SECTION 319
NON-POINT SOURCE POLLUTION
CONTROL PROGRAM

INFORMATION/EDUCATION/TRAINING/DEMONSTRATION PROJECT – SEGMENT II

FINAL REPORT

319 Information and Education Project

By

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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.

Grant # C-998185-07

EXECUTIVE SUMMARY

Project Title: 319 Information and Education Project - Segment II

Project Start Date: September 1, 2007 Project Completion Date: September 30, 2010

FUNDING

Total Budget	348,070.00
Total EPA Grant	200,000.00
Total Expenditure of EPA Funds	179,698.28
Total Section 319 Match Accrued	386,840.10
Budget Revisions	0.00
Total Expenditures	566,538.38

SUMMARY ACCOMPLISHMENTS

The 319 Information and Education Project successfully promoted and facilitated public understanding of watersheds and related management issues through the continued implementation of a comprehensive, coordinated statewide effort. The Project achieved 140% of its milestones. In doing so, the project funded 12 projects through mini-grants, established a volunteer monitoring program, supported 24 water festivals, reached over 200 educators, and engaged 130 citizens in World Water Monitoring Day with many more participating statewide.

Improved evaluation demonstrated that the project showed qualitative evidence of achieving its outcomes.

For every dollar of 319 funds spent, approximately $2.15 in cash and in kind was leveraged. More than 30 different organizations, local agencies and groups participated as a co-sponsor of the project.

The 319 Information and Education Project continues to be a valuable part of the strategy to protect watersheds. The partnership of federal, state, and non-profit organization leverages the strength of each to deliver a project that is effective and useful for the citizens of South Dakota.

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Introduction

The South Dakota 319 Information and Education Project is dedicated to informing and educating South Dakotans about non-point source pollution and watershed protection. This report will discuss the project's goals, outcomes and activities from October 1, 2007 through September 30, 2010.

The South Dakota 319 Information and Education Project (I&E Project) began in 2004. Previous to the project, watershed protection outreach and education were coordinated by the South Dakota Department of Environment and Natural Resources Water Resources Assistance Program. However, staffing limitations within the department in mid-2003 required a new method of delivering outreach and education. The South Dakota Department of Environment and Natural Resources partnered with the South Dakota Discovery Center, outsourcing much of the day to day delivery and oversight of outreach and education save for some watershed project coordinator training and web activities. This partnership is described more in depth in the *South Dakota Nonpoint Source Management Plan,* December 2007 (http://denr.sd.gov/dfta/wp/NPSMgmtPlan07.pdf)

The original information and education project that resulted from this partnership ran until September 30, 2007, reaching South Dakotans statewide with the message about watershed protection and preventing non-point source pollution. These topics are particularly important in South Dakota as non-point source pollution is a primary contributor to water pollution with sedimentation, algae and bacteria being the pollutants of concern. (South Dakota Department of Environment and Natural Resources, *2008 South Dakota Integrated Report*).

The first stage of the I&E Project met or exceeded almost all its milestones and objectives. Given the success of the original project and the benefits of continuing the project seamlessly, the I&E Project was continued for an additional three years. It is this continuation that is the subject of this report.

Like the original project, the second iteration was statewide in scope. The broad geographic focus was to ensure that all South Dakotans were being reached with the important message of watershed protection. Under the current structuring of 319 projects, South Dakotans who live in impaired watersheds where there is an active improvement project are reached with watershed specific information and education. That leaves a vast number of unreached and formerly reached citizens who are not receiving any information about watershed protection. Since watershed protection requires continual and repeated practices by a wide array of stakeholders, a statewide project was deemed necessary to support current, past and future watershed improvement projects.

The I&E Project used a variety of practices to reach different audiences. The adult audience was reached through a volunteer monitoring program, workshops, and outreach conducted at the local or regional level by groups availing themselves of mini-grant funds provided by the I&E Project. The youth audience was reached by training educators in various watershed education curricula, water festivals and youth and student outreach events.

2.0 PROJECT GOALS, OBJECTIVES AND ACTIVITIES

The goal of the South Dakota 319 Information and Education Project is to promote and facilitate public understanding of watersheds and related management issues through the continued implementation of a comprehensive, coordinated statewide effort that began during 2004.

The Information and Education Project had two broad objectives: information and education. For the purposes of this Project, information is used to refer to outreach that is fact based and is targeted towards adults and the broader community. Delivery methods can be broad - media, publications - or focused, as in a workshop. Information projects also refer to any activities that enhance this particular 319 Information and Education Project (see Task 1, Product 1).

Education projects are also fact based but include the development of critical thinking skills. Education projects are targeted towards students (pre-kindergarten through college) and youth. The delivery methods can be direct to students as happens at a Water Festival, or indirect as through the agency of a trained teacher or Scout leader.

Table one in section summarizes the products completed during the Information and Education Project in a milestone chart.

Objective 1: Support statewide, regional and local watershed information projects.

Task 1: Evaluate statewide I&E strategy and revise as necessary to best address current and future program needs.

Product 1: A revised I&E strategy that addresses current and future program needs. The 319 Non-Point Source Task Force Information and Education Subcommittee (Subcommittee) met in July 2009 to revise the vision statement and outcomes for the Information and Education project. This work is represented in the Project Implementation Plan (PIP) of the 2010-2013 Information and Education Project.

Task 2: Provide support for local, regional and statewide projects through a competitive mini-grant program.

Product 2: Local or regional watershed I&E projects supported by competitive mini-grants. The Subcommittee met semi-annually to review and award funds from the I&E program. The following projects were funded. The final reports from the projects are available at: http://www.sd-discovery.com/watershed_minigrant.shtm

Product 2.1. Animal Nutrient Management
Status: First phase completed August 31, 2010. To be continued under 2010 - 2013 319 I&E.
A key clean water issue for livestock producers in South Dakota is livestock manure entering water and causing bacterial and nutrient loading. Each year, approximately 50 livestock producers work with the Agricultural Nutrient Management Team (ANMT) from the Lower James Resource Conservation and Development Council in South Dakota to plan and implement livestock manure containment and field application methods to protect water quality.

Assistance has been provided to 97 producers through 9/1/2010. These producers have developed nutrient management plans for their livestock manure systems and applied manure according to their plan on 7,395 acres. Table 1 shows the milestones completed.

A request was made and granted to extend the project for three more years due to the high participation of producers. The extension will allow for a more robust fact sheet to be developed as it will be based on a larger data set as well as allow for more producers to be reached through outreach.

Item	**Progress 9/1/2010**	**Project Total Planned**
Total Producers assisted in completing Manure Sampling and assisted with Nutrient Management plan implementation utilizing ANMT assistance.	97 (161% of 2008/2009 Goal)	75
Number of Manure Samples submitted for Analysis from the 75 farms	161 (124% of 2008/2009 Goal)	150
Development of the Fact Sheet using data gathered from manure samples	Develop At End of Grant 2013	1
Outreach to livestock producers and service providers	3,150 (63% of 2008/2009 Goal)	5000

Table 1: Animal Nutrient Progress Chart.

Product 2.2. Basic Limnology
Status: Completed August 31, 2010
This project is sponsored by the Water Resources Institute at the South Dakota State University. The purpose of this project is to teach and train up to 180 adults about basic limnology concepts and provide tools for them to demonstrate limnology concepts and/or speak to small groups about lake water quality and watersheds. The presentation is designed so that after attending the workshop, attendees will be able to share what they have learned with a secondary audience.

Two basic limnology workshops are held each year, one at the NeSoDak Bible Camp on Enemy Swim Lake in NE South Dakota and one in the Black Hills.

The project completed the planned number of workshops to date. Thirty eight people were trained during 2009.

Figures 2 and 3. David German and Dennis Skadsen teach participants to collect macroinvertebrate samples.

Sampling equipment at Grace Coolidge Creek in the Black Hills.

Sampling in Sica Hollow in Roberts County.

Figures 4 and 5. Participants collected macroinvertebrates in Sica Hollow and stored them in coolers for later identification.

Roger Foote and Laura Hubers work together to collect macroinvertebrates in Sica Hollow.

Laura Hubers checks the cooler to verify macroinvertebrates.

Figure 1: Basic Limnology Field Session

Product 2.3. Dakota Water Watch Program
Status: Completed August 31, 2010.
The Dakota Water Watch Program is a volunteer monitoring program sponsored by the East Dakota Water Development District. Dakota Water Watch provides training and resources to residents and land owners in the East Dakota Water Development district which is most of the Big Sioux River watershed. Dakota Water Watch is also initiating the development of an online water quality database for volunteers throughout the state including youth and school based monitors.

Dakota Water Watch's monitoring program equips and trains volunteer monitors to sample water bodies. The program offers four levels of monitoring. Baseline monitoring consists of observing and recording physical parameters (temperature, water clarity, weather conditions, algal conditions, presence of wildlife, presence of aquatic nuisance species) of a water body at least once each month between April and October. In addition to recording objective physical measurements, monitors are asked to rank on a scale from strong positive to strong negative, how they felt water quality influenced the recreational use of the water.

Bacteria monitoring track involves the collection of a water sample for bacterial analysis in addition to observing and recording all of the same physical conditions as Baseline Monitoring. Because having each sample processed by the state health lab would be cost prohibitive considering the number of samples involved, mini-labs manned by volunteers were set up across the area covered by Dakota Water Watch.

Lake Index Monitoring is done at mid-lake locations and thus requires the volunteer to have access to a watercraft. Lake index monitoring involves a volunteer collecting and recording all of the same information covered by baseline monitoring. However, the volunteer also collects water samples that are then shipped to the State Health Lab in Pierre, SD for analysis. Due to the low probability of finding a significant amount of bacteria in the center of a lake, bacteria samples are not collected as part of this monitoring track. Parameters sampled for vary by lake, but nearly every lake involved is sampled for total phosphorus and chlorophyll-a. Additional parameters sampled for include: total suspended solids, total dissolved solids, total Kjehldahl nitrogen, nitrates, ammonia, alkalinity, and pH.

Table 2: Participation in Dakota Water Watch

	Volunteers	Monitoring Sites	Water Bodies
2008	48	82	18
2009	64	100	20
2010	51	99	30

The fourth monitoring track, "Other Monitoring", is offered for an individual or group with specific interests outside of the three main monitoring tracks. For example, one volunteer collected nutrient data on streams feeding and draining Lake Hendricks in order to monitor the impacts of recent conservation work that had been done within the watershed. The South Dakota Canoe and Kayak Association has participated in "snap-shot" sampling events where multiple watercraft sample many sites concurrently across a single lake to see what conditions were like on that lake on that specific day. Additional "Other Monitoring" options include monitoring invasive species, plant communities, wetlands, sediment depths, and water chemistry.

Table 2 shows the participation in Dakota Water Watch volunteer monitoring while Figure 2 shows the lakes monitored during 2009.

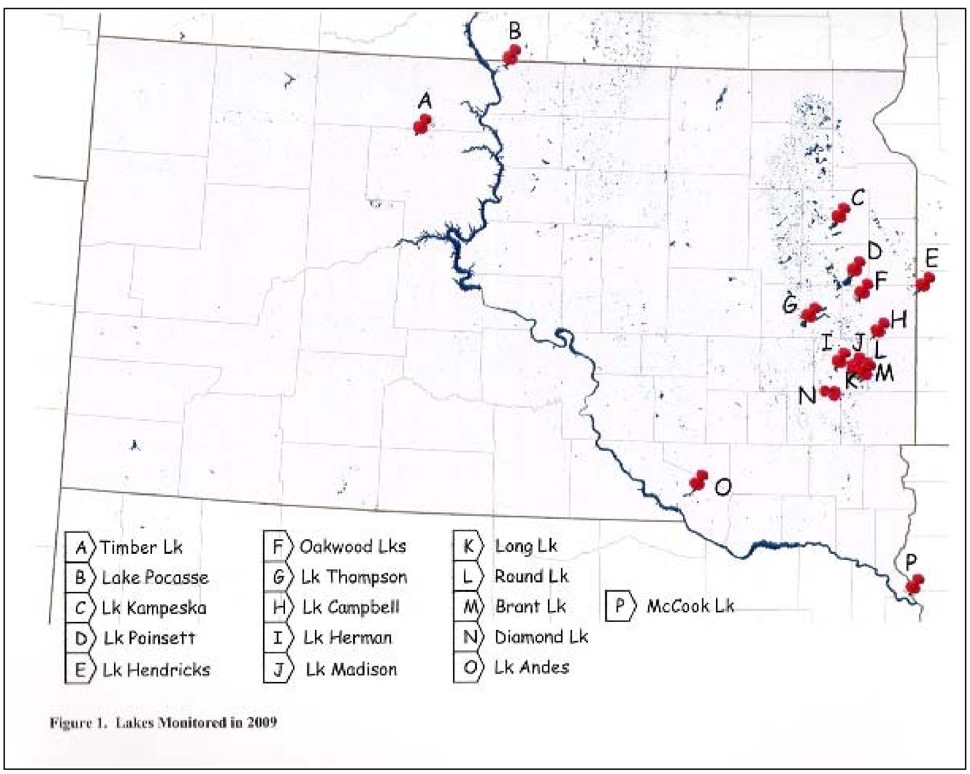

Figure 2: Lakes Monitored by Dakota Water Watch volunteers 2009

Product 2.4. Lake Cochrane Monitoring
Status: Completed August 1, 2010
The main component of the project sponsored by the Lake Cochrane Improvement Association is an extensive water monitoring program that began spring 2008. Over 150 samples have been taken. The data was compiled by the South Dakota Department of Environment and Natural Resources and reported in Water Quality Investigations Report (June 2010) for the Lake Cochrane Improvement Association.

The project was started in response to concerns about the hydrology of Lake Cochrane per the specifications of permit FC-23, established during 1997. The permit allowed adjacent Lake Oliver to flow into Lake Cochrane. Lake Cochrane is one of the higher quality lakes in South Dakota as it is spring fed and minimally impacted by watershed alterations. The concern was that Lake Oliver, which is regarded as a lesser quality lake, is negatively impacting Lake Cochrane.

The study states:

> The results of this investigative study conclude that Lake Oliver has not had a significant impact on Lake Cochrane water quality or ecology over the past 13 years. A host of management options are recommended to encourage future protection and enhance the beneficial uses of Lake Cochrane.

Product 2.5. McCook Lake Monitoring
Status: Completed
This project was sponsored by the McCook Lake Recreation Association. The goal of this project was to evaluate the water quality at McCook Lake, SD by visual observations and processing of water samples for *E. Coli* and total coliform bacteria collected by volunteer monitoring programs.

Volunteers monitored 13 sites on McCook Lake in partnership with Dakota Water Watch for bacteria contamination using the Coliscan Easygel method. Findings were consistent with other bacteria data collected by Dakota Water Watch in that E coli bacteria levels were low in lakes, higher in rivers but did not exceed levels recommended by the Environmental Protection Agency. The project will continue in partnership with Dakota Water Watch with local sponsors: McCook Lake Area Recreation Association, the Izaak Walton League, and the City of North Sioux City.

This project was conducted separately from Dakota Water Watch because McCook Lake is outside of East Dakota Water Development Districts (the Dakota Water Watch sponsor) service area.

Product 2.6-7.Pickerel Lake Tributary Monitoring and *Pickerel Lake Tributary Monitoring (Continuation)*
Status: Completed December 31, 2008 and August 1, 2010 respectively

The goal of these two projects was to determine if watershed sources of non-point source pollutants were contributing to the degradation of Pickerel Lake's water quality through tributary water quality sampling. Lake residents and resource agencies were concerned about recent declines in the lakes Trophic State Index and required additional data to determine the cause.

The Day County Conservation District in partnership with the Greater Pickerel Lake Association proposed a one year tributary water quality project to accomplish this goal.

The project was completed during December 2008 and was refunded until August 1, 2010 to allow for further investigation into the decline of the trophic state index of Lake Pickerel.

The data was compiled and will be presented in a report available on the Northeast Glacial Lakes Watershed Protection and Improvement Project website at:
http://www.neglwatersheds.org/waterqualityreports.html

Product 2.8. Soil Sampling

Status: Completed August 1, 2010

Livestock producers use manure management systems for containment of livestock manure, and proper field application of manure onto fields. As part of the manure management system, producers are required to have a nutrient management plan on all fields and acres which are slated for manure application.

Soil samples to identify soil nutrient levels on which to base manure application are needed prior to manure application on fields (usually every 2-3 years). Many producers in South Dakota, however, are not currently using soil sampling and testing to calculate manure application rates. In many cases, this leads to over application of nutrients, especially nitrogen and phosphorus, which can lead to potential groundwater or surface water degradation.

The purpose of this project was to train and equip five producers to use good soil sampling practices in order to properly manage manure applications.

Three producers were trained and equipped to conduct soil sampling, 14 producers were contacted. Excessively wet field conditions limited participation and sample collecting.

Product 2.9. South Dakota Watershed Boundary Dataset

Status: Completed August 1, 2010

The Hyde County Conservation District received a grant during July 2009 to work with the US Geologic Survey to make the South Dakota Watershed Boundary Dataset more accessible by loading it onto Google Earth. Before the development of this dataset, this information was available only on the NRCS website and map layers had to be downloaded via FTP or purchased on CD/DVD.

The Watershed Boundary Dataset was developed for Google Earth and is available at: http://sd.water.usgs.gov/projects/GoogleHuc/GoogleHUC.html. A press release was issued and picked up by media outlets. Figures 3 and 4 are snapshots of South Dakota's watershed boundaries that are now visible on Google Earth, thanks to the project.

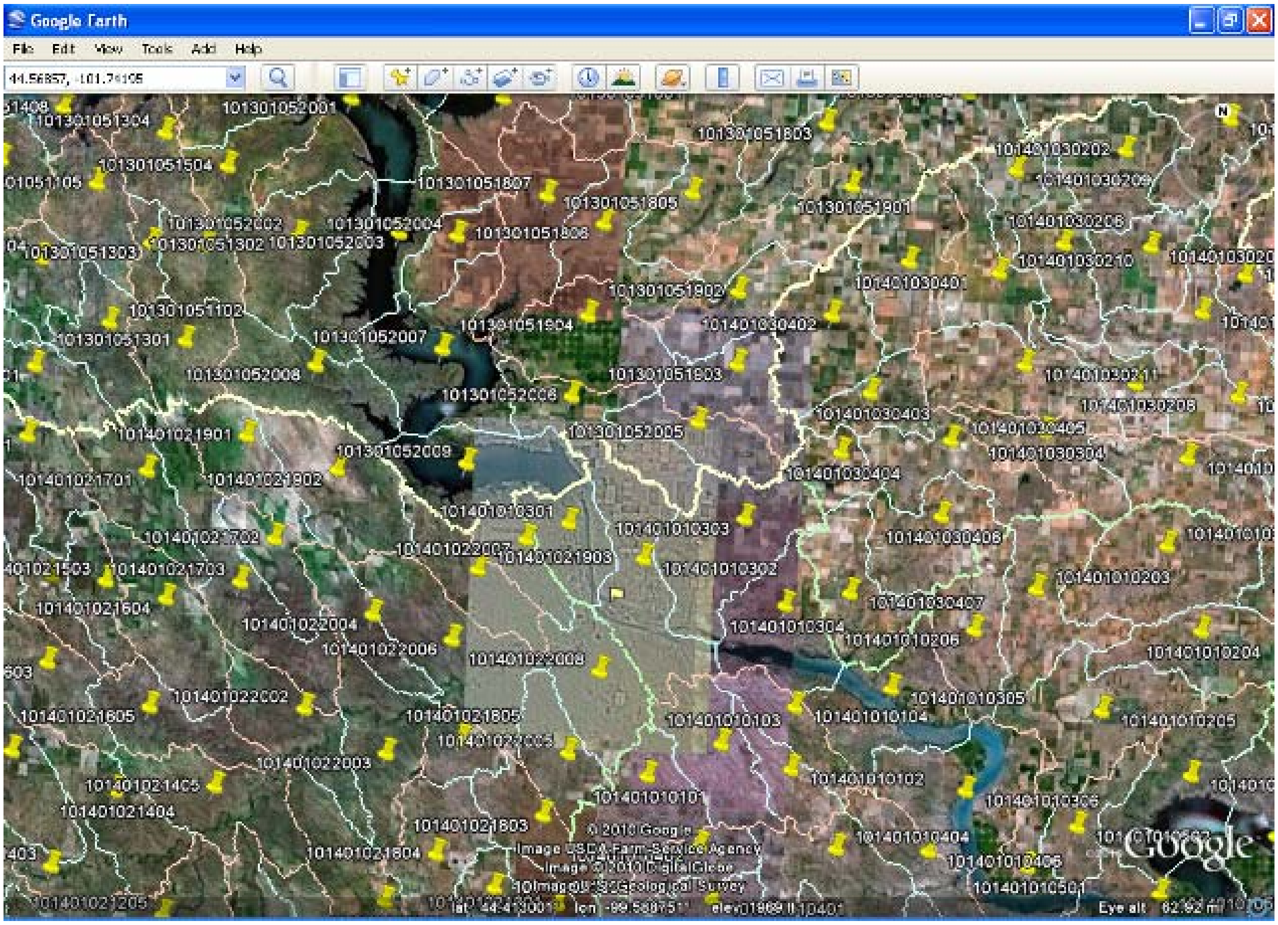

Figure 3: Watershed Boundary Dataset.

Figure 4: Watershed Data Boundary Dataset Drill Down.

Product 2.10. South Dakota Lakes & Streams SPLASH
Status: Completed December 31, 2008
The South Dakota Lakes and Streams Association published four newsletters *SPLASH* on watersheds and water quality issues and were sent to a mailing list of 120 people. The Association also maintained a website that receives about 300 hits per month. (www.sdlakesandstreams.com).

Figure 5 below shows the cover page of a newsletter published by the South Dakota Lakes and Streams Association.

SOUTH DAKOTA LAKES AND STREAMS

SPLASH

Volume 5 Quarterly Issue 5 Winter, 2008

PURSUING THE GOALS FOR THE NEW SDL&SA
A Special Issue on Progress Toward Achieving Our Goals

2008 SDL&SA ANNUAL MEETING: A Historic Event

The 15th annual meeting of SDL&SA was held at the Lakeview Resort on Lake Poinsett, September 19th. To those who took time out of their busy schedules to attend, we thank you for your continued support. For those who couldn't make it, you missed some very interesting and informative presentations and discussions. SDL&SA president **Jerry Myers**, presented **"The State of the Association"** with **"A New Beginning"** power point.

Deb Springman, Water Resource Biologist with EDWDD is temporary coordinator of Dakota Water Watch and new director of the Brookings Water Festival. Our plan is to link their website of real time data to our website.

