		
Sep-11					
Sep-18	1				
Sep-25					
Total Rounds	13	6	8	8	

Table 5
1995 Sampling Season
Chemical Analyses and Costs by Sample Series

Sample series	Trib 100	Trib 101	Lake 200	Event 300	
stations	6	7	1	4	
samples/round	6	7	4	4	
rounds	13	6	8	8	
total samples	78	42	32	32	
Analyses					**Unit Cost**
total P	1	1	1	1	$10.45
soluble P	1	1	1	1	$8.75
no23-N	1	1	1	1	$15.00
nh34-N	1	1	1	1	$11.00
tkn	1	1	1	1	$14.10
conductivity			1		$3.30
alkalinity			1		$4.50
pH			1		$1.10
Turbidity			1		$10.00
TVS					$12.00
TSS	1	1		1	$12.00
sulfate			1		$10.00
iron			1		$10.00
manganese			1		$10.00
silica			1		$15.00
Chlorides					$6.60
Secchi Disk			1		$0.00
Temperature			1		$0.00
Dissolved Oxygen			1		$0.00
Chlorophyll A			1		$16.50
Phytoplankton			1		$25.00
Zooplankton					$25.00
cost/sample	$71.30	$71.30	$164.70	$71.30	TOTAL
cost/series	$5,561	$2,995	$5,270	$2,282	$16,108
percent of total	34.5	18.6	32.7	14.2	100.0

greatly aid in the prognostic projections of ultimate lake recovery that is so important to the area residents. This coupling of watershed monitoring/sedimentigraphy has been successfully employed in several projects including: the Vadnais Lake/Lambert Creek CWP, the Lake Shaokatan CWP, and the Lake Benton Diagnostic Study.

Program Element 5: Staff Gage and Precipitation Monitoring

The LVIC will monitor a network of staff gages located throughout the watershed at low priority stations on a twice weekly basis. Flow measurements and subsequent stream ratings will be developed at each of these sites by the project consultant in conjunction with the project sponsors and applied to the staff gage readings to provide a cost effective, continuous record of flow at each site throughout the study period. The watershed residents will also erect and equip a network of precipitation stations that will be read and recorded following each rainfall event that occurs during the study period. A staff gage will also be located and record within the lake to determine changes in water volumes during the open water season that are necessary for the system hydrological and mass balances.

Program Element 6: Septic System Survey

In 1991 a septic system survey was conducted by lake association members and county staff. The primary objective was to quantify the number of nonconforming septic systems. By utilizing the septic system data and existing soils data, a map was generated indicating the most likely locations of nonconforming septic systems within the watershed.

A total of 60 residences were polled, of which 52 were lake shore properties. All of the lakeshore residents returned the survey form and a total of approximately 88% of all forms were completed and returned. This survey will be updated by reviewing current Le Sueur County records of septic system installations that have occurred within the watershed since the 1991 survey was conducted.

Program Element 7: Data Analysis and Assessment

Data analysis and assessment for the project will include a review of previous and current data for trend analysis, nutrient budgeting, and integration of land use and water quality for point and non-point source assessment. Automated field stations will be downloaded on a monthly basis to a storage module (Campbell Scientific) and uploaded to an IBM 486 DX66 personal computer. All data will be compiled, edited, and stored on Lotus 123 spreadsheet and Approach database software. Watershed loading calculations will be performed using Flux (Walker, 1986) and lake models will be developed using Bathtub (Walker, 1986). The final data will be transferred electronically to MPCA STORET database via Lotus 123 spreadsheet input.

In addition to the loading calculations and lake modeling, a land use model will be developed to predict the specific subwatershed runoff and mass loadings that can be compared to actual measured loadings. This will enable managers to determine specific contributions of such practices as feedlot operations, cultivation practices and proximity, manure application practices,

cattle grazing practices and proximity, septic systems, urban influences, road repair/construction activities, etc. These models will also enable managers to assess the positive impacts of BMP's such as buffer strips, conservation tillage, wetlands, CRP acreage etc. The cummulative effect of these data gathering/modeling efforts will enable managers and planners to develop a comprehensive, site specific implementation plan that will greatly enhance the likelihood of successful remediation within this lake/watershed system.

Program Element 8: Information and Education Plan

In the summer of 1995 a focused effort to inform and involve watershed residents, including the farming and lakeshore communities, political representatives, local organizations, government officers, and watershed residents, will be initiated. The information and education plan will encompass the following issues: Drainage systems and minor watershed basins, nonpoint source pollution related to land use and land cover, urban and agriculture best management practices, point source pollution, water quality concerns and perceptions, habitat preservation, and shoreland development and use as related to water quality. This information will be distributed by newspapers, newsletters, and one page fact sheets, in addition to presentations before the Resource Committee. A special technical information and education committee will be assembled to coordinate and effect this component.

Program Element 9: Implementation Plan Development

Upon receiving the CWP Phase I grant a Resource Committee will be formed to oversee the diagnostic study and aid in the development of the implementation plan. Crop and livestock producers, lakeshore residents, and watershed residents will comprise the committee. The Resource Committee and area citizens will be presented with information and data regarding watershed management. Following these informational meetings, implementation strategies related to best management practices, education, zoning, incentives, cost sharing, acquisition, and easements will be formulated and presented to the Resource Committee. Accordingly a final implementation plan will be developed. All the project participants will be involved in the development of the implementation.

Program Element 10: Fiscal Management and Administration

It will be the responsibility of the project sponsor to manage the fiscal and administrative affairs of this project.

