HICKORY GROVE LAKE
WATERSHED MANAGEMENT ACTION PLAN

Story County's Flagship Park

Approval Date:

Re-evaluation Date:

Submitted By:

Prepared By: Aaron Andrews (Hickory Grove Lake Watershed Coordinator, ISU)
Dr. Michelle Soupir (Assistant Professor in Ag and Biosystems Engineering, ISU)
Rohith Gali (Graduate Student in Ag and Biosystems Engineering, ISU)

ACRONYMS USED IN THIS REPORT:

319 – EPA Clean Water Act Section 319 Program
BMP – Best Management Practice
CARD – Center for Agriculture Research and Development
CHL-A – Chlorophyll-a
CREP – Conservation Reserve Enhancement Program
CRP – Conservation Reserve Program
EPA – United States Environmental Protection Agency
EQIP –Environmental Quality Incentives Program
GIS – Geographic Information System
IDNR – Iowa Department of Natural Resources
ILF—Iowa Learning Farms
ISU – Iowa State University
NRCS – Natural Resources Conservation Service
PFI—Practical Farmers of Iowa
RUSLE – Revised Universal Soil Loss Equation
SCCB – Story County Conservation Board
SD – Secchi Depth
SWCD – Soil & Water Conservation District
SWAT—Soil and Water Assessment Tool
TMDL – Total Maximum Daily Load
TP – Total Phosphorus
TSI – Carlson's Trophic State Index
TSS – Total Suspended Solids
UHL – University Hygienic Laboratory
WIRB – Watershed Improvement Review Board
WMP – Watershed Management Plan
WRP – Wetland Reserve Program
WQIP—Water Quality Improvement Plan

MEASUREMENT ABREVIATIONS:

Ac – acres
Ac-ft – acre-feet
ft - feet
lbs - pounds
L - liters
m - meters
m^3 – cubic meters
mg/L – milligrams per liter, or parts per million
µg/L – micrograms per liter, or parts per billion
mi – miles
MPN – Most Probable Number
mS/cm – milliSiemens per centimeter
NTU – Nephelometric Turbidity Units
ppb – parts per billion (µg/L)
ppm – parts per million (mg/L)
mg/m^2 – milligrams per square meter
yr – year

TABLE OF CONTENTS

1 VISION STATEMENT

Hickory Grove Lake—Story County's "flagship park", will continue to be the premier natural resource venue in the county providing exceptional recreational opportunities for local citizens, as well as those traveling from communities across Iowa, though enhanced water quality, improved safety and enriched beach experiences by reduction of indicator bacteria.

2 COMMUNITY BASED PLANNING

Hickory Grove Lake has had a strong community connection since its inception. In 1960 the Story County Conservation Board took a survey of the recreational and related needs of the county residents and found that the community very much wanted a local lake. So, the board actively began investigating sites around Story County for making such a project a reality. Once the site was identified, a local farmer became the "prime mover" in making contacts necessary to purchase land. The Iowa Conservation Commission approved contracts with six landowners for acquisition of the land that is now Hickory Grove Park. Momentum and enthusiasm for the project built and the Story County Board of Supervisors began providing a budget to keep the project moving. Both local funding and tax dollars were used to finance the project. Land acquisition took place between 1961 and 1964 and construction was completed by 1966. Story County road equipment and employees helped to build the park's road system and neighboring landowners contributed in various ways. Hickory Grove Lake was built with support and cooperation of voters, elected officials, agency employees, and neighborhood landowners. The lake began filling in 1967, was opened for recreational activities on Labor Day 1968, and was full by 1969.

Several agencies, local organizations, and other groups have been involved with the ongoing Hickory Grove Lake Watershed project. Collaborators involved in the project include; Iowa Department of Natural Resources (IDNR), Story County Conservation Board (SCCB), Iowa Department of Agriculture and Land Stewardship (IDALS), USDA Natural Resources Conservation Service (USDA-NRCS), Story Soil and Water Conservation District (SWCD), Prairie Rivers RC&D, Iowa State University, Iowa Learning Farms, local landowners, homeowners, watershed residents and members of the local community.

Over the years several groups have been involved in the protection of Hickory Grove Lake. In-lake water monitoring at Hickory Grove began during the 1970's and continues today. Some of the first watershed assessments were completed in the early 1990's which primarily focused on estimating soil erosion from cropland areas in the watershed.

In 2008, the Story SWCD received a Watershed Development and Planning Assistance Grant from IDALS to get the planning process started. This plan involved collaboration between the Story SWCD, IDNR, USDA-NRCS, and SCCB. As an integral part of the process, Iowa State University was contracted by IDNR to perform an approved water quality monitoring effort to identify potential sources of bacteria, other contributors to water quality degradation, and develop a Water Quality Improvement Plan (WQIP—aka. TMDL) for Hickory Grove Lake.

A Watershed Advisory Committee (WAC) was formed in 2009 and has come together to meet a number of times. The first WAC meeting was held on March 12th, 2010 and identified a number of ideas for the project's first public meeting. Further discussions were directed toward performing initial meetings with landowner/operators and those having unpermitted septic systems in the watershed. Other suggestions that came up in this meeting included trying to get Colo and Collins-Maxwell Schools, FCA, Kiwanis, Rotary and Lions groups involved in the project.

A second meeting was held shortly after on May 5th, 2010 to provide a watershed update and finalize planning for the upcoming field day on June 23rd, 2010. A CRP application was signed for nearly 40 acres just southeast of the lake and planted to native species in fall 2010. This area was also targeted for a CREP application however, its construction was found to be cost prohibitive at the time.

Further WAC meetings were held on 10/6/2010, 2/14/2011, 11/30/2011 and 11/16/2012. The information gathered throughout these meetings guided the development of a comprehensive watershed management plan to address Hickory Grove Lake's bacteria impairment and prevent degradation of water quality.

Table 1: Watershed Advisory Committee

Name	Title/Affiliation
George Antoniou	Iowa DNR, Lakes Program
Ben Dodd & Jeff Kopaska	Iowa DNR, Fisheries
Kyle Ament	Iowa DNR, NPS Project Officer
Mike Cox	Story County Conservation, Director
Dustin Eighmy	Story County Conservation, HGL Resident Ranger
Ryan Wiemold	Story County Conservation, Park Ranger
Margaret Jaynes	Story County, Sanitarian
Amy Yoakum	Story County Conservation, Natural Resource Specialist
Aaron Andrews	Iowa State University, HGL Watershed Project Coordinator
Erv Klass	Story SWCD, Chair
Dana Holland	Marshall-Story USDA-NRCS, District Conservationist
James Martin	IDALS, Regional Coordinator
John Paulin	Prairie Rivers of Iowa RC&D, Coordinator
Matt Helmers	Iowa State University, Iowa Learning Farms
Michelle Soupir	Iowa State University, Agricultural and Biosystems Engineering
Rohith Gali	Iowa State University, Graduate Research Assistant
James Russel	Homeowner
Andy Swanson	Producer (largest)
Keith McKinney	Homeowner & Producer

3 PUBLIC OUTREACH

3.1 PREVIOUS PUBLIC OUTREACH

Public outreach for the Hickory Grove Lake Watershed Project began in 2009. The first watershed field day was held on June 23rd 2010. Those present included landowners, agency employees, public officials and other groups. Participating groups were SCCB, Story NRCS, Story SWCD, ISU, Heartland Ag, Iowa Learning Farms (ILF), VanWall Equipment, IDNR Fisheries, Pheasants Forever, IDALS, and Practical Farmers of Iowa (PFI).

A Hickory Grove Lake newsletter was developed and distributed by the Story Soil and Water Conservation District in spring 2011. The newsletter provided a watershed project update including progress and standing of current grants, plans for upcoming park improvements, results of ongoing water quality monitoring by Iowa State University, future direction of the project and also provided information on opportunities for landowners to enroll in conservation programs such as EQIP and CRP.

A second watershed field day hosted by the Iowa Learning Farms was held at Hickory Grove Lake on September 8th, 2011. The field day focused on strategies to reduce erosion and limit nutrient losses into water bodies with guest speakers covering topics on soil erosion, the importance of fencing cattle out of streams, and water quality benefits of strip-tilling. Personal invitations for the 2011 field day were sent to all watershed residents, as well as landowners and operators managing land within the watershed.

As a result of discussion between WAC members present at the fall 2011 meeting it was deemed necessary for the watershed coordinator to hold individual one-on-one outreach meetings with landowner/operators within the Hickory Grove Lake watershed. Previous public outreach efforts were marginally successful at drawing watershed residents and landowner/operators to public meetings. An additional mailing was sent out in November 2011 to all Hickory Grove Lake watershed landowner/operators. This mailing included the Fall 2011 Hickory Grove Lake Watershed Newsletter, as well as a personal letter introducing the new watershed coordinator and notifying recipients that they would be contacted in the near future in regards to coordinating individual one-on-one meetings. Results of individual one-on-one meetings are presented in the following section of this report.

Iowa State University presented water quality monitoring results at the Story County Conservation Board meeting on June 11, 2012. There were a large number of people (108) in attendance at the meeting as a result of a proposed confined animal feeding operation (CAFO)

which was to be built within approximately ¾ of a mile of Hickory Grove Park. ISU also provided updated brochures summarizing water quality monitoring beginning in spring 2010.

Funds contributed by Story SWCD made it possible to produce new public outreach and educational signage within Hickory Grove Park. Additional collaborators in constructing outreach signage were SCCB, ILF and ISU. Five kiosks were built and installed at heavy use locations around the park in summer 2012 followed by installation new education and outreach signage in fall 2012.

3.2 PUBLIC OUTREACH PLAN

A public outreach campaign is needed to promote an appreciation of Hickory Grove Lake and Park to generate pride in local water quality, which ultimately will require changes in habits and practices. Also important in this project is education about bacteria and how high levels harm water quality, and in turn animals and humans. The changes made in the Hickory Grove Lake Watershed and Park can eventually remove Hickory Grove Lake from the U.S. EPA 303(d) impaired water bodies list.

The Hickory Grove Lake watershed contains farmland, park property, roads and rural acreages but people come from all around central Iowa to utilize the lake and park. A public outreach campaign must have components that reach out to watershed residents as well as lake and park users. The materials suggested in the following public outreach plan were created with this in mind and the goal of reaching multiple audiences. In addition to any immediate action generated by this project, this outreach campaign should create *lasting* tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park, increase park usage and therefore stimulate the local economy.

GOALS:

1. Remove the bacteria impairment at Hickory Grove Lake by reducing bacteria violations to, or below, the allowable level of 10% of samples exceeding the single sample maximum criterion of 235 cfu/100 ml during the recreational period and total elimination of geometric mean violations within 3 years of the project start date. Further reduce single sample maximum violations to 5% or below within 5 years of the project start date.

2. Reduce overall bacteria loading to Hickory Grove Lake by reducing contributions from migratory birds at the beach and excluding cattle from streams in the watershed within 3 years and inspecting, repairing/updating all 8 unpermitted septic systems in the watershed within 5 years of the project start date.

3. Maintain and improve water quality of Hickory Grove Lake in order to prevent future impairment designation for sediment or phosphorus loading by stabilizing shorelines, gullies and streambanks and maintaining an average Carlson TSI of 63 or below.

   Within 5 years of the project start date:
   - Reduce **total** sediment loading by 677 tons per year (62.9%)
   - Reduce **total** phosphorus loading by 3,492 pounds per year (31.1%)

   Within 10 years of the project start date:
   - Reduce total **internal** phosphorus loading by 2,287 pounds per year (41.2%)

4. Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages to continually generate pride and community connection of/to Hickory Grove Lake and Park, and increase park usage therefore stimulating the local economy.

TARGET AUDIENCE:

Who will be involved with making changes to the land and water?

- Story County Conservation Board
- Iowa Department of Natural Resources
- Landowners
- Agricultural producers on rented land
- Hunters of geese and other animals
- Recreational lake and park users

Who will be involved with moving the project forward?

- Story County Conservation Board
- Story Soil and Water Conservation District
- Hickory Grove Lake Watershed Advisory Committee
- Prairie Rivers RC & D
- Iowa Department of Natural Resources
- Iowa Department of Agriculture and Land Stewardship
- Elected representatives to local, state and federal governments

Who will be promoting the message to the target audiences?

- Community leaders and spokespersons
  - SWCD Commissioners

    - Hickory Grove Lake Watershed Coordinator
    - Key local landowners/agricultural producers
    - County Board of Supervisors, City Councils and Township Trustees
- Project partners and stakeholders
    - SCCB Staff
    - Hickory Grove Lake Watershed Coordinator
    - USDA-Natural Resources Conservation Service
    - Farm Services Agency (FSA)
    - Local landowners and producers
    - Iowa State University Extension
    - Iowa Learning Farms
    - Practical Farmers of Iowa
- Local news media
    - Newspapers
        - Nevada Journal
        - Ames Tribune
        - Story County Sun
        - Iowa State Daily (ISU)Times-Republican (Marshalltown)
        - Slater Tri-County Times
        - Des Moines Register
        - City of Colo Newsletter
        - SCC Prairie Horizons Newsletter
    - Television
        - WOI—ABC 5
        - KCCI—CBS 8
        - WHO—NBC 13
        - KCWI—WB 23
        - KDIN—IPTV 11
        - KDSM—FOX 17
    - Radio
        - KASI 1430 AM
        - WOI 640 AM
        - WOI 90.1 FM
- Local businesses and visitors booths
    - Country House Restaurant
    - Twin Anchors Golf Course and Campground
    - Reed's Corner & Niland's Café
    - Jax Sporting Goods

    - Sportsman's Warehouse
    - Ames Convention & Visitors Bureau
    - Iowa State University Visitors Booth
    - Marshalltown Convention & Visitors Bureau
- Local associations and foundations
    - Jefferson Highway Association
    - Central Iowa Tourism Region
    - Iowa Natural Heritage Foundation
    - Rotary Club
    - Lions Club
- Local outdoor recreational clubs
    - Pheasants Forever
    - Ducks Unlimited
    - Central Iowa Anglers
    - Ames Anglers
    - Izaak Walton League
    - Hickory Grove Lake Triathlon
- Farmers Markets
    - City of Ames
    - City of Colo
    - City of State Center
- Local Youth Organizations
    - 4H
    - FFA
    - FCA
    - Boy Scouts
    - Girl Scouts
- Community Centers
    - Ames
    - Maxwell
    - Zearing
- Local Churches
    - Cambridge (3)
    - Collins (2)
    - Colo (3)
    - Maxwell (5)
    - Nevada (10)

TARGET AUDIENCE RESEARCH:

Individual one-on-one meetings were initialized in March of 2012 and conducted throughout the following spring. The watershed coordinator met with approximately 80% of the landowner/operators who are managing land in the Hickory Grove Lake watershed. The purpose was to gain a better understanding of landowners' perception of water quality issues within the watershed and to assess their willingness to participate in a watershed improvement project. Prior to these conversations, most of the landowners did not have a strong understanding of the water quality issues in the watershed. The watershed coordinator informed landowners of the elevated bacteria levels in the lake that are likely due to a combination of factors including; the resident geese population, unrestricted cattle access to a stream feeding the lake and contributions from one or more faulty/outdated septic systems in the watershed.

- All 12 of the landowners were very agreeable to whatever measures that would be taken to prevent the geese from polluting the beaches.
- Only one out of the 12 landowners interviewed had an unpermitted septic system. This landowner was open to getting more information about the potential for updating their system. Further work is needed to address septic system issues. The watershed coordinator will plan to contact the remaining landowners having unpermitted/outdated septic systems in the watershed (eight in total).
- Eleven of the 12 landowners expressed interest in putting additional conservation practices on their land to help improve water quality if significant funding were available to help pay for these practices. They had the strongest interest in installing additional waterways, but the primary impairment of the lake is bacteria. While EPA, Section 319, funds would only be available for those practices that directly address bacteria reductions, there are other programs available for other problems in the watershed that could lead to impairment in the near future.

The one-on-one interviews were conducted prior to a controversy in late spring 2012 concerning the installation of a confined animal feeding operation (CAFO) immediately outside the watershed and approximately three quarters of a mile from Hickory Grove Lake. Two public meetings were held in June and hundreds of citizens were in attendance. The meetings were heated because citizens thought the CAFO would be too close to Hickory Grove Lake and Park. Most of the folks protesting the CAFO were from outside of the watershed. Follow-up interviews will be held to see if this controversy had an adverse effect on landowners' willingness to participate in a watershed improvement project. The manure management plan has been withdrawn at this time. The proposed plan included manure application on a total of 345 acres, of which, approximately 150 acres were within Hickory Grove Lake Watershed. The

landowner/operator manages an additional 80 acres within the watershed which were not included in the manure management plan.

The recent CAFO controversy makes it even more important to be aware of the sensitivities of the watershed residents, as well as those living near the park and lake. Given the success of the first round of personal interviews, additional conversations should be conducted by the watershed coordinator. The watershed improvement project needs the participation of its landowners. Trust needs to be built with the landowners in order to ensure their participation and make changes on the land.

A public outreach campaign should be aimed at promoting an appreciation of Hickory Grove Lake to regular lake users as well as attracting new lake users. Thus, in addition to one-on-one meetings with agricultural producers, the watershed coordinator conducted 87 lake user surveys at Hickory Grove Lake and Park between late summer 2011 and the summer of 2012. As indicated by the lake usage survey found in the Hickory Grove Lake Watershed Citizen Awareness Campaign located in Appendix A of this report, users who were surveyed traveled an average of 26 miles to visit the lake: 14 percent lived in Colo, 11 percent were from Ames and 10 percent from Marshalltown. Fifty-three percent of the people surveyed using the lake were from Story County.

Because most lake users are from communities outside the watershed, the awareness and appreciation campaign must encompass a wider geographical scope. Residents in Story County including Ames, Nevada and Colo should be included. Also the campaign should expand to include the communities of Cambridge, Collins, Maxwell, Marshalltown, Rhodes and State Center.

Water quality matters a great deal to the people using the lake. Respondents were asked to rank a list of issues concerning the lake as to whether it was *not important* to *very important* (see pages 15-17 of the Hickory Grove Lake Watershed Citizen Awareness Campaign). The top three rankings as *very important* in the usage survey pertained to water quality: Safety from bacteria contamination/health advisories (80%), lack of water odor (45%) and water clarity (33%). Outreach campaigns should use these issues and explain how they connect to water quality and the plans to improve the overall watershed.

The Hickory Grove Lake Watershed (as all watersheds) is unique. Because there are no communities within the watershed and the majority of the lake users come from further distances, the awareness and appreciation campaign will have a different approach.

Landowners and agricultural producers

Potential barriers to participation:

- Reluctance to work with/lack of trust with government agencies
- Concern about drainage rights and water back-up onto land or into drainage tiles during heavy rainfall events
- Skepticism about action being taken and cost share incentives ever materializing
- Bitterness about not being included in previous watershed campaigns
- Current/previous landowner efforts to improve practices not being met equally by peers and reluctance to engage further until others do so as well
- Viewpoint that the lake was constructed to serve simply as a sediment basin for soil lost from agricultural fields and disconnect with the importance of topsoil loss as related to productivity and profitability
- Viewpoint that cost share dollars expire too quickly and typically reward those who are doing poorly
- Concern about productive agricultural land being taken out of production
- Not recognizing "time of transfer" law as a motivator to update septic systems due to no interest in ever selling their property
- Potential bitterness about uproar over the proposed CAFO

Motivators, incentives or benefits to encourage participation:

- Funding assistance/cost-share for installing best management practices
- Increased land value and aesthetics
- Convey the importance of topsoil and organic matter in stabilizing yields across the field and down the row leading to increased profitability
- Increases in efficiency and cost savings associated with reduced tillage and nutrient use
- Convey benefits of enhanced soil quality as related to resilience in relation to a changing climate
- Potential incentives for updating septic systems and low-interest loan programs
- Improved water quality and opportunities for local recreation
- Increased pride of management and local community

County residents and park/lake users

Potential Barriers to participation:

- Lack of concern and knowledge about water quality issues
- Lack of understanding about watershed concepts and land management impacts on water quality

- Residents and park/lake users seeing in-park wildlife management efforts as a nuisance or inhumane

Motivators, incentives or benefits to encourage participation:

- Improvement in water quality resulting in increased safety from bacterial contamination and enriched park/lake usage experiences
- Improved water access and enhanced recreational experiences
- An overall increase in park/lake usage with complementary increases in local revenue
- A more diversified landscape leading to increased aesthetics, wildlife habitat and hunting opportunities

Partners and regulatory agencies

Potential Barriers to participation:

- Personnel turnover and having multiple responsibilities/jurisdictions
- Losses in funding resulting cutbacks due to recent changes in the farm bill

Motivators, incentives or benefits to encourage participation:

- Working together for improved water quality and reducing topsoil loss
- Building relationships between organizations
- Opportunity to improve public image and rapport with landowners

OUTREACH STRATEGY:

A proposed public outreach strategy has been developed for Hickory Grove Lake by the Iowa Learning Farms extension and outreach program at Iowa State University. The full Hickory Grove Lake Watershed Citizen Awareness Campaign is presented in Appendix A at the end of this report.

The first step in developing a public outreach campaign involves generating a core branding element which is readily identifiable, meaningful to the target audiences and is a consistent symbol incorporated in all public outreach materials.

- Watershed identification logo: this logo was created in December 2011 and is currently being implemented into the marketing materials and signage.
- A campaign slogan is also an important branding tool. An example of a slogan is: **"Protecting today. Preserving for tomorrow."** The slogan can be included on all of the components of the campaign in conjunction with the watershed identification logo.

Several different marketing media have the potential to be utilized in the campaign. The outreach materials are designed to be complementary, promoting an awareness and appreciation for Hickory Grove Lake.

Brochure: A general overview brochure has been developed to inform readers about the watershed, the project and its goals. The language and images used in the brochure, and all appropriate materials, emphasize the importance of water quality for watershed residents and visitors to Hickory Grove Park. The brochure is currently available at the Story County Conservation Nature Center. Brochures should be placed throughout Hickory Grove Park

including the campground, two bathhouses and shelter houses. It should also be available at neighboring businesses including Twin Anchors Campground and Golf Course. Local sporting goods stores also have the potential to reach out to target audiences. Brochures could be posted at Jax Sporting Goods in Ames and Sportsman's Warehouse in Ankeny. Brochures could also be available at all of the local tourism bureaus including Ames Convention & Visitors Bureau, Iowa State University Visitors Booth and the Marshalltown Convention & Visitors Bureau.

News media: Regular press releases will be sent to area newspapers and radio stations to support the park's events and watershed improvement achieved goals.
A weekly radio segment that discusses conservation could be aired on the Ames radio station KASI-1430AM, featuring the watershed coordinator or a locally recognized personality.

Movie Theater advertising: Many theaters project local business ads prior to movie previews. Movie theaters are located in the cities of Nevada, Marshalltown and Ames. Ads promoting the watershed project and Hickory Grove Lake as well as why clean water quality is important to everyone can be part of these advertisements, provided the movie theater company participates in this practice.

Multi-Lingual Signage: Hickory Grove Lake is visited by a growing number of Spanish-speaking families and individuals. Although the lake usage surveys indicate that only three percent of the groups using the lake spoke Spanish, they should not be overlooked. According to 2010 U.S. Census data, the nearby community of Marshalltown has a Hispanic population of 24.1 percent, which has doubled since 2000. Therefore, it is recommended that any new marketing signage, be made available also in Spanish. This will help protect the health of all lake users and recognize this segment of the population as important stakeholders in the campaign. Current warning signs have implemented both languages. It is also recommended that additional signage be implemented at the beach given that 52 percent of respondents indicated that they used the lake for swimming and 80% of the respondents said it was *very important* to know if there were any safety issues concerning bacterial contamination and/or health advisories.

Watershed Boundary Signs: Signage will be created to mark the geographic boundaries of the watershed. The signs will say, “Now Entering Hickory Grove Lake Watershed” and will contain the logo and slogan. The signs will provide a different perspective of the area and introduce the concept of watersheds to those who may not have previous knowledge of it. These signs will increase the visibility of and generate curiosity about the Hickory Grove Lake watershed project.

Promotional Road Signs: Small signs will be placed along well-traveled roads within the watershed, such as the entrances to Hickory Grove Park, containing sequential facts, as well as messages about the aesthetics of Hickory Grove. The signs will be reminiscent of the old Burma-Shave advertising road signs and placed in groups of four or five. The first three or four signs will contain the featured message with the last containing the logo and slogan for the watershed project. Each set of signs will be different, to engage people and generate curiosity about the project.

Signs can include information about soil and water quality or just encourage those passing by to visit the park.

Because most people who frequent the park come from surrounding towns, marketing materials need to be placed within the park itself as well as nearby sites where visitors frequent. Informational posters about the watershed improvement efforts will be placed strategically throughout Hickory Grove Park including the campground, two bathhouses and shelter houses.

Campground: Sixty percent of those surveyed were camping at the lake. Therefore, informational brochures given to campers upon registering at Twin Anchors and the Hickory Grove Lake campgrounds would be an excellent means of increasing public awareness of watershed and water quality issues. Brochures should highlight water quality issues, as well as the reasoning and importance of geese management efforts being taken within the park. Flyers can be placed in the bathhouses at the beach and the campgrounds with information on events and project progress.

Golf Course: Twin Anchors Golf Course is located near the entrance to Hickory Grove Park. To promote the park to golfers, special scorecards could be used that contain details about the watershed, the lake and the park. These scorecards could be made unique by numbering them and offering a daily drawing for a prize. The player with the corresponding number could win a complementary beverage or other prize funded by the watershed project. The intent is to encourage people to read the information more closely. Additional options for the scorecards could be to include a coupon as part of the scorecard to receive a logo'd golf ball or pack of custom golf tees with the project information on it.

Geocaching: Geocaching is an outdoor hi-tech treasure hunting game using GPS-enabled devices. Participants navigate to a specific set of GPS coordinates and then attempt to find the cache (container) hidden at that location. Geocaching is a fast growing activity across the United States. There are many smartphone applications for GPS and geocaching. Park employees or volunteers could work with the Iowa Geocachers Organization to promote the park as a geocache location

(www.iowageocachers.org). Because 22 percent of lake usage survey respondents indicated that they spent their time at the park for nature appreciation, geocaching would be an activity for those who appreciate nature and would help new users discover the beauty of the park. Hickory Grove Park could have its own geocaching map so that people could explore the park and learn more about the watershed. The cache locations will be available to download from the Internet. Geocaching encourages people to visit all of the park's amenities; there are many niches in the park to explore. Each cache will have a fact about the lake, park or watershed. The container's contents could change as watershed improvement progresses and events change at the park. Geocaching can be done as a group or people can venture out on their own. This is also a great family activity, which would be a great addition to Hickory Grove Lake Park due to the fact that 39 percent of lake usage respondents had an average of four children with them.

Hickory Grove Triathlon

(http://www.hickorygrovetriathlon.com/**):** The Hickory Grove Triathlon is held annually in August. A partnership between the Hickory Grove Watershed Project and the Triathlon could be established and a general awareness event for the watershed improvement project could be held in conjunction with the triathlon. The triathlon brings a different audience of athletes who may not utilize the lake any other time outside this event. Because the triathlon participants swim as part of the event (or can't because of high bacteria levels), the campaign could have a distinct impact. In addition, silicone wristbands, which are popular among athletes, could be created and provided to the athletes with their registration packets, or even sold to generate additional revenue for the project. The wristbands could contain the slogan of the watershed, the Hickory Grove logo and the triathlon logo.

Trick-or-Treat Night in the campground: As 59 percent of lake usage respondents indicated that they spend their free time camping, events that utilize the campgrounds could be promoted in this outreach campaign. One such already established event is the annual Breezy Bay Campground Halloween Trick-or-Treat Night. The campers who participate are awarded a free night's stay at the campground. To promote the watershed campaign, candy could be given out to trick-or-treaters with messages attached about the Hickory Grove project. Additional park event promotion could also be included. This event could be expanded to include Twin Anchors campground also.

Appreciation Events: A Hickory Grove Lake Appreciation Day could be held to celebrate the progress made in the Hickory Grove Lake Watershed campaign. Live music, food, fishing and

canoeing demonstrations and geocaching information could be included. Area organizations such as Pheasants Forever, Ducks Unlimited, Central Iowa Anglers and the Izaak Walton League could have information tables, too. The appreciation day could be held in the spring in conjunction with Earth Day. The Iowa Learning Farms Conservation Station should be included at the appreciation day. The Conservation Station is an effective tool for demonstrating how conservation practices benefit water and soil quality and for bringing people together around conservation issues. The rainfall simulator component of the Conservation Station has an effective visual display, which demonstrates how different land practices (urban and rural) affect surface and subsurface water quality. The Conservation Station also contains a learning lab with various lessons that can be changed depending on the targeted message and audience at the event.

A fall event can be held to promote the park and its autumn colors such as a "Turkey Trot" 5k or 10k run around the lake. T-shirts with the watershed logo can be given away to participants and project informational brochure and flyers for events can be given to participants and visitors.

Learning Opportunity: As part of the campaign, an IOWATER volunteer water quality monitoring workshop could be held. Watershed residents should be encouraged to participate in the workshop with their children or grandchildren of appropriate ages. Then volunteers can conduct the monitoring together, so ownership of the watershed and pride in water quality can be nurtured through multiple generations. The IOWATER program also offers a subsequent workshop on bacteria monitoring, and this workshop could be offered locally if enough interest is generated. All of the events provide opportunities for watershed residents and visitors to network and learn from one another and unite as a watershed community.

Restaurants: Watershed residents, landowners/operators and area lake users frequent the Country House Restaurant, located on Highway 30, as well as Niland's Café on the historic Jefferson Highway in Colo. Printed, paper placemats and table tents could be placed at dining tables in these restaurants. The placemats and table tents will contain information about Hickory Grove Lake Watershed project, the lake and the park to call attention to its amenities. Other restaurants outside of the watershed should be targeted as well. There are several restaurants in the surrounding area including Ames, Marshalltown, Nevada, State Center, Collins and Cambridge that may be willing to use placemats, display table tents and brochures.

Colleges and Universities: Hickory Grove is also unique in that it rests between a major university and an area community college. Iowa State University set a record for enrollment in 2012 with over 31,000 students. Marshalltown Community College enrolls an average of 2,000 students every year. Many students may not know of Hickory Grove Park and would likely take

advantage of its close proximity. There are bulletin boards and places for brochures where promotion about the lake and events could be posted. Table tents are also very common in the dining centers and would be viewed by thousands of students every day. Clubs and student organizations could utilize the shelter houses for meetings and outdoor activities. This may be a good avenue for creating some type of "friends of Hickory Grove Lake watershed" group. It would also be a way to engage the fishing club, geocachers and other outdoors clubs that likely already exist at ISU and may be using the lake/park. A partnership with the Program for Women in Science and Engineering (PWSE) at Iowa State University could also be a great way to connect Hickory Grove Park to ISU. Outdoor classrooms could be conducted at Hickory Grove Lake Park or the organization members could be called upon to help with above outdoor activities at the park.

Farmers Markets: Ames has three farmers markets that operate from May through October. They include the Ames Farmers Market, Main Street Market and North Grand Farmers Market. Colo and State Center also have regular farmers markets. Those involved with the watershed project could have a booth with information about the project and what community members can do to improve water quality in their area. Handouts at the booth can include the general informational brochure and additional fact cards about water quality and what can be done to improve it (e.g. What is a watershed? What watershed do you live in? What are some of the issues that your community is facing with its water quality/impairments?). The booth should appeal to all ages. Kids can take home a picture to color or a worksheet regarding pollution and water quality. The farmers market booth is also a great venue to promote upcoming events at the lake.

ILF Farmer Partners: Currently there is one resident landowner/operator within the watershed who is implementing several conservation farming practices to curb erosion and slow the flow of water. The farmer has reworked grassed waterways utilizing mulch material to ensure good establishment, practices 100% no-till farming and aims to plant cover crops on 100% of the acres being row crop farmed in 2013. This farmer will be asked to become an Iowa Learning Farms partner and host a field day for watershed residents and other farmers to discuss his successful operation.

Service clubs: Involving youth groups, such as Boy and Girl Scouts, or 4-H, in the watershed project help bring awareness to the issues involving the watershed to new, younger audiences. This will help engage the next generation who will be taking care of the water quality and the lake. The groups can plan service projects that help the lake such as trash pick up days, painting picnic tables, etc.

Middle school and elementary students: Currently the Ames Middle School 6th grade class travels to Hickory Grove Lake for their annual outdoor day. Story County Conservation staff are educators for this event, teaching the basics of canoeing, team-building and compass skills. The Conservation Station and/or a watershed activity could be added to the classes' rotations to learn about their surroundings that day and to learn more about water quality in general. Other area schools could be invited to participate in their own outdoor classroom, of which Iowa Learning Farms will sponsor. Ideally, there would be five or six different learning stations, each with its own presenter or team of presenters. Iowa Learning Farms will work with the watershed coordinator and Story County Conservation to lead learning stations/group sessions during the day-long event. Examples of such partners may include local ISU Extension and Outreach personnel, local DNR/NRCS staff, local SWCD commissioners and local Farm Bureau personnel. Students would be bussed to the park then divided into groups to experience the different learning stations. Student groups would rotate to each of the different learning stations, spending approximately 30 minutes at each stop, participating in such activities as nature hikes/scavenger hunts, fish species identification, birds and furs, geocaching, and water quality monitoring.

High School students: Another opportunity for youth involvement would be possible through a partnership with instructors and high school student organizations, including:

- Ames High School's 100th Green Butterfly Environmental Club
- Nevada High School FFA chapter
- West Marshall High School FFA chapter, which encompasses nearby communities State Center and Colo-Nesco High Schools

These groups could take a field trip to Hickory Grove or conduct an outdoor class and learn about the watershed. Design and creation of a Hickory Grove Lake Watershed website could become a class project for students, in which the watershed coordinator and/or advisory board would serve as the client and consult with the teacher(s) and student group(s) regularly. In addition to raising students' awareness of local environmental issues, this partnership would be a great learning opportunity for the students and would benefit the watershed project by utilizing students' computer and design skills.

Local associations and foundations: Local organizations are commonly very active within the community and can be great groups to engage to help with promotion of the watershed project and building pride for the local resource. Presentations can be given to the Jefferson Highway Association, as well as Women's Rotary and Lions Clubs. Promotional materials for Hickory Grove Lake can also be provided to the Central Iowa Tourism Region association and posted on their website (www.iowatourism.com). The Heart of Iowa Nature Trail supported by the Iowa

Natural Heritage Foundation (INHF) passes directly south of Hickory Grove Lake just 10 miles away. Educational brochures could be placed at trailheads in the nearby towns of Cambridge, Collins, Huxley, Maxwell, Marshalltown, Melbourne, Rhodes and Slater. INHF boasts that it "often targets public and private land protection to key locations within critical watersheds" and has been involved with a number of other projects in Story County. Thus, there is potential for involving INHF in the Hickory Grove Lake Watershed project as well. A special feature on Hickory Grove Lake could also be included in the *Iowa Natural Heritage* magazine published quarterly.

Church groups: People often use their church for idea exchange and discussion on a variety of topics, religious and nonreligious. Clean water is a human right and discussing within the church community why and how to clean up local waters would be appropriate. By calling awareness of Hickory Grove Park to area churches and their various groups, the park could be used as a venue for classes, social and youth group activities.

Volunteer Organizations: United Way volunteers are currently actively involved in the Hickory Grove Lake Watershed project. Volunteers have been working with SCCB staff to clear invasive species from around the shores of Hickory Grove Lake. It is important that this relationship be maintained and other volunteer organizations become actively involved.

