Clear Lake Watershed Management Plan

Hancock and Cerro Gordo County, Iowa

Approval Date: July, 2011

Re-evaluation Date: July, 2015

Submitted By:
The Association for the Preservation of Clear Lake

Prepared By:
David Knoll, Environmental Specialist
Iowa Department of Agriculture and Land Stewardship

ACRONYMS USED IN THIS REPORT:
319 – EPA Clean Water Act Section 319 Program
APCL – The Association for the Preservation of Clear Lake
BMP – Best Management Practice
CARD – Center for Agriculture Research and Development
CHL – Chlorophyll a
CLEAR – Clear Lake Enhancement and Restoration
CLSD – Clear Lake Sanitary District
CREP – Conservation Reserve Enhancement Program
CRP – Conservation Reserve Program
D&F – Diagnostic and Feasibility
EPA – United States Environmental Protection Agency
GCC – Grit Collection Chambers
GIS – Geographic Information System
IDNR – Iowa Department of Natural Resources
ISU – Iowa State University
NRCS – Natural Resources Conservation Service
RUSLE – Revised Universal Soil Loss Equation
SD – Secchi Depth
SWCD – Soil & Water Conservation District
TMDL – Total Maximum Daily Load
TP – Total Phosphorus
TSI – Carlson's Trophic State Index
TSS – Total Suspended Solids
UHL – University Hygienic Laboratory
WILMS – Wisconsin Lakes Modeling Suite
WIRB – Watershed Improvement Review Board
WMP – Watershed Management Plan
WRP – Wetland Reserve Program

MEASUREMENT ABREVIATIONS:
Ac – acres
Ac-ft – acre feet
ft - feet
lbs - pounds
L - liters
m - meters
m3 – 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/m2 – milligrams per square meter
yr – year

TABLE OF CONTENTS

1. Vision Statement:

Clear Lake will remain north central Iowa’s most valuable natural resource by sustaining a healthy ecosystem, achieving excellent water quality, providing unparalleled recreational opportunities, and continuing to be the economic engine for the local communities it serves both now and into the future.

2 Community Based Planning

The Clear Lake Enhancement and Restoration (CLEAR) Project is a community-led project to improve the water quality of Clear Lake that has been underway since 1995. The CLEAR Project sponsors include the Association for the Preservation of Clear Lake (APCL), the Hancock Soil & Water Conservation District (SWCD), the Iowa Dept. of Agriculture & Land Stewardship (IDALS), the Iowa Dept. of Natural Resources (IDNR) and the U.S. Environmental Protection Agency (EPA). The community has been heavily involved in water quality improvement planning for the past several years. Therefore, it was not deemed necessary to hold large public planning sessions, but instead hold meetings between the Watershed Advisory Group and the Technical Advisory Committee. The public was given opportunities to learn and comment on current and future lake restoration activities at events such as the Clear Lake Earth Day in April, 2010 and the Association for the Preservation of Clear Lake Annual Picnic in August, 2010.

Members of both the technical and the watershed advisory committee were present for the CLEAR Project annual review meeting which took place in February, 2010. The meeting explained the watershed management plan development process and the roles that each committee would play. As a result of the meeting, the groundwork for developing the WMP was laid.

The first official meeting with both advisory groups took place on June 1st, 2010. Paul Garrison and Buzz Sorge with the Wisconsin DNR were asked to perform a peer review of the lake restoration activities and provide input on further potential lake and watershed improvements. The purpose of the meeting was to hear their recommendations and discuss the suggestions. Their comments focused primarily on “in-lake” restoration since that is where their expertise lies. The primary recommendation was to determine the reason for a lower abundance of aquatic vegetation than what would be expected for the amount of existing water clarity. A list of comments and suggestions they shared at the meeting is provided in Appendix 1.

A meeting took place with officials from the City of Clear Lake on October 12th, 2010. The purpose of this meeting was to review previous urban conservation improvements and to determine future potential projects. The meeting resulted in a list of proposed activities and expenses that were included in the management plan.

A second meeting between the technical advisory committee and the watershed advisory committee took place on October 21st, 2010. All suggested restoration activities and estimated total costs were presented to the advisory committees to rank and prioritize the recommendations that had been made. The committees reviewed and discussed the recommendations to determine which were highest priority to proceed with. The committees also provided suggestions of other activities that were not originally on the list. The information gathered at the meeting was utilized to develop the watershed management plan goals, objectives, and management practices.

Members of the watershed advisory group also discussed aspects of the watershed management plan at the APCL regular board meetings. These meetings took place about once every two months during the watershed management development process. A list of the watershed and technical advisory team members is provided in Tables 1 and 2.

Table 1: Technical Advisory Committee

Name	Title
George Antoniou	Iowa DNR Lakes Program
Paul Garrison	Wisconsin DNR Lakes Program
Scott Grummer	Iowa DNR Fisheries
David Knoll	CLEAR Project Coordinator
Jason Moore	NRCS District Conservationist
Buzz Sorge	Wisconsin DNR Lakes Program
Jim Wahl	Iowa DNR Fisheries
Guy Zenner	Iowa DNR Wildlife

Table 2: Watershed Advisory Group

Name	2010 Title
Bob Amosson	APCL Director/Cerro Gordo Supervisor
Tom Birdsall	APCL Director
Ali Child	APCL Director
John Clemons	APCL Director
Nelson Crabb	APCL Director/City of Clear Lake Mayor
Randy Cram	APCL Director
Mark Ebeling	APCL Director
Tom Ebeling	APCL Director
Scott Flory	APCL Director/Clear Lake City Administrator
Terry Hoil	APCL Director
Kirk Kraft	APCL Director
Jan Lovell	APCL Director
Tom Lovell	APCL Director
John Lundberg	APCL Secretary/Treasurer
Charlie MacNider	APCL Director
Doug Merbach	APCL Director
Sarah Mooney	APCL Director
Julie Nichols	APCL Director
Brad Price	APCL Director
Tom Sawyer	APCL Director
Bob Swanson	APCL Director
Deb Tesar	APCL Director
Mark Tesar	APCL Director
Terry Unsworth	APCL President

APCL: Association for the Preservation of Clear Lake

3 Public Outreach

The CLEAR Project has been very active in public outreach activities since the project began in 1995. A variety of outreach activities have been utilized to keep the public, stakeholders, and project partners educated about their role in the Clear Lake restoration efforts. The continuance of a strong educational program will be a focus during the upcoming phases of the project. This is especially important so that an attitude of complacency does not set in now that many of the large scale projects, such as dredging, have been completed. Each specific aspect of the outreach campaign will be tailored to the intended audience and to the goal of the outreach. The primary objectives of the public outreach campaign and annual goals are listed below.

OVERALL OUTREACH PROGRAM OBJECTIVES:

1. Raise awareness to watershed landowners/operators about the important role they play in lake restoration.
2. Promote the installation of best management practices so practices are implemented.
3. Educate youth about the importance of water quality.
4. Educate lake users about stopping the spread of invasive aquatic species.
5. Promote the successes of the lake restoration project and changes in water quality.
6. Provide information to other water quality improvement projects.

SPECIFIC OUTREACH PROGRAM ANNUAL GOALS:

1. Community Group Presentations:
    a. Provide a minimum of three presentations to local community groups such as Lion's Club, Rotary Club, etc.
    b. Provide presentations to colleagues at meetings and seminars as requested.
2. Local Students Activities:
    a. Conduct a minimum of one activity with local students to increase awareness. Previous activities that should be continued include:
        i. Use of the EnviroScape model with 3rd grade students at the annual Ag Fair
        ii. A lakeshore cleanup project with 7th grade students
        iii. Presentations to high school environmental studies classes
3. Print Media:
    a. Publish a quarterly newsletter for members of the Association for the Preservation of Clear Lake
    b. Publish a brochure to be mailed out in local telephone company bills
    c. Prepare an article to be published in the City of Clear Lake newsletter
    d. Send a mailing to rural watershed residents regarding agricultural conservation practices, septic system update programs, etc.
    e. Utilize local newspapers to publish a minimum of three articles annually. Newspaper outlets include:
        i. Clear Lake Mirror Reporter
        ii. Mason City Globe Gazette

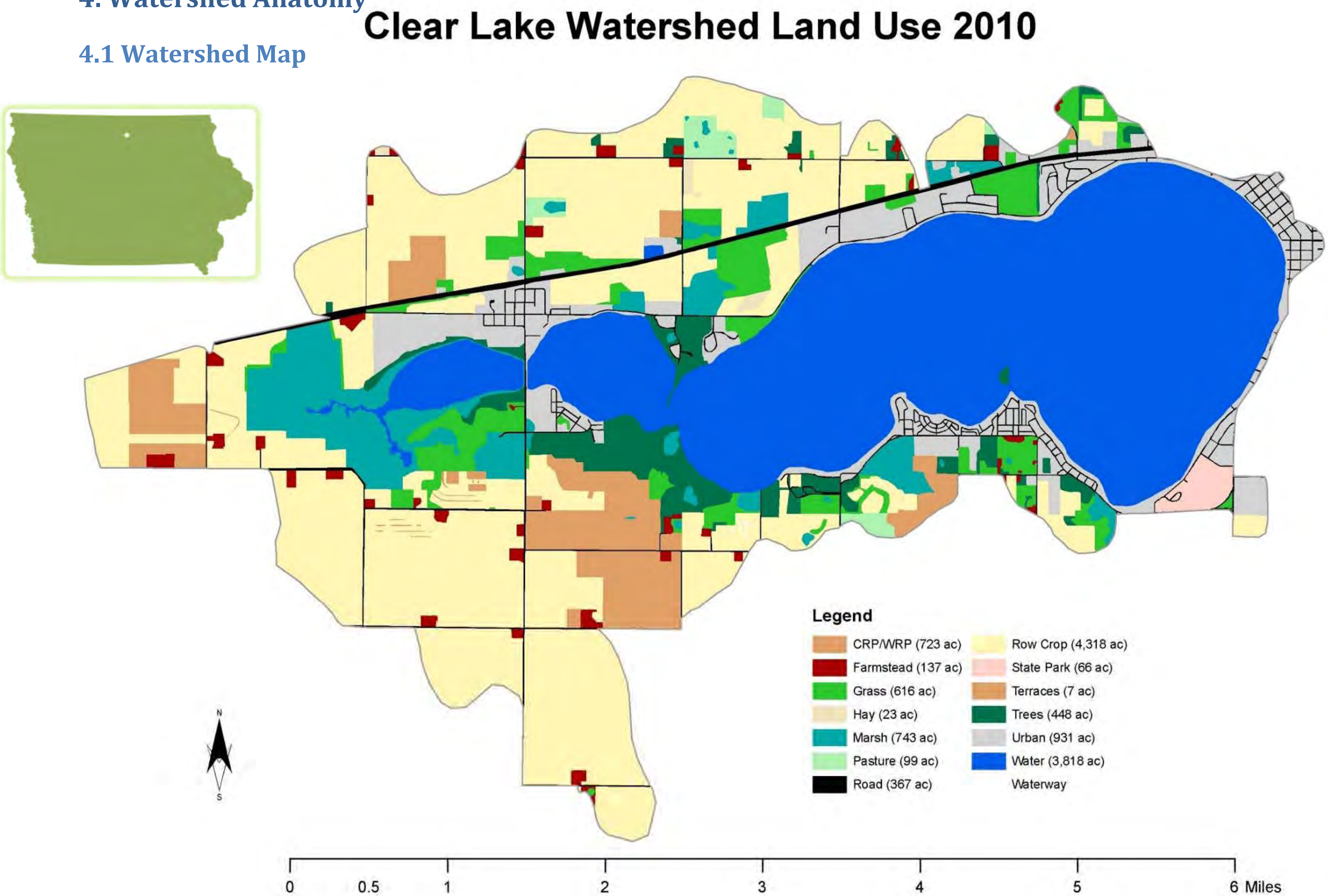
        iii. Des Moines Register
4. Radio and Television Media
    a. Utilize local radio and television media to perform interviews and provide information a minimum of one time per year. Radio and TV Stations include:
        i. KGLO, KLSS (Mason City)
        ii. KIMT (Mason City), KAAL (Austin, MN)
5. Tours of Restoration Activities
    a. Provide a minimum of one tour per year for project partners and other groups interested in performing lake restoration activities. The tour can highlight project accomplishments such as:
        i. Storm water grit collection chambers, rain gardens, permeable pavement, and other urban restoration practices.
        ii. Wetland restoration, prairie restoration, and other agricultural watershed improvements.
        iii. Dredge containment site, Ventura Marsh restoration, shoreline stabilization, and other "in-lake" restoration activities.
6. Meetings and Special Events
    a. Attend meetings to plan and discuss lake restoration activities such as:
        i. APCL board of director meetings
        ii. Soil & Water Conservation District meetings
    b. Participate in an annual event to updated the public and partners on lake restoration accomplishments and current water quality conditions. Events include:
        i. APCL Annual Picnic
        ii. CLEAR Project annual review meeting
        iii. Earth Day Green Expo booth
7. Special Documents
    a. Develop a lakeshore homeowners manual to underscore the important roles these residents play in lake stewardship. This manual would be created by the end of phase I and then updated annually as needed.
8. Surveys
    a. Perform a survey of lake users and local residents to determine if attitudes, perceptions, and understanding of Clear Lake water quality issues have changed over time.