Section 5: Milestone Schedule

Program Element 1 - Work and Monitoring Plan Development

Activity	Time Frame Start - End	Responsibility
Initial Work and Monitoring Plan Development	03/95 - 07/95	Project Sponsor, Project Consultant
Submit Revisions	As appropriate	Project Sponsors, Project Consultant
Development subsequent Modifications	As necessary	Project Sponsors, Project Consultant

Program Element 2 - Water Quality Monitoring

Activity	Time Frame Start - End	Responsibility
Routine Monitoring - Lake	05/95 - 09/95	Consultant, Volunteers
Secchi Disc Monitoring	05/95 - 10/95	CLMP, Volunteers
Staff Gage Monitoring	03/95 - 10/95	Lake area volunteers
Routine Monitoring In-flow	03/95 - 10/95	Consultant, Sponsors
Storm Monitoring	03/95 - 11/95	Consultant, Sponsors
Fish Survey	05/95 - 08/95	DNR-Fisheries

Program Element 3 - Watershed Assessment

Activity	Time Frame Start - End	Responsibility
Review and Update of Land Use Data	3/95 - 7/95	SWCD, Project Sponsor
Compiling Land Use Data	5/95 - 8/95	MPCA, Project Sponsor
Evaluation and Assessment of Data	10/95 - 12/95	Project Sponsor, MPCA Project Consultant DNR, Resource Committee
Public Meetings	1/96 - 6/96	Project Sponsor DNR, Resource Committee

Program Element 4 - Sedimentigraphy

Activity	Time Frame Start - End	Responsibility
Collection and Coring	06/95	Sedimentologist
Synthesis and Write -up	7/95 - 10/95	Sedimentologist

Program Element 5 - Staff Gage and Precipitation Monitoring

Activity	Time Frame Start - End	Responsibility
Lake Stage Monitoring	04/95 - 10/95	Area Volunteers
Flow Monitoring	03/95 - 10/95	Area Volunteers Project Sponsors
Precipitation Monitoring	03/95 - 10/95	Area Volunteers SWCD

Program Element 6 - Septic System Survey

Activity	Time Frame Start - End	Responsibility
Update 1992 Septic Survey	12/95	Project Sponsor

Program Element 7 - Data Analysis and Assessment

Activity	Time Frame Start - End	Responsibility
Historical Data	3/95 - 12/95	Project Sponsor Project Consultant
Water and Sediment Data Analysis	10/95 - 3/96	Project Sponsor Project Consultant Sedimentologist
Computer Modeling	10/95 - 04/96	Project Sponsor Project Consultant
Nutrient Budget	10/95 - 01/96	Project Sponsor Project Consultant
Numerical Goal Determination	1/96 -5/96	Project Sponsor Project Consultant Resource Committee

Program Element 8 - Information and Education Plan

Activity	Time Frame Start - End	Responsibility
Assemble Information	5/95	MES, Resource Committee Project Sponsors
Draft Education Programs	6/95 - 3/96	MES, Resource Committee
Begin Information and Education Program	3/96 - 6/96	MES, Resource Committee

Program Element 9 - Implementation Plan Development

Activity	Time Frame Start - End	Responsibility
Assemble Resource Committee	3/95	Project Sponsor
Informational Meetings	5/95 - 6/96	Project Sponsor Resource Committee
Develop Implementation Plan	10/95 - 6/96	Project Consultant MES, SWCD, DNR, Resource Committee

Program Element 10 - Fiscal Management and Administration

Activity	Time Frame Start - End	Responsibility
Fiscal Management	03/95 - 12/96	Project Sponsor
Administration	03/95 - 12/96	Project Sponsor

Section 6: Monitoring Plan

A. Purpose

1. The purpose of the monitoring plan is to obtain site specific data that will ultimately determine what sources can be remedied and those that cannot, or are background. In doing so, characterizing the background or natural sources will aid in determining a realistic, obtainable, water quality goal for Lake Volney.

The monitoring plan presents a direct, concerted strategy that is both proven and effective. The plan will allow the Resource Committee to arrive at their objectives in a timely manner (apx. 1 year), and will intimately involve the local residents, contributing sponsors, and, most importantly, those landowners whose practices may be contributing to the water quality problem in both the effort and ultimate solution. The plan will provide the information and education to the area citizens and volunteers by involving them in the sample and data collection process; a hands-on apprenticeship that will "drive home" the relationship between watershed land use and downstream lake water quality conditions.

The monitoring program is streamlined to include only the collection of data that is pertinent to the design of remedial actions. It is truly a diagnostic effort that can be readily distinguished from a purely academic investigation in that the effort begins with the findings of the academic literature and utilizes the information in diagnosing the problem much as a doctor uses the knowledge of the medical field to treat individual patients.

B. Summary of Previous Studies

A description of the Lake Volney Watershed, known problems, and a review of water quality information are provided in Section 1 of the work plan. The current information on water quality is insufficient for developing an implementation plan to address non-point source pollution and all known studies fail to identify sources of pollution.

C. Monitoring Site Selection and Description

To accomplish the goals of this project, a monitoring a network will be established. This network includes 1 lake site, 6 major tributary stations, 1 lake outlet and a number of low priority sites which will be sampled on a 'grab' basis. Four sites will be automated (computers, flumes, storm event samplers) with equipment used in previous studies (German-Jefferson and Lake Washington CWP's), in addition to county equipment, in a very cost effective manner. The above sites were selected based on relative water volumes passing each site and the suspected nutrient/sediment loadings determined from the initial watershed review. The description , sampling frequency, and analytes to be measured at the proposed sampling sites are listed in Tables 3-5.

D. In-Lake Water Quality Monitoring

To characterize the in-lake conditions, one primary site will be monitored (see Figure 1). The lake site will be monitored from May 1995 to September 1995. The frequency of sampling and the parameters that will be measured are described in Tables 4 and 5. Secchi disk transparency , temperature, and dissolved oxygen will be directly measured at the time of sampling. The vertical distribution of nutrients will be characterized by grabbing samples at the 3, 6, 10, and 16 meter depths using a Doppler Brass Muffalator, Type II. Samples will be collected by area volunteers under the training and supervision of the project consultant and project sponsor.

E. Stream and Lake Out-Flow Monitoring

Stream flows will be monitored from March (snow melt) through September 1995. The sampling frequencies and analytes to be quantified are shown in Tables 4 and 5. Stage-discharge relationships will be developed for all stations both high and low priority. High priority stations, with the exception of the lake outflow (lake outflows represent steady flow regimes in which automated recording is not necessary), will be equipped with Campbell CR10 computers, ISCO storm-event samplers, stilling wells with floats and potentiometers, and a Parshall flume will be installed at one of these stations. The potentiometers will be connected to the floats via a steel tape and provide an analog signal that increases and decreases voltage corresponding to the rise and fall of the stream water level. The calibrated signal is then read by the computer on a continuous 15 minute basis, converted to a discharge (cfs) using the stream rating equation, and stored for later retrieval. The computer will also compare the flow measurement to flows during the previous hour, and if the flows have substantially increased , signal the storm event sampler to initiate a flow based sampling composite sequence (grab sampling will be gathered on a scheduled basis, see Table 4). This algorithm will provide representative samples of both dynamic and quiescent flow regimes that are required for the accurate estimation of mass loadings from stream sites.

