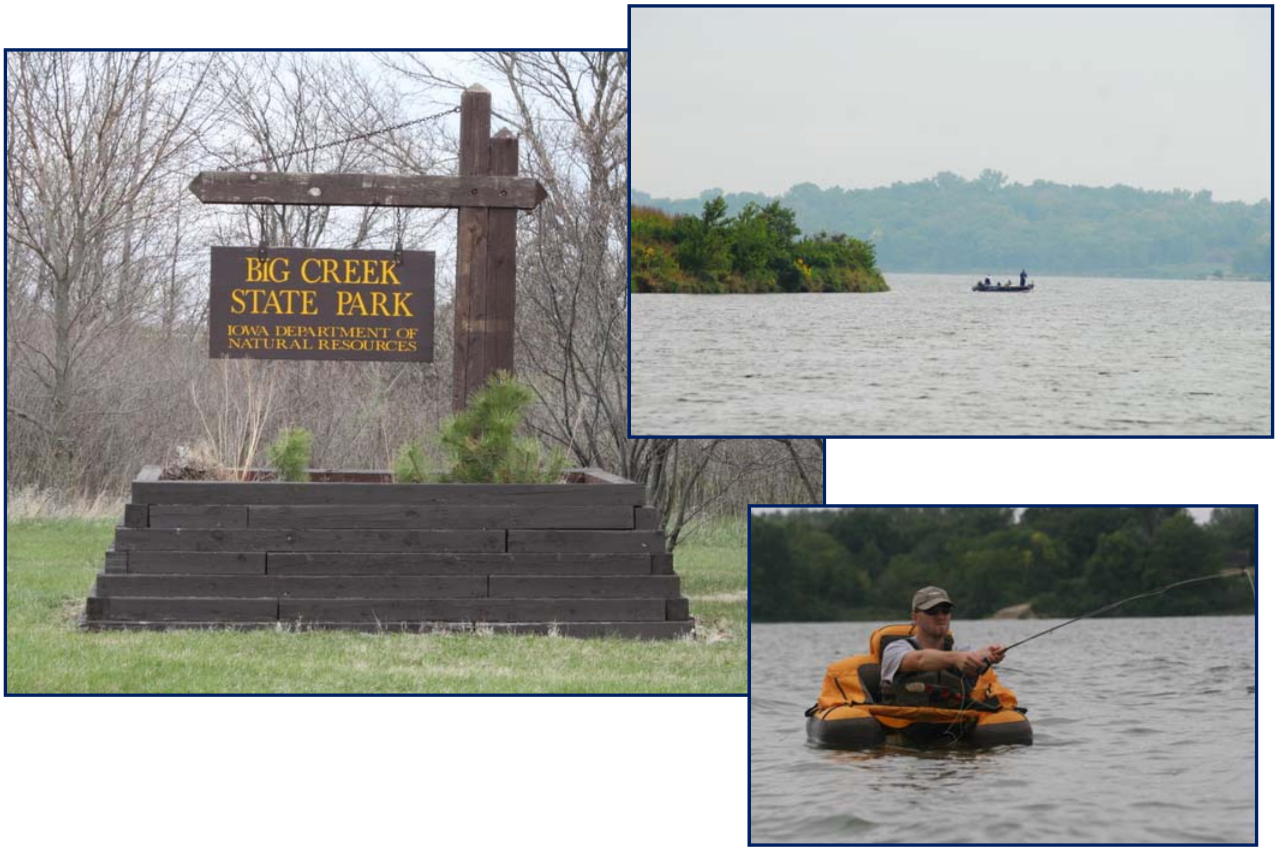
Big Creek Lake
Watershed Management Action Plan



Big Creek Lake will be central Iowa's premier recreational destination for outdoor enthusiasts with improved water quality through the reduction of bacteria, sediment and nutrients.

Report Commissioned by: Polk and Boone County Soil and Water Conservation Districts
Paul Miller (Polk County), Kevin Kordick (Boone County)
Sean McCoy (Watershed Project Coordinator)

Prepared by: Adam Kiel (Upper Des Moines & Raccoon River Coordinator, IDNR)
Gregory M. Pierce, PE, CPESC (Nilles Associates, Inc.)

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BIG CREEK LAKE
WATERSHED MANAGEMENT ACTION PLAN

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PREFACE

"Big Creek is an extremely important outdoor recreational resource for Central Iowans. It is one of the highest pressured lakes (per acre) in the state when it comes to fishing pressure. In recent years, the water quality at Big Creek has shown signs of major degradation. We have noticed increased turbidity in the main lake. The areas above the rock sills are nearly filled in with sediment and are no longer effective at trapping sediment. We have noticed tremendous bluegreen and green algae blooms that are causing lake users to call us regarding the safety of the lake. We are often asked if the lake is safe for kids and pets to be around and if the fish are safe to eat. The beach warnings (due to high E. coli counts) are also becoming a yearly issue at Big Creek as well. It is our opinion that the water quality at the deep end (near dam) is not always representative of the water quality in the upper 1/2 of the lake. We notice significant turbidity and bluegreen algae blooms in the upper end of the lake; these characteristics are not always apparent in the deeper end of the lake."

– Ben Dodd, Fisheries Biologist, Iowa Department of Natural Resources (2011)

This Watershed Management Action Plan represents a cooperative effort of the Polk and Boone County Soil and Water Conservation District (SWCD) offices and the Iowa Department of Natural Resources (IDNR). Adam Kiel (IDNR) and Gregory Pierce (Nilles Associates, private consultant) assisted with guiding discussions regarding developing this plan, incorporating required information from various sources (previous assessments, grant applications and studies) and editing the final plan document.

The preparation of this plan follows completion of several field assessments, public meetings, grant applications and review of the Water Quality Improvement Plan (TMDL) completed by the Iowa Department of Natural Resources for Big Creek Lake (2010). The TMDL report cited bacteria (E. coli) as the primary pollutant of concern for public use of Big Creek Lake. Although not included in the TMDL, previous assessment work has also included watershed erosion (sediment transport) and phosphorus pollution as items needing to be addressed to restore the overall quality of Big Creek Lake.

This document outlines a twenty year implementation period for a plan to address these identified water quality impairments, remove this water body from the list of impaired waters and to fully realize the potential for recreation and public use of the lake.

1 WATERSHED PLANNING

On March 25, 2009 an initial watershed meeting was held with the purpose of developing the scope of water quality improvements within the Big Creek Lake watershed and framing those into a grant applications to obtain funding to develop a Watershed Management Action Plan (WMAP) and install water quality protection practices throughout the watershed. There were 11 stakeholders in attendance which included local landowners and public officials. Data collected during the watershed assessment process (2008-2009) was presented and specific problem issues were highlighted. The types and amounts of practices to address identified problems were reviewed and project goals and a timeline were developed. Enthusiasm and interest for the project and water quality improvement was high.

A second meeting was held on August 16, 2010. This meeting was facilitated by John Paulin of Prairie Rivers Resource Conservation and Development (RC&D). At this meeting the participants were asked to identify key uses of the Big Creek Watershed that need protection or enhancement, also identified were concerns which could impact the lake and watershed.

Resources and activities to be protected or enhanced:

- Wildlife habitat
- Deer and pheasant hunting
- Fishing, boating and swimming
- Parks and recreational areas
- Community vitality and economic development related to these resources

Key concerns within the watershed that were discussed:

- Deterioration of water quality
- Reduced potential for waterfowl hunting
- The historic change of the hydrology within the watershed
- Severe channel bank erosion
- Soil loss from fields and in-stream channel degradation
- Stream livestock crossings
- Decline in the population and variety of fish species
- Seasonal algal blooms at Big Creek Lake
- The ability for local landowners to install upland conservation practices
- The impact of tiled drainage systems on water quality and quantity
- Rural and municipal sanitary sewer systems that may not be functioning as intended
- The impact of absentee landowners on adoption of conservation practices

The conclusions drawn from these meetings have been used to form various aspects of this Watershed Management Action Plan. To ensure watershed goals and objectives are being achieved a formal Big Creek Lake Watershed Advisory Committee was established. Members of this committee are listed in **Table 1.** Many of the public outreach recommendations gleaned from the watershed meeting are included in the Public Outreach Plan, Section 9.

Contact	Affiliation
Scott Rolfes	ACOE
Mike Salati	Boone County Sanitarian
Kevin Griggs	Boone SWCD
Sean McCoy	IDALS - DSC
Vince Sitzmann	IDALS - DSC
Ben Dodd	IDNR – Fisheries
George Antoniou	IDNR - Lake Restoration
Chad Kelchen	IDNR – Parks
Kelly Smith	IDNR – Private Lands
Mary Skopec	IDNR - Water Monitoring
Adam Kiel	IDNR - Watershed Improvement
Josh Gansen	IDNR - Wildlife
Jim McCasland	Polk County Sanitarian
Chip Mathis	Polk SWCD
Kevin Kordick	USDA – NRCS, Boone County
Paul Miller	USDA – NRCS, Polk County

Table 1: Watershed Technical Advisory Committee.

2 WATERSHED ANATOMY

2.1 WATERSHED MAP AND LOCATION NARRATIVE

Big Creek Lake is located in the northwest corner of Polk County, 2 miles north of Polk City, Iowa. Big Creek Lake itself encompasses 781 acres and was built in 1972 by the Army Corps of Engineers as a part of a flood control project. The watershed for Big Creek Lake is 47,665 acres and encompasses portions of northwest Polk County, south east Boone County and far southwest Story County (See **Map 1, page 8**). The Big Creek Lake Watershed encompasses three 12 digit HUC watersheds; the Upper Big Creek-Des Moines River (071000040701), Little Creek (071000040702) and Lower Big Creek-Des Moines River (071000040703). **Table 2** lists basic lake and watershed information.

Waterbody Name	Big Creek Lake
8 Digit Hydrologic Unit Code (HUC):	07100004
IDNR Waterbody ID	IA 04-UDM-0140-L_0
Location	S22,T81N,R25W
Latitude	41.8122 N
Longitude	93.7413 W
Water Quality Standard Designated Uses	Class A1 Primary Contact Recreation Class B (WW-1) Aquatic Life HH Human Health
Tributaries	Big Creek and Little Creek
Receiving Waterbody	Des Moines River
Lake Surface area	755 acres (does not include area behind sediment detention structure)
Maximum Depth	53.4 feet
Mean Depth	19.4 feet
Volume (Estimate as of 2006)	14,573 acre-feet
Watershed Area (with lake)	47,666 acres
Watershed/Lake Area Ratio	61

Table 2: Lake and watershed information.

2.2 PUBLIC USES

Public Uses of Big Creek Lake

Big Creek Lake is surrounded by a 3,550 acre state park and wildlife refuge that is owned by both the Iowa DNR and the Army Corps of Engineers but is managed by the Iowa DNR Wildlife and Parks (**See Map 2, page 10**). The park and lake offer recreational opportunities and are favorite destinations of Central Iowa residents. Park amenities include 3.4 acre swimming beach, shelters, picnic areas, playgrounds, a sports field, several boat ramps, a shooting range, and several miles of multi-purpose trails.

According to the Iowa DNR, an average of 740,600 people visited Big Creek Park annually from 2001-2008. The Center for Agricultural and Rural Development (CARD) at Iowa State University estimates these visitors contribute $19.09 million annually to the local economy, which in turn supports 233 jobs and $4.77 million of labor income for the towns near the park. Looking at the annual usage statistics more closely, one can see decreased park usage the years following highly publicized beach warnings. From 2001 through 2004 park usage increased every year fro 673,709 visitors in 2001 to an astounding 815,458 visitors in 2004. During the summer of 2004, high bacteria levels forced the DNR to post beach warnings on 11 separate occasions. The high bacteria levels observed at the Big Creek public beach were publicized in local and state-wide newspapers and on Des Moines area television and radio news programs. In 2005, visitation to the park decreased by 17% to a total of 681,081. In the years since, annual visitation has slowly increased back to near 2004 levels; 799,555 people visited the park in 2008 (**See Table 3**). Since 2004 the public beach at the park has only had 2 occurrences of high bacteria levels requiring beach warning signs to be posted.

	2001	2002	2003	2004	2005	2006	2007	2008
Number of Visitors	673,709	761,516	768,335	815,458	681,081	682,851	742,240	799,555

Table 3: Annual Visitors to Big Creek Park as Logged by Vehicle Counters

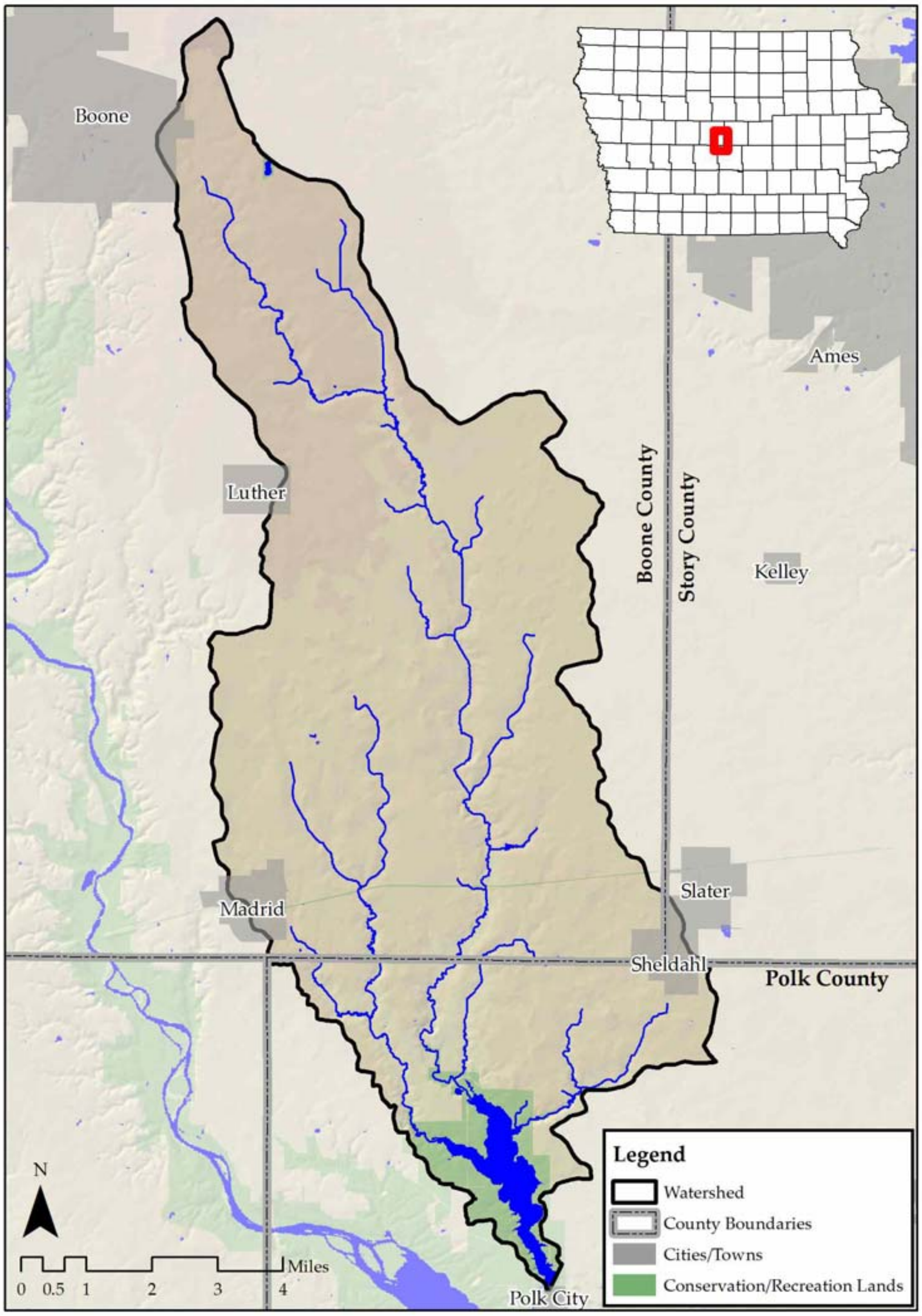
2.3 PHYSICAL CHARACTERISTICS

Hydrology

The 47,665 acre watershed and 781 acre lake make for a watershed to lake ratio of 61:1. The current lake volume is estimated to be 14,573 acre feet and the mean depth is 19.4 feet with a maximum depth of 53.4 feet. There are three streams that feed Big Creek Lake, they are Turkey Creek, Big Creek and Little Creek, currently none of these streams are listed on the 303(d) Impaired Waters List. The total stream miles within the watershed is estimated to be 64 miles.

Land Use

Big Creek Lake watershed is 47,665 acres (74.5 square miles) in size and extends from the communities of Polk City to Boone (a straight line distance of 24 miles). The watershed is predominately cropland with a corn and soybean rotation. The timbered areas are concentrated in the state park and along the streams that feed Big Creek Lake. Approximately two percent of the watershed is used for grazing. **Table 4 (page 9)** shows the land use information for the watershed. **Map 3 (page 11)** shows how these land uses are distributed throughout the watershed in the year 2008.



Map 1: Big Creek Lake Watershed boundary.

	Row Crop	CRP/ Grassland	Farmstead	Grapes	Grazed Timber	Parkland	Semi and Permanent Pasture	Road / Urban / Residential	Timber / Shrub	Water
Percent of Watershed (%)	81.3	4.8	2.2	0.04	0.05	1.6	1.6	4.8	2	1.7
Land Area (ac)	38,773	2,278	1,039	23	27	752	752	2,273	931	816

Table 4. Land Uses in the Big Creek Watershed 2008

Soils

The predominant soil association in the watershed is: Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils. The landscape is nearly level and has gently sloping (0-5%) hills. These prairie derived soils developed from Wisconsin till on the Des Moines Lobe. Depressional and calcareous soils are common. Secondary soil association include: Clarion, Nicollet, Storden, and Webster soils.

Topography

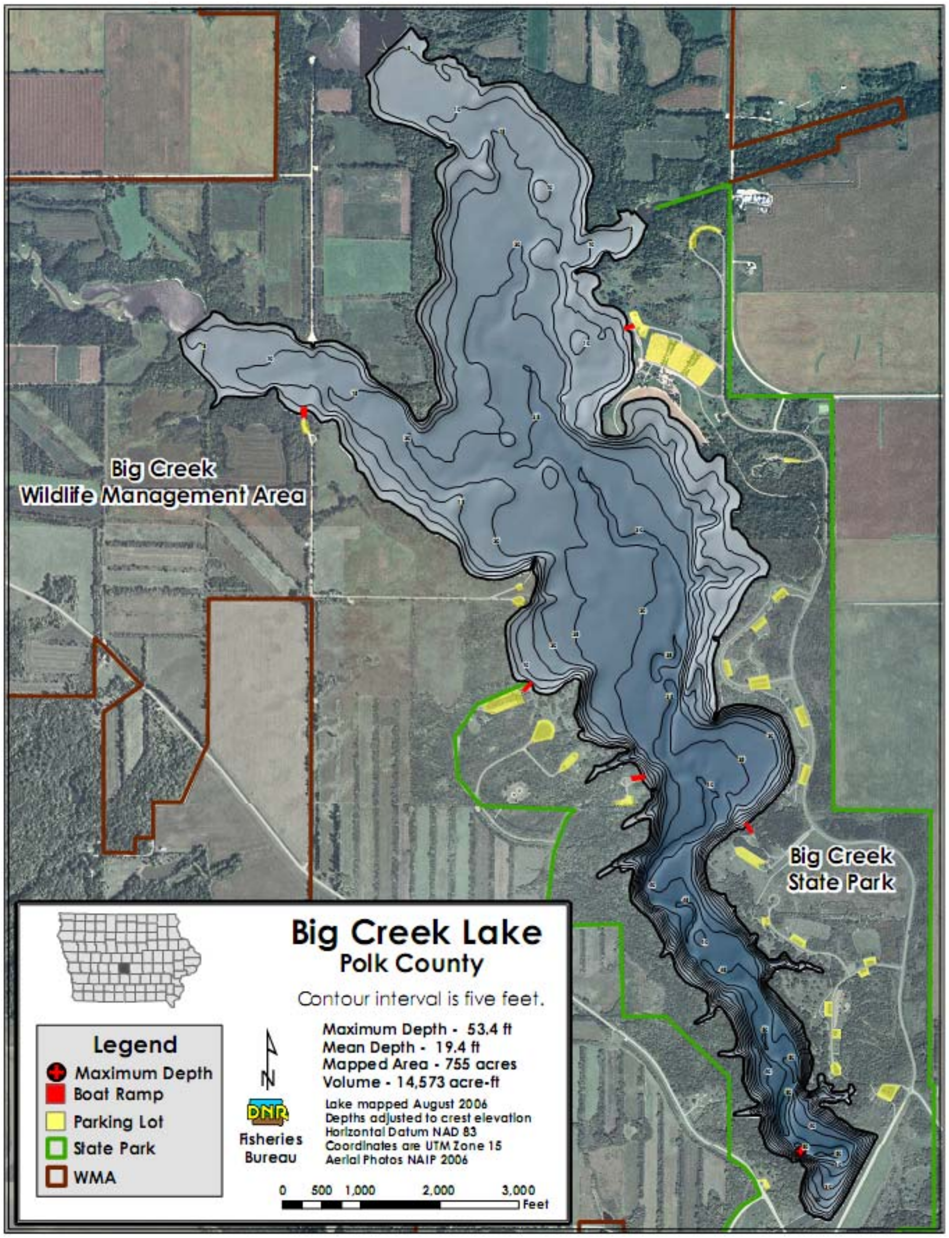
The Big Creek Lake watershed has a mean slope of 3.1%. **Table 5** summarizes the slope classes. The high elevation of the watershed is 1,189 feet above sea level and the low elevation is 918 feet above sea level. 14,998 acres or 31% of the watershed are estimated to be draining to depressional areas.

Slope Class	Acres	% of Watershed
A (0-2%)	21,730	45.6%
B (2-5%)	19,423	40.7%
C (5-9%)	4,201	8.8%
D (9-14%)	1,262	2.6%
E (14-18%)	463	1.0%
F (18-25%)	369	0.8%
G (25%+)	219	0.5%

Table 5: Average Slopes in the Big Creek Watershed

Geology

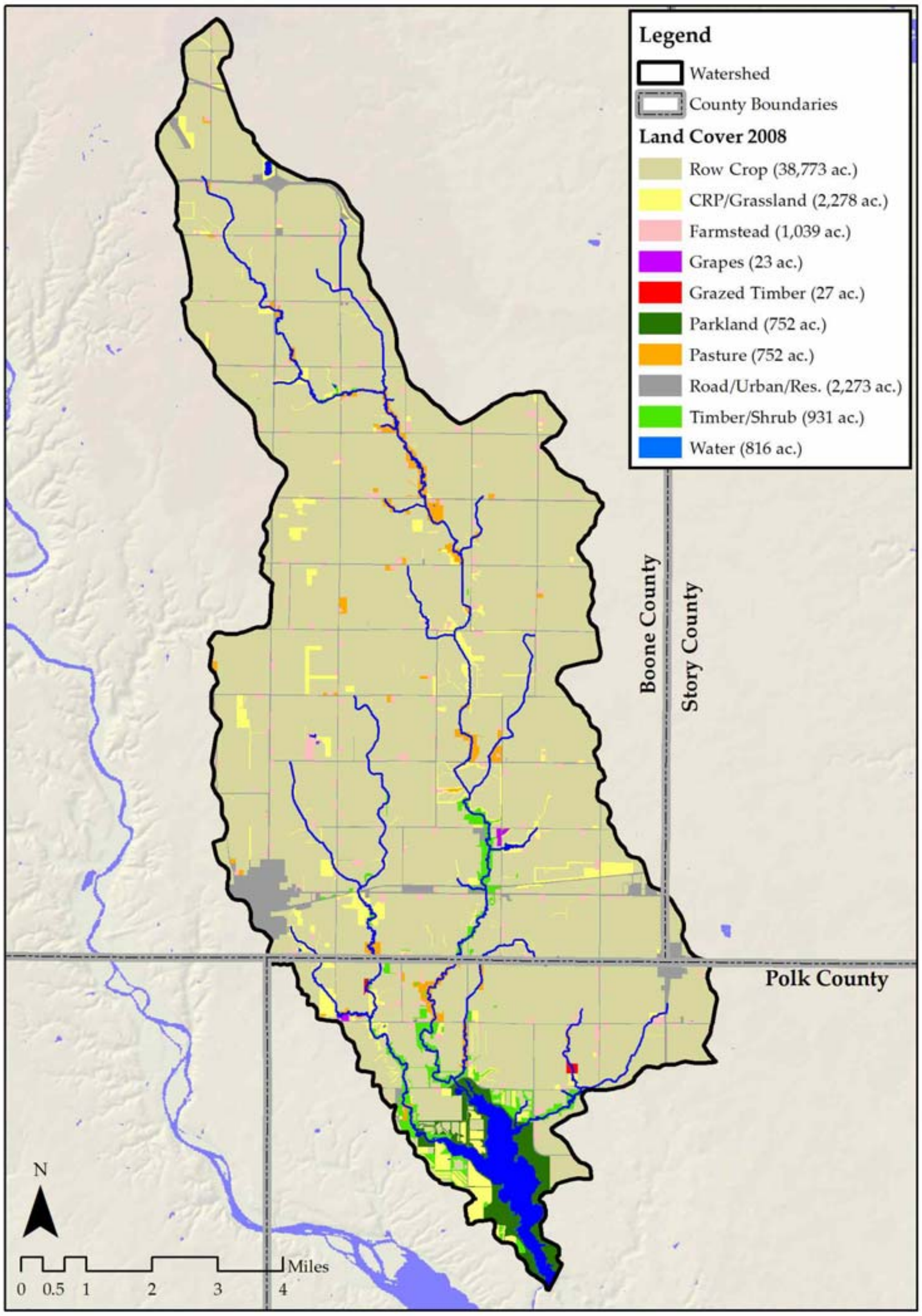
These portions of Boone and Polk Counties are located within the Des Moines Lobe. The last glacier to enter Iowa advanced in a series of surges beginning just 15,000 years ago and reached its southern limit (the site of modern-day Des Moines) about 14,000 years ago. By 12,000 years ago, the ice sheet was gone leaving behind a poorly drained landscape of pebbly deposits from the stagnant decaying ice, sand and gravel from swiftly flowing melt water streams, as well as clay and peat from glacial lakes. Today, broadly curved bands of ridges and knobby hills set among irregular ponds and wetlands punctuate the otherwise subtle terrain of this freshly glaciated landscape.