EVALUATION:

Each year the outreach plan will be evaluated to determine if it is meeting the specific goals listed above. The evaluation will consist of determining if the quantities of public outreach activities that were planned actually took place. More importantly it will also include gathering feedback from the "customers" that the CLEAR Project interacts with to determine if their decision to become involved with the project was influenced by public outreach activities. Changes will be made to the program as needed to ensure the overall goals are being met.

4. Watershed Anatomy

4.1 Watershed Map



4.2 Location Narrative and History:

LOCATION:

The Clear Lake watershed spans two counties in north central Iowa, Cerro Gordo and Hancock. The Clear Lake watershed is located in the HUC 10 Willow Creek/Winnebago River watershed (ID # 0708020303). About 7,110 acres (84%) of the watershed is located in western Cerro Gordo County while the remaining 1,340 acres (16%) is located in eastern Hancock County. The City of Clear Lake is located on the north-eastern shore of the lake. Mason City, the largest community in north-central Iowa, is located 10 miles east of Clear Lake. The lake is located at the intersection of two major roadways, Interstate 35 and Highway 18.

POPULATION:

Population data was determined by reviewing U.S. Census Bureau estimated populations as of 2009 (U.S. Census Bureau, 2009). The population of Cerro Gordo County is 43,927 while the population for Hancock County is 11,339. The City of Clear Lake (pop. 7,812) and Mason City (pop. 27,489) are the two main population centers in north central Iowa. The proximity of the lake to these communities is one of the reasons Clear Lake is the fourth most visited lake in the state (CARD, 2008). In addition to the City of Clear Lake, there are two other communities in the watershed. The City of Ventura, which has a population of 722, is located entirely within the watershed. The south shoreline of Clear Lake is also developed and is in the jurisdiction of Cerro Gordo County. About 1,000 people reside in this area of the watershed. In total, there are about 5,000 people living in the developed areas of the watershed. The rural portion of the watershed consists of approximately 50 farms and 125 landowner/operators involved in row crop production.

OWNERSHIP:

A significant amount of the Clear Lake watershed, roughly 1,500 acres, is in public ownership. About half of these acres are comprised by the Ventura Marsh Wildlife Habitat Area. Two State Parks and several City Parks are located in the watershed. Another 500 acres of land is in private ownership, but is open for public use. Therefore, 24% of the Clear Lake watershed is open to the public. The Iowa DNR, the Nature Conservancy, City of Clear Lake, City of Ventura, and Cerro Gordo County are the primary owners of the public land in the watershed. Additionally, there is privately owned property with conservation easements through the Iowa Natural Heritage Foundation that is open to public use. The remaining 76% of the watershed is in private ownership. Clear Lake itself is also a significant public use area totaling more than 3,600 acres in size.

4.3 Physical Characteristics:

HYDROLOGY:

Clear Lake is one of only 34 natural glacial lakes in Iowa and with a surface area of 3,625 acres, it is the third largest in the state. The watershed of Clear Lake has an area of 8,454 acres, resulting in a watershed to lake ratio of 2.3 to 1 (see Table 3). Estimates for lake hydrology were made in the Clear Lake Diagnostic and Feasibility (D&F) Study based on data collected over the two-year study (Downing, Kopaska, Bonneau, 2001). The hydraulic residence time estimate ranged from 1.6 years based on inflow data, to 6.3 years based on outflow data in the D&F Study. Lake modeling completed in 2010 estimated the average residence time at 5.0 years. The hydrology of the lake has been modified to a limited extent by lake dredging which took place after the D&F Study was completed. The maximum depth, mean depth and lake volume were updated to reflect the impacts of dredging and presented along with the other hydrological information from the Clear Lake D&F Study in Table 3.

Because of Clear Lake's origin and relatively small drainage area, watershed precipitation is the major factor governing lake levels. Many small tributaries drain the watershed. The greatest portion (47%) of surface flow passes through Ventura Marsh on its way to the lake. At one time, Ventura Marsh was connected to the west end of the lake by a narrow inlet, but now is separated from the lake by a road. A control structure allows water to flow from the marsh into the lake during wet periods. A comparison of lake level and precipitation data indicates a direct relationship exists between the two. The water levels in Clear Lake and in nearby shallow wells show similar fluctuations, indicating that the lake and its surficial aquifer are hydraulically connected. Clear Lake is sustained in part by groundwater inflow from the north, west and south. However, during prolonged periods of below-normal precipitation, the inflow diminishes and the lake level subsequently declines.

Table 3: Clear Lake Hydrological Information

Description	Units
Lake surface area	3625 Acres
Volume	35582 Ac-ft
Maximum depth	30.0 ft
Mean depth	9.8 ft
Length of shoreline	14.1 mi
Shoreline development index	1.60
Watershed area	8,454 Acres
Watershed area/Lake area ratio	2.3
Estimated Hydraulic Residence Time	5.0 years

SOILS:

The soils of the watershed are prairie and forest derived, and the dominant soil associations are Canisteo-Nicollet-Clarion and Clarion-Webster-Nicollet. The most common soil series found in the watershed are Clarion (25%), Webster (14%), and Canisteo (10%). (Downing et al., 2001)

Clarion Series:

The Clarion series consists of well drained, moderately permeable soils on the uplands. These soils formed in glacial till under prairie vegetations. Slope ranges from 0 to 14 percent.

Webster Series:

The Webster series consist of poorly drained, moderately permeable soils on the uplands. These soils formed in glacial till and local alluvium derived from glacial till. The native vegetation was prairie. Slope ranges from 0 to 2 percent.

Canisteo Series:

The Canisteo series consists of poorly drained, moderately permeable soils on the uplands. These soils formed in calcareous glacial sediment under water tolerant grasses. Slope ranges from 0 to 2 percent.

Hydrologic soils groups are used to help estimate runoff from precipitation. Soils are grouped according to their ability to absorb water when the soils are wet and receive precipitation from storms of long duration. Combinations of groups are used for heterogeneous soil complexes. Soils are grouped in categories A to D with A soils having the lowest runoff potential (highest infiltration) when thoroughly wet. Most soils in the watershed (94%) are classified hydrologically as Group B. However, many (40%) of the Group B soils were originally D group soils that have had infiltration improved due to the addition of field tile. Group A soils are found in a few locations in the watershed, and Group C and D soils are present, but rare due to the prevalence of field tile. Group B soils have a moderately low runoff potential when thoroughly wet. These soils consist chiefly of moderately deep or deep, moderately well drained or well-drained soils that have moderately fine texture to moderately coarse texture. They have a moderate rate of water transmission.

GEOLOGY AND TOPOGRAPHY:

Clear Lake and its watershed lie in the Algona-Altamont moraine complex of the Des Moines Lobe. The watershed has a varying topography with slopes from 0 to 25 percent. However, the vast majority of the watershed (83%) is nearly level with slopes ranging from 0 to 5%. Only three percent of the watershed has slopes greater than 9%.

CLIMATE:

The climate in Cerro Gordo County is hot in the summer and cold in the winter. The highest recorded temperature was 107 degrees in 1936 and the lowest was -35 degrees in 1899. The average high temperature in the summer is 81 degrees while in the winter the average high is 26 degrees. The average precipitation is 32.45 inches per year. June is historically the wettest month of the year.

THREATENED AND ENDANGERED SPECIES AND ENVIRONMENTS:

There are a total of three federally threatened and endangered species that could potentially inhabit the Clear Lake Watershed. The Western Prairie Fringed Orchid and the Prairie Bush Clover are both considered threatened while the Topeka Shiner is listed as endangered. In addition to these federally listed species, there are more than 60 species of plants and animals that are listed as threatened, endangered, or of special concern. The entire list of these species is included in Appendix 2.

HISTORICAL LAND USE:

The Clear Lake watershed is located in the Des Moines Lobe and is part of the larger “prairie pothole” region. This area was once a vast tall grass prairie ecosystem, interspersed with upland savanna, prairie marshes and sloughs. Pothole wetlands and several shallow lakes, such as Clear Lake, were also abundant throughout this region of the State. As is typical for the prairie pothole region, the Clear Lake watershed was dominated by prairie, but had several marsh areas. The majority of the southern and eastern shoreline areas were dominated by timber, likely oak savannahs. A map of the historic land use is shown in Figure 1.

CURRENT LAND USE:

Like the rest of north central Iowa, the land use of the Clear Lake watershed has been drastically altered from its original prairie and wetland state. Today, the 8,454 acre Clear Lake watershed consists primarily of row crop production (54%), urban/roads (16%), and wetland/CRP (9%) land uses (Figure 2). The watershed to lake ratio is 2.3 to 1, which is very small compared to many other Iowa lakes. A 740 acre wetland complex known as Ventura Marsh is located on the west edge of Clear Lake and flows into the lake. See section 4.1 above for a current watershed map.

Figure 1: Clear Lake Historical Land Use

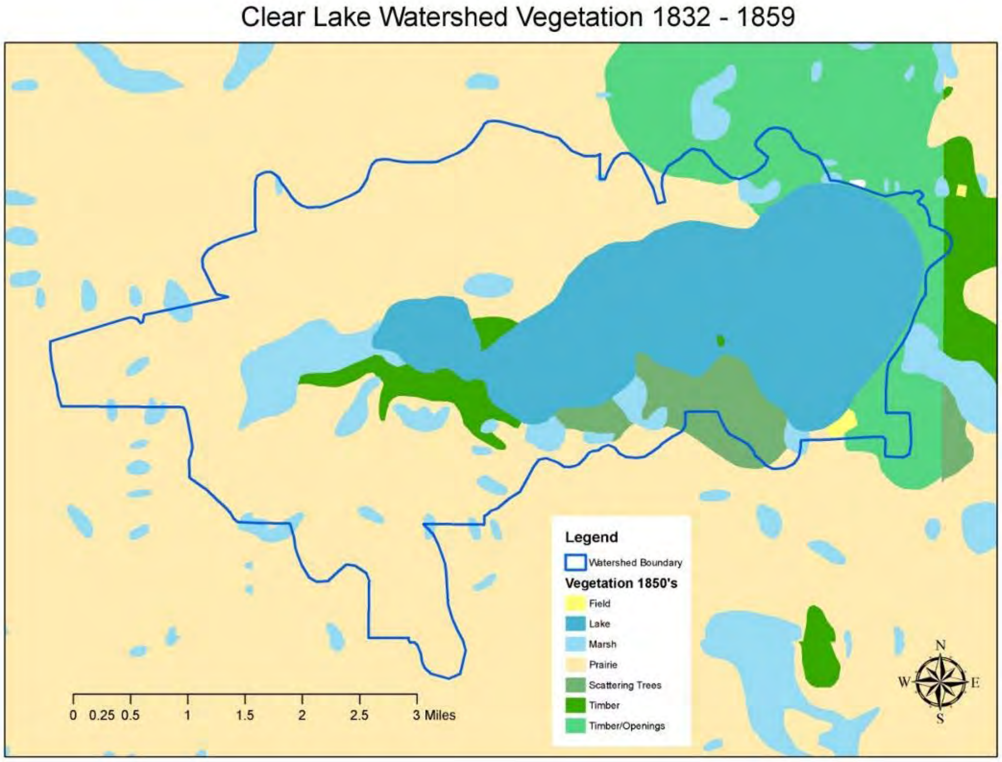
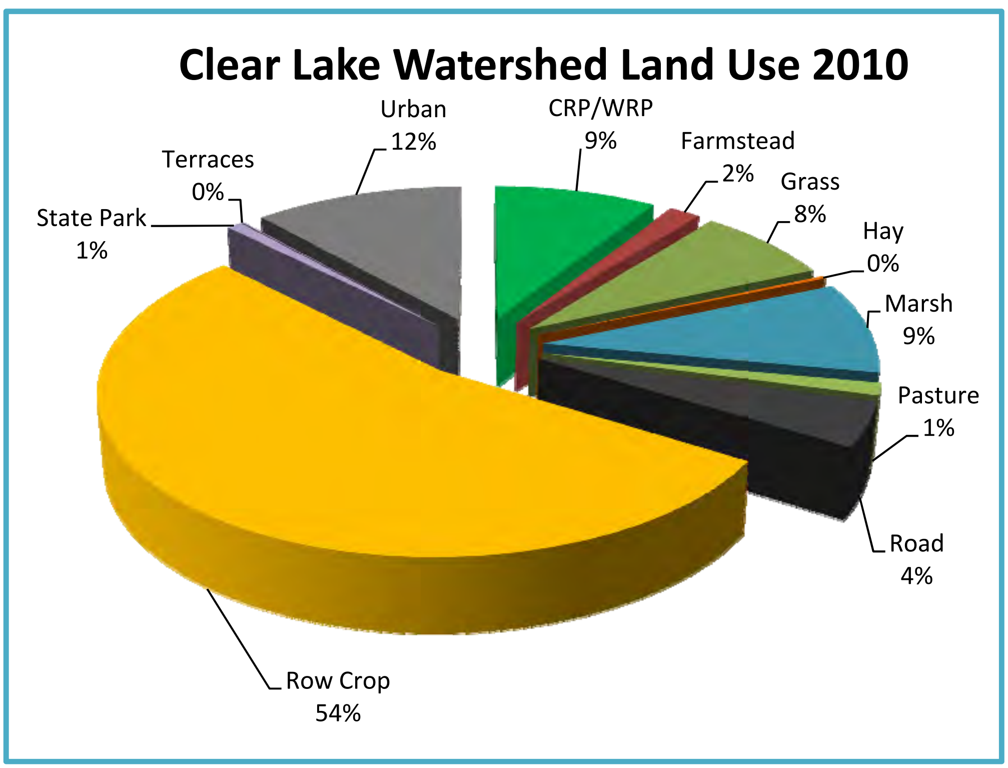