F. Water Sampling and Field Measurements

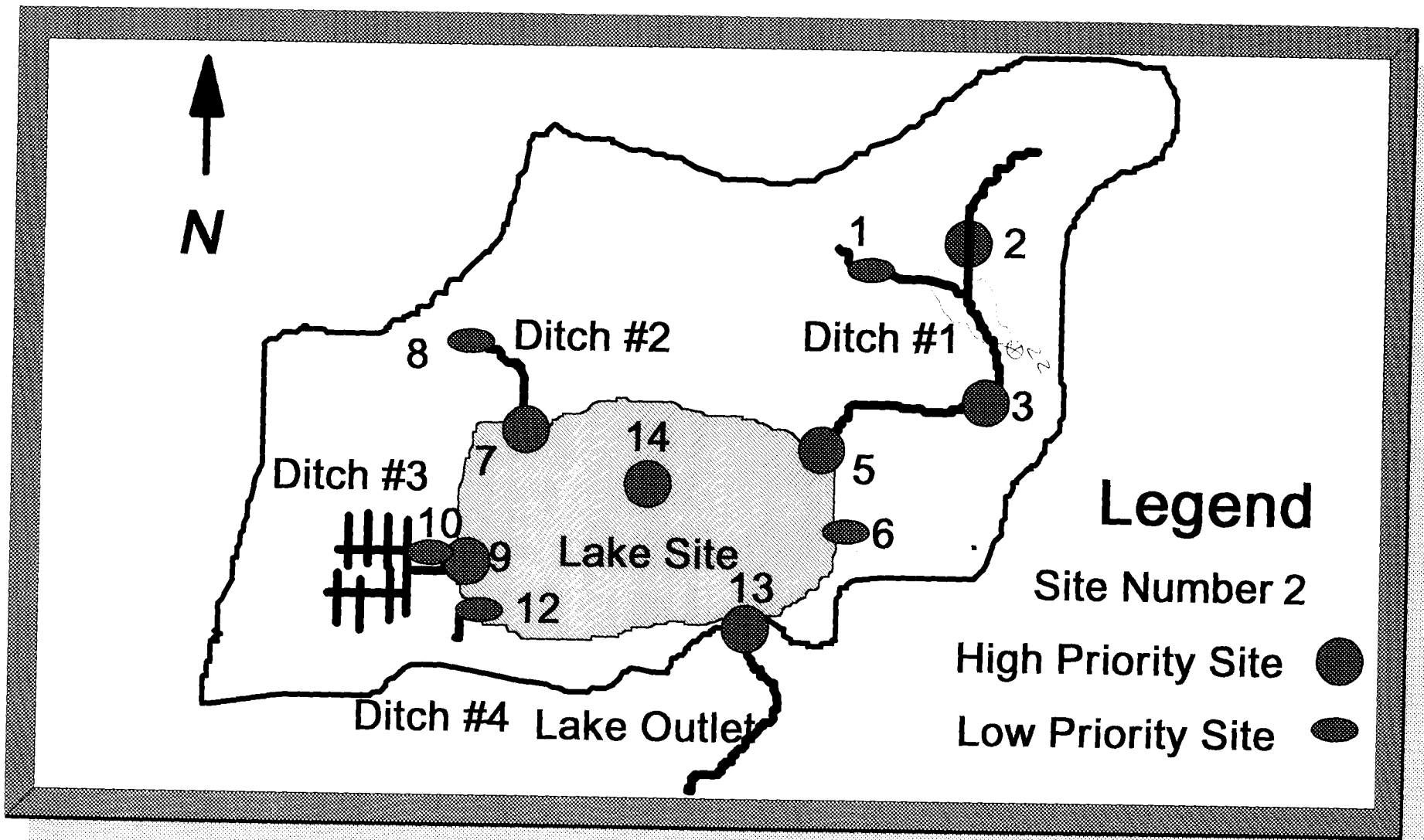
Lake in-flow and stream samples will be collected by ISCO samplers or by hand in pre-cleaned polyethylene/polypropylene bottles. All samples will be coded, placed on ice and immediately transferred to the laboratory. Samples requiring preservation will be preserved in the field and transported to the appropriate Mankato State University laboratory on ice. Field sampling protocols as well as equipment maintenance and calibration will be consistent with accepted published methods and written QA/QC guidelines.

G. Laboratory Chemical Analysis

All water quality chemical analyses will be performed by the Water Quality Laboratory at Mankato State University. All methods used will be according to Standard Methods for Analysis of Water and Wastewater, American Public Health Association (1985) or Methods for Chemical Analyses of Water and Wastes, U.S. Environmental Protection Agency (1983). A detailed