High School/Community/Sporting Events: The Hickory Grove Lake watershed project could increase its presence in the surrounding local communities and generate renewed interest in project efforts through sponsorship at local sporting events.

Table 2. Public Outreach Time Frame (to be developed annually)

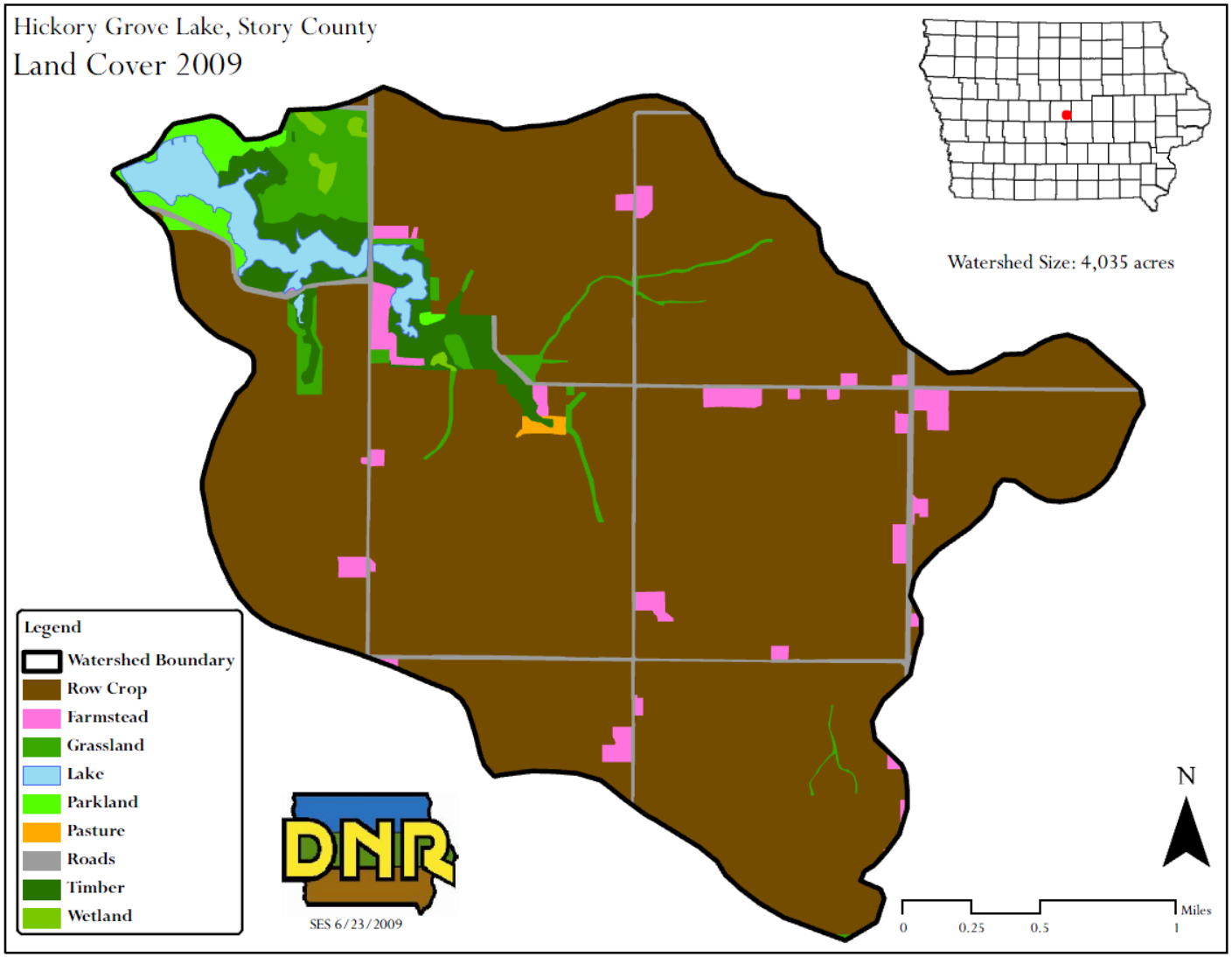
Quarter	Public Outreach Objective
Quarter 1: January-March	• General informational brochure (finished) • Establish geocaching • Continue one-on-one conversations with watershed residents • Website creation
Quarter 2: April-June	• Create and erect beach signage and other park signage • Watershed boundary signs • Appreciation Day event • Develop placements for area restaurants • Conduct outdoor classrooms • Continue one-on-one conversations with watershed residents
Quarter 3: July-September	• Create & distribute table tents for college dining halls • Service club projects (cleaning, painting, etc) • Triathlon (August) • Conduct outdoor classroom (Sept) • ILF Field Day • Continue one-on-one conversations with watershed residents
Quarter 4: October-December	• Trick-or-treat night at campground • Turkey Trot 5K run • Fall Watershed Update Newsletter • Continue one-on-one conversations with watershed residents

EVALUATION:

Evaluation of the effectiveness of the public outreach campaign will include; conducting a survey of watershed residents and lake users during each phase of the project, tracking attendance at public outreach events, tracking media coverage, keeping record of one-on-one communications with individual landowner/operators, and tracking progress of the implementation of best management practices. Trends noted during evaluation will be used to alter/re-direct the public outreach strategy as deemed necessary.

4 WATERSHED ANATOMY

4.1 WATERSHED MAP WITH LAND-USE



4.2 LOCATION NARRATIVE AND HISTORY

LOCATION:

The Hickory Grove Lake Watershed is located in the southeast quarter of Story County, Iowa approximately 2.5 miles southwest of Colo. The watershed is a sub-basin of the HUC 8 South Skunk River Watershed (ID # 7080105) and further, the HUC 12 Lower East Indian Creek Watershed (ID # 07080150604). Hickory Grove Lake and County Park is located 12 miles east of the intersection of U.S. Interstate 35 and U.S. Highway 30 and two miles west of the intersection of U.S. Highway 30 and U.S. Highway 65. Figure 1 shows the location of the 4,035 acre Hickory Grove Lake Watershed.

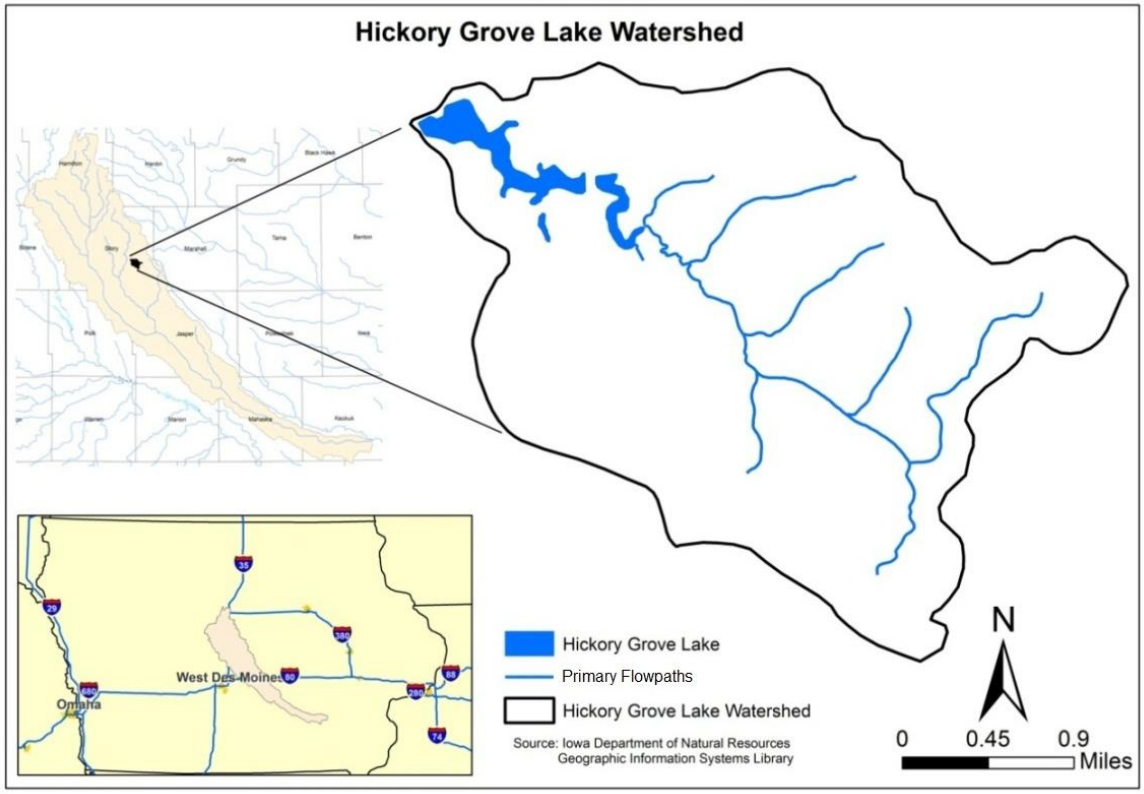


Figure 1. Location of Hickory Grove Lake Watershed in Story County, Iowa

POPULATION:

Review of the 2010 United States Census showed the population of Story County to be 89,542. While there are no cities within the watershed itself there are several small surrounding communities within Story County, and the immediately adjacent Marshall County which the lake serves as a recreational area. The population of the watershed consists of approximately 15 farms with about the same number of landowner/operators involved in row-crop production, as well as a total of 28 rural residences. Not all landowner/operators live within the watershed. The population and distance of surrounding communities are presented in Table 3.

Table 3. Surrounding communities and relation to Hickory Grove Lake

City	Population (2010)	Distance (mi)
Ames	58,965	17.5
Cambridge	827	17.9
Collins	495	9.0
Colo	876	3.7
Huxley	3,317	22.8
Maxwell	920	10.0
McCallsburg	333	16.7
Melbourne	830	19.4
Nevada	6,798	8.0
Roland	1,284	20.7
State Center	1,468	11.6
Zearing	554	15.1

OWNERSHIP:

Hickory Grove Park is owned by Story County, managed by SCCB and accounts for 445 acres of the watershed (approximately 11%) which includes its 98 acre man-made lake originally impounded in 1968. The remaining 89% of the watershed is privately owned and is primarily involved in row-crop farming. Being a 45 minute drive from Des Moines and a 15 minute drive from Ames, Hickory Grove Park is the largest and most popular owned by Story County.

4.3 PHYSICAL CHARACTERISTICS

HYDROLOGY:

The watershed of Hickory Grove Lake is 4,035 acres, resulting in a watershed-to-lake ratio of 40:1. In 1979, the lake featured a maximum depth of 45 feet, mean depth of 16 feet, storage volume of 1,591 acre feet and 5.2 miles of shoreline. Much of the Hickory Grove Lake Watershed is under subsurface drainage management; a drainage district on the east side of the watershed drains approximately 2,173 acres of the watershed. The drainage district is considered to be one of the major flow paths to the lake and is estimated to be responsible for 75% of the inflow to the lake. The drainage district, drainage tile mains, and surface inlets are shown in Figure 2. Hydrological information for Hickory Grove Lake is provided in Table 4. Lake depth and contours for the main basin of the lake are shown in Figure 3.

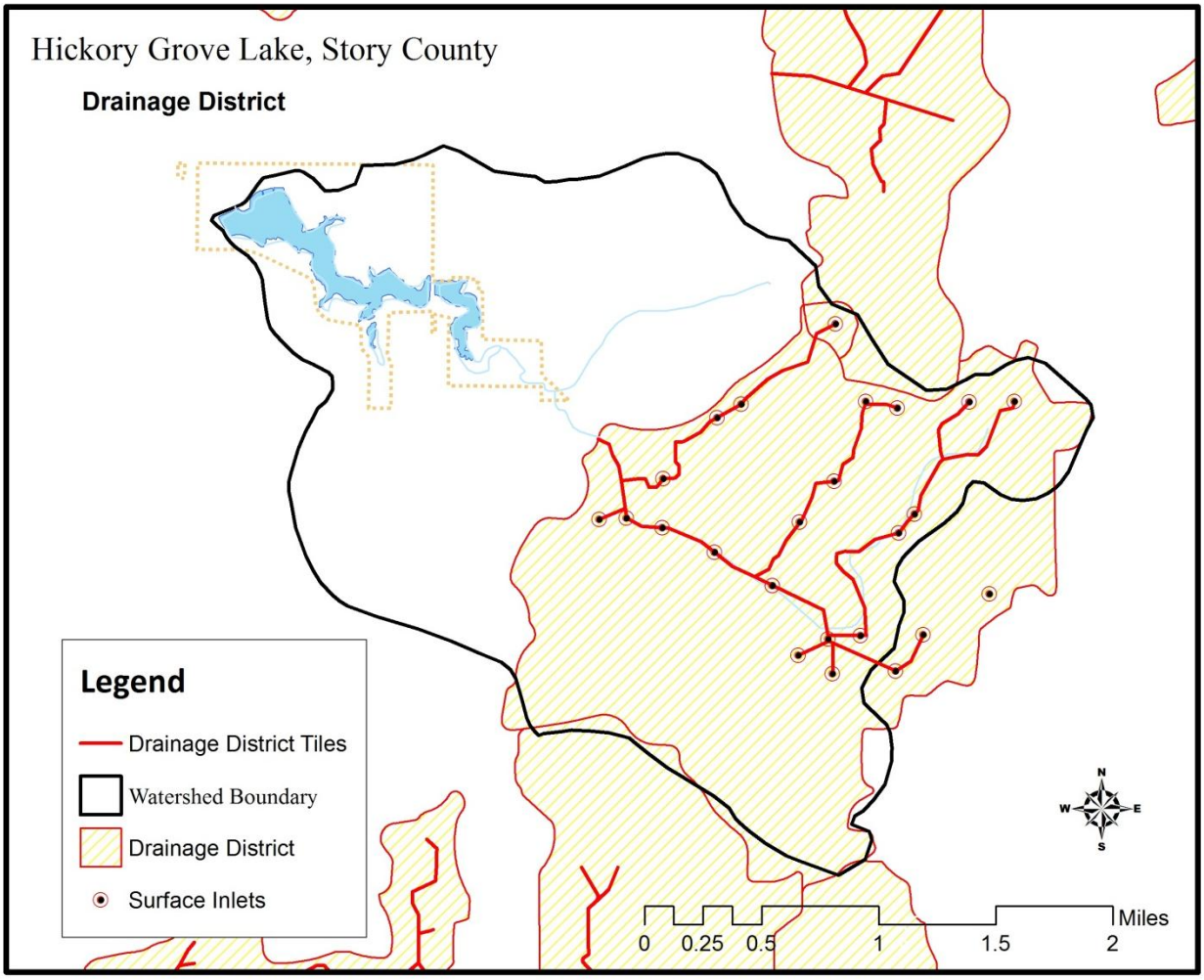


Figure 2. Drainage district area, tile mains and surface inlets in Hickory Grove Lake Watershed

Table 4. Hickory Grove Lake Hydrological Information

Description	Value	Units	Year
Lake Surface Area	98	Acres	2006
Volume	1,269.9	Acre-feet	2006
Maximum Depth	36.4	Feet	2006
Length of Shoreline	5.1	Miles	2006
Shoreline Development Index	3.6		2006
Watershed Area	4,035	Acres	2010
Watershed area/Lake area ratio	40:1		

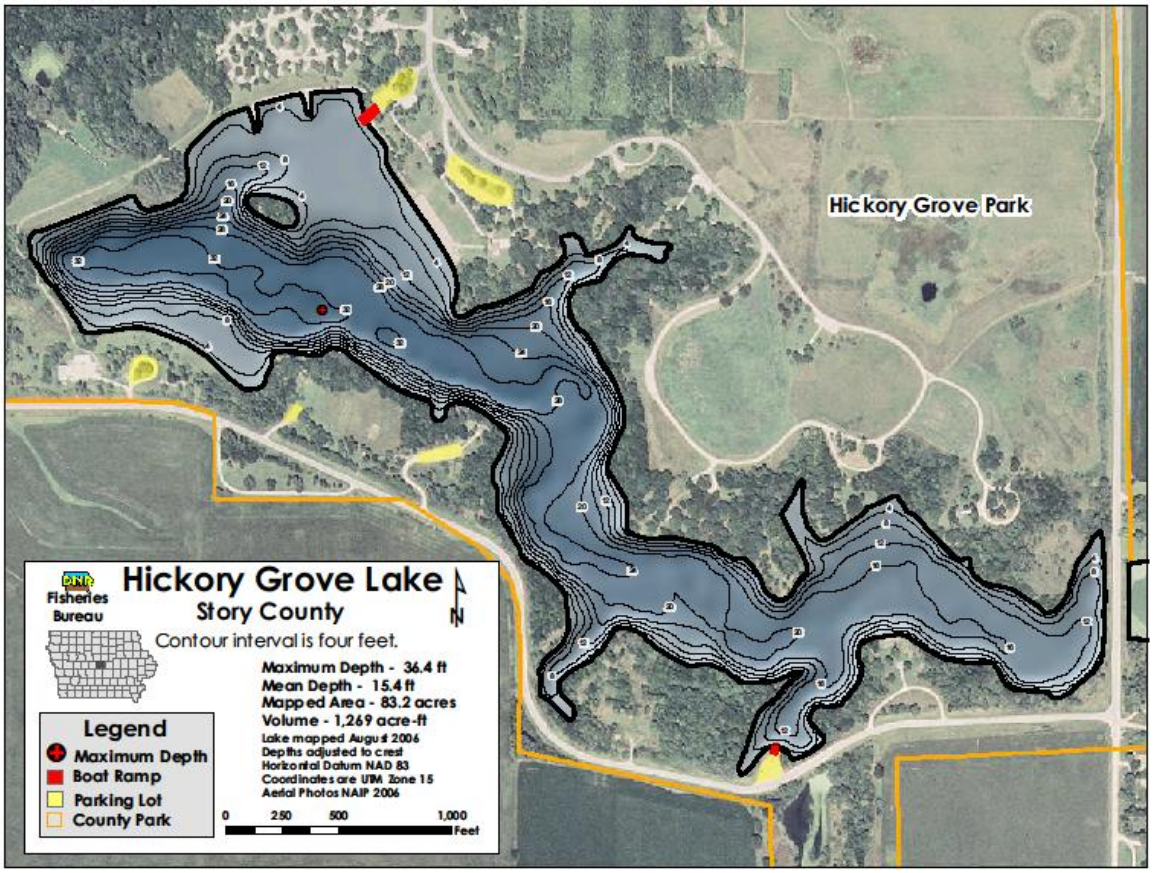


Figure 3. Hickory Grove Lake Depth and Contours

SOILS:

The soils data in the watershed is obtained from USDA-NRCS Soil Survey Geographic Database (SSURGO). The soils in this watershed are mostly fine-loamy, fine-silty and coarse-loamy soils. The soils in this watershed are dominated by hydrologic soil group B: 73.38% of the watershed is in hydrologic soil group B, 25.63% of the watershed is in hydrologic soil group D and 0.99% of the watershed is in hydrologic soil group A. There are three dominant soil types in the watershed which comprise 78% of the watershed: Clarion, Nicollet and Webster (Table 5).

Table 5. Major soil types in the watershed

Soil Name	% of watershed
Coland	1.18
Clarion	27.96
Canisteo	11.20
Nicollet	24.24
Okoboji	1.75
Harps	1.56
Webster	26.4
Water	2.53
Lester	1.94

The SSURGO data depicts information about the kinds and distributions of soils on the landscape. The SSURGO data contains both spatial and tabular data for each soil survey area, and the tabular dataset contains the physical and chemical soil properties. Each soil survey area has a map unit linked to the attributes in SSURGO database. A map unit is a collection of areas defined and named in terms of their soil components. Each map unit differs in some respect from all others in a survey area (USDA-NRCS). The map units in the Hickory Grove Lake Watershed are shown in Figure 4. The map unit ID's listed in Figure 3 starts with a common symbol of IA 169; where IA refers to State and 169 refers to County ID.

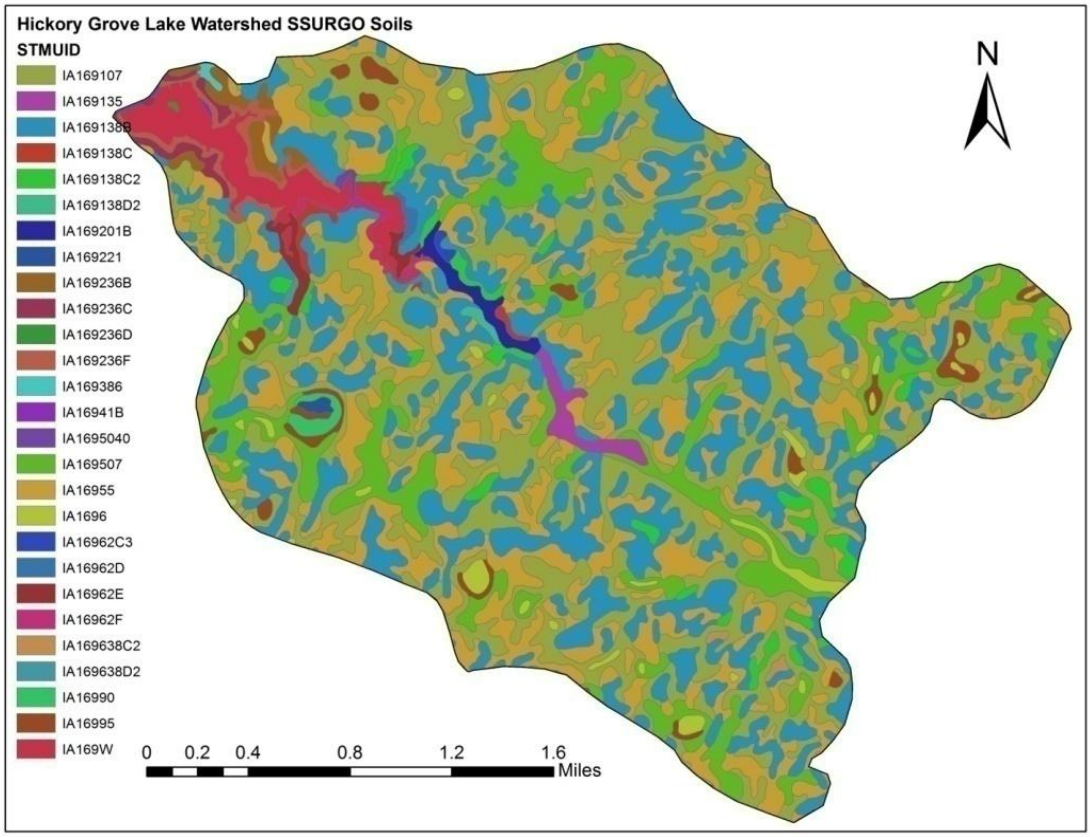


Figure 4. Soil Survey areas in Hickory Grove Lake Watershed

GEOLOGY AND TOPOGRAPHY:

A 3-m resolution digital elevation model DEM for Story County, Iowa is produced by aggregating 1-m resolution elevation data from the state of Iowa's LiDAR program (Figure 5). The slopes in the watershed ranged from 0.0% to 75.1%, with mean slope of 2.7% and median slope of 2.0%. Most of the watershed is under 2% slope and the highest slopes are observed around the lake. A topographical map of the Hickory Grove Lake watershed is also provided in Figure 6.

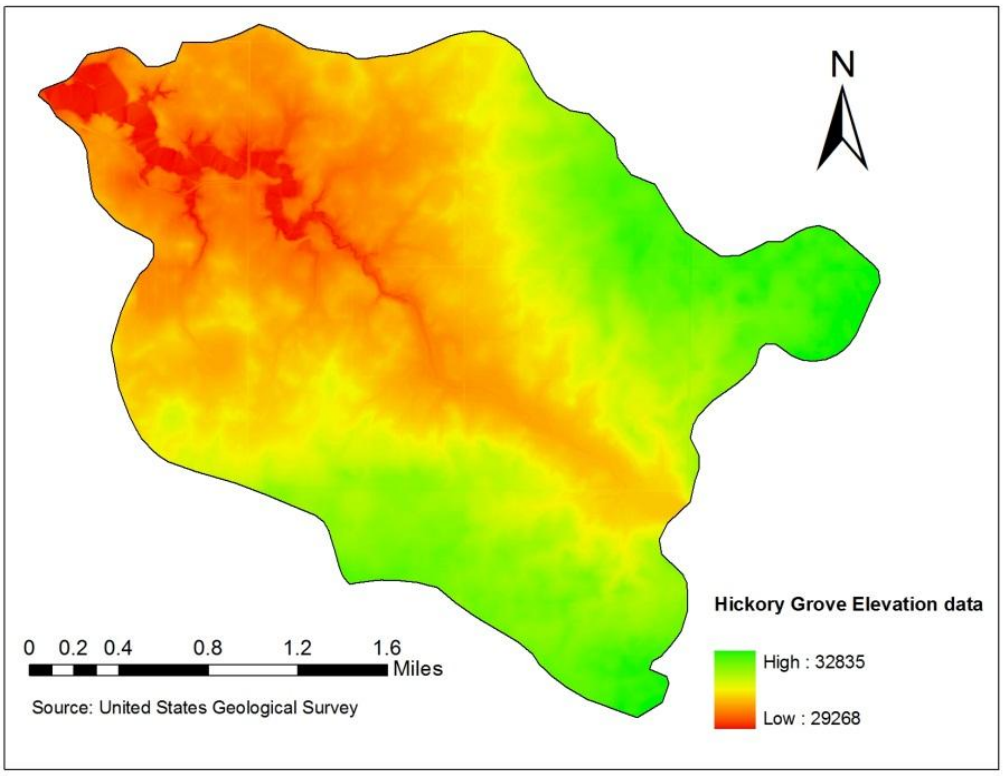


Figure 5. Spatial Distribution of Slopes in Hickory Grove Lake Watershed

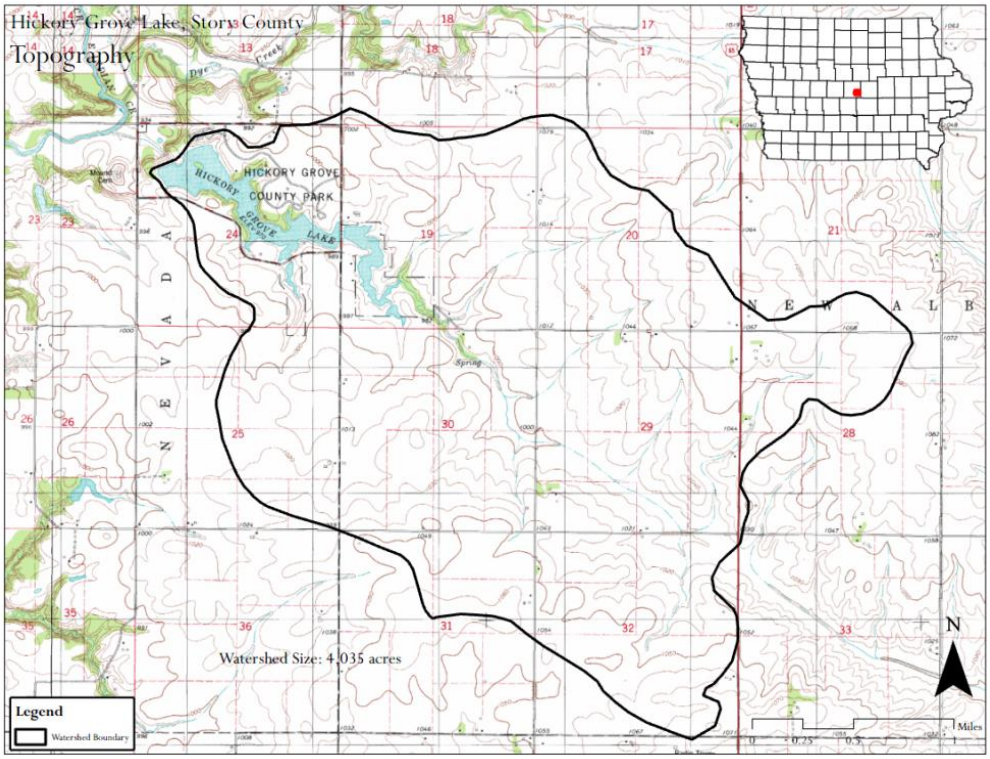


Figure 6. Topography of Hickory Grove Lake Watershed

CLIMATE:

There are three National Weather Service (NWS) COOP stations within 30 miles of Hickory Grove Lake. The daily precipitation data for the above three stations was obtained from Iowa Environmental Mesonet (IEM), IEM also provides the spatially distributed NEXRAD MPE data for the watershed. The average annual precipitation for the years 2000-2011 was 36.87 inches while the average over recorded history is 32.38 inches. The average high temperature in summer is 83 degrees while in winter the average high is 32 degrees.

THREATENED AND ENDANGERED SPECIES AND ENVIRONMENTS:

There are a total of three species in Story County which are listed as federally threatened or engendered that may inhabit the Hickory Grove Lake Watershed. The Indiana Bat is listed as endangered and the Prairie Bush Clover and Western Prairie Fringed Orchid are both listed as threatened.

HISTORICAL LAND USE:

The area which Hickory Grove Park now encompasses was once dominated by woodland and a meandering stream prior to the beginning of lake construction in 1968. The adjacent area which comprises the remainder of the watershed was covered in a tall grass prairie prior to settlement. Figure 7 shows the historical land use in the area as of 1832-1859.

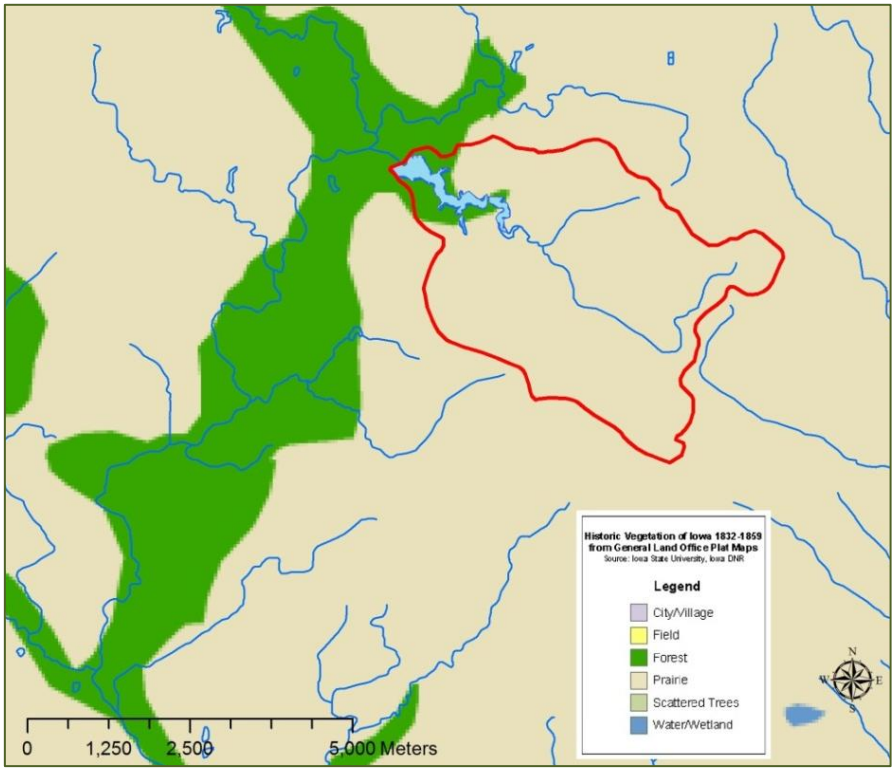


Figure 7. Historical Land Cover 1832-1859

CURRENT LAND USE:

The United States Department of Agriculture, National Agricultural Statistics Service (NASS) cropland data layer shows that land use in the watershed is dominated by row crop agriculture. Most of the agricultural land is in a corn-soybean rotation. Approximately 82% of the watershed is cropland and other land uses in the watershed include pasture, rangeland, timbered areas, wetland, urban areas/roads and small amounts of CRP. Figure 8 shows the land uses in the watershed by percent according to 2009 NASS land use data. Figure 9 shows the spatial land use distribution within the Hickory Grove Lake watershed.

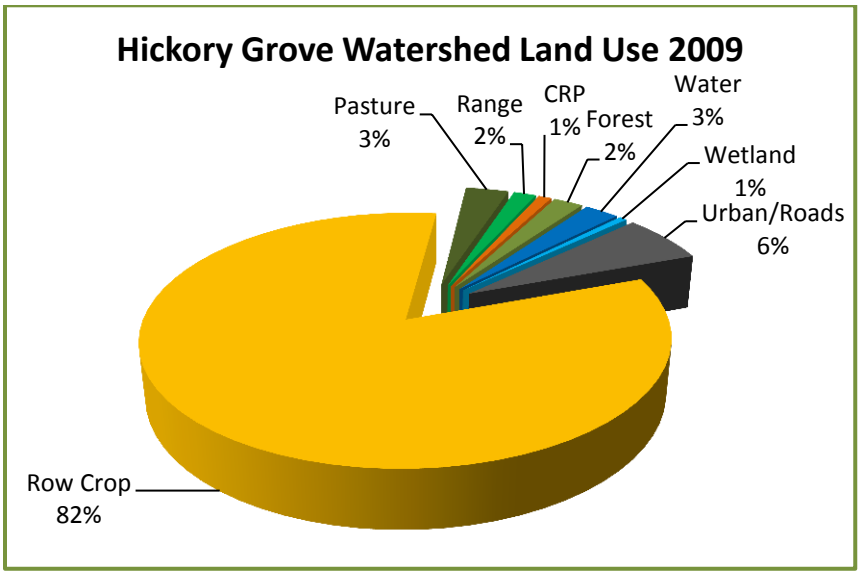


Figure 8. Land use composition of the Hickory Grove Lake Watershed (2009)

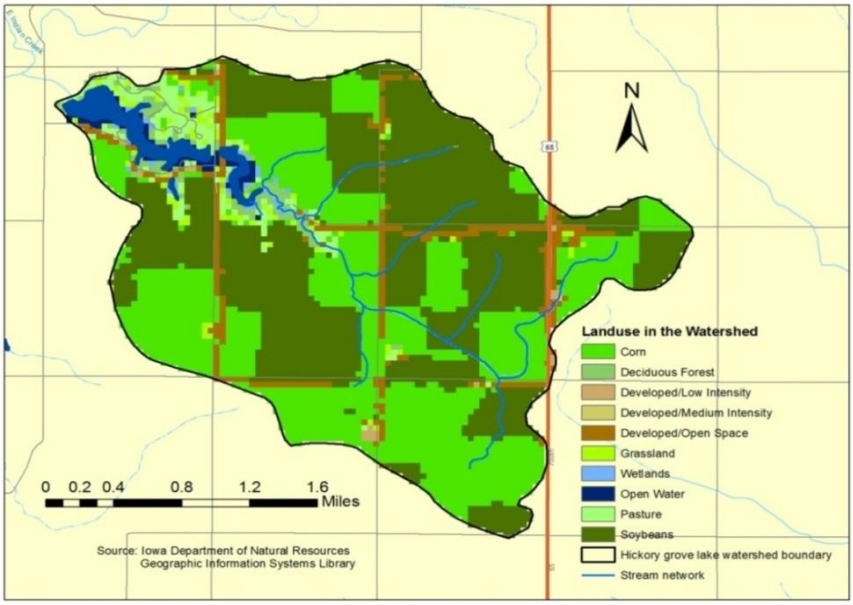


Figure 9. Spatial distribution of land use in Hickory Grove Lake Watershed (2009)

LAKE USAGE AND ECONOMIC VALUE:

Hickory Grove Park is an important recreation destination for central Iowans. According to the Iowa Lakes Valuation project, Hickory Grove Lake attracts between 65,000-75,000 household trips per year. In addition to camping, fishing, swimming and hiking, the park hosts many special events on a yearly basis. Fiscal Year 2009 Community Uses include the Cy-Man Triathlon (1000 visits), Nevada High School Cross Country Invitational (2600 visits), Iowa State University Fishing Club Tournament (100 visits), Environmental Education Field Trips (800 visits), and Youth Camping (444 visits). Other users include American Heritage Girls, Nevada Cross Country Team, Boys and Girls Club, Girl Scouts, Boy Scouts, and Cub Scouts. Since 2009, the Cy-Man Triathlon has been renamed the Hickory Grove Triathlon. In 2011 and 2012 it was necessary for the event to be converted to a duathlon due to elevated bacterial levels at the Hickory Grove Lake beach. The total number of campers totaled 19,000 visits and 56 lodge rentals accounted for an additional 2600 visits in 2009. During 2002-2005, the lake averaged 71,123 visitors annually who spent an average of $6.46 million each year leading to support of 79 jobs and $1.61 million of labor income in the region. Table 6 provides a breakdown of average expenditures by visitors to Hickory Grove Lake.