Figure 2. Clear Lake Land Use 2010



LAKE USAGE AND ECONOMIC VALUE:

The economic and recreational value Clear Lake provides to the north central Iowa area cannot be overstated. A 2008 Center for Agriculture Research and Development study at Iowa State University found that during the 2002-2005 period, Clear Lake averaged 432,312 household trips annually (CARD, 2008). The visitors spend an average $43.36 million annually which in turn supports 529 jobs and $10.83 million of labor income in the region (Table 4). The study showed that Clear Lake was the fourth most visited lake in the State. Clear Lake offers a bevy of recreational opportunities. The lake offers good fishing for walleyes, muskie, catfish, yellow bass, crappies, and other panfish. According to data collected by IDNR Fisheries staff, an average of over 36,000 angler trips are taken to Clear Lake each year. About 25% of Clear Lake anglers drive a distance of more than 30 miles to fish at the lake. Sailing, jetskiing, and pleasure boating are other popular recreational activities at Clear Lake. From 2002-2010, an average of about 16,000 boats were utilized on Clear Lake annually. A summary of angling and boating data is provided in Table 5. Two state parks and one city park are located along the shorelines of the lake and offer picnicking, hiking, wading, and swimming opportunities. Clear Lake State Park is one of the most heavily used parks in the State with about 100,000 visitors annually (J. Rembe, personal communication, 2010).

Table 4: Clear Lake Tourist Average Spending

Category	Single Day	Multiple Day	Annual Single Day	Annual Multiple Day	Total
Supplies	$17.00	$59.65	$5,654,730	$5,945,972	$11,600,702
Eating and Drinking	$9.45	$96.30	$3,143,365	$9,599,280	$12,742,645
Gas and Car Expenses	$5.10	$29.70	$1,696,419	$2,960,526	$4,656,945
Lodging	$0.60	$69.80	$199,579	$6,957,734	$7,157,313
Shopping and Entertainment	$10.85	$36.05	$3,609,049	$3,593,500	$7,202,549
Total	**$43.00**	**$291.50**	**$14,303,142**	**$29,057,012**	**$43,360,153**

Source: http://www.card.iastate.edu/lakes/lake_economic.aspx?id=21

Table 5: Clear Lake Angler and Boating Data:

Lake Use Data (April - October)	2002-2010 Annual Average
Angler Trips (Local)	8,205
Angler Trips (<30 mi)	19,063
Angler Trips (>30 mi)	8,120
Angler Trips (Out of State)	805
Angler Trips (Total)	36,193
Boats (Sail/Jet Ski/Pleasure)	15,929

5 Pollutants and Causes

5.1 Designated Use

Each lake and stretch of stream or river in Iowa is designated for specific uses. Clear Lake contains the below designated uses according to the Iowa Water Quality Standards. Each of these uses is described in more detail below. It should be noted that Clear Lake is no longer used for drinking water, but the classification remains due to prior use of the lake for potable water.

> 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 canoeing. Clear Lake is currently not meeting this designated use due to excessive nutrient and bacteria loading.
>
> 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. Clear Lake is currently not meeting this designated use due to excessive nutrient loading.
>
> C (potable water source)
> Drinking water supply (Class “C”). Waters which are used as a raw water source of potable water supply.
>
> 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 harvested for human consumption.

If the water quality in the stream or lake does not allow it to meet its designated use, it does not meet Iowa's water quality standards and is considered "impaired." The waterbody is then placed on the "303(d)" list, commonly known as the "impaired waters list." Clear Lake was placed on Iowa’s 2002 303(d) impaired waters list for not meeting the primary contact recreation designated use due to algae and nutrients. The lake was again added to the impaired waters list in 2004 due to bacteria. A Total Maximum Daily Load (TMDL), now referred to as a “Water Quality Improvement Plan”, was written for the algae and nutrients impairment in 2005. A TMDL plan has not yet been prepared for the bacteria impairment. Ventura Marsh, which 47% of Clear Lake’s surface flow passes through, was also placed on the impaired waters list for algae and turbidity. A TMDL plan was approved for Ventura Marsh in 2010.

The primary water quality impairment the plan proposes to address for Clear Lake is total phosphorus loading, which is strongly correlated to sediment loading. Phosphorus and sediment are the key contaminants that drive Secchi disk depth, chlorophyll a, and total phosphorus water quality goals that were established in the TMDL. Primary sources of total phosphorus loading to Clear Lake include non-point source runoff from agricultural and developed areas, internal loading, direct precipitation onto the lake surface, and groundwater. Also of importance is the reduction in bacteria loading to Clear Lake. Although no funding is currently being sought from the EPA to address bacteria loading, this plan provides assessments and suggestions for reducing bacteria loading. As more information regarding bacteria loading is gathered, the plan will be reevaluated may seek future EPA funding.

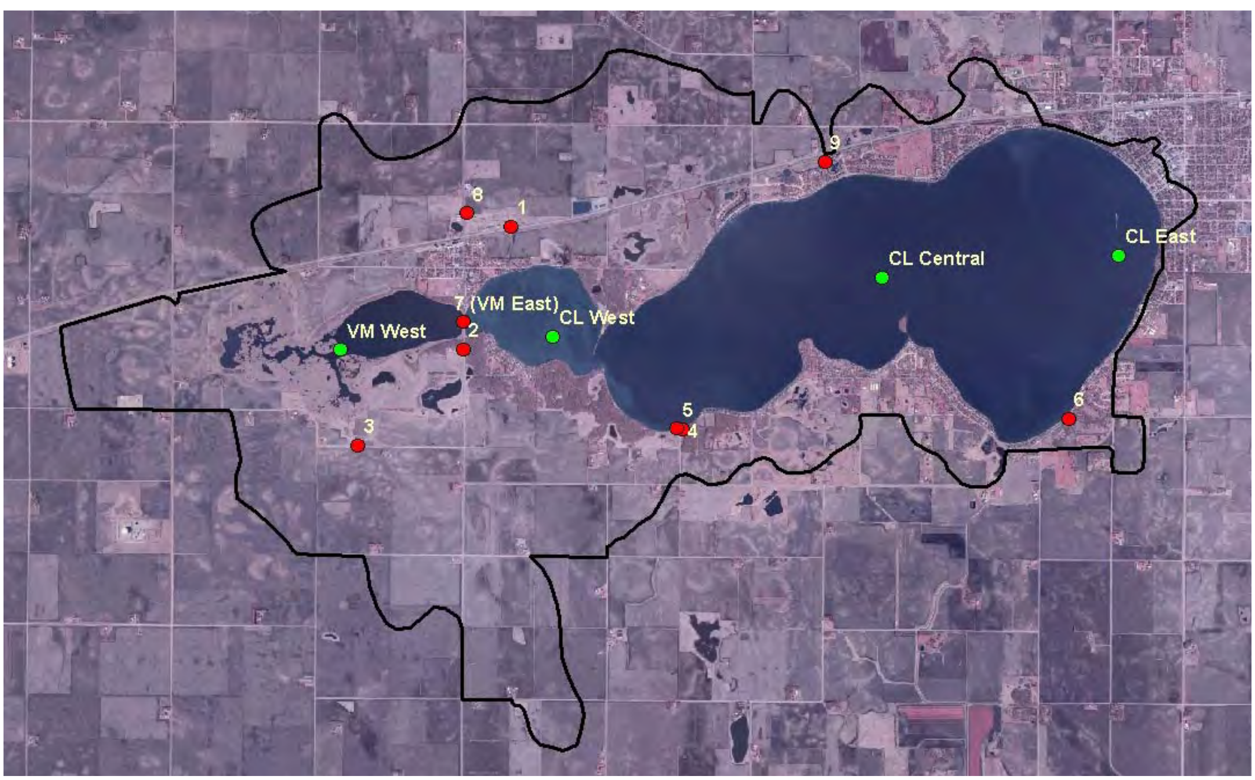
The Ventura Marsh TMDL identified internal loading of total phosphorus and suspended sediments as the key pollutants to be reduced. The plan also identified benthivorous fish (common carp) as the primary sources of the internal loading. Activities are currently underway to reduce the carp population by installing pump station that will allow for water level control. Once the pump station is completed, the DNR plans to manage the water levels in the marsh in a manner that will cause winter fish kills to greatly reduce the carp population.

5.2 Water Quality Data

WATER MONITORING REVIEW:

Frequent monitoring of Clear Lake's water quality has been taking place since 1998 when the Clear Lake Diagnostic & Feasibility (D&F) Study began. IDNR, Iowa State University (ISU), University Hygienic Laboratory (UHL), and CLEAR Project have all assisted with sample collection. Samples were collected twice a month from April-October from three sites on Clear Lake each year. The only exception was that from 2000-2003, a total of only three samples were collected from just one sample site a year. In addition to lake monitoring, one site at Ventura Marsh and 8 tributary sites were monitored at various times and frequencies since 1998. The marsh and tributary data was utilized in developing phosphorus loading estimates, as described in Section 6 or the WMP. All sampling followed procedures outlined in the Quality Assurance Project Plan (QA/WM/11-01), which is on file with the DNR and also with the CLEAR Project.

Figure 3: Clear Lake, Ventura Marsh, and Tributary Sample Site Locations



Green = Limnological monitoring sites on Clear Lake and Ventura Marsh

Red = Tributary monitoring sites in the Clear Lake watershed
*Tributary Site 7 same as Ventura Marsh East site, also monitored as limnological site

CLEAR LAKE WATER MONITORING RESULTS SUMMARY:
The water quality of Clear Lake is degraded by several pollutants that enter the lake from non-point source runoff. The contaminants that have the greatest impact on the water quality of Clear Lake are described in more detail below. In 2005, the Environmental Protection Agency (EPA) approved a water quality improvement plan, formerly known as a total maximum daily load (TMDL), that set numeric targets for total phosphorus (TP), chlorophyll a (CHL), and Secchi depth (SD) based on Carlson's Trophic State Index (TSI). The TSI goal can be converted to actual concentration amounts based on the formula used to derive the TSI. If the Clear Lake TMDL were prepared today, the IDNR would determine current water quality conditions by using the median value of the last five years of monitoring data from the Central sample site for samples collected May through September. Although this method reduces annual variations in data, it provides more of a water quality trend information than current conditions. The current water quality of Clear Lake was therefore determined by taking the mean of the previous three years (2008-2010) of data for all three lake sample sites. The results of both methods for estimating current conditions are shown in Table 6. The monitoring was performed via a cooperative agreement between ISU, IDNR, CLEAR Project, and the University Hygienic Laboratory. The monitoring data is stored on the DNR's STORET database (DNR, 2010).