Map 2: Big Creek Lake bathymetry 2006

Climate

The climate in central Iowa is classified as humid continental. The average temperature in January is 19.4 degrees Fahrenheit. The average July temperature is 76.6 degrees Fahrenheit. Total annual rainfall averages 33.12 inches while snowfall averages 33.3 inches per year. The average length of the growing season for the area averages 160 days.

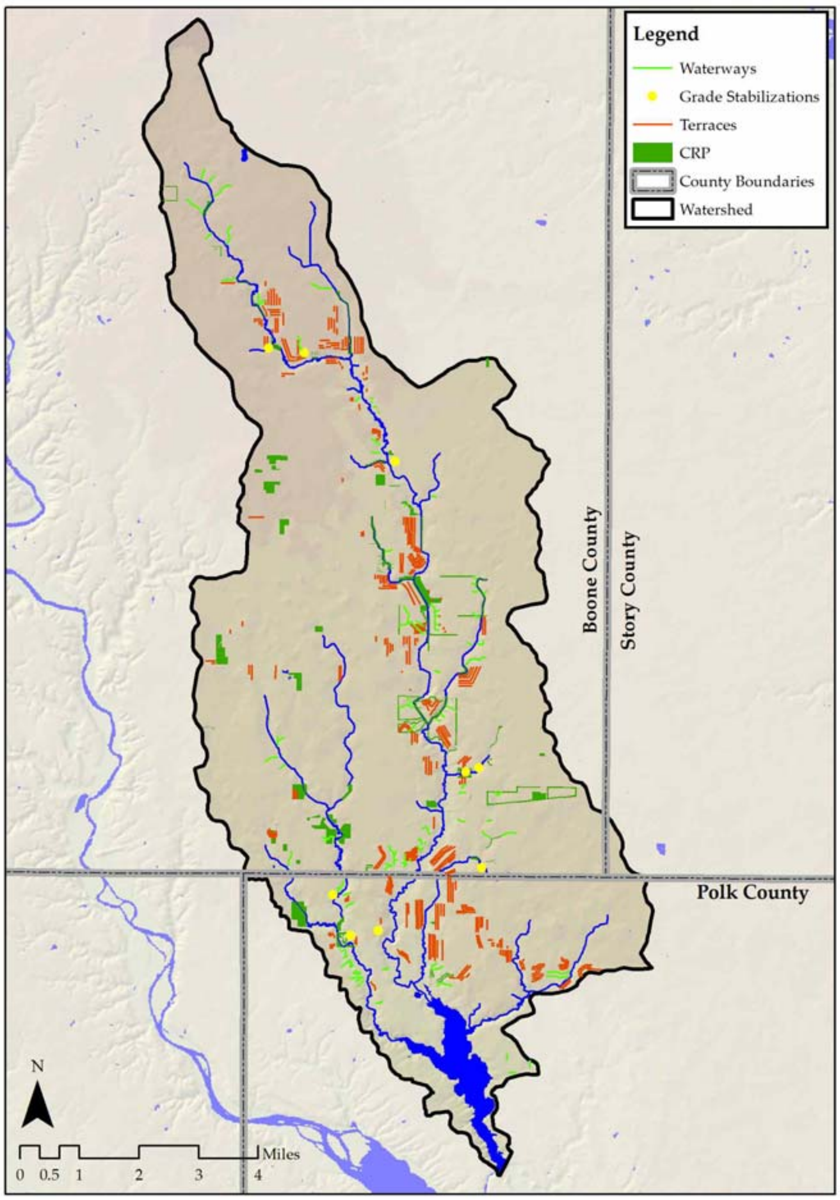


Map 3: Big Creek Lake Watershed land cover 2008.

Existing Conservation Practices

A variety of conservation practices have been employed throughout the watershed, primarily intended for the betterment of agricultural production. **Map 4** illustrates the location of many of these practices within the watershed.

- 9 Grade Stabilization Structures (Farm Ponds)
- 89,500 feet (17 miles) of grassed waterways
- 316,000 feet (60 miles) of terraces
- 855 acres of CRP
- 0 manure settling basins
- 0 acres of pasture management
- 0 feet of streambank stabilization
- An unknown number of water and sediment control basins



Map 4: Existing Conservation Practices within Watershed - 2008.

3 WATER QUALITY

3.1 IMPAIRMENTS & DESIGNATED USES

Big Creek Lake was included on the 303(d) list of impaired waters in the following years: 1998, 2002, 2006, 2008, and draft 2010 list. Most recently the impairment listing has been a result of high bacteria levels captured as part of the IDNR beach monitoring program at the State Park beach. In previous 303(d) lists, Big Creek has been cited with excessive sediment and nutrient loads, these impairments were removed after review of ISU's Lake Monitoring Program data from 2000 to 2004.

Big Creek Lake is described in Iowa's Water Quality Standards as having three use designations: Class A1 (primary contact recreation), Class B (WW-1) (aquatic life), and Class HH (human health/fish consumption). Big Creek Lake's Class A1 uses are assessed as "not supported" due to high levels of indicator bacteria that exceed the state water quality criteria. The Class B (WW-1) and Class HH uses are however, assessed as "fully supported."

Class A1 Designation: Since 1999 the swimming beach at Big Creek Lake State Park has been monitored once a week during the primary contact recreation months, May through September. Bacteria testing has consisted of composite samples taken from nine sampling points representing three transects along the beach's length (center of the beach and at both ends) at three water depths (ankle-deep, knee-deep, and chest-deep). According to IDNR's assessment methodology, two minimum quality bacteria parameters must be constantly attained for the Class A designation of the lake to be considered "fully supported."

These parameters are:

1. All thirty-day geometric means for the three-year assessment period are less than the state's geometric mean criterion of 126 E. coli orgs/100 ml.
2. Not more than 10% of the samples during any one recreation season exceed the state's single-sample maximum value of 235 E. coli orgs/100 ml.

Big Creek Lake beach monitoring did not meet the geometric mean parameter for bacteria.

Class B (WW-1) Designations: Aquatic life in Big Creek is listed as "fully supported" on the 2008 305(b) list. This assessment was based on cumulative data provided by the IDNR Fisheries Bureau, IDNR ambient lake monitoring program, IDNR's beach monitoring program, and results from ISU and UHL lake surveys. From 2002-2006 there were no violations for ammonia or dissolved oxygen, and only one violation of the pH criterion.

Class HH Designations: Fish consumption was assessed as "fully supported" on the 2008 305(b) list. In 2004, U.S. EPA and IDNR conducted a fish contaminant assessment at Big Creek Lake. The composite samples of fillets from channel catfish and largemouth bass had low levels of contaminants, there has never been a fish consumption advisory issued for Big Creek Lake.

Although aquatic life and human health/fish consumption have been deemed "Fully supported," water quality problems and fishing hindrances are known to exist especially in rainy years with large amounts of runoff and associated nutrients reaching the lake. IDNR Fishery biologists at Big Creek Lake noted a decline in observed water quality and subsequent filamentous and blue-green algal blooms after heavy spring precipitation in 2008. Questions and comments were received from many concerned citizens who use Big Creek State Park regularly, all wondering why the water quality was noticeably worse in 2008 than in past years. In addition, IDNR fishery biologists noted angler success was hindered in 2008 when compared to previous years, likely due to the algal blooms and overall lack of water clarity/quality. These observations support that diminished water quality associated with sediment and nutrient loading to Big Creek Lake is amplified in wet years.

The volume of Big Creek Lake at the time of construction in 1972 has not been precisely defined but based on a lake storage curve provide by the Army Corps of Engineers the volume was estimated to be just under 16,000 acre feet.. Sedimentation has caused a significant loss in volume since construction. A 1993 survey of Big Creek Lake showed a volume of 15,659 acre feet, a similar survey in 2006 found the volume to be 14,573 acre feet. This volume loss of 1,086 acres feet from 1993 to 2006 equates to a loss of nearly 7% of the lake volume in 13 years. **Figure 1** is series of aerial photographs from the 1990s to 2009 that shows the sediment accumulation where the main tributary, Big Creek, enters Big Creek Lake.

Figure 1: Sediment Deposition in Big Creek Lake 1990s to 2009.

3.2 WATER QUALITY DATA

Water samples collected from DNR monitoring programs and DNR organized volunteers (ambient lake monitoring program, beach monitoring program, and IOWATER program) and analyzed by Iowa DNR's Watershed Monitoring and Assessment Section, indicate Big Creek Lake experiences high levels of bacteria during certain flow conditions. The Big Creek Lake TMDL analyzed years of water quality data and concluded that violations occur during most all flow regimes but violations do occur most frequently at high and moderate flows. As with most lakes and streams where high levels of bacteria are chronic, the Big Creek Lake watershed has multiple sources of bacteria than are more readily carried to the lake during high flow or flood conditions.

Data collected between 2004 and 2006 was used as justification to include Big Creek Lake on the 2008 303(d) Impaired Waters List. During this period the geometric means of 6 thirty day periods exceeded the standard of 126 E. coli organisms per 100 mL in 2004. This standard was again violated 5 times in 2008. See **Table 5** for violations per year. It should be noted that bacteria sampling from 1999-2001 was used to determine best methods for the Beach Monitoring Program, these samples were used in the TMDL but were not used to determine impairment, thus the discrepancy in **Table 4** and **Figure 2**.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of samples exceeding one-time limit	1	0	0	1	5	0	1	1	5	2
Number of months with High geometric mean	0	0	0	0	6	0	0	0	5	0

Table 5: Beach Monitoring E. coli Violations by Year.

In 2004, 23% of the samples exceeded the single sample criterion of 235 E.c oli organisms per 100 mL, in 2008 19% of the samples exceeded that criterion. The allowable level of 10% was well exceeded in both 2004 and 2008. See **Figure 2** for E. coli monitoring results and precipitation. For a full report of E. coli monitoring at Big Creek State Park beach see the Appendix.

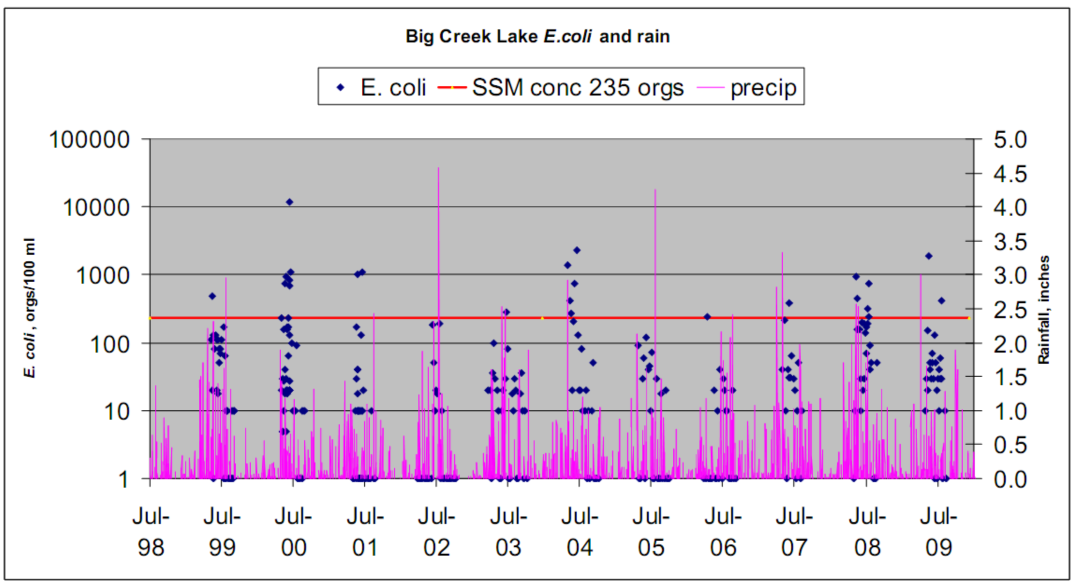


Figure 2: E. coli Levels and Precipitation

As previously mentioned Big Creek Lake sees high loads of sediment and nutrient delivery to the lake. **Figure 1** provides visual evidence of the sediment impacts on the lake. From 2000 to 2010 one in-lake location (BCL1 on **Map 15, page 41**) was monitored at least three times each year. This monitoring site is located at the deepest point within the lake and is far from any tributaries entering the lake, for this reason monitoring results at this site may not reflect conditions elsewhere in the lake. Carlson's Trophic State Index is used by the Iowa DNR to determine violations of water quality standards, and has been used to analyze the secchi depth, chlorophyll-a and phosphorus measurements in Big Creek Lake. The impairment threshold for chlorophyll-a and Secchi depth is a TSI value of 65 or greater. The results from the Big Creek ambient site are presented in **Figures 3, 4 and 5 (pages 16-17)**.

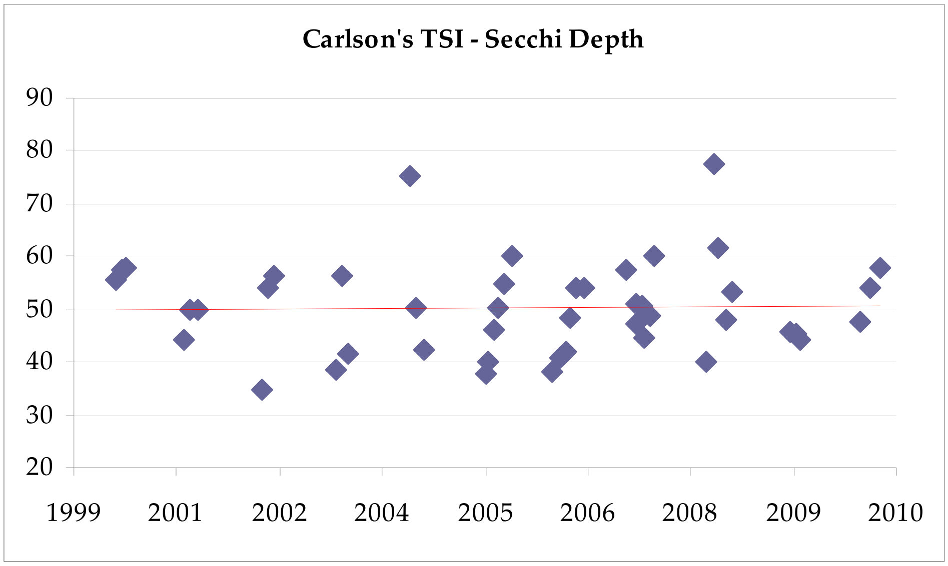


Figure 3: Secchi depth TSI.

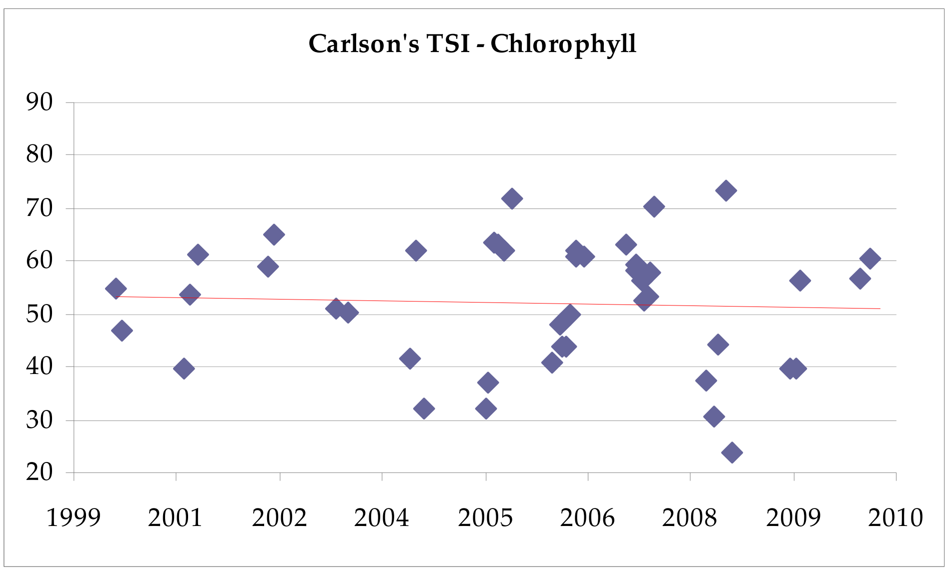


Figure 4: Chlorophyll TSI.

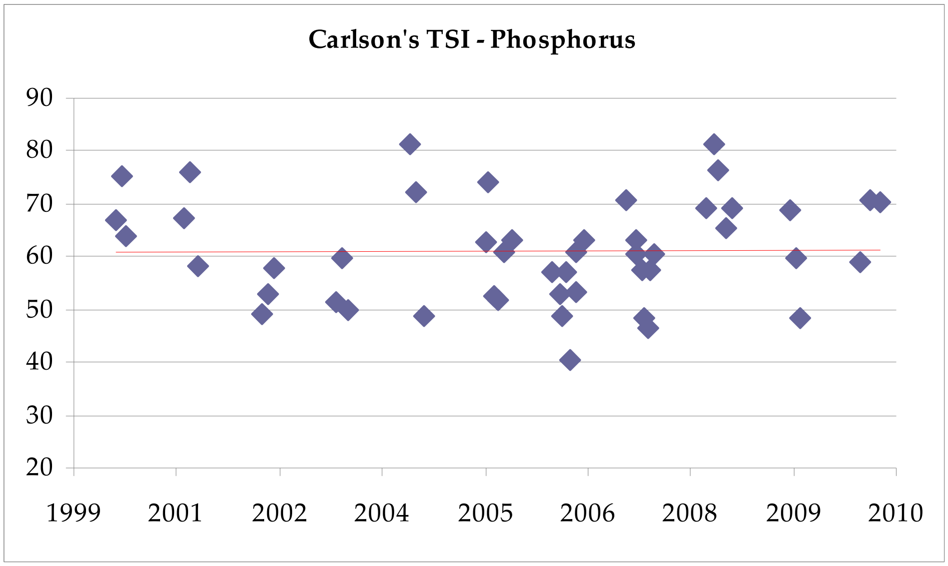


Figure 5: Phosphorus TSI.

3.3 WATER QUALITY IMPROVEMENT PLAN (TMDL) EXISTING LOADS, POLLUTANT ALLOCATION AND SUMMARY

Bacteria

The Water Quality Improvement Plan (aka TMDL) for Big Creek Lake was prepared by William Graham, PE of the Iowa Department of Natural Resources in 2011. This document is currently under review, and has not been approved by EPA. It was prepared to establish Total Maximum Daily Load (TMDL) limitations related to the high bacteria concentrations that have been observed at the State Park beach.

The Water Quality Improvement Plan found the highest bacteria loading occurs during storms when maximum runoff and bacteria concentrations are highest. These elevated loads and flows often cause bacteria concentration to exceed the criteria. The criteria are a geometric mean (GM) of 126 *E. coli* organisms/100ml and a single sample maximum (SSM) of 235 *E. coli* organisms/100ml. The other condition leading to criteria violations occurs during dry flow. There are not any elevated sample loads at the low flow condition. The flow conditions are described in **Table 6 (page 18)**.

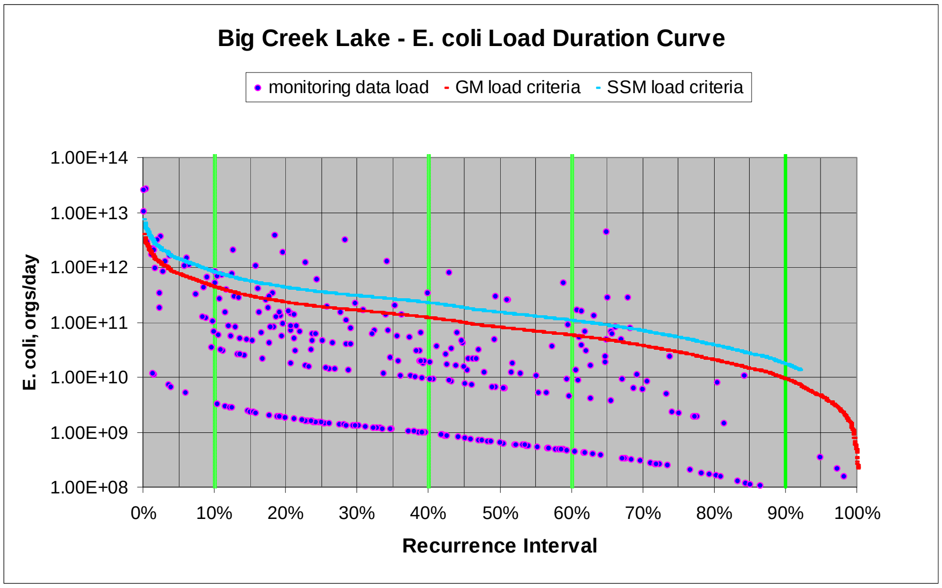


Figure 6: Load Duration Curve.

The *E. coli* load capacity is the number of organisms for a flow volume that can be in the lake and still meet the water quality criteria. A load duration curve based on monitoring data for bacteria and simulated flow has been used to establish the target loads for Big Creek Lake and is shown in **Figure 6**. The lower curve shows the *E. coli* count for the geometric mean criteria and the upper curve shows the *E. coli* count for the single sample maximum (SSM) criteria. The points on the chart represent observed (monitored) *E. coli* concentrations converted to loads using simulated flow for the sampling date. Points above the load duration curves are violations of the WQS criteria. The load reduction can be thought of as the reduction necessary to have all points below the water quality standard criteria; this load reduction was calculated for the five flow conditions and is shown in **Table 7 (page 19)**. Positive values means a reduction is necessary, negative values mean the exiting load is less than the water quality standard criteria load.

Flow condition	Description
High flow – 0 to 10% recurrence interval	Runoff conditions predominate here and the flows and loads are the greatest primarily from nonpoint sources available for washoff.
Moist conditions – 10 to 40% recurrence interval	Runoff conditions are gradually decreasing in volume as is their contribution to bacteria loading.
Mid-range flow – 40 to 60% recurrence interval	Impacts from runoff in this flow recurrence interval are still an important fraction but flow from groundwater and interflow are a growing part of the total. Loads originate from minor occurrences of local runoff and from the continuous septic tank, and cattle in the stream.
Dry conditions – 60 to 90% recurrence interval	Runoff loads at this flow recurrence interval are a shrinking fraction of the total. Flow from groundwater and interflow are a growing part of the total. Loads originate from minor occurrences of local runoff and increasingly from failed septic tanks, and cattle in the stream.
Low flow – 90 to 100% recurrence interval	This is the low flow to no flow condition. Loads in this flow condition are nearly all from local continuous sources although the delivery of these continuous loads can be greatly reduced in the driest conditions.

Table 6. Flow condition descriptions.

Flow percent recurrence	Geometric mean departure from capacity, orgs/day	Single sample max departure from capacity, orgs/day	Geometric mean percent reduction needed	Single sample max percent reduction needed
0 to 10 %	1.74E+12	1.10E+12	70.1%	44.3%
10 to 40 %	1.12E+11	-4.86E+10	37.6%	-16.3%
40 to 60 %	-3.16E+10	-1.00E+11	-66.2%	-210.0%
60 to 90 %	2.89E+10	4.67E+09	50.8%	8.2%
90 to 100 %	-3.84E+09	-7.62E+09	-740.0%	-1466.7%

Table 7: Departure from Load Capacity and Load Reductions necessary to meet water quality standards. Positive values indicate instances where a reduction in E. coli is necessary, negative number indicate water quality standards are met.

The Water Quality Improvement Plan utilized DNR and University Hygienic Laboratory summer beach monitoring data from 2000 through 2008. Samples were collected at the lake's beach once a week, usually from mid-April to mid-October. The watershed was modeled using the Soil and Water Assessment Tool (SWAT), output from the model was used to simulate flows to the lake based on precipitation and temperature data from the nearby Ames West weather station. To model flows and load reductions the Water Quality Improvement Plan utilized data from:

- IDNR State Park staff that are on site daily.
- IDNR Wildlife and Fisheries biologists who work in the area and are familiar with lake and watershed aquatic and wildlife populations.
- Soil and Water Conservation District staff that performed a watershed assessment in 2008 estimating the numbers of livestock in the watershed.
- IDNR Field Office staff familiar with manure problems in the watershed.
- IDNR Beach Monitoring staff responsible for collecting bacteria data.

The Water Quality Improvement Plan identifies nonpoint sources of the bacteria as the sole contributor of bacteria as there are no permitted point source discharges in the watershed. The nonpoint sources of bacteria include local wildlife, grazing livestock and feedlots, cattle in streams, manure applications, poorly functioning septic systems and wash off from built-up areas. A detailed assessment of these sources is found in Chapter 4 – Pollutant Source Assessments.

Sediment

Although not impaired for sedimentation it is of critical importance to prevent future loss of volume in Big Creek Lake. A 1993 survey of Big Creek Lake showed a volume of 15,659 acre feet, a similar survey in 2006 found the volume to be 14,573 acre feet. This loss of 1,086 acre feet equates to a loss of nearly 7% of the lake volume in 13 years. The estimated existing sediment load to Big Creek Lake is 7,214 tons per year. This estimate was calculated using watershed assessment data and Natural Resource Conservation Service (NRCS) erosion and sediment delivery models.

Sources of sediment in the watershed include sheet and rill erosion, classic gullies, ephemeral gullies and streambank erosion. A detailed assessment of these sources is found in Chapter 4 – Pollutant Source Assessments.

Phosphorus

Phosphorus enrichment ratios are often used to determine phosphorus loading rates. The Iowa DNR has conducted state wide shallow soil sampling to determine phosphorus concentrations; the state-wide average is 1.6 pounds of phosphorus per ton of soil.

(Source: http://www.igsb.uiowa.edu/webapps/gsbpubs/pdf/ofr-2010-1.pdf).