Table 6. Hickory Grove Lake Tourist Average Spending

Category	Single Day	Multiple Day	Annual Single Day	Annual Multiple Day	Total
Supplies	$17.00	$59.65	$976,211	$817,145	$1,793,357
Eating and Drinking	$9.45	$96.30	$542,659	$1,319,214	$1,861,872
Gas and Car Expenses	$5.10	$29.70	$292,863	$406,860	$699,724
Lodging	$0.60	$69.80	$34,455	$956,190	$990,645
Shopping and Entertainment	$10.85	$36.05	$623,053	$493,849	$1,116,902
Total	$43.00	$291.50	$2,469,241	$3,993,259	$6,462,499

5 POLLUTANTS AND CAUSES

5.1 DESIGNATED USE

According to the Iowa Surface Water Classification, Hickory Grove Lake is designated for A1 -- Primary contact recreation, B(LW) – Aquatic Life and HH – Human Health uses as described below. Hickory Grove Lake was listed on the 2008 303(d) Impaired Waters Listing for elevated indicator bacteria levels and not supporting its A1-Primary contact recreation designated use.

> A1 (Primary Contact Recreation)
> Primary contact recreational use (Class "A1"). Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational boating. Hickory Grove Lake was listed as not supporting this designated use after 5 consecutive samples being above the geometric mean of 126 cfu/ml during the recreational period in 2008.
>
> B(LW) (Aquatic Life)
> Lakes and wetlands (Class "B(LW)"). These are artificial and natural impoundments with hydraulic retention times and other physical and chemical characteristics suitable to maintain a balanced community normally associated with lake-like conditions. Hickory Grove Lake is presently listed as supporting this designated use.
>
> HH (Human Health)
> Human health (Class "HH"). Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvest for human consumption. Hickory Grove Lake is presently listed as supporting this designated use.

In general, Hickory Grove Lake is experiencing event driven water quality problems. Surface runoff related to precipitation events has led to gully erosion, debris and nitrogen spikes immediately after these events. The eastern end of the lake is now sediment filled, limiting boat access. The fishery is healthy; however, carp have destroyed much of the vegetation.

While the lake is impacted by nutrient and sediment inflows during rain events, it is not currently listed as impaired for either of these contaminants as based on existing limnological data. A Water Quality Improvement Plan (WQIP) for Hickory Grove Lake was finalized by ISU and submitted to IDNR in 2012.

5.2 WATER QUALITY DATA

WATER MONITORING REVIEW:

Water quality monitoring first began at Hickory Grove Lake in 1979. A comprehensive Watershed Analysis was conducted in 1989-90 and resulted in a final report presenting watershed and lake assessment data in 1991 through funding contributed by the Division of Soil Conservation-Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, and the U.S. Environmental Protection Agency. Further water quality monitoring at Hickory Grove Lake was conducted by; Iowa State University from 2004-2007 in a statewide survey of Iowa Lakes, a statewide ambient lake monitoring program conducted from 2005-2008 by the University Hygienic Laboratory, an IDNR-county voluntary beach monitoring program from 2006-2008, and the current ongoing monitoring by Iowa State University which began in April 2010, as well as ongoing voluntary beach monitoring by the Story County Conservation Board in cooperation in collaboration with the IDNR.

The Iowa State University Limnology Laboratory has been collecting data on Hickory Grove Lake since 2000 which is made available through the Iowa Lakes Information Report on the Iowa DNR website and a summary is also available in Appendix B of this report.

Current monitoring by Iowa State University in the Hickory Grove Lake Watershed features monitoring for total suspended solids, nutrients and indicator bacteria to estimate the pollutant loads delivered to the lake. A monitoring network was designed to monitor water quality in Hickory Grove Lake Watershed and monitoring equipment was installed in the spring of 2010. Water quality is being monitored at five locations: two locations for subsurface drainflow, one location for both surface runoff and drainflow, one location at the downstream outlet of the lake and one location at the south side of the lake (behind the south boat ramp). The locations of the monitoring sites are shown in Figure 10. Hickory Grove Lake Watershed is being monitored through grab sampling and daily composite samples collected by an ISCO (automated sampler).

Grab samples are collected once a week and the standard operating procedures for grab sample collection can be found in the Hickory Grove Water Quality Improvement Plan QAPP R2 which is on file with the Iowa DNR Lakes Restoration Program as well as Iowa State University. Automated samplers are used to collect daily composite samples and measure flow at the following locations Tile Drain, Large Culvert and North Subwatershed. Grab samples are analyzed for *E. coli*, Total suspended solids, Nitrate, Ammonia, Dissolved Reactive Phosphorus, Total Nitrogen and Total Phosphorus. Samples collected by the ISCO are analyzed for all parameters except *E. coli*. The sampling sites in Hickory Grove Lake Watershed were monitored from April 9, 2010 to July 19, 2012 through grab sampling. Daily composite samples from automated samplers were collected from August 9, 2010 to July 2012. Beginning in 2011, 3-day

composite samples were collected. Samples were not collected during winter (December – February).

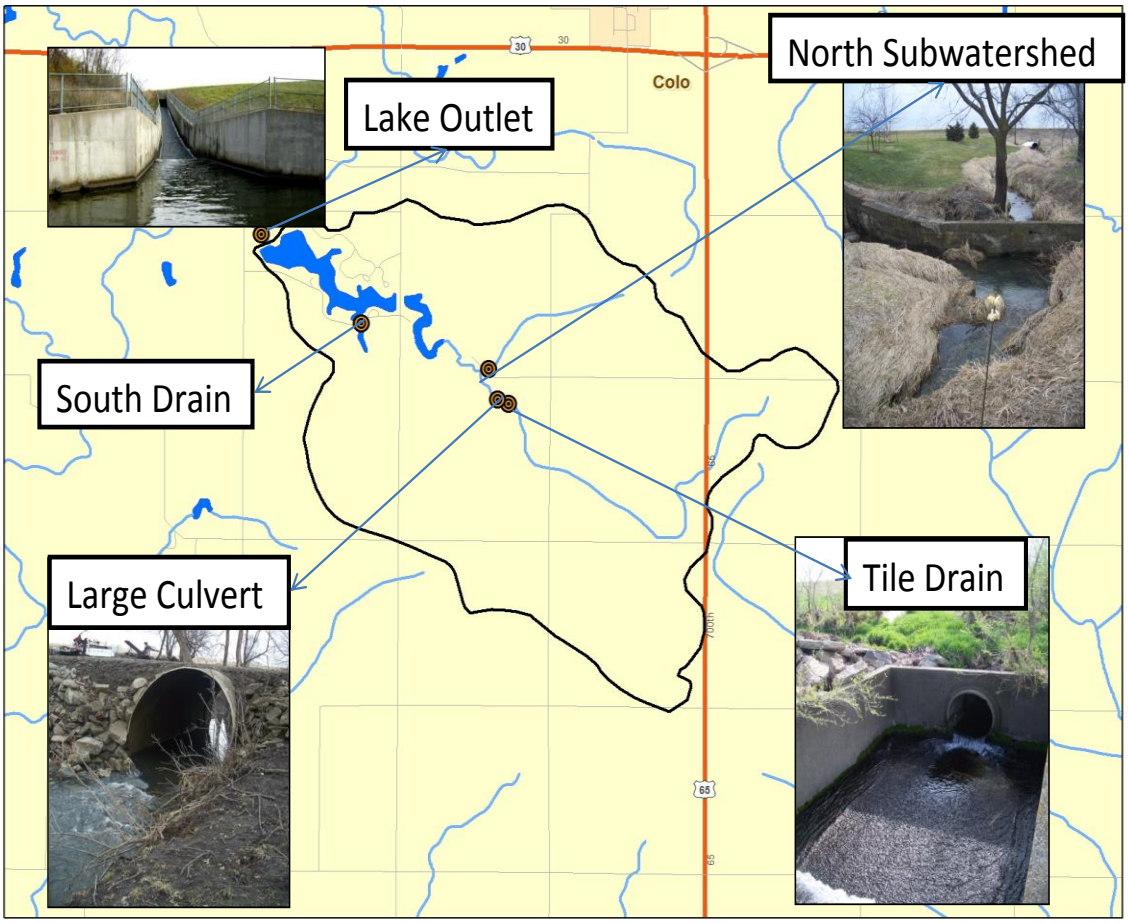


Figure 10. Hickory Grove Lake Watershed Monitoring Network

Spatial sampling for indicator bacteria was also conducted at locations shown in Figure 11 on August 30, 2011 to assess whether the *E. coli* concentrations in the lake are concentrated only at the beaches where geese are observed or the *E. coli* concentrations are distributed over the whole lake. Both water and sediment samples were collected and analyzed for indicator bacteria.

A second spatial sampling was conducted on September 5th, 2012 and water samples were again collected from multiple locations around the lake as shown in Figure 12. Submerged beach sediment samples were also collected from multiple locations on October 8, 2012. Results from the second spatial, and beach sediment samplings are provided in Tables 8 and 9.

Watershed and lake monitoring results were used in developing the Water Quality Improvement Plan for Hickory Grove Lake submitted to the IDNR in late summer 2012.

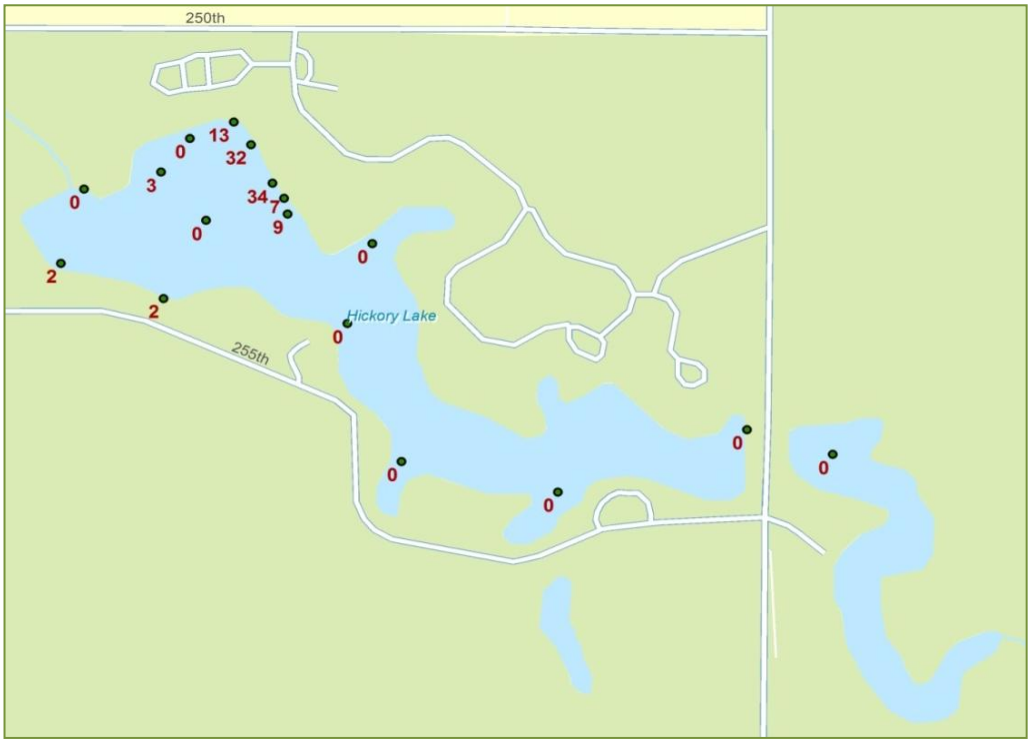


Figure 11. *E. coli* spatial sampling in Hickory Grove Lake on August 30th, 2011

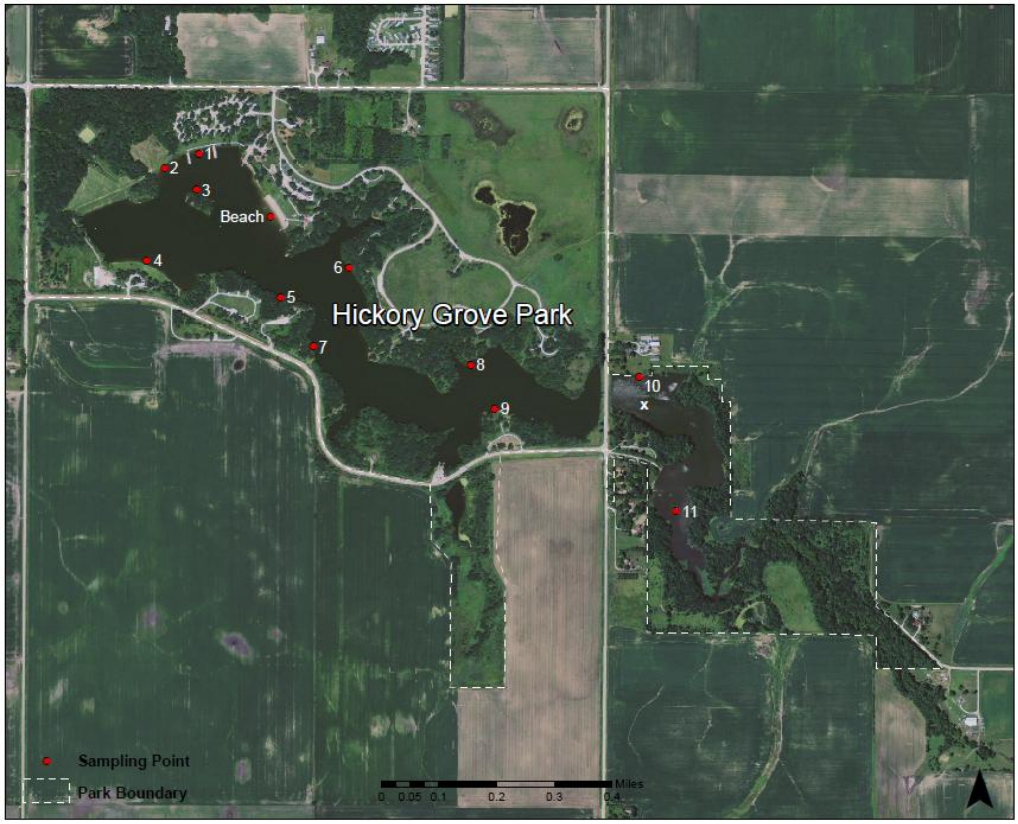


Figure 12. *E. coli* spatial sampling in Hickory Grove Lake on September 5th, 2012

WATERSHED MONITORING AND IMPAIRMENT SUMMARY:

The water quality of Hickory Grove Lake watershed is impacted by non-point pollutant sources including surface runoff, tile drainage discharge, fecal contributions from cattle, geese and other wildlife, and from at least one (or more) leaky septic source(s) as there are 8 unpermitted septic systems within the watershed which have the potential to be draining into the main drainage district tile feeding Hickory Grove Lake.

- Hickory Grove Lake was impaired for bacteria 2 times in 2010 and 5 times in 2011 and 7 times in 2012.
- For three consecutive years, *E. coli* was observed in water samples collected from the tile drain throughout the monitored period (April 2010 to 10 August 2010).
- Spatial sampling was conducted in lake for bacteria on the 30th of Aug 2011. *E. coli* was observed only in samples collected close to the beach.
- Optical Brighteners were present in water samples collected from tile drain on the 10th of Nov 2011, potentially indicating a human source of bacterial contamination.
- Low flows in the watershed in 2011 and 2012 can be attributed to low total annual rainfall (752 mm, and 560 mm, respectively) in Hickory Grove Lake Watershed; in 2010 it was 1124 mm.
- Throughout the monitored period, the north subwatershed had higher nitrate concentrations than other monitoring locations. The average nitrate concentration at the Large Culvert and North Subwatershed locations were 7.94 mg/L and 12.2 mg/L, respectively.
- Similar trends of increasing nitrate concentrations during the spring, peaking in June and receding back to initial concentrations in August were observed at all monitoring locations.
- The average total nitrogen (TN) concentrations at the Tile Drain, Large Culvert and North Subwatershed in 2010 were 6.72 mg/L, 6.26 mg/L, and 11.28 mg/L, respectively, in 2011 the concentrations were 9.59 mg/L, 11.35 mg/L, and 13.02 mg/L, respectively, and in 2012 the concentrations were 11.36 mg/L, 10.6 mg/L, and 15.5 mg/L, respectively.
- The average total phosphorus (TP) concentrations at the Tile Drain, Large Culvert and North Subwatershed in 2010 were 0.07 mg/L, 0.07 mg/L, and 0.04 mg/L, respectively, in 2011 the concentrations were 0.10 mg/L, 0.097 mg/L, and 0.09 mg/L, respectively, and in 2012 the concentrations were 0.19 mg/L, 0.46 mg/L, and 0.22 mg/L, respectively.
- The average TN and TP concentrations at the Tile Drain, Large Culvert, and North Subwatershed were higher in 2012 when compared to 2010 and 2011.

HICKORY GROVE LAKE BEACH MONITORING SUMMARY:

The Hickory Grove Lake beach was monitored for *E. coli* by collaboration between SCCB and IDNR. The *E. coli* impairments at Hickory Grove Lake Beach occurred on two occasions in 2010, five occasions in 2011 and seven occasions in 2012 based on available data shown in Appendix C. The local beach monitoring data by IDNR from 2004 to 2012 showed that *E. coli* impairments typically occurred during the months of July and August. According to SCCB and IDNR beach monitoring, Hickory Grove Lake was impaired on August 22, 2011, however the streams draining to the lake stopped flowing by the end of July, 2011 and therefore no samples were collected at the tile drain after August, 2011. During the months of June-August 2011, there were no significant rainfall events. Similarly, in 2012 there were no samples collected after late July from the Tile Drain location. However, in 2012 six of the seven beach impairments took place during this period and swimming was not recommended at Hickory Grove Lake for approximately two months. The high *E. coli* counts at the lake beach during these periods indicate the likely contribution from the presence of geese at the lake beach. The SCCB Park Ranger living on-site indicated heavy beach usage was taking place by geese during evening hours and other times when beach users were not present.

TSI SUMMARY:

The Hickory Grove Lake water quality data was obtained from the Iowa Lakes Information System, IDNR for 2000-2011. This data is collected and maintained by the Limnology Laboratory at ISU. The lake water quality data is provided in Appendix B of this report. The average total phosphorus concentration in the lake over the monitored period was 0.055 mg/L, the TP concentrations were very high in 2004 and 2010 (0.134 mg/L and 0.08 mg/L, respectively). The average TN concentration in the lake for years 2000-2009 was 7.81 mg/L. The TN:TP ratio provides information on the limiting nutrient for algal growth in the lake. The overall TN:TP ratio in Hickory Grove Lake is 245 (Appendix B); a study by Carlson states that TN:TP ratios greater than 10 indicate phosphorus limitation (Carlson and Simpson, 1996) and a study by Minnesota Pollution Control Agency states that ratios greater than 17 suggest phosphorus limitation (MPCA, 2005). The above values imply that algal growth in Hickory Grove Lake is phosphorus limited.

WATERSHED WATER QUALITY RESULTS DETAILS:

E. coli:

Figure 13 shows the *E. coli* concentrations in samples collected from Hickory Grove Lake Watershed for years 2010 - 2012. *E. coli* was detected in water samples collected from the tile drain throughout the monitoring period. The sampling sites Tile Drain and Large Culvert had relatively higher *E. coli* counts when compared to the other monitoring locations. The peak *E. coli* count (4773 cfu/100 ml) was observed on July 26, 2012 at Tile Drain location.

The *E. coli* counts at the Tile Drain and Large Culvert locations were in agreement throughout the monitoring period -- the intermittent presence of cattle in the stream between Tile Drain and Large Culvert did not appear to increase the *E. coli* counts at the Large Culvert. However, it should be noted that cattle are accessing the stream downstream of the Tile Drain and Large Culvert locations as well. The steep, highly eroded stream banks in the upper reaches may promote higher cattle usage in the lower reaches thus potentially underestimating the influence of livestock access to bacteria loading of the lake. Conversation with the landowner indicated cattle were often using the stream reach downstream of the Large Culvert location and especially in times of hot, dry weather. The locations Lake Outlet and South Drain observed low concentrations for most of the monitored period. The *E. coli* concentrations at the Lake Outlet exceeded the EPA single sample mean standards once in 2010, 4 times in 2011, and none in 2012, whereas the concentrations at the lake beach exceeded the SSM standard twice in 2010, 5 times in 2011, and 7 times in 2012. There was no consistent relation between Lake Outlet and Lake Beach *E. coli* concentrations for the entire monitored period. The peak *E. coli* count (1200 cfu/100 ml) at the Lake Outlet was observed on April 28, 2011 and the Lake Beach observed highest *E. coli* count (12000 cfu/100 ml) on August 27, 2012. The Lake Outlet stopped flowing by third week of July 2012, so no samples were collected in August 2012 at the Lake Outlet when the Lake Beach had high concentrations.

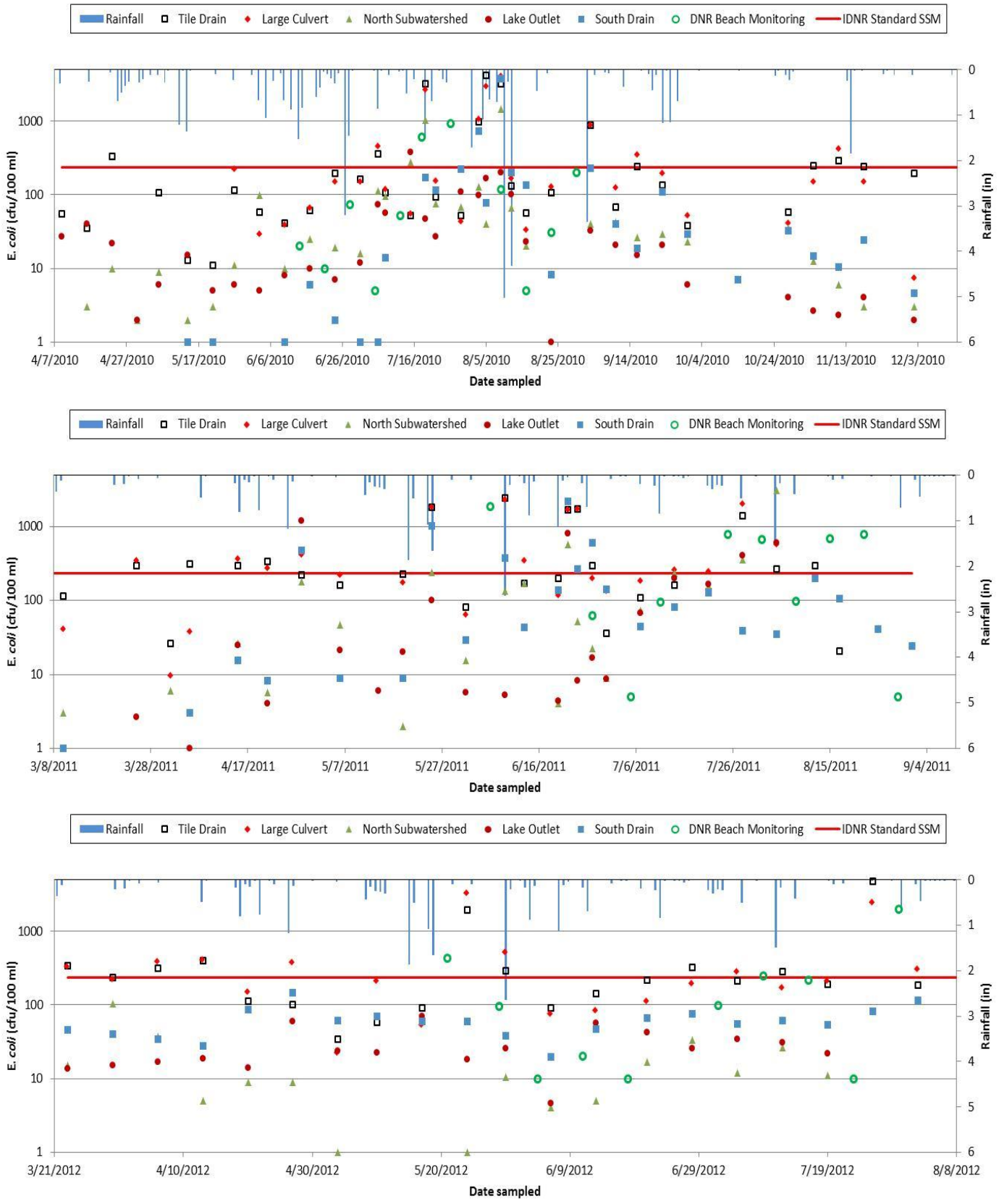


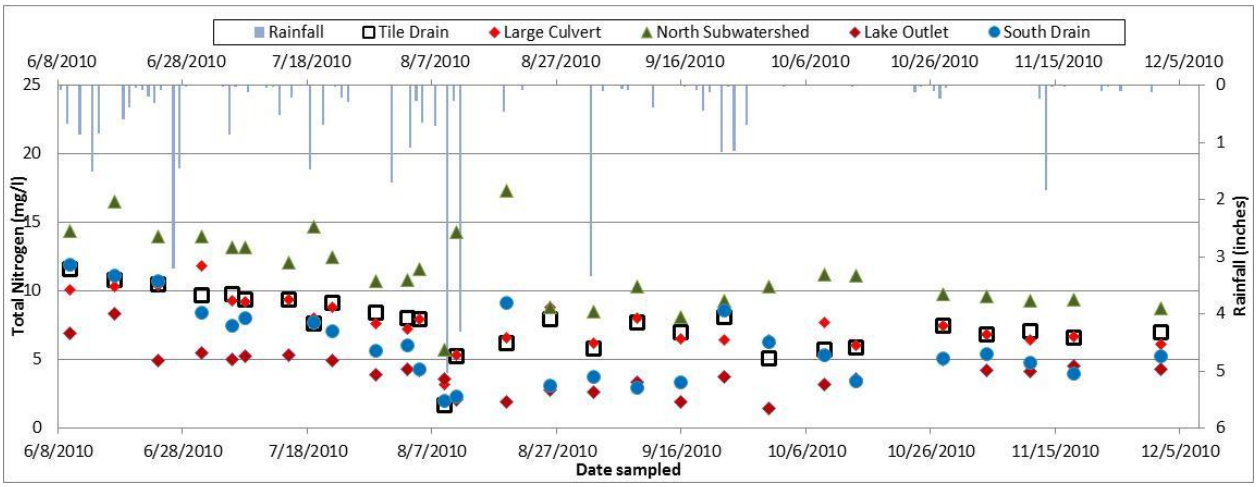
Figure 13. *E. coli* concentration in Hickory Grove Lake Watershed

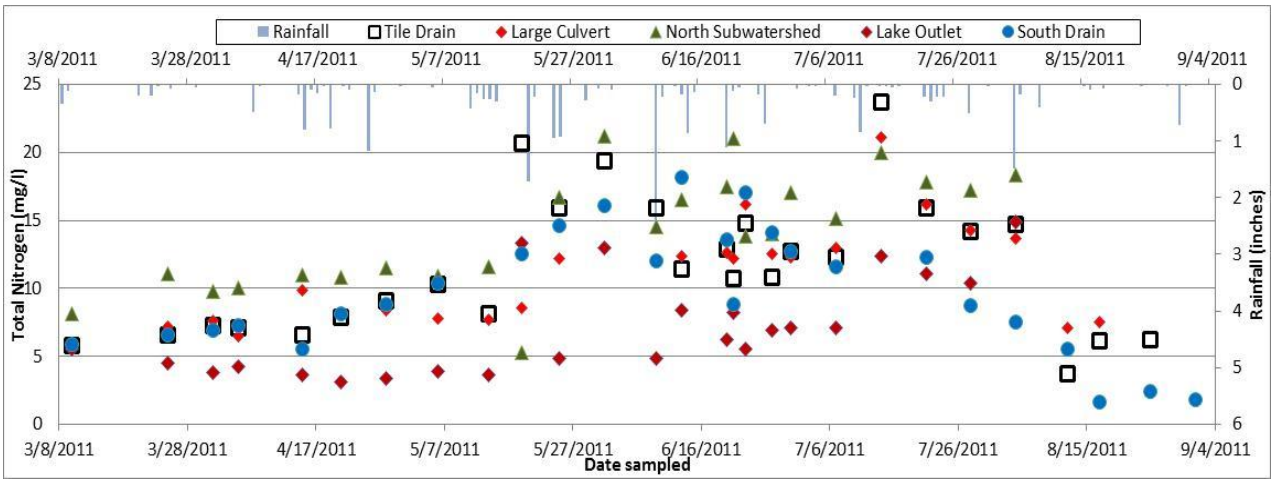
OPTICAL BRIGHTENER SAMPLING:

An optical brightener test, which is used to determine the presence of detergents/fabric softeners in water samples was conducted on water samples collected from the Tile Drain monitoring location on November 10th, 2011 and the test showed the presence of optical brighteners. The presence of both optical brighteners and the *E. coli* in water samples collected from tile drain indicate that there is a potential human fecal contamination. The Optical Brightener test was conducted by IDNR – Water Laboratory and the report is attached to this report in Appendix D.

TOTAL NITROGEN:

Figure 14 shows the total nitrogen (TN) concentrations in the Hickory Grove Lake Watershed for the entire monitored period (2010 – 2012). Throughout the monitored period the TN concentrations at the North Subwatershed were higher compared to other locations. The 3-yr average TN concentration at the Tile Drain, North Subwatershed and Lake Outlet were 9.86 mg/L, 13.38 mg/L, and 5.3 mg/L, respectively. The TN concentrations at the Tile Drain and the Large Culvert were mostly similar throughout the monitored period. The peak TN concentration (23.9 mg/L) was observed at the North Subwatershed location on April 13, 2012. Throughout the monitored period, the TN levels at the Lake Outlet were consistently low. The average TN concentration in 2012 was higher compared to the average TN concentrations in 2010 and 2011 at all monitoring locations.





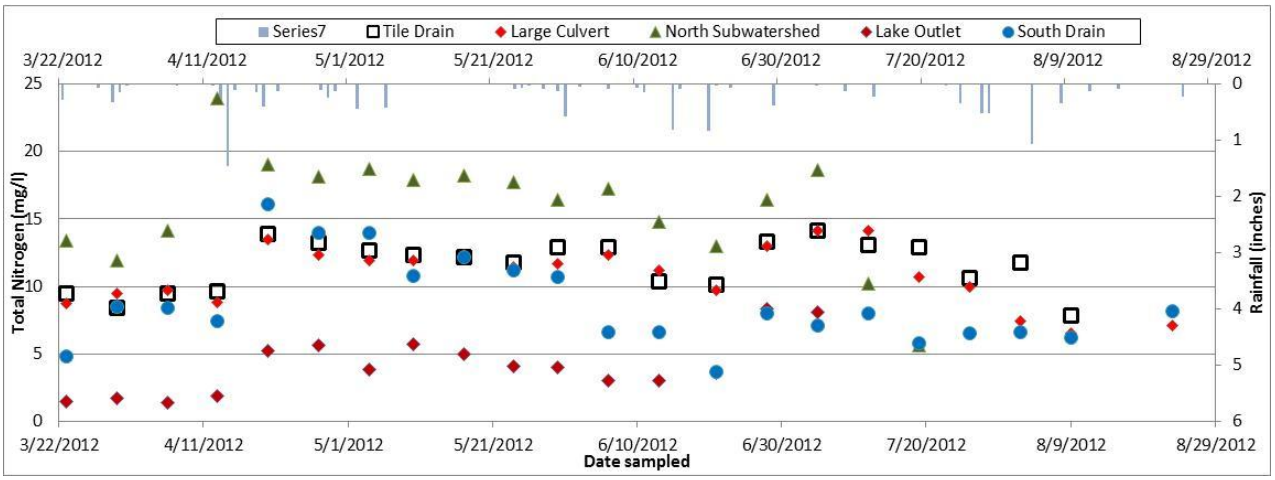


Figure 14. Total Nitrogen concentrations in Hickory Grove Lake Watershed

TOTAL PHOSPHORUS:

The Total Phosphorus (TP) concentrations in the watershed for the entire monitored period are shown in Figure 15. The average TP concentrations in 2012 were higher compared to concentrations in 2010 and 2011 at all monitoring locations. The average TP concentration at the Large Culvert in 2010 was 0.07 mg/L, in 2011 was 0.096 mg/L and in 2012 was 0.45 mg/L. The average TP concentration at the Lake Outlet in 2010 was 0.07 mg/L, in 2011 was 0.13 mg/L and in 2012 was 0.20 mg/L. The TP concentrations at the South Drain monitoring location were consistently higher than other locations throughout the monitored period. The TP concentrations at South Drain were high throughout the monitored period irrespective of the rainfall/runoff events whereas TP concentrations at the other locations were influenced by rainfall/runoff events.