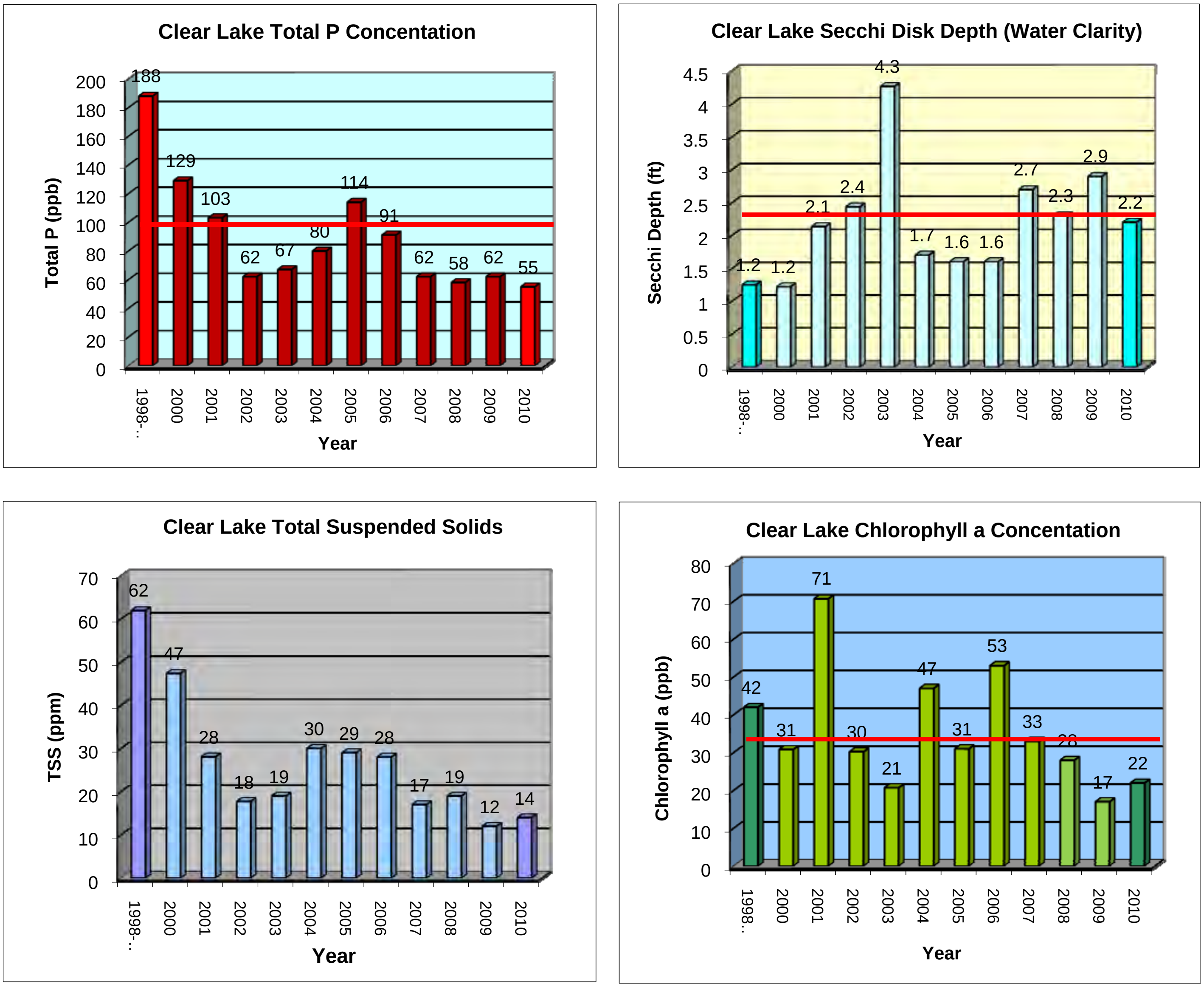
The recent water monitoring results show that Clear Lake is meeting the targets set by the IDNR and the EPA in the Clear Lake Total Maximum Daily Load plan for algae and nutrients (IDNR, 2005). These targets were developed as a means of enabling Clear Lake to support its designated uses. However, the data shows that the Secchi disk depth goal is only barely being met, indicating the lake is in a transitional phase but has not yet clearly demonstrated the ability to achieve the desired water clarity on a consistent basis. Further efforts are needed to maintain the current water quality and provide further clarity improvements to ensure Clear Lake continues to meet the TMDL goals.

Table 6: Clear Lake TMDL Water Quality Targets and Current Monitoring Results

Parameter	TSI Goal	Concentration Goal	2008-2010 Mean	2006-2010 Median
Total Phosphorus	<70	< 96 µg/L	58 µg/L	50 µg/L
Chlorophyll	<65	< 33 µg/L	22 µg/L	25 µg/L
Secchi Disk Depth	<65	> 0.7 m	0.75 m	0.70 m

CLEAR LAKE WATER QUALITY RESULTS DETAILS:
Several chemical as well as biological measurements were collected as part of the CLEAR Project /ISU/IDNR monitoring that took place from 2005-2010. This data is available from the Iowa DNR, or can be viewed at www.clearproject.net. The primary parameters measured to indicate changes in water clarity were total phosphorus, chlorophyll a, total suspended solids, and Secchi disk depth. Graphs summarizing the last twelve years of monitoring are shown in Figure 4 on the following page. The data is the mean value of all three lake sample site locations. The red horizontal line denotes the TMDL target concentration for the parameters.

Figure 4: CLEAR/DNR/ISU Clear Lake Water Quality Data 1998-2010. (Red horizontal line indicates TMDL targets)



PHOSPHORUS:

Phosphorus is the limiting nutrient that is most responsible for algal production at Clear Lake. Both dissolved (ortho-phosphorus) and total phosphorus has been monitored at Clear Lake from 1998 to present. Ortho phosphorus represents the portion of total phosphorus available for uptake by algae. Ortho phosphorus levels at Clear Lake almost always are below detectable limits. This indicates that algae production is high enough to use all available phosphorus. Total phosphorus includes both dissolved and particulate forms and indicates the amount of phosphorus that can potentially be converted and made available for uptake. The Clear Lake Diagnostic and Feasibility (D&F) Study determined that a realistic goal for Total P concentrations at Clear Lake after all recommendations were implemented would be 100 µg/L. Likewise, the TMDL stated that if a 50% reduction in P loading was achieved, a realistic goal would be 96 µg/L. Water monitoring has shown that the reduction in TP has exceeded expectations as TP levels of the past three years has averaged 58 µg/L. This equates to a 69% reduction in TP from what was measured during the Clear Lake D&F Study (188 µg/L).

CHLOROPHYLL A:
Chlorophyll a is used as a measurement of algal biomass in the water column and can be useful in tracking trends in the amount of algae production at Clear Lake. Several factors such as nutrient availability, water temperature, and sunlight all affect the amount of algae production and chlorophyll a concentrations in a given year. It is therefore not uncommon to see these numbers fluctuate from year to year. The goal set for Chlorophyll a in the TMDL was 33 µg/L. Water monitoring has shown that Clear Lake has been achieving this goal since 2007 and has averaged 22 µg/L over the past three years. This represents a 48% reduction in chlorophyll a over what was measured during the D&F Study (42 µg/L).

TOTAL SUSPENDED SOLIDS:
Total suspended solids (TSS) is a measure of both the inorganic and organic suspended solids in the water column. This total is most often dominated by inorganic materials such as silt. High amounts of TSS result in a brown, murky coloration of water. The Clear Lake TMDL did not include a goal for TSS at Clear Lake, however it is a parameter commonly measured to indicate water quality. Water monitoring at Clear Lake has shown that TSS levels have averaged 15 mg/L over the past three years. This represents a 76% reduction in TSS over what was measured during the Clear Lake D&F Study (62 mg/L).

SECCHI DISK DEPTH:
Secchi disk depth is a measurement of water transparency. In Clear Lake, the two primary factors influencing transparency are algae production and suspended solids in the water column. As nutrients, algae, and suspended solids decline, a noticeable increase in water transparency should occur. The goal set for water transparency at Clear Lake in the TMDL was 0.7 m (2.3 feet). Over the past three years, Clear Lake has averaged 0.75 m (2.5 ft). This represents a 108% improvement over the transparency measured during the D&F Study (1.2 ft).

CLEAR LAKE BEACH BACTERIA MONITORING SUMMARY:
In 2004, Clear Lake was again added to the 303(d) Impaired Waters List due to a bacteria impairment. A TMDL has not yet been written to address this impairment. Routine beach bacteria monitoring by IDNR staff has taken place at two State owned Clear Lake swim beaches since 2000. Additionally, samples have been collected at a City owned swim beach since 2007. Samples are collected weekly from Memorial Day weekend through Labor Day weekend on all three beaches.

The IDNR utilizes the beach monitoring data from a three year time period to determine if a bacteria impairment is taking place. A geometric mean is calculated for each 30 day cycle during the three year monitoring period. If the monitoring shows any E. coli geometric mean levels above 126 MPN/100 ml for any 30 day period during the three years analyzed, the water body is considered impaired. Additionally, if the weekly E. coli level of 235 MPN/100 ml is exceeded “substantially more” than 10% of the time, the water body will also be listed as impaired. For the 2012 303(d) list, monitoring from the

2008-2010 swim seasons will be analyzed. Data from those years indicate that Clear Lake will still be considered impaired for bacteria due to having a total of eight geometric mean violations over that time frame.

It should be noted that the 2008 and 2009 data showed significant improvements in bacteria levels, but the number of geometric and weekly bacteria violations rose significantly in 2010. The reason for the 2010 increase in swim advisories is unknown, but is likely due to a combination of factors that included increased rainfall amounts, lower water clarity, and increased water bird use of the beaches.

Table 7: Geometric Mean Results for Clear Lake Beaches

Year	Clear Lake State Park Geometric Mean Violations	McIntosh Woods Geometric Mean Violations	Clear Lake City Beach Geometric Mean Violations	Total
2004	11	0	NA	11
2005	12	0	NA	12
2006	7	0	NA	7
2007	2	1	0	3
2008	0	0	0	0
2009	0	0	0	0
2010	4	4	0	8

Table 8: Weekly Monitoring Results for Clear Lake Beaches

Year	Total Samples	Clear Lake State Park Beach E. coli violation	McIntosh Woods Beach E. coli Violations	Clear Lake City Beach E. coli Violations	Percentage of Annual E. Coli Violations
2004	39	10	0	NA	26%
2005	40	11	1	NA	30%
2006	41	5	1	NA	15%
2007	49	4	2	1	14%
2008	68	2	3	1	9%
2009	68	2	0	2	6%
2010	54	8	5	1	26%

6 Identify Pollutant Sources

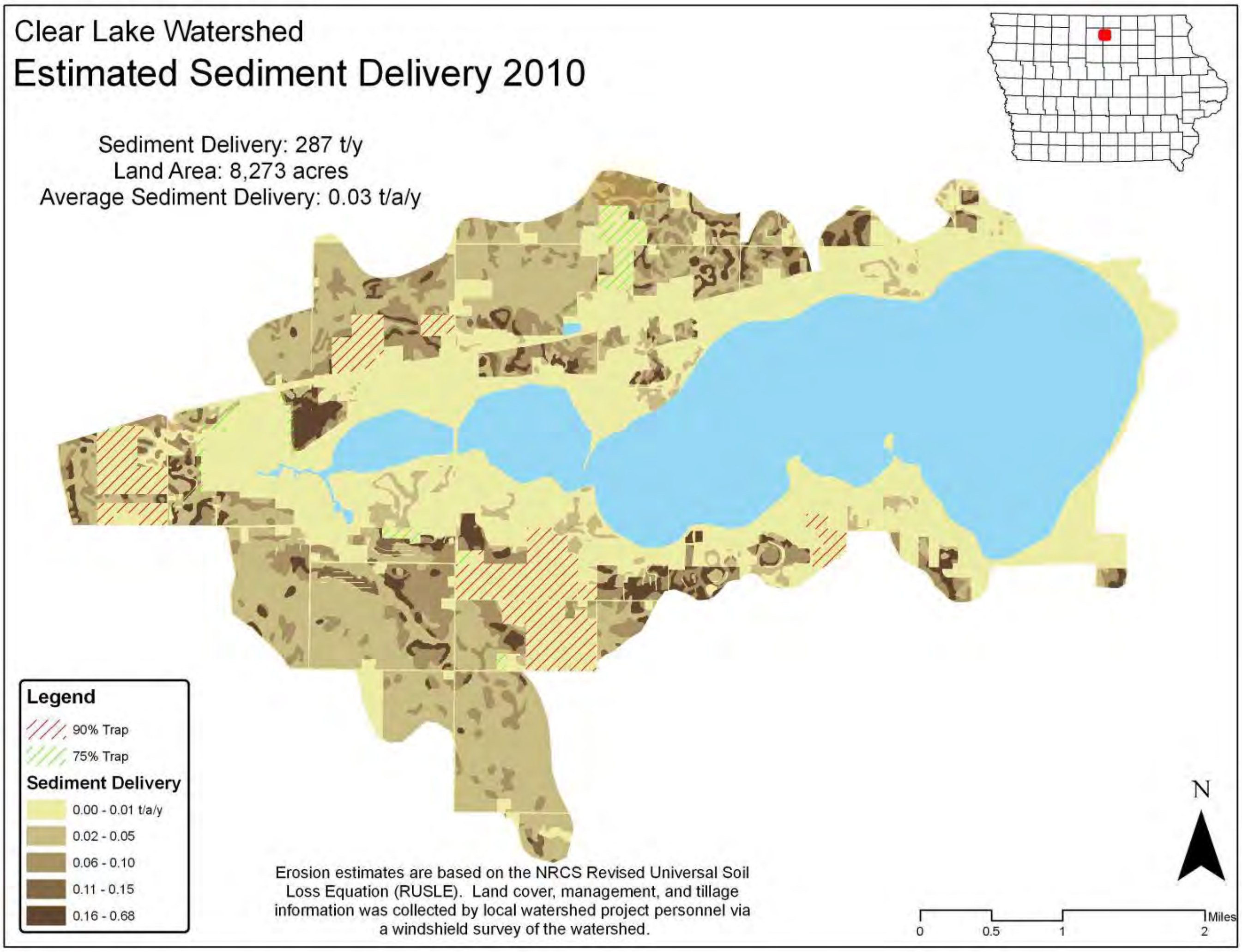
6.1 Assessments

A variety of assessments were completed to identify pollutant sources and determine priority areas for implementing restoration activities. A summary of the assessments is provided below.