Rick Smith, coordinator of the Lake Poinsett Watershed updated us on their activities since the 2007 SDL&SA annual meeting.

Roger Strom, Water Project Coordinator, EDWDD, presented a PPT on CAFO's and on the Big Sioux River Implementation phase.

Janie Wittmeier brought us up-to-date on the Lake Association data base she is collecting for our website.

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SPLASH CONTENTS INSIDE THIS ISSUE

Spring SPLASH due in March, 09 Watch for new website format in 2009

1

Figure13 5: Cover page of SPLASH

Product 2.11. World Water Monitoring Day Kits
Status: Completed August 1, 2010.
World Water Monitoring Day is an international effort, sponsored in part by the United States Environmental Protection Agency, to promote understanding of water quality and watersheds through water quality monitoring. To promote this monitoring event, the 319 Information and Education Committee authorized the purchase of World Water Monitoring Day kits with mini-grant funds by the South Dakota Discovery Center. The SD Discovery Center and Water Festival distributed kits to classroom teachers, out of school time staff, youth program leaders and concerned citizens

Figure 6: Family monitoring the Big Sioux River.

Over 130 students have been reported as participating in World Water Monitoring Day from the kits purchased. Data collected as a part of WWMD during 2009 shows over 300 participants monitored 19 sites. South Dakota was in the top 20 of the 50 states participating in World Water Monitoring Day. World Water Monitoring Day is a major thrust of the Youth and Student Outreach and will be discussed in depth in that section.

Product 2.12. Zero Phosphorous Online Campaign
Status: Completed August 1, 2010.
The South Dakota Lakes and Streams Association received a grant during January 2009 to upgrade its web site software in order to conduct a no/low-phosphorous lawn fertilizer campaign. The web site transition has been achieved and the project continues with updates to the website and newsletters about the importance of testing soiling and using low/no phosphorous fertilizer.

The website received over 4,100 hits since January 2010. The South Dakota Lakes and Streams Association has 22 lake association members which represents several hundred people as an audience for the Low/No Phosphorous outreach.

The South Dakota Lakes and Streams Association featured a No Phosphorous display at their annual meeting. Figure 7 shows the logo developed to promote no/low phosphorous.

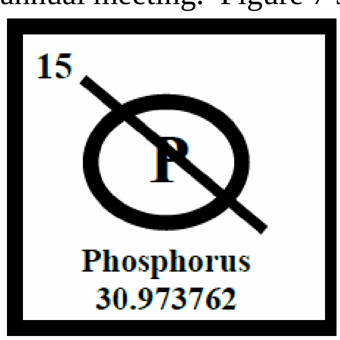


Figure 7: South Dakota Lakes & Streams Zero Phosphorous Logo.

Objective 2: Educate students and educators about watershed and non-point source issues.

Task 3: Support water education and water educator professional development activities that align with state educational initiatives and standards.

Product 3: Facilitator Training
Facilitator trainings function as train-the-trainer sessions. Part of delivering statewide training in water and watershed education to teachers, youth program staff and volunteers, and natural resource agency outreach staff is to have a network of facilitators equipped to conduct workshops in their locale and sphere of influence and/or act as an advocate for your trainings. Those who attend facilitator trainings have already been trained in the core curricula used by the 319 Information and Education Project, specifically Project WET (Water Education for Teachers) and the Leopold Education Project (LEP).

Figure 8: Instruction about how to teach the t-tube is a common facilitator training activity.

Facilitator trainings provide more content knowledge about water and watersheds as well as training in some of the ancillary skills such as leading a meeting. Facilitator trainings may also occur in the form of a mentored training where the I&E Coordinator works one on one with a new facilitator in setting up and conducting a training.

Of the three facilitator trainings that occurred during the project, two were large group trainings and one was a mentored training. There are seven active facilitators in South Dakota.

Figure 9: Educators learn an activity that expands instruction about the water cycle to include elements of the watershed.

Product 4: Educator Trainings
Educator trainings train and equip teachers, youth program staff and leaders and natural resource agency outreach staff to teach about water and watersheds using hands-on, inquiry based methods that support current trends and initiatives in education. The 319 Information and Education Project utilizes two national curricula: Project WET (Water Education for Teachers) and the Leopold Education Project (LEP) as the core of their training programs. These curricula have been classroom tested; use

high-quality, research based resources and methods; and their respective content supports the goals of the 319 Information and Education Project.

The workshops are delivered in diverse settings. Some are delivered over satellite network. Some are one day sessions. Others are multi-day sessions and include an overnight field component to allow educators time to practice and reflect on the activities. This flexibility allows us to reach a wide range of educators who have differing needs and goals for their personal professional development.

All workshops, except for those for the teachers of the youngest children, include a training session on incorporating World Water Monitoring Day into their classroom.

Sample workshop agendas are enclosed in Appendix A.

Product 5: Water Festivals

Water festivals are hands-on learning events about water. The traditional model for festivals features stations with an activity about some aspect of water. These festivals are targeted to 4th – 5th grade students. Students attend with their classes for a half or whole day, rotating from station to station approximately every half hour.

There are six active traditional festivals supported by the 319 Information and Education Project. These festivals are represented by the blue dotted markers in Figure 10. These festivals served approximately 14,100 students and teachers during 2008-2010.

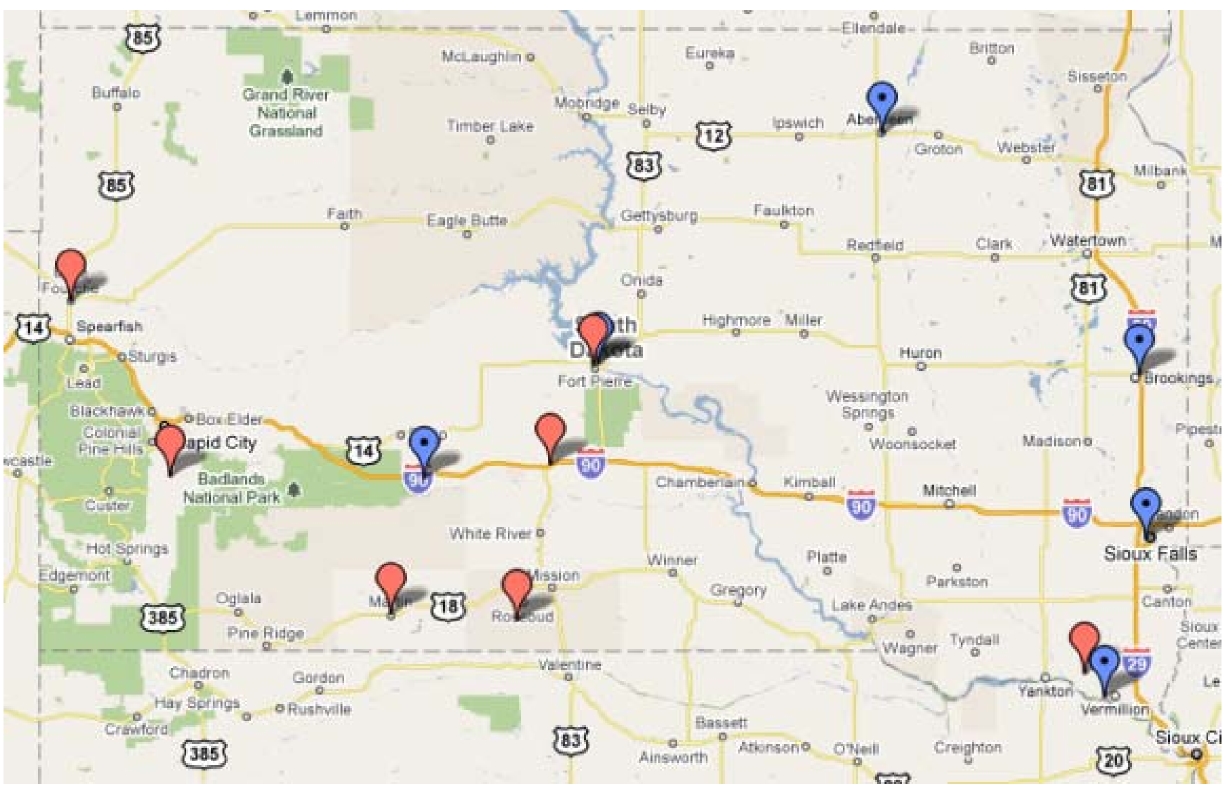


Figure 10: Map of Water Festivals.

In addition to the traditional festivals, the 319 Information and Education Project supported the pilot of a family water festival in partnership with the South Dakota Department of Education. This festival was developed to serve out of school/after school care sites which are supported by the 21st Century Learning Community Program of the US Department of Education. This program has a parent night component as well as requirements to promote math and science learning. The Family Water Festival was developed to help meet those program requirements for these sites. The 319 Information and Education Project took over the administration of the project after the initial development and pilot testing of the program.

The family water festivals are similar to traditional festivals in that both use the station format. However, children participate in the family water festival with their parents in lieu of their classmates. (Figure ~~12~~ 11). There are 13 stations grouped according to four themes: Water and People; Water, Plants and Animals; Water Health; and Water, Our Resource. Each station comes with a complete set of materials, set up instructions for the volunteer staffing that station, and instructional signage on how to do the activity. Non-food consumables for 100 participants are provided. The family water festival also provides each child with a journal to extend the learning of that station.

Figure 11: Family water festivals involve parents and students participating in stations together.

The red markers in Figure ~~11~~ 10 show where the family water festival has been. The family water festival has served over 700 adults and children.

Product 6: Youth and Student Outreach

Youth and student outreach utilizes methods other than Water Festivals to serve K-16 students with hands-on learning about water and watersheds. The most common method of serving youth and students was through World Water Monitoring Day Outreach. World Water Monitoring Day is an international outreach to involve people in monitoring a local water body and understanding their watershed. Participants in World Water Monitoring Day collect data on a water body's pH, clarity, dissolved oxygen, and temperature either using the World Water Monitoring Day kit or their own equipment. The 319 Information and Education Project provided 130 kits to serve over 470 students in various grades. Some locations used their own equipment. All results were reported in the

Figure 12: Students measure dissolved oxygen as part of World Water Monitoring Day outreach.

World Water Monitoring Database.
In addition to the World Water Monitoring Day outreach, youth and student projects consisted of the following:

- Participation in four Earth Day/ Environmental Education Week outreach.
- Two water themed programs at the public library,
- Supporting 30 public libraries statewide during the 2010 summer reading program when the theme was “Make a Splash: Read” by mailing out activity guides and curriculum.
- Two in house programs at the South Dakota Discovery Center for school groups.
- One booth targeted towards children at a community festival.
- Two school programs in partnership with the Day County Conservation District
- Support of South Dakota State University’s BioBlitz outreach.

In total, there were 30 discrete youth and student outreach events with over 1700 youth, students or youth program leaders participated.

Table three summarizes the products completed during the Information and Education Project in a milestone chart.

2.1 PLANNED AND ACTUAL MILESTONES, PRODUCTS, AND COMPLETION DATES.

Table 3: Planned and Actual Milestones.

Goal/Objective/Task	Quantity Planned/ Quantity Realized	Achieved: Year 1 Oct. 2007 – Sept. 2008 Months 1 - 3	Months 4 - 6	Months 7 - 9	Months 10 - 12	Year 2 Oct. 2008 – Sept. 2009 Months 1 - 3	Months 4 - 6	Months 7 - 9	Months 10 - 12	Year 3 Oct. 2009 – Sept. 2010 Months 1 - 3	Months 4 - 6	Months 7 - 9	Months 10 - 12
Objective 1: Support local, regional and statewide I&E projects													
Task 1: I&E Strategy Evaluation and Revision	1/1								1				
Task 2: Competitive mini-grants													
Product 2: Local or regional watershed I&E projects	15/12		3	1	3		3		2				
Objective 2: Educate students and educators about watershed and non-point source issues													
Task 3: Delivery of water education and water education trainings													
Product 3: Project WET Facilitator Network	5/3			1	1				1				
Product 4: Educator Trainings	24/25	1	3	3		3	3	2	1	4	1	2	2
Product 5: Water Festivals	12/26		1	4	4	1	3	5	3		2	1	3
Product 6: Youth/Student K-12	12/30		1	5	2	1	1	2	6			6	6

Explanation for Milestones Not Achieved

While most of the milestones were achieved as expected, two were not. The first of the two milestones involves Objective 1, Task 2, Product 2, local projects funded by mini-grants. It was anticipated that 15 local or regional projects would receive mini-grants but only 12 were funded. Projects that received mini-grant funding were selected by a subcommittee of the 319 Non-point Source Task Force which consists of organizations and agencies involved in some aspect of watershed protection and restoration. Subcommittee members decided to fund the regional volunteer monitoring project at a higher level since such a project would in turn help coordinate local volunteer monitoring efforts. So rather than funding a few smaller projects at a lower level, the Subcommittee decided to fund a larger project at a higher level which would engender and support its own smaller projects.

The second milestone that was not met as anticipated was Objective 2, Task 3, Product 3 facilitator meetings. Five meetings to support those delivering watershed education were planned, but only three were held. One meeting was not held because partner organizations (Project Learning Tree and Project WILD) opted to not participate. The cost was too prohibitive to hold a meeting just for those involved in delivering watershed education training.

A second smaller meeting was not held mainly due to logistics and scheduling. Interest was expressed by several parties in attending a WET only facilitator training but a convenient time and location for all parties was not found.

2.2 EVALUATION OF GOAL ACHIEVEMENT AND RELATIONSHIP TO THE STATE NPS MANAGEMENT PLAN

Goal Achievement

The goal of the South Dakota 319 Information and Education Project is to promote and facilitate public understanding of watersheds and related management issues through the continued implementation of a comprehensive, coordinated statewide effort that was begun in 2004.

Goal achievement can be measured both quantitatively and qualitatively. Quantitatively, the goal achievement is measured in the number of products successfully completed. Out of 69 anticipated products, 97 were achieved for a 140% success rate. The two products (mini-grants and facilitator workshops) that were not achieved at 100% had an achievement rate of 80% and 60% respectively.

Qualitatively, goal achievement is measured by how *well* the goal was achieved. This measurement is a little more difficult to capture. To help determine how well project activities promoted and facilitated public understanding of watersheds and related management issues (the goal), the 319 I&E Project identified desired short term outcomes expected from project activities. Each activity of the project was expected to achieve one of the following outcomes:

- Knowledge and awareness of local or statewide watershed issues and concerns related to watersheds and nonpoint source pollution.
- Knowledge and awareness of urban and innovative agriculture watershed protection activities.

- Participation in activity or activities that maintain, protect or restore watersheds.

This qualitative measurement is determined by evaluation and will be discussed more in depth in Section 3.0.

Relationship to the State NPS Management Plan
The mission of the South Dakota Non-Point Source Program is:

> *Protect or restore the chemical, physical, and biological integrity of the waters of the state by promoting locally sponsored projects where waters are threatened or impaired due to nonpoint sources of pollution.*

To achieve this mission, the South Dakota Non-Point Source Program has its goal:

> *Maintain a balanced program focused on the restoration and maintenance of the beneficial uses of the State's water resources impaired by nonpoint source pollution by developing and implementing workplans to attain the TMDLs for listed waterbodies.*

To achieve this goal and fulfill the mission, objectives were identified for seven program areas, one of which was information and education (I&E). Objective Five (5) in the Non-Point Source Management Plan is

> *Provide for an outreach program that conveys information and participation opportunities to targeted segments of the state's urban and rural populations.*

The South Dakota Department of Environment and Natural Resources (DENR) selected the South Dakota Discovery Center to facilitate aspects of that outreach. The Department of Environment and Natural Resources retained some elements of outreach such as training watershed coordinators and web outreach as well as requiring that each implementation project have an information and education component.

The 319 Information and Education Project coordinates with the State Non-Point Source Management Plan by conducting outreach to targeted audiences that are not reached by DENR or TMDL project outreach.

3.0 Long Term Results in Terms of Behavior Modification, Stream/Lake Quality, Groundwater, and/or Watershed Protection Changes.

The 319 Information and Education project contributed to water quality by developing the knowledge, skills and abilities of targeted groups of citizens to understand watershed protection and act upon that understanding. Development of these knowledge, skills and abilities is a multi-faceted process with various methods and intensity levels of outreach required.

True long term results are difficult to determine as the 319 Information and Education Project does not have the timeframe or the finances to support a longitudinal follow up of those reached by the project. Thus the project has identified immediate and intermediate outcomes which are expected to yield long term results. Immediate and intermediate outcomes are more easily measured than long term outcomes which need to be tracked over a period of years. The immediate and intermediate outcomes are discussed more in depth in Section 5.0.

A logic model is useful for seeing how immediate and intermediate outcomes relate to long term results. Table 4 is the logic model for the 319 Information and Education project. The model below shows the relationship of output/product to long term outcomes.

Table 4: 319 Information and Education Project Logic Model.

Output/ Product	Audience	Outcomes		
		Immediate	Intermediate	Long term
Projects conducted by local/regional stakeholder groups	Adult, community	Audience increases in knowledge of water quality and watershed protection issues.	As opportunities present themselves, those adults and community members participate in watershed protection practices	A large number of informed and active citizens positively impact water quality through good watershed management.
Educator workshops	K-16 students	Educators increase in the knowledge, skills and ability to integrate instruction about water and watersheds into their classrooms.	Educators utilize assets (knowledge, skills, abilities, resources) acquired during the workshop in their classrooms.	Youth and Students are educated and positively impact water quality by engaging in life long watershed protection.
Water Festivals	Grade 4-5 students	Students increase in knowledge about water, water quality and watersheds through hands-on experiences.	Students build upon the knowledge acquired at Water Festivals	Youth and Students positively impact water quality by engaging in life long watershed protection.
Youth and Student outreach	K-16.	Students increase in knowledge about water, water quality and watersheds through hands-on experiences including World Water Monitoring Day.	Students participate in watershed protection activities such as monitoring as part of the curriculum and youth programs.	Youth and Students positively impact water quality by engaging in life long watershed protection.

5.0 MONITORING RESULTS FOR DEMONSTRATION PROJECTS

This section will discuss the methods used to evaluate the 319 Information and Education Project. This section will also discuss the data collected by the three main monitoring projects funded by the 319 Information and Education Project.

Evaluation

In addition to reporting the quantitative results of the 319 Information and Education Project (Section 2.0), the project has attempted to capture qualitative results. Qualitative reporting is more time consuming and expensive than quantitative which is usually a matter of good record keeping. Never the less, there are some lower cost, less time intensive methods to capture qualitative impacts of a program and the staff of the 319 Information and Education Project has endeavored to use them.

While the qualitative reporting has been more robust than the first three years of the project there are still some gaps. Qualitative reporting relies heavily upon the willingness of program participants to accurately and completely provide feedback. This does not always happen, especially in longer term time frames. There is also a core body of evaluation knowledge that while not difficult does require more than "drive by" training to acquire. All project activity managers did not have this core body of knowledge since their area of expertise was elsewhere.

Despite these barriers, the 319 Information and Education Project overall was successful in getting qualitative feedback about many of its activities.

The projects goal is to promote and facilitate public understanding of watersheds and related management issues. To help determine if the goal is being met, three outcomes were identified.

- Knowledge and awareness of local or statewide watershed issues and concerns related to watersheds and nonpoint source pollution.
- Knowledge and awareness of urban and innovative agriculture watershed protection activities.
- Participation in activity or activities that maintain, protect or restore watersheds.

The outcomes can be grouped and simplified somewhat for the purposes of reporting. In essence, the measureable outcomes desired by the 319 Information and Education Project are 1) increased knowledge and/or 2) participation in watershed protection activities.

For some project activities, knowledge or participation in watershed protection was not able to be measured. In those instances, a third outcome – ongoing use of I&E assets - serves as the measure of effectiveness. The Water Festival and Youth and Student activities specifically are evaluated according to this measure as teachers and youth program leaders repeatedly use those assets that they find effective and worthwhile. Surveying students directly about increased knowledge or participation is difficult as best evaluation practices require any survey of minors to be vetted by an Institutional Review Board unless administered by the educator for the educator's or school's purposes.

Below are three tables summarizing the results from the evaluation of 319 Information and Education project activities. The tables each focus on one category of outcome: increased knowledge, participation, and ongoing use of I&E assets. All tables list the activity, the means used to evaluate the activity, and the result that demonstrates the outcome was achieved.

Table 5: Activities that contributed to increased knowledge.

Activity	Evaluated By:	Outcome: Increased Knowledge
Basic Limnology offered two – three day classes in basic limnology for adults. Attendees included lake association members, teachers and natural resource agency staff.	Pre/post test. Post-event open ended survey.	The pre/post tests show a significant increase in knowledge about macroinvertebrates and limnological concepts. Comments solicited from participants after the fact show that participants are using the knowledge and skills in their respective spheres.
Lake Cochrane Monitoring project re-assessed and reported the impact of allowing Lake Oliver drain into Lake Cochrane.	Interview with report author.	Residents have a higher degree of assurance that the quality of Lake Cochrane will be maintained.
Educator workshops	Post event survey	85% of educators (n=142) responding to an online survey within two weeks of a watershed education workshop self reported that they acquired knowledge, skills and abilities that they will use in their classrooms. See below for more educator workshop evaluation results.

Table 6: Activities that contributed to participation.

Activity	Evaluated By	Outcome: Participation
The Animal Nutrient Management project has assisted 97 producers with developing animal nutrient management plans.	Producers documented manure application in plans.	Manure applied to a collective 7,395 acres according to management plan.
Dakota Water Watch has developed a volunteer monitoring program in the state.	Data reports, feedback from volunteers.	Volunteers are monitoring 30 local water bodies, contributing to information and support of local watershed projects.
McCook Lake project monitored 13 sites for bacteria.	Data reports. Feedback from volunteers	The monitoring will continue supported by Dakota Water Watch. Outreach about residential storm water impacts is occurring.
Pickerel Lake Tributary Monitoring and Continuation Projects sampled the tributaries to better understand the trophic state of the lake.	Report from Greater Pickerel Lake Association members	Members of the Greater Pickerel Lake Association are continuing the monitoring as a volunteer led effort in partnership with Dakota Water Watch

Table 7: Activities that utilized I&E assets on an on-going basis.

Activity	Evaluated By:	Outcome: Ongoing Use of I&E Asset
Water Festivals	Reports from Festival coordinators	Participation at traditional water festivals has remained consistent over the years indicating that educators feel this is a worthwhile event for their students to attend.
Youth and Student	Data reports from World Water Monitoring Day; reports from those who requested kits.	As of December 13, 2010, over 1,100 South Dakotans have participated in World Water Monitoring Day since 2007 according to the World Water Monitoring Day data. The 319 Information and Education Project has actively and continually promoted this event in the state. Over 130 of those participants were provided kits by the project.