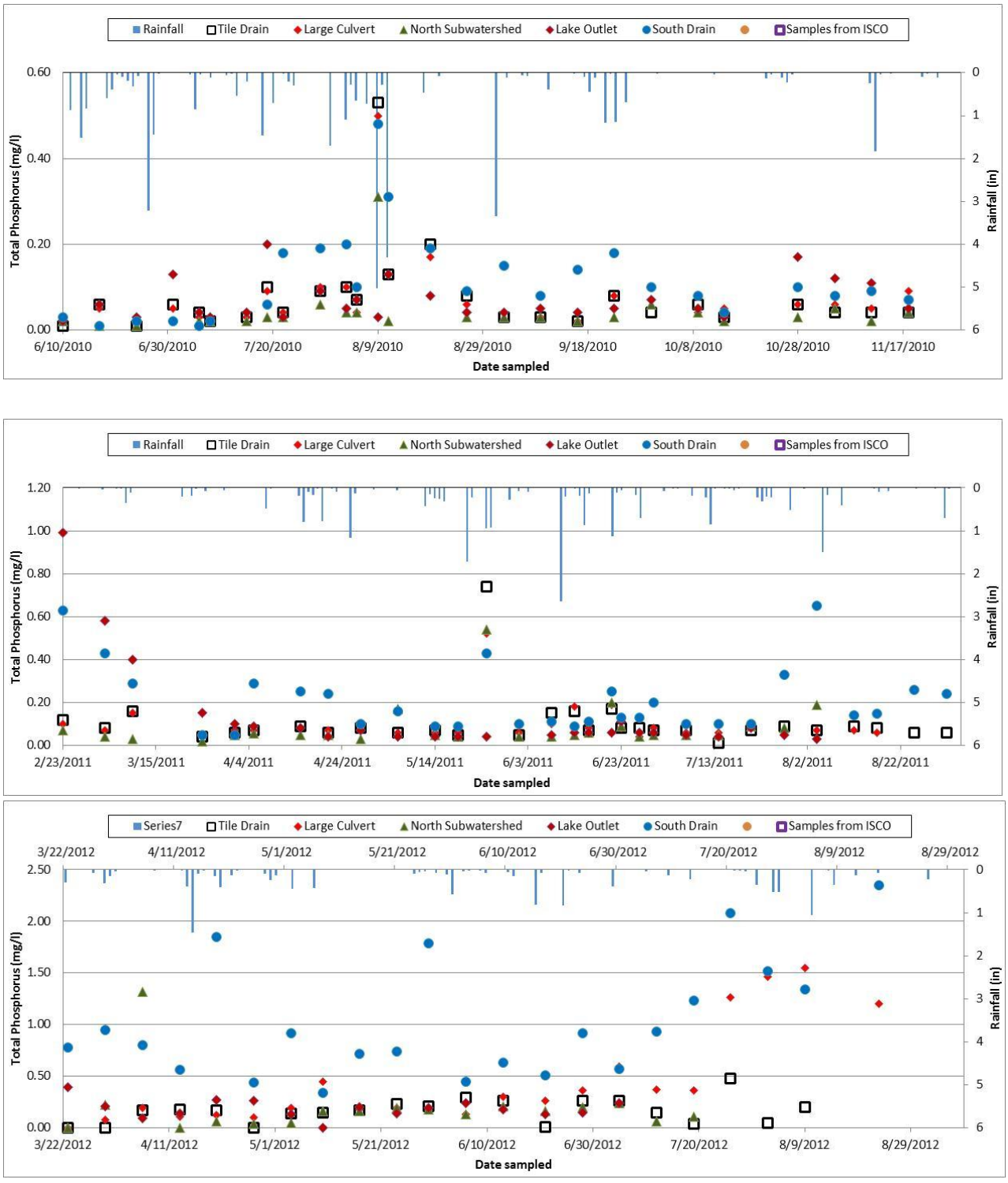


Figure 15. Total Phosphorus concentrations (mg/L) in Hickory Grove Lake Watershed

IN-LAKE WATER QUALITY RESULTS DETAILS:

SPATIAL INDICATOR BACTERIA SAMPLING:

Spatial sampling was conducted in Hickory Grove Lake for *E. coli* on August 30th, 2011 to assess whether the *E. coli* concentrations in the lake are concentrated only at the beaches where geese are primarily observed or if the *E. coli* concentrations are distributed over the whole lake. The IDNR monitors the lake beach every week during the recreational period (April – October) and it is necessary to identify whether the *E. coli* was observed only at the beaches or in the whole lake. Figures 10 (and 11) show the spatial sampling conducted in the Hickory Grove Lake for *E. coli*. The bacteria were detected only in the samples collected at the beach where the *E. coli* counts observed were less than 35 cfu/100 ml. The beach monitoring by IDNR showed that Hickory Grove Lake beach was impaired on August 22, 2011 due to high bacteria counts (790 MPN/100 ml), whereas by the next week August 29, 2011 only 5 MPN/100 ml (Figure 11) were detected. Sediment samples were also collected from the lake for *E. coli* at six locations and *E. coli* was detected at only two locations in bed sediments. The sediment sample collected at the beach had 88 cfu/100 ml whereas the water sample collected at the same location had 9 cfu/100 ml. The sediment samples collected from the Sediment Basin (East end of the lake) had zero colony forming units.

A second spatial sampling was performed on September 5, 2012 by SCCB in collaboration with IDNR. Results of the second spatial sampling at locations shown previously in Figure 11 are presented in Table 8. Bacteria concentrations were above water quality standards in 4 locations at the north end of the lake where the beach is located. The highest readings were again observed at the beach location. At sites 1, 2 and 4 indicator bacteria were also observed above the single sample maximum of 235 cfu/100 ml. Discussion with park staff indicated that geese had been frequently using the beach and island site close to the time of sampling. The week prior to sampling, dense algae blooms were noted as being present at the beach, as well as in the small bays and near the spillway at the north end of the lake.

Table 8. *E. coli* Concentration for September 5, 2012 Spatial Sampling at Hickory Grove Lake

Collection Site	Concentration (MPN/100ml)
Beach Composite	1300
1	510
2	340
3	190
4	240
5	41
6	86
7	41
8	10
9	20
10	31
11	74

Additional sediment samples were collected from the beach on October 8, 2012. A grid pattern was used to collect the composite sediment samples from 9 locations and out to a maximum distance of 30 feet from shore. Water depth at the farthest sampling location from shore reached approximately 3 feet. Results shown in Table 9 indicate that high levels of indicator bacteria were present within the submerged beach sediments. Levels of indicator bacteria did not necessarily decrease with distance from the shoreline.

Table 9. *E. coli* concentration in beach sediments at Hickory Grove Lake on October 8, 2012

ID	*E. coli* (cfu/g)
1	4
2	37
3	55
4	27
5	19
6	58
7	115
8	24
9	15

Additional sediment samples will be taken at the beach in spring as soon as winter ice melts and before migratory geese reappear to determine if overwintering of indicator bacteria is taking place. While survival over winter is not probable, a complete investigation of beach sediment/sand is warranted.

BEACH MONITORING:

Results from ongoing beach monitoring from 2004 to 2012 are shown in Table 10. *E. coli* levels at the beach at Hickory Grove Lake have exceeded the geometric mean of 126 cfu/100ml greater than five times in 2008, 2011 and in 2012. The single sample maximum of 235 cfu/100ml was also exceeded five times in 2011 and seven times in 2012. This monitoring indicates an increase in *E. coli* levels at Hickory Grove Lake's beach which have the potential to pose a significant health risk to people using the beach area.

Table 10. *E. coli* levels at Hickory Grove Lake beach 2004 to 2012.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
# Geometric mean violations	1	1	0	0	3	0	0	6	5
# Detects above the single sample maximum of 235 cfu/100 ml	1	2	3	0	2	2	2	5	7

IDNR requirements for bacteria sampling state that during each 3 month period a total of five samples must be taken which are spaced evenly over one calendar month with a minimum of two days between each sample and that no more than two samples are collected in a period of seven consecutive days. During the recreation season (March 15 – November 15th), no greater than 10% of water samples collected shall exceed the single sample maximum of 235 cfu/100 ml. At Hickory Grove Lake 21% of the samples taken between June 2, 2004 and August 27, 2012 have exceeded the single sample maximum. In both 2011 and 2012, 50% of the samples taken were above this limit. A full *E. coli* monitoring report for Hickory Grove Lake is included in Appendix C.

TSI RESULTS:

Carlson Trophic State Index (TSI) is defined as the total weight of living biological material (biomass) at a specific location and time (Carlson, 1977). Three variables such as Chlorophyll-a, Secchi depth, and total phosphorus can be used to calculate TSI or algal biomass. Of the three indices, chlorophyll-a is the better predictor of algal biomass; Table 11 shows the TSI values and their corresponding chlorophyll-a, Secchi depths, total phosphorus concentration ranges and the lake attributes.

Table 11. TSI values and the lake attributes (Carlson and Simpson, 1996)

TSI	Chlorophyll-a (µg/L)	Secchi Depth (m)	TP (µg/L)	Attributes	Water Supply	Fisheries & Recreation
<30	<0.95	>8	<6	**Oligotrophy:** Clear water, oxygen throughout the year in the hypolimnion	Water may be suitable for an unfiltered water supply.	Salmonid fisheries dominate
30-40	0.95-2.6	8-4	6-12	Hypolimnia of shallower lakes may become anoxic		Salmonid fisheries in deep lakes only
40-50	2.6-7.3	4-2	12-24	**Mesotrophy:** Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration.	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3-20	2-1	24-48	**Eutrophy:** Anoxic hypolimnia, macrophyte problems possible		Warm-water fisheries only. Bass may dominate.
60-70	20-56	0.5-1	48-96	Blue-green algae dominate, algal scums and macrophyte problems	Episodes of severe taste and odor possible.	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56-155	0.25-0.5	96-192	**Hypereutrophy:** (light limited productivity). Dense algae and macrophytes		
>80	>155	<0.25	192-384	Algal scums, few macrophytes		Rough fish dominate; summer fish kills possible

The Carlson TSI values were used to evaluate the relationships between TP, chlorophyll-a and Secchi depth in Hickory Grove Lake. The average TSI values estimated from chlorophyll-a, Secchi depth and TP for the monitored period is shown in Table 12. Based on the ratings by Carlson and Simpson (1996), the TSI scores suggest that Hickory Grove Lake is classified as eutrophic. The last three years (2009-2011) of lake monitoring show increasing TP, chlorophyll-a, and Secchi depth calculated TSI values. The impairment threshold for chlorophyll-a and secchi depth calculated TSI is 65 or greater.

Table 12. Average TSI values in Hickory Grove Lake (based on 2000-2011 averages)

	Chlorophyll-a	Secchi	TP
Average TSI	57	54	60
Average TSI for years 2009-2011	63	61	64

Figure 16 shows the TSI values of chlorophyll-a, Secchi depth and TP for the monitored period in Hickory Grove Lake (2000 to 2011). The general trend of TSI values is that Secchi depth TSI values are lower than TSI values for TP and chlorophyll-a.

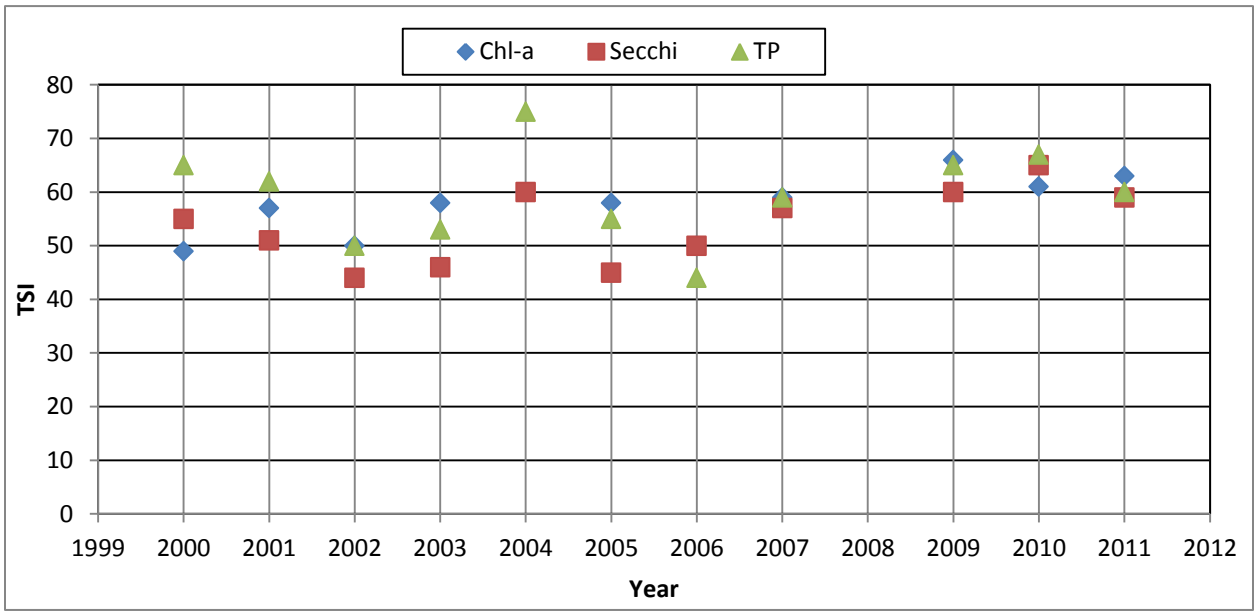


Figure 16. Average TSI values in Hickory Grove Lake

The TSI values of the last three years of monitoring (2009-2011) indicate dominance of blue green algae in the lake. Carlson and Simpson (1996) have developed a method to interpret the condition of the lake based on the deviations between TSI values for chlorophyll-a, Secchi depth and TP. If TSI (TP) is higher than TSI (Chl-a), it suggests that there are limiting factors to algal growth other than TP. If TSI (Chl-a) is lower than TSI (SD) it represents the transparency is affected by the non-algal turbidity and whereas if the TSI (Chl-a) is greater than TSI (SD) then transparency is affected by the large particles, rather than fine clay particles. Based on the quadrant chart developed by Carlson and Simpson (1996), the TSI values of Hickory Grove Lake indicate high zooplankton populations, water clarity influenced by larger soil particles.

The average TP concentration observed in the lake for the last 10 years (2001-2011) was 54.9 µg/L, and the highest TP concentration of 80.6 µg/L was observed in 2010. The average nitrate concentration in the lake for the last 10 years (2001-2011) was 6.21 mg/L. The lake average nitrate concentration in 2001 was 11.99 mg/L exceeding the EPA drinking water quality standard.

Historically, Hickory Grove Lake has been listed as one of the top 12 lakes in Iowa for water clarity (once a popular scuba destination). Secchi depth in 2005, 2006, and 2007 was 2.9m, 2.0m and 1.25 m, respectively. The average Secchi disk depth for the last three years (2009-

2011) was 1.02 m. Secchi results indicate a recent decline in water clarity at Hickory Grove Lake. While the current TSI value for Hickory Grove Lake is below impairment status, the lake does suffer from frequent expansive algae blooms, especially during late summer months.

6 IDENTIFY POLLUTANT SOURCES

6.1 ASSESSMENTS

GOOSE ASSESSMENT:

The Story County Conservation maintenance shop, in addition to the park ranger residence, is located within Hickory Grove Park, thus staff are able to provide estimates of geese using the lake (Table 13). Park staff estimate that as of 2012 there were approximately 50 resident geese using Hickory Grove Lake throughout the year. During the fall and winter season this number increases to between 150 and 200 geese. Additionally, it is common that between 1,200 and 1,500 migrant geese stop at the lake during winter migration using the lake for a period of one to two months. These large numbers of migratory geese revisit the lake in spring as early as March.

Resident geese routinely loaf on the beach and the hillside immediately behind the beach, as well as the hillside below the park's campground. Geese are primarily present at these locations in the absence of park users and often during evening hours. However, it is becoming common to see them foraging throughout the park during daylight hours and geese are becoming seemingly more comfortable in the presence of park users. Both migratory and resident geese congregate heavily around the island location in the center of the main basin of the lake. This area is likely a preferential nesting site as being isolated from predators and disturbance.

Table 13. Estimated Monthly Geese Numbers at Hickory Grove Lake

Month	Estimated Geese Numbers
Jan	500
Feb	100
Mar	100
Apr	100
May	50
Jun	50
Jul	50
Aug	50
Sep	100
Oct	200
Nov	1200
Dec	1500

SEPTIC SYSTEM ASSESSMENT:

An assessment of permitted septic systems in the watershed was conducted by the Story County Environmental Health Department (Figure 16). Results showed that there are a total of eight unpermitted septic systems within the watershed and two immediately outside the watershed having the potential to be contributing to bacterial concentrations present at the Tile Drain location. The concurrent positive optical brightener test, described previously in this report, and presence of elevated levels of indicator bacteria at this monitoring location support the likelihood that at least one or more septic systems is contributing to degradation of water entering Hickory Grove Lake. Total estimated bacteria and phosphorous loading from unpermitted septic sources is 4.87 x 10^{12} cfu per year and 28 pounds per year, respectively (Estimated load reductions for bacteria and total phosphorus assume a 50% failure rate and that all *E. coli* and total phosphorus generated by the households are deposited directly in the tile drain).

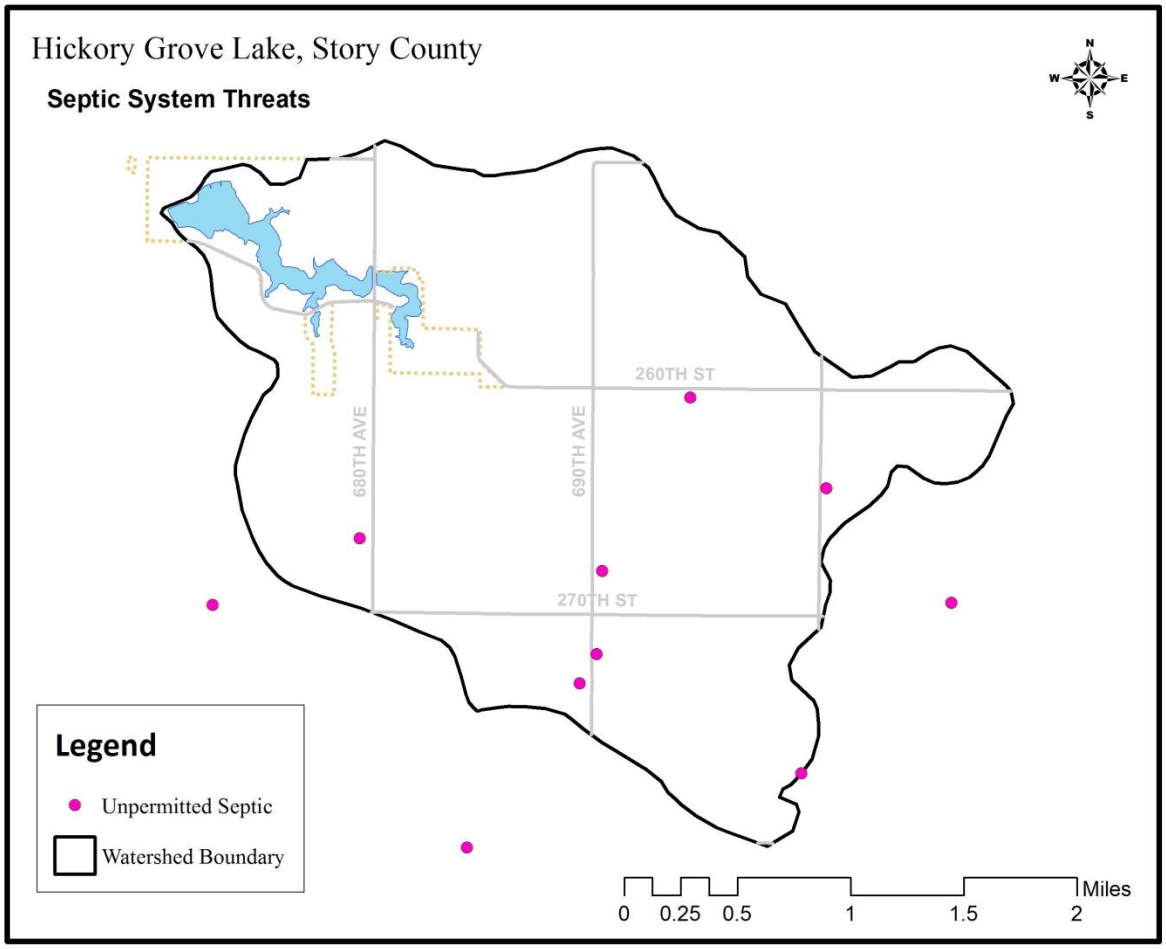


Figure 16. Septic System Threat Assessment for Hickory Grove Lake

LIVESTOCK ASSESSMENT:

Livestock assessments were completed through personal communications with landowners in the watershed. There are a total of five sites having livestock in the watershed (Figure 17). Between ten and twelve cattle are present at any given time and granted full access to the 1,400 foot stream reach beginning at the Tile Drain monitoring location and ending at the southeastern-most boundary of Hickory Grove County Park. Cattle access to the stream in this location has severely accelerated streambank erosion and promoted the growth of invasive tree species in addition to being a source of nutrients and bacteria to Hickory Grove Lake. The approximately 12 acre pasture area is the primary grazing source while the stream is used as the primary watering location. Further livestock present in the watershed at the four other locations is limited to less than a dozen laying hens at each of the sites, with one location also having between fifty and seventy-five ewes for approximately three months of the year. Cattle exclusion will eliminate direct bacteria loading to the stream by 2.63 x 10^{10} *E. coli* organisms per day and TP loading by 28 pounds per year. Additional sediment, total phosphorus and bacteria reduction will be achieved by mitigating pasture runoff through implementation of a rotational grazing plan and riparian buffer installation.

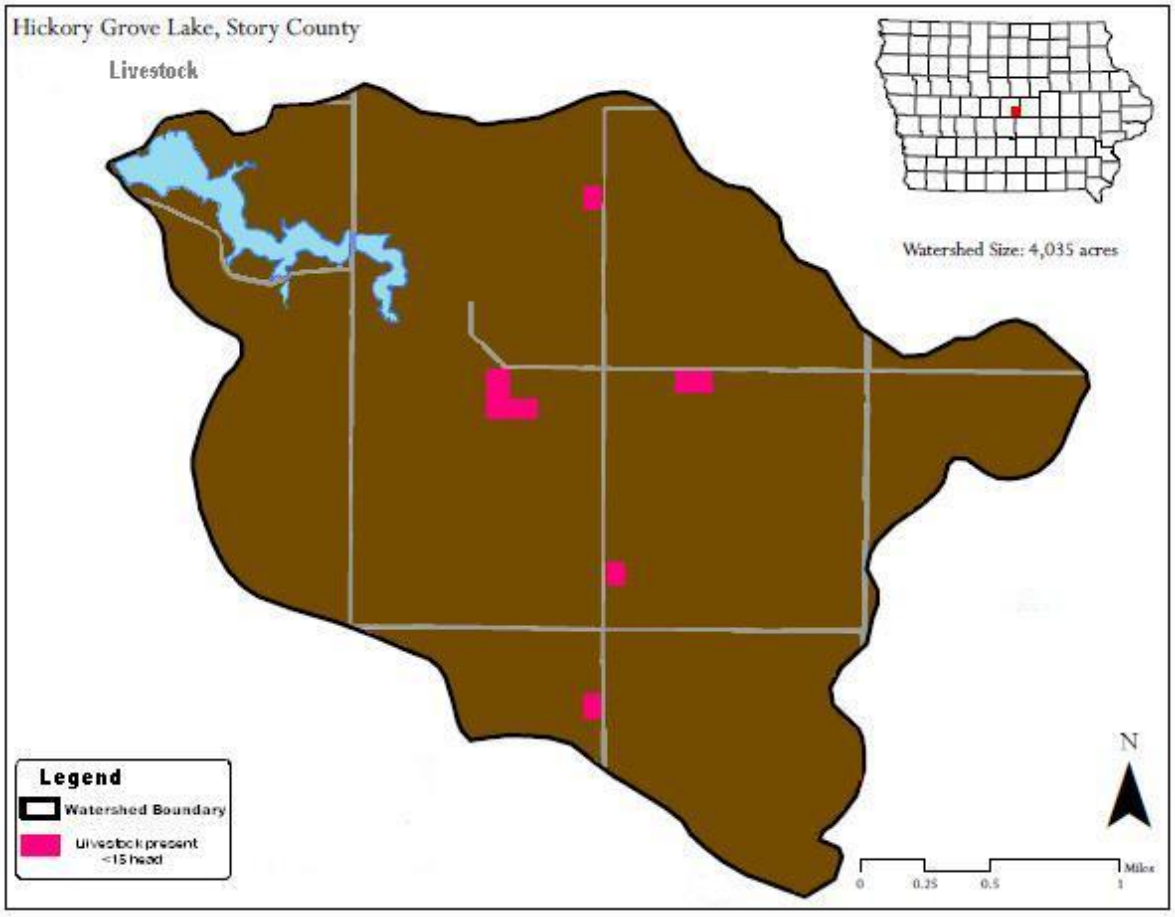


Figure 17. Livestock Assessment for Hickory Grove Lake Watershed

SHEET AND RILL EROSION ASSESSMENT:

The sheet and rill erosion in the Hickory Grove Lake was estimated by Iowa DNR and is shown in Figure 18. The land use and soils data in the watershed were used to calculate the sheet & rill erosion. LiDAR data was used to determine the slopes and slope lengths in the watershed. The sheet & rill erosion in the watershed is distributed throughout the watershed except for some fields in the southern part of the watershed. The sheet & rill erosion from the field at the east of the intersection of 270th St and 690th Ave is eroding at the rate of 5.01 – 37.78 tons per acre per year. The total sheet & rill erosion in the watershed is 6,295 tons per year.

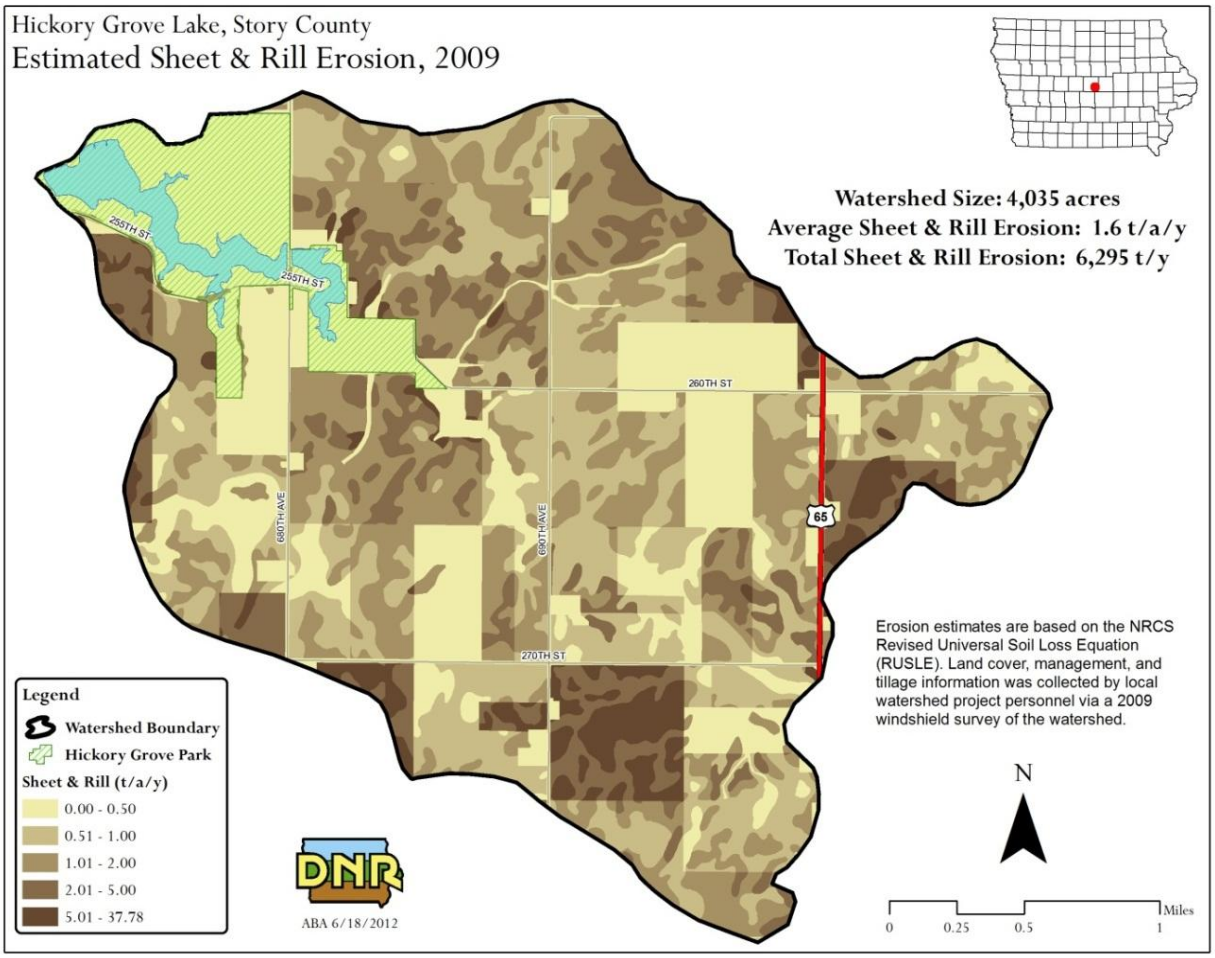


Figure 18. Estimated Sheet and Rill Erosion for the Hickory Grove Lake Watershed (2009)

SEDIMENT DELIVERY ASSESSMENT:

The total sediment load delivered to the Hickory Grove Lake from the watershed was estimated by Iowa DNR and is shown in Figure 19. The sediment delivery to the lake was estimated using NRCS Revised Universal Soil Loss Equation (RUSLE). Average sediment delivery in the watershed is 0.08 tons per acre per year. With a sediment delivery ratio of 4.9%, the total sediment delivered to the lake is 306 tons per year. Areas where soil erosion is more likely to occur are near the east end of the lake. A field/cropland at the intersection of 270th st and 690th Ave is losing soil at higher rates. The management practices such as grassed waterways in the watershed were not considered in the sediment load calculation (Personal Communication: Andy Asell), which could impact the loads delivered to the lake.

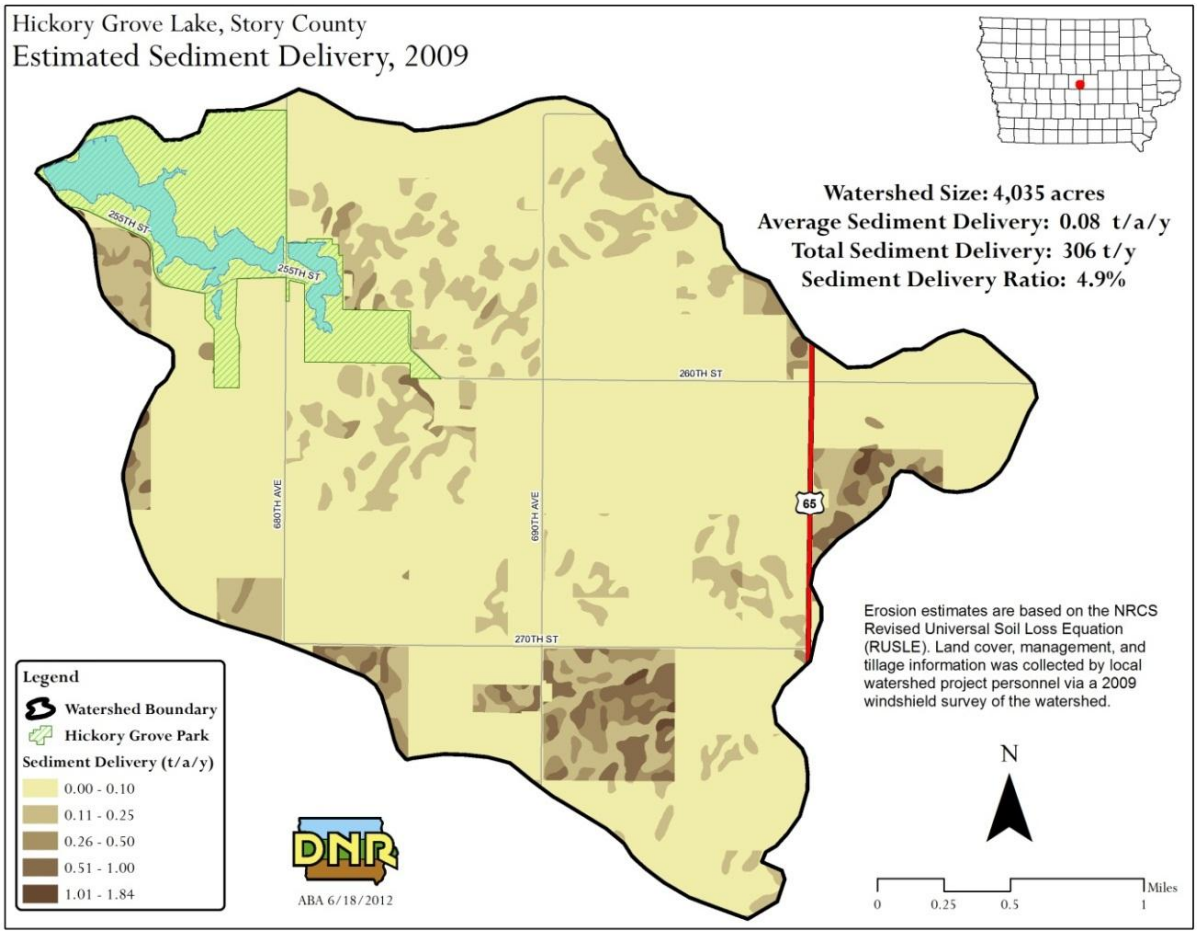


Figure 19. Estimated Sediment Delivery for the Hickory Grove Lake Watershed (2009)

STREAM ASSESSMENT:

RASCAL stream and gully assessments were conducted by the NRCS in cooperation with IDNR in 2010. Results of the stream assessment are presented in Figure 20. Streambank erosion is a significant source of sediment and phosphorous loading to Hickory Grove Lake with a total of 6,384 feet of eroding streambanks needing to be addressed. Total streambank erosion in the watershed was found to be 496 tons per year. Cattle are granted full access to 1,400 feet of the stream, as described in the livestock assessment above, accelerating streambank erosion along this reach. Stabilizing the streambanks in the watershed and eliminating this source of erosion and sediment loading will reduce TP loading by 794 lbs per year.

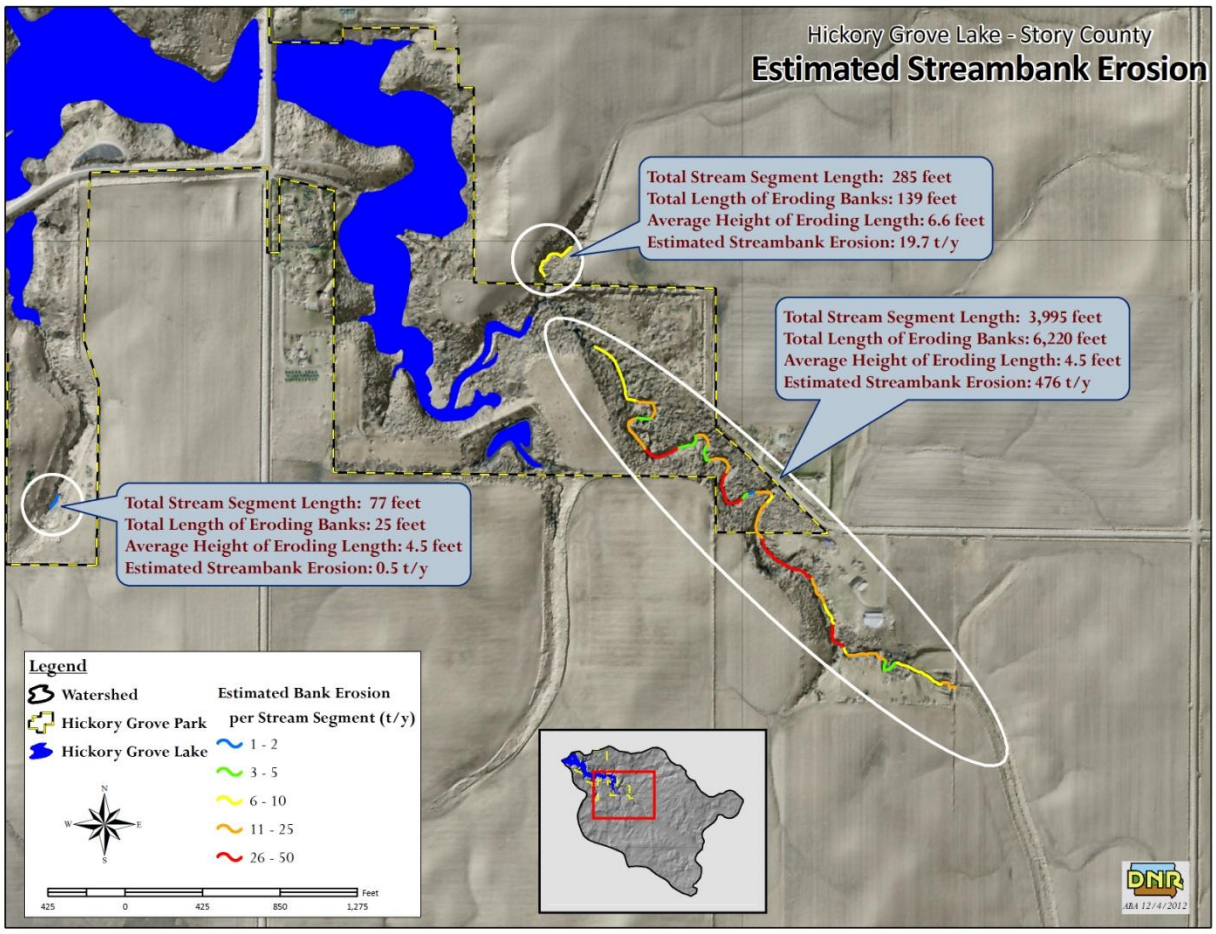


Figure 20. RASCAL Stream Assessment Summary for Hickory Grove Lake Watershed

GULLY EROSION ASSESSMENT:

Figure 21 shows results of the gully erosion assessment in Hickory Grove Lake Watershed. Gully assessment indicated total erosion from gullies, headcuts and knickpoints was 179 tons per year. Severe gully erosion is taking place in the watershed as shown to both the southeast and north of the east basin of the lake. Additional sediment basins were constructed south of the southern boat ramp in 1970 and south of the eastern game area in 1971 which are also now sediment filled. Several smaller to moderately sized ephemeral gullies are present within Hickory Grove Park which are additional sources of sediment and phosphorus loading to the lake. Gully stabilization has the potential to reduce TP loading by approximately 287 pounds per year.