Figure 1

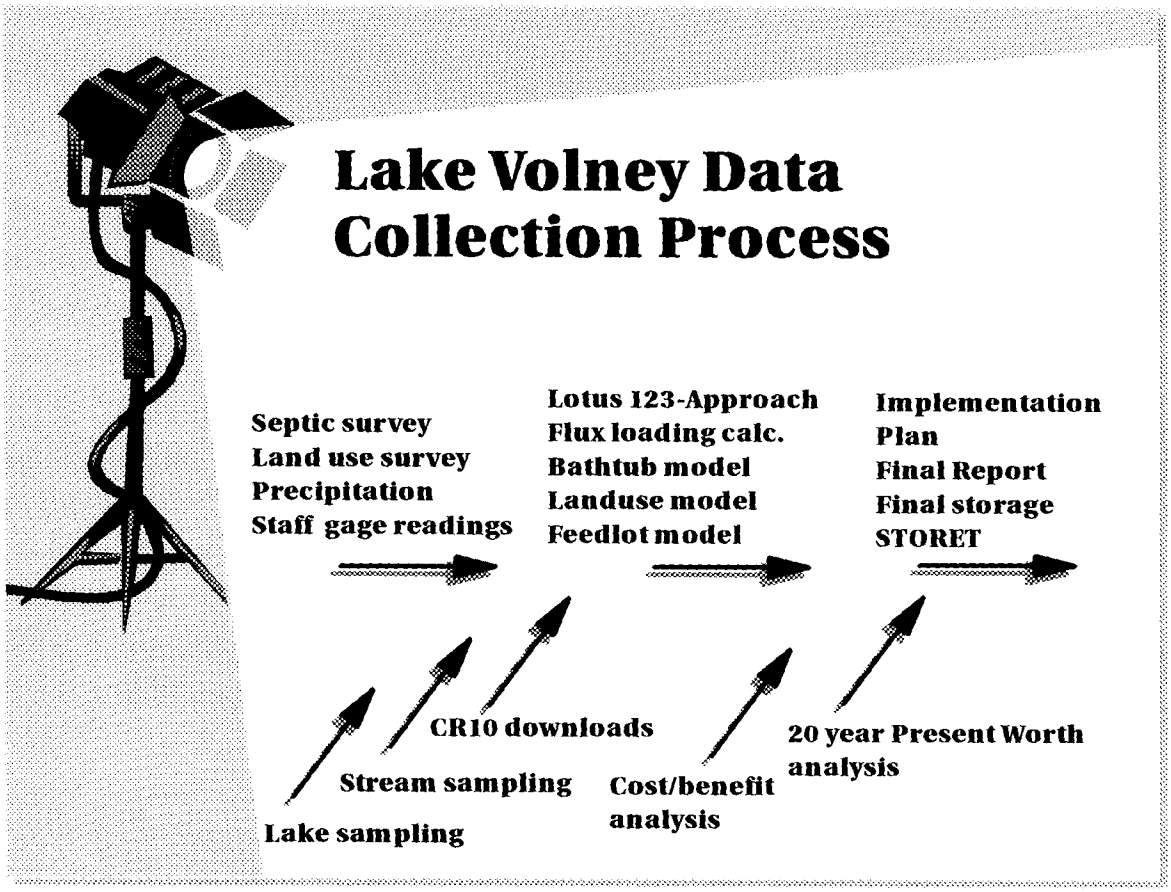
LAKE VOLNEY WATERSHED AND LAKE SAMPLING SITES



methods manual has been assembled and will be submitted with the final work plan. A quality assurance/quality control plan will also be submitted with the final work plan.

H. Data Management

Standardized data transmittal forms will be employed in the data collection process, including approved protocols consistent with sampling theory. These forms include observations of climatic and lake conditions, field data, and laboratory data. The completed data forms will be electronically transferred to computer files (Lotus 123 spreadsheet and Approach database). The flow of the entire data collection process is characterized in the diagram below: Accuracy, precision and completeness of data will be the responsibility of the project consultant. All statistical calculations will be accompanied by estimates of certainty.



I. Surface Sediment and Core Analysis

Dr. Daniel Engstrom from the Limnological Research Center, University of Minnesota, will collect 5 surface core samples (5cm depth) and 1 deep core (>1 meter), within the deeper portion of the lake bottom, to determine the availability of sediment bound phosphorus and potential for recycling within the lake. The samples will be collected during the ice period in late winter (time permitting) or early spring to ensure the results will be ready in time for inclusion in the final diagnostic and feasibility report. Estimates of refractile and non-refractile organics along with

carbonate and non-carbonate materials will accompany the labile/non-labile phosphorus determinations.

J. Fisheries Survey

A fisheries population survey will be conducted on the lake by the Minnesota Department of Natural Resources. Fish numbers, biomass, and species will be described.

K. Septic System Survey

The detailed Septic System Survey conducted in 1992 will be revised utilizing current Le Sueur County records to include any additional conforming systems installed since the original survey was conducted. Mass loadings of phosphorus to the lake due to septic input will be estimated utilizing the septic system survey which indicates the number of known conforming systems and modeled phosphorus loading due to nonconforming septic systems.

Section 7: Watershed Assessment Update

The Lake Volney watershed consists of 1906 acres in south central Minnesota. The watershed is in the North Central Hardwood Forest Ecoregion. Land use is consistent with the pattern typical for the southern part of the ecoregion as it fringes on the Western Corn Belts Plains ecoregion.

Land use information compiled in 1991 for the AGNEPS model will be updated to current land uses by county and SWCD staff members. All available land use, soils, wetlands, conservation tillage, and the MPCA ecoregion data will be collected and compiled. Maps and data bases developed by this process will provide a viable means to identify areas within the watershed for possible implementation actions based on inflow nutrient data. Land use information will be revised using procedures developed for the Minnesota River Assessment Project (MRAP) Level I. A Level I study involves determining an ecoregion nonpoint source pollution potential for each minor watershed utilizing State Planning Agency's Land Management Information Center (LMIC) data. Ecoregions are classified by percent area of land use, water orientation, soil texture and hydrologic groups, and slope parameters. These different parameters are used to calculate nonpoint source pollution potentials for each minor watershed.

Section 8: Itemized Work Plan Budget

The itemized work plan budget is presented, in detail, on the following 11 pages.