The soil sampling project had made initial contact with producers to implement soil testing as part of fertilizer application. The project was not able to be completed due to inclement weather thus the expected outcomes were not measured.

Three of the projects: SPLASH, No/Low Phosphorous and Watershed Data Boundary Dataset did not measure the outcomes for knowledge or participation as the audiences are large, ongoing and diffuse. The projects were designed to support increased knowledge.

Educator workshops were successful in increasing knowledge of educators. To help assess to what degree teachers participated in watershed outreach by using their knowledge, skills and abilities with their students, a second survey was administered to participants of three of the workshops six months post-event. The survey assessed if educators were using or intended to use the assets acquired during the workshop. Two surveys were administered – one during 2008 and the second during 2010. Using the assets gained in the classroom indicates a change in practice to implement increased or improved watershed instruction.

The response to these follow up surveys was low; only twelve of 40 participants responded although the second survey is still open at the time of the writing of this report. Out of the 12 respondents, 10 indicated that they had used content from the workshop in the six months since the workshop. Ten respondents also indicated that they would use content in the upcoming six months. The feedback on the workshop was still strongly positive, with all participants indicating that they felt the workshop was a positive experience professionally and personally.

Youth and student evaluation was focused on World Water Monitoring Day (WWMD) as WWMD was the primary activity of Youth and Student outreach. The other youth and student activities were discrete and localized, usually one time events occurring in a particular location. At this writing, there is no mechanism to capture feedback or input about these other events, something which will be addressed in future 319 Information and Education Projects.

Summary

Qualitatively, the 319 Information and Education project is achieving its goal by successfully realizing outcomes in the various target audiences. This is not to say the goal is being perfectly or completely achieved. However, the evaluation does show that the 319 Information and Education project is accomplishing what it set out to.

To continue building upon this success, the 319 Information and Education project staff will:

1. Select and realize outcomes that are likely to lead to water quality improvements
2. Continue to improve both quantitative and qualitative evaluation by building the capacity of all project coordinators to conduct evaluation.
3. Continue to evaluate and assess projects, developing and utilizing an integrated evaluation plan. This includes a more thorough evaluation of water festivals.

Water Quality Data

The 319 Information and Education project supported three activities which yielded water quality data: Dakota Water Watch, a volunteer monitoring effort which includes McCook Lake monitoring; Pickerel Lake tributary monitoring and Lake Cochrane Monitoring.

The methods and data are summarized in their respective final reports which are included in the Appendices of this report.

6.0 PUBLIC INVOLVEMENT AND COORDINATION

Section 6.0 discusses how the public was involved in this project and how the various partners contributed to the project. With a project of this scope and breadth, it is difficult to identify every source of involvement and coordination. Thus only the entities that made significant financial, technical or administrative contributions will be listed.

6.1 State Agencies

The lead state agency that coordinated the project was the South Dakota Department of Environment and Natural Resources (DENR) by providing administrative and grant management assistance. The 319 Information and Education funds were awarded by the DENR to the South Dakota Discovery Center.

The DENR also provided technical assistance to the Lake Cochrane Monitoring project by conducting the monitoring and writing the report.

Game, Fish and Park partnered with this grant in co-facilitating educational outreach opportunities.

The South Dakota Department of Education supported the aims of the project by funding the development of the Family Water Festival with 21st Century Learning Community funds, a federal block grant to the states.

South Dakota State University and the Water Resources Institute conducted limnology workshops and assisted with the Pickerel Lake Tributary Monitoring projects. The Office of the state climatologist partnered on educational outreach to teachers.

Staff from the SD Department of Agriculture and South Dakota State University served on the Non-Point Source Task Force Information and Education Subcommittee which helps select mini-grants.

State agencies have been strong supporters of the Water Festival throughout the state. Water Festival coordinators are not required to list presenters provided but the Departments of Environment and Natural Resources, Game Fish and Park, Agriculture and the South Dakota State University provide presenters for the festivals.

6.2 Federal Agencies

The US Environmental Protection Agency provided national support for World Water Monitoring Day and funding for the 319 Information and Education Project.

The US Geological Service was the technical lead for the Watershed Boundary Data project.

Staff from the Natural Resource Conservation Service served on the Non-Point Source Task Force Information and Education Subcommittee which helps select mini-grants.

Federal agencies provide support for Water Festivals through staff volunteering for Water Festivals. Agencies such as the Natural Resource Conservation Service, US Fish and Wildlife, Bureau of Reclamation have provided volunteers over the years. These volunteers are not counted as part of the match provided by water festivals towards the 319 Information and Education Project.

6.3 Local Agencies

The bulk of support for the 319 Information and Education Project comes from local agencies and groups.

The East Dakota Water Development District is the largest supporter of information and education, supporting the volunteer monitoring project by providing a staff member whose wages and benefits count as match.

Agricultural producers were an important part of the Animal Nutrient Management project and to a lesser extent the Soil Sampling project by contributing inkind volunteer hours towards watershed protection.

Educators provided match in the form of time and travel at trainings. They also provided cash by paying a deposit for the workshops. Educators are the front line resource for reaching youth and students. Time is valued only during the training itself at the rate set by Independent Sector, a research organization dedicated to the study of the non-profits and volunteers The valuations set by Independent Sector are accepted by the Federal Government for determining match.

Lake associations were also an important source of funds for several projects. These associations consist of residents on or near lakes who have a vested interest in protecting the quality of the lake. The associations are funded by dues and local fund raisers.

The Day County Conservation District provided support to the Pickerel Lake Tributary Monitoring project by conducting the monitoring.

The local water festivals depend heavily on donations from local entities. These festivals also depend on volunteers for staffing and in-kind donations to provide food, venue and resources. The major contributors to the Water Festivals are listed below in Table 9.

6.4 Sources of Funds

Table 8: Sources of Funding by Objectives.

BMP		Allocated	Used
O1-T1 Mini-Grants	319	$72,000.00	$51,721.29
	Mini-grant recipients	$48,950.00	$113,670.73
O2-T3-P4Project WET Facilitator Network	GF&P - Non-Federal	$2,250.00	$0.00
	Wet Facilitators	$2,250.00	$0.00
O2-T3-P5 Project WET Educator Trainings	319	$23,500.00	$23,500.00
	Ducks Unlimited	$0.00	$1,412.00
	Wet Attendees	$13,000.00	$37,777.43
O2-T3-P6 Water Festivals	319	$12,000.00	$12,000.00
	Local Water Festivals	$24,000.00	$173,853.90
	SD Discovery Center	$0.00	$15.34
O2-T3-P7 Students/Youth Events	319	$3,000.00	$3,000.00
	Youth Organizations/ Schools	$2,000.00	$1,729.87
Total		**$202,950.00**	**$418,680.56**

Non Salary Information		Allocated	Used
Office Space	SD Discovery Center	$18,000.00	$18,000.00
Supplies	319	$500.00	$500.99
	SD Discovery Center	$1,550.00	$1,595.70
Travel	319	$3,500.00	$3,500.00
	SD Discovery Center	$2,350.00	$2,421.15
Total		**$25,900.00**	**$26,017.84**

Salary Information		Allocated	Used
Project Coordinator	319	$75,000.00	$75,000.00
	SD Discovery Center	$9,000.00	$15,165.10
Administrative Assistant	319	$10,500.00	$10,476.00
	SD Discovery Center	$1,545.00	$801.72
SD Discovery Center Staff support	SD Discovery Center	$23,175.00	$20,397.16
Total		**$119,220.00**	**$121,839.98**
TOTAL ALLOCATED AND USED		**$348,070.00**	**$566,538.38**

Table 9: Other Sources of Funds.

State	
South Dakota State University	7,111.00
Federal	
US Geological Survey	5,000.00
Local Agencies and Groups	
South Dakota Discovery Center	58,396.17
Ag Producers	22,733.00
Ducks Unlimited	1,412.00
Lower James RC&D	900.00
Coordinated Soil & Water Grant	2,189.00
Lake Cochrane	987.00
SDLSA	3,960.19
Pickerel Lake	7,492.80
McCook Lake	2,751.60
East Dakota Water Development District	65,546.02
Educators	37,777.43
Youth Organizations	1,729.87
Water Festivals Contributors	
AAUW	200.00
Brandon Valley City Hal	500.00
Brandon Valley School	500.00
City of Brandon-	500.00
City of Brandon	500.00
City of Harrisburg	300.00
City of Sioux Falls	30,000.00
Conservation Districts	4,200.00
East Dakota Water Development District	27,400.00
Fraternal Order of Police, Lodge #4	450.00
HDR Engineering & Howard R Green	500.00
James Valley Water Dev District	1,000.00
Living River Group of the Sierra Club	500.00
Minnehaha Community Water Corp-	3,000.00
Misc.	1,225.00
Municipalities	1,600.00
Other	5,418.90
SD Rural Water	1,500.00
Sioux Valley Energy-	1,000.00
USD IdEA Program	480.00
Vermillion Water Development District	200.00
Wal Mart	1,000.00
Water Project Districts	3,000.00
Water Utilities	4,400.00
Volunteers (1,000 vols. x $14.08/hour x 6 hours)	84,480.00

7.0 ASPECTS OF THE PROJECT THAT DID NOT WORK WELL

As with any project, there are aspects that presented challenges. The 319 Information and Education Project is no exception.

The first challenge for the project was supporting the facilitator network. This was discussed above in Section 2.0.

The facilitator network was conceptualized to consist of people who have been trained to deliver watershed education in their locale. This sounds like a good model to disseminate trainings but it does not work quite as envisioned. South Dakota is a rural state with low population density except for the two urban areas, Sioux Falls and Rapid City. The demand for workshops in any given locale is fairly low, perhaps one every two to three years. This workshop infrequency has led to facilitators not feeling vested in the program and thus not self identifying as facilitators. Every volunteer manager knows the best way to lose volunteers is to not use them. The result has been that the WET coordinator is the one who delivers most of the workshops.

For this reason, a new paradigm for facilitators must be developed. The role of a facilitator has been revised to mean not just someone who delivers workshops but also serves as an advocate and support for watershed education in his sphere. In these days of full plates, it is not always feasible to ask someone to take on the role of workshop leader, but there are many who are willing to provide what support they can. These facilitators need a different type of support from the 319 Information and Education Project. They should be provided on-going information about the status of watershed education activities as well as recognition for their support.

Another challenge was working with volunteer led groups that did not have the capacity necessary to administrate a mini-grant. Tasks such as reporting and evaluation were particularly challenging to groups. Since the volunteer led groups often represent important target audiences, the projects they lead are an important part of the 319 Information and Education project strategy and thus should remain fundable by the 319 Information and Education Project. The challenge is to build their capacity in a way that is not onerous in comparison to the amount of funds granted.

To help volunteer led groups fulfill the administrative requirements, resources will be made available to them. The 319 Information and Education Project director will also work more closely with minigrant sponsors, providing assistance as needed.

8.0 FUTURE ACTIVITY RECOMMENDATIONS

The 319 Information and Education Project has been funded for an additional three years per the recommendation of the 319 Non-Point Source Task Force.

The outcomes of the project have been revised with input from the 319 Non-Point Source Task Force Subcommittee. The outcomes are:

a. Increased awareness and/or knowledge of watershed ecology.
b. Increased awareness of NPS pollution causes, effects and remedies.
c. Increased awareness of and participation in NPS best management practices.
d. Increased capacity to deliver NPS I&E.
e. Increased ability to deliver watershed education.

These outcomes will assist in evaluating the project by providing clear expectations as to what should happen as a result of information and education activities.

The third phase project was funded at $300,000 with an expected match of $234,136. Since the current project generated over $360,000 match at the $200,000 level, reaching the expected match levels should not be difficult. Coordination with other agencies and other funding sources should remain essentially the same.

The increase in funding provided for volunteer monitoring as an activity apart from the mini-grants, outreach using social media, and a conference to network stakeholders. These activities were recommended by the 319 Non-Point Source Task Force Subcommittee.

Thus, the recommendations for future activity are:

1. Continue what works: mini-grants, volunteer monitoring, educator trainings, water festivals, youth and student outreach.
2. Pilot a social media outreach.
3. Improve evaluation by building capacity of groups.
4. Conduct a state-wide evaluation of water festivals in order to get a better sense of their contribution to the project.

8.1 Description of Information and Education Outputs

The 319 Information and Education Project has focused on disseminating outputs rather than developing them. However, the project does make resources available to borrow.

- Enviroscape - a watershed model to demonstrate non-point source pollution
- Ground Water model, - a model of how ground water works and how pollutants can move underground
- Secret Agent Worm Soil Kit, - a kit that demonstrates erosion
- Macromania Game – a game to understand how macrovinvertebrates can indicate water quality

- Volunteer Water Quality Monitoring Kit – a trunk with 6 Dissolved Oxygen kits, thermometers, pH strips and 6 transparency tubes. This equipment provides data that is more precise than that provided by the World Water Monitoring Day kit
- Wetlands Trunk – books, puppets, games and posters to instruct about wetlands
- Lakes and Streams trunk – books, puppets, game and posters to instruct about lakes and streams
- Watershed maps (North America, Missouri River & South Dakota) Large maps delineating watersheds
- Family Water Festival – 13 activities and supplies to create a water festival event (see section 2.4 for more details).
- Signage – Four signs suitable for printing that explain ground water, wetlands, hydrology and non-point source pollution.

Appendix A

Sample Educator Workshop Agendas

Rationale

The Leopold Education Project (LEP) is a curriculum resource that fosters critical thinking skills, facilitates inquiry and investigation into the ecology, and integrates literature, civics and geography with natural science. The LEP uses essays from Aldo Leopold's *A Sand County Almanac* to lead into the study of the natural world and the reflection on man's interaction with and responsibility to the land. At the heart of the LEP is the concept of land ethic which Leopold defines as a responsibility to the soil, water, plants and animals based on the ecological concept of community.

Educators who participate in a Leopold Education Project training will receive a full set of curriculum resources, including teacher's guide, video, task cards and a copy of *A Sand County Almanac* to equip them to implement LEP activities into their classroom. At the training, they will be provided ample opportunity to practice these activities and adapt them to their teaching situations. A multi-day field session will permit educators an extended session to practice, evaluate and refine hands-on activities in the outdoors.

Educators will also be given the opportunity to engage in personal development as they reflect upon Leopold's essays. Part of the class will be devoted to developing a personal statement of land ethic and discussing a contemporary issue in the context of that land ethic. In the field, "Leopold moments", those moments of personal meaning and discovery, will be shared daily.

In keeping with the professional responsibility of environmental education, the LEP does not lead participants to a predetermined outcome. The purpose is education, not advocacy.

Goals and Outcomes:

The goals of the Leopold Education Project training are to:

1. Train and equip educators to implement LEP into their teaching practice.
2. To foster the on-going development of the educator's land ethic through reflection on the writings of Aldo Leopold, knowledge of and experiences with the ecology, and analysis of current issues.

These goals will be successfully achieved if:

By the end of the Leopold Education Project classroom session, the educator:

1. Participates in all activities and field investigations.
2. Facilitates 1 activity or field investigation as part of a small group per *Lessons in a Land Ethic* guide.
3. Demonstrates proficiency in field investigations, including mapping, water quality monitoring protocols (temp. clarity & turbidity) and use of field identification guides.
4. Drafts a written land ethic.
5. Analyzes a current issue involving nonpoint source pollution in the context of the land ethic.

Within a week after the classroom session, the educator will observes the natural world and records her observations on 10 separate occasions in a journal.

Within two weeks after the training the educator:

1. Proposes how to integrate an LEP activity into her practice and posted it online.
2. Posts online her concluding remarks, explaining the significance of Leopold's writing and the concept of the land ethic to the educator.

Texts and Resources

A Land Ethic (online at Google Books)

A land ethic. Retrieved April 1, 2008 from Google Books. Web site: http://books.google.com/books?id=LICERWI0YJYC&pg=PA225&dq=Land+Ethic&lr=&sig=c97uSIBYkOXSIglfmOTexqeS_Jg#PPA201,M1

Notes on Keeping a Field Journal

Notes on keeping a field journal. Retrieved April 1, 2008, from University of Western Ontario Web site: http://instruct.uwo.ca/biology/320y/fj.html

Introduction to Watershed Ecology

Introduction to watershed ecology. Retrieved April 1, 2008, from US Environmental Protection Agency Web site: http://www.epa.gov/watertrain/ecology/

Ecosystem Services: Benefits to Human Societies

Ecosystem services: Benefits to human societies. Retrieved April 1, 2008 from US Environmental Protection Agency website: http://www.epa.gov/watertrain/ecosyst.html

A Sand County Almanac

Leopold, A (1968). *A sand county almanac: and sketches here and there*. New York: Oxford University Press.

A Lesson in a Land Ethic

The Leopold Education Project. *A lesson in a land ethic.* St. Paul: Pheasants Forever

Aldo Leopold: A Prophet for All Seasons (video)

Task cards

Knapp, C. *Task Cards* St. Paul, MN: Pheasants Forever

Agenda

Online

Pre-Class Assignments May 19-June2

Read:

The Land Ethic:

Notes on Keeping a Field Journal

Complete one of two:

Introduction to Watershed Ecology module

Ecosystem Services: Benefits to Human Societies module.

Post-Class Assignment: June 4 - 18

1. Develop and post a lesson/activity plan.
2. Share concluding remarks. Explain the significance of Aldo Leopold and how your land ethic has been impacted by this class. Speculate on future behavior impacts.

Contact Hours: 4

Agenda (cont).

Classroom Session: June 3

8:00AM	Welcome and Housekeeping
8:15	Concept map
8:30	*Blue Ribbon Quotes*
8:45	Dr. Daniel Hubbard of SDSU: *An Overview of Leopold and the Land Ethic*
9:45	Break
10:00	Land Ethic: Draft and Discuss a current issue in the context of your land ethic.
10:30	*January Thaw:* Game Scene Investigation
11:00	Small group assignments: Select essays and ready activities
12:00PM	Working lunch: Dutch oven demo, continued small group prep time
12:30	Small groups present activities
1:30	Break
1:45	Small groups present activities
2:30	Activity development: Plan a Leopold Inspired field activity to pilot in the field session
3:00	The Nature Journal
3:30	Field Investigation Practices Using Field Guides Water Quality Monitoring Mapping
4:30	Wrap up discussion: Putting it all together
4:45	Trip overview w/ outfitter.
5:00	Dismissal

Contact Hours: 9

Overnight Field Session: June 4 - 6

Day 1 (8 hrs)	Put in kayaks at Pickstown. En route: Conduct inventories and field investigations at sites of interest. Pilot activities. Journal entries. At camp: Evening discussion. (inventories, Leopold "moments"). Complete at least three journal entries by end of day. Option of mapping camp site.
Day 2 (8 hrs)	En route: Conduct inventories and field investigations. Pilot activities. Journal entries. At camp: evening discussion (inventories, Leopold "moments"). Map must be completed. Four journal entries completed by end of day.
Day 3 (6 hrs)	Back on river. Conduct inventory. Complete three journal entries. Off river by 2PM and return to Pickstown. Turn in field notebooks.

Contact Hours: 22

Total Contact Hours: 35

Assessment

	1 Not at all	2 Partially	3 Mostly / Completely
Completes the pre-class assignments.			
Participates in classroom session. Asks and answers questions. Shares new or relevant ideas or information.			
Facilitates an activity as part of a small group in a manner that facilitates inquiry into and discussion about the ecology.			
Demonstrates proficiency in the field investigations. Can draw a map of a study site; sample a water body for temperature, clarity and turbidity; and use field identification guides to identify soil, rocks, plants, insects and animal sign.			
Writes multiple drafts of a land ethic, showing consideration of both the scientific and social aspects of responsibility for land.			
Analyzes a current issue in the context of the land ethic, able to think from a personal and social perspective.			
Maintains a nature journal during the field session, contributing 10 separate entries that evidence proper form and investigation and inquiry into the ecology.			
Integrates the LEP into teaching practice as demonstrated by a lesson plan. If no product of the LEP is appropriate for the educator's assignment, then an LEP inspired activity can be substituted if the educator explains the relationship between the activity and the LEP.			
Shares concluding remarks which reflect upon the impact Leopold, the LEP and the land ethic had on the educator personally.			

In order to receive credit the educator must score an average of 18 points using the rubric above.

Rationale:

Environmental education goes beyond the study of ecology or life science. The purpose of environmental education is to develop the skills and knowledge that equip students to think critically about personal actions, community decision making, and the resultant impacts to the environment. To this end, *Advanced Environmental Education* will develop the environmental education practice of teachers through Monitoring of and participation in experiential, inquiry based learning in the outdoors. Class participants will focus on understanding the relationship of science and civics in the context of the environment. The class will use activities to explore the themes of People Impact Their Environment, People Understand Environmental Impacts through Science and People Respond to Environmental Impacts through Civic Action. The class will then design and implement a field investigation of the Missouri River using their understanding of the Clean Water Act and South Dakota's water quality policies. Graduate students will also have to write an essay relating how their teaching assignment relates to environmental education plus complete an online module about watershed monitoring.

Texts:

- *Science & Civics*; Project WILD, 2005 (S&C)
- *Healthy Water, Healthy People*; Project WET International Foundation, 2003 (HWHP)
- *Volunteer Stream Monitoring: A Methods Manual* US EPA 1997 (US EPA Methods Manual)
- Article: *Notes on Keeping a Field Journal* University of Western Ontario Biology Department http://instruct.uwo.ca/biology/320y/fj.html
- *Overview of Watershed Monitoring.* US Environmental Protection Agency. http://www.epa.gov/watertrain/monitoring

Learning Outcomes/Assessment Outputs:

By the end of the class, learners will be able to:

1. Analyze how science and civics mutually inform each other in an environmental context. Assessed by: Activity participation, concept map
2. Evaluate environmental and civic conditions to design an environmental investigation. Assessed by: *Designing the Study*, *Overview of Watershed Monitoring* (graduate only)
3. Demonstrate skills needed to conduct environmental investigations according to protocol. Assessed by: Field sessions, field journal

Requirements:

In order to receive graduate credit for the class, learners will

1. Participate in all class and field activities
2. Score at least 8 points on the attached rubric.
3. Submit a portfolio with the following:
    a. Concept map (Pre and post class session)
    b. Short essay on how the skills, content and material from their teaching assignment are utilized in environmental education.
    c. Field notebook
4. Complete the online training module *Overview of Watershed Monitoring* found at the EPA's Watershed Academy with online test.