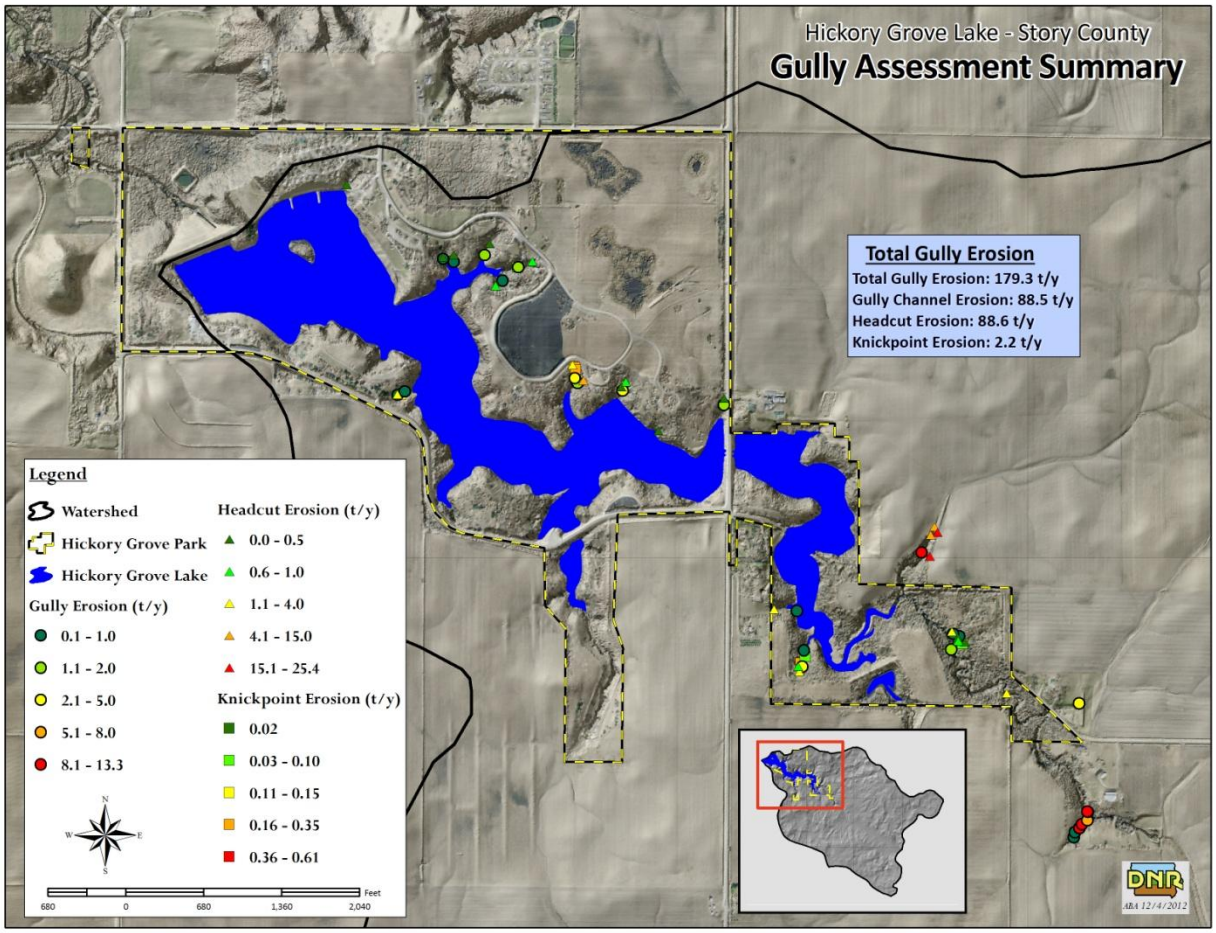


Figure 21. Gully Assessment Summary for the Hickory Grove Lake Watershed

SHORELINE STABILIZATION ASSESSMENT:

Shoreline protection at Hickory Grove Lake began in 2004 with rip-rap installations occurring in 2004, 2005 and 2006. A shoreline assessment of Hickory Grove Lake was conducted in 2010 to identify areas where bank and shoreline erosion is still occurring around the perimeter of the lake. Several areas were identified as needing additional shoreline protection to prevent further sedimentation and phosphorus loading to the lake. Figure 22 shows areas where additional protection is needed on approximately 2,000 feet of shoreline. At an average bank height of 3.5 feet and assuming an erosion rate of 0.3 feet/year, the estimated sediment delivery due to shoreline erosion is approximately 95 tons per year. Addressing these areas will reduce direct TP loading by 151 pounds per year.

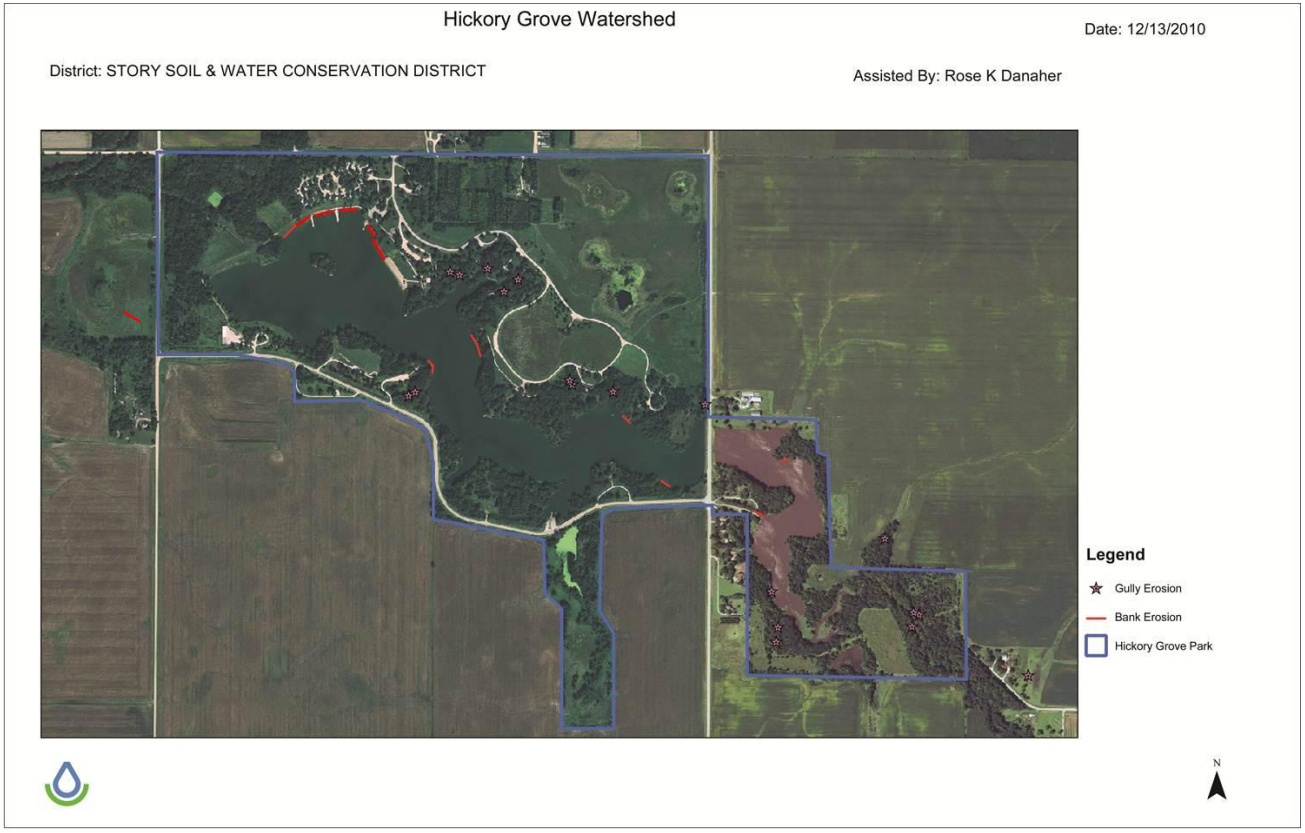


Figure 22. Shoreline stabilizations needed in Hickory Grove Lake Park

FISHERIES ASSESSMENT:

The fishery in Hickory Grove continues to look very good and provides a quality fishery for central Iowa anglers. Sampling in 2012 showed a quality bluegill population with sizes ranging from 3 to 9 inches. The average size was 7.5 to 8 inches. Both black and white crappie are present in fair numbers and respectable sizes. The black crappies ranged from 6 to 12.5 inches with two predominant year classes around 8 and 10.5 inches. The white crappies ranged from 5 to 13 inches with most being 8 to 10 inches. Largemouth bass were not sampled in large numbers during 2012 due to clear water in the spring at the time of the sample, making them less susceptible to electrofishing. Largemouth bass were sampled from 10.5 to 13.5 inches. Historically, Hickory Grove has been a quality bass fishery and should continue to be. Anglers were observed catching numerous bass with some 18 plus inch fish. Channel catfish are very abundant with sizes from 13 to over 30 inches. Most catfish fall between 17 and 22 inches. The only undesirable species sampled was common carp. A population of large adult common carp is present which have destroyed the majority of the vegetation in Hickory Grove Lake.

6.2 POLLUTANT LOAD ALLOCATIONS

The following section of the report quantifies the bacteria and nutrient load inputs to the lake from the watershed and the required load reductions to meet the desired water quality in the lake. The Federal Clean Water Act requires all states to identify impaired waterbodies and develop a Total Maximum Daily Load. A TMDL is the maximum amount of pollutant load that a waterbody can receive and still meet its designated use. TMDL is the sum of all loads from point sources, non-point sources and a margin of safety.

TMDL = WLA + LA + MOS

WLA = Waste Load Allocation (Point sources)
LA = Load Allocation (Non-point sources)
MOS = Margin of Safety (To account for any uncertainty)

BACTERIA LOADS:

The Hickory Grove Lake watershed has livestock in the watershed at five locations. Ten to twelve head of cattle at the Large Culvert monitoring location have direct access to 1,450 feet of stream feeding Hickory Grove Lake. A watershed assessment by the Story County Environmental Health Department has shown that there are 8 unpermitted septic systems in the watershed, and 2 immediately outside the watershed with potential to be contributing to bacteria loading at the Large Culvert location. Poultry manure is being applied on a large field in the north sub-watershed every two to three years (Personal Communication, Aaron Andrews). Other sources

such as resident wildlife and bird migration during spring and fall also are likely contributing to elevated *E. coli* levels in Hickory Grove Lake.

When Iowa lake beaches are listed on the 303d list due to elevated concentrations of fecal indicator bacteria, the typical TMDL approach is to allocate load reductions at the beach to both migratory and resident waterfowl and other point and nonpoint sources contributing to the lake from the watershed. A watershed modeling approach is advantageous in that during the implementation phase, the model can be used to target areas contributing higher loads, and if future impairments are identified the model can likely be applied to other contaminants. However, making the connection between elevated bacteria levels at a beach and watershed land management practices can be challenging. Common watershed scale models used to set TMDLs have limited capabilities to predict bacteria transport, and spatially distributed lake bacteria models that could be used to predict the combined impacts of watershed loads and beach loads to identify hot spots within the lake do not exist.

Bacterial concentrations at the lake inlet are likely not representative of the concentrations at the beach unless the beach is spatially located very close to the watershed inlet point. Other instances in which beach waters may be heavily influenced by watershed conditions are when beach waters directly receive bacteria loads from runoff from areas of the watershed where bacteria are present. Allocating loads back to watershed stakeholders in the case of beach bacteria impairments should be applied with caution. In-lake processes contributing to bacterial removal include decay via natural death, predation, damage by UV radiation, sedimentation, and interactions with plants and algae. Further, resuspension of bacteria laden beach sands during recreation or due to wave action can act as a source of bacteria to the local beach waters. The following sections provide an overview of the monitoring and modeling used to set bacteria load reductions at the beach in the Hickory Grove Lake. It is important to note that the Hickory Grove Lake watershed contains no point sources and is a small watershed dominated by agricultural landuse.

COMPARISON OF *E. COLI* CONCENTRATIONS AT TILE DRAIN TO LAKE BEACH:

Figure 23 shows the *E. coli* concentrations measured at the drainage district outlet (Tile Drain monitoring location) and at the lake beach for 2010 and 2011. The Iowa DNR has collected samples at the lake beach only during the recreation season (April – September). There was no clear and consistent relationship between the two sites. During the relatively dry years of 2011 and 2012 an interesting trend was noted. The main drainage district tile line discharging to the lake ceased flowing in early August and late July of 2011 and 2012, respectively. The *E. coli* concentrations at the lake beach exceeded the SSM in 50% and 80% of the samples collected during this time of no inflow in 2011 and 2012, respectively. The *E. coli* concentration at the Lake

Beach was 12,000 MPN/100 ml in third week of August 2012, despite all contributing flow from the watershed having ceased by July 26th, 2012.

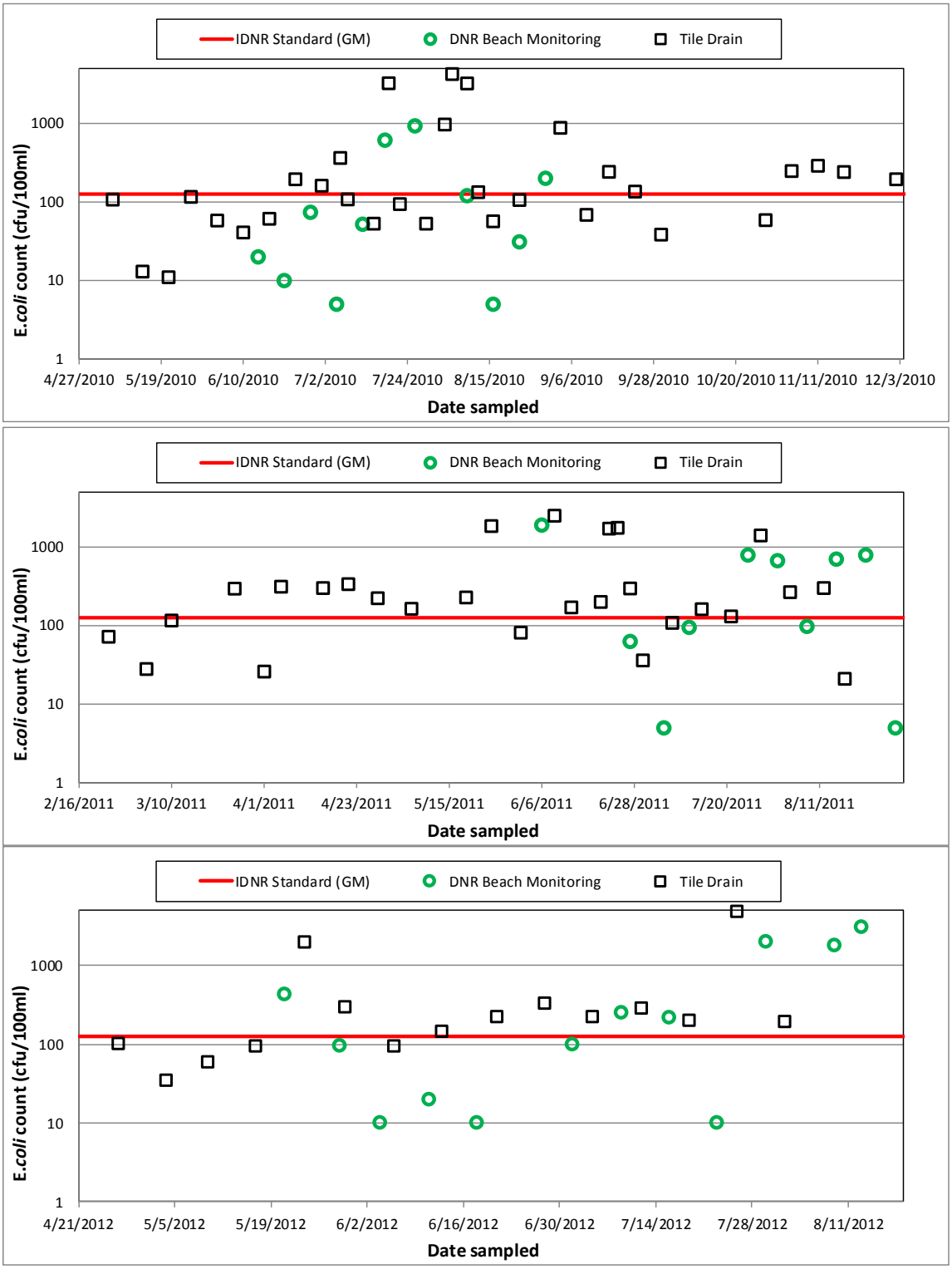


Figure 23. *E. coli* concentrations at Lake Beach and Drainage District outlet for 2010 – 2012.

COMPARISON OF *E. COLI* CONCENTRATIONS AND PRECIPITATION PATTERNS:

The correlations between lake beach *E. coli* concentrations and the rainfall amounts were investigated. Figure 24 shows the *E. coli* concentrations at the lake beach plotted against rainfall amounts in mm. Figure 25 shows relationships between rainfall and *E. coli* concentrations; bacteria levels were only used if precipitation occurred the day prior to or the day of sample collection. Precipitation data was obtained from a weather station in Ames. No obvious trends were observed to indicate relationships between beach bacteria concentrations and rainfall.

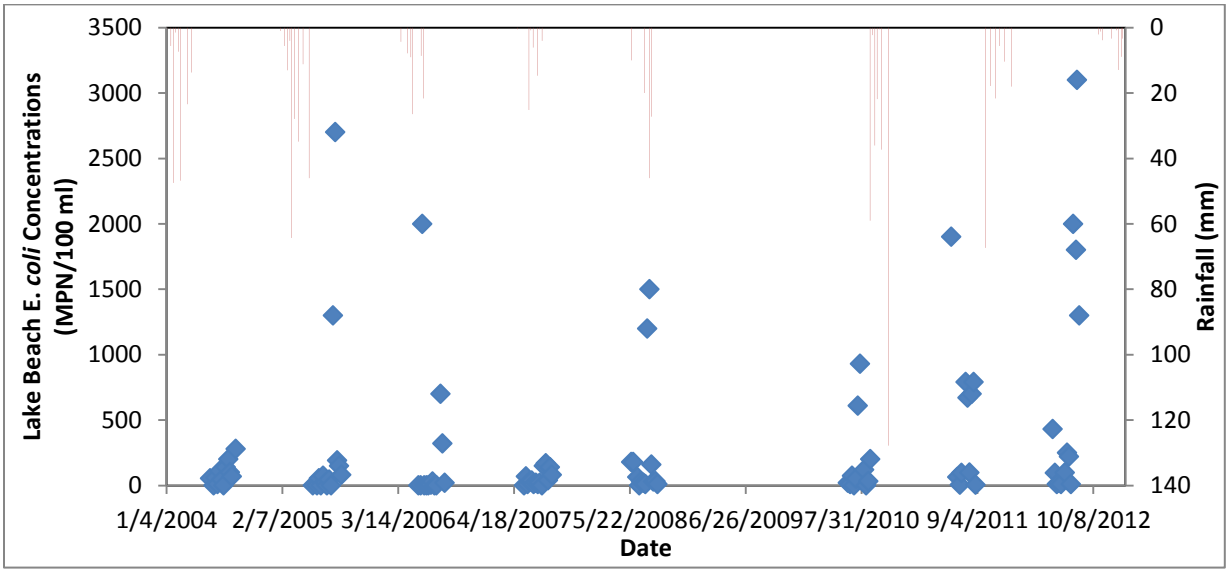


Figure 24. Rainfall and *E. coli* levels at the Hickory Grove Lake beach from 2004 through 2012.

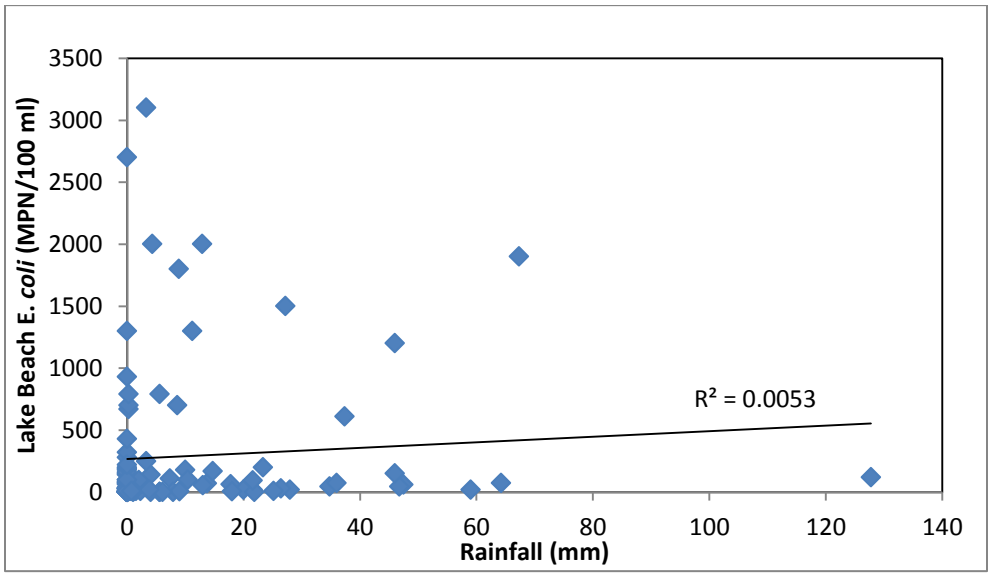


Figure 25. Correlations between rainfall and *E. coli* levels at the Hickory Grove Lake beach from 2004 through 2012.

TMDL METHOD: NEAR-SHORE BEACH VOLUME MODEL

Based on monitoring data, a correlation between watershed bacteria contributions measured at the tile drain outlet and beach *E. coli* concentrations was not found. Therefore, a simple approach such as the near-shore beach volume method is recommended to set load reductions at beaches when the only known source of bacteria is wildlife. This method has been previously applied at bacteria impaired beached in Iowa at George Wythe Lake and Lake Geode. While simple, this approach sets load reductions based on the dominate source of fecal bacteria at the beach and allows 319 funds to target the sources which will result in improvements in beach water quality.

Chapra (1997) presents an approach to estimate bacteria concentrations during steady-state conditions, and assumes that the diffusion of organisms is equal in all directions.

$$C = \frac{W}{\pi HE} K_0 \quad \overline{\frac{kr^2}{E}}$$

Where:

C = Concentration (mass/length^3)

W = mass loading rate (mass/time)

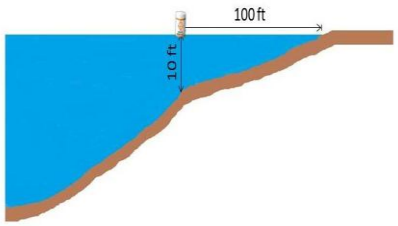
H = depth, corresponding with radius (length)

E = diffusion (length^2/time)

k = decay rate (1/time)

r = radius/distance from beach (length)

K_0 = first-order modified Bessel function of the second kind



First, the near shore beach volume at Hickory Grove Lake was calculated:

Radius/distance from the beach = 100 ft

Depth corresponding with radius = 10 ft

Length of the beach = 300 ft

Area of the beach = $\frac{1}{2} * 10 * 100$ = 500 ft^2

Near Beach Shore Volume (NBSV) = 500 ft^2 * 300 ft = 150,000 ft^3 (or) 1.44 ac-ft

Next, the bacteria load to the waterbody was calculated. It was estimated that there are approximately 100 resident geese at the park during the recreational season (Dustin Eighmy, Hickory Grove Park Ranger). During the migratory season, the geese numbers at Hickory Grove Lake range between 1500 and 2000 and the migratory birds primarily reside in the middle of the lake and around the island. Previous research by Paul Mammenga (South Dakota Waterfowl Biologist) has found that the majority of the time geese will defecate while on the water (Mammenga, 2007). The daily bacteria load from geese is approximately 4.9E+10 fecal coliform

organisms per goose per day (USEPA, 2001). The Iowa DNR has developed and equation to estimate *E. coli* based on the fecal coliform organisms for waterbodies in Iowa.

$$E.\ coli = FC \times 0.92$$

Thus, the bacteria load generated by geese is 4.51×10^{10} *E. coli* organisms per day per goose. The total bacteria load from the estimated geese at the Hickory Grove Lake Beach is 4.51×10^{12} *E. coli* organisms per day. Geese spend the majority of their time in or near the lake, and therefore we assumed that at least 50% of the bacteria load generated by geese is received by the lake. We also assumed that the geese spend equal time at four locations in the lake and therefore only ¼ of the estimated load to the lake is deposited in the beach area. The total bacteria load received by the beach is 1.13×10^{12} *E. coli* organisms per day. The designated uses of Hickory Grove Lake are primary contact recreation, aquatic life and human health. The standards set by IDNR state that the daily maximum *E. coli* concentrations in any waterbody should not exceed 235 cfu/100 ml (or) 2.90×10^{19} cfu/ac-ft and the geometric mean standard is set at 126 cfu/100 ml (or) 1.55×10^{9} cfu/ac-ft. If the *E. coli* concentrations in a waterbody exceed the standards, then the waterbody is impaired for bacteria.

The above model was used to estimate the maximum allowable load to the Hickory Grove Lake Beach when diffusion of organisms was considered. Table 14 shows the parameter values used in the model.

Table 14. Parameter values and ranges used in the near shore beach model

Parameter	Value/range	Units
W	4.51E+10	*E. coli* per day per goose
H	10	ft
E	930 to 9.3E+8	ft^2/day
k	1.6 (Bowie et al. 1985)	per day
R	100	ft
C	2.90E+9	cfu/ac-ft

A Monte Carlo simulation was performed on the above model with 1000 simulations to vary the diffusion parameter *E* within the specified range. The range was set based on observed Iowa DNR *E. coli* concentrations at the Hickory Grove Lake beach. The daily allowable maximum daily bacteria load from geese was estimated as 1.87×10^{11} cfu/day, and the geometric mean bacteria load was estimated as 1.01×10^{11} cfu/day. The above loads were calculated using the beach volume as 1.44 ac-ft. The bacteria loads represent the median loads from the 1000 simulations

performed. The daily maximum and geometric mean loads were approximately equal to the daily loads generated by four and two geese, respectively. As few as 5 resident geese can elevate the *E. coli* concentrations at the beach above water quality standards.

The method described previously is recommended when the bacteria levels at an impaired beach are exceeding water quality standards and the elevated *E. coli* concentrations at the beach do not appear to be related to watershed bacteria loads. Watershed activities may still have some impact on lake water quality but the overwhelming load to the beach due to resident geese creates a local hot spot with elevated *E. coli* concentrations which are not observed at other locations within the waterbody.

Intensive monitoring over three years identified *E. coli* concentrations in lake inflow that were often elevated above water quality standards. To better assess improvements in water quality due to implementation of management practices in the watershed, a secondary compliance location could be established at the primary lake inlet if the criteria are met through the required use attainability analysis. Here a TMDL could be established using the traditional load duration curve or watershed modeling techniques and implementation of management practices would be reflected by improvements in water quality at the lake inlet location.

NUTRIENT LOADS:

The point source pollution contribution to the Hickory Grove Lake is zero as there are no point sources in the watershed. Total Phosphorus (TP) is the limiting nutrient for algae growth in fresh water lakes and is used as proxy to reduce Chlorophyll-a concentrations and increase the Secchi depth. The BATHTUB model was used estimate the required TP load reductions delivered to the lake in order to meet the desired water quality in the lake. The TP concentrations in the tributaries (South drain and Sediment basin) were decreased until the Carlson TSI of TP, Chl-a and Secchi depth fell below 63, an approach used by IDNR to remove the waterbodies from impaired water's list (Charles Ikenberry, Personal communication, 2012). Hickory Grove Lake is divided into three segments: Main Lake, Sediment Basin and South Drain (Figure 28). The segments Sediment basin and South drain receive nutrient loads from the watershed and these two segments flow into the Main Lake, therefore nutrient load reductions required to improve the lake water quality are also recommended at the Sediment basin and South drain locations.

Figure 28. Hickory Grove Lake segments in BATHTUB model

The load reductions required to improve the water quality in the Main Lake and the lake as a whole were calculated and the required load reductions in the tributaries (South drain and Sediment basin) are shown below in Table 16. In order for a waterbody to be delisted from 303(d) the Iowa DNR and EPA Region 7 have different approaches: the Iowa DNR recommends that Main Lake/segment must be targeted where the water quality data was collected as part of the ambient monitoring program and EPA Region 7 recommends that Whole Lake must be targeted for load reductions; therefore, the nutrient load reductions for both the Main Lake and the Whole lake were determined. Differences between the two approaches are due to the number of segments in the lake, the area of each segment, and contributing areas to each segment.

WASTE LOAD ALLOCATION:

The Waste Load Allocation (WLA) is the maximum amount of the pollutant that can be received from point sources. There are no point sources in the Hickory Grove Lake Watershed; therefore the WLA is set as zero kilograms per year.

LOAD ALLOCATION:

The Load Allocation (LA) is the maximum allowable amount of pollutant that can be received from non-point sources. The LA for Sediment basin and South drain was calculated using a 10% of Margin of Safety (MOS). The summary of existing TP loads to the lake and required load reductions are shown in Table 16.

Table 16. Summary of Total Phosphorus TMDL results for Hickory Grove Lake

	Main Lake	
	Sediment Basin	**South Drain**
TMDL (lbs/yr)	5,176	3,402
WLA (lbs/yr)	0	0
LA (lbs/yr)	4,659	3,062
MOS (lbs/yr)	518	340
Existing Load (lbs/yr)	7,800	3,419
Total % Reduction	**40**	**10**

The existing TP loads to Hickory Grove Lake were obtained from calibrated SWAT model output. The existing TP loads from the watershed to the Sediment basin and South drain segments were 5,176 pounds per year and 3,402 pounds per year, respectively. If the TMDL is set so that the Main Lake section will achieve a TSI less than 63, the Sediment basin and South Drain load allocations were 4,659 pounds per year and 3,062 pounds per year, including the margin of safety. In order to improve the water quality in the main basin of Hickory Grove Lake the TP inputs need to be reduced by 40% at the Sediment basin and 10% at the South drain.

SEDIMENT LOAD ASSESSMENT:

Monitored Sediment Loads from the Watershed – ISU

Total suspended solids (TSS) concentration was monitored at three of the monitoring locations: Tile Drain, Large Culvert and North Subwatershed. TSS concentration was multiplied with flow at these locations to obtain suspended sediment loads being delivered to the lake. TSS was observed in water samples collected only during rainfall/runoff events during the 2010 and 2011 monitoring seasons at the three locations. The total sediment load observed at Large Culvert location during 2011 was less than 0.2 tons per acre.

Diagnostic Feasibility Study for the East End of the Lake

In 2012, the total storage capacity in the east end of the lake (sediment basin) was estimated to be 100,717 m^3 (81.65 ac-ft). The average depth of the east basin was assumed to be 5 feet (personal communication; Andrews, A., 2012). In 1970, when the east basin was first constructed it had a maximum depth of 15 feet and an average depth of 12.5 feet. The total storage volume at the time of construction was 251,793 m^3 (204.13 ac-ft). The saturated density of the muck-sediment was assumed to be 0.23 t/m^3. Between 1970 and 2012, the sediment basin accumulated a calculated estimate of 808 tons of sediment per year. In 2012, the total estimated storage volume loss of the east basin was 60%.

Total sediment loading to the east basin as based on SWAT estimated sheet and rill erosion from the watershed, as well as RASCAL estimated erosion from gullies, headcuts, knickpoints and streambanks contributing to the east basin was used to calculate the total storage volume lost to sedimentation for the last five years (Table 17). Total sediment loading per year estimated by the above two methods is very well correlated supporting estimated storage loss.

A direct measure of sediment load delivered to a waterbody from a watershed is difficult to estimate as it depends on factors such as the intensity of runoff, erodibility factor of soils, and seasonal variability. Therefore a phased approach or storage volume loss approaches are being used by Iowa DNR to set sediment load reductions. In a phased approach, the target sediment loads will be modified/adjusted as the new data is available. An approach developed by the Nebraska Department of Environmental Quality for addressing lake sedimentation states that a reservoir may be listed as impaired when the annual storage loss exceeds 0.75% in any given year (TMDL - Wagon Train Lake). The storage volume lost in the east basin each year was greater than 0.75%. Therefore, it can be inferred that the east basin of Hickory Grove Lake is currently impaired by sediment.

Table 17. Annual sediment loadings to Sediment Basin and storage volume lost to sediment

Year	Sediment from the watershed (t)	Gully + Streambank erosion (t/yr)	Total sediment loading (t)	Sediment volume, (m^3)	Storage volume lost to sediment
2007	101	644.9	745.9	3243	2.77%
2008	179	644.9	823.9	3582	3.14%
2009	104	644.9	748.9	3256	2.95%
2010	131	644.9	775.9	3373	3.15%
2011	41	644.9	685.9	2982	2.88%

Two large culverts/flow-through tubes allow water to flow from the east basin of Hickory Grove Lake to the main basin and have historically provided boat access to either basin of the lake. Boat access via this pass-through route is now limited. On the east side, water depth from sediment to the bottom of the tubes is approximately 2-3 feet. Average water depth considering sediment accumulation and storage volume loss over 43 years decreases by approximately 2.1 inches per year. Estimated functional life-expectancy for maintaining sediment in the east basin and preventing further sedimentation of the main basin of Hickory Grove Lake is less than 10 years.