Using a 1.6 pound per ton enrichment ratio with current sediment delivery estimates Big Creek Lake is receiving approximately 11,542 pounds per year of phosphorus from watershed sources. This only estimates sediment attached phosphorus and does not take into account other types or sources of phosphorus in the lake or watershed. A detailed assessment sediment and phosphorus source is found in Chapter 4 – Pollutant Source Assessments.

4 POLLUTANT SOURCE ASSESSMENTS

A comprehensive assessment of the Big Creek Lake watershed was completed using the planning and protocol tools from the Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources (IDNR) and the Natural Resource Conservation Service (NRCS). The assessments were conducted in 2008 and 2009. The assessment results have been grouped into two categories, those related to the bacteria impairment and those related to sediment and phosphorus.

Bacteria Source Assessment

Wildlife

Geese: The Iowa DNR estimates the resident goose population at Big Creek from June through October is about 63 with no migrants in the summer and up to 80 migrants in the late fall. The geese are frequently in or near the lake so the potential for bacteria loads from their feces is very high, especially since they prefer to spend most of their time on the beach and lawns near the beach sampling locations. One study of Canada Geese fecal samples found they contained an average concentration of 15,300 bacterial organisms / gram. A Canada goose typically produces around 33 grams of dry fecal material daily (nearly 505,000 bacterial organisms for each animal). These estimates are intended to show the magnitude of the bacteria contribution from geese, these numbers were not used in the Total Maximum Daily Load calculation.

(Source: Applied and Environmental Microbiology, December 1999, p. 5628-5630, Vol. 65, No. 12)

Deer: The DNR estimates the deer population in Polk County to be about 0.009 deer per acre, for the TMDL calculations this number has been increased ten percent to account for wildlife other than deer and geese, such as raccoons, so that the total estimate is one deer per 100 acres. It is estimated that there are 548 deer in the watershed with 129 in the park or in close proximity to the lake. The deer are in the park year round and have high source potential because of their proximity to the lake.

Livestock

There are 22 livestock operations within the watershed (11 cattle, 6 horse, 5 swine). Six of the operations are Confined Animal Feeding Operations (CAFO) and the remaining sixteen are open feedlots. There is also 687 acres of annually grazed pasture.

CAFO Summary

- 5 of the operations are swine and 1 is cattle
- 10,862 total swine
- 95 total cattle
- 23 total buildings
- Each have their own waste management systems on site

Open Feedlot

- 10 of the feedlots have cattle and 6 have horses
- 435 total cattle
- 39 total horses
- 13 discharge into an agriculture field and 3 into a stream
- 3 are considered to have a frequent flood risk
- 10 are year round lots and 6 are seasonal

Open Grazers

- 752 acres of annually grazed pasture
- 27 total pastures
- 21 cattle pastures with 334 total head
- 5 horse pastures with 20 total head
- 1 sheep pasture with 20 total head
- 23 pastures are considered to have a frequent flood risk
- 21 pastures have direct access to streams

The estimated head count of total livestock either in CAFOs, open feedlots, or grazing is 11,805. This number was calculated by either speaking directly with operators or visually estimating livestock numbers in open feedlots and pastures.

Watershed Pasture Ground: There are 752 acres of annually grazed pasture in the Big Creek Watershed. Ninety-five percent of this ground either straddles or is bordered by creeks draining to Big Creek Lake (**Map 5, page 24).** The vast majority of the watershed is prime Des Moines Lobe farmland, only the steeper areas along the valley walls of the streams and the wet lowland areas directly along the streams are not suitable for row crops, and thus, the high percentage of pasture ground along the stream corridors results.

Confined Animal Feeding Operations and Open Feed Lots: Six CAFO's and 16 open livestock feed lots are located within in the Big Creek watershed. Manure from CAFO's is stored on site in waste storage facilities and is applied to agricultural land according to MMP guidelines, some on fields in the watershed.

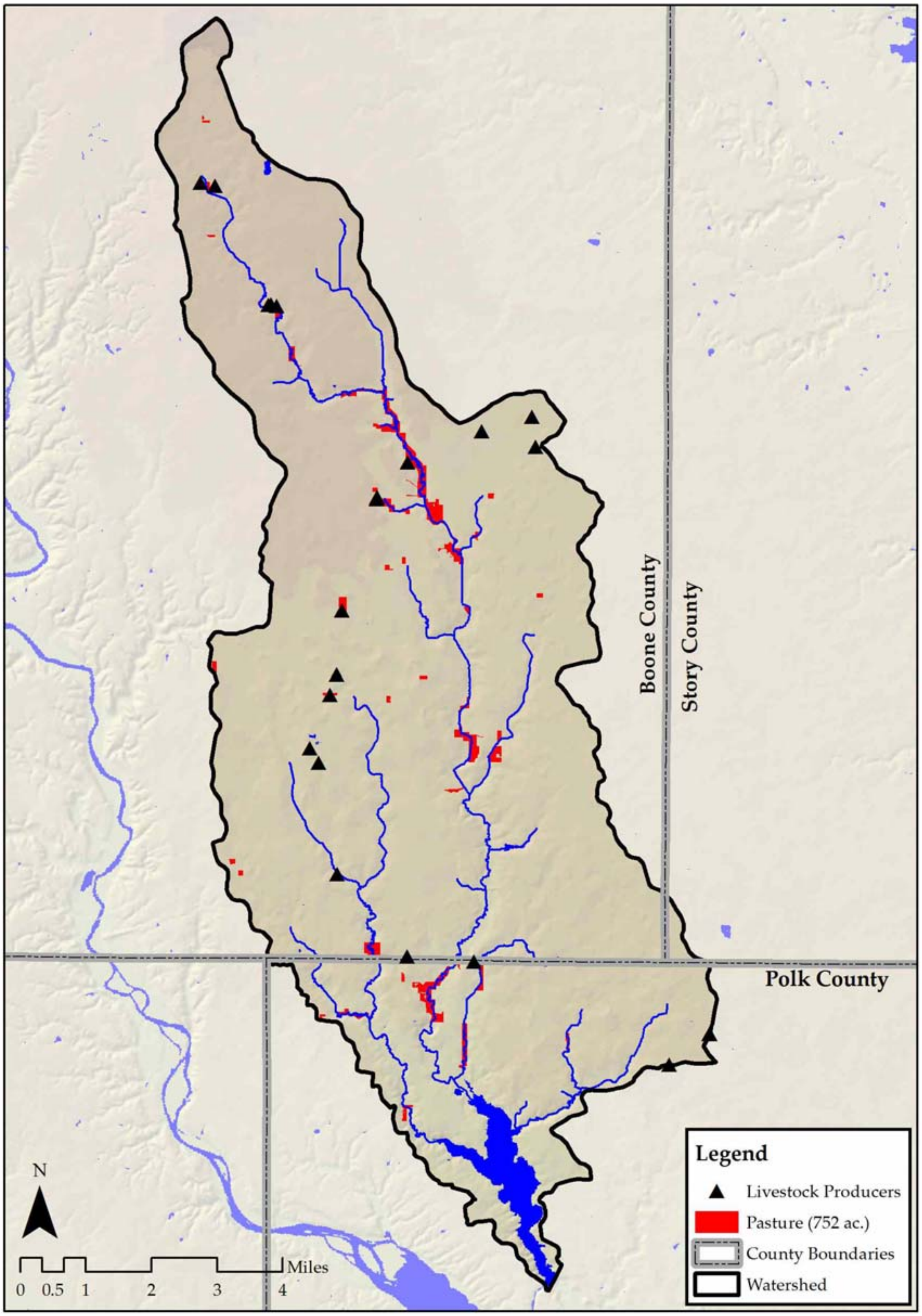
Manure Spreading Fields Identified in Manure Management Plans: 1,239 acres of row cropped agricultural land receive an average of 5,481 gallons of manure application annually as part of registered Manure Management Plan (MMP) applications. These fields are identified and manure application methods are classified on **Map 6 (page 25)**. Seven of the fields receiving MMP applications are bordered by a stream draining to Big Creek Lake.

Septic Systems

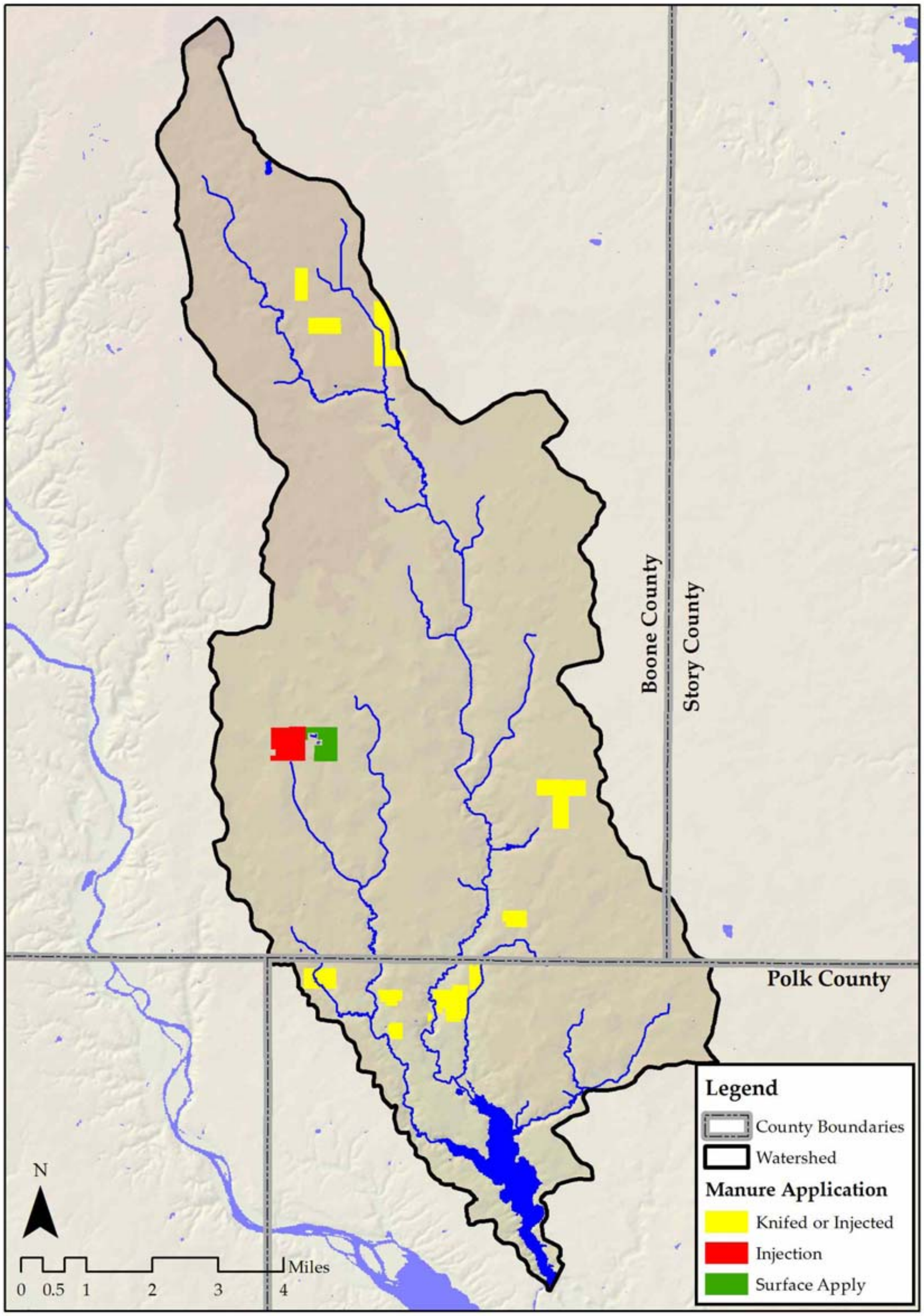
There are 328 rural residences in the Big Creek Watershed, most if not all of which, treat waste with on-site septic systems. See **Map 7 (page 26)** for locations of rural residences. **Table 8** shows the proximity of each rural residence to a stream draining to Big Creek Lake. There are likely a number of systems that are not functioning properly due to poor design, lake of maintenance, inappropriate soil conditions and old age. Non-functioning septic systems closest to the streams are more likely to contribute bacteria to Big Creek Lake unless the septic system is bypassed altogether and waste outlets directly to a tile line emptying in stream, in which case the distance of the septic system from the stream is irrelevant. No discharges of waste from septic systems or tile lines that may be bypassing septic systems were observed while conducting the RASCAL stream assessments, however, not all the streams in the watershed were assessed and some were assessed with ice cover.

	<250′	250-500′	500-2000′	>2000′
# of Residences	14	29	123	162

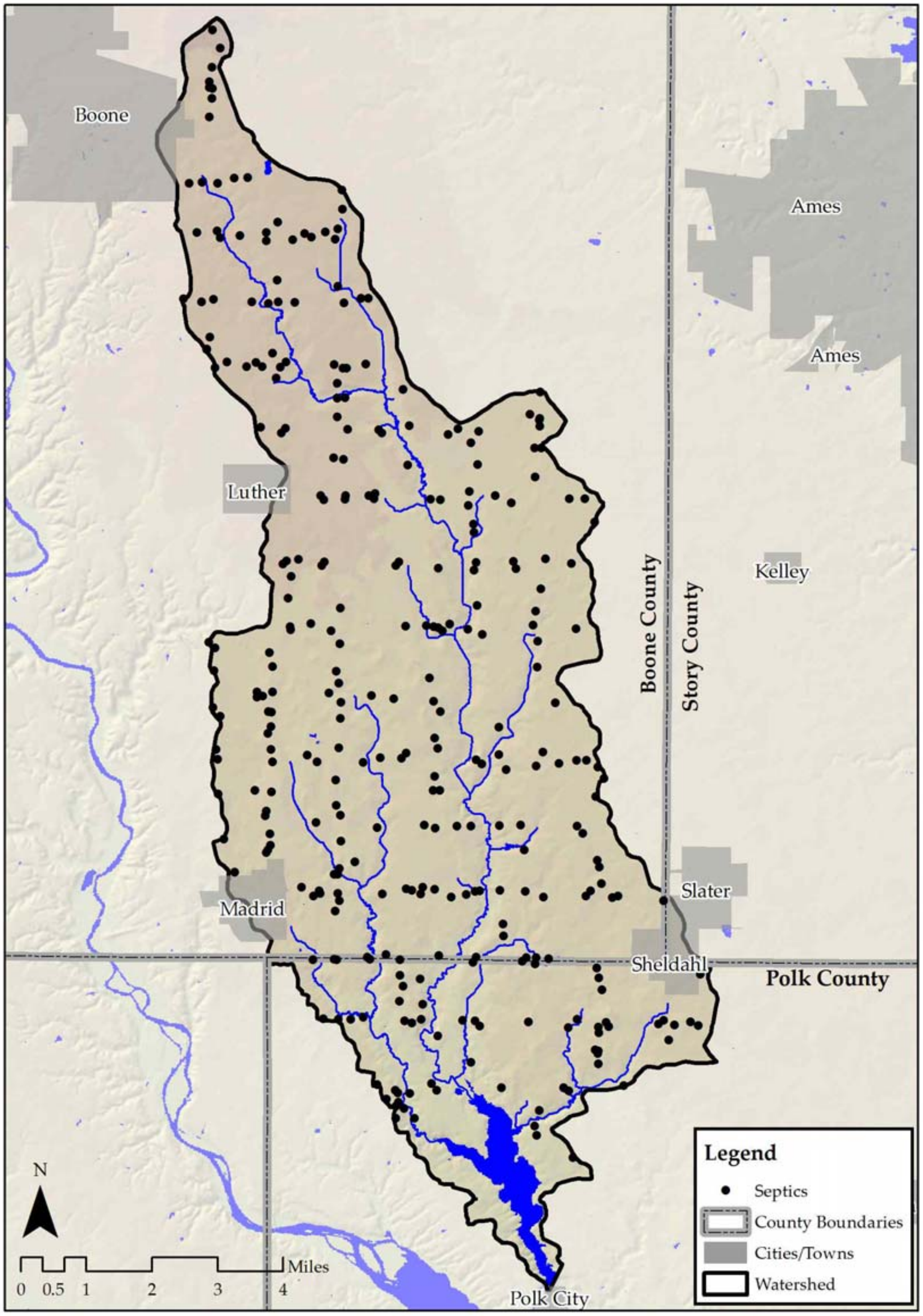
Table 8. Big Creek Lake Watershed Residence-Distance to Stream.



Map 5. Livestock Producers and Pasture Locations - 2008.



Map 6: Manure Application Methods - 2008.



Map 7: Rural Residences with Septic Systems – 2008.

Sediment and Phosphorus Source Assessment

Several sources of sediment and phosphorus were identified within the Big Creek Lake watershed, the sources were field verified and quantified during the comprehensive watershed assessment in 2008 and 2009. They include the following: sheet and rill erosion, classic gully erosion on state managed land, classic gully erosion on private land, ephemeral gully erosion from agricultural areas, and stream bank erosion. An estimated sediment delivery budget was calculated for the Big Creek Lake watershed after analyzing all quantifiable data and is displayed in **Table 9**. A detailed discussion of the various sediment sources is provided in the following sections. As previously mentioned a phosphorus enrichment ratio of 1.6 pounds for every ton on sediment delivery was used to estimate phosphorus loading.

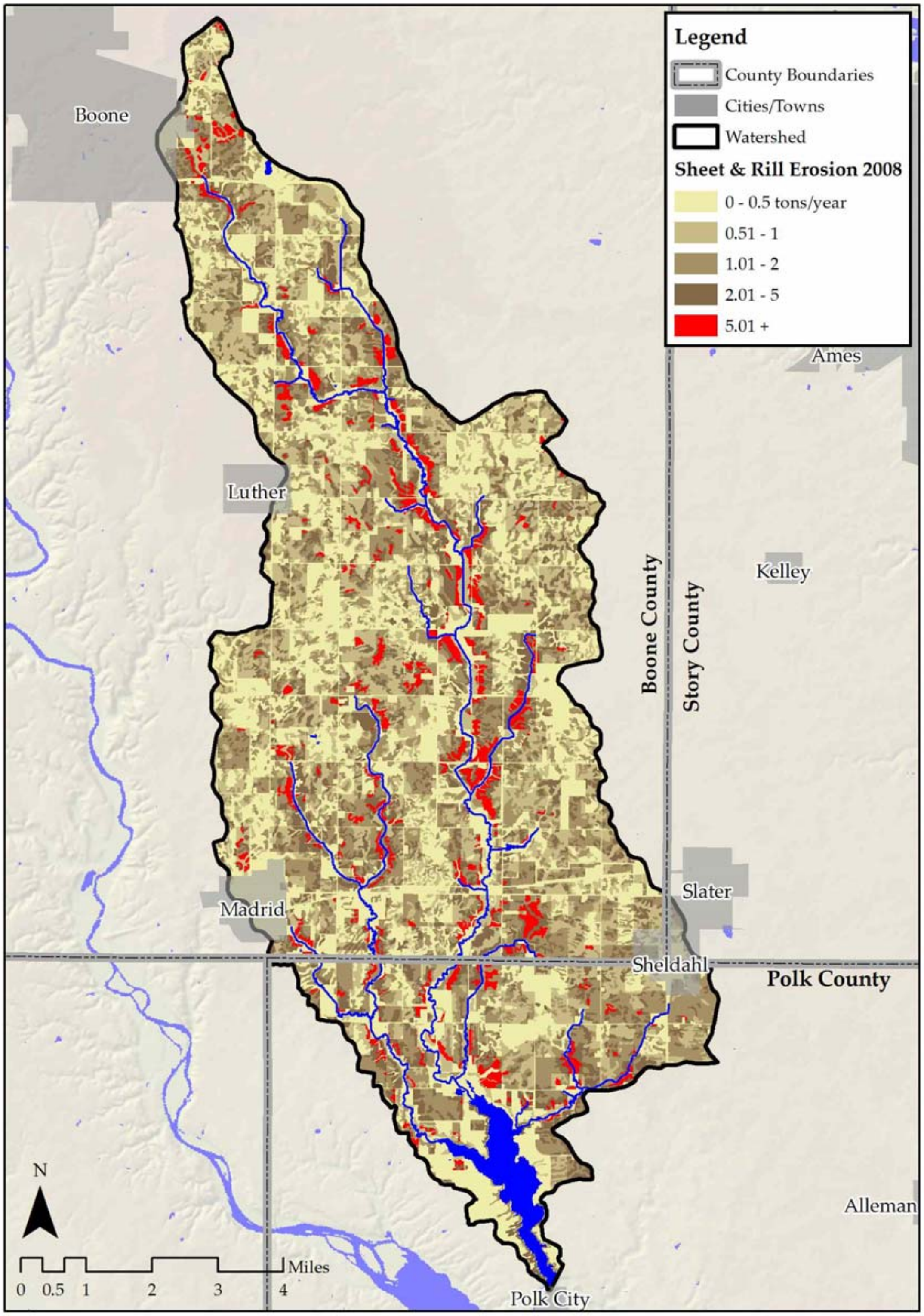
Source	Gross Erosion (t/y)	Delivery Ratio	Sediment Delivered to Big Creek Lake (t/y)	Phosphorus Delivered to Big Creek Lake (lbs/yr)	Percent Contribution
Sheet and Rill Erosion	36,533	3.20%	527	843	7%
Classic Gullies	655	90.00%	589	942	8%
Ephemeral Gullies	4,148	70.00%	2,904	4,646	40%
Streambank Erosion	3,596	90.00%	3,236	5,178	45%
Total	**44,932**		**7,256**	**11,610**	

Table 9. Big Creek Lake Watershed Sediment and Phosphorus Budget.

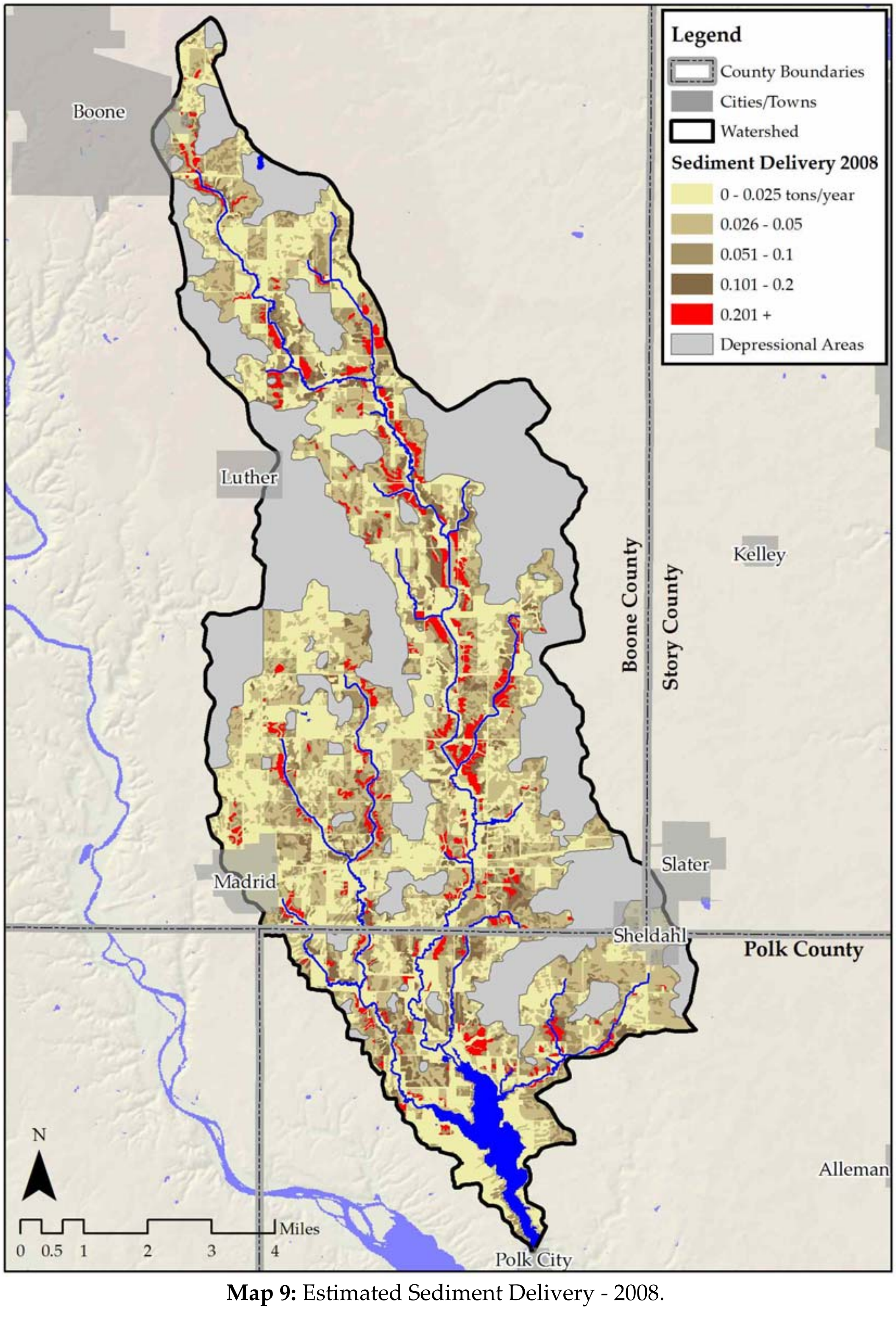
Sheet and Rill Erosion

A windshield survey of land uses was completed for the watershed in 2008 and 2009. The survey consisted of driving the watershed and recording land usage, field tillage practices, existing BMP types and placements, identifying where future BMPs would be beneficial, and livestock operation locations and types. Recently obtained LIDAR data for the watershed was used to complement the windshield survey. A 3D elevation model was extracted from the LIDAR data, allowing analyses of areas that were not visible from the road; the LIDAR elevation data was accurate to within 6 inches and had a resolution of 3 meters.