In order to received undergraduate credit for the class, learners will

1. Participate in all class and field activities
2. Complete the pre-class assignments, including self test of Overview of Watershed Monitoring
3. Submit a portfolio with the following:
    a. Concept map (Pre and post class session)
    b. Field notebook
    c. Reflective essay
4. Score at least 4 points on the rubric

Agenda:

Pre-class assignment:

1. Read *Notes on Keeping a Field Journal.*
2. Complete *Overview of Watershed Monitoring*: Take self test at the SD Discovery Center website

In-class activities:

Day 1

8:00 – 8:15	Icebreaker and Information
8:15 – 8:45	Concept Map of Science & Civics
8:45 -9:45	**People impact their environment** Activities: *Color Me A Watershed; There is No Point to this Pollution*(demo)
9:45 – 10:00	Break
10:00 – 10:45	**People understand environmental impacts through science.** Activities: *There Is No Point…, Feeding the Soil* (S&C)
10:45 – 11:45	**People respond to environmental impacts through civic action.** *Presidential Prerogatives: Procedures 1 & 2* (S&C) *Who Cares?*(S&C)
11:45 – 12:00	Break
12:00 – 1:00	**Working Lunch: Policy and legislation is shaped by science.** *Intro to Clean Water Act*
1:00 – 3:30	***Designing the Study*** *Water Quality Monitoring: From Design to Data* (HWHP), Water Quality of the White River (groups set their own break) (US EPA Methods Manual)
3:30 – 4:30	Field Skill Practice: Based on the results of the study design, learners will practice field skills. Pre-trip orientation from outfitting staff.
4:30 – 5:30	The field journal, revisit concept map, essay (graduate), *Pollution: Take It or Leave It* (HWHP) (undergrad), written evaluation

Contact Hours: 9.5

Day 2: Field Work

The day will be spent in the field sampling water quality at intervals determined by the study. There will be a debrief at the end of the day to synthesize and compare data.
Contact Hours: 8

Day 3: Field Work

The day will be spent in the field sampling water quality at intervals determined by the study. There will be a debrief at the end of the day to synthesize and compare data.
Contact Hours: 8

Day 4: Field Work

Part of the day will be spent in the field sampling water quality at intervals determined by the study. There will be a debrief at the end of the day to synthesize and compare data.
Contact Hours: 5

Post-class Assignment (by June 20)

Write a short essay reflecting on this experience personally and professionally.
Contact Hours: 2.0
Total Contact Hours: 32.5

Rubric

When assessing (output)	Look for ability to : (outcome)	Beginner (0 points for each category)	Developing (1 point for each category)	Accomplished (2 points for each category)	Master (3 points for each category)
Participation (classroom)	Analyze how science and civics mutually inform each other in an environmental context. Evaluate environmental and civic conditions to design an environmental investigation	Does not participate.	Participates in only some of the activities; contributes only when required	Participates in the class and field activities; contributes original ideas.	Shows leadership in discussion; asks probing questions; contributes original ideas, information and perspectives.
Portfolio	Analyze how science and civics mutually inform each other in an environmental context. Demonstrate skills needed to conduct environmental investigations according to protocol	Portfolio not completed	Portfolio completed.	Portfolio completed with demonstrations of gains in knowledge (concept map). Grad students show ability to relate teaching to environmental investigations . The field notebook is completed according to protocol, has at least four entries, and one drawing.	Portfolio completed with evidence of mature thinking about the science/civics relationship & analysis of teaching practice and integration of environmental investigation (grad students). Field notebook is completed according to protocol, with data section, more than four descriptive entries, and one drawing.
Participation (Field Activities)	Demonstrate skills needed to conduct environmental investigations according to protocol.	Does not participate	Participates only in some of the activities. Does not follow protocol.	Participates in activities. Follows protocols.	Participates in field activities. Assists less experienced learners with protocols.
Overview of Watershed Monitoring	Evaluate environmental and civic conditions to design an environmental investigation.	Less than 65% of answers correct.	65% - 75% answers correct.	76% - 85%answers correct.	More than 86% correct.

DDN EE for 3-5 Agenda
Class 1
Project WET
September 28, 2009

1. Icebreaker – Raining Cats & Dogs
2. Overview: WET & EE
3. Activities:
    a. Incredible Journey
    b. Stream Sense
    c. Pass the Jug
    d. Water Concentration
    e. Choices & Preferences
    f. Money Down the Drain
    g. Water Write: Water Yarn
    h. What's the Solution?
4. Wrap-Up

Materials:
Each person should have:
1. Blank paper
2. A natural object: leaf, pine cone, stick (not a rock).
3. Printouts for Choices and Preferences, Water Concentration, Money Down the Drain
4. Scissors

Each site should have
5. Printouts for Incredible Journey, Pass the Jug, Water Proverbs
6. Colored pencils
7. Nine paper clips, flat & untwisted.
8. Nine brass paper fasteners ("brads")
9. Scissors
10. 3 clean plastic bottles with three large cups.
11. Pin and small nail
12. Stop watch (cell phone stop watch will do)

Printouts

DDN EE for 3-5 Agenda
Class 2
Project WET
October 5, 2009

Agenda

1. About Project WET
    a. Goal
    b. Purpose
    c. Structure
    d. Other guides
    e. Funding and support in South Dakota
    f. Mailing out the Guide

2. World Water Monitoring Day
    1. Purpose of WWMD
    2. Watch video
    3. Tell how to get kits

3. Activities: Discover a Watershed Missouri River
    a. The Big Muddy: related to WWMD p150

    b. Seeing the Missouri Watershed p.65
        Do this one, talk through maps

    c. CFS ASAP p. 95
        Do this one, make a cubic foot of water

    d. Home Away from Home p. 259
        do this one

    e. Get to Camp p. 350
        do this one

    f. Get the Missouri Basin Ground Water Picture p159
        talk through

    g. Missouri River Extremes p. 100
        talk through

    h. Beyond the 100th Meridian
        talk through p. 196

4. Wrap Up and evaluation
    a. Other EE: LEP & EECSD
    b. Evaluation: To be completed online
    c. Receive disc w/ CD files afterwards,

Rationale:
Everyone lives in a watershed. Understanding watersheds is an important part of understanding environmental and human communities. This professional development opportunity will equip teachers with the knowledge and skills to integrate investigation and instruction about watersheds into their classrooms, utilizing 21st Century Skills to build environmental literacy.

Discover a Watershed will utilize the methodology of place based education to study the three components of the watershed: the physical setting (climate, geology and hydrology), the ecological setting (soil, plants and animals), and the cultural/human setting (history, geography and civics).

Educators will spend one day in the classroom learning hands-on and inquiry based activities to instruct about the components of the watershed. Time will also be spent practicing field skills to use in the outdoors. Educators will also prepare an activity as part of a small group to present in the field.

Educators will spend two days/one night in the outdoors, practicing the field skills along a river in South Dakota (selection depends on flows). While in the field, educators will map a site; draw, describe and identify plants; do a soil characterization profile; and sample water quality as well as reflect on the human/cultural interaction. They will also present the activity prepared in the classroom, using the outdoors as the setting.

The classroom resources have been selected to supplement each other. *Discover a Watershed: Missouri River Educator's Guide* published by Project WET is an award winning curricula that features activities specific to the Missouri River watershed. The GLOBE project is an interagency program of the National Aeronautic and Space Administration (NASA), National Science Foundation, the US Department of State and the University Corporation for Atmospheric Research. GLOBE is an international environmental science and education project to collect useable, real world data. *Places We Live* is published by Project Learning Tree as a curriculum to introduce students to the concepts of community planning. And *A Sand County Almanac* by Aldo Leopold and two classroom resources *Lessons in a Land Ethic* and *Exploring the Outdoors with Aldo* provide activities of place and personal connection to a setting.

Objectives:
By the end of the training, participants will:
1. Understand the physical, ecological, and cultural components of the watershed.
2. Be able to integrate relevant instruction about watersheds into their classroom.
3. Be able to execute field skills.

Requirements:
1. Read the pre-class essays *Tips and Techniques for Exploring Place* and *Notes on Keeping a Field Journal*.
2. Participate in all classroom and field activities.
3. Maintain a nature journal with the following:
    a. Two entries dedicated to plants including a drawing and description.
    b. Two entries dedicated to water quality, including:
        1. Water clarity
        2. Water temperature
        3. Water speed using Log Line
    c. A map
    d. One Soil Characterization profile
    e. Two entries reflecting on being in place on the river.

4. Facilitates a peer led activity in the field.
5. Develop a lesson plan.
6. Score 10 out of 15 on the rubric below.

Resources:

- *A Sand County Almanac.* Leopold, Aldo. Oxford University Press. 1968*
    - *Exploring the Outdoors with Aldo.* Pheasants Forever. 2009
    - *Lessons in a Land Ethic.* Pheasants Forever.
- *Discover A Watershed: Missouri River Educator's Guide.* Project WET. 2004.
- *GLOBE Teachers Guide, Soil Chapter*. 2005. www.globe.gov.
- *Tips and Techniques for Exploring Place.* University of Vermont and Place-based Landscape Analysis and Community Education (PLACE). 2009 http://www.uvm.edu/place/
- *Notes on Keeping a Field Journal.* From the University of Western Ontario's Program for Field Biology online guidance for students. 2006 version.

Pre-class Assignment Read: *Tips and Techniques for Exploring Place* and *Notes on Keeping a Field Journal*
Contact Hours: 2

June 28: Session 1

8:00 – 8:30 **Introduction**
Icebreaker: *Are You Like Leopold?*
Places We Live: Personal Place

8:30 – 11:45 **Understanding Place:**
Discover a Watershed: Seeing the Missouri Watershed
Activity: Watershed models
Understanding Place: Ecological Setting
Soils
GLOBE Activity: Why Study Soil
GLOBE Soil Characterization Profile (Field Skill)
Plants
Lessons in a Land Ethic –Axe in Hand
Activity: Tree identification
Animals
Lessons in Land Ethic – January Thaw
Make and Take: Track Sheet
Activity: Macro-Mania

12:00 – 1:00 Working Lunch: Overview of Missouri Watershed: Presentation

1:00 – 3:30 **Nature Journal**
Lessons in a Land Ethic – A Green Pasture
Understanding Place: Physical Setting
Community Collaborative Rain, Hail, Snow network training www.climate.sdstate.edu
Understanding Place: Physical Setting
Hydrology
Discover a Watershed: The Big Muddy (Field Skill)
Discover a Watershed: Log Line (Field Skill)
Understanding Place: Cultural Setting
Places We Live: Green Spaces

3:45 – 5:30 **Prepare Peer Teaching Activities in the Field**
Exploring the Outdoors – Wake Up Little Birdie
Exploring the Outdoors - Botany Scavenger Hunt
Exploring the Outdoors – My Special Place
GPS
Prep by Outfitters

Contact Hours: 9

June 29 - 30: Session 2

Field activities. Facilitate field session. Maintain nature journal. Data share.

Contact Hours: 19

By July 14: Session 3

Assignment: Develop a lesson plan integrating course content into class.

Contact Hours: 1

Total Contact Hours: 31

Rubric

When assessing (output)	Look for evidence of (outcome)	Inadequate (0)	Acceptable (2)	Exceptional (3)
Classroom Participation	Understanding on how physical, ecological and cultural settings are integrated.	Does not participate.	Participates but only when required as part of the group. Does not offer new information or examples. Participation demonstrates an understanding of watershed and place.	Participates asking and answering questions, offers new information & examples from personal experiences. Participation demonstrates a robust understanding of watershed and place.
Peer Facilitation	Ability to instruct about watersheds and place	Does not participate in the peer facilitation	Participates but does not expand or adapt the activities; does not add questioning or model good teaching practice.	Participates, expanding and adapting the activities. Models good teaching practice.
Lesson Plan	Concepts learned in class integrated into their classroom.	No lesson plan submitted.	Lesson plan is submitted.	Lesson plan is submitted. It is aligned to standards and is modified for that teacher's classroom situation.
Nature Journal	Understanding on how physical, ecological and cultural settings are integrated.	Has less than half the required elements.	Has more than half to all required elements. Reflection essays do not show a relationship between at least two of the settings.	Has all the required elements. Reflection essays show a relationship between two of the settings.
Field Skills	Ability to execute field skills	Does not execute field skills	Executes field skills as part of a group.	Takes initiative to execute field skills.

Must score 10 out of 15 in order to receive credit.

Appendix B

Lake Cochrane Monitoring Report

WATER QUALITY INVESTIGATION
FINAL REPORT

LAKES COCHRANE/OLIVER WATERSHED
DEUEL COUNTY, SOUTH DAKOTA

Prepared By

Paul Lorenzen, Environmental Program Scientist

Water Resource Assistance Program-Watershed Protection
Division of Financial and Technical Assistance
South Dakota Department of Environment and Natural Resources

Prepared for the

Lake Cochrane Improvement Association
Water Quality Committee

June 2010

INTRODUCTION

The natural outlet of Lake Oliver was obstructed by a network of roads and other residential development activities established around Lake Cochrane in the early 1960s. Lake Oliver eventually experienced high water levels which resulted in flooding of adjacent roads, the state recreation area and residential property. The first documented flood event occurred in 1987 with additional occurrences in 1993 and 1995.

Natural outflow from Lake Oliver to Lake Cochrane was permanently restored in 1997 following construction of a controlled outlet structure. The outlet structure is authorized by Flood Control Permit FC-23 which was approved by the state Water Management Board for the Department of Game, Fish and Parks. The permit contains several limitations, conditions and qualifications to address potential water quality concerns by restricting Lake Oliver water from entering Lake Cochrane during months when algae blooms may occur.

The permit (FC-23) contains the following operating criteria in the interest of Lake Cochrane water quality:

- The control structure will remain open October 16 through June 14 to lower the Lake Oliver water level to the established outlet elevation of 1683.6 fmsl.
- The control structure will be closed June 15 through October 15 and Lake Oliver water will be stored up to an elevation of 1685.0 fmsl.
- When an elevation of 1685.0 fmsl is reached, water will spill uncontrolled over the weir. If a precipitation event occurs during June 15 through October 15 that causes flow over the weir to reach an elevation of 1685.3 fmsl, the control structure will be opened until Lake Oliver attains an elevation of 1684.3 fmsl.

Many Lake Cochrane residents disagreed with FC-23, in particular, the decision to restore the natural outflow of Lake Oliver to Lake Cochrane. Most claimed that water from Lake Oliver would degrade the high-quality condition of Lake Cochrane. The Department of Environment and Natural Resources (DENR) was sensitive to the allegations and incorporated Lake Cochrane into annual lake sampling efforts to investigate potential changes in the water quality over time.

DENR also conducted a watershed scale water quality assessment study in 1999 (DENR, 2000). This comprehensive study documented tributary and lake water quality and recommended best management practices to protect Lakes Cochrane and Oliver. DENR later provided financial and technical assistance to the Deuel County Conservation District to support a watershed restoration project. The project started in 2002 and concluded in 2005. A final report documenting all completed activities is available at: http://denr.sd.gov/dfta/wp/TMDL/TMDLCochraneOliverImpl.pdf

DENR regularly communicates with the Lake Cochrane Improvement Association (LCIA) to provide updated information regarding water quality of Lake Cochrane. In addition, DENR has provided technical assistance for water quality monitoring, phosphorus management and guidance on permit processes. The general focus has been on phosphorus inputs from Lake Oliver, though discussions have recently involved a suite of other sources within the Lake Cochrane watershed. Information gained by the LCIA is relayed to local residents.

Several local residents claim Lake Oliver outflow has increased phosphorus levels in Lake Cochrane resulting in more algae blooms, dense aquatic plants and decreased water clarity. The objective of this investigative report is to document and explain the potential impacts, if any, concerning Lake Oliver outflow on water quality and ecology of Lake Cochrane over the past several years.

WATER QUALITY DATA

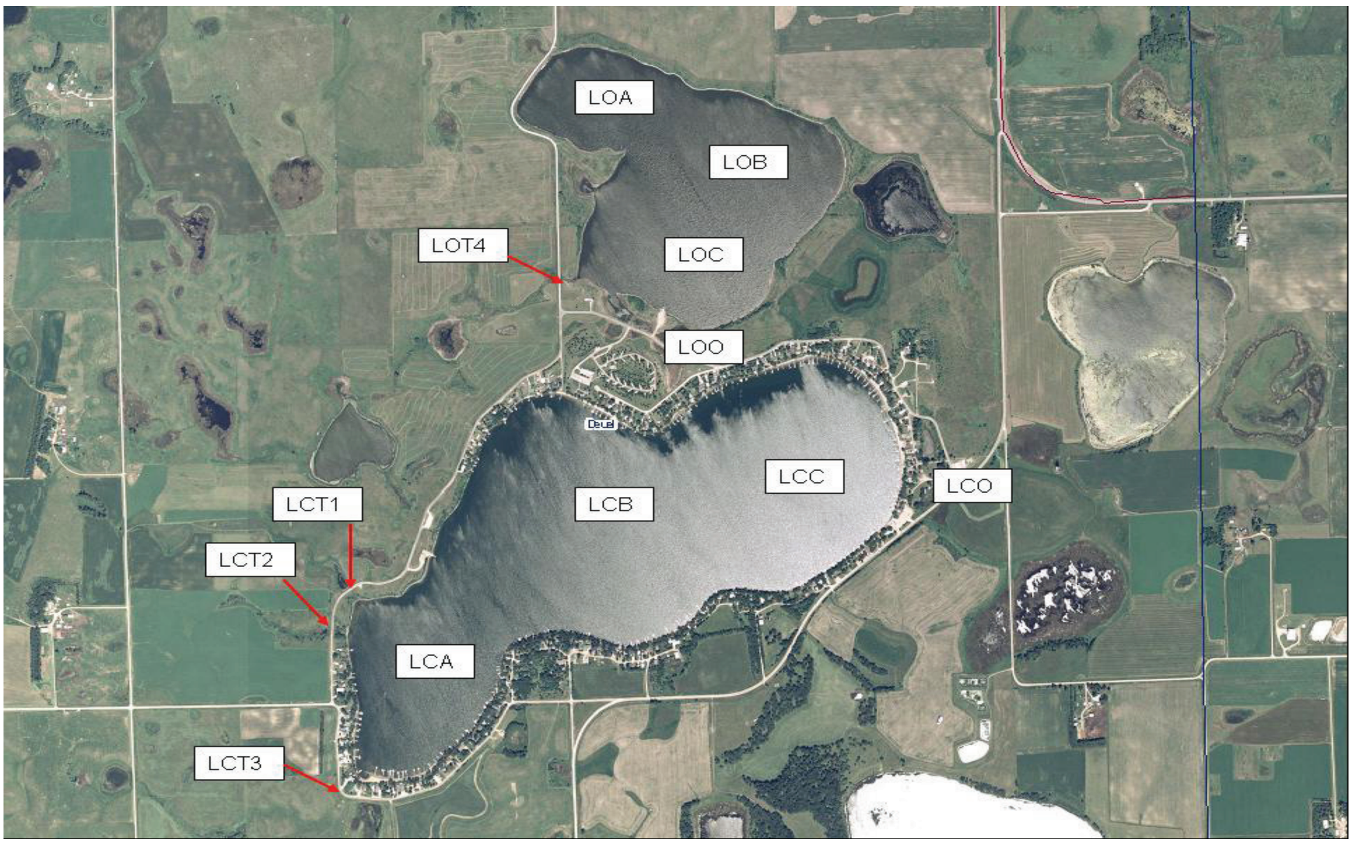
DENR considers Lake Cochrane one of the most intensively sampled lakes in South Dakota. Several sources of data were used to generate the results of this investigative report. DENR used data from sampling efforts conducted over the past 20 years including data from annual sampling visits, 1999 assessment study, 2002 restoration project and the national lakes survey.

Continuous water level recorders were installed at the Lake Oliver and Lake Cochrane outlets in 2008. The water level measurements were calibrated to the outlet elevation at feet mean sea level (fmsl) for each of the respective outlet structures. A weir equation designed for the Lake Cochrane outlet was used to convert the average daily water level measurements to an average daily flow rate. The daily flows were summed for the total recorded flow period (water above 1682.6 fmsl) to quantify a total annual flow volume.

A regression equation was used to predict the flow rate at different elevations through the Lake Oliver outlet structure. The linear regression equation was derived from paired elevation and flow rate data established during the design of the outlet structure.

The LCIA established a water quality committee to conduct water quality sampling. The committee members sampled locations consistent with those established by DENR (See Map on page 4). The water quality sampling was a component of a larger project to provide information and education regarding nutrients and nutrient reductions within the Lake Cochrane watershed. The majority of data used in the generation of this report, in particular, data from 2008 and 2009 was collected by the water quality committee.

John Appelen a retired civil and agricultural engineering consultant and hydrologist conducted water sampling, performed flow estimates and constructed a water-nutrient balance for 2007. Values generated by Mr. Appelen were used when appropriate.



Map depicting monitoring sites for studies conducted within the Lake Cochrane watershed overlaid on 2008 aerial imagery

RESULTS AND DISCUSSION

Lake Oliver Outlet Phosphorus

The phosphorus concentrations associated with Lake Oliver outflow to Lake Cochrane have shown improvement since 1999 (Table 1). During the 1999 assessment study, common carp were frequently observed near the upstream end of the outlet structure. The resulting carp activity contributed to increased suspended solids and associated phosphorus concentrations. The carp issue was resolved when a dense stand of cattails established in the wetland area between the main lake and the outlet structure. The cattails provide a restrictive barrier impeding carp from staging near the outlet structure. Cattails also sequester nutrients and slow sediment movement. The average phosphorus concentration from Lake Oliver outflow for samples collected after 1999 was 0.052 mg/L with a standard deviation of +/- 0.02 mg/L. In addition, suspended solids concentrations were very low with many values below the SD State Health Laboratory detection limit (<3 mg/L) indicating clear water with little to no solids.

Table 1. Phosphorus and suspended solids concentrations from Lake Oliver outflow.

Sample Date	Total Phosphorus (mg/L)	Total suspended solids (mg/L)
04/28/1999	0.058	5
05/05/1999	0.087	41
05/12/1999	0.048	8
06/03/1999	0.072	6
05/08/1999	0.055	10
05/20/1999	0.211	182
06/03/1999	0.059	8
06/08/1999	0.105	23
06/10/1999	0.06	8
04/10/2006	0.063	Na
03/28/2007	0.022	5
03/28/2007	0.038	4
04/02/2007	0.044	7
04/02/2007	0.075	<3
04/15/2007	0.044	Na
05/18/2007	0.03	Na
04/21/2008	0.09	4
05/12/2008	0.036	3
05/20/2008	0.062	Na
06/05/2008	0.072	<3
03/21/2009	0.081	<3
04/11/2009	0.062	<3
04/25/2009	0.032	<3
05/10/2009	0.029	<3

Grey bar indicates common carp were present when sample was collected

The phosphorus load from Lake Oliver to Lake Cochrane was directly measured in 1999, 2007, 2008 and 2009 (Table 2). The phosphorus loads were variable ranging from 28.5 pounds to 7 pounds. The measured phosphorus loads were used to estimate a phosphorus load for all years since the outlet was constructed.