ITEMIZED PROGRAM BUDGET

Lake Volney Improvement Project

PROGRAM ELEMENT 1-Work and Monitoring Plan Development/Revisions

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr-LeSueur Co.	$30.00	100	$3,000.00		$3,000.00
Assistant	$15.00	200	$3,000.00		$3,000.00
Supplies, office			$60.00		$60.00
Travel	$0.30	150	$45.00		$45.00
Subtotal-Project Sponsors			$6,105.00	$0.00	$6,105.00
b) Lake Association	$15.00	80	$1,200.00	$0.00	$1,200.00
c) Consultant	$50.00	80	$0.00	$4,000.00	$4,000.00
TOTAL PROGRAM ELEMENT 1			$7,305.00	$4,000.00	$11,305.00

PROGRAM ELEMENT 2-Water Quality Monitoring

Task 2.1-Lake Monitoring

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsor	$30.00	60	$1,800.00	$0.00	$1,800.00
Assistant	$15.00	100	$1,500.00		$1,500.00
Travel	$0.30	350	$105.00		$105.00
b) Lake Association	$15.00	280	$4,200.00	$0.00	$4,200.00
c) Consultant	$50.00	40		$2,000.00	$2,000.00
TOTAL TASK 2.1			$7,605.00	$2,000.00	$9,605.00

Task 2.2-Watershed Monitoring

Cost Category	Unit Cost	Quantity	In-Kind	Cash	Total
a) Project Sponsor	$30.00	80	$2,400.00	$0.00	$2,400.00
Assistant	$15.00	100	$1,500.00		$1,500.00
Travel	$0.30	450	$135.00		$135.00
b) Lake Association	$15.00	10	$150.00		$150.00
c) Consultant	$50.00	160		$8,000.00	$8,000.00
d) DNR-Waters					
Hydrologist	$25.00	20	$500.00		$500.00
Supplies			$100.00		$100.00
Travel	$0.28	96	$26.88		$26.88
e) DNR-Fisheries					
Field Biologist	$25.00	60	$1,500.00		$1,500.00
Supplies			$100.00		$100.00
Travel	$0.28	100	$28.00		$28.00
Subtotal DNR			$2,254.88		$2,254.88
TOTAL TASK 2.2			$4,804.88	$8,000.00	$12,804.88
TOTAL TASK 2.3 - Laboratory Analysis (see Table 3)				$16,108.00	$16,108.00
TOTAL TASK 2			$12,409.88	$26,108.00	$38,517.88

PROGRAM ELEMENT 3-Watershed Assessment

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr.-LeSueur Co	$30.00	60	$1,800.00		$1,800.00
Assistant	$15.00	100	$1,500.00		$1,500.00
Supplies			$100.00		$100.00
Travel	$0.30	60	$18.00		$18.00
Subtotal Sponsors			$3,418.00		$3,418.00
b) SWCD					
Field Specialist	$25.00	40	$1,000.00		$1,000.00
Supplies			$120.00		$120.00
Subtotal SWCD			$1,120.00		$1,120.00
Map Generation				$500.00	
c) Consultant	50	50	$0.00	$2,500.00	$2,500.00
TOTAL PROGRAM ELEMENT 3			$4,538.00	$3,000.00	$7,038.00

Program Element 3: Watershed Assessment

Land use information compiled in 1991 for the AGNEPS model will be updated to current land uses by county and SWCD staff members. All available land use, soils, wetlands, and the MPCA ecoregion data will be collected and compiled. Maps and data bases developed by this process will provide a viable means to identify areas within the watershed for possible implementation actions based on inflow nutrient data.

PROGRAM ELEMENT 4-Sedimentigraphy

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Lake Association					
Volunteer	$15.00	16	**$240.00**		**$240.00**
Boat Supplies			**$65.00**		**$65.00**
Subtotal-Lake Assoc.			**$305.00**		**$305.00**
b) Dr. Engstrom - LCR					
Collection & Coring				**$800.00**	**$800.00**
Lithology				**$1,000.00**	**$1,000.00**
Pb 210 Dating				**$1,400.00**	**$1,400.00**
Sediment Extraction				**$1,200.00**	**$1,200.00**
Chemical Analysis				**$1,100.00**	**$1,100.00**
Synthesis & Report				**$2,500.00**	**$2,500.00**
Subtotal-Sedimentologist			**$0.00**	**$8,000.00**	**$8,000.00**
c) Consultant	$50.00	12		**$600.00**	**$600.00**

TOTAL PROGRAM ELEMENT 4	**$305.00**	**$8,600.00**	**$8,305.00**

Task 5 - Staff Gage Reading and Precipitation Monitoring

	Cost Category	Unit Cost	Quantity	In-Kind	Cash	Total
a)	Lake Association	$15.00	280	$4,200.00	$0.00	$4,200.00
b)	Consultant	$50.00	10		$500.00	$500.00
TOTAL TASK 5				$4,200.00	$500.00	$4,700.00

PROGRAM ELEMENT 6-Update Septic Survey

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr-LeSueur Co.	$30.00	10	**$300.00**		**$300.00**
Assistant	$15.00	20	**$300.00**		**$300.00**
Subtotal-Project Sponsors			**$600.00**		**$600.00**
b) Community Health					
Representative	$20.00	10	**$200.00**		**$200.00**
Subtotal Community Health			**$200.00**		**$200.00**
c) Lake Association					
Volunteers	$15.00	25	**$375.00**		**$375.00**
Supplies			**$400.00**		**$400.00**
Subtotal Lake Assoc.			**$775.00**		**$775.00**
TOTAL ELEMENT 6			$1,575.00	$0.00	$1,575.00

PROGRAM ELEMENT 7-Data Analysis and Report

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr.-LeSueur Co.	$30.00	100	$3,000.00		$3,000.00
Assistant	$15.00	100	$1,500.00		$1,500.00
Subtotal Sponsors			$4,500.00	$0.00	$4,500.00
b) DNR					
Field Biologist	$25.00	20	$400.00	$0.00	$500.00
c) Consultant	$50.00	200	$0.00	$10,000.00	$10,000.00
TOTAL ELEMENT 7			$4,900.00	$10,000.00	$15,000.00

PROGRAM ELEMENT 8-Information and Education Plan

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr.-LeSueur Co.	$30.00	20	$600.00		$600.00
Assistant	$15.00	20	$300.00		$300.00
Office Supplies/Printing			$35.00		$35.00
Subtotal Sponsors			$935.00		$935.00
b) Extension Service					
Representative	$20.00	50	$1,000.00		$1,000.00
Supplies			$45.00		$45.00
Printing			$120.00		$120.00
Subtotal Extension Service			$1,165.00		$1,165.00
c) Lake Association					
Representative	$15.00	280	$4,200.00		$4,200.00
Supplies			$460.00		$460.00
Subtotal Association			$4,660.00		$4,660.00
d) Consultant	$50.00	0	$0.00		$0.00
TOTAL ELEMENT 8			$6,760.00	$0.00	$6,760.00