SEDIMENT DELIVERY ASSESSMENT

An updated sediment delivery assessment was completed to reflect current sediment delivery from sheet and rill erosion. This Geographic Information System (GIS) based assessment uses landcover, management, tillage, and elevation information to create a delivery estimate based on the Revised Universal Soil Loss Equation (RUSLE). The estimated current delivery to Clear Lake was found to be 287 tons/year of sediment. The Iowa State-Wide Trace Element Soil Sampling Project, (Rowden, 2010) found that there is an average of 1.6 lbs of TP in each ton of sediment delivered. Using this factor resulted in a loading of 459 lbs/year of total phosphorus. It should be noted that this tool only estimates sediment delivery from sheet and rill erosion, and is therefore an underestimate of the actual delivery taking place.

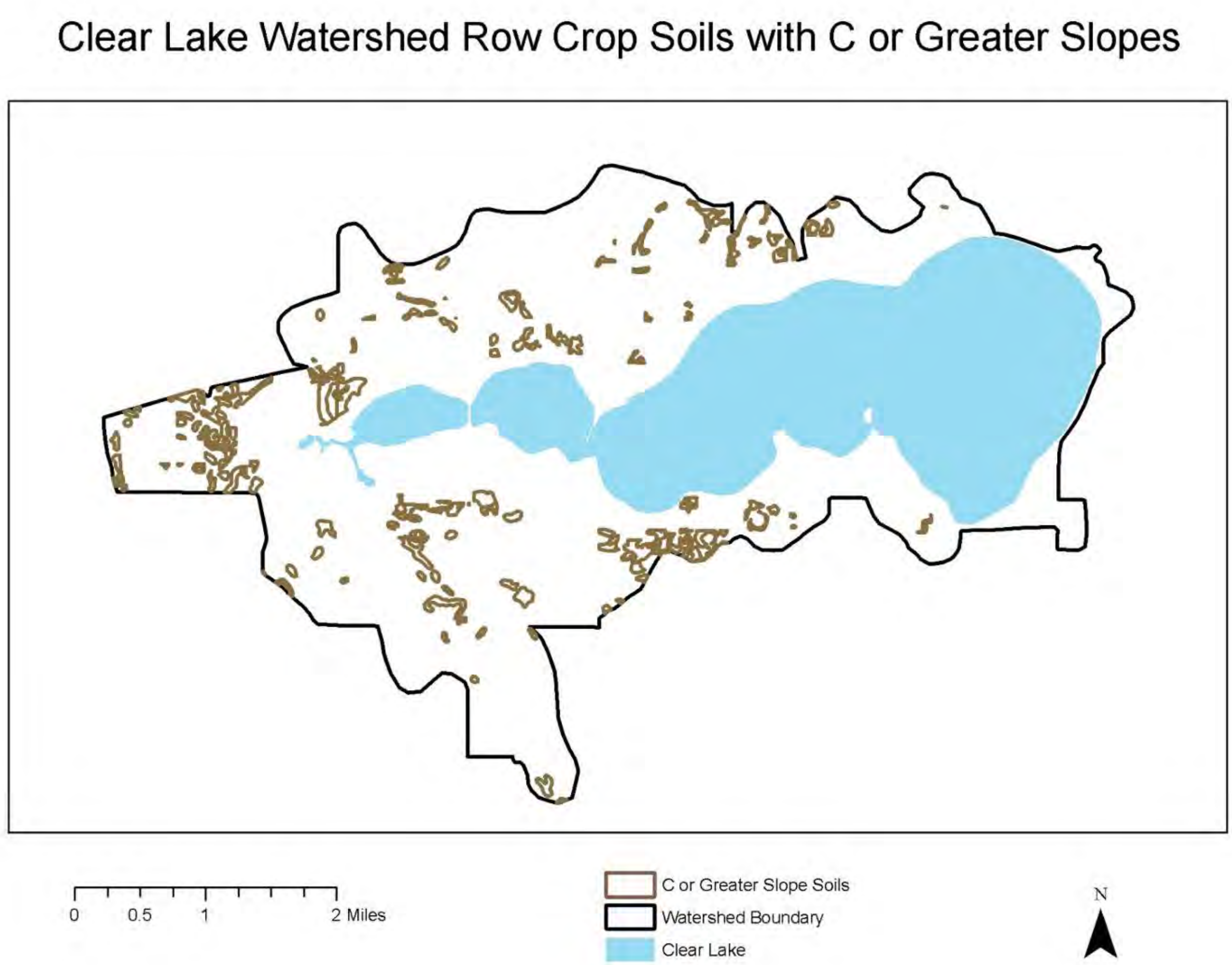
Figure 5: Clear Lake Watershed Estimated Sediment Delivery 2010



EPHEMERAL GULLY EROSION ASSESSMENT:

All row crop soils in the watershed with “C” or greater slopes were identified using Natural Resources Conservation Service (NRCS) soils information. These soils have slopes that are greater than 5%, and are therefore likely to develop ephemeral gullies. There were 422 acres of “C” (5-9% slope), 71 acres of “D” (9-14% slope), and 47 acres of “E” (14-18 % slope) soils in the watershed that are in row crop production. The total acres of 5% or greater slope soils was therefore 540. In order to determine erosion from ephemeral gullies, NRCS staff was consulted. For planning purposes, the NRCS uses a ratio of one ton/acre of gross erosion from ephemeral gullies for row crop acres with soils having a “C” or greater slope (K. Woida, personal communication, 2010). Woida commented that this amount likely represents the minimum amount of erosion taking place. To convert gross erosion to sediment delivery, a factor of 0.7 is used (NRCS Field Office Technical Guide). The tons of sediment delivery is then multiplied by 1.6 as described above to convert to lbs of phosphorus delivery. The phosphorus loading from ephemeral gullies in the watershed is therefore calculated as follows: 540 x 0.7 x 1.6 = 605 lbs/year of TP loading.

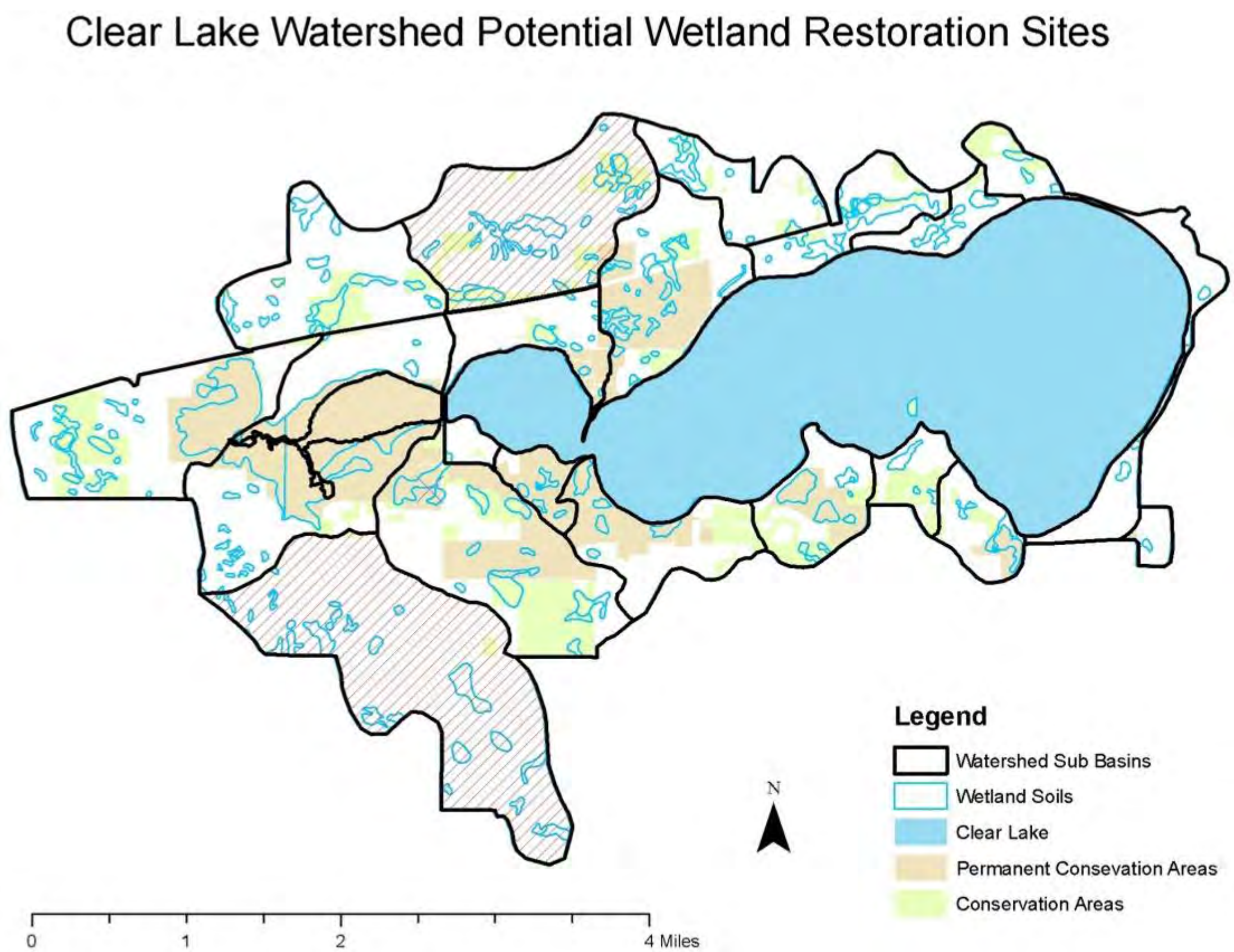
Figure 6: Clear Lake Watershed Row Crop Soils with Slope of 5% or Greater



HYDRIC SOILS ASSESSMENT

The below map shows the hydric soils in the watershed that are most suitable for wetland restoration. These areas are currently in row crop production, which contributes to phosphorus and sediment loading to Clear Lake. By converting these areas to wetland and permanent vegetation, soil erosion is reduced which in turn reduces sediment and phosphorus delivery These soil complexes contain hydro group "D" soils as described in Section 4.3 of this report. Additional hydric soils and potential wetland restoration areas exist in the watershed, but the map indicates those areas that have the highest potential. A green underlay map indicates the areas that are currently in a temporary conservation type cover such as CRP, grass, marsh, etc. The brown underlay shows the permanent easement areas that will remain in conservation cover. The map indicates several portions of the Clear Lake watershed could benefit from future wetland restoration activities. The sub watersheds of highest priority for future restoration are indicated by the diagonal red line overlay as little restoration has yet to take place in these areas. Individual wetlands were not ranked as each acre of cropland converted to wetland and prairie provides a similar amount phosphorus loading reduction. This is due to the fact that the restored pothole wetlands typically do not treat large drainage areas outside the boundary of the restoration area. Additionally, there will also be a focus working with landowners who own the temporary easements to prevent the property from being converted back to row crop production at a later date. If 1,000 acres of row crop were converted to wetland and prairie, a reduction of 410 lbs/year of TP loading to Clear Lake would be achieved (see Section 7.4).