Table 2. Years depicting actual measured phosphorus load from Lake Oliver to Lake Cochrane.

Year	1999	2007	2008	2009
LOO P-Load	19.3 lbs.	28.5 lbs	20.7 lbs	7 lbs
Source	DENR	John Appelen	DENR/LCIA	DENR/LCIA

Annual precipitation was used to determine the potential phosphorus load from Lake Oliver in years when the load was not directly measured. Average annual precipitation data was acquired from Clear Lake, South Dakota through the co-op extension with the climate center at South Dakota State University. The average annual precipitation values were paired with the measured phosphorus loads from Lake Oliver. A strong linear relationship (R^2=0.89) was observed with the four paired observations (Figure 1). This relationship indicates that nearly 90% of the variability in Lake Oliver phosphorus loading can be explained by precipitation. This makes sense given the fact that more precipitation equates to higher lake levels, more outflow and higher phosphorus loading.

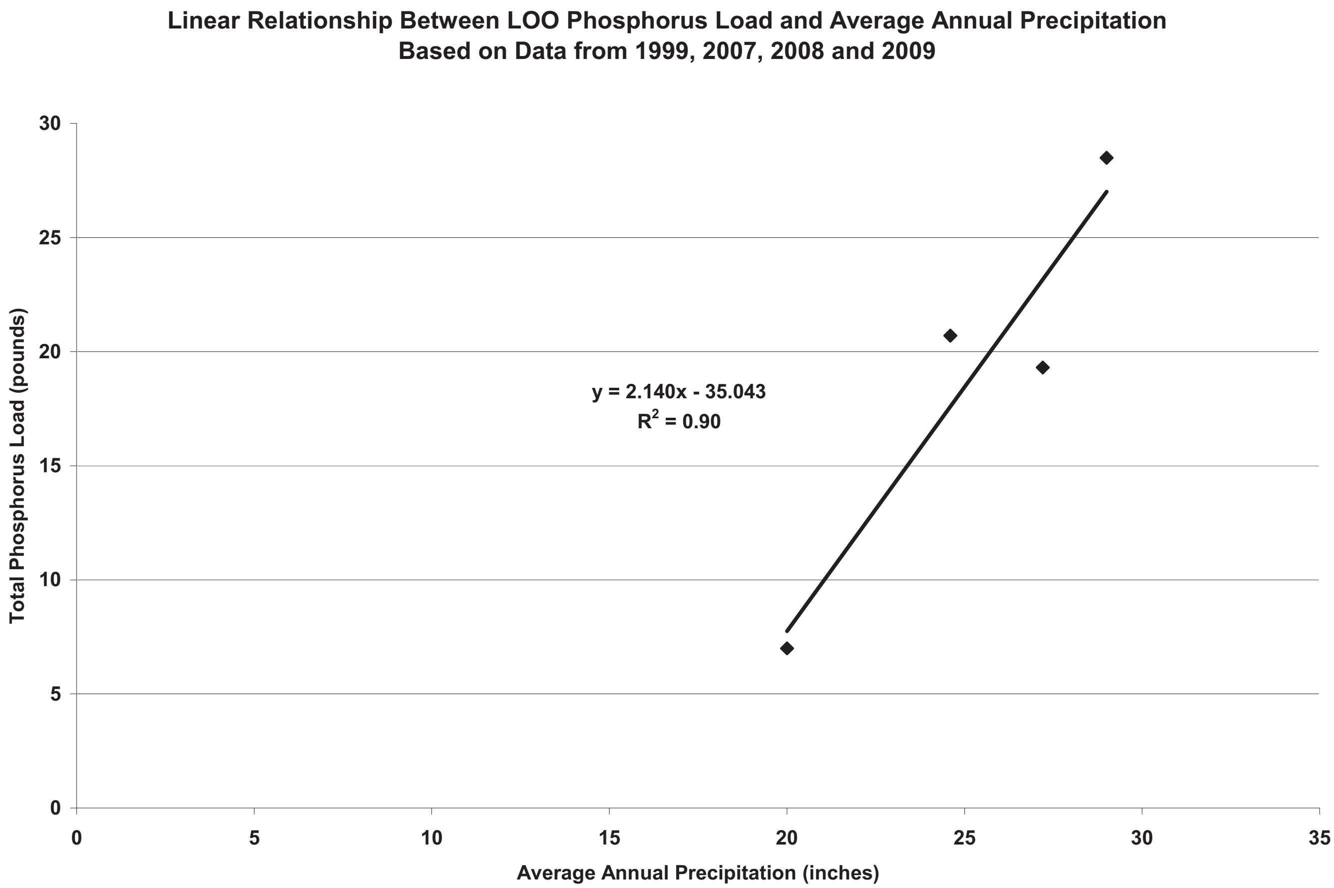


Figure 1. Linear relationship between measured Lake Oliver outlet phosphorus loads and average annual precipitation.

The regression equation (y=2.140x-35.043) derived from the line on the graph (figure 1) was used to determine Lake Oliver's annual phosphorus loading (y) based on annual precipitation (x) values for the past 13 years. The resultant phosphorus loads from 1997 through 2009 are presented in Table 3. Additional paired observations between Lake Oliver phosphorus load and annual precipitation would help strengthen this relationship.

Table 3. Estimated annual phosphorus load from the Lake Oliver outlet to Lake Cochrane over the past 13 years.

Year	Total Phosphorus. Load (pounds)
1997	20.9
1998	18.3
1999	**19.3**
2000	7.6
2001	29.4
2002	8.1
2003	5.2
2004	34.9
2005	28.2
2006	18
2007	**28.5**
2008	**20.7**
2009	**7**
Average Annual P	**18.9**

Actual measure values are shaded

The estimated annual phosphorus loads from Lake Oliver varied significantly, ranging from 35 pounds to 5 pounds. The average annual phosphorus load from Lake Oliver was calculated at 18.9 pounds. John Appelen estimated that Lake Oliver contributes a net gain of 15.2 pounds of phosphorus to Lake Cochrane on an average annual basis. Considering Lake Cochrane lost (LCO) approximately 4 pounds of phosphorus during 2 relatively average precipitation years (1999 and 2008) it is suspected that this estimate is reasonably accurate. Assuming an average annual net gain of 15.2 pounds equates to roughly 200 pounds of phosphorus retained by Lake Cochrane from Lake Oliver over the past 13 years.

The total water volume of Lake Oliver is approximately 1,500 acre-feet. The water volume associated with the estimated average annual phosphorus load (18.9 pounds) equates to an average annual water volume from Lake Oliver of 115 acre-feet. Multiplying 115 acre-feet by 13 years equates to roughly 1,500 acre-feet. Therefore, it is suspected that Lake Oliver has experienced a complete flush or replacement of water since outflow was restored in 1997. Lake Cochrane's flushing rate was not estimated for this investigation though Lake Oliver's inflow contribution has increased the flush rate of Lake Cochrane. Outflow is the only natural way for Lake Cochrane to expel phosphorus, sediment and other water quality constituents that promote productivity. Lake Cochrane experienced minimal outflow prior to the re-introduction of Lake Oliver which caused the lake to become saline (salty) or slightly brackish as indicated by elevated conductivity (1800 plus micro grams per centimeter) and the weak tea stained appearance.

Tributary Phosphorus

Tributaries also provide a source of phosphorus loading to Lakes Cochrane and Oliver. A small drainage to Lake Cochrane (LCT2) and the largest drainage to Lake Oliver (LOT4) have received considerable attention over the past 3 years (2007-2009). Both tributaries present unique situations that have warranted further monitoring.

Sampling efforts have focused on LCT2, despite the small drainage area. This tributary was identified as producing high phosphorus concentrations (DENR 1999). The average phosphorus concentration from 20 samples collected in 1999 was 0.184 mg/L. The average phosphorus concentration from 12 samples collected 2007 through 2009 was 0.222 mg/L.

The LCT2 drainage has a sediment retention pond with a standpipe initially constructed with the road infrastructure in the mid 1970's. This sediment basin was dredged and the standpipe was replaced during the restoration project in 2004. The sediment basin was designed to capture sediment while providing a potential nutrient reduction benefit. Initial sampling efforts on LCT2 following construction of the sediment pond revealed little benefit in nutrient reduction which is apparently still the case today (Haertel, 1978). This drainage supplies continuous low volume flow from an upstream spring. The spring fed nature of this drainage makes it difficult to drawdown the sediment pond to allow for storage as originally intended. Land-use in the drainage area is predominately agriculture which may contribute to the higher phosphorus concentrations. During the 1999 assessment study, LCT2 contributed only 2% of the hydrologic load to Lake Cochrane though 18% of the phosphorus load.

The tributary LOT4 was considered important because it contributes the largest drainage area to Lake Oliver. In addition, land-use near the downstream portion of the drainage was converted from grassland and hay ground to a golf course. The average phosphorus concentration from 12 samples collected in 2007 through 2009 prior to the official operation of the golf course was 0.06 mg/L. This is consistent with the average phosphorus concentration calculated during the 1999 assessment study (0.056 mg/L). The LOT4 drainage was estimated to contribute 2 pounds of phosphorus to Lake Oliver from 12.5 acre-feet of water volume in 2009. Future monitoring efforts should be conducted to evaluate the potential impact, if any, the golf course may have on the baseline average phosphorus concentration. Increased phosphorus concentrations will contribute to a higher loading potential to Lake Oliver.

The remaining tributaries to both lakes either contribute insignificant volume or have some best practical measure in place to minimize phosphorus loading. The LCT3 drainage is the largest direct drainage to Lake Cochrane. During the 1999 assessment study it was estimated that LCT3 and LOO contributed 78% of the annual phosphorus load to Lake Cochrane. Both these tributaries have mechanisms in place to slow nutrient and sediment inputs to Lake Cochrane.

The total phosphorus load from all the main Lake Cochrane tributaries was estimated for 2007, 2008 and 2009. The actual measured loads from the Lake Oliver outlet were used to provide a starting point to back-calculate the remaining tributary loads based on the percent phosphorus load contribution calculated during the 1999 assessment study (Table 4).

Table 4. Estimated phosphorus loads for the main Lake Cochrane tributaries for 2007, 2008 and 2009.

	1999	***2007***	***2008***	***2009***	
Site	Total P (pounds)	Total P (pounds)	Total P (pounds)	Total P Load (pounds)	Percent Contribution
LCT1A	0.06	0.07	0.051	0.02	0.1
LCT1	0.84	1.3	0.86	0.3	1.7
LCT2	9.1	13.5	9.2	3	18.3
LCT3	19.4	28.6	19.6	7	38.9
LCT4	1.1	1.6	1.1	0.4	2.2
LOO	19.3	28.5	20.7	7	38.8
Total	**49.8**	**73.5**	**50.5**	**17.7**	**100**

Grey signifies actual measured phosphorus loads

Suspended Solids

The cumulative suspended solids loading to Lake Cochrane was considered insignificant during the 1999 assessment study. However, the Lake Oliver outlet contributed 80% of the suspended solids loading to Lake Cochrane. The load was attributed to common carp activity near the upstream end of the outlet structure. As aforementioned, carp are no longer a factor and suspended solids concentrations have shown significant improvement. The average suspended solids concentration from Lake Oliver in 1999 was 32 mg/L. The average suspended solids concentration from samples collected in 2007, 2008 and 2009 was just below the health lab detection limit of 3 mg/L.

The average suspended solids concentration (2007-2009 data) from the largest direct drainage (LCT3) to Lake Cochrane was 6.3 mg/L, which is considered very low. The highest suspended solids concentrations were observed (average= 14 mg/L) from LCT2 though considered insignificant given the low annual water volume contribution. Overall, the annual suspended solids loading to Lake Cochrane is minimal. Suspended solids loading to Lake Oliver is also minimal. However, land-use in the Lake Oliver watershed has been recently undergone significant transformation, which could have an impact on suspended solids loading in the future.

Lake Cochrane Phosphorus

The growing season represents samples collected May through September. The bulk of available phosphorus data for Lake Cochrane was collected during the peak recreational season in June, July and August. Phosphorus data was available for May and September though limited to only 1999, 2008 and 2009. Therefore, the average growing season represents data collected in June, July and August. For comparison, the average May and September phosphorus concentrations were calculated at 0.024 mg/L and 0.031 mg/L, respectively.

The average growing season (June through August) phosphorus concentration of Lake Cochrane has remained steady too slightly improved since Lake Oliver outflow was restored to Lake Cochrane (Figure 2). The average phosphorus concentration of Lake Cochrane prior to the reintroduction of Lake Oliver (1989-1997) was calculated at 0.037 mg/L. The average phosphorus concentration subsequent to the reintroduction of Lake Oliver was calculated at 0.027 mg/L. This suggests that the minor phosphorus loads from Lake Oliver have had no significant impact on the phosphorus level of Lake Cochrane over the past 13 years.

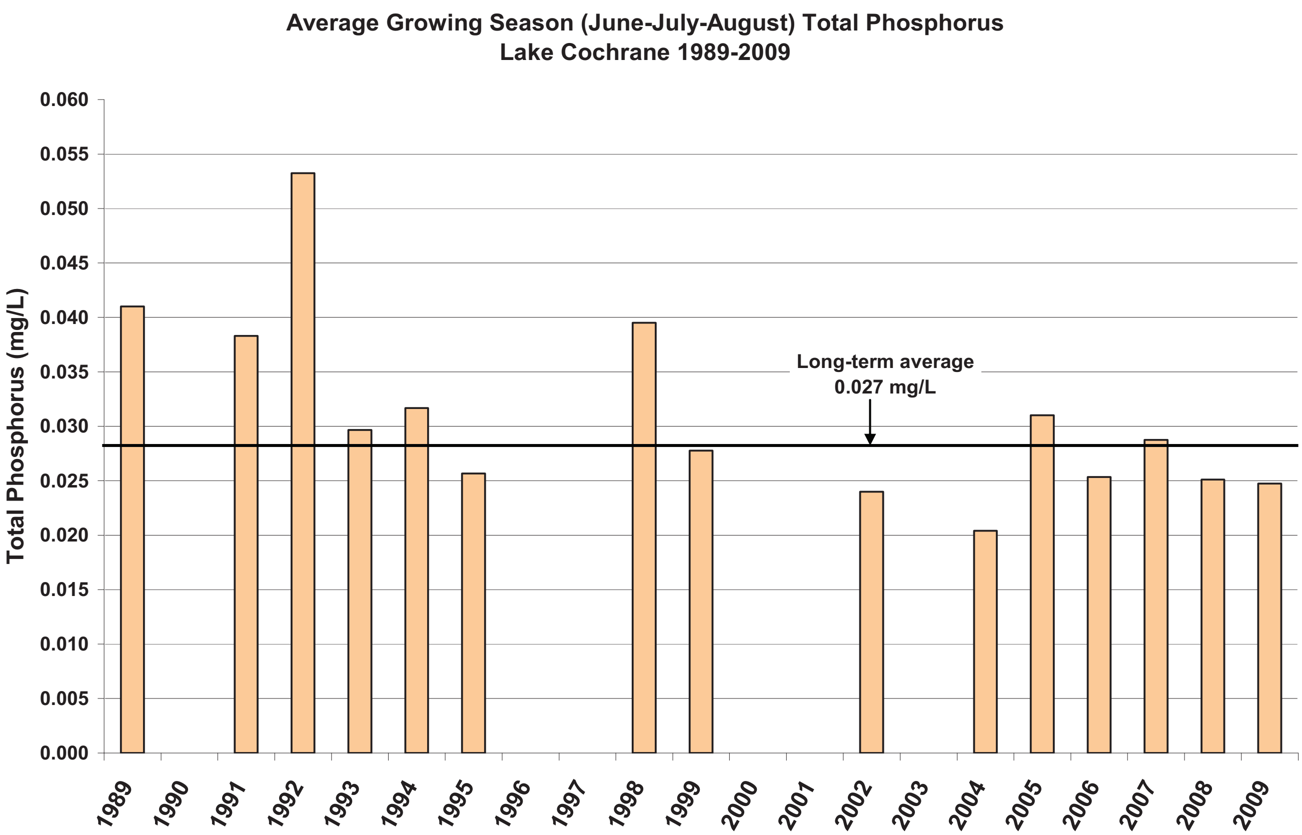


Figure 2. Average growing season phosphorus concentrations for Lake Cochrane 1989-2009.

Growing season phosphorus data collected on Lake Cochrane in 1970 and 1972 was used as a baseline for comparison. Historic phosphorus data was acquired from a peer-reviewed scientific publication produced by Dr. Lois Haertel a former limnologist and professor from South Dakota State University. Phosphorus samples were collected in locations consistent with sites LCB and LCC. The average phosphorus concentration in 1970 and 1972 was 0.026 mg/L and 0.022 mg/L, respectively (Table 5).

Table 5. Baseline phosphorus data collected by Dr. Lois Haertel 1970-1972.

Year	***1970***	***1971***	***1972***
Phosphorus (PO_4-P)	**0.026 mg/L**	0.097 mg/L	**0.022 mg/L**

Haertel (1976)

A reasonable baseline phosphorus concentration based on data from 1970 and 1972 suggests Lake Cochrane likely ranged from 0.02 mg/L to 0.03 mg/L. The average phosphorus concentration from all samples (May-September) collected in 2008 and 2009 was 0.026 mg/L, which is consistent with phosphorus concentrations observed nearly 40 years ago. This again indicates that Lake Oliver has had no impact on the phosphorus levels of Lake Cochrane since the outlet was restored.

The average growing season phosphorus concentration from 1971 was 0.097 mg/L. This value is an order of magnitude higher than any concentration observed over the past 20 years. Haertel (1976) attributed this uncharacteristic concentration to careless shoreline construction practices conducted during residential development. Dr. Haertel actually witnessed soil being bulldozed into the lake during a 1971 sampling visit. This phosphorus concentration contributed to the first documented blue-green algae bloom observed on Lake Cochrane. Lake Cochrane recovered rather quickly as the phosphorus concentration and associated blue-green algae dramatically receded by 1972.

The relatively elevated phosphorus concentrations in Lake Cochrane prior to Lake Oliver inflow was likely the result of numerous environmental factors. It is suspected that Lake Cochrane endured significant nutrient and sediment inputs from tributaries prior to the construction of sediment dams in the mid-1970s. Much of the sediment that entered from the main tributaries is still evident along the west and southwest portion of the lake. This area also harbors a very dense aquatic plant community.

In most years, Lake Cochrane receives a small amount of annual phosphorus loading. Annual changes in Lake Cochrane water quality and ecology are more likely the result of variable climate and internal nutrient dynamics associated with past nutrient inputs from agricultural run-off via the tributaries, shoreline development, early sewer systems, leaf matter, watercraft and other historic inputs that are still present within the lake basin. These factors likely mask the relatively low annual phosphorus loads received from Lake Oliver over the past 13 years.

Precipitation and Phosphorus

Annual precipitation contributes a significant portion of Lake Cochrane's hydrologic budget. In 1999, precipitation was estimated to contribute 67% of Lakes Cochrane's annual hydrologic budget (DENR 2000). The average annual precipitation for Lake Cochrane is approximately 25 inches according to long-term records acquired from the Clear Lake, SD.

Precipitation provides a source of phosphorus loading to receiving waterbodies. As rain or snow falls from the atmosphere it picks up dust particles which contain phosphorus. The actual phosphorus concentration in precipitation is variable though scientific research suggests a concentration of 0.003 mg/L is appropriate when applied to a volume or cumulative annual precipitation.

Using an average annual precipitation value of 25 inches over the surface area of Lake Cochrane (366 surface acres) equates to 732 acre-feet of volume. Applying 0.003 mg/L of phosphorus to 732 acre-feet yields an average annual phosphorus load of 6 pounds. This uncontrollable natural source of phosphorus is rather insignificant on an annual basis. Lake Oliver's estimated average annual phosphorus contribution to Lake Cochrane is only 3 times higher than the average annual phosphorus load associated with precipitation. This puts some perspective on the relatively low phosphorus contribution from Lake Oliver and the watershed in general.

Chlorophyll-*a*

Chlorophyll-*a* is a quantified measure of the green pigment found in free-floating algae. In general, increases in chlorophyll-*a* represent an increase in algae biomass. The average growing season (May-September) chlorophyll-*a* concentrations have declined consistently since 2001 in Lake Cochrane (Figure 3). The average chlorophyll-*a* concentrations were exceptionally low from 2007 through 2009. In general, the chlorophyll-*a* levels observed on Lake Cochrane are not representative of nuisance scale algae blooms. The decreasing trend in chlorophyll-*a* over the past several years implies that watershed phosphorus loads including that from Lake Oliver have not contributed to increased algae biomass in Lake Cochrane.

The chlorophyll-*a* data is not necessarily representative of all conditions that occur on Lake Cochrane during the open water season. Lake Cochrane is capable of producing nuisance level algae blooms which have been commonly reported to occur in the late summer or early fall following degradation of the resident plant community. However, the chlorophyll-*a* data suggests that algae blooms occur infrequently and are likely of short duration.