PROGRAM ELEMENT 9-Implementation Plan Development

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr.-LeSueur Co.	$30.00	75	$2,250.00		$2,250.00
Assistant	$15.00	120	$1,800.00		$1,800.00
Travel	$0.30	120	$36.00		$36.00
Subtotal Sponsors			$4,086.00		$4,086.00
b) Lake Association					
Representative	$15.00	160	$2,400.00		$2,400.00
c) SWCD					
Representative	$25.00	20	$500.00		$500.00
d) DNR					
Biologist	$25.00	36	$900.00		$900.00
Mileage	$0.28	200	$56.00		$56.00
Subtotal DNR			$956.00		$956.00
e) Consultant	$50.00	50	$0.00	$2,500.00	$2,500.00
TOTAL ELEMENT 9			$7,942.00	$2,500.00	$10,442.00

PROGRAM ELEMENT 10-Administration

Cost Category	Unit Cost	Quantity	Subtotals In-Kind	Cash	Total
a) Project Sponsors					
Project Mgr.-LeSueur Co	$30.00	300	**$9,000.00**		**$9,000.00**
Assistant	$15.00	200	**$3,000.00**		**$3,000.00**
Travel	$0.30	80	**$24.00**		**$24.00**
Subtotal Sponsor			**$12,024.00**		**$12,024.00**

TOTAL ELEMENT 10			**$12,024.00**		**$12,024.00**

Part IV - Project Budget

PROJECT BUDGET SUMMARY

	INKIND	CASH	TOTAL
Program Element 1: Workplan	$7,305.00	$4,000.00	$11,305.00
Program Element 2: Monitoring	$12,409.88	$26,108.00	$38,517.88
Program Element 3: Watershed Assessment	$4,538.00	$3,000.00	$7,038.00
Program Element 4: Sedimentigraphy	$305.00	$8,600.00	$8,305.00
Program Element 5: Staff Gage Monitoring	$4,200.00	$500.00	$4,700.00
Program Element 6: Septic Survey	$1,575.00	$0.00	$1,575.00
Program Element 7: Data Analysis	$4,900.00	$10,000.00	$15,000.00
Program Element 8: Information & Education	$6,760.00	$0.00	$15,000.00
Program Element 9: Implementation Plan	$7,942.00	$2,500.00	$10,442.00
Program Element 10: Administration	$12,024.00	$0.00	$12,024.00
Program Total	**$61,958.88**	**$54,708.00**	**$123,906.88**

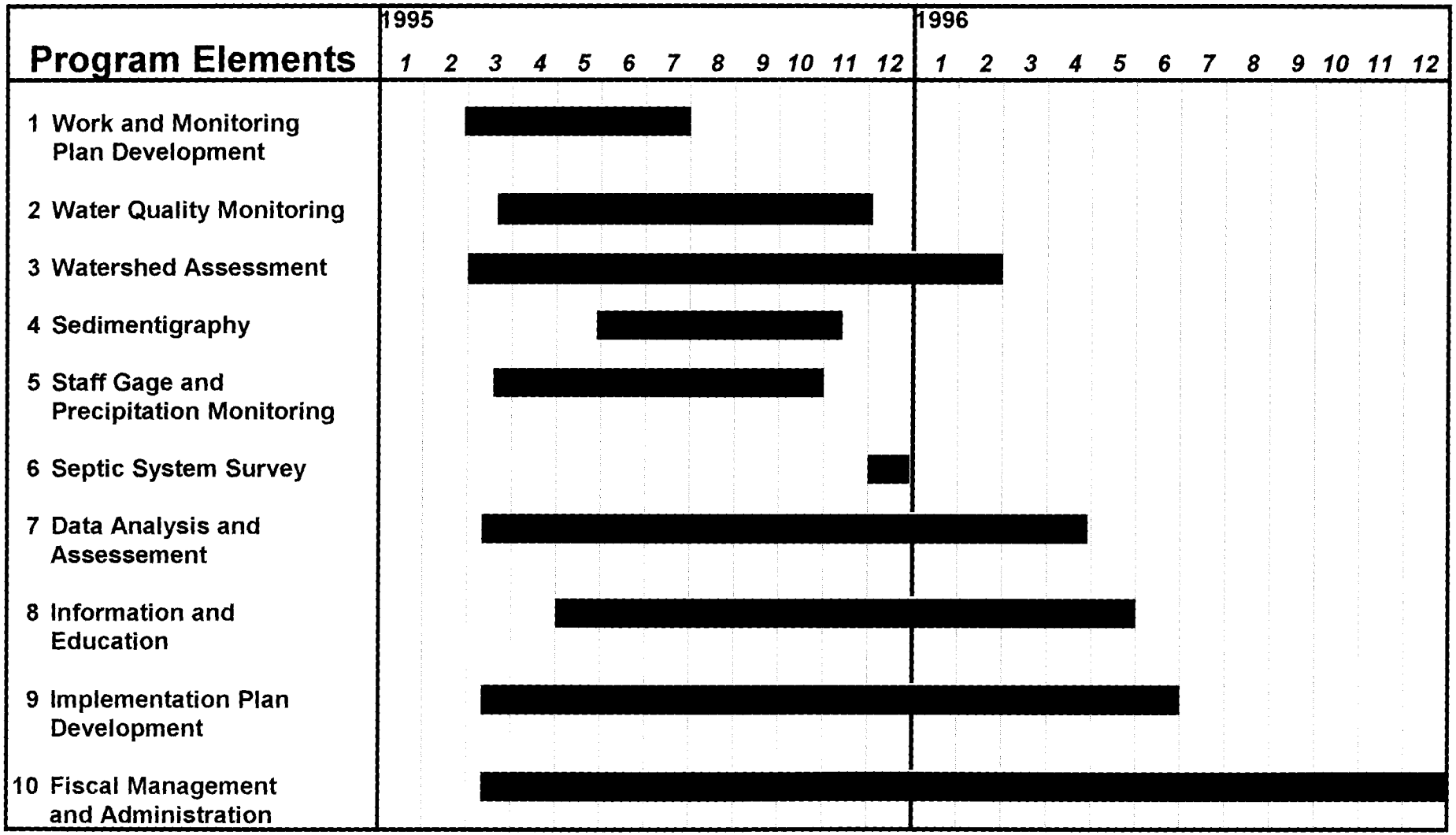
Project Sponsors

	INKIND	CASH	TOTAL
Project Sponsor LeSueur County	$35,868.00	$0.00	$35,868.00
Lake Association	$17,890.00	$2,500.00	$20,390.00
DNR	$3,610.88	$0.00	$3,610.88
SWCD	$1,620.00	$0.00	$1,620.00
Extension Service	$1,165.00	$0.00	$1,165.00
Community Health	$200.00	$0.00	$200.00
Issac Walton League	$0.00	$0.00	$0.00
Sportsmans Club	$0.00	$2,500.00	$2,500.00
Total Sponsorship	**$60,353.88**	**$5,000.00**	**$62,853.88**