Data collected during the Big Creek Lake Watershed assessment was used by IDNR's Watershed Improvement Section to create sediment erosion and delivery estimates for Big Creek Lake. GIS-based computer modeling sheet and rill erosion (RUSLE) and sediment delivery maps were created, see **Maps 8 and 9 (pages 28-29).** Utilizing LIDAR data, closed basins or pot-hole drained areas were excluded from the sediment delivery model as these areas not draining directly to streams do not contribute a measurable amount of sediment to the lake. Excluding the pot-hole drained areas from the watershed allowed us to further prioritize the remaining 32,685 stream drained acres (51 square miles) for sediment trapping BMPs. Of these non-pothole drained watershed acres just over 10% or only 3,377 acres contribute 74% (390 tons/yr) of the modeled sediment delivery (from sheet and rill erosion) to Big Creek Lake. These high contributing areas can be found on **Map 9 (page 30)** and are those with Sediment Delivery rate greater than 0.05 tons per acres year, these areas have been designated as high priority for placement of sediment trapping BMPs.



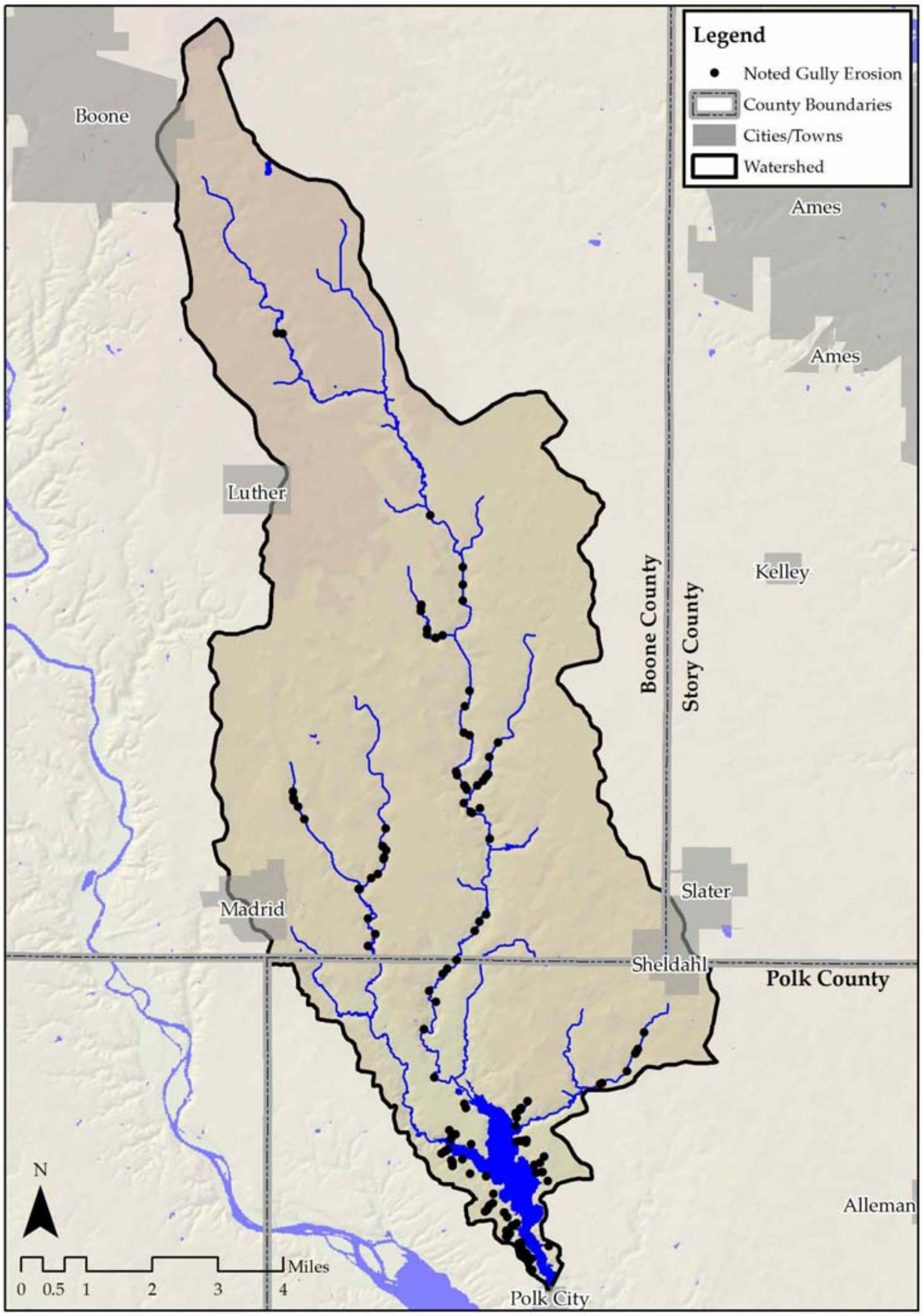
Map 8: Estimate Sheet and Rill Erosion - 2008.



Map 9: Estimated Sediment Delivery - 2008.

Classic Gully Erosion on State Managed Land

The entire perimeter of Big Creek Lake was assessed for gully erosion. There were a total of 25 gullies indentified that outlet directly into Big Creek Lake, all 25 of the identified gullies were located on state managed property. Combined, these gullies erode 655 tons of sediment annually, 589 tons of which are estimated to reach to the lake every year **(Map 10).**



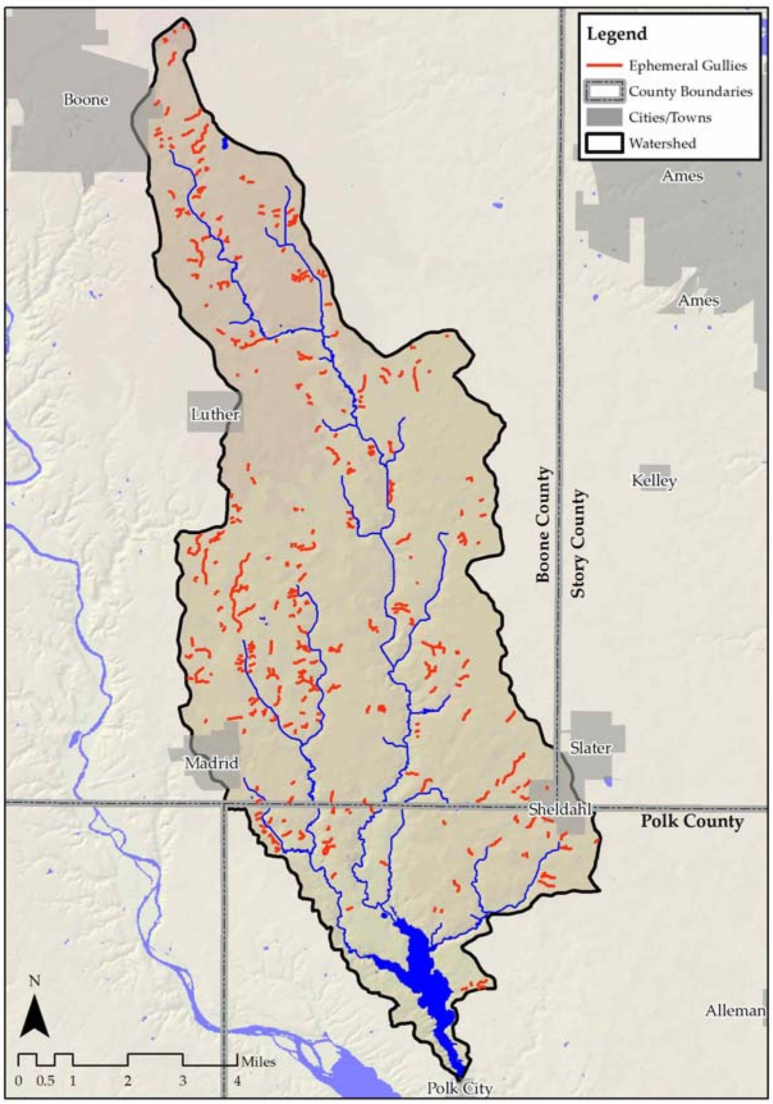
Map 10. Gully Erosion - 2008.

Classic Gully Erosion on Private Land

Over 100 gullies cutting from watershed streams towards agricultural fields were identified during the RASCAL assessment **(Map 10, page 30).** Due to the fact that these gullies are located on private land no estimate of erosion is available at the current time. It was noted during the stream assessment that none of these gullies approached the magnitude of the 10 worst gullies located on state managed ground.

Ephemeral Gully from Agricultural Areas

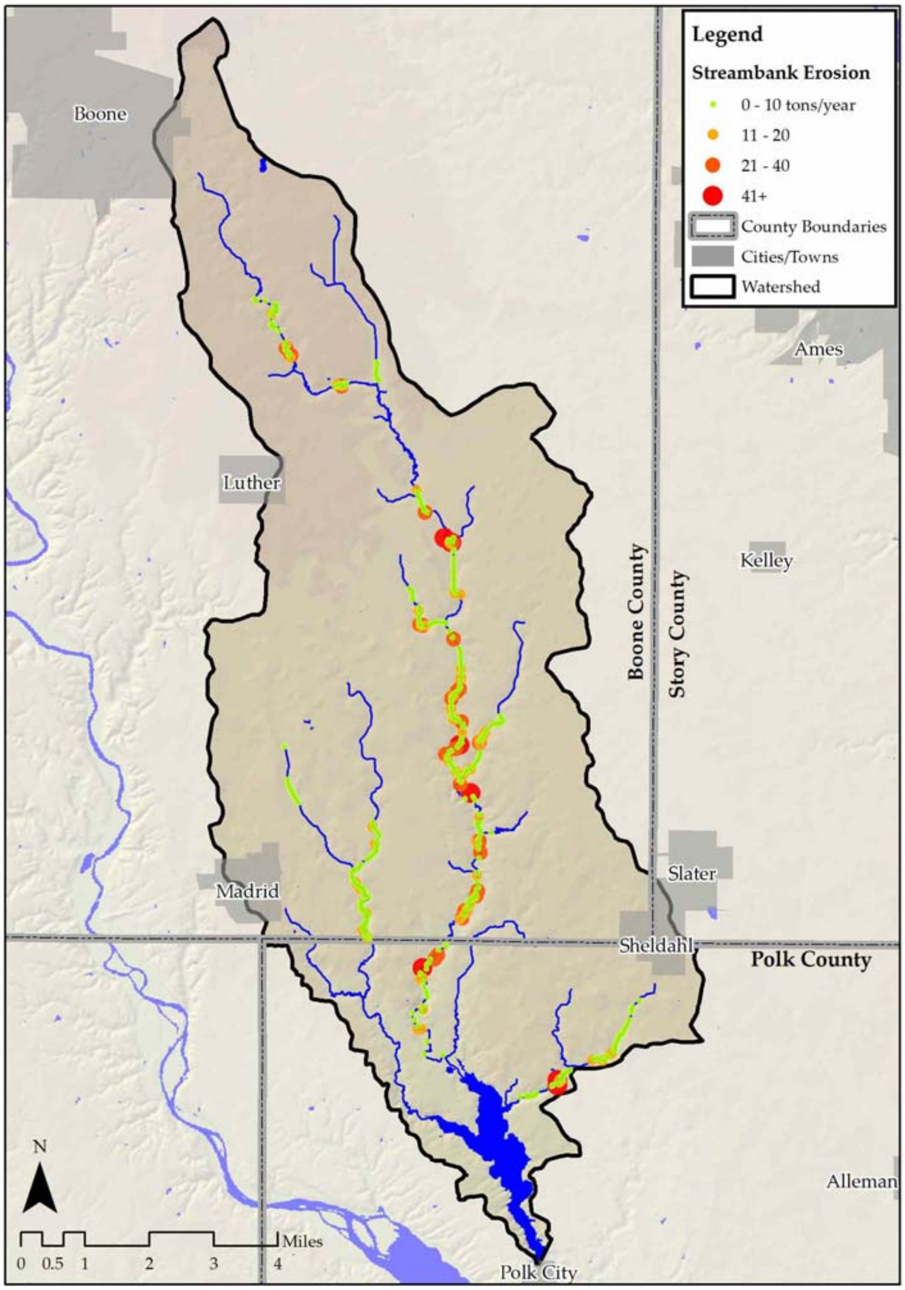
An estimated 4,148 tons per year of erosion occurs as a result of ephemeral gully erosion within the Big Creek Lake watershed, of this amount 2,903 tons per year is estimated to reach Big Creek Lake. Using windshield survey observations, LIDAR data, and high resolution photography, 243,990 feet of ephemeral gullies were identified. To calculate the erosion estimate it was assumed that these gullies average 2 feet wide, 5 inches deep and have a soil density of 85 pounds per cubic foot. The sediment delivery ratio used for ephemeral gullies was 70%. **(Map 11).**



Map 11. Ephemeral Gullies – 2008.

Streambank Erosion

Based on an in-depth assessment of stream conditions in 2008 and 2009 an estimated 3,596 tons of sediment per year erodes streambanks within the Big Creek watershed**.** Of that amount, 3,236 tons per year (90%) is estimated to reach Big Creek Lake annually. The actual amount is slighter larger since the estimate is only based on assessed segments of streams in the watershed (35 of the 43 total miles of stream were assessed). This category of erosion contributes the most sediment to Big Creek Lake. **(See Map 12)**



Map 12. Streambank Erosion – 2008.

5 GOALS AND OBJECTIVES

The primary goal of this Watershed Management Action Plan is to implement best management practices (BMPs) that will address the bacterial impairment. The secondary goal is to reduce sediment and phosphorus delivery to Big Creek Lake it improve and maintain water quality of this important resource. Both of these goals will be achieved through combination of practices that will target identified source areas and contributors.

Goal 1: Remove bacteria impairment at Big Creek Lake by reducing bacteria violations by 70% within 10 years of project start date. The 70% reduction goal was based on the Water Quality Improvement Plan (TMDL) recommendations to meet water quality standards, see Table 7. The predicted load reductions resulting from this goal were calculated using the Soil Water Assessment Tool (SWAT) Model, the same model used to develop the Water Quality Improvement Plan (TMDL). The combined benefits of Objectives 1, 2, 3 and 4 are shown to have an 80% reduction in the frequency of single sample maximum bacteria violations of the water quality standard and a total elimination of geometric mean violations. Although though there may still be single sample violations the frequency will be far less than 10% of the total samples, this is below the threshold to trigger impairment status. Figure 7 shows the modeled E. coli concentrations resulting from Goal 1, the purple line represents the predicted E. coli concentration with all current loads, the green line is the predicted concentration after the goose, deer and cattle inputs have been addressed. To determine progress towards reaching this goal water quality monitoring results from the State Park beach will be analyzed to determine if the frequency of violations, both single sample maximum and geometric mean, are being reduced. The frequency of water quality violations, rather than concentration, is being used as the measure of success because Iowa water quality standards state E. coli concentrations can exceed the single sample maximum up to 10% of the time and still not be considered impaired. Also it has been the frequency of violations that has drawn attention from the public and press. The State Park beach site will be used because it is this location that provided data used to determine the initial bacteria impairment and the load reductions included in the Water Quality Improvement Plan utilized data from this site. See Map 13 for ideal BMP placement locations associated with Goal 1.

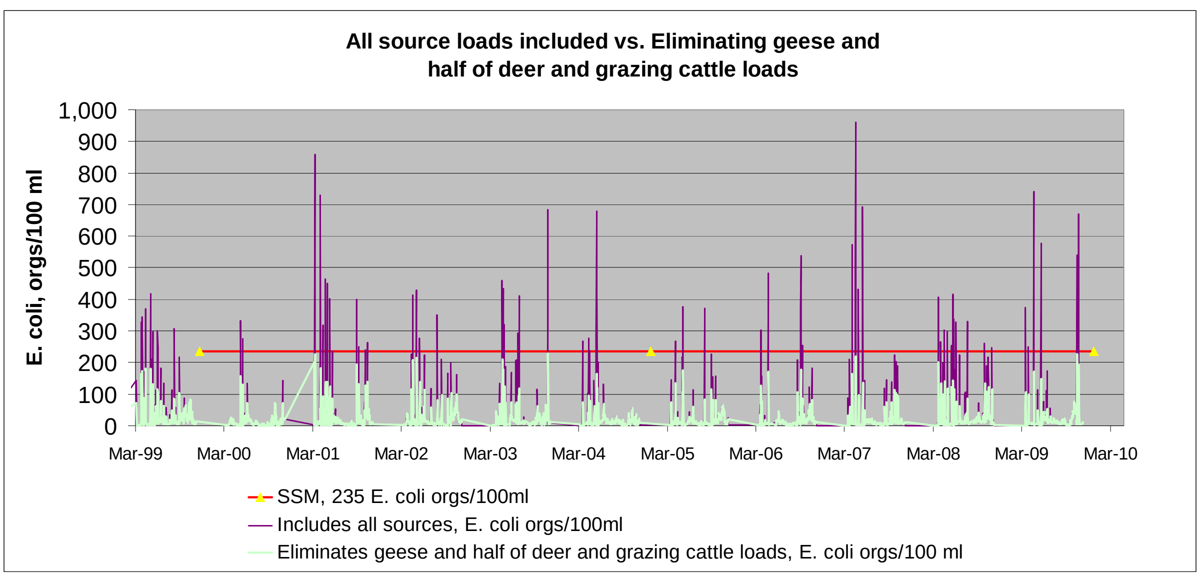


Figure 7. Modeled E. coli concentrations.

Objective 1: Reduce geese population and loafing times at and near the State Park beach. The SWAT modeling of this objective shows a **27% average reduction** in the number of bacteria single sample maximum violations and a total elimination of geometric mean violations. The modeled results of this objective alone would result in the frequency of single sample maximum violations being reduced below the impairment threshold but due to the complex nature of bacteria fate and transport additional measures will be needed to ensure bacteria sources in the watershed are addressed.

Task 1. Utilize dog services to "train" geese to avoid the beach area, this is anticipated to reduce goose loafing times at the beach.
Task 2. Install 2 "Away with Geese" light units near the beach. The lights are designed to disrupt night sleep patterns of geese and will force them seek refuge in areas away from the beach.
Task 3. Remove geese droppings at beach using beach grooming equipment.
Task 4. Modify landscaping of beach area to reduce goose loafing times at the beach.
Task 5. Create 1 alternative loafing area away from beach (already implemented by DNR Parks staff).
Task 6. Remove all goose nesting boxes and tubes (already implemented by DNR Wildlife staff).
Task 7. Hold special early goose hunting season (already implemented by DNR Wildlife staff).

Objective 2: Reduce bacterial loading from livestock throughout watershed with priority given to locations nearer the lake. A SWAT Model of objectives 2 and 3 shows a **51% reduction** in the number of bacteria single sample maximum violations and a total reduction of geometric mean violations. Objectives 2 and 3 were modeled in combination so the same reduction was assigned to both objectives. It should be noted that the stated reduction can not be achieved without accomplishing both objectives.

Task 1. Construct 5 manure settling basins.
Task 2. Restrict cattle access from 2.25 miles of streams.

Objective 3: Manage deer population near Big Creek Lake and construct basins to capture runoff from areas with high deer densities. A SWAT Model of objectives 2 and 3 shows a **51% reduction** in the number of bacteria single sample maximum violations and a total reduction of geometric mean violations. Objectives 2 and 3 were modeled in combination so the same reduction was assigned to both objectives. It should be noted that the stated reduction can not be achieved without accomplishing both objectives.

Task 1. Construct 10 sediment basins at key inflow points within Big Creek State Park and Wildlife Management Area aimed at treating runoff. The structures for this task also accomplish Goal 2, Objective 2, Task 1.
Task 2. Work with DNR Wildlife to actively mange for reduced deer populations.

Objective 4: Inform rural residents of potential impacts of failing septic systems. A SWAT Model addressing all failing septic systems shows a **2% reduction** in the number of bacteria single sample maximum violations.

Task 1. Provide information and education to rural residential landowners in regards to operation, maintenance and replacement options for non-functioning septic tanks and the water quality issues related to bacteria, resulting in the replacement of 5 of the failing systems within the watershed (Priority should be given to septic systems within 500 feet of a stream corridor)

Goal 2: Within 20 years of project start date, reduce sediment delivery to Big Creek by 30% or 2,269 tons per year. This goal is also anticipated to reduce sediment bound phosphorus delivery by 30% or 3,630 pounds per year. See Map 14 for ideal BMP placement locations in the watershed.

Objective 1: Work with land owners and operators to implement conservation practices on private land.

Task 1. Maintain at least 1,200 acres of CRP within the Big Creek Lake watershed. This objective will prevent a significant amount of sediment from reaching Big Creek Lake. It is estimated this task will prevent a sediment loading increase of 139 tons per year and a phosphorus loading increase of 222 pound per year.

Task 2. Construct terraces or water and sediment control basins on 4,500 acres of cropland. Targeted lands must meet the following criteria: 1) at least 20% of the field area has slopes greater than 5%, 2) the field is currently cropped and 3) the field does not currently have terraces. This objective is anticipated to reduce sediment delivery to Big Creek Lake by 471 tons per year and phosphorus delivery by 754 pounds per year.

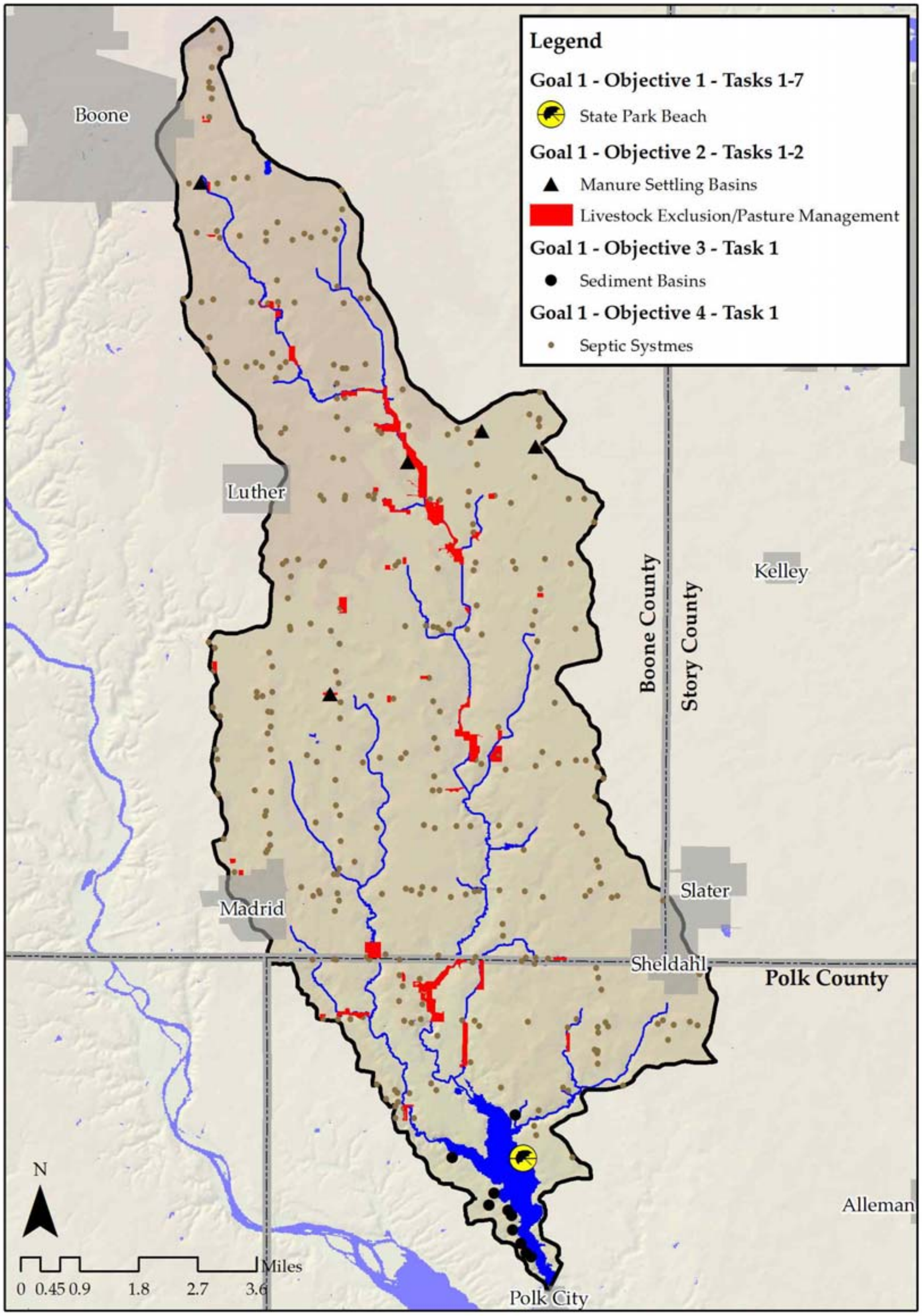
Task 3. Implement 35,000 feet of grassed waterways. This objective targets ephemeral gullies identified during a 2008 inventory of the Big Creek Lake watershed. This objective is anticipated to reduce sediment delivery to Big Creek Lake by 416 tons per year and phosphorus loading by 666 pounds per year.

Task 4: Implement 2,550 feet stream bank stabilization practices. This practice is targeted to severely eroding stream banks identified during a 2008 assessment of stream conditions. This objective is anticipated to reduce sediment delivery to Big Creek Lake by 663 tons per year and phosphorus delivery by 1061 pounds per year.