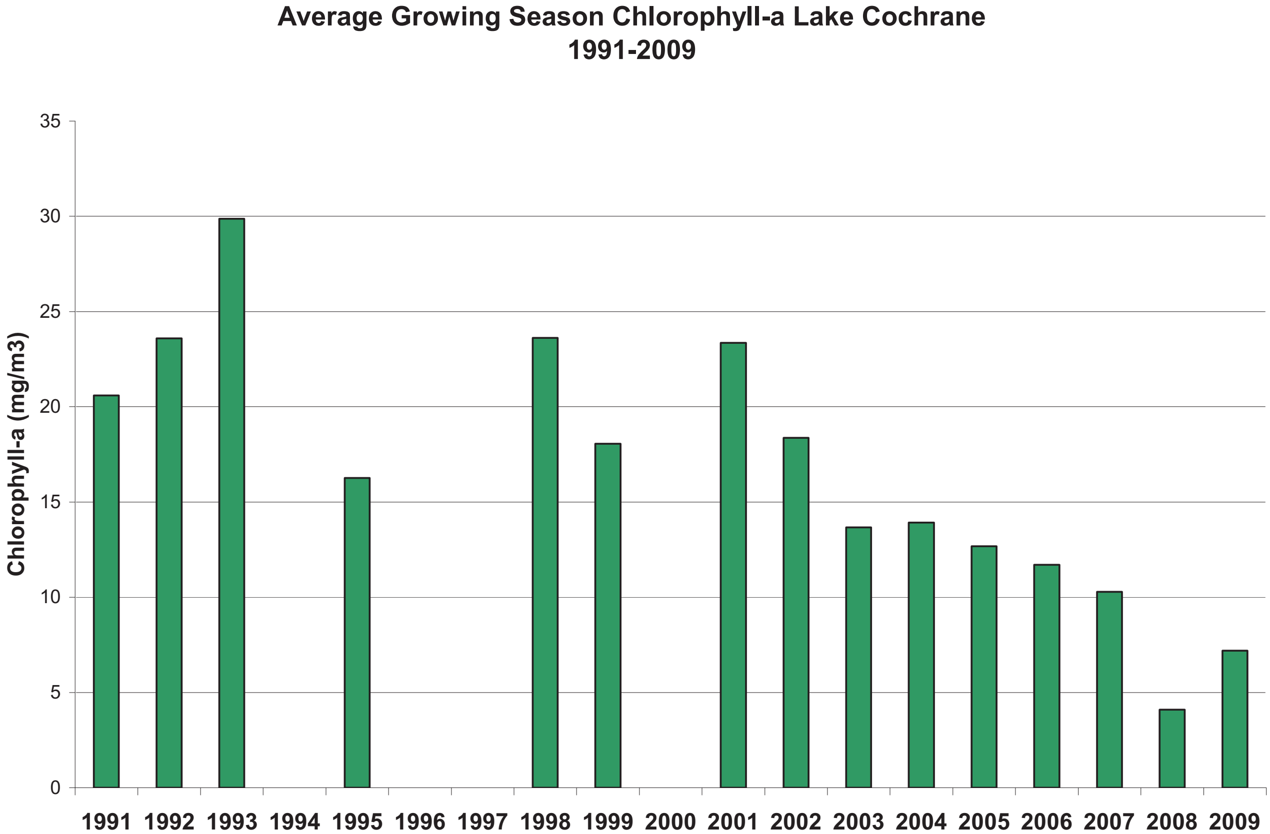


Figure 3. Average growing season chlorophyll-*a* concentrations for Lake Cochrane 1991-2009

Secchi Depth-Water Clarity

Secchi depth transparency is a measure of water clarity. Water clarity can be impeded by biological material such as particles associated with plants, algae or other aquatic organisms or by inorganic turbidity such as soil or clay particles in suspension. In general, the higher the Secchi depth value the greater the water clarity.

The average annual Secchi depth measurements on Lake Cochrane have been variable over the past nearly 40 years (Figure 4). Average growing season (May-September) Secchi depth ranged from a low of 3 feet to a high of just over 14 feet. Despite considerable variability, the Secchi depth has improved in Lake Cochrane in recent years. Water clarity is conducive to the aquatic plant community as plants require adequate sunlight to conduct photosynthetic processes. The Secchi depth has remained consistent if not slightly improved from the 1970's (Haertel, 1978), which further implies Lake Oliver has not had a major impact on the water clarity of Lake Cochrane.

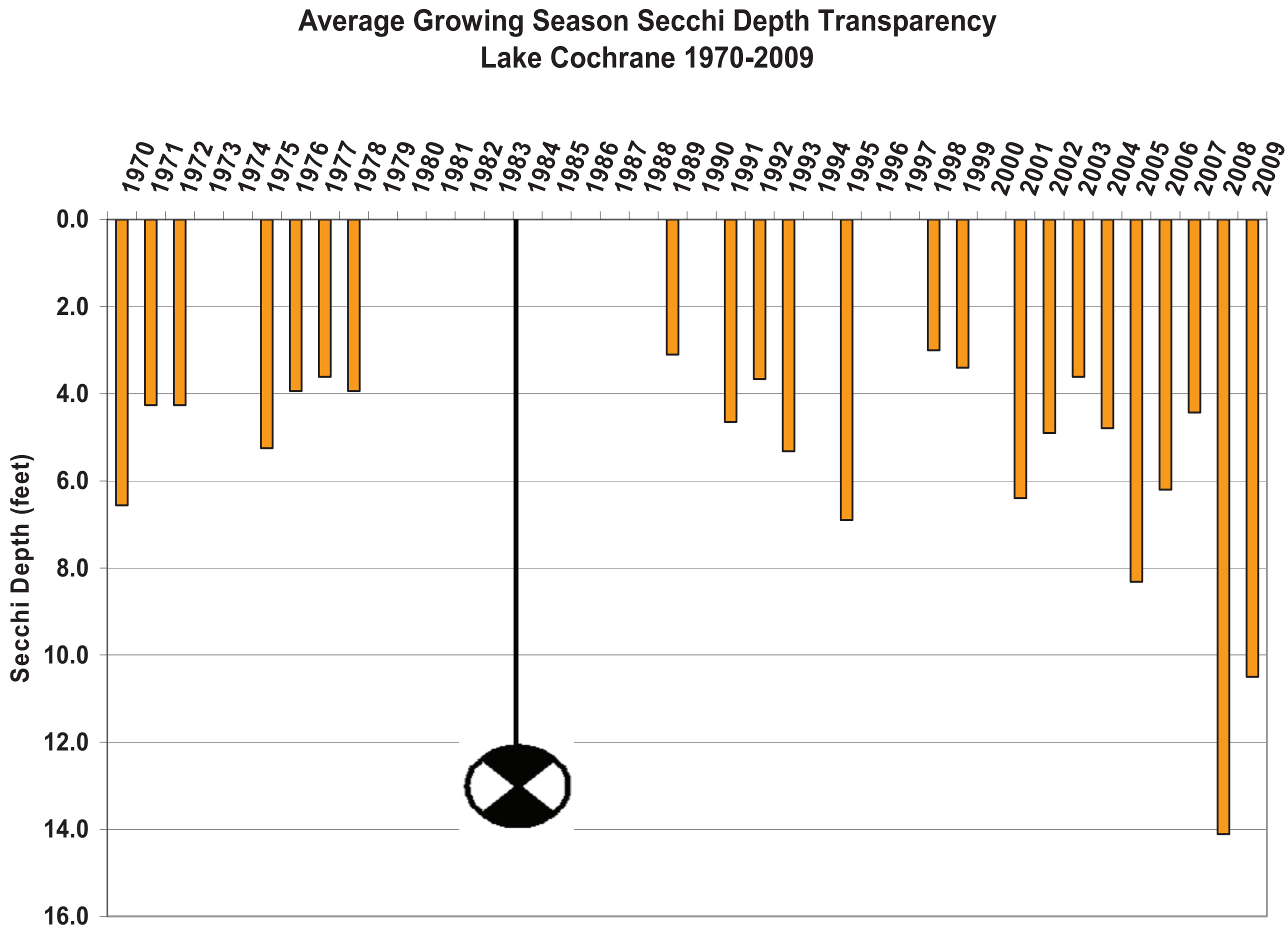


Figure 4. Average growing season Secchi depth for Lake Cochrane 1970-2009. Data from 1970-1978 acquired from Haertel, 1978.

<u>Aquatic Plant Community</u>

The plant community in Lake Cochrane has been established for many years. It is unknown exactly when the aquatic plants established in Lake Cochrane. Some local residents claim aquatic plants have inhabited Lake Cochrane for at least 40 years. Therefore, it is highly likely the aquatic plant community established sometime in the 1970s. Shoreline altering development and associated pollution sources such as sediment erosion, lawn fertilization and potential sewage issues likely laid the foundation for the current dense aquatic plant community.

The main tributaries (LCT1, LCT2, &LCT3) also contributed excessive sediment to Lake Cochrane prior to the construction of sediment basins in the mid 1970s. Legacy sediment is still evident in the west and southwest portions of the lake. This area of Lake Cochrane has a very dense community of aquatic plants. Aquatic plant surveys were conducted on

Lake Cochrane in 1999 and 2003. Both surveys concluded Lake Cochrane contained a dense and fairly diverse community of aquatic plants.

Aquatic plants were present at all depths over nearly the entire surface area of Lake Cochrane. Four species of aquatic plants were documented in Lake Cochrane. *Chara* sp. commonly referred to as Muskgrass or Stonewart was the most abundant aquatic plant. This "aquatic plant" is actually an algae species with physical plant-like features. *Chara* sp. in Lake Cochrane has a gritty texture from lime deposits indicative of hardwater or brackish lakes. *Chara* sp. typically reaches a maximum height of 1 meter, making it relatively inconspicuous in deeper water in the main basin.

Three other species of aquatic plant were identified in Lake Cochrane. Sago pondweed (*Potamogeton pectinatus*) and coontail (*Ceratophyllum desmersum*) common to many South Dakota lakes was found in relatively moderate density. A rare species of widgeon grass (*Ruppia* sp.) was found at low density. The water quality and physical structure of Lake Cochrane provides a favorable condition for both Chara sp. and Ruppia sp. which are relatively rare in South Dakota lakes. These species likely favor the hardwater or slightly brackish condition of Lake Cochrane resulting from minimal outflow over several decades.

Aquatic plants likely out-compete algae for nutrients and thus keep the incidence of prolific blooms in check. Water clarity is an important component for the health of aquatic plants as they need adequate sunlight to carry out photosynthetic processes. The plant community provides many ecological benefits to the biological community in Lake Cochrane. Because the plant community was well established and dense prior to the restoration of Lake Oliver outflow it is difficult to determine the actual impact, if any, the annual nutrient loads have had on plant productivity. The relative high density of the plant community indicates the lake is very productive.

Dissolved Oxygen

Dissolved oxygen is an important water quality element. Aquatic organisms such as invertebrates and fish rely on dissolved oxygen for survival. Dissolved oxygen is an important factor in phosphorus migration from bottom sediments. Bacteria use dissolved oxygen in the decay process of plants and algae. Lake Cochrane is susceptible to periodic low dissolved oxygen concentrations, due in large, to annual decomposition processes associated with the dense aquatic plant community.

Members of the water quality committee at Lake Cochrane collected dissolved oxygen measurements throughout the water column at three locations (LCA, LCB & LCC) monthly May through September in 2008 and 2009. Results indicated that Lake Cochrane maintained well oxygenated conditions in both years, respectively. On one occasion (July 2009), oxygen levels fell just below 5 mg/L throughout the water column. The lower values did not indicate severe oxygen depletion or anoxic conditions. The highest risk for low dissolved oxygen likely occurs in the fall and winter when bacterial decomposition of the plant community is most prominent.

Low dissolved oxygen near the sediment water interface can promote the release of phosphorus from sediments. Phosphorus released from the sediments can migrate throughout the water column, especially in well-mixed (wind and wave action) shallow lakes. In deep lakes, oxygen migration can be impeded by thermal stratification or the zone where water temperatures become colder near the bottom of the lake. Denser colder water acts as a barrier impeding the migration of phosphorus. Thermal stratification was not evident in Lake Cochrane (2008 and 2009) even at the deepest location. The incidence of thermal stratification on Lake Cochrane is rare and limited to days when the winds are relaxed.

The plant community in Lake Cochrane reduces the risk of phosphorus migration from the sediments during the growing season. Plants release oxygen into the water column minimizing the risk of low oxygen (<2 mg/L) conditions near the sediment water interface. Plants also provide a protective barrier between the bottom sediments and upper water column minimizing the potential for wind driven agitation to migrate phosphorus into the upper water column. In addition, the dense plant community requires a significant amount of phosphorus annually from the sediments for growth and maintenance, which limits availability to algae.

The bottom sediments in Lake Cochrane are likely rich in nutrients, in particular phosphorus due to historical inputs from natural and human induced sources. A combination of the current low annual phosphorus loading and internal controls (i.e., plant community and depth) that limit phosphorus recycling from the sediments are all mechanisms that shape the current ecology of Lake Cochrane. While the plant community provides many positives and negatives, disturbing the current ecological balance of Lake Cochrane could promote the increased risk of blue-green algae domination common of many prairie lakes in eastern South Dakota. Lake Cochrane's complex limnology and ecology makes it is difficult to predict the long-term effect, if any, that Lake Oliver will have on Lake Cochrane. However, the data provides no significant evidence that outflow from Lake Oliver has negatively impacted the water quality or ecology of Lake Cochrane over the past 13 years.

Nitrogen

The primary nutrient of concern for Lake Cochrane and Oliver has historically focused on phosphorus rather than nitrogen. Nitrogen is often overlooked due to its ubiquitous nature. Haertel (1976) reported that inorganic nitrogen was correlated to algae biomass in Lake Cochrane in the early 1970s. Most of the nitrogen in Lake Cochrane is in the organic form tied up in plant biomass. Therefore, algae growth in the summer months may be limited by available nitrogen. As plants die in late summer and early fall, Lake Cochrane commonly experiences an algae bloom. These blooms are likely the result of available inorganic nitrogen (nitrates and ammonia) as well as phosphorus released from decaying plant matter. To the contrary, the rather dense plant community out-competes algae for nutrients during the peak recreation season keeping prolific algae blooms from forming.

Lake Oliver

Lake Oliver receives very little phosphorus loading from its small watershed. In 2009, it was estimated that LOT4 contributed 2 pounds of phosphorus to Lake Oliver at an average concentration of 0.06 mg/L. During the 1999 assessment study LOT4 was estimated to contribute 57% of the total phosphorus load to Lake Oliver. Therefore, it was estimated that Lake Oliver received approximately 4 pounds of phosphorus from the main tributaries in 2009.

The average growing season (June through August) phosphorus concentrations of Lake Oliver has been stable with slight improvement over the past 4 years (Figure 5). Most of the Lake Oliver watershed was taken out of agricultural production and planted to native grasses as part of the Conservation Reserve Program (CRP). The improved phosphorus concentrations displayed by Lake Oliver in recent years, is likely a response of low annual phosphorus loading associated with CRP, coupled with restored outflow. A change in land-use practices is currently ongoing in the Lake Oliver watershed as most CRP contracts expired in 2007.

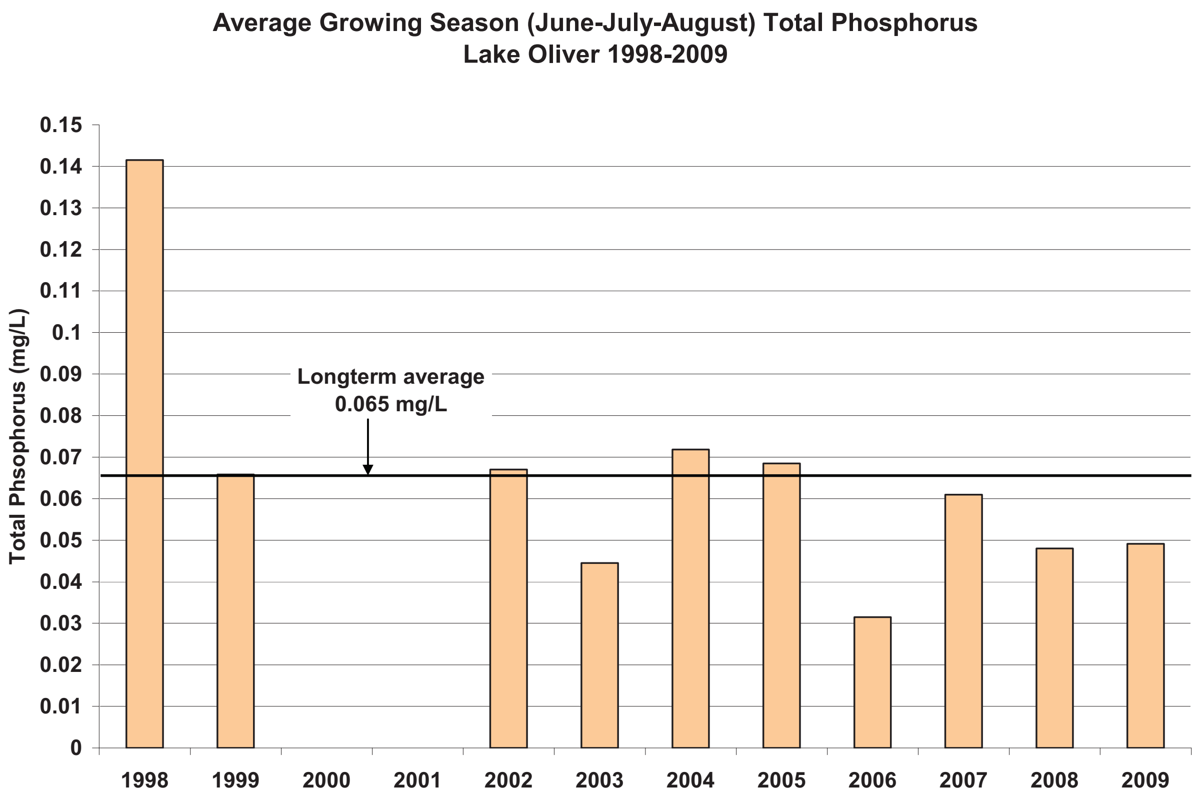


Figure 5. Average growing season phosphorus concentration from Lake Oliver 1998-2009.

The average growing season chlorophyll-*a* concentrations (May through September) in Lake Oliver have slightly declined since 1999 with the exception of 2007 (Figure 6). Summer algal biomass has been moderate to low over the past 10 years. Summer chlorophyll-*a* concentrations are not representative of concentration expected in April, May and early June when outflow from Lake Oliver occurs to Lake Cochrane. The average chlorophyll-*a* concentration for Lake Oliver in April-May of 2008 and 2009 was calculated at 6.2 mg/m^3.

Limiting outflow from Lake Oliver to spring and early summer has reduced the potential of releasing moderate algae blooms to Lake Cochrane. Flow exchange from Lake Oliver has typically been clear with minimal solids including algae. Allowing outflow to occur in spring reduces the chance of outflow in the summer months when algae biomass may be at moderate levels.

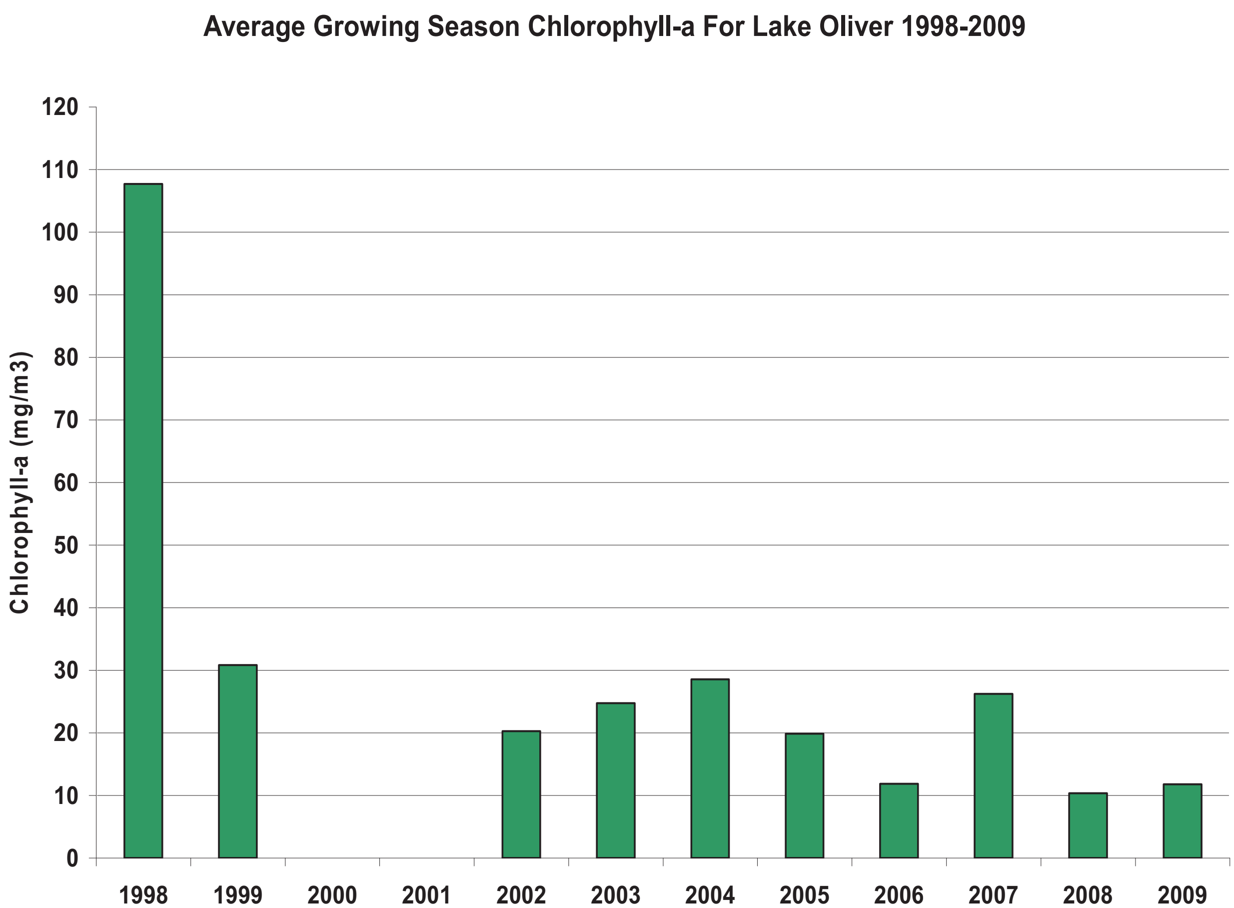


Figure 6. Average growing season chlorophyll-a concentrations for Lake Oliver 1998-2009.

The average growing season (May through September) Secchi depth measurements for Lake Oliver have been relatively steady over the past several years, with considerable improvement displayed in 2008 and 2009 (Figure 7). The water clarity of Lake Oliver is expected to be exceptionally better in the spring when algal abundance in Lake Oliver is relatively low. The main source of spring turbidity in Lake Oliver is likely inorganic sediment caused by wind and wave action. Water that exits Lake Oliver travels through a small wetland area between the main lake basin and the outlet structure which is congested with cattails. Dense cattails provide a mechanism for reducing sediment transport from Lake Oliver. As a result, spring outflow from Lake Oliver is generally of exceptional clarity supported by the low suspended solids concentrations observed from samples collected in 2007, 2008 and 2009.