Cash Outlays

	CASH	TOTAL
Project Consultant	**$30,100.00**	**$30,100.00**
MSU Laboratory	**$16,108.00**	**$16,108.00**
Sedimentologist	**$8,000.00**	**$8,000.00**
LeSueur County SWCD	**$0.00**	**$0.00**
Watershed Map Generation	**$500.00**	**$500.00**
Total Sponsorship	**$54,708.00**	**$54,708.00**

Figure 2


Program Elements
1995
1996
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
1 Work and Monitoring Plan Development
2 Water Quality Monitoring
3 Watershed Assessment
4 Sedimentigraphy
5 Staff Gage and Precipitation Monitoring
6 Septic System Survey
7 Data Analysis and Assessement
8 Information and Education
9 Implementation Plan Development
10 Fiscal Management and Administration

SECTION 9: STATEMENT OF QUALITY ASSURANCE

Quality assurance begins with a plan model based on a thorough understanding of project goals and the measurement process. The entire flow of information from the sample collection to an accurate understanding of the water quality conditions, should be carefully planned and documented with consideration given to final goal achievement (Berger & Hart, 1986).

Data handling

Protocols for data handling and reporting must be included in a quality assurance program to gain an accurate understanding of water quality conditions (Porter et al.,1988).

The complex nature of the information flow from the Lake Shaokatan watershed has prompted the creation of a well defined data handling program. The data needs of the watershed project are large and several agencies are involved. Sources of data include chemical data from Mankato State University Laboratories, quality control samples, hydrologic data, climate data, field data and topographic data.

Lotus 123 is used for data storage, retrieval, and reduction. Programmable field data loggers (Campbell CR10) are used to collect stream discharge data and control storm event samplers (Isco 2900). The word processing package Word Perfect, is used to generate reports and documents. Several spreadsheet templates, macros, translating programs and report procedures were also developed to reduce, transfer and report the data.

The software programs used to handle the workload can cause havoc when used improperly. A file can be deleted or easily altered with little or no warning. For these reasons data entered by keyboard is printed, edited and dated on the same day. Two floppy disk backups are dedicated to each subdirectory, or file if large enough, and files are copied only when file changes are made. An offsite backup of the entire hard disk is made weekly. All sampling sites will be identified according to STORET requirements and the data will be transferred to STORET automatically using a Lotus template. Copies of the STORET output will be carefully edited for accuracy.

Sample Handling

Uncertainty is introduced in each step of a data collection process and the entire process should be clearly understood if error reduction methods are to be employed. Each step must be carefully documented to ensure the reproducibility between sampling rounds and minimization of systematic error as much as possible. Complete detailed sampling instructions and training are provided to avoid contamination, sample mix up and improper treatment. The

current sampling design including locations, and frequencies is included in the appendix.

Disposable sampling bottles are used for all sampling in an effort to reduce systematic error, with the exception of the automated storm event bottles which are cleaned and rinsed after every use, Samplers and sample hoses are rinsed with sample water prior to individual samples taken. All samples are promptly removed from sunlight and kept cool during transport with any preservatives added to specially labeled bottles prior to sampling. Three bottles types are used: 1) white label, unpreserved; 2) yellow label, sulfuric acid preserved (2 mL); 3) red label, nitric acid preserved (2 mL). The nitric acid preserved bottles are for metal analysis, the sulfuric acid preserved bottles are for total nitrogen and total phosphorus analyses, and the remainder of the analytes are analyzed on the unpreserved samples.

LAKE VOLNEY HYDROLOGY METHODS

Procedure

The stream ratings were developed by mathematical relationships between water levels (gage) and discharge measurements (see Figure 1. Appendix) and are dependent on stable control structures (Parshall flumes, V-notched weirs, circular culverts, and box culverts). The weirs were fashioned by the Le Sueur County workers and set into place fortified with sandbags and metal stakes for stability. All control structures were equipped with staff gages and tied into known bench marks using standard leveling techniques.

Stream height vs discharge ratings were developed by stream measurement methods using current meters and dye dilution. Ratings are derived from log-log regression analysis using stream measurements from each site. The measurements are made using Marsh - McBirney current meter depending on the magnitude of the flow. Duplicate measurements must agree within 5% and "outlier" data are not used in the rating estimates.

Shifts in levels of either the weir and/or the gaging apparatus (stilling well, staff gage) are detected and determined by annual site leveling procedures. Shifts occurring during the water season are detected by current measurements and are identified as deviations from the established rating. A measurement deviating more than 5% from the rating indicates a departure from the defined stage/flow relationship at the control structure (weir/culvert). Corrective actions include site leveling followed by rating adjustments, and/or examination of the control structure for possible leaks.

The stream measurements are entered into a Lotus spreadsheet (Discharge.wk1, Figure 2. Appendix) and resulting discharges with their corresponding gage readings are saved automatically into site specific ASCII files. These files are individually imported into a macro menu driven sheet (Regress.wk1, Figure 3. Appendix) where log-log regression analysis and subsequent stream ratings are produced automatically. Dye dilution results are evaluated using methods as described by USGS[1].

The stream rating equations are entered into their prospective field datalogger programs and composite sheets (Composite.wk1, Figure 4. Appendix) to compute and store discharges every fifteen minutes and determine compositing volumes, respectively. Automated sampling sequences are initiated by the dataloggers based on a positive change in stream height of 0.05 ft or more within one hour. Once the sampling sequence is initiated, 24 samples will be taken regardless ensuing rainfall or flow condition. In concerning when to initiate an event sampling sequence, two possible errors are possible: 1) sampling a non-occurring storm and 2) not sampling an occurring storm. The above methodology reduces the possibility of the latter, more serious, error.