6.3 POLLUTANT DATA ANALYSIS

A Water Quality Improvement Plan has been developed by Iowa State University and is on file with the IDNR Watershed Improvement Program and ISU (Hickory Grove Water Quality Improvement Plan Final Report 2010-2011). The WQIP has been used to identify pollutant sources and in developing reductions necessary for maintaining and improving the water quality of Hickory Grove Lake. Necessary reductions for meeting water quality goals will be attained through implementation of the Best Management Practices (BMPs) discussed in the following section of this report. Figure 29 illustrates the land uses in the Hickory Grove Lake watershed.

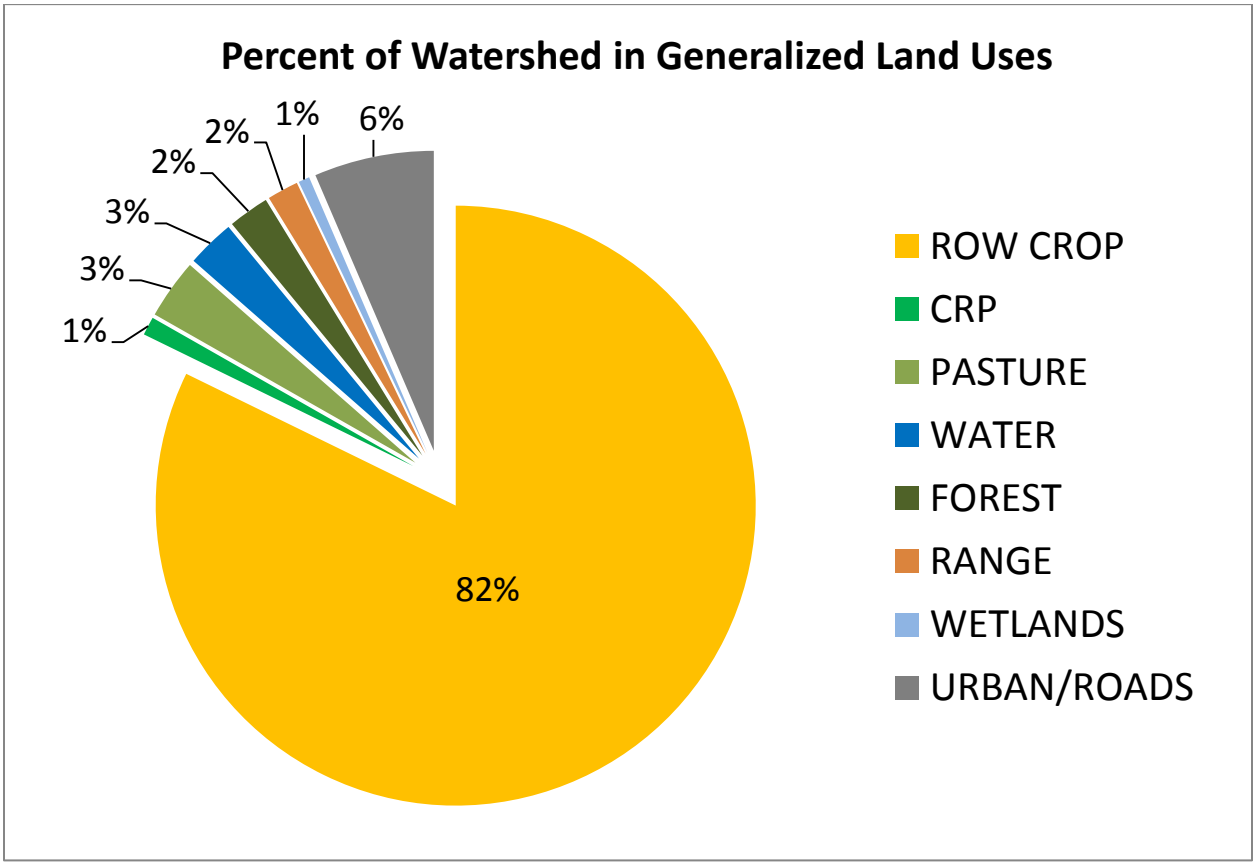


Figure 29. Land use composition of Hickory Grove Lake Watershed

BACTERIA:

The Water Quality Improvement Plan showed that elevated *E. coli* concentrations at the Hickory Grove Lake beach do not appear to be significantly correlated to watershed bacteria loads. However, watershed activities may still have an impact on lake water quality. While bacteria concentrations at the upstream Tile Drain and Large Culvert locations are not directly correlated to bacterial concentrations at the beach, bacteria loading at the inlet is occurring due to at least one (or more) faulty septic systems, as well as livestock which are granted full access to 1,400 feet of stream reach that accounts for approximately 75% of the inflow to Hickory Grove Lake.

There is also the potential for bacteria loading to be occurring from the north subwatershed with runoff events after the application of poultry manure every 2-3 years. The overwhelming load to the beach due to resident and migratory geese creates a local hot spot with elevated *E. coli* concentrations which are thus far not observed at other locations within the waterbody. Water quality improvement efforts for reducing bacteria concentrations and removing Hickory Grove Lake from the impairment designation should be first targeted at reducing the resident goose population and the amount of time they spend using the beach.

PHOSPORUS AND SEDIMENTATION:

While Hickory Grove Lake is not currently impaired based on calculated TSI values its water quality is in a state of decline. Thus, a secondary goal of this watershed management plan is to maintain or improve lake water quality such that Hickory Grove Lake is prevented from becoming listed as impaired based on total phosphorus calculated TSI values at any time during the proposed 12 year project and beyond. The WQIP showed that internal and watershed sources were the largest contributors to P loading together comprising 88% of the phosphorus input to the lake (Figure 30). Watershed loading was determined with SWAT model runs calibrated using existing monitoring data attained in 2010-2012. This includes runoff P contributions from sheet and rill erosion. Soil erosion and resulting sediment delivery from gullies, streambanks, and shorelines is also a significant source of total phosphorus entering Hickory Grove Lake together comprising approximately 10% of TP input.

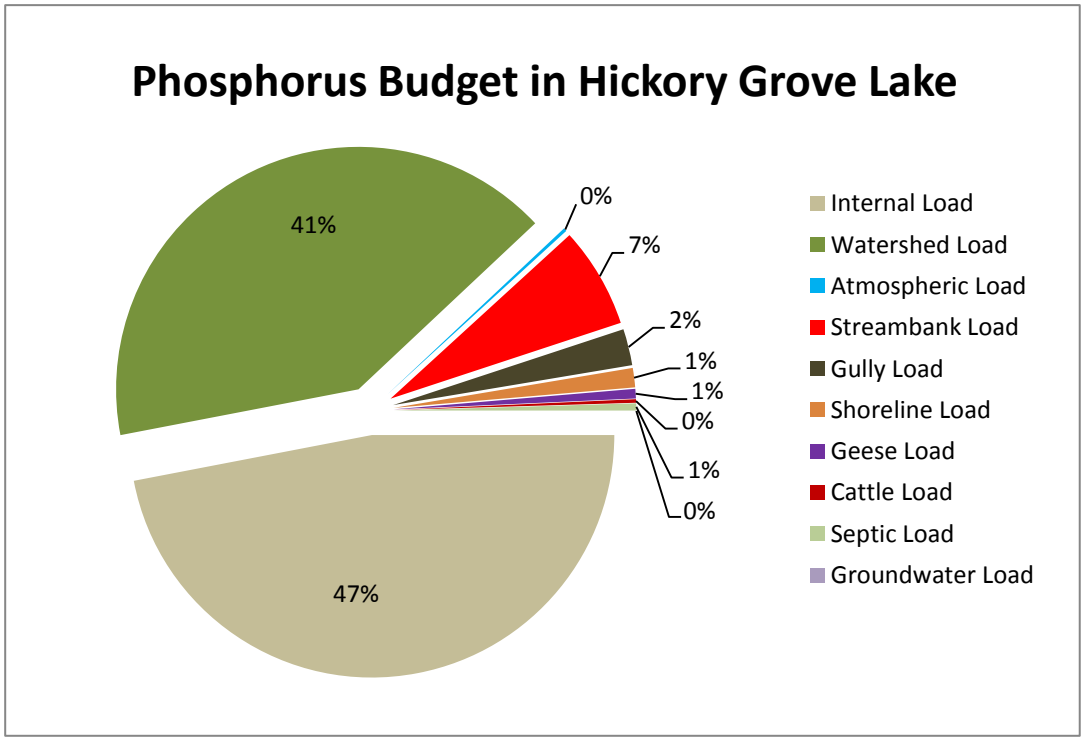


Figure 30. Relative sources of TP load contributions

Soil erosion from gullies (including headcuts and knickpoints) and streambanks are the primary sources of sedimentation to the east basin of Hickory Grove Lake. The main basin of the lake also suffers from shoreline and gully sources of sedimentation. Figure 31 shows the annual relative contributions of gullies and streambanks, as well as sheet and rill erosion, to total sediment loading of the east basin. Soil deposited in the east basin since its construction (over 43 years ago) has reduced the storage volume from an initial 204.13 ac-ft to 81.65 ac-ft. The accumulated sediment serves as a significant contributor to internal phosphorus loading of the main lake through sediment interactions with the water column leading to the release and increased availability of phosphorus. Once resusupended /remobilized phosphorus released is able to move into the main basin via the flow-through structure (tubes under 680th Ave) to the main basin of Hickory Grove Lake. Wind action and bottom-feeding fish interactions are primarily responsible for resuspension of sediments as is commonly the case, especially in shallow water bodies, such as the east basin. Heavy boating also commonly intensifies the problem however, Hickory Grove Lake does not suffer from resuspension from boating activities as it is less than 100 acres and features a no-wake, electric motor only restriction. Water quality improvement activities for reducing phosphorus and sediment loading must be focused on reducing erosion and sediment delivery from gullies, streambanks and the watershed while being coupled with dredging the nutrient-rich bottom sediments of the east basin.

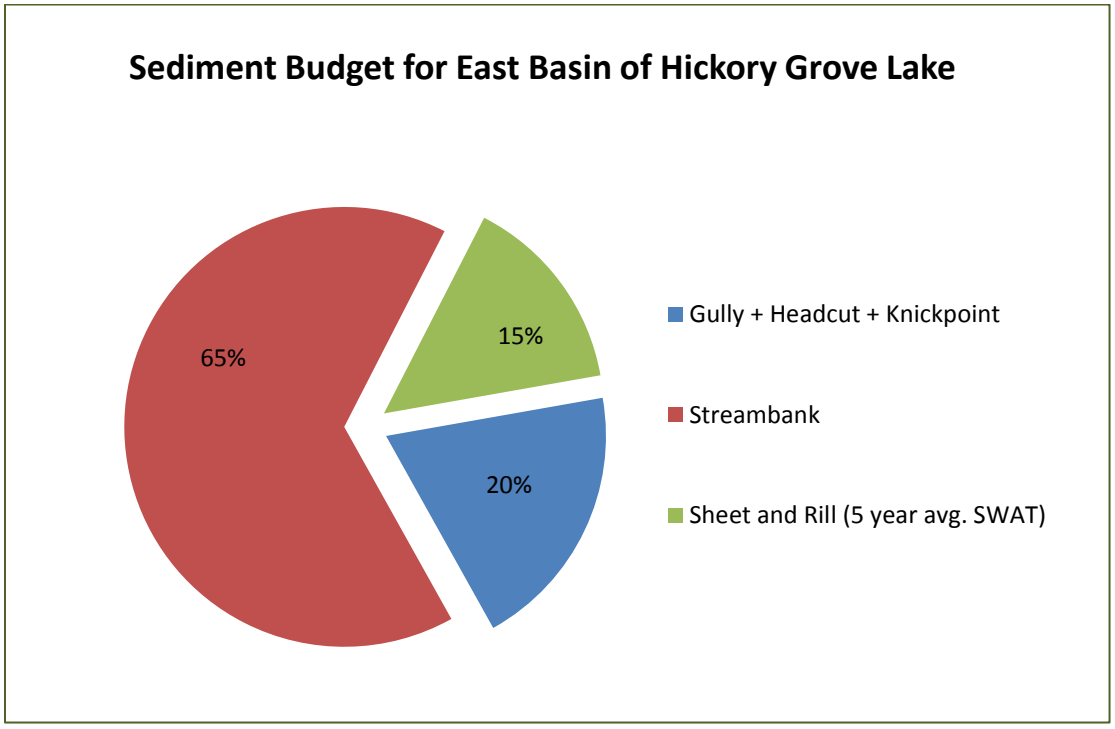


Figure 31. Relative sources of sediment load contributions to East Basin

7 WATERSHED PLAN GOALS AND OBJECTIVES

7.1 STATEMENT OF GOALS AND OBJECTIVES

The primary goal of this Watershed Management Action Plan is to develop a set of best management practices (BMPs) that will address the bacteria impairment at Hickory Grove Lake, thereby removing it from the Impaired Waters list, maintaining Class A1 designated use criteria and ensuring the safety of lake users. This primary goal will be accomplished through objectives targeted at reducing resident goose population and eliminating beach usage by geese.

A secondary goal seeks to reduce overall bacterial loading to Hickory Grove Lake and ensure water in the upper reaches of the lake is suitable for Class A2—secondary contact recreation. This goal will be accomplished through objectives targeted at livestock exclusion and reducing the potential septic system threat by leveraging local incentives to inspect, and if necessary, upgrade the unpermitted systems.

A third goal of this plan seeks to address sources of sedimentation and phosphorus loading to Hickory Grove Lake in order to prevent degradation of water quality, maintain and improve current water clarity and quality, and alleviate dense and potentially harmful algal blooms which commonly occur during summer months.

Finally, the public outreach materials implemented in educating target audiences about the water quality issues at Hickory Grove Lake will concurrently aid in meeting an additional goal of promoting the usage of Hickory Grove Lake and Park by residents in surrounding communities therefore increasing local revenue and leading to positive effects on the local economy.

The goals and objectives outlined here will be accomplished through implementation of the BMPs described in the following section of this report.

Goal 1: Remove the bacteria impairment at Hickory Grove Lake by reducing the frequency of single sample maximum violations to 10% (or less) of the samples taken during the recreational period within the first 2 years of the project start date. Within 5 years of the project start date bring this number to 5% (or less) and achieve total elimination of geometric mean violations.

> **Objective 1:** Reduce geese populations at Hickory Grove Lake and effectively deter usage in the northern basin, specifically discouraging geese usage at the beach and nearby island location.

Goal 3: Maintain and improve water quality of Hickory Grove Lake in order to prevent future impairment designation for sediment/nutrients while alleviating the occurrence of potentially harmful algae blooms due to phosphorus loading from sources both within and outside the borders Hickory Grove Park.

Objective 1: Work with landowners and operators to implement conservation practices on private lands for reducing sediment and nutrient inflows to Hickory Grove Park.

Objective 2: Work with public land managers to address the areas identified that are actively eroding within Hickory Grove Park.

Objective 3: Work with government agencies and public land managers to perform dredging of the east (sediment) basin of Hickory Grove Lake to reduce internal loading.

Goal 4: Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages to continually generate pride and community connection of/to Hickory Grove Lake and Park, and increase park usage therefore stimulating the local economy.

Objective 1: Implement an effective public outreach campaign which reaches out to and engages multiple audiences throughout all four phases of the 12 year project.

7.2 TARGETS AND LOAD REDUCTIONS

WATER QUALITY TARGETS:

In order to address the bacteria impairment at the Hickory Grove Lake beach, loads will need to be reduced from a total beach bacteria load of 1.13×10^{12} *E. coli* organisms per day to less than 1.01×10^{11} *E. coli* organisms per day. As few as 5 resident geese can elevate *E. coli* concentrations at the beach above water quality standards, thus an aggressive and comprehensive goose management will be proposed. Additional in-lake water quality goals stated previously seek to protect and improve the overall water quality of Hickory Grove Lake. A number of BMPs will be proposed in the following section of this report to ensure Hickory Grove Lake meets or exceeds State water quality standards.

Table 18. Summary of Hickory Grove Lake Water Quality Goals

Parameter	WQIP Goal	Current Water Quality (2009-2011)	HGL Advisory Group Goal	% Further Improvement
Beach Bacteria*	<1.01×10^{11} *E. coli* orgs/day -90% weekly monitoring samples below SSM-A1	1.13×10^{12} *E. coli* orgs/day -69% weekly monitoring samples below SSM	95% weekly monitoring below SSM Elimination of GM violations	26%
Secchi Disk Depth	1.37 m†	0.93 m	>2 m	53.5%
Total Phosphorus Loading	<3,492 lbs/yr	11,219 lbs/yr	<3,492 lbs/yr	31.1%
Average TSI‡	<63	64	63	1.6%
Internal Phosphorus Loading	-	5,551 lbs/yr	<3,263 lbs/yr	41.2%
Sediment Loading to East Basin	<191 tons/yr§	756 tons/yr	<191 tons/yr	74.7%
Sediment Loading to Main Basin	-	180 tons/yr	<68 tons/yr	62.2%

*2008-2012 data; Limnological data not available for 2008

†Standard for all Iowa lakes set by IDNR

‡As based on TP determination

§Reduction based on original design depth and storage volume loss not exceeding 33% over 100 year design life

The State of Iowa does not currently have numeric water quality criteria for siltation. As based on an existing as-built document, the storage volume loss of the east basin of Hickory Grove Lake between construction (1970) and 2012 is 123 ac-ft (60% of the original storage volume). The

historical external sediment load/sediment accumulation to the east basin is estimated at 808 tons per year. However, current assessments indicate average annual erosion contributing to the east basin over the last 5 years is 756 tons per year. In order for the east basin to meet criteria for the 100 year design life (as based on approximated as-built depths) that the U.S. Army Corps of Engineers typically uses (33% loss of storage volume causes impairment) the total storage volume loss for 100 years must not exceed 67 ac-ft. Total allowable sediment loading for a 100 year design life is 191 tons per year. To meet this design life requirement after a proposed dredging project, average annual sediment loading would need to be reduced by at least 565 tons per year, or 74.7 percent.

Reducing external sediment loading and excavation of nutrient enriched sediments currently deposited in the east basin will concurrently reduce internal phosphorus loading to the main basin of the lake. The current estimated useful life of the east basin is less than 10 years. Work proposed at the east basin coupled with additional BMPs discussed in the next section will extend the functional life expectancy of Hickory Grove Lake to well beyond the 100 year design life typically used by the U.S. Army Corp of Engineers.

Assessment indicates a total P load reduction of 1,083 pounds per year is achievable through targeted BMPs which reduce external sediment loading to Hickory Grove Lake. An additional reduction of 122 pounds per year will result from BMPs targeted at reducing the resident goose population, livestock exclusion from the stream feeding the lake, and through ensuring all septic systems are up to date and functioning properly. These BMPs, in total, account for a total P load reduction of 1,205 pounds per year. In order to meet the total phosphorus load reduction of 3,492 pounds per year, to ensure the total phosphorus calculated TSI value is maintained at 63 or below (as indicated by the TMDL) internal phosphorus loading must be reduced by 2,287 pounds per year, or 41.2 percent.

WATER QUALITY TARGET MILESTONES:

The watershed management plan has been developed to span over 12 years and was broken into four separate three year phases. The water quality goals laid out in Table 18 can be used to track the progress of project goals. Many of the proposed practices, if implemented, will lead to significant and nearly immediate reductions in sediment, phosphorus and bacteria loading. Other practices, such as dredging work described in the next section, will have long-term benefits spanning far beyond the proposed 12 year project. A schedule describing water quality milestone metrics, totals, estimated reductions and project outcomes is provided in Appendix E.

7.3 BEST MANAGEMENT PRACTICES

GOOSE MANAGEMENT:

A few strategies to control beach bacteria contributions from geese have been previously implemented. All but one nesting barrel has been removed from Hickory Grove Park. One remaining nesting barrel in the south sediment basin needs to be removed. The Story County Conservation Board passed a resolution to lift refuge status from Hickory Grove Park and a controlled goose hunt was initiated in 2005. A total of 58 geese were taken from 2005 to 2011. The controlled goose hunt was discontinued in 2012. Twenty five geese were relocated by the Iowa DNR in 2011. As of 2012, the resident goose relocation program has been suspended. During summer 2012, park staff estimated the presence of approximately 50 resident geese still using the site. Park staff has been harrowing the beach with a small disk implement and have recently begun trying to collect goose droppings by hand before harrowing. Reducing the amount of time resident geese spend in the main basin of the lake has the potential to significantly reduce the number of indicator bacteria found at the beach in addition to reducing phosphorus loading by approximately 75 pounds per year.

In order to more effectively address the potential of fecal contamination due to the geese population at the Hickory Grove Lakes' beach a suite of management practices will be adopted. Funding will be requested from the U.S. EPA Section 319 Nonpoint Source Management Program to implement a goose management plan. Geese often become adapted to dissuasion techniques hence a multi-faceted approach is needed to address the problem. These facets include but are not limited to:

- Grooming the island location and installing mylar tape, or electric tape fence, around perimeter. Two strands of twisted mylar tape, red on one side and shiny on the other can be useful in deterring geese. The island location currently acts as a safe haven for geese as being away from predation or human interaction. Fencing around the perimeter will provide both a visual and physical deterrent. It is important to deter geese from this location as it is located approximately 450 feet from the beach.
- Double stranded fencing will be placed around the perimeter of the beach location and along its shoreline outside of the recreational period between Memorial Day and Labor Day. During the recreational period park staff will manage a retractable double stranded fence implemented during evening hours each day.
- Park staff will continue the practice of harrowing the beach in order to expose existing bacteria in beach sands to ultraviolet radiation—a practice that has been proven effective at killing *E. Coli* bacteria. Purchasing a PTO driven grooming machine for removing goose droppings was investigated and a cost estimate is located in Appendix F. The machine could be mounted to an existing tractor on site and operated by park staff for removing

goose droppings however, goose management efforts aim to prevent geese from using the beach year round and thus, such a machine should not be necessary.

- Heavy beach usage by geese during evening hours supports the need for installing "Away with Geese" lighting at the beach and also at the nearby island location. The lights are to disrupt sleeping patterns of geese causing them to move elsewhere.
- Installation of an automated sonic deterrent device near the beach area. Sonic deterrents featuring both predator and distress calls have been used extensively in deterring nuisance avian species.
- Cracker/Bang Shells will be used to deter geese from using the island location located directly west and approximately 450 feet from the beach area. The launcher and shells must be of adequate capability of reaching out to the island site to be effective. These will be used in other locations as deemed appropriate.
- Green lasers have been shown to be effective at dispersing geese and other birds during evening hours and offer a silent method of dissuasion that will not disrupt park users. Handheld lasers will be utilized as appropriate in deterring the resident and migrant goose populations.
- Landscaping has the potential to further deter geese from using the beach. Research indicates geese prefer to be away from areas where predators may be able to hide or stalk their prey. Native grass plantings adjacent to, and behind the beach, may help to reduce usage. Planting shrubbery or placing boulders (greater than 2 feet in size) immediately behind the beach sand also has the potential to reduce usage by geese.
- There is little potential for an alternative loafing area to be developed given the small size of Hickory Grove Park.
- The practice of controlled goose hunting has currently been suspended due primarily to safety concerns as park usage commonly continues until well into the fall and winter months. Poor past success and Hickory Grove Park having Wildlife Refuge status also has influenced this decision. In total, 58 geese were taken as part of the controlled goose hunts held between 2005 and 2011. Only three geese were taken as part of the 2011/12 goose hunting season. The controlled goose hunt, if reinstated and promoted more extensively, has potential to be an effective deterrent of migrant and resident geese.
- The hiring of an approved dog service to visit the site randomly to deter the geese from using the beach before the recreational period in early spring when geese first arrive until Labor Day was investigated. An initial work proposal from the service "Animal Removal Solutions" is presented in Appendix G. U.S. EPA 319 funding will not be requested at this time for hiring a dog service due to the proposed cost, and the fact that SCCB staff is readily available to perform continual goose harassment.
- Research has not supported the cost effectiveness of the use of land applied liquid or granular goose repellents hence funding will not be sought for their use.

A map depicting where select goose management practices will be implemented at Hickory Grove Lake is provided in Appendix H of this document.

LIVESTOCK EXCLUSION, STREAMBANK STABILIZATION AND RIPARIAN BUFFER:
Cattle are given full access to the stream feeding Hickory Grove Lake between the Tile Drain location and the south eastern border of Hickory Grove Park—a total of approximately 1,400 feet. This pastured area has been overgrown with invasive tree species which are in need of removal before streambank stabilization and buffer seeding can occur. Plans have been drawn for an alternative watering source for cattle and a cost estimate for the pond is provided in Appendix I of this document (last updated in 2010). The streambanks in this location have eroded severely over the last 10-20 years and are in need reshaping, riprap and buffer installation to prevent further degradation of the stream, as well as bacteria, sediment and nutrient inflows to Hickory Grove Lake. Approximately 3,000 feet of fencing is needed to prevent cattle from accessing the buffer and stream. Livestock exclusion fencing has been shown to effectively reduce nutrient and sediment loading rates, as well as indicator bacteria counts in associated water bodies. For example, Line et al. (2000) showed over a 55% reduction in total nitrogen and over 78% reduction total phosphorus loading to the stream with additional reductions of nitrate and nitrite nitrogen. In addition, Owens et al. (1996) reported a 57% decrease in annual flow-weighted average sediment concentration and more than a 40% decrease in average annual soil loss when cattle were fenced out of the stream.

Approximately 450 feet of the stream reach is in need of bank reshaping to a 2:1 slope ratio and class D riprap installation on both banks. Over 1,000 feet of the stream reach will benefit from invasive tree removal to allow light to penetrate into the lower canopy and allow for buffer establishment. Riparian buffers used in conjunction with livestock exclusion fencing have been shown to reduce indicator bacteria counts by 52% and 46%, respectively (Meals, 2001). Line (2003) also documented a nearly 66% reduction in stream fecal coliform levels after fencing. Further, Sullivan et al. (2007) reported that the presence of a vegetative buffer of any size, from 1 to 25 meters, generally reduced the median fecal coliform bacterial counts by more than 99%. The landowner is willing to remove invasive trees and install fencing provided it is part of a cost-share program and an alternative watering source is made available. Stabilizing this area has the potential to reduce sediment loading up to 257 tons/year, as well as bacteria and TP loading by upwards of 90%. Larsen et al. (1994) concluded that a 95% reduction of bacterial loads was achievable through livestock exclusion.

ROTATIONAL GRAZING PLAN:
The approximately 12 acre pasture adjacent to the stream is currently continuously grazed by 10 to 12 cattle in any given year. It overgrazed to the extent that soils are left bare and compacted in

many areas of the pasture. Rotational grazing has been shown to reduce compaction of soils, improve soil quality and lead to an overall reduction in sediment, surface runoff, total phosphorus and other nutrient losses as compared to overgrazed lands. A study conducted by the USDA-ARS in Arkansas documented up to a 60% reduction in surface runoff and up to 50% reduction in total P loads with rotational grazing as compared to overgrazed lands. Coupling rotational grazing with the previously discussed riparian buffer has the potential to further reduce these losses reducing runoff by nearly 70% and total P loads by up to 75% (Pennington et al., FSA9530). Haan et al. (2004) also documented reduction of total and soluble P concentrations by 49.5% and 47.4%, respectively within downslope buffer locations, as compared to upslope grazed pasture locations. Researchers concluded that sediment and P losses in pasture runoff can be reduced by managing rotational stocking to maintain adequate grass height, improve soil quality and reduce bare ground. After buffer installation on approximately 2 acres of the pasture, a rotational grazing plan would be of great benefit on the remaining 10 acres.

SEPTIC SYSTEM UPDATES:

An optical brightener test was performed on water samples collected from the Tile Drain location on November 10th, 2011. Samples tested positive for optical brighteners suggesting at least one or more septic system(s) is discharging into a tile line connected to the main drainage district tile which feeds the stream emptying into Hickory Grove Lake. It is difficult to identify which septic system(s) may be contributing to *E. coli* and nutrient loading at the Tile Drain location. Therefore, efforts to leverage local funding will first be used to incentivize septic system inspections and upgrades at homes with the closest proximity to Hickory Grove Lake and those within closest proximity to drainage district tiles. In order to promote septic system upgrades and regular tank pumping among watershed residents, a field day will be held during installation of the first new/upgraded septic system project which will be cost-shared with the landowner, the Story SWCD and the Story County Environmental Health Department.

SHORELINE STABILIZATION:

Hickory Grove Lake's shoreline is 5.1 miles long and is owned by Story County. Several efforts have been made in the past to stabilize the lake's shoreline. The most recent of which took place in 2012 through a Fish Habitat Grant funded through the IDNR. Two of the park's fishing jetties, first installed in 1994, were overhauled by removing exposed Geoweb material, re-grading them down to 18" above normal pool level and relined with class D erosion stone resulting in improved safety, water accessibility and shoreline protection. Rip-rap was installed to other reaches of the shoreline in 2003, 2004, 2005 and 2006. Several other areas, totaling approximately 2,000 feet, along the shoreline of Hickory Grove Lake are in need of stabilization requiring installation of approximately 400 tons of class D riprap. The IDNR Lakes Restoration Group is interested in providing funding for addressing areas needing further shoreline stabilization at Hickory Grove

Lake. Stabilizing the remaining shoreline has the potential to reduce sediment loading up to 95 tons/year and TP loading by a corresponding 152 lbs/year.

GULLY STABILIZATION:

Active gullies are present in Hickory Grove Lake watershed both within and outside the borders of Hickory Grove Park. These gullies are primary sources of sediment and phosphorus loading to the lake. The most severe of these gullies are located on private lands. The proposed embankment pond and alternative watering location for cattle being excluded from the Tile Drain location and resulting stream will be located at one of the severe gully complexes serving to mitigate erosion. The second severe gully outside the park's borders will also require a large control structure for stabilization and safely conveying the flow of water coming from multiple directions. Gully stabilization outside the borders of Hickory Grove Park has the potential to reduce sediment delivery up to 131 tons per year, while gully stabilization within the park could reduce sediment delivery up to 48 tons per year. Stabilizing gullies within and outside the park could reduce total phosphorus loading by up to 287 pounds per year.

UPLAND CONSERVATION PRACTICES:

In 2010, 40 acres of critical land adjacent to the Tile Drain location (immediately east) was enrolled into the Conservation Reserve Program (CRP). This signup has prevented large sediment and debris inflows into the stream feeding Hickory Grove Lake and created essential habitat for upland game birds and other wildlife since 2010. Maintaining this CRP contract is very important for sustained protection of the lake. Prior to becoming enrolled in CRP, the area featured a grassed waterway in the main surface flow path leading to the Tile Drain location which was inadequate for preventing gully erosion. The area was a significant source of sediment inflows and commonly featured surface flows of water that over topped the grade stabilization structure. During extreme rain events surface water over topping the structure led to whirlpool action and severe bank erosion downstream. Benefits of stabilizing this downstream area have been described previously in the section addressing cattle exclusion and streambank stabilization. Heavy overflows have not been noted since the CRP establishment. This area should be seen as a high priority for land acquisition if such funds should come available.

Approximately 12,000 feet of grassed waterways were installed in the watershed between 2010 and 2012. The watershed could benefit from an additional 40,000+ feet of grassed waterways to mitigate sheet and rill erosion and safely convey water off of fields. Given the hydrology of the watershed, the efficacy of the majority of these new waterways in relation to having a direct impact on reducing sediment inflows to Hickory Grove Lake is difficult to determine. It is estimated that approximately 10,000 feet of the grassed waterways that the watershed would benefit from could lead to direct reduction of sediment inflows. It is also important to note that

there are a total of 24 surface inlets/intakes which tie directly into the main drainage district tile lines providing a conduit for surface waters to be carried away via subsurface drainage. Surface water inlets are located along primary surface flow paths and in most instances are not complimented by grassed areas/waterways. These inlets not only carry away surface water but could also be a significant pathway for sediment and phosphorus flows to the lake. The implementation of grassed waterways should be prioritized along the major surface flow paths. The use of grassed waterways will be promoted through public outreach components targeted at landowner/operators.

In spring of 2012, an approximately 500' terrace was built along the eastern side of the south sediment basin which will serve to reduce sediment deposition in this area, as well as aid in mitigating erosion from a large gully within the borders of Hickory Grove Park. The watershed could benefit from additional strategically placed terraces. However, as with grassed waterways mentioned above it is difficult to relate the impact of terraces on sediment delivery to Hickory Grove Lake given their location and the hydrology of the watershed.

As of 2012, cover crops were planted on over 130 acres and no-till and strip-till farming was being performed on 6% and 18% of the row-cropped acres, respectively. The use of cover crops, and tillage systems like no-till and strip-till will be promoted extensively in future public outreach materials and throughout the life of the project.

WETLAND INSTALLATION:

The prospect of installing an IDALS Conservation Reserve Enhancement Program (CREP) wetland was investigated in 2010 (Appendix J). Land acquisition/easements would need to be performed from/with at least two landowners in the watershed. The total amount of land to be included in the proposed site would be just over 93 acres, 40 of which are currently enrolled in CRP. In order for CREP program drainage requirements to be met, an additional easement would need to be signed with the adjacent landowner to the east of the proposed site. It would also be necessary to partner with Story County for roadwork and installation of a bridge over 690th Avenue to maintain the appropriate amount of separation between the tile outlet and normal pool level. The proposed wetland, if implemented, has the potential to remove nitrate in drainage water (as well as potentially serving as a catchment for sediment and phosphorus) from nearly half of the watershed. The challenges and costs associated with excavation and maintaining the proper degree of separation between normal pool level and the main tile outlet was found to be cost prohibitive at this time.

BIOREACTOR INSTALLATION:

Recent water quality monitoring by ISU has identified consistently high nitrate loading occurring in drainage water from the North Subwatershed location. Woodchip bioreactors are an emerging technology and edge-of-field practice which have been found successful at converting nitrate in water to benign nitrogen gas through microbial processes by way of naturally occurring denitrifying bacteria. There is potential for a woodchip bioreactor to be installed in the north subwatershed which could reduce high nitrate loading from tiles draining the area. Recent research evaluating the effectiveness of woodchip bioreactors has shown an average bioreactor load reduction of 45% and total nitrate-nitrogen load reduction of 32% (Christenson et al., 2012). Outreach efforts with landowners in the subwatershed will promote the use of bioreactors for nitrate removal.

SEDIMENT BASIN DREDGING:

Figure 31 provides an aerial view of the sediment basin over time and a large aerial view of Hickory Grove Lake taken in 2010. The east basin of the lake (sediment basin) was first constructed in 1970. At the time of construction the basin had an estimated average depth of 12.5 feet and a maximum depth of 15 feet. Boat access to this area is now limited. Maximum depth of the east sediment basin is now approximately 7 feet however, average depth is likely closer to 4-5 feet. The sediment basin and pass through structure (large tubes under 680th Ave) has effectively prevented sediment inflows from making it to the main basin of Hickory Grove Lake over the last 40+ years. However, it is difficult to identify how much longer the sediment basin will be effective at preventing sedimentation of the main basin. There are upland sources of sedimentation which will be addressed in the first phase of a proposed 12 year plan laid out in the following section of this document. After these sources of sedimentation are addressed in phase 1, in phase 2 the IDNR Lakes Restoration Group plans to perform a lake drawdown and dredge the sediment basin.