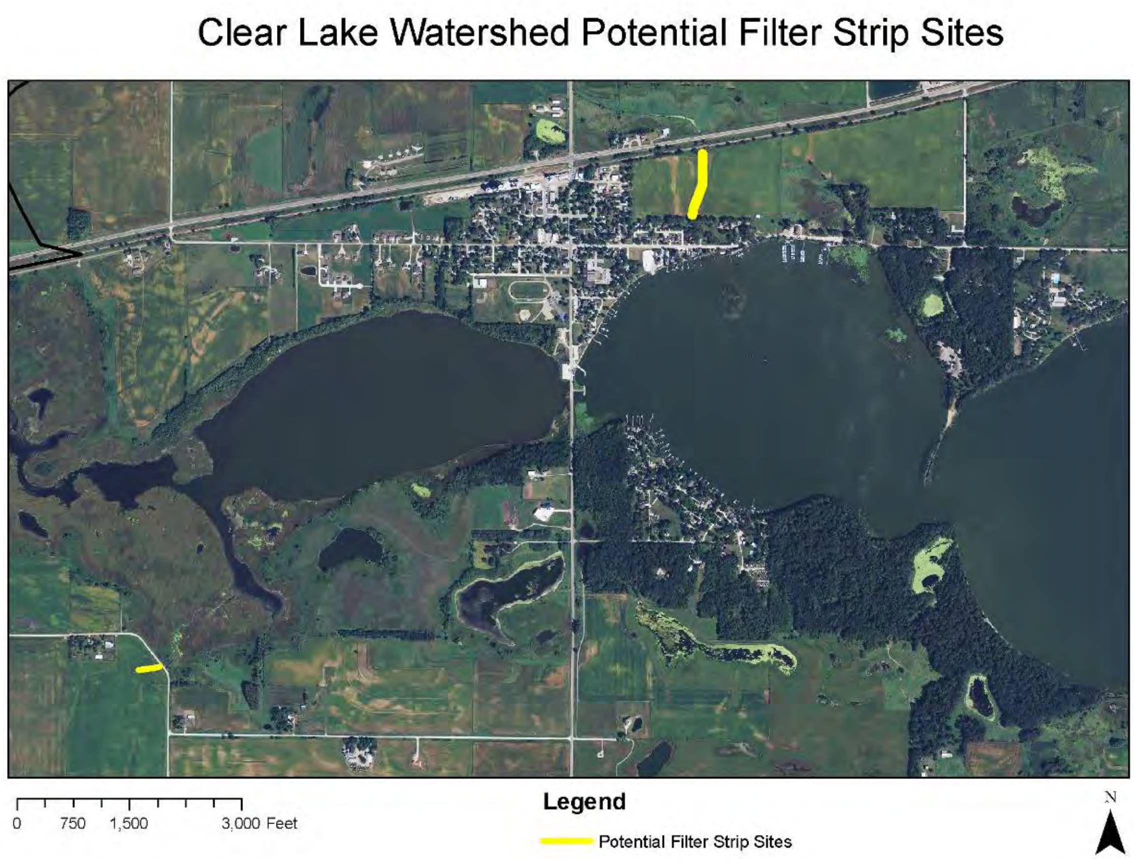
Figure 7: Clear Lake Watershed Potential Wetland Restoration Sites



CLEAR LAKE POTENTIAL FILTER STRIPS

There are only two small tributaries totaling about 1,500 feet in length in the Clear Lake watershed that are not currently buffered by perennial vegetation (Figure 8). Placing a 100 ft. filter strip on both sides of the two tributaries would result in about seven acres of crop land being seeded to perennial vegetation. The conversion of crop land to vegetation along the stream corridor would reduce sediment and phosphorus delivery to Clear Lake. The sediment delivery calculator was used to determine that the practice would result in a sediment delivery reduction of 35 tons/year, corresponding to a TP loading reduction of about 56 lbs/year.

Figure 8: Clear Lake Potential Filter Strip Sites



SHORELINE STABILIZATION ASSESSMENT

A survey of Clear Lakes 14 miles of shoreline was completed in the fall of 2010 to review the need for further shoreline stabilization. Both public owned shoreline and private owned shoreline was analyzed. Shoreline areas that had at least 1 ft of vertical raw bank exposed with little or no vegetation present were determined to be in need of future improvements. It was determined that a total of about 2,700 feet of shoreline would benefit from stabilization, as shown in Figure 8. About 1,500 feet of the areas needing protection is on public property and 1,200 feet is on private property. An overall estimate of the erosion indicated that the currently unprotected areas contribute about 114 tons of sediment and

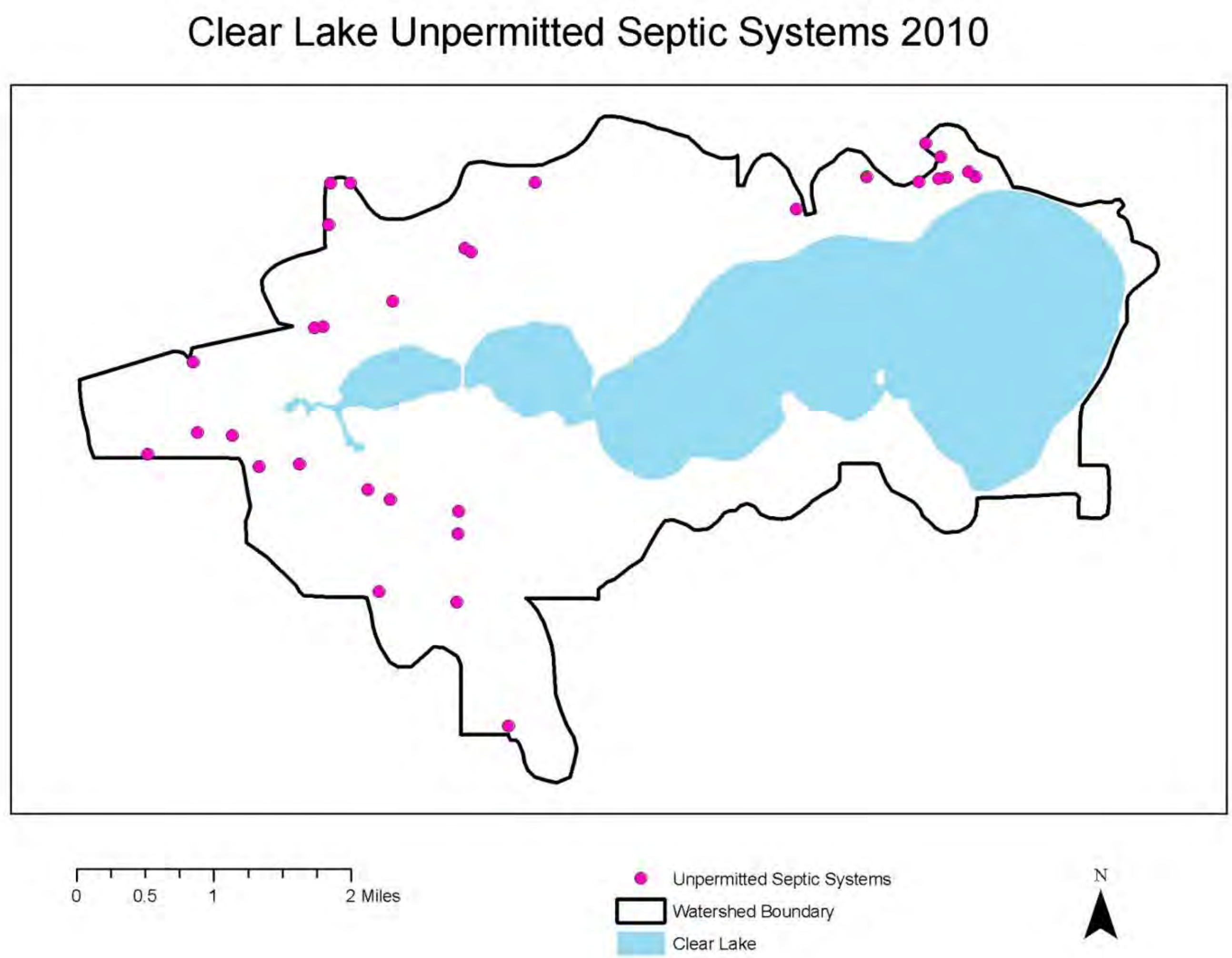
182 lbs of phosphorus to Clear Lake each year, making shoreline stabilization a high priority for future work activities. A shoreline stabilization project on the 1,500 ft of publicly owned shoreline is scheduled for completion by the spring of 2011.

Figure 9: Clear Lake Potential Shoreline Stabilization Sites

SEPTIC SYSTEM ASSESSMENT

According to information received from the Cerro Gordo Department of Public Health, there are 31 septic systems in the Clear Lake watershed for which no permit records exist. The lack of records indicates that these systems are most likely unpermitted and do not have secondary treatment as required by State law. Even though none of the unpermitted systems are on the shoreline of Clear Lake, it is likely that most are connected to a drainage tile that outlets to a ditch or stream that flows directly into Clear Lake. A "time of transfer" law requiring the inspection and upgrade of septic systems at the time of sale has been in place in Cerro Gordo County for several years and this law has now been adopted statewide. Although the law will eventually result in all septic systems in the watershed being permitted, this could take decades to accomplish and allow bacteria and nutrients to enter Clear Lake in the meantime. Since Clear Lake is impaired by bacteria, a priority of the project will be to upgrade the unpermitted systems using local funding incentives to ensure all meet current state and local codes. It is difficult to quantify the amount of bacteria unpermitted septic systems are contributing to the lake, but it is logical to assume they are an important contributing factor. Phosphorus loading from septic systems was calculated based on number of systems, user days, and book values of phosphorus loading. Based on Clear Lake data, the estimated loading is 125 lbs/year (see Section 7 for more details).

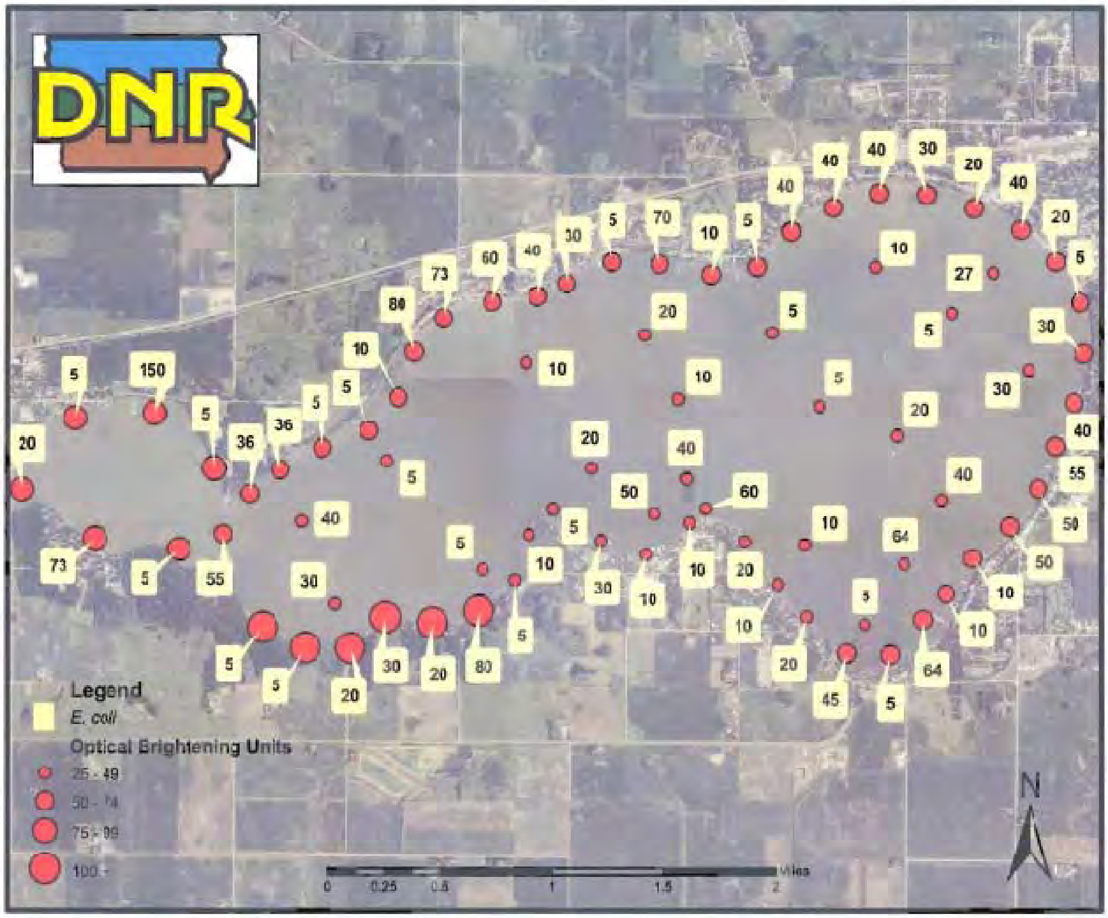
Figure 10: Clear Lake Unpermitted Septic Systems 2010



BEACH BACTERIA ASSESSMENT

A preliminary investigation in beach bacteria sources was completed by the Iowa DNR in 2007. The DNR used fluorometry to identify the presence of human sources. Although the research did find areas in the lake with higher fluorescence, there is no background data to compare it to so it is difficult to determine if the "high" levels were actually linked to human waste water. Also, the higher levels of fluorescence did not always correlate to elevated E. coli numbers (CFU/100 ml) as shown in Figure 10. The information may prove beneficial for use with future investigations. A more thorough investigation into beach bacteria sources is needed in order to draw conclusions. No EPA funds are being sought until further bacteria information is collected.