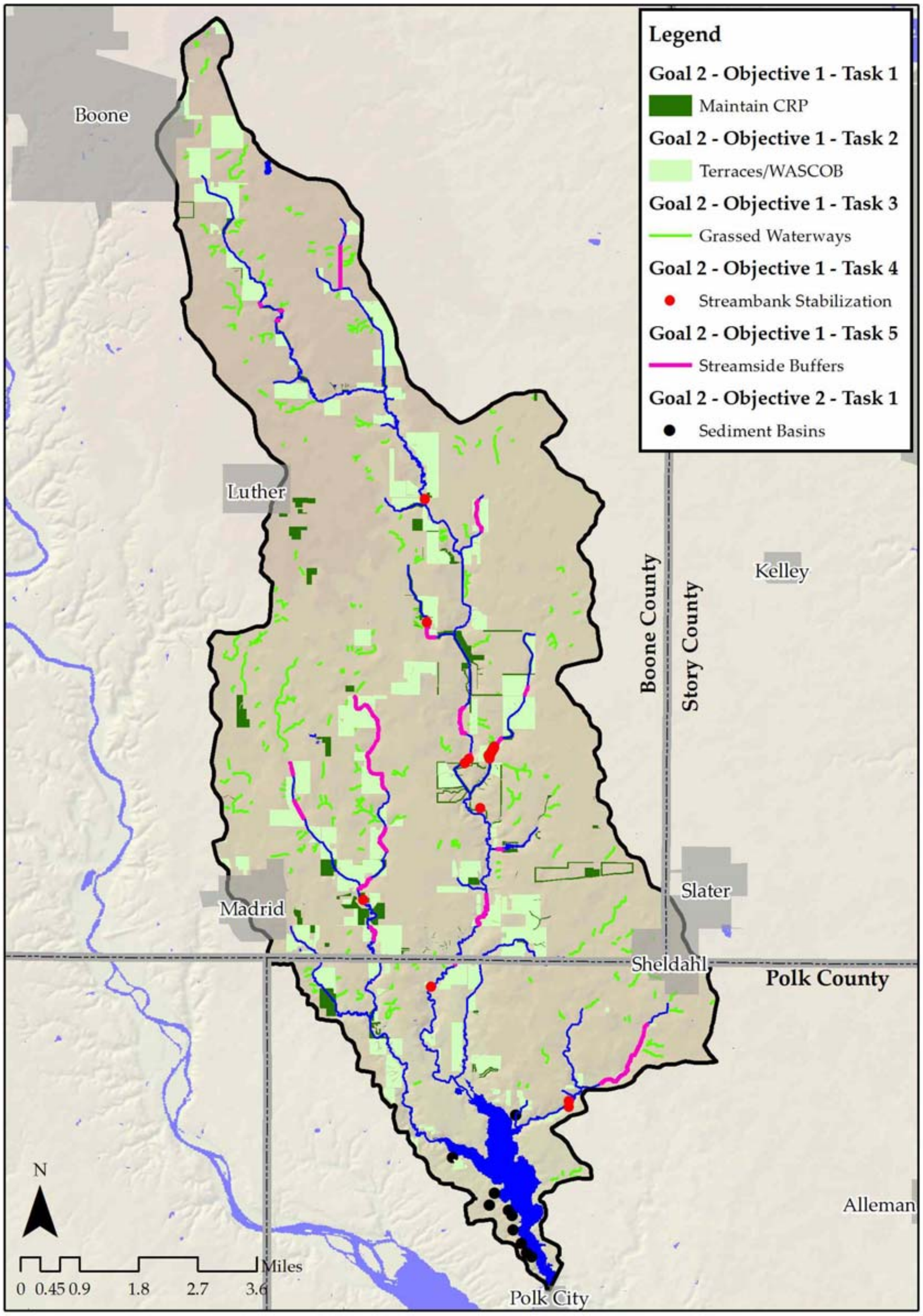
Task 5. Implement 80 acres of streamside buffers. This practice will be targeted to areas along non-pastured stream reaches noted as having buffer widths less than 30 feet. This objective is anticipated to reduce sediment delivery to Big Creek Lake by 200 tons per year and phosphorus delivery by 320 pounds per year.

Objective 2: Work with public land managers to implement conservation practices.

Task 1. Construct 10 sediment basins. These structures will be targeted to severely eroding gully locations around Big Creek Lake. This objective is anticipated to reduce sediment delivery to Big Creek Lake by 519 tons and phosphorus delivery by 830 pound per year. The structures for this task also accomplish Goal 1, Objective 3, Task 1.



Map 13. Goal 1 ideal BMP placement.



Map 14. Goal 2 ideal BMP placement.

6 IMPLEMENTATION SCHEDULE & MILESTONES

See tables included in **Appendix A-1**.

7 WATER MONITORING PLAN

The goals and objectives of water monitoring in the Big Creek Lake watershed are as follows:

1. Document the removal of water quality impairment for the water body of interest.
2. Document loading reductions for pollutants to the impaired stretch as identified in the TMDL plan and/or the project implementation grant.

Big Creek Lake in Polk County is impaired due to high levels of indicator bacteria. The primary goal of the Big Creek Watershed Project is to implement best management practices that will address the bacterial impairment of this important recreational resource in order to remove it from the 303d list. A secondary goal is to reduce sediment and phosphorus loading to Big Creek Lake.

Monitoring Needs:

1. Annual lake/beach monitoring to determine if water quality "standards" are being met (progress toward bacteria goals).
2. Monitor the performance of BMPs including pasture management, goose management, MMP plans, and septic systems to determine if load reduction strategies have been effective.
3. Monitor the performance of stream bank stabilization, terraces, CRP buffers, and water and sediment control structures. Track bacteria concentrations and delivery to the lake.
4. Conduct and repeat RASCAL stream bank and gully erosion assessment after BMP implementation to quantify reduction in sediment delivery from these sources. The assessments will be conducted every five years to assist with the plan evaluation process.

The main objective of the Big Creek Lake 319 monitoring program is to develop a monitoring network that can track the impacts of installation of Best Management Practices (BMPs) designed to improve water quality in Big Creek Lake. In addition, the network should be capable of documenting total loading of nutrients and sediment to Big Creek Lake. To do this, the network should represent water quality from a variety of weather conditions.

The Big Creek Lake monitoring network is designed to monitor pre-project, and post-project conditions in the tributaries feeding Big Creek Lake, at the beach, and in the lake itself. This monitoring network, however, could be turned into a long-term monitoring network with local support. In order to determine the difference between pre- and post-project conditions the sample collection, preservation, and analytical techniques are generally constant from one year to the next. The only exceptions are those changes needed to be consistent with revised USEPA approved methods and those changes that occur based on location and design of BMPs. DNR and local project staff will conduct all sampling; this provides consistency throughout the sampling effort.

The data collected for this monitoring represent conditions in Big Creek Lake and its watershed. The measurements made include those for which standards or USEPA criteria may be used to judge water quality. The flow conditions at the time of sampling are measured at the tributary locations to better evaluate the data and to calculate the loading of bacteria, nutrients and sediment from the watershed to Big Creek Lake.

The Big Creek Lake watershed monitoring network has been designed to address the goals and objectives addressed above. The monitoring is a blend of fixed station, fixed sampling and event sampling to catch rainfall runoff events. Locations of monitoring stations were chosen to meet the following general criteria

- Sites are located so as to subdivide the project watershed into subwatersheds that are likely to demonstrate a measureable change in water quality during the life of the project (3-5 years).
- Site locations are chosen to meet requirements of landowner access and permission.
- Fixed monitoring locations are chosen to represent the condition of the impaired stretch and to provide the ability to reassess the waterbody for future 303d/305b reports.

Tables 10, 11 and 12 describe the location of Big Creek Lake stations to be sampled. **Map 15** shows the location of sampling stations.

DNR staff will collect samples from in-lake locations on a monthly basis (**Tables 10 and 11, page 39-40**). Local field staff will collect tributary grab samples biweekly from the fixed locations listed in **Tables 10 and 11 (See Map 15, page 41)**. Sampling is to occur on a set day of the week during the biweekly period. This allows for a consistent sampling interval and allows the data from all sites to be directly compared. The State Hygienic Laboratory (SHL) will analyze these samples for parameters listed in **Table 11**. DNR staff will obtain instantaneous flow measurements at the time of sampling, when feasible.

Site Name	*Stream Name*	*County*	*Monitoring Station Locations*	*STORET #*
BCW1	North Fork Big Creek	Boone	250th Street east of T Avenue	13080001
BCW2	West Branch Big Creek	Boone	T Avenue south of 250th street	13080002
BCW3	Main Stem Big Creek	Boone	280th Street west of V Avenue	13080003
BCW4	Big Creek	Boone	310th Street east of Unicorn Ave	13080004
BCW5	Big Creek	Boone	310th Street east of Site 4	13080005
BCW6	Little Creek	Boone	NW 166th Avenue east of T Ave	13770001
BCW7	Little Creek	Polk	T Avenue north of NW 158th Ave	13770002
BCW8	Big Creek	Polk	NW 100th Street north of NW 150th Ave	13770003
BCW9	Big Creek	Polk	150th Avenue west of NW 100th Street	13770004
BCW10	Little Creek	Polk	NW 146th Avenue	13770005
BCW11	Turkey Creek	Polk	NW 86th Street	13770006

Table 10. Fixed Tributary Biweekly and Event Monitoring Stations

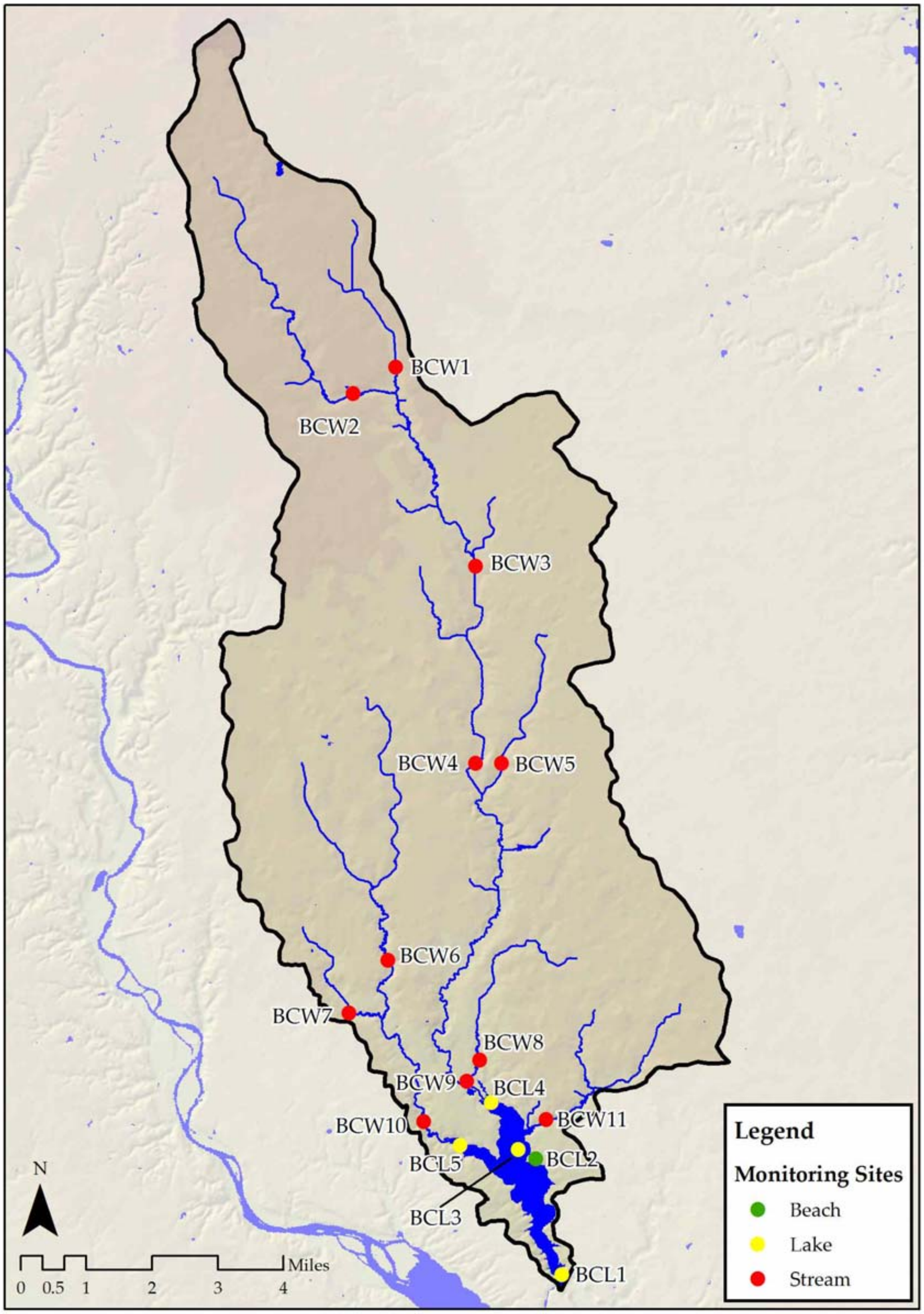
Lake Site	*X (meters)*	*Y (meters)*	*STORET #*
BCL1 (Deep water)	0439224	4627155	22770004
BCL2 (Beach)	0438583	4629995	26770001
BCL3 (Main lake near Marina)	0438151	4630234	26770003
BCL4 (Big Creek Rock Sill)	0437493	4631386	26770002
BCL5 (Little Creek Rock Sill)	0436731	4630325	26770004

Table 11. UTM Coordinates of In-Lake Sampling Sites

Secchi Depth (lake only)	Flow (stream only)
Ammonia – nitrogen	Nitrate + Nitrite-Nitrogen
Total Phosphate (as P)	Total Kjeldahl Nitrogen
Turbidity (stream only)	Total Suspended Solids (stream only)
E. coli	Temperature (field)
Dissolved Oxygen (field)	pH (field)
Dissolved Oxygen Profile (lake only)	

Table 12. Parameters monitored for Big Creek 319 Monitoring Program.

A Quality Assurance Project Plan (QAPP) has been prepared and approved by the Iowa DNR Water Monitoring and Assessment Section. See **Appendix A-2**.



Map 15. Map of monitoring sites for the Big Creek Lake 319 water quality monitoring

8 PUBLIC OUTREACH PLAN

Public outreach (also known as information and education, communications, marketing or public relations) is a way to motivate people to participate in water quality improvement. It goes beyond just informing the public and moves them to action. Public outreach takes a social science approach to water quality goals. The key to increasing participation in water quality improvement efforts is to gain an understanding of community, create incentives and motivate people to take action. The following section follows DNR recommendations for developing a Public Outreach Plan.

1. Goals

- **Remove bacteria impairment at Big Creek Lake by reducing bacteria violations by 70% within 10 years of project start date.**
- **Within 20 years, reduce sediment delivery to Big Creek by 30% or 2,269 tons per year. This goal is also anticipated to reduce sediment bound phosphorus delivery by 30% or 3,630 pounds per year.**

2. Target Audiences

Who will be needed in order to make changes to the land and water?

- Iowa Department of Natural Resources
- Landowners
- Agricultural producers on rented lands
- Agencies and regent universities related to state research farms
- Hunters of deer and other game animals
- Recreational lake and park users

Who will be depended upon to advance this project?

- Polk and Boone County Soil and Water Conservation District (SWCD)
- Big Creek Advisory Committee
- City governments of Madrid, Sheldahl, Slater, Luther, Boone and Polk City
- Iowa Department of Natural Resources (IDNR)
- Iowa Department of Agriculture and Land Stewardship (IDALS)
- Elected representatives to local, state and federal governments

Who will be needed to advance this message to these people?

- Community leaders and spokespersons
  - SWCD Commissioners
  - Big Creek Watershed Project Coordinators
  - Key local landowners or agricultural producers
  - County Board of Supervisors, City Councils and Township Trustees
- Project partners and stakeholders
  - Other United States Department of Agriculture (USDA) / IDALS personnel

    - Big Creek Watershed Project Coordinators
    - Key local landowners or agricultural producers
    - IDNR Big Creek Lake State Park personnel
    - Central Iowa Anglers
    - Polk City Chamber of Commerce
    - Iowa Cattlemen's Association
    - Iowa Pork Producers
    - Iowa Soybean Association
    - Iowa State University Extension
- Local agriculture-based and outdoor recreation-based business and clubs
    - Pheasants Forever
    - Ducks Unlimited
    - 4-H
- Newspapers
    - Des Moines Register
    - Madrid Register News
    - Slater Tri-County Times
- Radio
    - 20 local FM radio stations
    - 10 local AM radio stations
    - WOI (ABC 5), KCCI (CBS 8), KDIN (IPTV 11) WHO (NBC 13), KDSM (FOX 17, KCWI (WB 23), KFPX (ION 39)
- Television
    - WOI (ABC 5)
    - KCCI (CBS 8)
    - KDIN (IPTV 11)
    - WHO (NBC 13)
    - KDSM (FOX 17)
    - KCWI (WB 23)
    - KFPX (ION 39)

3. Target Audience Research

The following section includes assumptions regarding target audiences developed during public outreach efforts related to the development of this plan, but does not represent extensive research of the target audiences.

Landowners and agricultural producers
Potential barriers to participation:

- Potential reduction in amount of productive agricultural land
- Cost of installing and maintaining conservation practices
- Concern about ceding control of land use
- Reluctant to work with government officials and programs
- Reluctant to change current watering or manure management practices
- Perception of past inconsistent direction on management practices by separate government agencies (getting the "run around" or conflicting advice)
- Not wanting to install practices unless others do as well

- Perception that current practices don't impair watershed and concern that new practices will not provide measurable results
- Viewpoint that issues are caused by "someone else's water" and responsibility for repairs should fall on other land owners or government agencies

Motivators, incentives or benefits to encourage participation:
- Funding assistance programs to offset costs of preferred management practices
- Conveying that better water management can reduce valuable soil loss along stream corridors and upland waterways
- Maximize agricultural yields by working with producers to match land uses with site soils, etc. to increase production or identify additional land under utilized for production
- Strengthen connections between landowners / producers and the recreational opportunities at Big Creek Lake
- Promote cost savings to producers by avoiding overuse of fertilizers and chemicals

County residents
Potential barriers to participation:
- Little or no understanding of water quality issues
- Lack of identification with the watershed (most people know their address and what county they live in, but fewer know where runoff from their property goes)
- Feeling that they can make little impact on the larger watershed (either positive or negative)
- Residents' time already devoted to work, family, etc. and it may be difficult to encourage participation if they feel there is nothing at stake for them

Motivators, incentives or benefits to encourage participation:
- Residents that visit Big Creek Lake can enjoy recreation there more if water quality is improved
- Water quality improvement can increase tourism demand and encourage spending and spur economic development in the area
- Conservation practices can add beauty and other recreational and hunting opportunities throughout watershed

Partners and regulatory agencies
Potential barriers to participation:
- Jobs can have multiple responsibilities
- Agencies may have jurisdiction over larger areas, not just focused on Big Creek
- Separate departments may have some goals that conflict

Motivators, incentives or benefits to encourage participation:
- Joint effort desired to improve water quality within watershed, reduce losses of crops and valuable topsoil and protect infrastructure from damage from flooding

4. Outreach Strategy

Goal #1 (Primary goal): Reduce bacterial loading to Big Creek Lake in an effort to remove it from the Impaired Waters List.

Audience:
- Iowa Department of Natural Resources
- Landowners
- Agricultural producers on rented lands
- Agencies and regent universities related to state research farms
- Hunters of deer and other game animals
- Recreational lake and park users

Potential barriers to adopting practices:
- Costs of participation could affect abilities of producers to be profitable
- Funding sources to install practices on state owned land or within research farms
- Difficulty in reaching a diverse array of residents and stakeholders over such a large area
- Practices located closer to lake will be more effective at addressing impairment (reduces number of participants that can make measurable differences on impairment)
- Reluctance to change practices that are familiar
- No feeling of ownership or responsibility for a share of the problem
- How to encourage additional hunting to reduce wildlife levels within this watershed vs. other locations

Possible solutions:
- Develop the Advisory Committee into a permanent entity to aid with education and advocacy efforts and meet twice annually
- Hold 1 public meeting annually to educate local stakeholders about water quality improvement efforts
- Develop internet resources to educate the public (website, Facebook page, etc.) and update bi-monthly
- Develop a newsletter that will distributed to watershed stakeholders twice annually
- Have at least 15 face-to-face meetings with landowners and producers throughout the watershed
- Hold 1 field days annually addressing production issues related to bacterial contamination and residential septic systems
- Arrange at least two television or radio interviews or spots to educate on efforts to improve water quality in Big Creek Lake
- Develop education signs that highlight accomplishments, watershed boundaries and stream crossings
- Develop funding sources to offset cost of installation of practices
- Establish funding sources and commit to investments in infrastructure and equipment to install and maintain practices on state owned land or within research farms
- Focus the effort to install practices where they will provide the most benefit to reducing bacterial loadings (closer to lake). Stakeholders in these locations may already feel a stronger connection to the lake.
- Educate when current practices aren't working and demonstrate how preferred practices can lead to measurable results

- Demonstrate how typical stakeholders contribute to the nature of the impairment and how their efforts can lead to a noticeable improvement in water quality at Big Creek Lake
- Demonstrate the need to control wildlife population within the Big Creek watershed, especially in those areas closest to the lake
- Facilitate at least four newspaper articles annually highlighting water quality improvement efforts

Goal #2 (Secondary goal): Improve overall water quality of Big Creek Lake by reducing sediment and phosphorus delivery to Big Creek Lake.

Audience:
- Iowa Department of Natural Resources
- Landowners
- Agricultural producers on rented lands
- Agencies and regent universities related to state research farms

Potential barriers to adopting practices:
- Costs of participation could affect abilities of producers to be profitable
- Funding sources to install practices on state owned land or within research farms
- Reluctance to change practices that are familiar
- No feeling of ownership or responsibility for a share of the problem

Possible solutions:
- Develop the Advisory Committee into a permanent entity to aid with education and advocacy efforts and meet twice annually
- Hold 1 public meeting annually to educate local stakeholders about water quality improvement efforts
- Develop internet resources to educate the public (website, Facebook page, etc.) and update bi-monthly
- Develop a newsletter that will distributed to watershed stakeholders twice annually
- Have at least 15 face-to-face meetings with landowners and producers throughout the watershed
- Hold 1 field days annually addressing production issues related to bacterial contamination and residential septic systems
- Arrange at least two television or radio interviews or spots to educate on efforts to improve water quality in Big Creek Lake
- Develop education signs that highlight accomplishments, watershed boundaries and stream crossings
- Show how conservation practices can reduce topsoil loss and productive land along unstable stream banks
- Develop funding sources to offset cost of installation of practices
- Establish funding sources and commit to investments in infrastructure and equipment to install and maintain practices on state owned land or within research farms
- Educate when current practices aren't working and demonstrate how preferred practices can lead to measurable results
- Demonstrate where the majority of erosion and nutrient loadings are being generated and focus efforts to install practices there
- Hold field days related to conservation practices which address sediment and nutrient delivery

5. Measuring Effectiveness; Promote Successes

The Public Outreach plan will be reviewed annually and the following items should be documented:

- Advisory Committee attendance and meeting minutes
- Attendance and content of public meetings and field days
- Number of landowners and/or producers involved in project
- Copies of semi-annual newsletter
- Copies of internet content as updated
- Copies of related newspaper articles published
- Park and lake usage information
- Records on dates and times of radio or television spots
- Evaluation of practice implementation
- Evaluation of water quality monitoring information
- Recommendations on adjustments to public outreach efforts or practices expected to be installed

9 RESOURCE NEEDS

Significant resources will be necessary to accomplish the goals highlighted in this watershed management plan. Table 13 provides an estimate of the total cost of best management practices and resources needed to implement the watershed management plan. Cost share rates will be determined as resources are secured through grants and other available sources of funding. Technical assistance and cost share from existing programs will be extremely important if this project is to accomplish the necessary goals. Technical assistance and cost share will be needed from USDA-NRCS staff and programs including but not limited to the Environmental Quality Incentive Program (EQIP), the Conservation Reserve Program (CRP), and the Continuous Conservation Reserve Program (CCRP). Technical and financial assistance from IDALS-DSC will be necessary; this could include the Low and No-Interest Loan Program (SRF), the Iowa Financial Incentives Program (IFIP), the Watershed Protection Fund (WSPF), the Water Protection Fund (WPF), and the Watershed Improvement Review Board (WIRB). Technical and financial assistance from the Iowa Department of Natural Resources will also be required; this will include the Non-Point Source Program, Lake Restoration Program and the Publicly Owned Lakes (POL) Program. The Army Corp of Engineers will also be important partners in this project but funding for watershed based water quality improvement projects is unknown.

Goal-Objective-Task	Component	Phase 1 Years 1-5	Phase 2 Years 6-10	Phase 3 Years 11-15	Phase 4 Years 16-20	TOTALS
1-1-1	Goose-Be-Gone Dog Service	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ 6,500.00	**$ 26,000.00**
1-1-2	"Away with Geese" Lights	$ 1,000.00	$ -	$ -	$ -	**$ 1,000.00**
1-1-3	Beach Groomer	$ 42,000.00	$ 4,000.00	$ 4,000.00	$ 4,000.00	**$ 54,000.00**
1-1-4	Modify Landscaping	$ -	$ -	$ -	$ -	**$ -**
1-1-5	Maintain Alternative Goose Loafing Area	$ -	$ -	$ -	$ -	**$ -**
1-1-6	Remove nesting boxes and tubes	$ -	$ -	$ -	$ -	**$ -**
1-1-7	Early goose hunting season	$ -	$ -	$ -	$ -	**$ -**
1-2-1	Manure Settling Basins	$ 250,000.00	$ -	$ -	$ -	**$ 250,000.00**
1-2-2	Restrict Livestock Access	$ 18,500.00	$ 18,500.00	$ -	$ -	**$ 37,000.00**
1-3-1 & 2-2-1	Sediment Basins	$ 400,000.00	$ -	$ -	$ -	**$ 400,000.00**
1-4-1	Address Failing Septics	$ -	$ -	$ -	$ -	**$ -**
2-1-1	Maintain 1,200 acres of CRP	$ -	$ -	$ -	$ -	**$ -**
2-1-2	Terraces	$ 135,000.00	$ 267,500.00	$ 530,000.00	$ 267,500.00	**$1,200,000.00**
2-1-3	Grassed Waterways	$ 28,750.00	$ 28,750.00	$ 28,750.00	$ 28,750.00	**$ 115,000.00**
2-1-4	Streambank Stabilization	$ 80,000.00	$ 120,000.00	$ 120,000.00	$ 88,000.00	**$ 408,000.00**
2-1-5	Buffers (incl. 10 yr payment)	$ 48,325.00	$ 48,325.00	$ 48,325.00	$ 48,325.00	**$ 193,300.00**
	Water Monitoring	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	**$ 40,000.00**
	Public Outreach	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	**$ 20,000.00**
	Project Administration (1 FTE salary and benefits plus travel, training and supplies)	$ 432,500.00	$ 432,500.00	$ 432,500.00	$ 432,500.00	**$1,730,000.00**
	TOTALS	**$ 1,457,575.00**	**$ 941,075.00**	**$ 1,185,075.00**	**$ 890,575.00**	**$4,474,300.00**

Table 13. Total cost of financial resource needs, estimates in 2011 ($).