Studies have shown that internal phosphorus loading due to external sediment deposition is a significant factor in measured total phosphorus concentrations in lake water. Internal phosphorus loading effects vary however it has been found to be increasingly detrimental in shallower water bodies where the sediment surface to water column ratio is relatively low. Further, internal loading from bed sediments has been found to be very persistent often causing decline in lake water quality well after (decades later) external sources of sedimentation are addressed. Phosphorus can be released from sediment depths as low as 20 cm and the release/retention mechanisms are many, often site-specific, and complex which include a large number of chemical, physical and biological variables (Sondergard et al., 2003). While it is difficult to model or quantify the impact of deposited bed sediments on internal P loading the impact of such sediment has been found to be significant. Dredging of phosphorus-rich deposited bed sediment

has been found to be an effective tool for reducing internal phosphorus loading and should take place in the east basin of Hickory Grove Lake in conjunction with the other best management practices laid out in this management plan as an internal phosphorus load reduction of 2,287 pounds per year is needed to maintain a TSI of 63 or below.

EAST SEDIMENT POND AND SOUTH DRAIN:

The south drain and eastern sediment ponds were constructed in 1970 and 1971, respectively, to trap sediment and nutrients from the south before entering Hickory Grove Lake. The east sediment pond is now sediment filled and capacity for any pre-treatment of water before entering the lake has been greatly reduced, also partially due to modifications made to the standpipe which once held back water for primary treatment. Standpipe modifications were made to alleviate problems with water backing up into an adjacent landowner's newly acquired field shortly after transfer of the land in 1989. A verbal agreement for backing-up water with the pre-existing landowner was not carried through during land purchase and modification of the standpipe was performed to alleviate tension over inadequate drainage. Excavation of the east sediment pond without building the area up may only provide minimal sediment and water storage. Land acquisition of the 15.3 acres directly to the south of the East Game Area of Hickory Grove Park may be a viable option for increasing pre-treatment potential of water, as well as sediment and emergency storage of water and should be prioritized if such funds should become available. A feasibility study is needed to identify the best potential options for restoring functionality to the east sediment pond.

In order to maintain and improve the water quality of the main basin of Hickory Grove Lake as based on a TSI level of 63, TP loads to the South Drain must be reduced by 10%. There are additional gully and streambank sources of erosion in the south game area surrounding the South Drain of Hickory Grove Park which were not documented in the original RASCAL assessment completed in 2010. Further investigation is needed in the south game area to determine BMPs for recommendation. Dredging the South Drain has been discussed which could increase the potential for primary treatment of water before entering the main basin of Hickory Grove Lake via a standpipe structure running under 255th St . A feasibility study is also needed to identify the best potential options for restoring functionality to the South Drain location.

1994 2006 2010 2012

Figure 31. Historical Imagery for the Hickory Grove Lake Sediment Basin (large 2010)

8 WATER MONITORING PLAN

8.1 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan was prepared by Iowa State University and approved by the Iowa DNR. The plan covered monitoring at five locations in the watershed described previously in section 5.2 Water Quality Data. The document Hickory Grove Water Quality Improvement Plan QAPP R2 is on file with the IDNR and also with Iowa State University. The water monitoring procedures used by ISU from 2010-2012 and outlined in the QAPP will be used in future monitoring activities.

8.2 WATER MONITORING PLAN

A comprehensive watershed management plan will maintain the current monitoring network throughout all phases of the project. Continued beach monitoring by SCCB in collaboration with IDNR will ensure the beach is safe for swimming and allow for tracking progress and success of the plan. Continued monitoring at sites monitored by ISU will allow for tracking of bacteria and nutrient sources from the watershed, as well as those leaving Hickory Grove Lake and being deposited into East Indian Creek. Future monitoring data will be used in conjunction with in-lake monitoring to ensure Hickory Grove Lake is meeting water quality goals and direct future watershed improvement efforts. If a secondary compliance location for class A2 designated use at the lake inlet is instituted the existing modeling network could be expanded to include monitoring immediately downstream of the livestock exclusion reach allowing for further tracking of progress toward project goals.

9 IMPLEMENTATION SCHEDULE AND FUNDING PLAN

Table 19. Total cost of financial resource needs in 2012 ($).

Component	Phase 1 Years 1-3	Phase 2 Years 4-6	Phase 3 Years 7-9	Phase 4 Years 10-12	Total Cost	Potential Funding Sources
Groom and Fence Island Location	$ -	$ -	$ -	$ -	$ -	SCCB (in-kind)
Fence Beach outside Rec. Season	$ 250	$ -	$ -	$ -	$ 250	319, SCCB (in-kind)
"Away with Geese" Lights (4)	$ 1,500	$ -	$ -	$ -	$ 1,500	319, SCCB (in-kind)
Pyrotechnic Launcher (2)	$ 100	$ -	$ -	$ -	$ 100	319, SCCB (in-kind)
Screamers, Bangers and Primers	$ 250	$ 250	$ 250	$ 250	$ 1,000	
Sonic Deterrent	$ 1,000	$ -	$ -	$ -	$ 1,000	319, SCCB (in-kind)
Green Laser	$ 2,000	$ -	$ -	$ -	$ 2,000	
Native Landscaping	$ -	$ -	$ -	$ -	$ -	SCCB (in-kind)
Retractable Fence during Rec. Season	$ 200	$ -	$ -	$ -	$ 200	319, SCCB (in-kind)
Livestock Exclusion-Materials Cost	$ 2,000	$ -	$ -	$ -	$ 2,000	USDA-NRCS (EQIP), WIRB,
Installation Cost	$ -	$ -	$ -	$ -	$ -	Landowner (in-kind)
Alternative Watering Location (pond)	$ 17,000	$ -	$ -	$ -	$ 17,000	USDA-NRCS (EQIP), 319, WIRB, Landowner
Streambank Stabilization (Out-of-Park)	$ 500,000	$ -	$ -	$ -	$ 500,000	USDA-NRCS (EQIP), 319, WIRB, Landowner, SWCD, Story Co.
Gully Stabilization (Out-of-Park)	$ 20,000				$ 20,000	USDA-NRCS (EQIP), Landowner
Maintain/re-enroll CRP (40 ac)	$ -	$ -	$ -	$ -	$ -	USDA-NRCS, landowner
Shoreline Stabilization	$ 25,000	$ 25,000	$ -	$ -	$ 50,000	IDNR Lakes, Story County
Gully Stabilization (In-Park)	$ -	$ -	$ -	$ -	$ -	SCCB (in-kind), EPA 5-Star
Streambank Stabilization (In-Park)	$ -	$ -	$ -	$ -	$ -	SCCB (in-kind)
Dredging of east settling basin	$ -	$ 1,600,000	$ -	$ -	$ 1,600,000	IDNR Lakes, Story County
Address unpermitted septics	$ 32,000	$ 32,000	$ -	$ -	$ 64,000	Story SWCD, Story Environmental
Demonstration + pump vouchers	$ 5,000	$ -	$ -	$ -	$ 5,000	Health Department, Landowner
Water Monitoring	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 120,000	IDNR Lakes, 319
Public Outreach	$ 10,000	$ 5,000	$ 5,000	$ 5,000	$ 25,000	
Project Administration (1 ½-time salary + benefits)	$ 82,200	$ 82,200	$ 82,200	$ 82,200	$ 328,800	319, Story County, SCCB, Prairie Rivers RC&D
Totals	$ 728,500	$ 1,774,450	$ 117,450	$ 117,450	$ 2,737,850	

9.1 TECHNICAL ASSISTANCE AND RESOURCE NEEDS

Table 19 provides an estimate of the total cost of the recommended best management practices included in this plan and identifies potential funding sources which will be important to realization of the work proposed. Cost-share opportunities will be sought after and utilized as available in order to best leverage potential sources of funding. Technical assistance and cost-share will be critical to moving the project forward. This includes but is not limited to technical and financial assistance from agencies including; U.S. EPA, USDA-NRCS, IDNR, and IDALS-DSC. Programs such as the USDA-NRCS Environmental Quality Incentive Program (EQIP) and the Conservation Reserve Program (CRP) will be utilized as applicable for on-farm watershed work. Technical and financial assistance from IDALS-DSC should be pursued and may include applicable programs such as the Low and No-Interest Loan Program (SRF), the Iowa Financial Incentives Program (IFIP), the Watershed Protection Fund (WFP), and the Watershed Improvement Review Board (WIRB). Further assistance will be sought from the U.S. EPA 5 Star Restoration Program, as well as Section 319. Technical and financial assistance from the Iowa Department of Natural Resources will also be needed including the Non-Point Source Program, Lake Restoration Program, and the Publicly Owned Lakes (POL) Program. Technical design assistance will be necessary from USDA-NRCS and IDNR staff.

10 REFERENCES

Agouridis, C.T., S.R. Workman, R.C. Warner, and G.D. Jennings. 2005. Livestock Grazing Management Impacts on Stream Water Quality: A Review. Journal of the American Water Resources Assoc. June. Paper No. 04076: 591-606.

Andrews, A. 2012. Personal communication (Email: andrews1@iastate.edu). Ames, IA.: Iowa State University.

Andy, Asell. 2012. Personal Communication (Email: andy.asell@dnr.iowa.gov). Des Moines, IA.: Iowa DNR.

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

Carlson, R.E and J. Simpson. 1996. A coordinator's guide to volunteer lake monitoring methods. North American Lake Management Society. 96pp.

Christenson, L., A. Bhandari, M. Helmers, K. Kult, T. Sutphin, and R. Wolf. 2012. Performance Evaluation of Four Field-Scale Agricultural Drainage Denitrification Bioreactors in Iowa. ASABE ISSN 5151-0032.

Haan, M.M., J.R. Russel, W. Powers, J.L. Boehm, S. Mickelson, and R. Schultz. 2004. Impacts of Cattle Grazing Management on Sediment and Phosphorus Loads in Surface Waters. Iowa State University Animal Industry Report. Environment A.S. Leaflet R1921.

Helmers, M.J. 2012. Personal communication (Email: mhelmers@iastate.edu). Ames, IA.: Iowa State University.

Ikenberry, C. 2012. Personal communication (Email: Charles.Ikenberry@dnr.iowa.gov). Des Moines, IA: Iowa DNR.

Jha, M., P.W. Gassman, and J.G. Arnold. 2007. Water Quality Modeling for the Raccoon River Watershed using SWAT. *Transactions of ASABE.* 50(2): 479-493.

Jha, M. 2009. Hydrologic simulations of the Maquoketa River Watershed using SWAT. Center for Agricultural and Rural Development (CARD). Paper: 09-WP-492.

Larson, R.E. J.R. Miner, J.C. Buckhouse, and J.A. Moore. 1994. Water-Quality Benefits of Having Cattle Manure Deposited Away from Streams. Bioresource Tech. 48(2):113-118.

Line, D.E., W.A. Harman, G.D. Jennings, E.J. Thompson, and D.L. Osmond. 2000. Nonpoint-Source Pollutant Load Reductions Associated with Livestock Exclusion. J. Environ. Quality 29(6):1882-1890.

Line, D.E. 2003. Changes in a Stream's Physical and Biological Conditions Following Livestock Exclusion. ASABE ISSN 0001-2351. Vol. 46(2): 287-293.

Meals, D.W. 2001. Water quality response to riparian restoration in an agricultural watershed in Vermont, USA. Water Science and Tech. 43(5): 175-182.

MPCA. 2005. Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria. September 2005.

Owens, L.B., W.M. Edwards, and R.W. Van Keuren. 1996. Sediment Losses From a Pastured Watershed Before and After Stream Fencing. J. Soil and Water Conserv. 51(1):90-94.

Pennington, J., A. Sharpley, J. Jennings, M. Daniels, P. Moore Jr., and T. Daniel. Grazing Management Affects Runoff Water Quality and Forage Yield. Ag. and Natural Resources FSA9530-PD-6-09N. University of Arkansas Division of Agriculture. (http://www.uaex.edu)

Schilling, K.E., and J. Spooner. 2006. Effects of watershed-scale land use change on stream nitrate concentration. *J. Environ. Qual.* 35: 2132-2145.

Sondergard, M., J.P. Jenson and Erik Jeppesen. 2003. Role of sediment and internal loading of phosphorus in shallow lakes. National Environmental Research Institute, Denmark. Hydrobiologia 506-509: 135-145.

Sullivan, T.J., J.A. Moore, D.R. Thomas, E. Mallery, K.U. Snyder, M. Wustenberg, J. Wustenberg, S.D. Mackey, and D.L. Moore. 2007. Efficacy of Vegetated Buffers in Preventing Transport of Fecal Coliform Bacteria from Pasturelands. Environmental Management 40: 958-965.

Total Maximum Daily Load for Wagon Train Lake – Lancester County, Nebraska for Sediment and Phosphours. Nebraska Department of Environmental Quality.

Hickory Grove Lake Watershed Citizen Awareness Campaign

DRAFT

Prepared by Jacqueline Comito, Aaron Andrews, Carol Brown, Ann Staudt and Nathan Stevenson

October 1, 2012

Funded by:

Story County Soil and Water Conservation District and

Iowa Department of Natural Resources USEPA Section 319

In cooperation with Iowa Learning Farms – *Building A Culture of Conservation*

Special Thanks to Watershed Project Coordinator Aaron Andrews

Hickory Grove Lake Watershed Awareness Campaign

Background

A 98-acre man-made lake located in Story County, Iowa, Hickory Grove Lake is an important recreational resource for Iowa citizens and travelers through the state. The lake flows into East Indian Creek, which is a tributary of the Skunk River. Hickory Grove Park is the largest and most popular park maintained by Story County Conservation. This recreational area receives more than 70,000 visitors each year. Some attractions of this lake and park include hiking trails, camping, hunting, boating and canoeing, fishing and cross-country skiing.

The Hickory Grove Lake Watershed is a sub-basin of the HUC 8 South Skunk River Watershed - 07080105. It has a drainage area of 4,035 acres and the land use is dominated by cropland (84.7%); major crops are corn and soybeans.

A review of the 2010 U.S. Census showed that 89,542 people live in Story County. The watershed population is quite small with approximately 15 farms and nearly the same number of landowners and operators involved in row crop production on these farms. Additionally, there are 28 residences located within the watershed. Not all of the landowner/operators live within the watershed. While there are no communities in the watershed itself, there are several small towns within Story County and adjacent Marshall County in which the lake serves as a popular recreational area.

According to the Iowa Surface Water Classification, the lake is designated for primary contact recreation, aquatic life and human health uses. In 2008, it was listed on the 303(d) Impaired Waters Listing for elevated bacteria levels. Hickory Grove Lake is experiencing event-driven water quality problems. Surface runoff related to precipitation events has led to gully erosion as well as debris and nitrogen spikes immediately after these events. The eastern end of the lake is now sediment filled, limiting boat access. The fishery is healthy, however, carp have destroyed much of the vegetation and IDNR considered a lake drawdown after the fish population estimate in the fall of 2010.

Goals and Strategies

The primary goals of this campaign are to promote an appreciation of Hickory Grove Lake and Park and to generate pride in local water quality, which ultimately will require changes in habits and practices. Also important in this project is education about bacteria and how high levels harm water quality, and in turn animals and humans. The changes made can eventually remove the Hickory Grove Lake Watershed from the U.S. EPA 303(d) impaired water bodies list.

Hickory Grove Lake Watershed contains farmland, park property, roads and rural acreages but people come from all around central Iowa to utilize the lake and park. This campaign must have components that reach out to watershed residents as well as lake and park users. The materials suggested in this proposal were created with this in mind and the goal of reaching multiple audiences. In addition to any immediate action generated by this project, this outreach campaign should create *lasting* tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park.

Audience I: Landowners and Operators

Due to the fact that there are so few landowners and operators within the watershed, personal nurturing of watershed residents is the most appropriate approach to garner trust and ultimately change.

During spring 2012, watershed coordinator Aaron Andrews conducted one-on-one interviews with 80 percent (12) of the producers in the watershed. The purpose was to gain a better understanding of landowners' perceptions of water quality issues within the watershed and to assess their willingness to participate in a watershed improvement project.

Prior to these conversations, most of the landowners did not have a strong understanding of the water quality issues in the watershed. Andrews informed landowners of the elevated bacteria levels in the lake that are likely due to a combination of factors including; the resident geese population, unrestricted cattle access to a stream feeding the lake and contributions from one or more faulty/outdated septic systems in the watershed.

Preliminary outcomes with watershed residents' interviews

- All 12 of the landowners were very agreeable to whatever measures that would be taken to prevent the geese from polluting the beaches.

- Only one out of the 12 landowners interviewed had an unpermitted septic system. This landowner was open to getting more information about the potential for updating their system. Further work is needed to address septic system issues. Andrews will plan to contact the remaining landowners having unpermitted/outdated septic systems in the watershed (eight in total).
- Eleven of the 12 landowners expressed interest in putting additional conservation practices on their land to help improve water quality if significant funding were available to help pay for these practices. They had the strongest interest in installing additional waterways, but the primary impairment of the lake is bacteria. While EPA, Section 319, funds would only be available for those practices that directly address bacteria reductions, there are other programs available for other problems in the watershed that could lead to impairment in the near future.
- Six of the 12 landowners expressed reservations about working with agencies to improve the watershed and restore the lake.
    - One person said he preferred to be as far removed from government as possible. He also "preferred to stay out of the spotlight" and would allow signage on his land only if his name was not included on the sign.
    - Two landowners expressed concern about the quantity of water backing up on their land due to the now shallow silt retention basin located in the south end of the east game area in Hickory Grove Park. Tension over the issue stemmed from an unwritten easement with the previous landowner which allowed water to back up into the field during times when water levels were high.
    - Another landowner was "bitter" about a previous watershed improvement project because he was told his farm did not qualify for the incentives as being outside of the watershed, when in fact, his farm is within the watershed.
    - A landowner complained that during a project in the 1970s, promised cost-share dollars failed to materialize, and when they finally did materialize the incentives only went to those who were poorly managing the land (rewarding those for bad behavior). The landowner also expressed frustration that his increased efforts in conservation were not being met with similar efforts from others managing land within the watershed.

The one-on-one interviews were conducted prior to the controversy in late spring 2012 concerning the installation of a confined animal feeding operation (CAFO) immediately outside the watershed and approximately three quarters of a mile from Hickory Grove Lake. Two public meetings were held in June and hundreds of citizens were in attendance. The meetings were heated because citizens thought the CAFO would be too close to Hickory Grove Lake and Park. Most of the folks protesting the CAFO were from outside of

the watershed. Follow-up interviews will be held to see if this controversy had an adverse effect on landowners' willingness to participate in a watershed improvement project. The manure management plan has been withdrawn but the landowner plans to resubmit in the future. The proposed plan included manure application on a total of 345 acres, of which, approximately 150 acres were within Hickory Grove Lake Watershed. The landowner/operator manages an additional 80 acres within the watershed which were not included in the manure management plan.

The recent CAFO controversy makes it even more important to be aware of the sensitivities of the watershed residents, as well as those living near the park and lake. Given the success of the first round of personal interviews, additional conversations should be conducted by the watershed coordinator. The watershed improvement project needs the participation of its landowners. Trust needs to be built with the landowners in order to ensure their participation and make changes on the land.

Audience II: Hickory Grove Lake and Park Users

This campaign is aimed at promoting an appreciation of Hickory Grove Lake to regular lake users as well as attracting new lake users. As indicated by the lake usage survey (see page 15), users who were surveyed traveled an average of 26 miles to visit the lake: 14 percent lived in Colo, 11 percent were from Ames and 10 percent from Marshalltown. Fifty-three percent of the people surveyed using the lake were from Story County.

Because the lake users are from communities outside the watershed, the awareness and appreciation campaign must encompass a wider geographical scope. Residents in Story County including Ames, Nevada and Colo should be included. Also the campaign should expand to the east to include the Marshalltown area.

Water quality matters a great deal to the people using the lake. Respondents were asked to rank a list of issues concerning the lake as to whether it was *not important* to *very important* (see pages 15-17 of this report). The top three rankings as *very important* in the usage survey pertained to water quality: Safety from bacteria contamination/health advisories (80%), lack of water odor (45%) and water clarity (33%). Outreach campaigns should use these issues and explain how they connect to water quality and the plans to improve the overall watershed.

The Hickory Grove Lake Watershed (as all watersheds) is unique. Because there are no communities within the watershed and the majority of the lake users come from further distances, the awareness and appreciation campaign will have a different approach.

Branding Elements

Core branding elements for the watershed awareness campaign are being created to support this plan.

- Watershed identification logo: this logo was created in December 2011 and is currently being implemented into the marketing materials and signage.

- A campaign slogan is also an important branding tool. An example of a slogan is: **"Protecting today. Preserving tomorrow."** The slogan can be included on all of the components of the campaign in conjunction with the watershed identification logo.

Marketing Support

Several different marketing media will be utilized in the campaign. The outreach materials are designed to be complementary, promoting an awareness and appreciation for Hickory Grove Lake.

Brochure: A general overview brochure has been developed to inform readers about the watershed, the project and its goals. The language and images used in the brochure, and all appropriate materials, emphasize the importance of water quality for watershed residents and visitors to Hickory Grove Park. The brochure is currently available at the Story County Conservation Nature Center.

Brochures should be placed throughout Hickory Grove Park including the campground, two bathhouses and shelter houses. It should also be available at neighboring businesses including Twin Anchors Campground and Golf Course.

Brochures could be available at all of the local tourism bureaus including Ames Convention & Visitors Bureau, Iowa State University Visitors Booth and the Marshalltown Convention & Visitors Bureau.

News media: Regular press releases will be sent to area newspapers and radio stations to support the park's events and watershed improvement achieved goals.

A weekly radio segment that discusses conservation could be aired on the Ames radio station KASI-1430AM, featuring the watershed coordinator or a locally recognized personality.

Movie Theater advertising: Many theaters project local business ads prior to movie previews. Movie theaters are located in the cities of Nevada, Marshalltown and Ames. Ads promoting the watershed project and Hickory Grove Lake as well as why clean water quality is important to everyone can be part of these advertisements, provided the movie theater company participates in this practice.

Watershed Signage

Multi-Lingual Signage: Hickory Grove Lake is visited by a growing number of Spanish-speaking families and individuals. Although the lake usage surveys indicate that only three percent of the groups using the lake spoke Spanish, they should not be overlooked.

According to 2010 U.S. Census data, the nearby community of Marshalltown has a Hispanic population of 24.1 percent, which has doubled since 2000. Therefore, it is recommended that current warning signage, as well as new marketing signage, be made available also in Spanish. This will help protect the health of all lake users and recognize this segment of the population as important stakeholders in the campaign.

It is also recommended that the signage be moved in front of the beach where the visibility of the signage is most beneficial, especially given that 52 percent of respondents indicated that they used the lake for swimming and 80% of the respondents said it was *very important* to know if there was any safety issues concerning bacterial contamination and/or health advisories.

Watershed Boundary Signs: Signage will be created to mark the geographic boundaries of the watershed. The signs will say, "Now Entering Hickory Grove Lake Watershed" and will contain the logo and slogan. The signs will provide a different perspective of the area and introduce the concept of watersheds to those who may not have previous knowledge of it.

These signs will increase the visibility of and generate curiosity about the Hickory Grove Lake watershed project.

Promotional Road Signs: Small signs will be placed along well-traveled roads within the watershed, such as the entrances to Hickory Grove Park, containing sequential facts, as well as messages about the aesthetics of Hickory Grove. The signs will be reminiscent of the old Burma-Shave advertising road signs and placed in groups of four or five. The first three or four signs will contain the featured message with the last containing the logo and slogan for the watershed project. Each set of signs will be different, to engage people and generate curiosity about the project. Signs can include information about soil and water quality or just encourage those passing by to visit the park.

One example:

It's the beauty we observe Not to is a mistake Help us today preserve Hickory Grove Lake

Promotion In and Near Hickory Grove Lake and Park

Because most people who frequent the park come from surrounding towns, marketing materials need to be placed within the park itself as well as nearby sites where visitors frequent.

Informational posters about the watershed improvement efforts will be placed strategically throughout Hickory Grove Park including the campground, two bathhouses and shelter houses. Additional messaging should be posted to inform the lake users of upcoming events at or around the park using the permanent sign holders shown above.

Other posters could include explanations of park clean-up efforts such as the dogs that have been "hired" to scare away the geese. This would be a fun and interesting way to explain the problems and solutions along the beach at Hickory Grove Lake. A "biography" about the each dog and its work schedule could be posted which may encourage people (especially dog lovers) to make return trips to the park to see the dogs at work.

Campground: Sixty percent of those surveyed were camping at the lake. Therefore, informational brochures given to campers upon registering at Twin Anchors and the Hickory Grove Lake campgrounds would be an excellent means of increasing public awareness of watershed and water quality issues. Flyers can be placed in the bathhouses at the beach and the campgrounds with information on events and project progress.

Golf Course: Twin Anchors Golf Course is located near the entrance to Hickory Grove Park. To promote the park to golfers, special scorecards could be used that contain details about the watershed, the lake and the park. These scorecards could be made unique by numbering them and offering a daily drawing for a prize. The player with the corresponding number could win a complementary beverage or other prize funded by the watershed project. The intent is to encourage people to read the information more closely. Additional options for the scorecards could be to include a coupon as part of the scorecard to receive a logo'd golf ball or pack of custom golf tees with the project information on it.

Activities in Hickory Grove Park

Geocaching: Geocaching is a real-world, outdoor hi-tech treasure hunting game using GPS-enabled devices. Participants navigate to a specific set of GPS coordinates and then attempt to find the cache (container) hidden at that location. Geocaching is a fast growing activity across the United States. There are hundreds of smartphone applications for GPS and geocaching. Park employees or volunteers could work with the Iowa Geocachers Organization to promote the park as a geocache location (www.iowageocachers.org).

Because 22 percent of lake usage survey respondents indicated that they spent their time at the park for nature appreciation, geocaching would be an activity for those who appreciate nature and would help new users discover the beauty of the park.

Hickory Grove Park could have its own geocaching map so that people could explore the park and learn more about the watershed. The cache locations will be available to download from the Internet. Geocaching encourages people to visit all of the park's amenities; there are many niches in the park to explore.

Each cache will have a fact about the lake, park or watershed. The container's contents could change as watershed improvement progresses and events change at the park. Geocaching can be done as a group or people can venture out on their own. This is also a great family activity, which would be a great addition to Hickory Grove Lake Park due to the fact that ercent of lake usage respondents had an average of four children with them.

Hickory Grove Triathlon (http://www.hickorygrovetriathlon.com/**):** The Hickory Grove Triathlon is held annually in August. A partnership between the Hickory Grove Watershed Project and the Triathlon could be established and a general awareness event for the watershed improvement project could be held in conjunction with the triathlon.

The triathlon brings a different audience of athletes who may not utilize the lake any other time outside this event. Because the triathlon participants swim as part of the event (or can't because of high bacteria levels), the campaign could have a distinct impact.

In addition, silicone wristbands, are popular among athletes, could be created and provided to the athletes with their registration packets. The wristbands could contain the slogan of the watershed, the Hickory Grove logo and the triathlon logo.

Trick-or-Treat Night in the campground: As 59 percent of lake usage respondents indicated that they spend their free time camping, events that utilize the campgrounds could be promoted in this outreach campaign.

One such already established event is the annual Breezy Bay Campground Halloween Trick-or-Treat Night. The campers who participate are awarded a free night's stay at the campground. To promote the watershed campaign, candy could be given out to trick-or-treaters with messages attached about the Hickory Grove project. Additional park event promotion could also be included. This event could be expanded to include Twin Anchors campground also.

Appreciation Events: A Hickory Grove Lake Appreciation Day could be held to celebrate the progress made in the Hickory Grove Lake Watershed campaign. Live music, food, fishing and canoeing demonstrations and geocaching information could be included. Area organizations such as Pheasants Forever, Ducks Unlimited and the Izaak Walton League

could have information tables, too. The appreciation day could be held in the spring in conjunction with Earth Day.

The Iowa Learning Farms Conservation Station should be included at the appreciation day. The Conservation Station is an effective tool for demonstrating how conservation practices benefit water and soil quality and for bringing people together around conservation issues. The rainfall simulator component of the Conservation Station has an effective visual display, which demonstrates how different land practices (urban and rural) affect surface and subsurface water quality. The Conservation Station also contains a learning lab with various lessons that can be changed depending on the targeted message and audience at the event.

A fall event can be held to promote the park and its autumn colors such as a "Turkey Trot" 5k or 10k run around the lake. T-shirts with the watershed logo can be given away to participants and project informational brochure and flyers for events can be given to participants and visitors.

Learning Opportunity: As part of the campaign, an IOWATER volunteer water quality monitoring workshop could be held. Watershed residents should be encouraged to participate in the workshop with their children or grandchildren of appropriate ages. Then volunteers can conduct the monitoring together, so ownership of the watershed and pride in water quality can be nurtured through multiple generations. The IOWATER program also offers a subsequent workshop on bacteria monitoring, and this workshop could be offered locally if enough interest is generated.

All of the events provide opportunities for watershed residents and visitors to network and learn from one another and unite as a watershed community.

Expanded Area Promotion

Restaurants: Watershed residents and area lake users frequent the Country House Restaurant, located on Highway 30, as well as Niland's Café in Colo. Printed, paper placemats and table tents could be placed at dining tables in these restaurants. The placemats and table tents will contain information about Hickory Grove Lake Watershed project, the lake and the park to call attention to its amenities.

Other restaurants outside of the watershed should be targeted as well. There are several restaurants in the surrounding area including Ames, Marshalltown, Nevada, State Center,

Collins and Cambridge that may be willing to use placemats, display table tents and brochures.

Colleges and Universities: Hickory Grove is also unique in that it rests between a major university and an area community college. Iowa State University set a record for enrollment in 2012 with over 31,000 students. Marshalltown Community College enrolls an average of 2,000 students every year. Many students may not know of Hickory Grove Park and would likely take advantage of its close proximity.

There are bulletin boards and places for brochures where promotion about the lake and events could be posted. Table tents are also very common in the dining centers and would be viewed by thousands of students every day. Clubs and student organizations could utilize the shelter houses for meetings and outdoor activities. This may be a good group for creating some type of "friends of Hickory Grove Lake watershed". This would be a way to engage the fishing club, geocachers and other outdoors clubs that likely already exist at ISU.

Farmers Markets: Ames has three farmers markets that operate from May through October. They include the Ames Farmers Market, Main Street Market and North Grand Farmers Market. Colo and State Center also have regular farmers markets.

Those involved with the watershed project could have a booth with information about the project and what community members can do to improve water quality in their area. Handouts at the booth can include the general informational brochure and additional fact cards about water quality and what can be done to improve it (e.g. What is a watershed? What watershed do you live in? What are some of the issues that your community is facing with its water quality/impairments?). The booth should appeal to all ages. Kids can take home a picture to color or a worksheet regarding pollution and water quality.

The farmers market booth is also a great venue to promote upcoming events at the lake.

People Involvement

ILF Farmer Partners

Currently there is one resident within the watershed who is implementing several conservation farming practices to curb erosion and slow the flow of water. This farmer will be asked to become an Iowa Learning Farms partner and host a field day for watershed residents and other farmers to discuss his successful operation.

Youth Groups

Service clubs: Involving youth groups, such as Boy and Girl Scouts or 4-H, in the watershed project help bring awareness to the issues involving the watershed to new, younger audiences. This will help engage the next generation who will be taking care of the water quality and the lake. The groups can plan service projects that help the lake such as trash pick up days, painting picnic tables, etc.

Middle school and elementary students: Currently the Ames Middle School 6th grade class travels to Hickory Grove Lake for their annual outdoor day. Story County Conservation staff are educators for this event, teaching the basics of canoeing, team-building and compass skills.

The Conservation Station and/or a watershed activity could be added to the classes' rotations to learn about their surroundings that day and to learn more about water quality in general.

Other area schools could be invited to participate in their own outdoor classroom, of which Iowa Learning Farms will sponsor. Ideally, there would be five or six different learning stations, each with its own presenter or team of presenters. Iowa Learning Farms will work with the watershed coordinator and Story County Conservation to lead learning stations/group sessions during the day-long event. Examples of such partners may include local ISU Extension and Outreach personnel, local DNR/NRCS staff, local SWCD commissioners and local Farm Bureau personnel.

Students would be bussed to the park then divided into groups to experience the different learning stations. Student groups would rotate to each of the different learning stations, spending approximately 30 minutes at each stop, participating in such activities as nature hikes/scavenger hunts, fish species identification, birds and furs, geocaching, and water quality monitoring.

High School students: Another opportunity for youth involvement would be possible through a partnership with instructors and high school student organizations, including:

- Ames High School's 100th Green Butterfly Environmental Club
- Nevada High School FFA chapter
- West Marshall High School FFA chapter, which encompasses nearby communities State Center and Colo-Nesco High Schools

These groups could take a field trip to Hickory Grove or conduct an outdoor class and learn about the watershed.

Design and creation of a Hickory Grove Lake Watershed website could become a class project for students, in which the watershed coordinator and/or advisory board would serve as the client and consult with the teacher(s) and student group(s) regularly. In

addition to raising students' awareness of local environmental issues, this partnership would be a great learning opportunity for the students and would benefit the watershed project by utilizing students' computer and design skills.

College students: A partnership with the Program for Women in Science and Engineering (PWSE) at Iowa State University would be a great way to connect Hickory Grove Park to ISU. Outdoor classrooms could be conducted at Hickory Grove Lake Park or the organization members could be called upon to help with above outdoor activities at the park.

Church groups: People often use their church for idea exchange and discussion on a variety of topics, religious and nonreligious. Clean water is a human right and discussing within the church community why and how to clean up local waters would be appropriate. By calling awareness of Hickory Grove Park to area churches and their various groups, the park could be used as a venue for classes, social and youth group activities.

High School/Community/Sporting Events: The Hickory Grove Lake watershed project could increase its presence in the surrounding local communities and generate renewed interest in project efforts through sponsorship at local sporting events.

Time frame

Quarter 1: January-March	• General informational brochure (finished) • Establish geocaching • Continue one-on-one conversations with watershed residents • Website creation
Quarter 2: April-June	• Create and erect beach signage and other park signage • Watershed boundary signs • Appreciation Day event • Develop placements for area restaurants • Conduct outdoor classrooms • Continue one-on-one conversations with watershed residents
Quarter 3: July-September	• Create & distribute table tents for college dining halls • Service club projects (cleaning, painting, etc) • Triathlon (August) • Conduct outdoor classroom (Sept) • ILF Field Day • Continue one-on-one conversations with watershed residents
Quarter 4: October-December	• Trick-or-treat night at campground • Turkey Trot 5K run • Continue one-on-one conversations with watershed residents

Proposed Budget for Awareness Campaign

Item	Quantity	Budget
Brochures	2000	$425.00
Custom golf scorecards	1000	$120.00
Paper placemats	5000	$1600.00
Table tents	1000	$65.00
Coloring pages	500	$225.00
Fact cards	4000	$65.00
Watershed boundary signs 24x36”	10	$750.00
“Burma-shave” style signs-5 sets	25	$450.00
Beach & Park signage	6	$400.00
Custom-printed golf balls	300	$437.00
Silicon wristbands	1000	$300.00
Trick-or-treat expenses (candy and printing)		$100.00
HGL Appreciation Day		
Promotion		$200.00
Food/table service		$350.00
Musician honorarium		$350.00
Turkey Trot fundraiser		
Promotion		$200.00
Food/table service		$350.00
T-shirts	100	$1050.00
*Registration fees $25.00	150	+$3750.00
Memberships		
Ames Convention & Visitors Bureau		$200.00
Marshalltown CVB		$200.00
Colo-Nesco Athletic Booster Club		$100.00
AHS Athletic Booster Club		$350.00
Movie theatre Advertising Ames Cinemark theaters	30 sec. spot	$1000.00
Other items of minimal or no-cost		
Geocaching containers		
**Website		

*This is estimated income for the fundraiser. ** Story County Conservation has a departmental webpage on the www.storycountyiowa.gov website, in which Hickory Grove Park is included. This could be expanded at no cost.