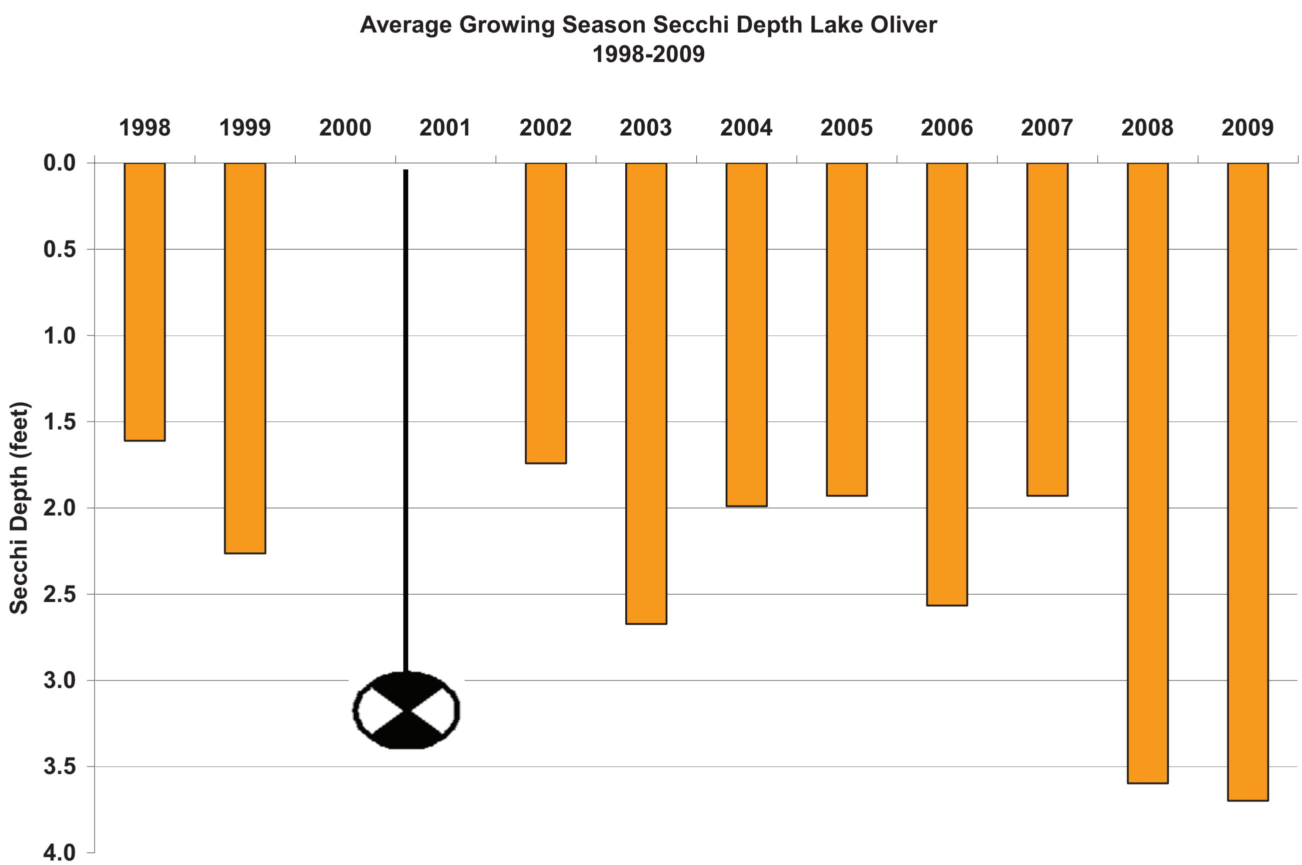


Figure 7. Average growing season Secchi depth measurements for Lake Oliver 1998-2009

CONCLUSION

The perception that Lake Oliver would degrade the high-quality condition of Lake Cochrane probably stemmed from flood conditions that occurred in the mid 1990's. During initial flood conditions the county installed temporary culverts to provide outflow from Lake Oliver to Lake Cochrane. The initial outflow from Lake Oliver was essentially unregulated. Several mechanisms are currently in place to minimize nutrient and sediment loading from Lake Oliver. Flood control permit FC-23 provides qualifications to limit inflow from Lake Oliver to spring and early summer when algae and associated nutrients are at a minimum. Dense cattails established in the small wetland between the main Lake Oliver basin and the outlet structure trap and sequester nutrients and sediment reducing transport from Lake Oliver to Lake Cochrane. In addition, dense cattails eliminate rough fish activity near the upstream end of the outlet structure providing further reduction benefits. The result has been relatively low annual phosphorus loads from Lake Oliver to Lake Cochrane from 1997 to 2009.

Lake Cochrane apparently has the capacity to assimilate the relatively low annual phosphorus loads from the watershed. Annual phosphorus received by Lake Cochrane, including that from Lake Oliver is likely exported in outflow, stored in the sediments or used by organisms such as fish, invertebrates, aquatic plants and algae. The general, trophic condition (phosphorus, chlorophyll-*a* and Secchi depth) of Lake Cochrane has not been significantly impacted by annual phosphorus loads from Lake Oliver since outflow was permanently restored in 1997.

The water quality and ecology of Lake Cochrane is likely dictated by historic nutrient and sediment inputs. The main tributaries to Lake Cochrane provided significant sedimentation and associated nutrients prior to the construction of sediment dams in the mid 1970s. Intense residential development and shoreline alterations including a host of other natural and human induced sources have contributed significant nutrients and sediment to Lake Cochrane. Considering outflow from Lake Cochrane has been relatively minimal, especially prior to the re-introduction of Lake Oliver, most of the pollutants received by Lake Cochrane are still contained in the lake. The rather dense aquatic plant community is a likely result of these historic nutrient and sediment inputs.

The dense aquatic plant community in Lake Cochrane provides many ecological benefits. The aquatic plant community likely out competes algae for nutrients reducing the incidence of frequent and intense blue-green algae blooms common to many prairie lakes in eastern South Dakota. The relatively good water clarity displayed by Lake Cochrane is a function of the plant community. The plant community can also have some negative effects though it is an important component of the ecology of Lake Cochrane.

The results of this investigative study conclude that Lake Oliver has not had a significant impact on Lake Cochrane water quality or ecology over the past 13 years. A host of management options are recommended to encourage future protection and enhance the beneficial uses of Lake Cochrane.

RECOMMENDATIONS

Aquatic Plant Control: Work in conjunction with the Department of Game, Fish and Parks and the Department of Environment and Natural Resources to implement an appropriate aquatic plant removal program. Selective harvest of aquatic plants will increase shoreline usability and remove nutrients stored in plant biomass.

Rough Fish Removal: Develop a plan to encourage long-term eradication of rough fish, primarily bullheads and carp, from Lakes Oliver and Cochrane. The removal of rough fish would remove nutrients and reduce the potential risk for nutrient migration caused by bottom sediment agitation.

Leaf and Debris Removal: Promote the annual removal of fallen leaves and other organic materials including aquatic plants from residential shorelines to decrease nutrient inputs to Lake Cochrane.

Continued Public Outreach: The LCIA should continue to promote nutrient and sediment reduction practices to local residents, landowners in the watershed and the general public through continued information and education outreach. Strongly encourage local residents to use non-phosphorus based lawn fertilizer as a common lawn care practice.

Prairie View Golf Course: The LCIA should form a relationship with the golf course manager or developer to encourage the use of non-phosphorus based fertilizer for turf management. In addition, encourage sediment erosion control measures for the irrigation ponds to minimize the potential for sediment transport, especially during spring run-off. Incorporating best management practices tailored to reduce nutrient and sediment transport from the golf course is strongly recommended to minimize loading to Lake Oliver.

Water Quality Monitoring:

Continue to monitor annual water quality of Lakes Cochrane/Oliver and associated tributaries. Results of future water quality monitoring efforts can be used to document potential changes or trends over-time.

Lake Outlet Debris Removal: Develop a plan and locate volunteers to keep the Lake Oliver outlet and the Lake Cochrane outlet free of debris in the spring during potential outflow. Ensuring proper function of the outlets is important to nutrient management and reduces the potential for flooding during high water.

Additional management options include selective sediment dredging along the west and southwest near the main tributary inlets of Lake Cochrane and the establishment of aquatic plants in Lake Oliver. These options would require outsourcing and may not be feasible due to expense.

LITERATURE CITIED

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Haertel, L. 1976. Nutrient limitation of algal standing crops in shallow prairie lakes. *Ecology* (57) 4, pp-664-678.

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Appendix C

Dakota Water Watch-Final Report

The Dakota Water Watch Program was instituted in 2007 by the East Dakota Water Development District (EDWDD). EDWDD is a political subdivision of state government established in 1963, designed to promote conservation, development, and proper management of water resources. There are six other water development districts in South Dakota. It is a non-regulatory entity governed by a nine member elected board that represents all or part of 11 counties in eastern South Dakota. In addition to Dakota Water Watch, EDWDD is also involved in watershed assessments, ground water protection, regional water festivals, implementation projects, and providing financial and technical assistance.

In South Dakota, many lakes and streams used for swimming and boating have little to no current data regarding the health safety of those waters. Only 115 lakes, or about 20% of lakes in the state, are routinely sampled for water quality by the Department of Environment and Natural Resources (DENR), and many of these are only sampled once every four years. Additionally, the state's 142 Water Quality Monitoring (WQM) stations are stretched across close to 10,000 miles of perennial waterways, and there is minimal monitoring on South Dakota's approximately 1.8 million acres of wetlands.

The goals of the Dakota Water Watch Program are as follows: First, to support citizen monitoring efforts. This was accomplished by becoming the point of contact for the few small existing volunteer monitoring programs that were already in place across South Dakota and by working to actively support and recruit new citizen monitors. Bringing all existing and future volunteer monitoring programs under one roof brings consistency to the data collection and documentation process. The second is to establish baseline water quality data. People spread across the state, sampling waters near their homes and/or important to them, could add greatly to the DENR's understanding of certain lake and stream systems. The information gathered could also highlight water bodies that may need further attention that would not otherwise have been noticed under the state's current monitoring system. Third, is to build community awareness and stewardship. A formal program gives people who are interested in water resources, but not sure what they can do, some direction as to how they can work to learn about and protect waters important to them. With more knowledge, citizens would be better prepared and more likely to take action to remedy water issues concerning them. Finally, Dakota Water Watch helps citizen monitors make connections by networking with others from across the state. The program lets them know that there are others with similar concerns and that they are not alone in their efforts. Dakota Water Watch also serves as a hub through which volunteers can share information and ideas.

PROGRAM ELEMENTS

Recruitment efforts for new program volunteers has consisted of presentations at lake association meetings and at the South Dakota Lakes and Streams annual meeting; information available through the EDWDD website; displays at Dakota Rural action Earth Day events, farm shows, and the state fair; and by word of mouth. Once an individual or group has expressed interest in the program, an appropriate monitoring track is settled upon by the volunteer and Dakota Water Watch staff.

The program consists of four different monitoring tracks. The most basic monitoring track is "Baseline Monitoring". This type of monitoring is best suited for volunteers with little to no experience and/or those with the least amount of time to devote to the program. Baseline monitoring consists of observing and recording physical parameters (temperature, water clarity, weather conditions, algal conditions, presence of wildlife, presence of aquatic nuisance species) of a water body at least once each month between April and October. In addition to recording objective physical measurements, monitors are asked to rank on a scale from strong positive to strong negative, how they felt water quality influenced the following activities: recreating by the water, boating, fishing, waterskiing/jet skiing, swimming, and allowing pets to drink or swim. These subjective measurements are used not only to track if the people who monitor a certain lake are noticing a change in water quality through time, but also whether a water body, which may show undesirable numerical measurements, is seen by those who use it as being truly degraded. For example, a lake that normally has poor water clarity may not be seen by the local residents as adversely affected in regards to swimming because everyone is used to it being that way.

Monitor Taking a Secchi Disk Reading on Oakwood Lakes.

For those volunteers willing to make a slightly larger commitment to the program, there is the "Bacteria Monitoring" track. This type of monitoring involves the collection of a water sample for bacterial analysis in addition to observing and recording all of the same physical conditions as Baseline Monitoring. Because having each sample processed by the state health lab would be cost prohibitive considering the number of samples involved, mini-labs manned by volunteers were set up across the area covered by Dakota Water Watch. A mini-lab operator can either be a volunteer who monitors a specific site(s) or someone whose only involvement with the program is culturing the bacteria samples. Due to the time constraints involved in incubating bacteria, mini-lab operators set a schedule as to when they will accept samples or simply require sample collectors to provide them with a certain amount of notice ahead of time. Samplers are provided with disposable sterile sample bags to collect their bacteria samples along with coolers and ice packs to keep the sample cool between the monitoring location and the mini-lab.

The third sampling track is called "Lake Index Monitoring". This type of sampling is done at mid-lake locations and thus requires the volunteer to have access to a watercraft. Lake index monitoring involves a volunteer collecting and recording all of the same information covered by baseline monitoring. However, the volunteer also collects water samples that are then shipped to the State Health Lab in Pierre, SD for analysis. Due to the low probability of finding a significant amount of bacteria in the center of a lake, bacteria samples are not collected as part of this monitoring track. Parameters sampled for vary by lake, but nearly every lake involved is sampled for total phosphorus and chlorophyll-*a*. Additional parameters sampled for include: total suspended solids, total dissolved solids, total Kjehldahl nitrogen, nitrates, ammonia, alkalinity, and pH.

The fourth monitoring track, “Other Monitoring”, is offered for an individual or group with specific interests outside of the three main monitoring tracks. For example, one volunteer collected nutrient data on streams feeding and draining Lake Hendricks in order to monitor the impacts of recent conservation work that had been done within the watershed. The South Dakota Canoe and Kayak Association has participated in “snap-shot” sampling events where multiple watercraft sample many sites concurrently across a single lake to see what conditions were like on that lake on that specific day. Additional “Other Monitoring” options include monitoring invasive species, plant communities, wetlands, sediment depths, and water chemistry.

<u>Training</u>

After a group or individual has expressed an interest in the Dakota Water Watch Program, a suitable time and location is arranged to meet with Dakota Water Watch personnel to receive supplies and training. While an attempt is always made to group people together at centralized training sessions, scheduling conflicts usually dictate that training be done on an individual or specific group level. The small size of the program, and the limited area covered at this time, make this arrangement possible. At a typical training session the volunteer receives a booklet containing step by step instructions explaining how to pick their monitoring site and perform their monitoring duties. They also receive any permanent equipment, supplies, and data sheets they would need based on the type of sampling they plan to do. If a suitable water body is located nearby, Dakota Water Watch staff will assist the monitor in collecting a simulated sample and filling out the appropriate paperwork. This is a very “hands-on” process and every effort is made to have the volunteer do as much of the work as possible so they will be ready when they were in the field on their own. Dakota Water Watch staff is also available by telephone and email to answer any questions the monitor may encounter. Most mini-lab operators were trained during the Dakota Water Watch pilot program in 2007 and do not require retraining. New mini-lab operators are trained in person when they receive their materials. Training consists of a demonstration on how to operate the incubator, how to properly handle and dispose of samples, how to count bacteria colonies, and how to fill out the bacteria monitoring data sheet that accompanies each sample.

Demonstration by Dakota Water Watch Staff During a Training Session on How to Take a Water Sample and Fill Out The Accompanying Paperwork.

Data Management

When a sample is taken, one to three pieces of paperwork are generated. A field monitoring data sheet is filled out at each sample site on each visit no matter which type of monitoring a volunteer is doing (see Appendix A). Once completed, this data sheet is mailed as soon as possible to Dakota Water Watch. Bacteria monitors, in addition to the field monitoring data sheet, fill out part of a bacteria monitoring data sheet (name, date, time, location) for each bacteria sample they collect (see Appendix A). This data sheet is then passed on to the mini-lab operator who completes the rest of the data sheet with information relating to the incubation process as well as the final bacteria counts. Lake index monitors complete a SD Water Quality Data Sheet each time they take a water sample (see Appendix A). This sheet is sent to the State Health Lab in Pierre, SD along with the sample as part of the DENR's and the State Health Lab's record keeping process. Lake index monitors also complete a field monitoring data sheet that is sent to Dakota Water Watch. The State Health Lab analyzes the samples and sends the results to Dakota Water Watch. It is important that all paperwork is sent to Dakota Water Watch as soon as possible so that it can be checked for errors or anomalous readings. If errors are detected, Dakota Water Watch staff contacts the monitor right away and tries to make a correction while the event is still fresh in his/her mind. After data is deemed to be acceptable, it is entered into an Excel spreadsheet.

At season's end, each monitor receives a booklet containing a brief summary of data from each water body, an explanation of the parameters Dakota Water Watch monitors for and why they are important, and a complete listing of all data collected by the project that year. Also, two times each season, all registered monitors receive a newsletter with a data summary, tips to help volunteers monitor more effectively, and any Dakota Water Watch news. An electronic copy of all data collected, as well as all data sheets generated by the program, is on file at the EDWDD office in Brookings, SD. In 2009, all data available at that time was submitted to the SD DENR for possible inclusion in the 2010 integrated report.

Quality Assurance/Quality Control

As mentioned above, part of the quality assurance and quality control (QA/QC) for Dakota Water Watch is to have Dakota Water Watch staff check each data sheet submitted for errors or strange readings. Due, to the relatively low number of data sheets involved, checking each one individually is possible. If the volume of data sheets gets to be high, a certain percentage of data sheets will be checked at random to ensure accuracy. Another element of QA/QC incorporated into the Dakota Water Watch program is the fact that all monitors are using the same equipment and datasheets. This reduces the number of errors made while reading and recording measurements. Additionally, mini lab operators culture three Petri dishes per sample and then average the resulting bacteria counts. This limits the effects of differential growth of bacteria within each culture. Finally, a combination of field sample blanks and duplicates, along with lab blanks, are a check for possible sources of contamination and inconsistencies throughout the sample collection and incubation process.

Monitor Holding a Lake Water Sample (Left) and a "Blank" Water Sample (Right).

Participation & Data

The number of volunteers participating in Dakota Water has generally increased since its inception in 2007. The original pilot program consisted of 21 bacteria monitors. In 2008, there were 48 volunteers (45 monitors across the three major monitoring tracks and three mini-lab operators) monitoring 82 sites (77 lake, five stream) covering 18 water bodies. In 2009, volunteer numbers increased to 64 (61 monitors and three mini-lab operators), covering 100 sites (95 lake, four stream, one pond) and 20 individual water bodies. In 2010, the number of volunteers dropped slightly to 51 (48 monitors and three mini-lab operators). The number of monitoring sites also fell to 99 (91 lake, seven stream, one pond), but the number of water bodies sampled increased to 30. While not all volunteers remain active, over the last three years, more than 85 citizens across the state have participated to some degree in Dakota Water Watch. Note: The drop in volunteer numbers in 2010 can be partially attributed to several of the Canoe and Kayak Association members being unable to attend their annual monitoring event. Also, many volunteers monitor in groups with friends and family. This can lead to confusion when calculating the number volunteers in the field as they can vary significantly from event to event and from season to season. Steps have been taken to modify our paperwork to minimize the effects of these discrepancies in the future.

Along with increases in the number of volunteers involved with Dakota Water Watch, the amount of data generated by the program has grown each of the past three years. In 2008, 321 Secchi depth measurements and 329 bacteria samples were taken. In 2009, the numbers increased to 474 Secchi depth measurements and 461 bacteria samples. In 2010, they increased again to 548 Secchi depth measurements and 522 bacteria samples.

Results

As mentioned earlier, a goal of Dakota Water Watch is to establish baseline data for surface waters that have little to no data on record. While the program has gotten off to a good start, three years is a relatively small data set, and the baseline data will become more reliable with each year that monitoring continues. That being said, several trends have begun to reveal themselves, but further investigation is needed to see if these are true over the long term or merely indicative of temporary conditions.

Table 1 shows Secchi depth averages by year for lakes involved in Dakota Water Watch over the last three years. To create this table, all of the transparency measurements recorded for a sample site within a given month were averaged together. For lakes with multiple sampling locations, the monthly averages for each site were averaged together to determine the lake-wide Secchi depth measurement for that month. To calculate the yearly transparency average, each of the monthly averages for a particular lake was averaged together. Some of the transparency values are followed by a "+" sign. This is the result of the water clarity measurement being greater than the total depth of the water at a site on that lake during at least

Table 1. Secchi Depth Averages In Meters For Lakes Involved With The Dakota Water Watch Program For 2008-2010.

Secchi Depth Averages (in meters) for Dakota Water Watch Lakes, 2008-2010			
	2008	2009	2010
Andes	0.31	0.29+	0.32
Brant	0.91	1.09+	1.08+
Blue Dog			0.59
Campbell		0.22	0.28
Cochrane	2.69+		
Dry			1.00+
Grass	0.30		0.21
Hendricks		1.60	0.79
Henry			0.58+
Herman	0.48+	0.59+	0.71+
Kampeska	0.72+	0.85+	
Long	0.31	0.26	0.54+
Madison	0.68+	0.95+	0.63+
McCook	0.63	0.62	0.60
Oakwood		0.46+	0.75+
Pocasse	0.57	0.45	0.43
Poinsett		1.24+	1.39+
Round	0.46	0.77+	0.71
Thompson		0.53+	0.46
Waubay (North)	1.68		1.27
Waubay (South)	2.61		1.21

one sampling event during a given year. When the Secchi disk is visible on the bottom of the lake or stream, it is impossible to say with certainty what the exact Secchi depth value is. All that can be said is that it is greater than the measured depth at that time. Therefore, all values containing a "+" sign must be treated as relative values.