A APPENDIX

Items Included Within this Appendix:

(1)	**Reference Sources**	
(2)	**Appendix A-1:**	**Implementation Schedule and Milestones**
(3)	**Appendix A-2:**	**Big Creek Lake Quality Assurance Project Plan**
(4)	**Appendix A-3:**	**Big Creek TMDL Water Quality Monitoring Data**
(5)	**Appendix A-4:**	**Big Creek TMDL Geese Bacteria Loading Calculations**

Reference Sources for this Plan:

Iowa Water Quality / Watershed Project Application, Big Creek Lake Watershed Project; April 1, 2009.

Watershed Management Action Plan – DNR Guidebook, Iowa Department of Natural Resources; July 2009.

Water Quality Improvement Plan for Big Creek Lake (Polk County, Iowa) – TMDL for Pathogen Indicators (E.coli), Iowa Department of Natural Resources Watershed Improvement Section, Draft Plan 2010.

Lake Geode Watershed Management Plan – Draft Plan December 2009.

Quality Assurance Project Plan – Big Creek Lake, Iowa Department of Natural Resources, 2010.

Applied and Environmental Microbiology, December 1999, p. 5628-5630, Vol. 65, No. 12.

Goal 1: Remove bacteria impairment at Big Creek Lake by reducing bacteria violations by 70% within 10 years of project start date.

Objective 1: Reduce geese population and loafing times at and near the State Park Beach

Task	Phase 1 Milestone	Phase 1 Outcome	Phase 2 Milestone	Phase 2 Outcome	Phase 3 Milestone	Phase 3 Outcome	Phase 4 Milestone	Phase 4 Outcome	WMP Milestone	WMP Outcome
1. Utilize Goose-Be-Gone dog services to reduce goose loafing times at the beach.	*Yearly*	*27% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations*	*Yearly*	*Maintain reductions acomplished during Phase 1*	*Yearly*	*Maintain reductions acomplished during Phase 1 and 2*	*Yearly*	*Maintain reductions acomplished during Phase 1, 2 and 3*	*Yearly*	*27% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations*
2. Install 2 "Away with Geese" units near the beach.	*2 no.*		*0*		*0*		*0*		*2 no.*	
3. Remove geese droppings at beach using beach grooming equipment.	*Yearly*		*Yearly*		*Yearly*		*Yearly*		*Yearly*	
4. Modify landscaping of beach area to reduce goose loafing times at the beach.	*1 ac*		*0*		*0*		*0*		*1 ac*	
5. Create 1 alternative loafing area away from beach (already implemented by DNR Parks staff).	*1 no*		*0*		*0*		*0*		*1 no.*	
6. Remove all goose nesting boxes and tubes	*Already Implemented*		*Maintain*		*Maintain*		*Maintain*		*Maintain*	
7. Hold special early goose hunting season	*Already Implemented*		*Maintain*		*Maintain*		*Maintain*		*Maintain*	

Objective 2: Reduce bacterial loading from livestock throughout watershed with priority given to locations nearer the lake

Task	Phase 1 Milestone	Phase 1 Outcome	Phase 2 Milestone	Phase 2 Outcome	Phase 3 Milestone	Phase 3 Outcome	Phase 4 Milestone	Phase 4 Outcome	WMP Milestone	WMP Outcome
1. Construct 5 manure settling basins	*5 basins*	*51% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations [1]*	*0*	*51% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations [1]*	*0*	*Maintain reductions acomplished during Phase 1 and 2*	*0*	*Maintain reductions acomplished during Phase 1, 2 and 3*	*5 basins*	*51% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations [1]*
2. Restrict cattle access from 2.25 miles of streams	*1.125 miles*		*1.125 miles*		*0*		*0*		*2.25 miles*	

Objective 3: Manage deer population near Big Creek Lake and construct basins to capture runoff from areas with high deer densities

Task	Phase 1 Milestone	Phase 1 Outcome	Phase 2 Milestone	Phase 2 Outcome	Phase 3 Milestone	Phase 3 Outcome	Phase 4 Milestone	Phase 4 Outcome	WMP Milestone	WMP Outcome
1. Construct 10 sediment basins at key inflow points within Big Creek State Park and Wildlife Management Area aimed at treating runoff	*10 basins*	*51% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations* [1]	*0*	*Maintain reductions acomplished during Phase 1*	*0*	*Maintain reductions acomplished during Phase 1 and 2*	*0*	*Maintain reductions acomplished during Phase 1, 2 and 3*	*10 basins*	*51% reduction in single sample maximum bacteria violtions and a 100% reduction in geometric mean violations* [1]
2. Work with DNR Wildlife to actively mange for reduced deer populations	*Yearly*		*Yearly*		*Yearly*		*Yearly*		*Yearly*	

Objective 4: Inform rural residents of potential impacts of failing septic systems

Task	Phase 1 Milestone	Phase 1 Outcome	Phase 2 Milestone	Phase 2 Outcome	Phase 3 Milestone	Phase 3 Outcome	Phase 4 Milestone	Phase 4 Outcome	WMP Milestone	WMP Outcome
1. Provide septic system information and education to rural residential landowners	*Yearly I&E and 5 new systems*	*Increased awareness*	*Yearly I&E*	*Increased awareness*	*Yearly I&E*	*Increased awareness*	*Yearly I&E*	*Increased awareness*	*Yearly I&E and 5 new systems*	*Increased awareness*

Goal 2: Reduce sediment delivery to Big Creek by 40% or 2,836 tons per year. This goal is also anticipated to reduce sediment bound phosphorous delivery by 40% or 4,538 pounds per year.

Objective 1: Work with private land owners to implement conservation practices

Task	Phase 1 Milestone	Phase 1 Outcome	Phase 2 Milestone	Phase 2 Outcome	Phase 3 Milestone	Phase 3 Outcome	Phase 4 Milestone	Phase 4 Outcome	WMP Milestone	WMP Outcome
1. Maintain at least 1,200 acres of CRP in the watershed	*1,200 acres or Maintain 2011 levels*	*Prevent 139 t/y sediment and 222 lb/y increase in P*	*1,200 acres or Maintain 2011 levels*	*Prevent 139 t/y sediment and 222 lb/y increase in P*	*1,200 acres or Maintain 2011 levels*	*Prevent 139 t/y sediment and 222 lb/y increase in P*	*1,200 acres or Maintain 2011 levels*	*Prevent 139 t/y sediment and 222 lb/y increase in P*	*1,200 acres or Maintain 2011 levels*	*Prevent 139 t/y sediment and 222 lb/y increase in P*
2. Construct terraces or water and sediment control basins to treat 4,500 acres	*500 acres*	*52 t/y sediment and 83 lb/y P reduction*	*1000 acres*	*105 t/y sediment and 168 lb/y P reduction*	*2000 acres*	*209 t/y sediment and 334 lb/y P reduction*	*1000 acres*	*105 t/y sediment and 168 lb/y P reduction*	*4500 acres*	*471 t/y sediment and 754 lb/y P reduction*
3. Implement 35,000 feet or 32.1 acres of grassed waterways	*8750 feet*	*104 t/y sediment and 166 lb/y P reduction*	*8750 feet*	*104 t/y sediment and 166 lb/y P reduction*	*8750 feet*	*104 t/y sediment and 166 lb/y P reduction*	*8750 feet*	*104 t/y sediment and 166 lb/y P reduction*		*416 t/y sediment and 666 lb/y P reduction*

4. Implement 2,550 feet of streambank stabilization practices	*500 feet*	*130 t/y sediment and 208 lb/y P reduction*	*750 feet*	*195 t/y sediment and 312 lb/y P reduction*	*750 feet*	*195 t/y sediment and 312 lb/y P reduction*	*550 feet*	*143 t/y sediment and 229 lb/y P reduction*	*2,550 feet*	*663 t/y sediment and 1061 lb/y P reduction*
5. Implement 80 acres of streamside buffer	*20 acres*	*50 t/y sediment and 80 lb/y P reduction*	*20 acres*	*50 t/y sediment and 80 lb/y P reduction*	*20 acres*	*50 t/y sediment and 80 lb/y P reduction*	*20 acres*	*50 t/y sediment and 80 lb/y P reduction*	*80 acres*	*200 t/y sediment and 320 lb/y P reduction*

Objective 2: Work with public land managers to implement conservation practices

Task	**Phase 1 Milestone**	**Phase 1 Outcome**	**Phase 2 Milestone**	**Phase 2 Outcome**	**Phase 3 Milestone**	**Phase 3 Outcome**	**Phase 4 Milestone**	**Phase 4 Outcome**	**WMP Milestone**	**WMP Outcome**
1. Construct 10 sediment basins at key inflow points within Big Creek State Park and Wildlife Management Area aimed at treating runoff	*10 basins*	*519 t/y sediment and 830 lb/y P reduction*	*0*	*0*	*0*	*0*	*0*	*0*	*10 basins*	*519 t/y sediment and 830 lb/y P reduction*

[1] Goal 1, Objective 1, Tasks 2 and 3 were modeled in combination therefore the same outcomes are listed for both tasks.

Quality Assurance Project Plan

Chemical/Physical Water Quality Monitoring of Iowa's Streams and Rivers

Iowa's Project 319 Watershed Improvement Grants
Big Creek Lake

Iowa Department of Natural Resources
Iowa Geological and Water Survey

County Soil and Water Conservation District Project Coordinator:	Sean McCoy	Date
Iowa Department of Natural Resources Project Coordinator:	Mary Skopec/Lisa Fascher	Date
University Hygienic Laboratory SHL Project Officer:	Mike Schueller	Date
Plan Prepared By DNR Quality Assurance Officer	Lynette Seigley	Date

TABLE OF CONTENTS

DISTRIBUTION LIST

Steve Hopkins, Nonpoint Source Program, Iowa Department of Natural Resources
Jeff Wasson, State Hygienic Laboratory at the University of Iowa, Iowa City
Cam Conrad, Watershed Monitoring and Assessment Section, Iowa Department of Natural Resources
John Miller, State Hygienic Laboratory at the University of Iowa, Des Moines
John Olson, Watershed Monitoring and Assessment Section, Iowa Department of Natural Resources
Mike Schueller, State Hygienic Laboratory at the University of Iowa, Iowa City
Lynette Seigley, Watershed Monitoring and Assessment Section, Iowa Department of Natural Resources
Mary Skopec, Watershed Monitoring and Assessment Section, Iowa Department of Natural Resources
Mike Wichman, State Hygienic Laboratory at the University of Iowa, Iowa City
Sean McCoy, Big Creek Lake Project Coordinator, Tama County Soil and Water Conservation District
Ben Dodd, Fisheries, Iowa Department of Natural Resources
Adam Kiel, Watershed Improvement Section, Iowa Department of Natural Resources

PROJECT/TASK ORGANIZATION

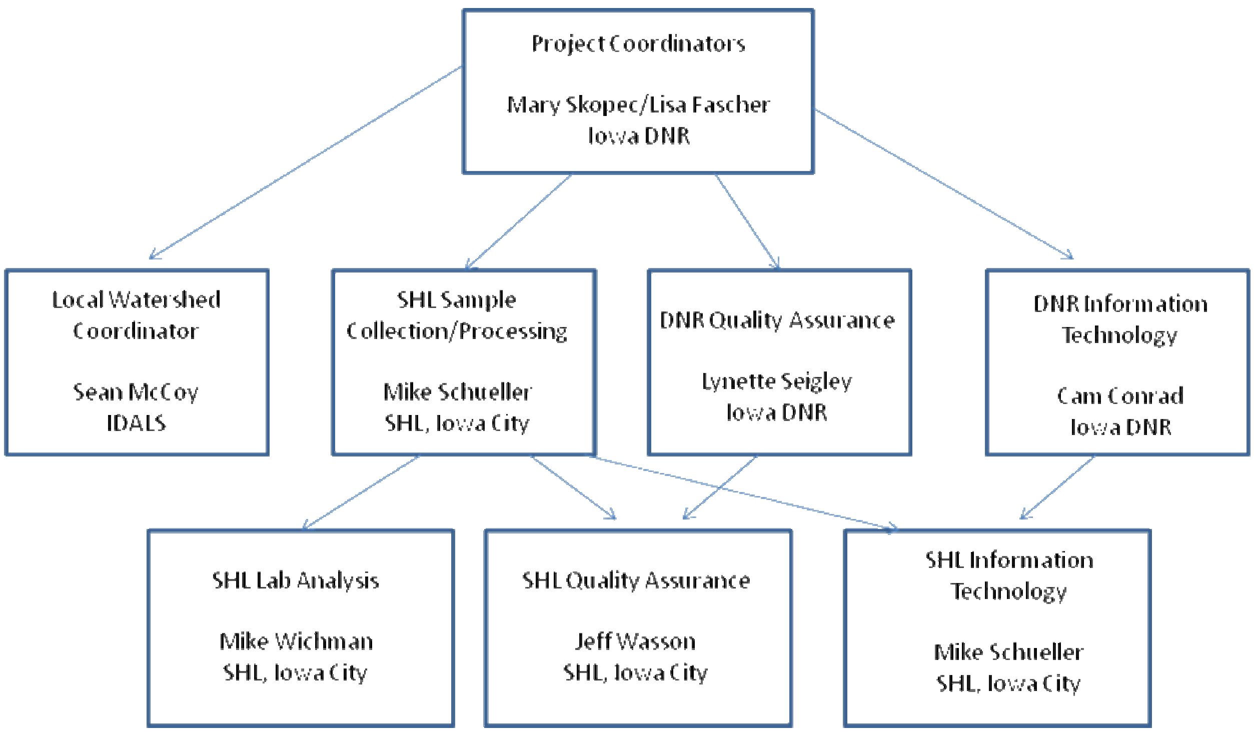
Figure 1 shows the project organization, lines of responsibility, and lines of communication for this project. The Iowa Department of Natural Resources – Watershed Monitoring and Assessment Section is responsible for overall management of the Ambient Water Monitoring Program and the 319 Water Monitoring Program. The

DNR Project Coordinator is responsible for overall coordination, writing of contracts to the State Hygienic Laboratory at the University of Iowa (SHL; formerly known as the University Hygienic Laboratory) for completion of sample collection and analyses, and payment of bills for work completed. The DNR Quality Assurance officer is responsible for carrying out the quality control/quality assurance exercises and data management as outlined in the QAPP. The DNR Information Technology officer is responsible for receival of data from the laboratory, the upload of data into Iowa STORET or WQX compatible database, overall management of the STORET database, development of Web database access tools for STORET, and documentation for the database.

The SHL is contracted to conduct the chemical/physical water quality monitoring of Iowa's streams and rivers as part of the 319 Project Water Monitoring Program.

The Local project coordinator is responsible for communicating changes in the best management practice implementation (such as schedule of implementation, location of practices or other changes) that may impact the 319 monitoring project. The DNR project coordinators will update the QAPP and monitoring plan as needed.

Figure 1.



PROBLEM DEFINITION/BACKGROUND

In the fall of 2006, the U.S. Environmental Protection Agency (USEPA) conducted a Program Review of Iowa's NPS Management Program. Seven issues and concerns emerged from this review. Two of these concerns related to water quality monitoring associated with watershed projects. In summary, EPA recommended that 1) steps be taken to increase communication and cooperation between the water monitoring and nonpoint source programs at the Department; and 2) projects funded with incremental funds (following the nine elements of a watershed plan) need to include a water quality monitoring component as part of their project implementation plans. The NPS Program has been working with USEPA and coordinating with the water monitoring program on developing a strategy and plan for implementing water quality monitoring for all newly funded watershed projects which follow the nine elements of a watershed plan.

This document focuses on the physical/chemical monitoring of Big Creek Lake and its tributaries.

PROJECT DESCRIPTION

Chapter 455B of the Code of Iowa designates the Iowa Department of Natural Resources as the state agency responsible for management of the water resources in Iowa. The federal Clean Water Act provides funding to states through Section 319 to implement water quality best management practices.

Activities associated with 319 Water Monitoring Program are funded by grants provided by the U.S. Environmental Protection Agency (USEPA) from Section 319 of the Clean Water Act. Funding provided by the State of Iowa for stream and lake gaging is also used within the 319 monitoring program. The U.S. Geological Survey provides some matching funds for gaging activities.

GOALS/OBJECTIVES

The goals and objectives of the Iowa DNR 319 water monitoring program are as follows:

1. Document the removal of water quality impairment for the water body of interest.
2. Document loading reductions for pollutants to the impaired stretch as identified in the TMDL plan and/or the project implementation grant.

Big Creek Lake in Polk County is impaired due to high levels of indicator bacteria. The primary goal of the Big Creek Watershed Project is to implement best management practices that will address the bacterial impairment of this important recreational resource in order to remove it from the 303d list. This will be achieved through

1) Proactively addressing potential bacterial contributors through pasture management projects, BMPs aimed at reducing runoff from MMP manure applied fields, information and education related to non-functioning septic systems, and goose management at Big Creek State Park;
2) Reduction of sediment and phosphorus delivery by 927.5 tons/year and 1,205.75 pounds/year respectively through the implementation of BMPs that include: terraces, water and sediment control basins, grade stabilization structures, grassed waterways, streambank stabilization, and CRP buffers/ upland treatment;
3) Watershed outreach activities that include landowner hosted field days geared toward critical application components for successful project implementation that include water quality education, pasture management practices, septic system management, BMP education, newsletters and local media campaigns.

Monitoring Needs:

1. Annual lake/beach monitoring to determine if water quality “standards” are being met (progress toward bacteria goals).
2. Monitor the performance of BMPs including pasture management, goose management, MMP plans, and septic systems to determine if load reduction strategies have been effective.
3. Monitor the performance of stream bank stabilization, terraces, CRP buffers, and water and sediment control structures. Track bacteria concentrations and delivery to the lake.
4. Conduct and repeat RASCAL stream bank and gully erosion assessment after BMP implementation to quantify reduction in sediment delivery from these sources.

DATA QUALITY OBJECTIVES

The main objective of the Big Creek Lake 319 monitoring program is to develop a monitoring network that can track the impacts of installation of Best Management Practices (BMPs) designed to improve water quality in Big

Creek Lake. In addition, the network should be capable of documenting total loading of nutrients and sediment to Big Creek Lake. To do this, the network should represent water quality from a variety of weather conditions.

The Big Creek Lake 319 monitoring network is designed to monitor pre-project, and post-project conditions in the tributaries feeding Big Creek Lake, at the beach, and in the lake itself. This monitoring network, however, could be turned into a long-term monitoring network with local support. In order to determine the difference between pre- and post-project conditions the sample collection, preservation, and analytical techniques are generally constant from one year to the next. The only exceptions are those changes needed to be consistent with revised USEPA approved methods and those changes that occur based on location and design of BMPs. DNR and local project staff will conduct all sampling; this provides consistency throughout the sampling effort.

The data collected for this monitoring represent conditions in Big Creek Lake and its watershed. The measurements made include those for which standards or USEPA criteria may be used to judge water quality. The flow conditions at the time of sampling are measured at the tributary locations to better evaluate the data and to calculate the loading of bacteria, nutrients and sediment from the watershed to Big Creek Lake. The quantitation limits specified in Table 1 are sufficient to meet the data quality objectives for each analyte.

Appendices 1 through 3 are included to provide information on the analytical procedures used, sample container, sample preservation methods, maximum holding times, and data quality requirements.

Table 1. Water quality criteria for analytes monitored as part of Big Creek Lake's 319 Monitoring Program (source: Iowa Administrative Code, Chapter 61, p. 13-22). Only analytes with standards are listed.

Parameter	***Iowa Water Quality Standard***	***Applicable Designated Use Classification(s)***	***Parameter Quantitation Limit***
Ammonia Nitrogen	** (depends on pH and temperature of water)	B	0.05 mg/L
Dissolved Oxygen	7.0 mg/L (5.0 mg/L)[1] 5.0 mg/L (5.0 mg/L)[1] 5.0 mg/L (4.0 mg/L)[1] 5.0 mg/L (5.0 mg/L)[1]	BCW BWW BLR BLW	0.1 mg/L
Escherichia coli Bacteria	30- day geometric mean 126 organisms/100 ml** 30-day geometric mean 630 organisms/100 ml** single-sample maximum 235 organisms/100 ml** single-sample maximum 2880 organisms/100 ml**	A1, A3 A2 A1, A3 A2	10 organisms/100 ml
Nitrite + Nitrate as Nitrogen	10 mg/L	C	0.05 mg/L
pH	Minimum 6.5; maximum 9.0	A, B	0.1 unit
Temperature	Max. increase = 3°C not to exceed 32°C BWW	BLW, BLR	0.5°C
Total Kjeldahl Nitrogen	None	None	0.1 mg/L
Total phosphorus as phosphorus	None	None	0.02 mg/L
Total Suspended Solids	None	None	1 mg/L

[1] Minimum value for at least 16 hours of every 24-hour period (minimum value at any time during every 24-hour period)
"B" includes all of the following designated uses: BLW, BCW, BWW, BLR
"A" includes all of the following designated uses: A1, A2, A3
** Water quality standards criteria apply from March 15 through November 15 unless Class A2 and B(CW) or HQ then applies year-round.

TRAINING REQUIREMENTS/CERTIFICATION

There are no special training requirements associated with this project. A certified drinking water laboratory performs laboratory analyses. Field sampling completed by the local project staff is conducted according to DNR SOP (2002) for surface water monitoring. Local project staff will be trained in the SOPs by DNR Watershed Monitoring and Assessment Section quality assurance staff.

DOCUMENTATION AND RECORDS

SHL will report the data from the chemical/physical monitoring of Iowa's streams and rivers to the Iowa Department of Natural Resources in a WQX-compatible format on a monthly basis. The data will include the STORET station identification number, which will be provided by the DNR for all station locations. SHL will submit completed monitoring results to the DNR not later than fifteen (15) calendar days after the end of each month or as soon as possible following completion of all analytical determinations requested. Extra time for analysis is allowed in cases when the analytical work warrants. A notification to the submitter that analytical results from a sample will be delayed and the reason for the delay will be made within fifteen (15) calendar days of receipt of the sample if extra time is required for analysis.

SHL will provide a monthly Excel Spreadsheet report to the DNR via email from the SHL project coordinator. The report will detail the projects completed including the date, location, and number of stream or lake analyses per project, and parameters analyzed during the reporting period. Any deviation from normal sampling procedures, such as a change in sampling location, omission of samples for analysis, etc., will be identified to DNR in writing prior to transmittal of analytical results. Hard copies of all results will also be submitted to the DNR who will retain those results for at least 10 years.

Data collected as part of this project will be summarized by site, subwatershed, and 319 project area. Results will be presented as part of DNR technical reports, fact sheets, and at project meetings as requested by the project coordinator. Quarterly and annual reports on the status of the monitoring project and the results will be sent to the DNR Nonpoint Source coordinator and to the Local Project Coordinator. Information will also be presented at state and national meetings, and disseminated through the Ambient Watershed Monitoring and Assessment Program web site (www.igsb.uiowa.edu/wqm/) and press releases.

SAMPLING DESIGN AND COLLECTION METHODS

DNR staff and local project staff will perform sample collection. The sampling protocol will be conducted according to the DNR SOP for surface water monitoring (2002). Sample containers will be provided by SHL. Samples will be collected and returned to the laboratory by the collector or will be shipped to the SHL via an overnight courier. Field measurements will be recorded on an appropriate field data sheet and then transferred to electronic format. Example field data sheets are in Appendices 4 and 6. Appropriate chain of custody paperwork will be delivered with the water samples to the laboratory. An example of the SHL chain of custody is located in Appendix 5.

DESIGN AND RATIONALE

The DNR 319 Water Monitoring Network has been designed to address the goals and objectives addressed above. The monitoring is a blend of fixed station, fixed sampling and event sampling to catch rainfall runoff events. Locations of DNR monitoring stations were chosen to meet the following general criteria

- Sites are located so as to subdivide the project watershed into subwatersheds that are likely to demonstrate a measureable change in water quality during the life of the project (3-5 years).
- Site locations are chosen to meet requirements of landowner access and permission.
- Fixed monitoring locations are chosen to represent the condition of the impaired stretch and to provide the ability to reassess the waterbody for future 303d/305b reports.

Tables 2 and 3 describe the location of Big Creek Lake stations to be sampled. Figure 2 shows the location of sampling stations.

DNR staff will collect samples from lake locations on a monthly basis (Table 2). Local field staff will collect tributary grab samples biweekly from the fixed locations listed in Table 2 (Figure 2). Sampling is to occur on a set day of the week during the biweekly period. This allows for a consistent sampling interval and allows the data from all sites to be directly compared. SHL will analyze these samples for parameters listed in Table 3. DNR staff will obtain instantaneous flow measurements at the time of sampling, when feasible. Sampling site locations, analytical parameters, and sampling frequency may be modified through written agreement between the Department and SHL and the 319 project coordinator. All samples collected as part of this activity will be coded as **319-3 BGCRKLK.**

Table 2a. Fixed Tributary Biweekly and Event Monitoring Stations.