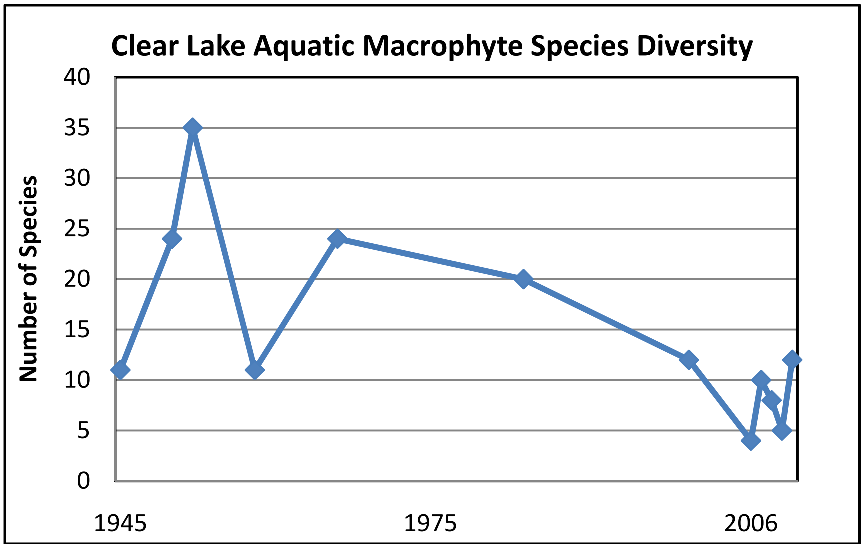
Figure 11: Results of Fluorometry Investigation Completed at Clear Lake in September, 2007



AQUATIC VEGETATION ASSESSMENT

The diversity and density of aquatic macrophytes (plants) are often a reflection of water quality and clarity. As water quality improves, typically so does the diversity and density of aquatic plants. Surveys of aquatic plants at Clear Lake have been conducted at different times over the past 100 years (Colvin, Katzenmeyer, Stewart, Pierce, 2010). Review of this data shows that aquatic macrophyte diversity has decreased significantly over the past 60 years (Figure 11). In 1952, 35 species were found compared to 21 species in 1981. Recent surveys from 2006 to 2010 were conducted by the Aquatic Nuisance Species section of Iowa DNR at 17 transect locations around the lake. For the recent surveys, a low of only 4 species was found in 2006, and a high of 12 species was found in 2010. Two or three species more than what was reported in the recent surveys have been found by IDNR Fisheries staff, indicating those numbers may be a little low (J. Wahl, personal communication, 2010). This information coupled with observations from Clear Lake DNR staff indicates that aquatic plants are increasing in diversity and density, but is still much less than what it was in the 1940's and 50's.

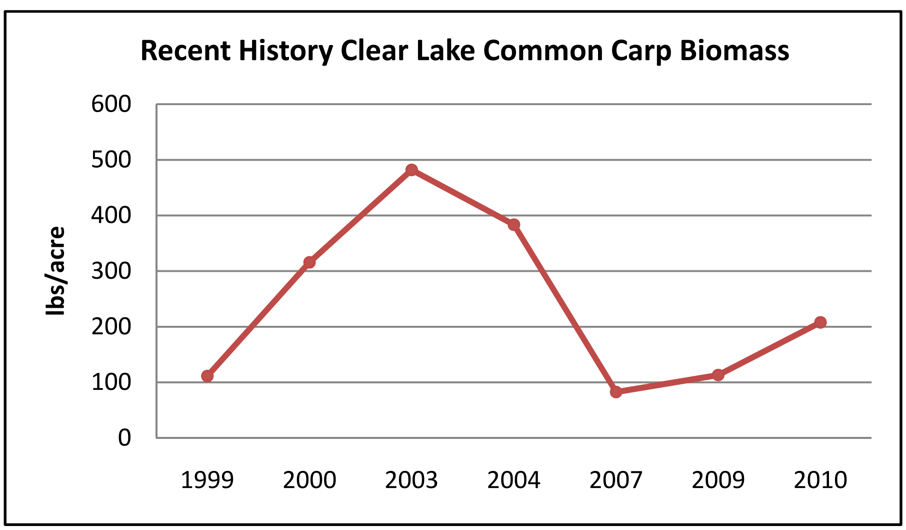
Figure 12: Clear Lake Aquatic Macrophyte Species Diversity Research Summary



FISHERIES ASSESSMENT

Common carp internal loading can provide a significant percentage of nutrient and sediment loading to shallow lakes, especially when common carp are abundant. Iowa State University and the Iowa DNR in cooperation with Iowa State University has been performing carp population estimates over the past few years as part of various research projects. Currently, the population of common carp is estimated at about 200 lbs/acre. This is down from about 400 lbs/acre about six years ago. Iowa DNR fisheries Biologist Scott Grummer determined that a realistic goal for the carp population in Clear Lake is less than 100 lbs/acre. This target was based on historic carp population data and anticipated future removal amounts via commercial fishing. Continuing efforts to reduce carp population levels will be a priority.

Figure 13: Recent History of Common Carp Biomass in Clear Lake



The diversity and density of fish species in a lake are also often a reflection of water clarity and quality. As water clarity and aquatic macrophytes increase, more species diversity takes place. The Clear Lake fishery has been dominated by fish species that are more tolerant to turbid conditions, such as yellow bass and walleye, for many years. Walleye have low natural reproduction and rely on stockings. Recent young of year monitoring which indicates fish spawning success has shown that several other species such as yellow perch, bluegill, crappie, and largemouth bass are now increasing in number (Appendix 3). This trend is expected to continue as water quality continues to improve.

PREVIOUS RESTORATION ACHIEVEMENTS ASSESSMENT

The Clear Lake Diagnostic and Feasibility Study provided several recommendations for watershed and lake improvements. The CLEAR Project used the Clear Lake D&F Study as the blueprint for restoration activities needed to improve the water quality of Clear Lake. The original recommendations in the study were reviewed to determine the level of accomplishment achieved to date. This information was compiled in Table 9 below and used to help gauge where further improvements are needed.

Table 9: Review of Clear Lake Diagnostic and Feasibility Recommendations and Accomplishments

In-Lake Recommendations	Percent Complete	Notes
Dredge West End of Clear Lake	100%	Removed 2.4 million cubic yards of sediment in 2008-2009
Fish Population Management	50%	Significant reductions in bullhead population achieved, however continued efforts are needed to reduce carp population levels to 100 lbs/acre or less.
No Wake Zone Enforcement	50%	Increased awareness, enforcement level same
Install Breakwater Structures	0%	Low public acceptance, not necessary to meet water quality goals
Aeration of West End After Dredging	0%	Not yet deemed necessary, will monitor to determine if needed in future
Agricultural Areas Watershed Recommendations	Percent Complete	Notes
Minimize Livestock Contact with Waterways	90%	Currently, no livestock has direct access to streams that drain to Clear Lake.
Place 10% of Ag Land in Permanent Vegetation	80%	Over 750 acres have been restored to prairie vegetation, representing about 15% of the original row crop acres. An additional 240 acres has been donated to the Nature Conservancy for future restoration.
Restore and Create 15 Wetlands	75%	About 12 wetland restoration sites have been completed, many are not in areas ISU recommended, but are still beneficial.
Reduce P Application and Nutrient Losses to Lake	75%	A nutrient management program was conducted for four years. Most producers do not over apply nutrients.
Use BMPs to Decrease Erosion	50%	Although few areas of the watershed have steep slopes, further CRP practices on these acres would be beneficial.
Inspection of Septic Systems and	25%	A time of transfer rule is in place meaning eventually

Elimination of Tile Line Black Water		all septic systems will be inspected.
Developed Areas Watershed Recommendations	Percent Complete	Notes
Installation of Storm Drain Filters	95%	A total of 37 out of 68 storm water outlets have been improved with various urban BMPs. This represents about 95% of all outlets treated that drain 5 acres or more.
Frequent Street Cleaning	90%	Regular street sweeping performed in City of Clear Lake and City of Ventura. Both communities have upgraded equipment in the past few years.
Abandoning septic and waste disposal systems.	75%	Most all septic systems in developed areas have been abandoned and connected to sanitary sewer. Current rules do not allow new septic on properties less than 10 acres.
Adoption of Policies Favoring Water Retention	50%	The City of Clear Lake has language in its code requiring retention of storm water. Further "green" development opportunities exist.
Promotion of Riparian and Nutrient Management Regulations	50%	Many information and education activities have taken place, however no regulation of nutrients is allowed by State law.
Adopt Comprehensive Riparian Management and Development Plans	50%	Although many activities suggested in a development plan have been enacted, few have been officially adopted.
Inspection and Upgrade of Storm Sewer and Sanitary Systems	20%	Areas along swim beaches and other problem areas have been inspected. About 20% of sewer mains in the watershed haven been upgraded to date.
Control Dust from Construction and Unpaved Roads	0%	Not a priority issue, no action has yet to take place.
Ventura Marsh Restoration	Percent Complete	Notes
Install a pumping system	100%	A pump station will be installed in FY'11 to allow for water level control of the marsh.
Install improved fish barriers	100%	New fish barriers will be installed in FY'11 at the pump station.
Enhanced fishery management	100%	The DNR will control water levels in the marsh to manage fish populations, this will be an ongoing need.
Separate eastern and western portion by building a dike	0%	It was determined the dike was not necessary to achieve water quality goals.
Installing islands in eastern basin	0%	It was determined islands were not necessary to achieve water quality goals.

MAINTENANCE NEEDS ASSESSMENT

More than 60 best management practices have now been implemented in the Clear Lake watershed. These practices require periodic maintenance in order for them to provide the pollutant loading reductions they were designed for. A complete list of installed practices is provided in Appendix 4. A basic maintenance schedule that should be followed for the predominant types of BMPs that have been installed in the watershed is provided on the following page.

Grit Collection Chambers:
Storm water catchment basins should be cleaned a minimum of one time per year, however two or three times per year is recommended. The City of Clear Lake is the only entity currently capable of cleaning the grit collection chambers (GCCs). Cerro Gordo County and the City of Ventura currently have an agreement with the City of Clear Lake to clean the GCCs in their jurisdiction. This agreement should continue to ensure proper maintenance is continued into the future.

Infiltration Trenches:
The rock infiltration trenches are expected to last about twenty years before replacement of the rock is needed. It is recommended that the infiltration trenches be inspected after ten years to ensure they are still functioning properly.

Rain Gardens:
The maintenance of rain gardens is important from both a water quality and an aesthetic standpoint. Rain gardens with native plantings should have vegetation removed either by hand or by burning once every three years to maintain a healthy native plant community. Rain gardens require weeding throughout the growing season and it is advised that a group of volunteers is developed to help with this maintenance.

Permeable Pavers/Pavement
Permeable pavers should be inspected after five years of installation to ensure infiltration is still taking place. When proper infiltration is no longer taking place, the replacement of aggregate in the spaces between pavers should take place. This is likely to occur about once every ten years.

Shoreline Stabilization:
Shoreline areas stabilized with fieldstone should be inspected every five years to ensure rock is in place and no bank undercutting is occurring. Repairs should be made as needed.

Conservation Reserve Program Practices:
Guidelines from the Farm Service Agency and the Natural Resource Conservation Service for maintaining native grass seeding and wetland restorations should be followed. Current rules require “mid contract management” on native seedings to enhance wildlife habitat in about year five of the contract. Restoration sites should also be checked annually the first three years after seeding to ensure proper establishment has taken place.

6.2 Pollutant Data Analysis

2010 ASSESSMENT OF TOTAL PHOSPHORUS LOADING

The Clear Lake TMDL prepared in 2005 focused on total phosphorus as the contaminant that needed to be reduced in order for Clear Lake to meet its designated uses. Although also impaired for bacteria, no TMDL has yet been prepared for this impairment. The 2005 total phosphorus TMDL utilized data from the 1998-2000 Clear Lake Diagnostic & Feasibility Study to determine phosphorus loading allocations. Many restoration activities have been implemented since the D&F Study, and water quality data has shown significant improvement in lake total phosphorus concentrations (188 µg/L in 1998-2000 vs. 58 µg/L in 2008-2010). For these reasons, it was necessary to develop new phosphorus loading estimates that more closely represented current conditions.

It should be noted that developing a truly accurate phosphorus budget requires a level of monitoring and data collection that exceeded both the time and funding limitations of the watershed management plan. The potential sources of total phosphorus loading were analyzed for the WMP using a variety of methods such as modeling, GIS analysis, literature values, and recent water monitoring data to estimate as closely as possible current loading amounts. The 2010 loading estimates should therefore be viewed as a reasonable estimate, but would require more intensive monitoring and data collection to validate.

It should also be noted that the Clear Lake D&F Study showed that phosphorus loading to Clear Lake is highly variable depending on precipitation and runoff amounts. The Clear Lake D&F Study was completed during one high precipitation period (48 inches in Aug 1998- July 1999), and one low precipitation period (28 inches in Aug 1999-July 2000). There was a large difference in TP loading between the two years as the loading for 1998-1999 was estimated at about 23,000 lbs and the 1999-2000 loading was estimated at about 11,000 lbs. The two periods were averaged to develop a mean annual phosphorus loading estimate of about 17,000 lbs in the D&F Study.