Between 2008 and 2010, 1,236 bacteria samples were collected and processed by Dakota Water Watch mini-labs. *E. coli* are measured in colony forming units per 100 milliliters of water (cfu/100mL). Figure 1 shows the percentage of bacteria samples collected from lakes that fell into one of four bacteria count number ranges (No Detection, 1-50 cfu/100mL, 50-235 cfu/100mL, greater than 235 cfu/100mL). The three smaller charts each represent a single year within the program while the fourth chart shows all samples collected over the past three years. No detection means that no *E. coli* bacteria were observed in any of the dishes cultured for a

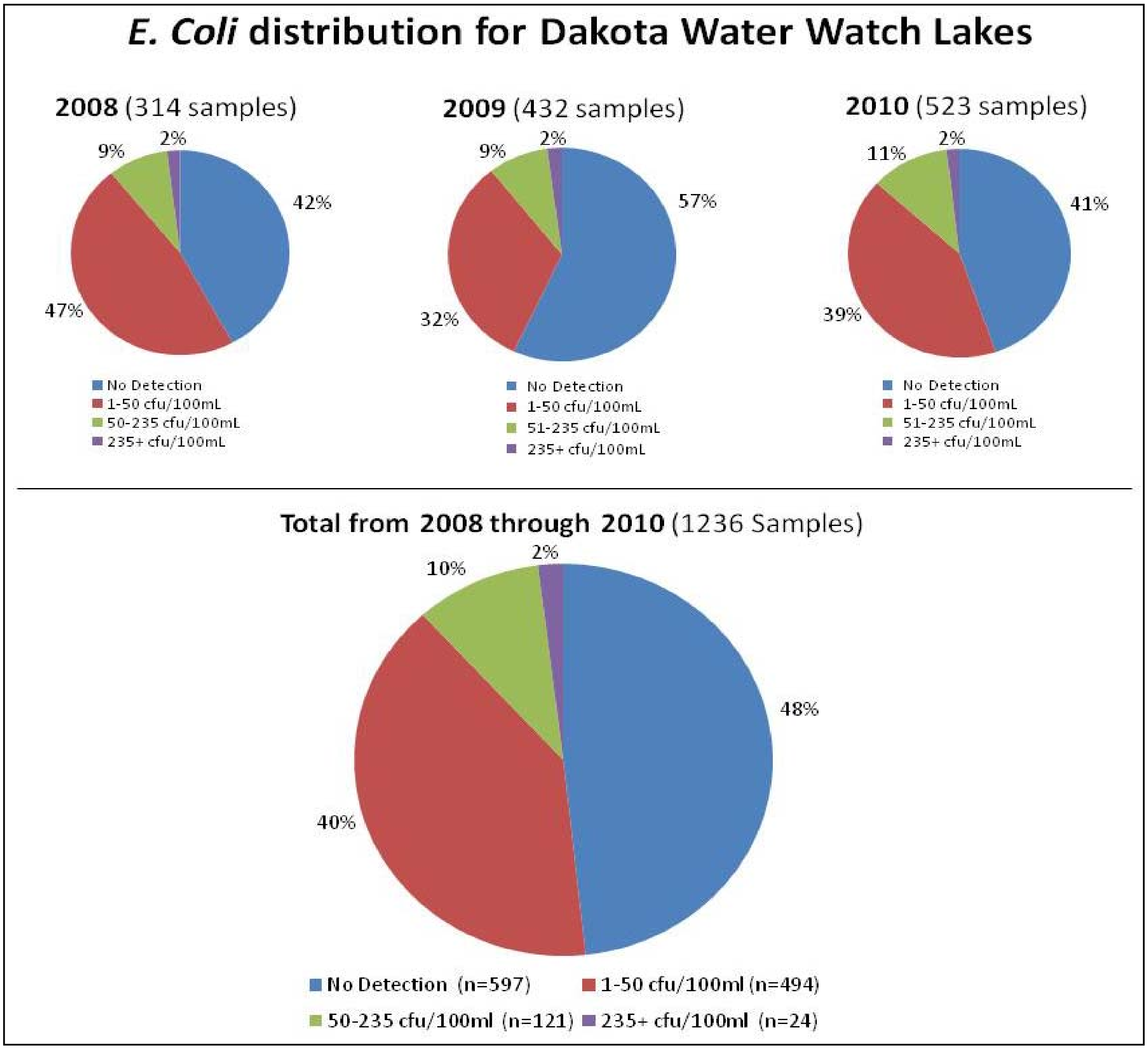

Figure 1. *E. coli* Distribution Based on Count Categories for All Lakes Involved With The Dakota Water Watch Program for Each Year (2008, 2009, & 2010) Along With a Summary of All Bacteria Samples From 2008-2010.

sample. A sample containing between 1 and 50 cfu/100mL *E. coli* is relatively common and not cause for too much concern. Samples with between 51 and 235 cfu/100mL *E. coli* are approaching (but still below) limits recommend by the EPA for intensively used recreational waters and set by the state of South Dakota for immersion recreation. Any number greater than 235 cfu/100mL breaks the South Dakota *E. coli* Standard for a single sample for waters designated for immersion recreation and indicates a potential heath issue.

At no point during the past three years have the total number of lake samples exceeding the 235 cfu/100mL level been more than two percent of the total number of samples collected. Between 2008 and 2010, almost 90% of samples have contained less than 50 cfu/100mL *E. coli*. While the percentage values for each category have remained fairly constant, 2009 was the "cleanest" year with 57% of samples showing no detection of *E. coli*. 2008 and 2010 were virtually identical in their percentages of no detections at 42% and 41% respectively. Lakes that did have samples exceed the 235 cfu/100mL mark usually only did so in very isolated cases. The only lake to have a recurring problem with *E. coli* numbers was McCook Lake in Union County. However, most of the problem samples were associated with rain events, and even then, represented a very small percentage of the total number of samples collected from that lake. Rain events cause upland runoff and higher inflows from the surrounding watershed which may contribute higher levels of bacteria to the lake.

One of the most noticeable trends in bacteria monitoring is the difference in *E. coli* levels between samples collected from lakes and those collected from streams. This is likely due to the fact that as streams wind their way through their watershed, they have many opportunities to come into contact with sources of bacteria from upland and/or urban runoff, domestic and wild animals watering in-stream, and storm sewers. During periods of higher flow, usually during a rain event, more material is washed into the stream which can also contribute to higher bacteria counts. Figure 2 shows the percentage of samples from each type of water body that fell into four different ranges of bacteria counts between 2008 and 2010. Percentages were used in place of actual sample numbers due to the fact that there were far more lake samples taken than stream samples. Again, *E. coli* counts over 235 cfu/100mL would be in violation of current South Dakota *E. coli* standards for immersion

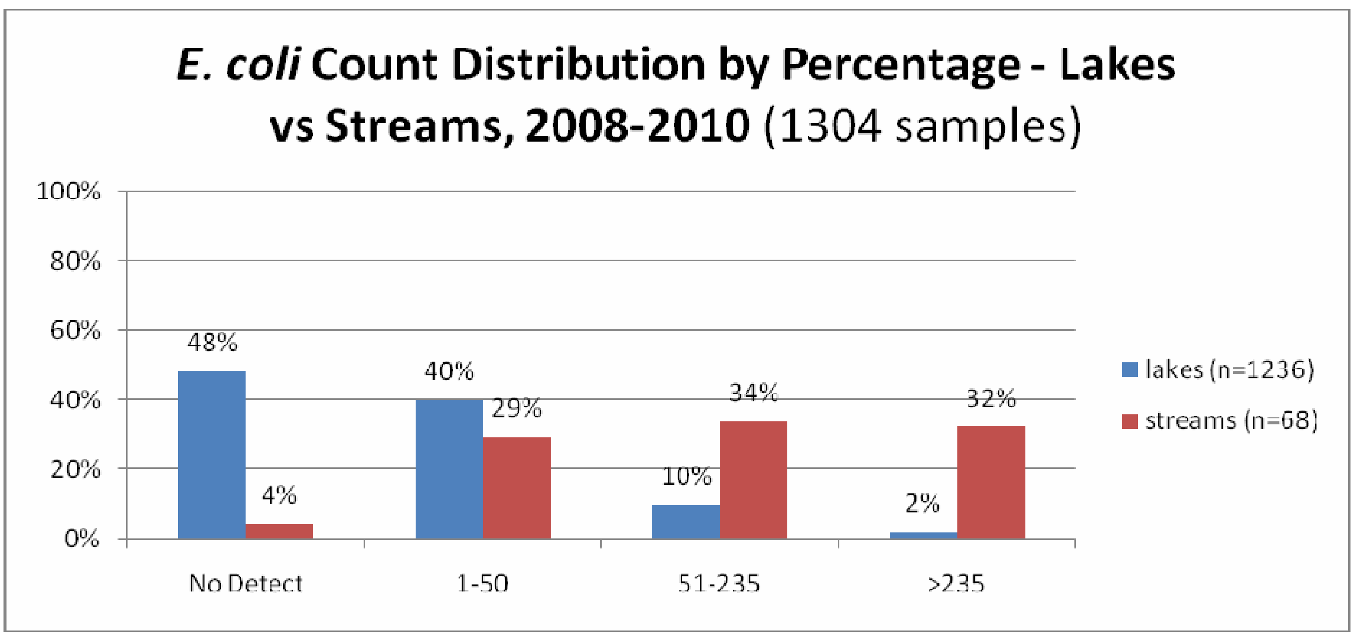

Figure 2. ***E. coli*** **Distribution by Percentage of Total Samples Taken For Each Category, Lakes vs. Streams**

recreation. Between 2008 and 2010, nearly half of all bacteria samples taken from lakes showed no detection of *E. coli*. As the number of *E. coli* colonies per sample increases, the percentage of all data that these samples represent steadily decreases. Only two percent of samples taken from lakes contained greater than 235 cfu/100mL *E. coli*. By comparison, nearly one-third of all samples from stream sites contained more than 235 cfu/100mL *E. coli*, and only four percent were no detections.

Difficulties and Potential Changes

While the overall operation of the Dakota Water Watch Program has gone smoothly, there have been several issues encountered and notable areas where improvements can be made. The largest problem that Dakota Water Watch had to deal with during this time period was the turnover in program staff during the 2008 sampling season. This was especially disruptive as it happened mid-season during the second year of the program's existence. Data sheets submitted for some time were not immediately checked for accuracy, and therefore, any errors were not immediately addressed. Also, presumably because volunteers received no direction or communication from Dakota Water Watch for a period of months during the 2008 sampling season, they lost interest and dropped from the program. These volunteers have been slow or unwilling to rejoin. Another matter that needs to be improved is volunteer training. Due to the relatively small number of volunteers involved in Dakota Water Watch initially, it was possible to conduct training on a one-on-one basis. With the number of volunteers participating now, it is not practical to visit each volunteer individually. Instead, a number of trainings will be set up throughout the area covered by the program at which volunteers can be trained and receive their materials. In the future, certain monitors in more distant areas could possibly be trained to train prospective volunteers in their area. A third issue affecting the program was the QA/QC system, specifically the collection of duplicates and blanks. Blank and duplicate sample sets need to be collected for at least 10% of the total samples collected to ensure accuracy and consistency. This was not achieved during any of the last three years of the program, and steps must be taken to increase these numbers in upcoming years. Finally, the program may have been too ambitious when initially conceived resulting in it being too complicated for volunteers. Most likely in an effort to catch up with well established programs in other states, many different and sometimes very complicated parameters were sampled for and observed. Many of these turned out to be too scientific to be done by inexperienced monitors, and therefore were too often done unreliably. As the program is still in its developmental stages, it would be better to concentrate our time and resources on basic water quality parameters and possibly expand the scope our investigations as volunteers become more experienced. Most of these issues have already been addressed, but more changes are likely in the future.

Summary

The Dakota Water Watch program is well on its way to accomplishing its goals. Over the past four years it has served as a point to consolidate and serve citizen monitoring efforts in South Dakota and has the capacity to continue to do so and grow in years to come. Information generated and compiled by Dakota Water Watch will continue to supplement data generated by government agencies and by private companies and will provide a clearer picture of water conditions across the state. Finally, the program will continue to unite concerned citizens to a common goal and provide networking possibilities. Even if some citizens choose not to participate consistently, or in future years, they hopefully will have gained a greater understanding and appreciation of their water resources.

Appendix A

Sample Data Sheets

FIELD MONITORING DATA SHEET

Complete each time samples are collected or observations & measurements are made

Monitor Name(s):
(Example: J. Doe)

Date: (mm-dd-yyyy)	**Time:** (24hr, ex: 1:10 PM is 1310)
Water Body Name:	**Sample Site ID:**

Weather Conditions

Cloud Coverage:

☐ Clear ☐ Scattered ☐ 1/2 ☐ Broken ☐ Overcast ☐ Obscured by fog or smoke

Wind Direction (direction wind is coming from) :________________________________

Wind Speed:

☐ Calm *(smoke rises vertically)* ☐ Slight breeze *(leaves rustle, flags stir)* ☐ Moderate breeze *(papers blow, small branches move, flags flap)* ☐ Strong breeze *(Large branches move, difficult to use umbrella)*

Current Precipitation:

☐ None ☐ Light rain (<0.3 cm/hr) ☐ Moderate rain (0.3-0.8 cm/hr) ☐ Heavy rain (>0.8 cm/hr) ☐ Snow/hail

Precipitation (Previous 24 hrs) **:**

Estimate total amount in **centimeters**: ________

Air Temperature (nearest 0.5°C) **:**________ **°C**

Note:

Measure in shade, out of direct wind and direct sunlight

Measure air temperature before water temperature

Physical Conditions (where applicable, please circle units used)

Water Temperature (nearest 0.5°C):

__________________ **°C**

Measure with bulb submerged 30 cm

Total Water Depth at Sample Site:

__________________ meters centimeters

Secchi Disk/T-tube: ________________________ meters centimeters

Measure on shady side of boat or dock preferably between 1000 and 1500. ** Remember to compensate for fastener

For *this time of year* water Levels are:

☐ Above normal ☐ Normal ☐ Below normal

What is your reference? ____

Water Color:

☐ Clear ☐ Dark Green ☐ Light Green ☐ Dark Brown ☐ Light Brown

Are there visible algae within the water? ☐Yes ☐No

Surface Materials (check all that apply)**:**

☐ Clear ☐ Algae Mat ☐ Floating Vegetation ☐ Scum ☐Snow/Ice ☐ Other_______________

Water Odor (check all that apply)**:**

☐ None ☐ Sewage/Manure ☐ Rotten Eggs ☐ Petroleum ☐ Dead Fish ☐ Decaying Material

☐Other____

Describe any conditions at the sample site that may affect today's measurements/observations: (Example: Cattle Grazing, construction activities, weed control, etc.)

Animals at Sample Site (observation or sign)

Be Specific (flock of geese, school of minnows)**:**

Aquatic Nuisance Species (check if observed)

☐ Purple loosestrife	☐ Eurasian water milfoil	☐ Curlyleaf pondweed	☐ Brittle naiad
☐ Didymo	☐ Zebra mussels	☐ Quagga mussels	☐ Rusty crayfish
☐ New Zealand mud snail	☐ European rudd	☐ Asian carp (silver, bighead, black, grass)	

How's the Water Today?

How do you think current water quality conditions affect the following uses? ✓Check one effect for each use.

USE	Strong Positive	Positive	Neutral	Negative	Strong Negative	Not Applicable
Enjoying the view/relaxing by the water						
Boating						
Fishing						
Waterskiing or Jet skiing						
Swimming						
Allowing Pets to drink or enter water						

Comments:

Method Assessment

If you have any questions or have had any problems with any of the procedures please include them here:

Please review the data sheet for completeness and Accuracy. Thanks!

Return to: Dakota Water Watch, East Dakota Water Development District,
132B Airport Avenue, Brookings, SD 57006

BACTERIA MONITORING LAB DATA SHEET

Complete each time a bacteriological sample is processed

Sample Site ID:	**Collection Date:** (mm-dd-yyyy)
Water Body Name	**Collection Time:** (24-hr, ex: 1:10 PM is 1310)
Sampler Name(s): (Example: J. Doe)	**Sampling Circumstances:** ☐ Scheduled ☐ Rain event ☐ Other (explain)

Sample Type(s): ____Regular ____Field blank ____Duplicate
(Enter number of each)

Laboratory Method & Results

(enter information & complete calculations)

Analyst Names(s):	**Transported to lab on ice?** ☐ **Yes** ☐ **No**

Were lab blanks or splits prepared? ☐ No ☐ Yes __ Lab blank __Splits
(Enter number of each)

Estimated Sample Volume in Whirl-pak Bag (mL)**:**

Time between collection and incubation:
(<6 hours is required)

Incubation Start Date: Time:	**Incubation Stop** Date: Time:
Incubation Period (hours): (~24 hrs. is best)	**Incubation Temperature (°C):** (29°- 37 °C is best)

Media Expiration Date:

Was sample diluted prior to culture? ☐ No ☐ Yes

If yes, calculate dilution factor ❸

(sample volume + sterile water volume) ÷ sample volume = ❸

Ex: [(1 mL sample water + 1 mL sterile water) ÷ 1 mL sample water] = ❸ **OR** [(1+1) ÷ 1] = 2 *which is the result for* ❸

Were colony counts an estimate based on grid counts? ☐ No ☐ Yes

Replicate #	**Culture Volume (mL)** ❶	***# E.coli* colonies/plate** ❷ (dark blue/purple)	**# General coliform colonies/plate** (pink/dark red)	***# other* colonies/plate** (blue-green/teal/white)	***E. coli* concentration Colony Forming Units (CFU)/100 mL** (❷÷❶)×100 × ❸
1					
2					
3					

Coliscan Easygel Counting Guide

- ***E. coli* colonies are dark blue to purple colored**
- General coliform colonies are pink to dark red. May be *Klebsiella*, *Citrobacter* and *Enterobacter* species.
- Other colonies colored blue-green, teal, or white may be *Salmonella* or *Shigella* species.
- **Do not** count "pin point" sized (< 0.5 mm) colonies
- If > 200 colonies per plate, write TNTC (too numerous to count).

If you have had any difficulty with any of the procedures please include them here:

Please review the data sheet for completeness and accuracy. Thanks!

Addendum for Blanks, Duplicates, & Splits

Complete each time a field or lab blank, duplicate, or split sample is processed.

Check one: □ **FIELD BLANK** □ **LAB BLANK** □ **DUPLICATE** □ **SPLIT**

Was sample diluted prior to culture? □ Yes □ No If yes, calculate dilution factor ❸

[(sample volume + sterile water volume) ÷ sample volume] = ❸

Ex: [(1 mL sample water + 3 mL sterile water) ÷ 1 mL sample water] = ❸ **OR** [(1+ 1) ÷ 1] = 2 *which is the result for* ❸

Replicate #	Culture Volume (mL) ❶	# *E.coli* colonies/plate ❷ (drk blue/purple)	# General coliform colonies/plate (pink/dark red)	# *other* colonies/plate (blue green/white)	*E. coli* concentration Colony Forming Units (CFU)/100 mL (❷÷❶) ×100 × ❸
1					
2					
3					

Check one: □ **FIELD BLANK** □ **LAB BLANK** □ **DUPLICATE** □ **SPLIT**

Was sample diluted prior to culture? □ Yes □ No If yes, calculate dilution factor ❸

[(sample volume + sterile water volume) ÷ sample volume] = ❸

Ex: [(1 mL sample water + 1 mL sterile water) ÷ 1 mL sample water] = ❸ **OR** [(1+1) ÷ 1] = 2 *which is the result for* ❸

Replicate #	Culture Volume (mL) ❶	# *E.coli* colonies/plate ❷ (drk blue/purple)	# General coliform colonies/plate (pink/dark red)	# *other* colonies/plate (blue green/white)	*E. coli* concentration Colony Forming Units (CFU)/100 mL (❷÷❶) ×100 × ❸
1					
2					
3					

Check one: □ **FIELD BLANK** □ **LAB BLANK** □ **DUPLICATE** □ **SPLIT**

Was sample diluted prior to culture? □ Yes □ No If yes, calculate dilution factor ❸

[(sample volume + sterile water volume) ÷ sample volume] = ❸

Ex: [(1 mL sample water + 2 mL sterile water) ÷ 1 mL sample water] = ❸ **OR** [(1+1) ÷ 1] = 2 *which is the result for* ❸

Replicate #	Culture Volume (mL) ❶	# *E.coli* colonies/plate ❷ (drk blue/purple)	# General coliform colonies/plate (pink/dark red)	# *other* colonies/plate (blue green/white)	*E. coli* concentration Colony Forming Units (CFU)/100 mL (❷÷❶) ×100 × ❸
1					
2					
3					

Return to: Dakota Water Watch, East Dakota Water Development District,
132B Airport Avenue, Brookings, SD 57006

DAKOTA WATER WATCH Making time for monitoring

Form dated March 2009

SD DENR Water Quality Data

Rev 7/09

Agency Code					
Sample Date		Sample Time		Sampler	
Source Water				Station ID	
Site Location					
Project				Project ID	

Type of Sample: ☐ Replicate ☐ Grab ☐ Integrated Vertical ☐ Blank ☐ Composit ☐ Integrated Flow

Medium ☐ Water / Other

Relative Depth ☐ Surface ☐ Bottom ☐ Midwater

Field Analyses

SPC/Cond @ 25c		µmho/cm	pH		SU
Dissolved Oxygen		mg/L	Air Temp		C
Discharge		CFS	Water Temp		C
Total Depth		Ft	Turbidity		NTU
Sample Depth		Ft	Secchi Disk		Meters
Width		Ft	Wind		mph
Gage Stage		Ft	Elevation		Ft

Field Comments

Bottle A

1 Liter @ 4C

☐ Alkalinity
☐ TSOL
☐ TSSOL
☐ VTSS
☐ TDSOL
☐ BOD
☐ CBOD
☐ CO3
☐ Hardness
☐ K
☐ Lab pH
☐ Lab Cond
☐ Nitrate
☐ Cl
☐ Fluoride
☐ HCO3
☐ SO4

Lab Filtered A Bottle

☐ Ca
☐ Mg
☐ Na

Bottle B

2 mL H2SO4

☐ Ammonia
☐ NO3-NO2-N
☐ TKN
☐ Total P
☐ COD

Bottle C

Na2SO3

Note: 250 mL of sample required if requesting more than one of the following:

* count/100 mL

☐ Fecal Coliform ☐ Entercocci*
☐ E Coli* ☐ Fecal PFG

Lab Comments

Bottle D

100 m Field FilteredL

0.25 mL H2SO4

☐ TDP ☐ DIN

Bottle R

☐ Ra 226 ☐ Ra 228

Bottle CN

500 mL NAOH

☐ CN ☐ WADCN

Bottle H

Liter Glass Amber

☐ TPH Amber

Bottle V

☐ VOC ☐ TOC
☐ TPH Vial ☐ DOC

Bottle E

Field Filtered

☐ SO4 ☐ Fluorid
☐ Cl ☐ HCO3

Metals

100mL each Total Dissolved Field Filtered	*Add 0.25 mL HNO3* Total with Acid Digestion
☐ Al	☐ Al
☐ Sb	☐ Sb
☐ As	☐ As
☐ Ba	☐ Ba
☐ Be	☐ Be
☐ B	☐ B
☐ Cd	☐ Cd
☐ Ca	☐ Ca
☐ Cr	☐ Cr
☐ Cu	☐ Cu
☐ Hg	☐ Hg
☐ Pb	☐ Pb
☐ Mg	☐ Mg
☐ Mn	☐ Mn
☐ Ni	☐ Ni
☐ Se	☐ Se
☐ Ag	☐ Ag
☐ Na	☐ Na
☐ Ti	☐ Ti
☐ U	☐ U
☐ Vn	☐ Vn
☐ Zn	☐ Zn
☐ Fe	☐ Fe
☐ Mo	☐ Mo
☐ Fluoride	
☐ K	
☐ Cl	
☐ Silica	

Relinquished By: ____________ Date/Time ____________
Received By: ____________ Date/Time ____________

Relinquished By: ____________ Date/Time ____________
Received By: ____________ Date/Time ____________

Relinquished By: ____________ Date/Time ____________
Received By: ____________ Date/Time ____________

Sample Temp (C) **Date / Time Recieved** **Lab #**