Income-generating ideas:

- ☐ Sell wristbands at Triathlon or school functions (i.e. football, basketball games)
- ☐ Concessions at school athletic events: portion of purchase goes to HGL (hot chocolate, popcorn)
- ☐ Turkey Trot is a fundraiser. Registration fees go to support HGL
- ☐ Hickory Grove Lake Charity Golf Outing. Registration fees to go support HGL
- ☐ Community Grants through Ames and Marshalltown Convention and Visitors Bureau and/or Chamber of Commerce

Hickory Grove Lake Watershed

Lake Usage Survey Results

An important part of mapping a watershed's community is usage surveys to help gain a better understanding of the ways that visitors use Hickory Grove Lake—the main focus of the watershed. Recreational areas, such as Hickory Grove Lake, bring numerous people to the watershed and also make up the fabric of the human landscape for an area.

Lake usage surveys allow the researcher to make observations about how a lake is used at any given time as well as talk with people who are utilizing the lake. Lakes can be a great point of entry for educating people about water quality issues as well as organizing action. Because of the economic and social importance of lake use in Iowa, having good water quality is a salient issue for many communities.

At three different times throughout the year (August 2011 to August 2012), members of the watershed-based community assessment team walked around Hickory Grove Lake conducting lake usage surveys. They started at the beach and campgrounds and worked their way around the lake, asking each group of people they met if they were willing to answer a few questions concerning their use and experience of Hickory Grove Lake. The survey was also administered in Spanish because of the significant number of native Spanish speakers recreating at the lake. The team conducted 88 group interviews representing 379 visitors to the lake.

This section of the watershed-based community assessment reports the results of a lake usage survey conducted for Hickory Grove Lake. This project is a collaboration between Iowa State University Extension and the Hickory Grove Lake Watershed group. Funded by Hickory Grove Lake Watershed planning group and Iowa Department of Natural Resources Section 319 funds, the purpose of this project is to develop and test a community assessment tool that can be used by watershed action teams and coordinators to better understand the community understanding of watersheds. Effective community assessments will allow watershed groups to develop goals, outreach and education regarding water quality challenges based on the values of the people living in the watershed.

Hickory Grove Lake Usage Survey (n=88 groups)

**3% of groups surveyed were native Spanish speaking (6% of the people)*

1. **How often do you visit the lake?**

17%.....First time
3%.....Daily
9%.....Every other day
6%.....Every week
8%.....Bi-weekly
16%.....Bi-monthly
32%.....2-4 times a year
8%.....Once a year

2. **Which seasons do you visit lake?**

17%.....Winter
32%.....Spring
95%.....Summer
37%.....Fall

3. **How many years have you been coming to the lake?**
average of 12 years (range 1 to 50 years)

4. **Where do you live?**

14%.....Colo
11%.....Ames
14%.....Nevada
10%.....Marshalltown
8%.....State Center
53%.....Inside Story County
47%.....Outside Story County

5. **How many miles do you drive to come to the lake?**
Average 26 miles; 60% drive 20 miles or less

6. **Please indicate the types of activities you do while you are visiting Hickory Grove Lake and what percentage of the time you do that activity.**

Activity ***Percentage of time***

Fishing..... 59%
Camping..... 59%
Recreational boating..... 18%
Swimming/ beach use..... 52%
Nature appreciation..... 22%
Picnicking..... 42%
Snowmobiling or winter activities..... 8%

Please indicate the importance of each of the lake characteristics.

Lake characteristic	No opinion	Not important	Somewhat important	Important	Very important
Water clarity		12%	18%	37%	33%
Hard, clean, sandy lake bottom in swimming area	7%	13%	11%	38%	31%
Lack of water odor	1%	7%	15%	32%	45%
Diversity of wildlife	9%	15%	29%	30%	17%
Diversity of fish species	8%	15%	15%	39%	23%
Quantity of fish caught	9%	22%	23%	30%	16%
Safety from bacteria contamination/health advisories		5%	2%	13%	80%

52% Male

48% Female

(approximate breakdown of sex by all folks represented with survey)

Age: 43 years (primary respondent)

Number of people in your group at lake: average group size is 4

39% of groups had an average of 4 children with them

APPENDIX B. HICKORY GROVE LAKE WATER QUALITY DATA

Parameter	2012	2011	2010	2009	2007	2006	2005	2004	2003	2002	2001	2000
Lake Depth (m)	9.9	10	10.4	10.2	10.3	10.1	10.4	10.5	10.5	8.8	11.1	10.7
Secchi Disk Depth (m)	1.4	1.1	0.7	1	1.3	2	2.9	1	2.7	3.1	1.9	1.4
Temperature(^{o}C)	23.1	23.3	23.3	23.1	25	25.2	24.3	21.7	23.5	26	22.2	24.2
Dissolved Oxygen (mg/L)	6.3	11.4	11.3	11.4	10.5	9.8	10.8	9.8	10.6	9.2	9.7	11.8
Dissolved Oxygen Saturation (%)	74.6	137	133	134.1	126.5	118.9	128.8	111.6	124.9	112.5	109.9	140.7
Specific Conductivity (µS/cm)	366.7	383	373	380	403	512.3	521.8	360.1	438.2	470.6	435.9	407.5
Turbidity (NTU)	8.8	13.7	9.3	9.8	7	8.4	8.2	26.3	5.1	2.7	5.2	5.7
Chlorophyll a (µg/L)	22.8	26.3	22.4	37.3	17.8	6.9	15.6	19.8	17.1	7.2	15.3	6.6
Total Phosphorus as P (µg/L)	41.3	48.9	80.6	67.5	45	15	35	134	30	25	56	67
SRP as P (µg/L)	10.3	<11	22.1	<9	<1	<1	<1	<1	2	<1	-	-
TKN (mg/L)	1	1	2	-	-	-	-	-	-	-	-	-
Total Nitrogen as N (mg/L)	-	-	-	4.3	9.08	6.42	9.04	7.44	9.09	9.46	12.24	3.24
(Phenate)Ammonia Nitrogen (NH_3 + NH_4^+) as N (µg/L)	99	148	168	<130	56	53	103	100	-	-	-	-
(Phenate)Ammonia Nitrogen (NH_3) as N (un-ionized)(µg/L)	<PQL	<PQL	<PQL	<130	7	5	12	8	-	-	-	-
Nitrate + Nitrite (NO_3 + NO_2) as N (mg/L)	1	5	3	3	8.03	5.8	7.89	6.22	7.91	8.4	11.99	1.12
TN:TP ratio	-	-	-	65	198	506	292	96	331	408	265	51
pH	8.4	8.3	8.3	8.7	8.6	8.2	8.3	8.4	8.6	8.4	8.1	7.8
Alkalinity as $CaCO_3$ (mg/L)	141	142	152	155	144	177	189	118	95	157	144	161
Silica as Si (mg/L)	-	-	-	-	-	-	5.43	7.77	2.47	1.55	-	-
Dissolved Organic Carbon (mg/L)	4	<7.6	<6.4	<6.2	4.15	3.51	3.48	4.1	7.71	9.12	-	-
Inorganic Suspended Solids (mg/L)	<2	<5	4	9	3	4	4	10	3	6	2	2
Volatile Suspended Solids (mg/L)	6	8	9	<8	4	3	4	5	4	4	2	4
Total Suspended Solids (mg/L)	8	10	14	12	7	7	8	15	7	10	5	6
Carlson Trophic State Index (Secchi)*	56	59	65	60	57	50	45	60	46	44	51	55
Carlson Trophic State Index (Chl a)*	61	63	61	66	59	50	58	60	58	50	57	49
Carlson Trophic State Index (TP)*	58	60	67	65	59	44	55	75	53	50	62	65

*Source: IDNR Lakes Information System, reporting by Limnology Laboratory, Iowa State University.

APPENDIX C. E. COLI RESULTS 2004-2012

Date	E. coli (cfu/100 ml)
6/2/2004	54
6/14/2004	0
6/21/2004	60
6/28/2004	10
7/6/2004	110
7/12/2004	45
7/19/2004	0
7/27/2004	140
8/4/2004	200
8/10/2004	100
8/16/2004	70
8/30/2004	280
5/23/2005	0
6/6/2005	0
6/13/2005	55
6/20/2005	0
6/27/2005	73
7/5/2005	20
7/11/2005	0
7/18/2005	45
7/25/2005	0
8/1/2005	1300
8/8/2005	2700
8/15/2005	190
8/22/2005	150
8/29/2005	82
5/23/2006	0
5/30/2006	0
6/5/2006	2000
6/12/2006	0
6/19/2006	0
6/26/2006	0
7/5/2006	6
7/10/2006	30
7/17/2006	0
7/24/2006	0
8/7/2006	700
8/14/2006	320

8/21/2006	20
5/22/2007	0
5/29/2007	70
6/4/2007	10
6/11/2007	30
6/18/2007	36
6/25/2007	10
7/2/2007	20
7/9/2007	10
7/16/2007	20
7/23/2007	0
7/30/2007	150
8/6/2007	170
8/13/2007	40
8/20/2007	140
8/27/2007	80
5/27/2008	180
6/2/2008	180
6/16/2008	63
6/23/2008	0
6/30/2008	30
7/7/2008	20
7/14/2008	10
7/21/2008	1200
7/28/2008	1500
8/4/2008	160
8/11/2008	30
8/18/2008	31
8/25/2008	10
6/16/2009	120
6/29/2009	0
7/6/2009	41
7/13/2009	63
7/20/2009	10
7/27/2009	110
8/3/2009	10
8/10/2009	1200
8/17/2009	0
8/24/2009	1900
6/14/2010	20
6/21/2010	10

6/28/2010	74
7/5/2010	0
7/12/2010	52
7/18/2010	610
7/26/2010	930
8/9/2010	120
8/16/2010	0
8/23/2010	31
8/30/2010	200
6/6/2011	1900
6/27/2011	63
7/5/2011	5
7/11/2011	95
7/25/2011	790
8/1/2011	670
8/8/2011	98
8/15/2011	700
8/22/2011	790
8/29/2011	5
5/21/2012	430
5/29/2012	97
6/4/2012	10
6/11/2012	20
6/18/2012	10
7/2/2012	98
7/9/2012	250
7/16/2012	220
7/23/2012	10
7/30/2012	2000
8/9/2012	1800
8/13/2012	3100
8/20/2012	1300
8/27/2012	12000

APPENDIX D. POSITIVE OPTICAL BRIGHTENER RESULT

Water Laboratory

Iowa Department of Natural Resources

Date of Report: 11/21/2011

Rohith Gali Doctoral Student Dept. of Ag & Biosystems Engineering Iowa State University Ames, IA 50010	Project Date Collected Date Received Collection Town Sample Matrix Collector Phone	Hickory Grove 11/10/2011 11/15/2011 Colo Surface Water Rohith Gali
Comments:		

Results of Analyses

Optical Brighteners

Sample Number	Collection Site	Collection Time	Concentration (µg/L)	Detection Limit (µg/L)
201102230	Tile Drain	09:45	23.3	0.1

Date Analyzed: 11/16/2011 Analyst: JM

Method: excitation fluorometry Verified: JM

Explanation of terms and abbreviations used within this report:

µg/L – micrograms per liter of water
Detection Limit – lowest concentration reliably measured

Please contact Jason McCurdy at (319) 335-1571 or Jason.McCurdy@dnr.iowa.gov with questions.

End of Report

Jason McCurdy
Microbiologist/Lab Coordinator

Oakdale Iowa Geological Survey
Water Laboratory
2390 Old Farmstead Road
Coralville, IA 52241
(319) 335-1571

APPENDIX E. MILESTONE METRICS AND PROJECT OUTCOMES

Goal 1: Address bacteria impairment of Hickory Grove Lake & remove it from the 303(d) list				**Phase 1**				
Goal 2: Reduce bacteria delivery to Hickory Grove Lake inlet								
Goal 3: Reduce total sediment and phosphorus loading by 677 tons per year and 3,492 pounds per year, respectively.								
Goal 4: Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages both in and outside the Hickory Grove Lake Watershed								
		Milestone metric	Milestone totals	2014	2015	2016	Project Outcome	Estimated Load Reductions
Task 1:	Implement goose management plan eliminating beach usage through various methods such as landscaping, fencing, and scare tactics.	geese population and reduction of geese on beach year round	100% Reduction	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	Reduction in beach bacteria sampling to <5% SSM violations and total elimination of geometric mean violations	Estimated 100% reduction of bacteria load to beach
Task 2:	Eliminate 100% of livestock access to stream within the watershed and install alternative watering source	% of livestock with no stream access	100%	Install 3,000 feet fencing and embankment pond	Task complete provided adequate cost-share is available		Reduction in bacteria and TP loading to lake inlet	Estimated reduction of 2.63×10^{10} *E. Coli* orgs. and TP by 28 pounds per year
Task 3:	Inspect, clean out, repair or update 100% of unpermitted septic systems in the watershed	100% fully functional and permitted septic systems	100%	2	2	2	Reduction in bacteria and TP loading to lake inlet	Estimated reduction of bacteria by 3.17×10^{12} *E. Coli* orgs and TP by 18.4 pounds per year*
Task 4:	Install strategically placed BMPs	Feet Shoreline Stabilized Feet Streambank Stabilized No. Gully Complexes Stabilized Acres Riparian Buffer Feet Grassed Waterways Acres Rotational Grazing Plan Acres CRP	2,000 ft 6,384 ft No. 15 2 ac 10,000+ ft 10 ac 40 ac	1,000 ft 2,800 ft 5 no. 2 ac. 2,000 ft. 10 ac. Maintain	1,000 ft 3,420 ft 5 no. Maintain 2,000 ft. Maintain Maintain	Complete 164 ft 5 no. Maintain 2,000 ft. Maintain Maintain	Reduction in TP & sediment loading from shoreline and external sources	Estimated reduction of sediment by 677 tons per year and TP by 1,067 pounds per year
Task 5:	Perform east basin dredging	cubic yards	197,600 yd^3	Begin 2017			Extend design life of east (sediment) basin and internal P load reduction	Extend functional life to 100+ years and internal P reduction of >2,287 pounds per year
Task 6:	Promote water quality messages through public outreach plan	select components of public outreach campain	100%	Throughout the life of the project work to create *lasting* tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park				

*Assuming a 50% failure rate and a 65% delivery rate

APPENDIX E CONT.

Goal 1: Address bacteria impairment of Hickory Grove Lake & remove it from the 303(d) list				**Phase 2**				
Goal 2: Reduce bacteria delivery to Hickory Grove Lake inlet								
Goal 3: Reduce total sediment and phosphorus loading by 677 tons per year and 3,492 pounds per year, respectively.								
Goal 4: Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages both in and outside the Hickory Grove Lake Watershed								
		Milestone metric	Milestone totals	2017	2018	2019	Project Outcome	Estimated Load Reductions
Task 1:	Implement goose management plan eliminating beach usage through various methods such as landscaping, fencing, and scare tactics.	geese population and reduction of geese on beach year round	100% Reduction	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	Reduction in beach bacteria sampling to <5% SSM violations and total elimination of geometric mean violations	Estimated 100% reduction of bacteria to beach
Task 2:	Eliminate 100% of livestock access to stream within the watershed and install alternative watering source	% of livestock with no stream access	100%	Task complete provided adequate cost-share is available				
Task 3:	Inspect, clean out, repair or update 100% of unpermitted septic systems in the watershed	100% fully functional and permitted septic systems	100%	2	Task complete provided adequate landowner cooperation			
Task 4:	Install strategically placed BMPs	Feet Shoreline Stabilized Feet Streambank Stabilized No. Gully Complexes Stabilized Acres Riparian Buffer Feet Grassed Waterways Acres Rotational Grazing Plan Acres CRP	2,000 ft 6,384 ft No. 15 2 ac 10,000+ ft 10 ac 40 ac	Complete Complete Complete Maintain 2,000 ft. Maintain Maintain	Complete Complete Complete Maintain 2,000 ft. Maintain Maintain	Task completed or maintain existing practice and continute to promote grassed waterway installation		
Task 5:	Perform east basin dredging	cubic yards	197,600 yd^3	197,600 yd^3	Task completed provided upland gully and streambank stabilization is achieved			
Task 6:	Promote water quality messages through public outreach plan	select components of public outreach campain	100%	Throughout the life of the project work to create lasting tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park				

APPENDIX E. CONT.

Goal 1: Address bacteria impairment of Hickory Grove Lake & remove it from the 303(d) list				**Phase 3**				
Goal 2: Reduce bacteria delivery to Hickory Grove Lake inlet								
Goal 3: Reduce total sediment and phosphorus loading by 677 tons per year and 3,492 pounds per year, respectively.								
Goal 4: Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages both in and outside the Hickory Grove Lake Watershed								
		Milestone metric	Milestone totals	2020	2021	2022	Project Outcome	Estimated Load Reductions
Task 1:	Implement goose management plan eliminating beach usage through various methods such as landscaping, fencing, and scare tactics.	geese population and reduction of geese on beach year round	100% Reduction	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	Reduction in beach bacteria sampling to <5% SSM violations and total elimination of geometric mean violations	Estimated 100% reduction of bacteria to beach
Task 2:	Eliminate 100% of livestock access to stream within the watershed and install alternative watering source	% of livestock with no stream access	100%	Task complete provided adequate cost-share is available				
Task 3:	Inspect, clean out, repair or update 100% of unpermitted septic systems in the watershed	100% fully functional and permitted septic systems	100%	Task complete provided adequate landowner cooperation				
Task 4:	Install strategically placed BMPs	Feet Shoreline Stabilized Feet Streambank Stabilized No. Gully Complexes Stabilized Acres Riparian Buffer Feet Grassed Waterways Acres Rotational Grazing Plan Acres CRP	2,000 ft 6,384 ft No. 15 2 ac 10,000+ ft 10 ac 40 ac	Task completed or maintain existing practice and continute to promote grassed waterway installation				
Task 5:	Perform east basin and shallow arm dredging	cubic yards	197,600 yd^3	Task completed provided upland gully and streambank stabilization is achieved				
Task 6:	Promote water quality messages through public outreach plan	select components of public outreach campain	100%	Throughout the life of the project work to create lasting tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park				

APPENDIX E. CONT.

Goal 1: Address bacteria impairment of Hickory Grove Lake & remove it from the 303(d) list				**Phase 4**				
Goal 2: Reduce bacteria delivery to Hickory Grove Lake inlet								
Goal 3: Reduce total sediment and phosphorus loading by 677 tons per year and 3,492 pounds per year, respectively.								
Goal 4: Increase public awareness of water quality issues and create *lasting* tools to promote water quality messages both in and outside the Hickory Grove Lake Watershed								
		Milestone metric	Milestone totals	2023	2024	2025	Project Outcome	Estimated Load Reductions
Task 1:	Implement goose management plan eliminating beach usage through various methods such as landscaping, fencing, and scare tactics.	geese population and reduction of geese on beach year round	100% Reduction	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	observe population - reduce beach usage 100%	Reduction in beach bacteria sampling to <5% SSM violations and total elimination of geometric mean violations	Estimated 100% reduction of bacteria to beach
Task 2:	Eliminate 100% of livestock access to stream within the watershed and install alternative watering source	% of livestock with no stream access	100%	Task complete provided adequate cost-share is available				
Task 3:	Inspect, clean out, repair or update 100% of unpermitted septic systems in the watershed	100% fully functional and permitted septic systems	100%	Task complete provided adequate landowner cooperation				
Task 4:	Install strategically placed BMPs	Feet Shoreline Stabilized Feet Streambank Stabilized No. Gully Complexes Stabilized Acres Riparian Buffer Feet Grassed Waterways Acres Rotational Grazing Plan Acres CRP	2,000 ft 6,384 ft No. 15 2 ac 10,000+ ft 10 ac 40 ac	Task completed or maintain existing practice and continute to promote grassed waterway installation				
Task 5:	Perform east basin and shallow arm dredging	cubic yards	197,600 yd^3	Task completed provided upland gully and streambank stabilization is achieved				
Task 6:	Promote water quality messages through public outreach plan	select components of public outreach campain	100%	Throughout the life of the project work to create lasting tools to promote water quality messages to continually generate pride of Hickory Grove Lake and Park				

APPENDIX F. BEACH GROOMING MACHINE

BARBER SAND MAN TT

Overview

The SAND MAN TT is the tractor-powered cousin of the Barber SAND MAN Model 850 walk-behind sand cleaner. Mounted to the 3 Point Hitch of a compact tractor, the TT utilizes the same proven sifting technology as the 850 allowing for the same stellar results in a fraction of the time. Stone, shell, glass, cigarette butts and other unwanted material are easily removed from the cleaning area and all from the comfort of the seat of the tractor. The mounting position of the SAND MAN TT provides for optimal maneuverability and a tight turning radius. Each unit includes Two (2) sets of Hot Dip Galvanized screens for efficiency in various conditions and applications.

Applications

Beaches-Beach Cleaning and Grooming
Horse Arenas-Grooming and Stone Removal
Infields-Grooming and Stone Removal
Seed Beds-Soil Grooming and Seedbed Preparation
Volleyball Courts-Grooming, Fluffing and Cleaning
Lake Shore Residences-Spring Clean up and Summer Maintenance

Specifications	U.S.	Metric
Cleaning Width	45 in	112.5cm
Cleaning Depth	Adjustable 0-4.5	Adjustable 0-11.25cm
Performance	1.5 acres/hr	6,000 sq. meters/hr
Hopper Capacity	33 gallons	125 Liters
Hopper Dump	Hydraulic Clam Shell	Hydraulic Clam Shell
Screen Mesh	3/8 in and ¾ in	5mm and 20mm
Weight	310 lbs	685kg
Dimensions	49in. x 46 in. x 32 in	125cm x 11cm x 81cm
Tractor Requirements	Minimum 20 – 30HP, 3 Point Hitch, Rear PTO, 1 Remote Hydraulic Valve, appropriate tires for sand use or specific application.	

H. Barber & Sons, Inc. 15 Raytkwich Drive Naugatuck, CT 06770 PH: 203.729.9000 800.355.8318 www.hbarber.com

PRICE QUOTE RECEIVED September 20, 2012:

Barber Sand Man: Tractor Powered Model:

The Barber Sand Man- Tractor Powered Model is the other alternative we discussed. The Sand Man Tractor Powered is a three point hitch mount unit that runs off the tractors PTO system. It utilizes a front cutting edge and an oscillating screening system. The unit has a rear hopper capacity of 33 gallons or 4.4 Cubic Feet which can be ground dumped from the controls of the tractor. The cleaning width of the unit is 3' 9" inches.

A video of the Sand Man TT can be found at the following link:
http://www.hbarber.com/videos/sand-man-tt-sifter.html

The screening system lifts the unwanted material to the rear hopper while returning the sand and soil back to the surface. The unit comes with two different screen sizes (3/8" and ¾") allowing for cleaning in both wet and dry conditions. The towing tractor must have a rear PTO shaft and one (1) rear hydraulic remote. A 20 to 25 PTO horse tractor would be recommended.

2011 Barber SAND MAN: Tractor Powered $11,800.00
Less Factory Direct - 1,000.00
Machine Price Ex-Factory Naugatuck, CT: $10,800.00

All of the above include a one (1) year warranty.

After you have reviewed this information, please feel free to contact me with any further questions.

Best Regards,
T.J. Chapman
H. Barber & Sons, Inc.
Office: 203-729-9000
Mobile: 203-305-4058
thomasc@hbarber.com
www.hbarber.com

APPENDIX G. INITIAL ANIMAL REMOVAL SOLUTIONS PROPOSAL

Goose Control Program

Goose control through the use of dogs is one of the most effective and publicly acceptable ways of decreasing the numbers of geese inhabiting your property. By introducing a "predator" to the area the geese become uncomfortable and with enough pressure will seek out alternative areas for roosting and feeding. With highly trained dogs there is no risk of injury to the geese.

No single technique is completely effective for deterring geese. Through the use of dogs and other devices such as lasers, screamer rockets, distress calls, visual barriers, and dog decoys we are able to put pressure on geese essentially forcing them to leave the area they inhabit for regular use. The process of establishing this fear in the geese is time consuming and we work relentlessly to achieve that goal.

Geese will continuously try to re-establish in an area simply because it is an inviting habitat and they are imprinted to the area. Therefore, constant pressure is needed to keep them away until your base population is gone due to age loses. In some cases this can be 10 years or more.

Habitat modification in some cases is crucial to the success of harassment programs. With the help of the customer in reduction of "safe zones", we can drastically speed up the effects of our service and long term numbers reduction. Any area that the geese feel that they can get to and have no concerns of the dog reaching them undetected need to be removed as an option. Additionally, making exit from the water as difficult as possible is recommended. This can include adding riprap or thick natural vegetation to shorelines to keep the geese from getting comfortable entering and exiting the water combined with the dog pressure making them unsure of where the predator threat may be located.

We have a long list of customers with varying sizes and types of habitat that we have helped with goose control issues. We have successfully driven geese from everything from quarter acre urban ponds to large public beach areas. All of these areas have been highly visible to the public. We pride ourselves on being discreet so as not to make the public aware of our intent to remove the geese from the area.

Combining the methods above have yielded us the results desired in the past. Our dogs are highly trained working animals and joining their skills with the additional devices and strategies above will give the results you need.

515-865-3244 • AnimalRemovalSolutions@mchsi.com

Animal Removal Solutions

October 28, 2012

Animal Removal Solutions proposal for goose control program for property located at:

Hickory Grove Park, Colo Iowa

COURSE OF ACTION 1
$70,000 March - August

Harassment of geese at above described location. Methods used to harass:

- Dog harassment
- Pyrotechnic and laser while onsite
- Boats

COURSE OF ACTION 2

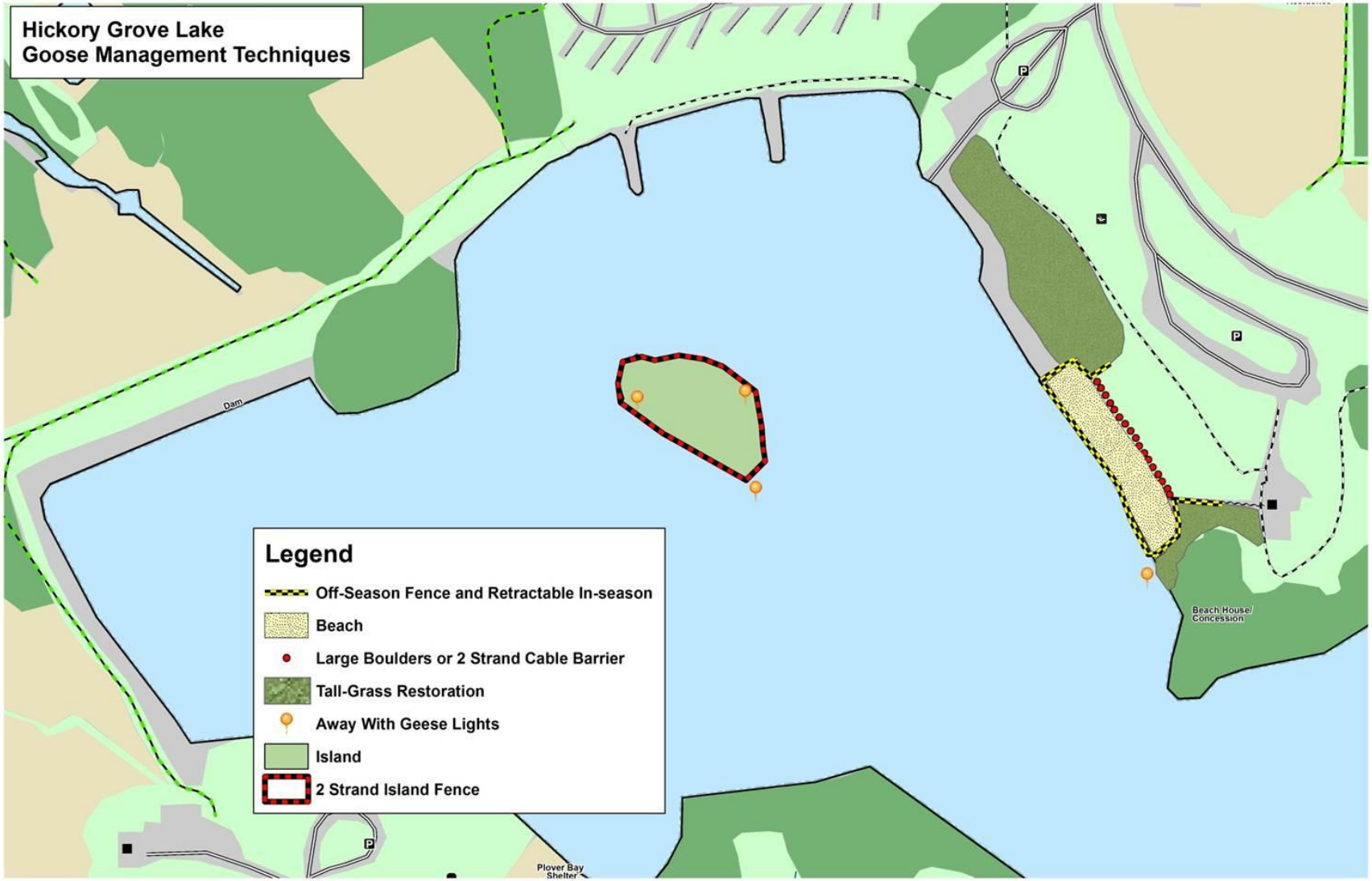
- Installation of automatic bird harassment lasers @$2,6000/unit
  (plus cost of electrical install 110 volt is required for each unit)
- Installation of bird harassment audio system @ $1,950/unit per 7 acres
- Installation of dog decoys @75/unit where needed

Thank you for considering Animal Removal Solutions. We look forward to doing business with you!

If you have additional questions, please call Ian at 515-988-7894.

515-865-3244 • AnimalRemovalSolutions@mchsi.com

APPENDIX H. MAPPED GOOSE MANAGEMENT STRATEGIES



APPENDIX I. ALTERNATIVE CATTLE WATERING LOCATION

COST ESTIMATE FOR EMBANKMENT POND

BOB JAMISON
68664 260th St
COLO, IA 50056
Home 377-2657
Shop 377-2627
NWNE 30 MILFORD

EARTHWORK	MAIN FILL 3191 CUYD @ $2.90	9253.90
	CORE TRENCH 372 CUYD @ $3.25	1209.00
PIPE	88' – 15" CORR STEEL PIPE @ $19.05/FT	1676.40
FABRICATION	2 PIECE ELBOW – 15"	105.00
HOOD FOR INLET	23X23 – 15" 16 GAUGE	108.11
CONNECTING BANDS	3 – 2 PIECE ROD & LUG 24" 16 GAUGE @ $98.02	294.06
DIAPHRAGM/ANTISEEP	2 – 2 PIECE 60X60 16 GAUGE CORR STEEL @$253.47	506.94
INSTALLATION		1500.00
DELIVERY		500.00
	SUBTOTAL	15153.41
CONTINGINCIES @ 10%		1515.34
	ESTIMATED TOTAL COST	16668.75

REFIGURED 12/29/10 BY ROSE DANAHER FOR HICKORY GROVE WATERSHED PROJECT

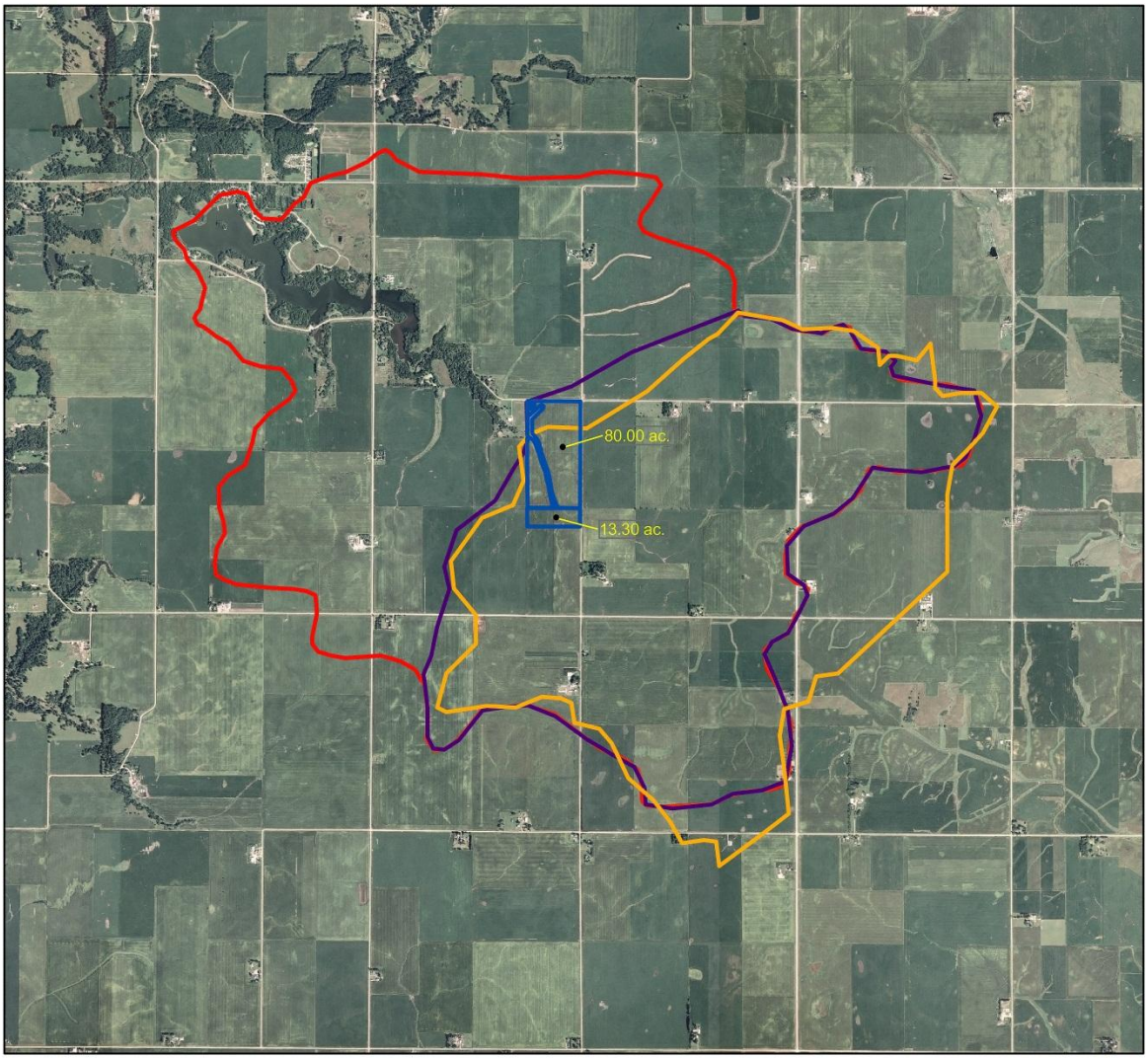
APPENDIX J. PROPOSED CREP WETLAND SITE

Hickory Grove Watershed

Date: 2/11/2010

District: STORY SOIL & WATER CONSERVATION DISTRICT
Approximate Acres:
Legal Description:

Assisted By: Rose K Danaher
State and County: IA, STORY



Legend

- Proposed CREP Site
- Tile Drainaige CREP - 2343 ac.
- Surface Drainage CREP - 2121 ac.
- HG Watershed - 4267 ac.

2,000 0 2,000 4,000 6,000 8,000
Feet

N