Site Name	*Stream Name*	*County*	*Monitoring Station Locations*	*STORET #*
1	North Fk Big Creek	Boone	250th Street east of T Avenue	
2	West Branch Big Creek	Boone	T Avenue south of 250th street	
3	Main Stem Big Creek	Boone	280th Street west of V Avenue	
4	Big Creek	Boone	310th Street east of Unicorn Ave	
5	Big Creek	Boone	310th Street east of Site 4	
6	Little Creek	Boone	NW 166th Avenue east of T Ave	
7	Little Creek	Polk	T Avenue north of NW 158th Ave	
8	Big Creek	Polk	NW 100th Street north of NW 150th Ave	
9	Big Creek	Polk	150th Avenue west of NW 100th Street	
10	Little Creek	Polk	NW 146th Avenue	
11	Turkey Creek	Polk	NW 86th Street	

Table 2b. UTM Coordinates of In-Lake Sampling Sites

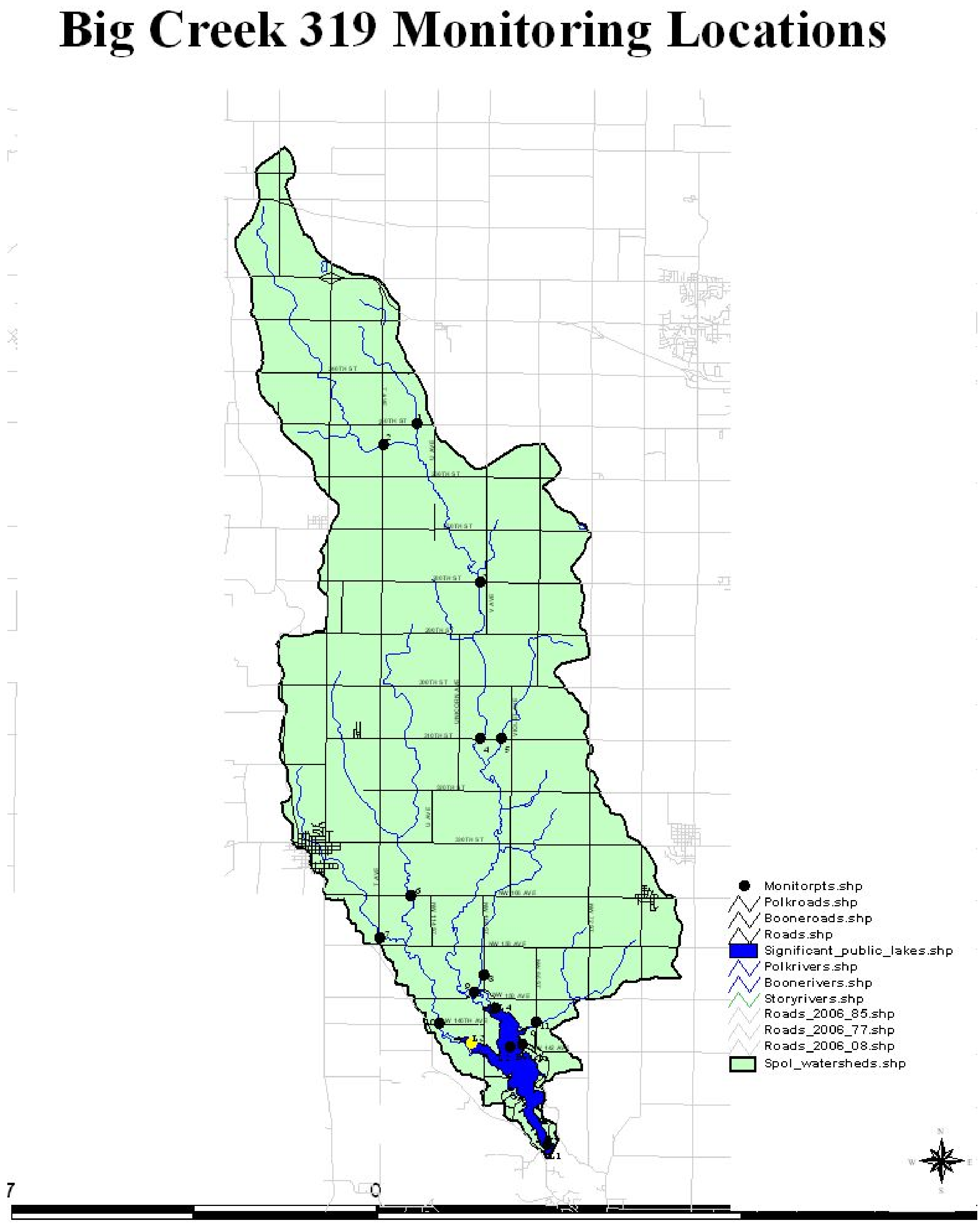
Lake Site	*X (meters)*	*Y (meters)*	*STORET #*
BCL1 (Deep water)	0439224	4627155	
BCL2 (Beach)	0438583	4629995	

BCL3 (Main lake near Marina)	0438151	4630234	
BCL4 (Big Creek Rock Sill)	0437493	4631386	
BCL5 (Little Creek Rock Sill)	0436731	4630325	

Table 3. Parameters monitored for Big Creek 319 Monitoring Program.

All Stations Parameters – Biweekly Sampling; March 1 – Nov 15 (plus events after 1" rains)	
Secchi Depth (lake only)	Flow (stream only)
Ammonia – nitrogen	Nitrate + Nitrite-Nitrogen
Total Phosphate (as P)	Total Kjeldahl Nitrogen
Turbidity (stream only)	Total Suspended Solids (stream only)
E. coli	Temperature (field)
Dissolved Oxygen (field)	pH (field)
Dissolved Oxygen Profile (lake only)	

Figure 2. Map of monitoring sites for the Big Creek Lake 319 water quality monitoring (Polk County).



SAMPLE METHOD REQUIREMENTS

DNR staff and local project staff will perform sample collection. A representative grab sample will be collected from each sampling location as outlined in the DNR SOP (2002) for chemical/physical water quality monitoring of Iowa's streams, rivers and lakes. Field measurements will be done by DNR and Local staff and performed as specified in the SOP. Grab samples will be preserved according to the same manual and transported by the collector to the laboratory for analysis. Samples collected by local project staff will be shipped to the SHL via an overnight courier.

Local staff also conducts stream event monitoring at one site in the Big Creek Lake watershed; events are generally from rain runoff. Event samples are collected after 1" or greater rainstorms.

Manual flow measurements are measured by DNR flow monitoring staff, which uses the U.S. Geological Survey flow measuring procedures as specified in the DNR SOP (2002) for chemical/physical water quality monitoring of Iowa's streams and rivers.

SHL and local project staff will follow the specimen handling procedures documented in the DNR SOP (2002) for the Ambient Water Monitoring Program.

Documentation

The SHL Laboratory Procedures Manuals indicate how data will be documented to protect it against legal and scientific challenge.

SAMPLE HANDLING AND CUSTODY REQUIREMENTS

The SHL will provide bottles, labels, forms, packaging, and shipping materials (if necessary). DNR and local project staff will label, preserve, and package the samples. DNR and local staff will arrange for transportation of samples they collect to the SHL laboratory in Ankeny. Sample bottle preparation and preservation methods are documented in Appendices 1 and 2. Samples collected by DNR and local project staff will be received at the Ankeny Laboratory Sample Receiving Section and processed according to the SHL-Des Moines Support Services SOP (SHL, 1997c). Sample chain of custody will be documented according to the Limnology Section SOP and the Limnology Section QASP (SHL 1997a; SHL 2000).

All samples submitted to SHL will be coded to a specific monitoring activity and will include a detailed written or photocopied list of the analyses to be performed. SHL log-in procedures will accommodate this code. In a format agreed upon by the DNR, a monthly report will be provided to the DNR from computer printouts of logged-in samples. Any deviation from normal sampling procedures, such as a change in sampling location, omission of samples for analysis, etc., will be identified to DNR in writing prior to transmittal of analytical results.

ANALYTICAL METHODS REQUIREMENTS

The State Hygienic Laboratory in Iowa City and Ankeny does analyses of water samples. Appendices 1 and 2 list the analytical procedures, maximum holding times, sample preservation methods for field and lab measurements, and laboratory methods. Samples will be disposed of via the sanitary sewer system; acidified samples will be neutralized before disposal. Analyses of samples with QA parameters outside acceptable limits will require reanalysis and, if deemed necessary by the QA Officer, corrective action to be undertaken. The SHL Sample Operations and Quality Assurance Officer is responsible for insuring that corrective action is taken and will report the corrective action to the DNR QA Officer. Individuals responsible for corrective action and corrective action procedures are described in the SHL's QA documents.

QUALITY CONTROL REQUIREMENTS

The SHL is a state agency under the Iowa Board of Regents. The Iowa General Assembly created the Laboratory in 1904 to meet the needs of the citizens of Iowa as the “state public health and environmental laboratory.” The statute placed the Laboratory as a “permanent part of the University of Iowa.” The SHL is well known for its high quality analytical performance. Since 1973, the Laboratory has had a cooperative agreement with the Iowa Department of Natural Resources to support many aspects of IDNR’s statewide environmental programs. Particular to monitoring related to Iowa’s 319 Program, the SHL conducts field and analytical efforts in support of this program. The program activities mainly include sample collection and analysis.

The SHL follows very strict Quality Assurance and Quality Control (QA/QC) guidelines to maintain a high degree of precision and accuracy. The Quality Assurance Program Plan of the University Hygienic Laboratory (SHL, 1997d) includes protocols for sample custody, holding and extraction times, and detection limits. Other procedures include: daily instrument calibration, interference checks, verification standards, assessment of extraction and sampling efficiencies. Confirmation studies are performed routinely. In general, at least one duplicate and one spike sample are prepared for each set of ten to fifteen samples. A minimum of one reagent blank is prepared and analyzed for each complete set of samples. Trip blanks are used for field sampling programs.

As part of its QA effort, SHL participates in numerous inter-agency and inter-laboratory proficiency testing and performance evaluation programs, including: U.S. EPA, Water Supply Series, Water Pollution Series, Office of Enforcement and Compliance Assurance series for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and Solid Waste Series; the U.S. Geological Survey Standard Reference Sample Program; and American Industrial Hygiene Association programs. In addition, the SHL has participated in the U.S. EPA Contract Laboratory Program, one of the most rigorous quality assured analytical programs for environmental laboratories.

Of the samples collected by SHL for this project, 10-15% of the samples will be blank or split samples, and will be collected according to the sampling protocol. The DNR SOP (2002) for chemical/physical water quality monitoring of Iowa’s streams and rivers outlines how sites are identified for blank or split samples. Data from these duplicate analyses will be evaluated and reported as per the Limnology SOP (SHL, 1997a) and the Limnology Section QASP (SHL, 1997b). Quality assurance/quality control procedures, acceptance criteria, corrective action, etc., are discussed in more detail in SHL’s QA documents.

EQUIPMENT TESTING, INSPECTION AND MAINTENANCE REQUIREMENTS

Field equipment calibration and preventive maintenance procedures are outlined in the DNR SOP (2002) for chemical/physical water quality monitoring of Iowa’s streams and rivers.

The laboratory equipment will be calibrated and maintained according to SHL’s standard operating procedures for the laboratory.

DATA MANAGEMENT

Samples collected will be logged into the SHL mainframe system (ELIS). Once analyses are completed, results are entered into ELIS by the analyst, and then released by another analyst.

SHL will report the data from 319 water monitoring stations to the Iowa Department of Natural Resources on a monthly basis in an electronic format that is STORET or WQX compatible. The data will include the STORET station identification number, which will be provided by the Iowa Department of Natural Resources for all station locations. SHL will submit completed monitoring results to the Iowa Department of Natural Resources not later than fifteen (15) calendar days after the end of each month.

For analytical results that are below the quantitation limit (including nutrients), the quantitation limit of the test will be reported with a "less than" designation. Results of *E. coli* bacteria tests run on samples that exceed EPA recommended holding times will be so indicated.

ASSESSMENT AND RESPONSE ACTION

The data collected through the 319 Water Monitoring Program are used in analyzing trends and describing water quality conditions for the impaired waterbody of interest and any other requested or required assessments. The database also provides a source of water quality information for other governmental agencies, industry, and the general public.

The data will also be used to report on the program effectiveness of the implementation of best management practices used as part of the Nonpoint Source program of the Iowa DNR.

REPORTS

SHL will provide a monthly report to the DNR in an Excel spreadsheet from logged-in samples. The report will detail the projects completed including the date, location, number of stream analyses per project, and parameters analyzed during the reporting period. Any deviation from normal sampling procedures, such as a change in sampling location, omission of samples for analysis, etc., will be identified to DNR in writing prior to transmittal of analytical results. Reports will be prepared by the SHL Sample Operations and Quality Assurance Officer and sent to the IDNR Project Officer. Hard copies of all results will also be submitted to the IDNR Project Officer.

DATA REVIEW, VALIDATION AND VERIFICATION REQUIREMENTS

Data associated with QA controls outside of the acceptance limits will be rejected by the SHL Section Chief or reviewing manager. Rejected data problems will be reported to the QA officer. Data verification will be conducted in accordance with data processing's SOP for ELIS. Rejected data is reported on the rejected data report to the analytical section chief and the SHL Sample Operations and Quality Assurance Officer. Data review, validation and verification criteria are discussed in the Limnology Section QASP (SHL, 1997b), and other SHL QA documents.

The data validation and verification process is discussed in the Limnology Section QASP (SHL, 1997b) and other SHL QA documents.

PROJECT ORGANIZATION AND RESPONSIBILITY

The following is a list of key project personnel and their corresponding responsibilities:

Sample Operations and Quality Assurance:

Mike Schueller
State Hygienic Laboratory – Iowa City
102 Oakdale Hall #101 OH
Iowa City, IA 52242-5002
(319)335-4500

Laboratory Analysis:

Mike Wichman
State Hygienic Laboratory - Iowa City
102 Oakdale Hall #101 OH
Iowa City, IA 52242-5002
(319)335-4500

Laboratory QC:

Jeff Wasson
State Hygienic Laboratory - Iowa City
102 Oakdale Hall #101 OH
Iowa City, IA 52242-5002
(319)335-4500

Laboratory Information Technology:

Mike Schueller
State Hygienic Laboratory – Iowa City
102 Oakdale Hall #101 OH
Iowa City, IA 52242-5002
(319)335-4500

DNR Information Technology:

Cam Conrad
Iowa Department of Natural Resources - Iowa Geological and Water Survey
Oakdale Research Center
Iowa City, IA 52242
(319)335-4022

DNR Quality Control/Quality Assurance:

Lynette Seigley
Iowa Department of Natural Resources - Watershed Monitoring and Assessment Section
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)335-1575

Overall Project Coordinators:

Mary Skopec
Iowa Department of Natural Resources - Watershed Monitoring and Assessment Section
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)335-1575

Lisa Fascher
Iowa Department of Natural Resources – Watershed Monitoring and Assessment Section
502 E. 9th St.
Wallace State Office Building
Des Moines, IA 50319
(515)242-6010

INFORMATION TECHNOLOGY

SHL will transfer 319 water quality surface water data to the DNR – Iowa Geological and Water Survey via the Survey's FTP site. Chemical and physical data is transferred in a text-delimited format. IGWS then completes a validity check on the data to verify site names, parameters, personnel sampling, and project code. A trip ID is established and added to the data before being uploaded into AWQMS. The data are placed in Access look-up tables and Visual Basic programming is used to create batch upload files into STORET or a WQX compatible database. The data are then available on the Web at http://www.igsb.uiowa.edu/webapps/iastoret/.

REFERENCES

Guidance for Quality Assurance Project Plans, February 1998, U.S. Environmental Protection Agency, EPA/600/R-98/018, 131 p.

Iowa Administrative Code, Chapter 61, Water Quality Standards.

Iowa Department of Natural Resources, 2002, SOP for Surface Water Quality Monitoring, Iowa City, IA.

University Hygienic Laboratory, 1997a, Limnology Section Standard Operating Procedures Manual, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 1997b, Limnology Section Quality Assurance Section Plan, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 1997c, University Hygienic Laboratory Des Moines Support Services Standard Operating Procedures, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 1997d, Quality Assurance Program Plan of the University Hygienic Laboratory, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 1999, University Hygienic Laboratory Iowa City Central Services Standard Operating Procedures, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 2000, Limnology Quality Assurance Section Plan, The University of Iowa Hygienic Laboratory, Iowa City, IA.

University Hygienic Laboratory, 2006, Stream and River Water Quality Sampling Standard Operating Procedure, The University Hygienic Laboratory, Iowa City, IA.

Appendix 1. Analytical procedures, maximum holding times, and sample preservation methods for field measurements.

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES				
Analyte	***Container***	***Preservative***	***Maximum Holding Time***	***Method***
Dissolved Oxygen	None required	None required	Analyze immediately	SM 4500-0-G
7 days Flow Rate	None required	None required	Analyze immediately	USGS CA8
pH, Field	None required	None required	Analyze immediately	SM17 4500 H
Temperature, Field	None required	None required	Analyze immediately	SM17 2550

Appendix 2. Analytical procedures, maximum holding times, and sample preservation methods for laboratory measurements.

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES				
Analyte	***Container***	***Preservative***	***Maximum Holding Time***	***Method***
Ammonia Nitrogen	250 ml plastic	Cool, 4°C H_2SO_4 to pH<2	28 days	LAC10-107-06-1J
Corrected Chlorophyll A	1 liter plastic	Cool, 4°C	24 hours water 21 days on a frozen filter	EPA 445.0 R 1.2
Escherichia coli Bacteria	120 ml clear plastic	0.008% NA2S2O3; Cool to 4 ◦C	<24 hours, <10°C for surface water	EPA 1603 (modified mTEC)
Kjeldahl Nitrogen, Total	250 ml plastic	Cool, 4°C H_2SO_4 to pH<2	28 days	LAC10-107-06-2E
Nitrate+Nitrite-Nitrogen	250 ml plastic	Cool, 4°C H_2SO_4 to pH<2	28 days	EPA 353.2
Orthophosphate, Filterable as P	250 ml plastic	Filter immediately Cool, 4°C	48 hours	LAC10-115-01-1A
Phosphorus, Total	250 ml plastic	Cool, 4°C H_2SO_4 to pH<2	28 days	LAC10-115-01-1D
Total Suspended Solids	1 liter plastic	Cool, 4°C	7 days	USGS I-3765-85

Appendix 3. Data quality requirements and assessments for the Big Creek Lake water quality monitoring.

Analyte	***Matrix***	***Method Detection Limit***	***Estimated Accuracy of True Value***	***Accuracy Protocol***	***Estimated Precision (Relative % Difference)***
Ammonia Nitrogen as N	Water	0.05 mg/L	+ 14%	Recovery on spikes	RDP < 20%
E. coli Bacteria	Water	10 organisms/100 ml	NA	NA	Three-year Average = 0.21
Kjeldahl Nitrogen, Total	Water	0.1 mg/L	+/- 10%	Recovery on spikes	RPD <20%
Nitrate+Nitrite-Nitrogen	Water	0.05 mg/L	±0.1 low level	Recovery on spikes	RDP < 20%
Phosphate, Total	Water	0.02 mg/L	±5%	Recovery on spikes	RPD <20%
Total Suspended Solids	Water	1 mg/L	± 10%	EPA check samples	RPD <20%

mg/L – milligrams per liter; NA – not applicable; RPD - Relative % Difference

Appendix 4. Sample Field Data Collection Form.

Big Creek Lake --- Lake Samples
319 Grant

Collector Name: ______________________

*Weather:*____ Air Temp (degrees F):____ Wind Conditions (check one): Calm___ Light Wind ___ Moderate Winds ___ Strong Winds ____

*Rain Total Last 24 hrs*______

Site	Date	Time	Water Temp °C	Secchi Disk Depth (m)	Wind Direction	Sample Bottles[2]	Comments
BCL1							
BCL2							
BCL3							
BCL4							
BCL5							

Notes:
1. Please use military time (for example, 1:00 pm is 1300; 2 pm is 1400)
2. Please indicate "all" if all sample analytes were collected; if not, please indicate analytes collected.
3. For field duplicates, please mark the site name plus 'Dup" behind it.
4. Please make a copy and send to Mary Skopec at Mary.Skopec@dnr.iowa.gov or
   US mail at 109 Trowbridge Hall, Iowa City, IA 52242

Appendix 5. SHL Sample Chain of Custody Form.

ORDER #: 52137

DATE PRINTED: 2010-08-30

PROJECT: 319-2 LKGDE

CONTAINERS: #1 x 1, #2 x 1, #32 x 1,

Comments: *Cooler with ice pakcs. Ship attention Caleb Waters.*

REPORT TO:

Attn: MARY SKOPEC
IOWA GEOLOGICAL SURVEY BUREAU
109 TROWBRIDGE HALL

IOWA CITY, IA 52242-1319
Phone: (319) 335-1575{ }
Fax: (319) 335-2754{ }

BILL TO:

IOWA GEOLOGICAL SURVEY BUREAU
109 TROWBRIDGE HALL

IOWA CITY, IA 52242-1319
Phone: (319) 335-1575{ }
Fax: (319) 335-2754{ }

PLEASE WRITE CORRECTIONS HERE

Environmental Sample Collection Form

Requested Analyses

1. Nitrate + Nitrite as N, Ammonia, TKN
2. Total Phosphate, TSS, E.coli

Complete and/or correct the following information

Collection Site: ______ (specific sample location)

Collection Town: ______

Purchase Order #: ______ (PO#, MFK, etc. if needed)

Collection Date/Time: / / : (year mm dd hh mm)

Client Reference: ______ (additional client information if needed)

Sample Description: surface water (water, soil, etc.)

Collector Phone #: ( ) -

Collector's Signature: ______

Collector's Name: ______ (please print)

For UHL Use Only. Please do not write below here.

RECEIVED BY: ______

pH: ______

SAMPLE INTACT: ☐ Yes ☐ No

TEMPERATURE: ______

University Hygienic Laboratory

102 Oakdale Campus, #101 OH
Iowa City, IA 52242-5002
Phone #: 319-335-4500
Fax #: 319-335-4555

Iowa Laboratories Complex
2220 S. Ankeny Blvd, Ankeny, IA 50023
Phone #: 515-725-1600
Fax #: 515-725-1642

http://www.uhl.uiowa.edu

Appendix 6. Project Coordinator Field Data Collection Form.

IOWATER

Volunteer Water Quality Monitoring

Standing Water Assessment

*** Recommended frequency: monthly from ice-out to freeze-over ***

Date __________ **Time** __________

IOWATER Monitor ______________________ **# of Adults** (*incl. you*) ______

Site Number ___________________________ **# of under 18** ______

Other Volunteers Involved ____

Physical Assessment

Weather (*check all that apply*)

Sunny ____ Partly Sunny ____ Cloudy ____ Rain/Snow ____ Windy ____ Calm ____

Air Temperature ______ °Fahrenheit

Precipitation ______ inches over the last 24 hours

Wind Direction (*check one*)

____ Not applicable ____ Northeast
____ North ____ Northwest
____ South ____ Southeast
____ East ____ Southwest
____ West

Wind Speed (*check one*)

____ Calm (0-5 mph, felt on face, leaves rustle)
____ Breezy (sustained 5-15 mph, small branches move)
____ Strong (sustained over 15 mph, small trees sway continuously, waves form)
____ Gusty (gust over 15 mph, small trees sway occasionally)

Site Location ____ Open Water ____ Shore or Dock

Secchi Disc Depth ____.____ meters

OR Transparency Tube ________ cm (*record whole numbers only – no tenths*)

Water Temperature ____ °Fahrenheit

Water Level (*check one*)

Above Normal ____ Normal ____ Below Normal ____

If lake is not at normal level, and you have means to measure, please specify:

inches above _______ or below _______ normal

Water Odor (*check all that apply*)

None ____ Sewage/Manure ____ Rotten Eggs ____ Petroleum ____ Fishy ____

Revised March 2006

Chemical Assessment

IMPORTANT: Use Point Sampling technique!

pH

Expiration date on bottom of bottle _______

check one – **4** ____ **5** ____ **6** ____ **7** ____ **8** ____ **9** ____

Nitrite-N (*mg/L*)

Expiration date on bottom of bottle _______

check one – **0** ____ **0.15** ____ **0.3** ____ **1.0** ____ **1.5** ____ **3** ____

Nitrate-N (*mg/L*)

Expiration date on bottom of bottle _______

check one – **0** ___ **1** ___ **2** ___ **5** ___ **10** ___ **20** ___ **50** ___

Dissolved Oxygen (*mg/L*)

Expiration date on back of color comparator _______

check one – **1** ___ **2** ___ **3** ___ **4** ___ **5** ___ **6** ___ **8** ___ **10** ___ **12** ___

Phosphate (*mg/L*)

Expiration date on back of color comparator _______

Expiration date on round color comparator _______

Expiration date on activator solution _______

check one – **0** ___ **0.1** ___ **0.2** ___ **0.3** ___ **0.4** ___ **0.6** ___ **0.8** ___

1 ___ **2** ___ **3** ___ **4** ___ **5** ___ **6** ___ **7** ___ **8** ___ **10** ___

Chloride

Expiration date on bottom of bottle _______

___________ **mg/L** – *Convert Quantab Units to mg/L using the chart provided on the bottle*

Biological Assessment

Water Color – Is there an obvious algal bloom? (algal mats present, water appears green or scummy) ____ No ____ Yes (*if yes, please submit a photo record*)

Habitat Assessment

*** Conduct only once per year, preferably in July, or if a major land use change occurs ***

Describe Lake Banks ____

____

____

____

Describe Adjacent Land Use ____

____

____

Other Observations and Notes:

____

____

____

Revised March 2006

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach (	4/16/2002 8:30	5		FALSE	FALSE
21770001	Big Creek Beach (	4/23/2002 9:55	5		FALSE	FALSE
21770001	Big Creek Beach (	4/30/2002 8:30	5		FALSE	FALSE
21770001	Big Creek Beach (	5/7/2002 8:38	5	5	FALSE	FALSE
21770001	Big Creek Beach (	5/14/2002 8:15	5	5	FALSE	FALSE
21770001	Big Creek Beach (	5/21/2002 8:30	5	5	FALSE	FALSE
21770001	Big Creek Beach (	5/28/2002 15:20	5	5	FALSE	FALSE
21770001	Big Creek Beach (	6/4/2002 14:30	5	5	FALSE	FALSE
21770001	Big Creek Beach (	6/11/2002 17:30	5	5	FALSE	FALSE
21770001	Big Creek Beach (	6/18/2002 15:15	5	5	FALSE	FALSE
21770001	Big Creek Beach (	6/25/2002 15:15	5	10	FALSE	FALSE
21770001	Big Creek Beach (	7/2/2002 15:55	180	16	FALSE	FALSE
21770001	Big Creek Beach (	7/9/2002 15:30	50	19	FALSE	FALSE
21770001	Big Creek Beach (	7/15/2002 14:30	10	25	FALSE	FALSE
21770001	Big Creek Beach (	7/23/2002 15:00	20	32	FALSE	FALSE
21770001	Big Creek Beach (	7/30/2002 15:15	18	32	FALSE	FALSE
21770001	Big Creek Beach (	8/6/2002 14:30	190	20	FALSE	FALSE
21770001	Big Creek Beach (	8/13/2002 15:00	5	20	FALSE	FALSE
21770001	Big Creek Beach (	8/20/2002 15:30	10	15	FALSE	FALSE
21770001	Big Creek Beach (	8/27/2002 14:15	5	12	FALSE	FALSE
21770001	Big Creek Beach (	9/3/2002 14:30	5	6	FALSE	FALSE
21770001	Big Creek Beach (	9/10/2002 14:40	5	6	FALSE	FALSE
21770001	Big Creek Beach (	9/17/2002 14:55	5	5	FALSE	FALSE
21770001	Big Creek Beach (	9/24/2002 14:45	5	5	FALSE	FALSE
21770001	Big Creek Beach (	10/1/2002 14:50	5	5	FALSE	FALSE
21770001	Big Creek Beach (	10/8/2002 15:10	5	5	FALSE	FALSE
21770001	Big Creek Beach (	10/15/2002 15:00	5	5	FALSE	FALSE
21770001	Big Creek Beach (	10/22/2002 15:45	5	5	FALSE	FALSE
21770001	Big Creek Beach (	10/29/2002 15:20	5		FALSE	FALSE
		N	**29**	**25**		
		MAX	**190**	**32.12219552**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach (	4/14/2003 9:00	20		FALSE	FALSE
21770001	Big Creek Beach (	4/21/2003 13:45	20		FALSE	FALSE
21770001	Big Creek Beach (	4/28/2003 8:30	5		FALSE	FALSE
21770001	Big Creek Beach (	5/5/2003 13:40	36	24	FALSE	FALSE
21770001	Big Creek Beach (	5/12/2003 14:15	100	26	FALSE	FALSE
21770001	Big Creek Beach (	5/19/2003 8:30	30	26	FALSE	FALSE
21770001	Big Creek Beach (	5/27/2003 8:30	20	29	FALSE	FALSE
21770001	Big Creek Beach (	6/2/2003 9:00	10	20	FALSE	FALSE
21770001	Big Creek Beach (	6/9/2003 12:30	5	11	FALSE	FALSE
21770001	Big Creek Beach (	6/16/2003 14:00	5	9	FALSE	FALSE
21770001	Big Creek Beach (	6/23/2003 14:35	10	9	FALSE	FALSE
21770001	Big Creek Beach (	6/30/2003 8:12	20	11	FALSE	FALSE
21770001	Big Creek Beach (	7/7/2003 8:30	30	24	FALSE	FALSE
21770001	Big Creek Beach (	7/14/2003 14:30	280	42	Single sample maximum violation	FALSE
21770001	Big Creek Beach (	7/21/2003 8:20	80	37	FALSE	FALSE
21770001	Big Creek Beach (	7/28/2003 8:30	5	28	FALSE	FALSE
21770001	Big Creek Beach (	8/4/2003 9:00	5	25	FALSE	FALSE
21770001	Big Creek Beach (	8/11/2003 8:45	18	13	FALSE	FALSE
21770001	Big Creek Beach (	8/18/2003 8:30	10	11	FALSE	FALSE
21770001	Big Creek Beach (	8/25/2003 13:40	30	14	FALSE	FALSE
21770001	Big Creek Beach (	9/1/2003 15:00	20	14	FALSE	FALSE
21770001	Big Creek Beach (	9/8/2003 8:15	5	11	FALSE	FALSE
21770001	Big Creek Beach (	9/15/2003 8:35	5	12	FALSE	FALSE
21770001	Big Creek Beach (	9/22/2003 14:00	18	13	FALSE	FALSE
21770001	Big Creek Beach (	9/29/2003 13:55	36	11	FALSE	FALSE
21770001	Big Creek Beach (	10/6/2003 8:30	10	11	FALSE	FALSE
21770001	Big Creek Beach (	10/13/2003 9:00	5	13	FALSE	FALSE
21770001	Big Creek Beach (	10/20/2003 8:15	10	10	FALSE	FALSE
21770001	Big Creek Beach (	10/27/2003 14:00	5		FALSE	FALSE
		N	**29**	**25**		
		MAX	**280**	**42.2357153**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	24-May-04	1400		Single sample maximum violation	FALSE
21770001	Big Creek Beach	01-Jun-04	410		Single sample maximum violation	FALSE
21770001	Big Creek Beach	07-Jun-04	270		Single sample maximum violation	FALSE
21770001	Big Creek Beach	14-Jun-04	20		FALSE	FALSE
21770001	Big Creek Beach	21-Jun-04	210	230.52	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	28-Jun-04	740	202.92	Single sample maximum violation	E coli geometric mean exceedance
21770001	Big Creek Beach	06-Jul-04	2300	286.49	Single sample maximum violation	E coli geometric mean exceedance
21770001	Big Creek Beach	12-Jul-04	130	247.53	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	19-Jul-04	20	247.53	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	26-Jul-04	20	154.67	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	02-Aug-04	80	99.12	FALSE	FALSE
21770001	Big Creek Beach	09-Aug-04	10	33.41	FALSE	FALSE
21770001	Big Creek Beach	16-Aug-04	10	20	FALSE	FALSE
21770001	Big Creek Beach	23-Aug-04	20	20	FALSE	FALSE
21770001	Big Creek Beach	30-Aug-04	5	15.16	FALSE	FALSE
21770001	Big Creek Beach	07-Sep-04	10	10	FALSE	FALSE
21770001	Big Creek Beach	13-Sep-04	5	8.71	FALSE	FALSE
21770001	Big Creek Beach	20-Sep-04	10	8.71	FALSE	FALSE
21770001	Big Creek Beach	27-Sep-04	50	10.46	FALSE	FALSE
21770001	Big Creek Beach	04-Oct-04	5	10.46	FALSE	FALSE
21770001	Big Creek Beach	11-Oct-04	5	9.1	FALSE	FALSE
21770001	Big Creek Beach	18-Oct-04	5	9.1	FALSE	FALSE
		N	**22**	**18**		
		MAX	**2300**	**286.49**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	16-May-05	90		FALSE	FALSE
21770001	Big Creek Beach	23-May-05	5		FALSE	FALSE
21770001	Big Creek Beach	30-May-05	5		FALSE	FALSE
21770001	Big Creek Beach	06-Jun-05	30		FALSE	FALSE
21770001	Big Creek Beach	13-Jun-05	60	20.96	FALSE	FALSE
21770001	Big Creek Beach	20-Jun-05	5	11.76	FALSE	FALSE
21770001	Big Creek Beach	27-Jun-05	120	22.21	FALSE	FALSE
21770001	Big Creek Beach	05-Jul-05	40	33.66	FALSE	FALSE
21770001	Big Creek Beach	11-Jul-05	45	36.5	FALSE	FALSE
21770001	Big Creek Beach	18-Jul-05	10	25.51	FALSE	FALSE
21770001	Big Creek Beach	25-Jul-05	72	43.49	FALSE	FALSE
21770001	Big Creek Beach	01-Aug-05	5	23.03	FALSE	FALSE
21770001	Big Creek Beach	08-Aug-05	5	15.19	FALSE	FALSE
21770001	Big Creek Beach	15-Aug-05	30	14.01	FALSE	FALSE
21770001	Big Creek Beach	22-Aug-05	5	12.2	FALSE	FALSE
21770001	Big Creek Beach	29-Aug-05	5	7.15	FALSE	FALSE
21770001	Big Creek Beach	05-Sep-05	5	7.15	FALSE	FALSE
21770001	Big Creek Beach	12-Sep-05	18	9.24	FALSE	FALSE
21770001	Big Creek Beach	19-Sep-05	5	6.46	FALSE	FALSE
21770001	Big Creek Beach	26-Sep-05	5	6.46	FALSE	FALSE
21770001	Big Creek Beach	03-Oct-05	20	8.52	FALSE	FALSE
21770001	Big Creek Beach	10-Oct-05	5	8.52	FALSE	FALSE
21770001	Big Creek Beach	17-Oct-05	5	6.6	FALSE	FALSE
		N	**23**	**19**		
		MAX	**120**	**43.49**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	18-Apr-06	5		FALSE	FALSE
21770001	Big Creek Beach	25-Apr-06	5		FALSE	FALSE
21770001	Big Creek Beach	02-May-06	240		Single sample maximum violation	FALSE
21770001	Big Creek Beach	09-May-06	5		FALSE	FALSE
21770001	Big Creek Beach	16-May-06	5	10.84	FALSE	FALSE
21770001	Big Creek Beach	22-May-06	5	10.84	FALSE	FALSE
21770001	Big Creek Beach	30-May-06	5	10.84	FALSE	FALSE
21770001	Big Creek Beach	05-Jun-06	20	6.6	FALSE	FALSE
21770001	Big Creek Beach	12-Jun-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	19-Jun-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	26-Jun-06	10	7.58	FALSE	FALSE
21770001	Big Creek Beach	03-Jul-06	5	7.58	FALSE	FALSE
21770001	Big Creek Beach	10-Jul-06	40	8.71	FALSE	FALSE
21770001	Big Creek Beach	17-Jul-06	5	8.71	FALSE	FALSE
21770001	Big Creek Beach	24-Jul-06	30	12.46	FALSE	FALSE
21770001	Big Creek Beach	31-Jul-06	20	14.31	FALSE	FALSE
21770001	Big Creek Beach	07-Aug-06	10	16.44	FALSE	FALSE
21770001	Big Creek Beach	14-Aug-06	10	12.46	FALSE	FALSE
21770001	Big Creek Beach	21-Aug-06	5	12.46	FALSE	FALSE
21770001	Big Creek Beach	28-Aug-06	5	8.71	FALSE	FALSE
21770001	Big Creek Beach	05-Sep-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	12-Sep-06	20	7.58	FALSE	FALSE
21770001	Big Creek Beach	19-Sep-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	26-Sep-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	02-Oct-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	10-Oct-06	5	6.6	FALSE	FALSE
21770001	Big Creek Beach	17-Oct-06	5	5	FALSE	FALSE
21770001	Big Creek Beach	24-Oct-06	5	5	FALSE	FALSE
		N	**28**	**24**		
		MAX	**240**	**16.44**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	5/22/2007	41		FALSE	FALSE
21770001	Big Creek Beach	5/30/2007	218		FALSE	FALSE
21770001	Big Creek Beach	6/5/2007	10		FALSE	FALSE
21770001	Big Creek Beach	6/12/2007	5		FALSE	FALSE
21770001	Big Creek Beach	6/19/2007	41	28.35298854	FALSE	FALSE
21770001	Big Creek Beach	6/26/2007	390	44.48924056	Single sample maximum violation	FALSE
21770001	Big Creek Beach	6/27/2007	31	41.88958996	FALSE	FALSE
21770001	Big Creek Beach	7/2/2007	31	30.26381285	FALSE	FALSE
21770001	Big Creek Beach	7/9/2007	63	41.12889746	FALSE	FALSE
21770001	Big Creek Beach	7/17/2007	30	55.4420069	FALSE	FALSE
21770001	Big Creek Beach	7/23/2007	20	49.19035601	FALSE	FALSE
21770001	Big Creek Beach	7/31/2007	5	22.57172236	FALSE	FALSE
21770001	Big Creek Beach	8/7/2007	10	18.00082297	FALSE	FALSE
21770001	Big Creek Beach	8/13/2007	51	17.25592666	FALSE	FALSE
21770001	Big Creek Beach	8/21/2007	5	12.05890951	FALSE	FALSE
21770001	Big Creek Beach	8/27/2007	10	10.49789046	FALSE	FALSE
		N	**16**	**12**		
		MAX	**390**	**55.4420069**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	5/20/2008	5		FALSE	FALSE
21770001	Big Creek Beach	5/28/2008	10		FALSE	FALSE
21770001	Big Creek Beach	6/3/2008	930		Single sample maximum violation	FALSE
21770001	Big Creek Beach	6/4/2008	450		Single sample maximum violation	FALSE
21770001	Big Creek Beach	6/9/2008	160	80.34467343	FALSE	FALSE
21770001	Big Creek Beach	6/18/2008	160	90.11925068	FALSE	FALSE
21770001	Big Creek Beach	6/23/2008	30	121.4813046	FALSE	FALSE
21770001	Big Creek Beach	6/25/2008	10	85.03143847	FALSE	FALSE
21770001	Big Creek Beach	6/30/2008	200	130.44906	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	7/7/2008	20	55.96332829	FALSE	FALSE
21770001	Big Creek Beach	7/9/2008	30	42.33865726	FALSE	FALSE
21770001	Big Creek Beach	7/14/2008	190	52.46652465	FALSE	FALSE
21770001	Big Creek Beach	7/16/2008	140	59.31479244	FALSE	FALSE
21770001	Big Creek Beach	7/22/2008	70	53.49156105	FALSE	FALSE
21770001	Big Creek Beach	7/23/2008	170	66.44330556	FALSE	FALSE
21770001	Big Creek Beach	7/28/2008	190	96.00534898	FALSE	FALSE
21770001	Big Creek Beach	7/30/2008	320	101.8146865	Single sample maximum violation	FALSE
21770001	Big Creek Beach	8/4/2008	240	111.9923342	Single sample maximum violation	FALSE
21770001	Big Creek Beach	8/6/2008	730	135.0833284	Single sample maximum violation	E coli geometric mean exceedance
21770001	Big Creek Beach	8/11/2008	90	188.707806	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	8/13/2008	40	161.5908919	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	8/18/2008	50	141.5524729	FALSE	E coli geometric mean exceedance
21770001	Big Creek Beach	8/25/2008	5	99.47410121	FALSE	FALSE
21770001	Big Creek Beach	9/3/2008	5	50.06511647	FALSE	FALSE
21770001	Big Creek Beach	9/8/2008	5	16.80210727	FALSE	FALSE
21770001	Big Creek Beach	9/16/2008	50	12.55943216	FALSE	FALSE
		N	**26**	**22**		
		MAX	**930**	**188.707806**		

SiteID	BeachName	LastSampleDate	EColiLastValue	EColiGeoMean	Single Sample Maximum Violation?	Geometric Mean Violation?
21770001	Big Creek Beach	5/19/2009	10		FALSE	FALSE
21770001	Big Creek Beach	5/26/2009	30		FALSE	FALSE
21770001	Big Creek Beach	6/1/2009	150		FALSE	FALSE
21770001	Big Creek Beach	6/3/2009	20		FALSE	FALSE
21770001	Big Creek Beach	6/8/2009	1900	70.24238063	Single sample maximum violation	FALSE
21770001	Big Creek Beach	6/10/2009	50	66.37344392	FALSE	FALSE
21770001	Big Creek Beach	6/15/2009	40	61.74121306	FALSE	FALSE
21770001	Big Creek Beach	6/17/2009	30	56.41484771	FALSE	FALSE
21770001	Big Creek Beach	6/22/2009	50	68.98658878	FALSE	FALSE
21770001	Big Creek Beach	6/24/2009	70	69.09846159	FALSE	FALSE
21770001	Big Creek Beach	6/29/2009	30	69.09846159	FALSE	FALSE
21770001	Big Creek Beach	7/6/2009	5	52.73913705	FALSE	FALSE
21770001	Big Creek Beach	7/8/2009	130	37.71653073	FALSE	FALSE
21770001	Big Creek Beach	7/13/2009	50	37.71653073	FALSE	FALSE
21770001	Big Creek Beach	7/15/2009	20	34.58621117	FALSE	FALSE
21770001	Big Creek Beach	7/20/2009	5	27.64611324	FALSE	FALSE
21770001	Big Creek Beach	7/22/2009	30	25.93599948	FALSE	FALSE
21770001	Big Creek Beach	7/28/2009	10	20.33600939	FALSE	FALSE
21770001	Big Creek Beach	7/29/2009	40	21.08060525	FALSE	FALSE
21770001	Big Creek Beach	8/3/2009	60	23.67867068	FALSE	FALSE
21770001	Big Creek Beach	8/5/2009	30	28.89472513	FALSE	FALSE
21770001	Big Creek Beach	8/10/2009	30	24.55051217	FALSE	FALSE
21770001	Big Creek Beach	8/12/2009	420	32.61214991	Single sample maximum violation	FALSE
21770001	Big Creek Beach	8/17/2009	5	26.66015687	FALSE	FALSE
21770001	Big Creek Beach	8/25/2009	10	28.64732867	FALSE	FALSE
21770001	Big Creek Beach	8/31/2009	5	24.73825195	FALSE	FALSE
		N	**26**	**22**		
		MAX	**1900**	**70.24238063**		

[a]Manny, B. A., W. C. Johnson and R. G. Wetzel. 1994. Nutrient additions by waterfowl to lakes and reservoirs: predicting their effects on productivity and water quality. Proceeding of the Symposium on Aquatic Birds in the Trophic Web of Lakes. J. J. Kerekes, ed. Hydrobiologia 279/280:121-132.

Goose defecation rates

	/hour	Hours	Total
Canada goose defecation rate - day[a]	1.96	12	23.5
Canada goose defecation rate - night[a]	0.37	12	4.4
Mean defecation rate/goose/day			28.0

Note: Above rates are about half of the rate estimated for white-fronted geese.

Nutrient content of goose feces

	grams
Mean dry weight of a goose dropping	1.17
Mean proportion by weight of "C"	0.759
Mean proportion by weight of "N"	0.048
Mean proportion by weight of "P"	0.015
	grams
Loading rate of "C" per dropping	88.8%
Loading rate of "N" per dropping	5.6%
Loading rate of "P" per dropping	1.8%

Daily loading of N & P per goose

	grams
Mean daily loading rate for "C" per goose	24.83
Mean daily loading rate for "N" per goose	1.57
Mean daily loading rate for "P" per goose	0.49

Canada goose counts at Big Creek Lake

	Canada Geese	
	Mid-Dec.*	Midwinter**
2007	0	0
2006	400	0
2005	0	0
2004	0	0
2003	0	0
	80	0

*Mid-Dec. = Goose count within a few days of Dec. 15.
**Midwinter = 1st week of January the following year.
e..g., the Midwinter count for 2007 was Jan. 9, 2008

Spring Canada Goose Population & Production Estimates
from ground counts by local wildlife staff

Year	Young Hatched	Nesting Adults
2008	78	26
2007	40	20
2006	60	22
2005	53	22
2004	85	34
Avg.	63	25

Big Creek Weekly Survey Count Data

	2007			2006			2005			2004			2003
		9	6	10									
9/13/2007	20	9	14	10	9	15	10	9	9	0	9	12	50
9/20/2007	0	9	20	10	9	22	10	9	17	0	9	17	0
9/27/2007	25	9	25	10	9	29	10	9	23	25	9	25	50
10/4/2007	0	10	4	0	10	6	0	9	30	25	10	2	50
10/11/2007	0	10	11	0	10	14	10	10	7	25	10	15	0
10/18/2007	0	10	18	25	10	20	0	10	14	25	10	22	0
10/25/2007	10	10	25	0	10	27	0	10	21	0	10	29	0
11/1/2007	50	11	2	0	11	4	0	10	28	0	11	5	0
11/8/2007	50	11	9	40	11	10	25	11	4	0	11	12	0
11/15/2007	0	11	16	40	11	17	25	11	11	0	11	19	0
11/21/2007	50	11	21	0	11	20	0	11	18	0	11	26	0
11/29/2007	100	11	30	0	12	1	0	11	24	0	12	5	0
12/6/2007	0	12	5	250	12	8	0	12	2	0	12	11	150
12/13/2007	0	12	14	400	12	15	0	12	10	0	12	17	0
12/21/2007	0	12	20	200	12	22	0	12	18	0	12	24	0
12/27/2007	0	12	27	0									

Numbers of Canada geese using Big Creek Lake Lake

Yellow shaded cells are for inputs.

Month	Breeders	Non Breeders	Young Prod	Total	Avg. Migrants	Locals + Migrants	Hrs of Daylight	Hrs of Night	Hours geese Spend on water Day	Hours geese Spend on water Night	Goose daylight hours/day	Goose daylight hours per month	Goose night hours/day	Goose night hours per month	Goose daylight + night hours
Jan	0	0	0	0	56	56	9	15	6.3	15	353	10937	840	26040	1193
Feb	0	0	0	0	40	40	11	13	7.7	13	308	8624	520	14560	828
Mar	30	10	0	40	60	100	13	11	6.5	11	647	20069	1096	33964	1743
Apr	30	10	0	40	8	48	14	10	7	5	333	9996	238	7140	571
May	30	10	58	97	0	97	15	9	3	4.5	292	9054	438	13580	730
Jun	30	2	32	63	0	63	16	8	3.2	4	203	6088	254	7610	457
Jul	30	2	32	63	0	63	15	9	3	4.5	190	5898	285	8847	476
Aug	30	2	32	63	0	63	13	11	2.6	5.5	165	5112	349	10813	514
Sep	30	2	32	63	8	71	11	13	5.5	13	393	11784	928	27854	1321
Oct	29	7	22	57	20	77	10	14	5	14	386	11977	1082	33535	1468
Nov	27	6	20	54	80	134	9	15	4.5	15	601	18028	2003	60095	2604
Dec	26	6	19	50	80	130	8	16	5.6	16	728	22581	2081	64516	2810
						943					4600	140148	10114	308554	14714

Assumptions:
Number of breeders at Big Creek Lake has averaged about 30 pairs/year during 2004-08. (G. Zenner, unpublished data - annual Canada goose production estimate provided by local wildlife staff)
There are 0.64 nonbreeding geese for each pair of geese observed on the CAGO Bpop Survey (G. Zenner, unpublished data)
Production equation assumes that 100% of breeders nest, and 70% of the nesting geese hatch a nest, and those that hatch a nest fledge 3 young/nest.
Number of migrant geese using the lake is estimated using the Midwinter count as a reference.
The average number of Canada geese counted at Big Creek Lake in Dec. during the last 5 years (2003-07) was 80 with all of these (400) occurring in 2006. (see winter goose counts tab).
Note: Estimates of monthy goose use above over estimate number of geese counted on Big Creek Lake in Sept., Oct. & Nov.(see winter goose counts tab)

Hrs on water - Assumptions

Calculaitons assume geese spend 1.5 hours feeding in uplands each morning and evening during fall & winter & early spring,
i.e., that the geese only spend 3 hours of the daylight hours per day foraging in the uplands during September through March
and spend the rest of the time on the water.
This grossly overestimates the amount of time geese spend on the water as geese may spend 100% of the day foraging in fields during fall and winter
depending upon the weather conditions.
During April through August, the calculations assume geese spend 0.33 of the daylight hours on the water and half of the night hours on the water.
This also overstimates the time geese spend on the water as young geese spend up to 90% of the daylight hours foraging in uplands in May, June & July.
Calculations assume geese spend the enire night on the water. This is incorrect as geese roost on land whenever possible.
However, since they generally roost close to the shore, I assumed that for practical purposes their feces were deposited in the water.
Goose daylight hours = Geese X Hours they spend on the water per day
Goose daylight hours per month = Goose Daylight hours X Days in the month

This model only estimates the nutrients from goose excrement deposited when geese are on the water.
Except during May and June, when the geese are flightless, we cannot assume that the time the geese spent off the water was within the watershed
as they could easily fly outside the watershed.

Month	Avg. Daily Goose Pop.	Monthly Goose Use Days	Goose: Hours on Water/Mo. Day	Goose: Hours on Water/Mo. Night	Goose: Droppings Deposited/Mo. Day	Goose: Droppings Deposited/Mo. Night	Grams (per month) of "C" Deposited Day	"C" Deposited Night	"N" Deposited Day	"N" Deposited Night	"P" Deposited Day	"P" Deposited Night	Grams Total "C"	Grams Total "N"	Grams Total "P"	Month
Jan	56	1,736	10,937	26,040	21,436	9,635	19,036	8,556	1,204	541	376	169	27,592	1,745	545	Jan
Feb	40	1,120	8,624	14,560	16,903	5,387	15,010	4,784	949	303	297	95	19,794	1,252	391	Feb
Mar	100	3,088	20,069	33,964	39,336	12,567	34,932	11,159	2,209	706	690	221	46,091	2,915	911	Mar
Apr	48	1,428	9,996	7,140	19,592	2,642	17,398	2,346	1,100	148	344	46	19,744	1,249	390	Apr
May	97	3,018	9,054	13,580	17,745	5,025	15,758	4,462	997	282	311	88	20,220	1,279	400	May
Jun	63	1,903	6,088	7,610	11,933	2,816	10,597	2,501	670	158	209	49	13,098	828	259	Jun
Jul	63	1,966	5,898	8,847	11,560	3,273	10,266	2,907	649	184	203	57	13,173	833	260	Jul
Aug	63	1,966	5,112	10,813	10,019	4,001	8,897	3,553	563	225	176	70	12,450	787	246	Aug
Sep	71	2,143	11,784	27,854	23,097	10,306	20,511	9,152	1,297	579	405	181	29,663	1,876	586	Sep
Oct	77	2,395	11,977	33,535	23,475	12,408	20,846	11,019	1,318	697	412	218	31,865	2,015	630	Oct
Nov	134	4,006	18,028	60,095	35,336	22,235	31,379	19,745	1,984	1,249	620	390	51,124	3,233	1,010	Nov
Dec	130	4,032	22,581	64,516	44,258	23,871	39,302	21,198	2,486	1,341	777	419	60,500	3,826	1,196	Dec
	943	28,801	140,148	308,554	274,690	114,165	243,933	101,382	15,427	6,412	4,821	2,004	345,315	21,838	6,824	
												Total g	345,315	21,838	6,824	
												Total Kg	345.3	21.8	6.8	
												Total lbs	761.3	48.1	15.0	
												Total droppings	388,855			