[1] Measurement of Discharge Using Tracers; Kilpatrick & Cobb, 1985.

Initial discrete event sampling (July, 1991) has shown that the nutrient concentration peak precedes the peak hydrograph in this watershed. Initial samples are favored for compositing insuring that the nutrient flush is represented. Samples are transported to MSU laboratory in a cooler with ice packs and composited into representative one liter samples for analysis. Copies of the datalogger programs and the stream ratings are provided at each hydrologic site to ensure correct operation and functioning. Annual mass loading estimates are derived from substance concentrations, corresponding flows and the average daily flows for the time period, using Flux (Walker 1984).

The non-point hydrologic data are downloaded on a monthly basis to the laboratory computer (PC 386). Each datalogger records and stores approximately 3,000 records of information per month and requires a detailed downloading procedure to insure the safety of the data. The data are initially transferred to a storage module (Campbell Scientific) which is read into the laboratory computer using the software package PC208 (Campbell Scientific). The ASCII files are stored in individual subdirectories (subdirectories of PC208 directory) named for each site (Figure 5. Appendix). The data are then translated into Lotus software and stored in subdirectories also named for each site. Each month the ASCII files in PC208 are replaced with the current data. Using this technique, Lotus translating programs automatically access the specific file for each site. The translated Lotus databases do not replace previous databases in each site directory, however, and are named instead for the current month, stored and merged annually.

When downloading the dataloggers, the task of editing thousands of records by hand is unreasonable. Graphs of the average daily discharge are produced automatically (Graph.wk1, Figure 6) and compared with rainfall records for anomalies. Lake system water balances (Balance.wk1, Figure 7. Appendix) are performed monthly with each download to estimate the total water balance error. The records of the download periods are kept in a separate ring binder. Standard operating procedures for maintenance, storm event, stream measurements, and data downloading are included in the Appendix.

Error in Stream Flow Measurement

Nearly all non-point watershed data are dependent on stream discharge estimates which are used, in conjunction with substance concentrations, to determine annual mass loadings from the local watershed. The multi-step procedure involved in determining discharges and resulting loading estimates illustrates the large number of possible error sources and their composite effect.

Estimating the variability of each step is difficult and certain assumptions have to made. Stream rating errors are calculated from the regression equations used, but the total error includes the error of the individual flow measurements used to make the rating. Variability in stream estimates are characterized by duplicate measurements, and the accuracy of the current meter is addressed

largely by factory recalibration on an biannual basis. For these reasons, much of the error must be assumed to be minimal and addressed largely by assurance documentation. Storm event samples are composited on a flow-weighted basis with site-specific bottle selection schemes that are based on initial hydrograph characterizations and are repeated with each storm. The sampling schemes are intended to represent the entire storm event. Any error associated with the sample bottle selection would be made on a consistent basis and would represent bias in the event load estimate. The magnitude of the bias would be proportional to the storm event frequency.

Errors in stream measurements, discharge rating regressions, loading calculation methods and analytical measurement can be characterized directly, but the additional components of the total error are more difficult to access. Variability in stream gaging apparatus (floats, potentiometer, etc.), sample collection apparatus, sample bottle selection, sample compositing and data handling, although minimized by a good quality assurance program, are difficult to evaluate.

Mass balance calculations on Lake Volney reflect the accuracy of the extensive monitoring efforts in the local watershed. The load estimate error of a given stream is only a component of the total lake system mass balance error, and includes error associated with lake level readings, lake volume estimates, rainfall measurements, evaporation models, and unmeasured quantities (groundwater inputs and ungaged runoff).

Components of the total error associated with different collection and measurement activities are thought to be independent of each other and equal in magnitude (Miah, 1988). Much of the error involved, if normally distributed, would cancel out and the limiting sum of these positive and negative variations would be their mean value. Any cumulative bias involved in the measurement process would become a component of the mass balance error.

REFERENCES

- Standard Methods for the Examination of Water and Wastewater,

17th Edition.

- Manual of Methods for Chemical Analysis of Water and Wastes, - Environmental Protection Agency, 1974.

- American Public Health Association (1975).

- Determination of Total Dissolved Nitrogen in Natural Waters. Limnol. Oceangr., 25 (4), 751-754.

- Modified Reagents for the Determination o Urea & Ammonia. Clinical Chemistry., 812: 130-132.

- Hewlett Packard 8451A Diode Array Spectrophotometer Operators Manual, 1985).

- Berger & Hart, 1986.

- Taylor, 1987.

- Taylor, 1986.

- Proter et. al. 1988.

- Osborn & Greenberg, 1989.

Project Organization

Le Sueur County
Local Project Sponsor

Terry L. Bovee
Le Sueur County
Zoning Administrator
Project Representative

Local Government

Planning and Zoning

- *On Site Septic System Evaluation*
- *Coordination*
- *Revision of Ordinances*
- *Watershed Assessment*
- Implementation Plan

Extension Service

- *Education fro Land Owners*
- *BMP's, Ag Land & Urban Land*

Soil & Water Conservation District

- *AGNPS Program*
- *ID Erodable Soils*
- *Watershed Assessment*
- *Inventory Soils*
- *Inventory Feedlots*

Community Health Service

- *Aid in On-site Septic System Evaluation*

Project Consultant

- *Hydrologic Investigation*
- *Lake Monitoring*
- *Loading Calculations*
- *Mass Balance*
- *Lake Modeling*
- *Implementation Plan*
- *Final Report*

Additional Sponsors

MN Department of Natural Resource

- *Fisheries Survey*
- *Assist in Watershed Assessment*
- *Implementation*

Montgomery Sportsman's Club

Issac Walton League

Lake Volney Association

- *Staff Gage Readings*
- *Precipitation Measurements*
- *Septic System Review*
- *Lake Sampling*
- *Implementation Plan*

Mankato State University Water Resources Center

- *Laboratory Analysis*
- *QA/QC*

Appendix A