The 2010 assessments attempted to develop a loading budget based on similar runoff conditions as the Clear Lake D&F and TMDL so reasonable comparisons can be made. The assessments estimated the 2010 annual phosphorus loading to be 6,410 lbs (Table 10). This equates to an overall reduction in total phosphorus loading to Clear Lake by 62% since the Clear Lake D&F Study was completed. The methodology used to estimate the 2010 total phosphorus loading amount is described in further detail below.

Table 10: Summary of Past and Present TP Load Estimates for Clear Lake

Total Phosphorus Sources	Clear Lake D&F Study (lbs/yr)	TMDL Plan Estimates (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Watershed (Undeveloped)	6,610	NA	1,970	70%
Watershed (Developed)	1,480	NA	1,200	19%
Watershed Total	**8,090**	**11,440**	**3,170**	**61%**
Ventura Marsh Internal	1,300	NA	800	38%
Clear Lake Internal	1,760	1,760	770	56%
Precipitation	4,840	4,500	970	80%
Groundwater	1,100	9,00	700	36%
TOTAL	**17,090**	**18,600**	**6,410**	**62%**

WATERSHED LOADING UNDEVELOPED AREAS:
Non point sources of total phosphorus loading from agricultural and non-developed areas were assessed using a variety of tools. One tool used was the updated cumulative sediment delivery estimate for the Clear Lake watershed. The tool uses landcover, management, and tillage information to create a delivery estimate based on the Revised Universal Soil Loss Equation (RUSLE). The estimated current delivery to Clear Lake was found to be 287 tons/year of sediment. Recent studies conducted in Iowa (Rowden, 2010) have indicated that 1.6 lbs of TP are delivered for each ton of sediment. Using this factor resulted in a loading of 459 lbs/year of total phosphorus. It should be noted that this tool only estimates sediment delivery from sheet and rill erosion and does not include ephemeral gully erosion. For planning purposes, the NRCS uses a ratio of one ton/acre of gross erosion from ephemeral gullies for row crop acres with soils having a "C" or greater slope. There are 540 acres in the Clear Lake watershed that fit this description. To convert gross erosion to sediment delivery, a factor of 0.7 is used (NRCS Field Office Technical Guide). The tons of sediment delivery is then multiplied by 1.6 as described above to convert to lbs of phosphorus delivery. The phosphorus loading from ephemeral gullies in the watershed is therefore calculated as follows: 540 x 0.7 x 1.6 = 605 lbs/year of TP loading. When added to the sheet and rill estimate, the total loading from agricultural and non-developed watershed sources is 1,064 lbs/year.

A second method of determining phosphorus loading from non-developed areas in the watershed was to utilize recent tributary monitoring data. Six main tributaries that were monitored in 1998-2000 as part of the Clear Lake D&F Study were again monitored in 2010. These tributaries drain more than 75% of the agricultural acres in the watershed. Samples were collected once per month for six months, and two rain events were also monitored. The mean TP concentration of the 48 samples from recent monitoring was found to be 162 µg/L. This concentration was multiplied by the mean water flux from agricultural areas in the watershed determined during the 1998-2000 Clear Lake D&F Study (8,047,760 m3). After the necessary conversions were made, this method estimated a current phosphorus loading of 2,875 lbs/year of total phosphorus from agricultural areas. It should be noted that this estimate is based on a very limited amount of monitoring data.

The two methods for assessment resulted in a range of 1,064-2,875 lbs/year of total phosphorus loading from non-developed/agricultural areas. The "most likely" phosphorus loading estimate was therefore determined by taking the mean of the two estimates, which equals 1,970 lbs/year. The total phosphorus delivery from agricultural areas in 1998-2000 was determined by the Clear Lake D&F Study to be 6,608 lbs. The 2010 total phosphorus delivery to Clear Lake therefore indicates a 70% reduction has taken place.

Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimates (lbs/year)	2010 Assessment (lbs/year)	TP Reduction D&F to 2010
Watershed (Ag)	6,610	NA	1,970	70%

WATERSHED LOADING DEVELOPED AREAS:
More than 40 urban best management practices (BMPs) have been installed since the total phosphorus delivery from developed areas had last been calculated during the Clear Lake D&F Study (Appendix 4). The BMPs included rain gardens, pervious pavement, infiltration trenches, and grit collection chambers.

The majority of these systems (31) were grit collection chambers. The engineering firm Veenstra & Kimm analyzed the best management practices before they were installed for drainage area size and total phosphorus removal. The BMPs were estimated to remove on average 70% of the TP from storm water runoff in the drainage area they treated (Veenstra & Kimm, 2008). The drainage area treated by BMPs was determined to be 320 acres. The Clear Lake Diagnostic and Feasibility Study determined the average TP loading from developed areas to be 1.7 lbs/acre. This amount was reduced to 0.51 lbs/acre (1.7 x 30%) for the 320 developed acres treated by BMPs. The remaining untreated developed area (611 acres) were attributed a TP loading of 1.7 lbs/acre. This resulted in the 2010 total phosphorus loading from developed areas being estimated at 1,200 lbs/year. It should be noted that better management practices such as reduced phosphorus fertilizer use and increased street cleaning has been observed since the D&F Study was completed ten years ago. These practices have also likely resulted in further TP loading reduction since. Unfortunately, no water monitoring data is available to confirm this reduction, so the original 1.7 lbs/acre estimate determined in the Clear Lake D&F Study was used.

Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimate (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Watershed (Developed)	1,480	NA	1,200	19%

VENTURA MARSH INTERNAL LOADING:

The Ventura Marsh internal P loading from the D&F Study was assessed by using the mean outflow concentration for 2008-2010 and the mean outflow water flux for Ventura Marsh that was determined during the Diagnostic and Feasibility Study. Data collected during the D&F found total phosphorus mean concentrations at the outlet to be 403 µg/L. The water monitoring collected from 2008-2010 showed the mean TP concentration had been reduced to 259 µg/L (40 samples). It was estimated that the average outflow water flux measured in the 1998-2000 D&F Study is representative of the 2008-2010 mean outflow water flux as the mean precipitation amounts for the two comparison periods were similar (37.9" and 36.4" respectively). Multiplying the estimated water flux determined in the D&F Study (1,404,407 m3) by the current total TP concentration (259 µg/L) and performing the necessary conversions equates to a total loading of 800 lbs/year of TP for the estimated 2010 loading allocation. The TP loading to Clear Lake estimated in the Ventura Marsh TMDL and the Clear Lake D&F study was 1,300 lbs/year. The 2010 estimate indicates a 38% reduction has taken place since that time.

Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimate (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Ventura Marsh Internal	1,300	NA	800	38%

CLEAR LAKE INTERNAL LOADING:

Several changes have taken place in the Clear Lake ecosystem over the past ten years that makes calculating internal loading difficult. Due to the shallow nature of Clear Lake, the main factors driving the internal loading of Clear Lake is the resuspension of bottom sediment from benthic fish and wind. Biomass estimates performed by IDNR fisheries staff has shown the population of common carp was very similar in 2009-2010 as it was when the D&F Study was completed. However, another benthic fish, black bullheads, have declined dramatically from an estimated 150 -300 lbs/acre during the D&F Study to less than 20 lbs/acre from 2009-2010 (S. Grummer, personal communication, 2010). Another substantial change to the benthic ecosystem is the infestation of zebra mussels that were first discovered in Clear Lake in 2005. The impact of zebra mussels on the benthic community and phosphorus cycling is currently being investigated by ISU and the IDNR. When the investigation is completed later in 2011, the internal TP loading estimate calculated below can be updated. The internal loading of Clear Lake was calculated in the Diagnostic and Feasibility Study by using a simple total mass balance equation. The equation used is as follows: (Lake TP concentration x lake volume) - external TP loading, not including Ventura Marsh. The same equation was utilized for the 2010 assessment using the current lake TP concentration (58 µg/L), the current lake volume (43,889,587,659 L), the updated external TP loading information (4,840 lbs), and making the necessary conversion to lbs. The results of this analysis indicated that internal loading now contributes about 770 lbs/year of TP to Clear Lake. This amount is substantially less than when the Clear Lake D&F Study was completed, but does equate to a slightly greater percentage of the overall TP budget (12%) than previously (9%).

Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimate (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Clear Lake Internal	1,760	NA	770	56%

PRECIPITATON:
The Clear Lake Diagnostic & Feasibility Study used volunteer monitoring to collect rainfall for measuring the total phosphorus concentration. The study found that the mean precipitation TP concentration was 169 µg/L. When the Clear Lake TMDL was prepared, the document pointed out that this total was more than three times higher than what is typically estimated for Iowa watersheds (50 µg/L). The exceptionally high levels of phosphorus in the rainwater that falls on Clear Lake is questionable as the Clear Lake watershed is not atypical of other watersheds in Iowa. A more intensive atmospheric deposition study was conducted by in 2002 and included a sample site at the Mason City Airport, which is located less than ten miles from the Clear Lake watershed (Anderson and Downing, 2006). That research showed that the average rainfall concentration was only 11 µg/L at Mason City, and was very similar to the other 5 sites in Iowa that were monitored. The study found that the total wet and dry atmospheric deposition was .30 kg/ha/year (.267 lbs/acre/year), which is the same value Iowa TMDL staff use in their assessments. The updated value was therefore used to estimate the 2010 TP loading from precipitation (3625 acres x .267lbs/acre/year = 970 lbs/year).

Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimate (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Precipitation	4,840	4,500	970	80%

GROUNDWATER:
The groundwater total phosphorus loading was assessed based on more recent groundwater monitoring data. The thirty-three piezometers monitored during the Clear Lake D&F Study (219 samples) were again monitored from 2005 -2007 (673 samples). The median rather than mean total phosphorus value was utilized in the D&F Study to estimate loading since some very high values were skewing the distribution. The same method was therefore utilized when analyzing the 2005-2007 monitoring data. The more recent monitoring showed the median total phosphorus concentration was 110 µg/L compared to 173 µg/L found during the D&F Study. The amount of groundwater inflow Clear Lake receives was estimated during the D&F Study using field measurement and modeling to be 7,900 m3/day. Multiplying the inflow (7,900 m3/day) by the updated concentration (110 µg/L) and making the necessary conversions indicates a groundwater phosphorus loading of 700 lbs/year.

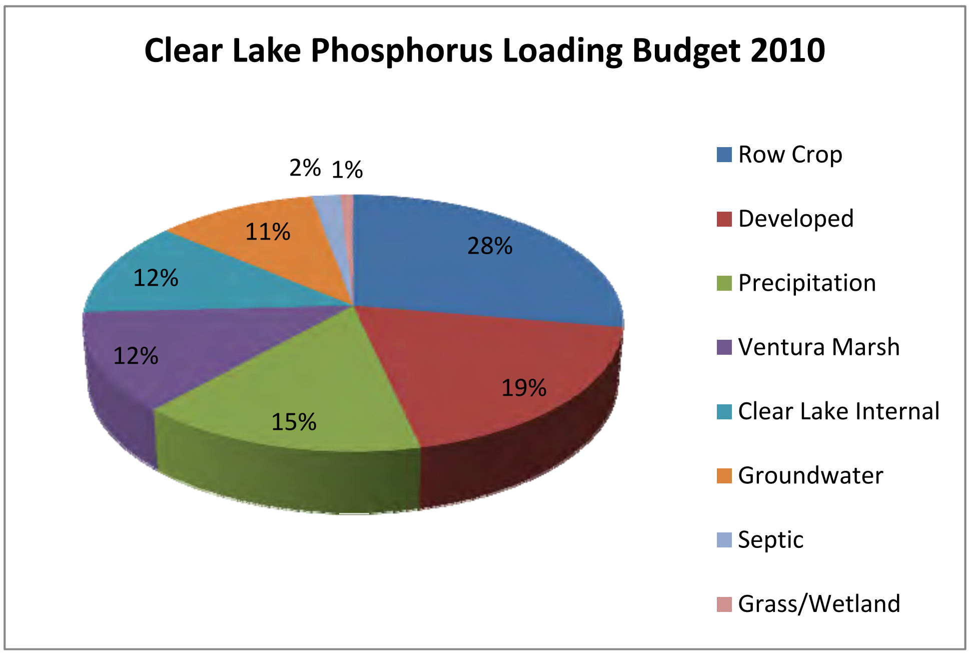
Total Phosphorus Source	Clear Lake D&F Study (lbs/yr)	TMDL Estimate (lbs/year)	2010 Assessments (lbs/year)	TP Reduction D&F to 2010
Groundwater	1,100	9,00	700	36%

6.3 Pollutant Data Sources

TOTAL PHOSPHORUS SOURCES

The 2010 assessments described on the previous pages were utilized to help develop an overall total phosphorus loading budget for Clear Lake. For land uses and sources which no assessments were completed, default loading estimates provided in the Wisconsin Lakes Modeling Suite (WILMS) were utilized. The results of the total phosphorus loading sources are shown in Figure 14. The results indicated that the areas of most concern were row crop, developed, and Ventura Marsh. Precipitation and groundwater were also significant contributors, but are considered background sources that are not easily impacted by restoration practices.

Figure 14: Clear Lake Total Phosphorus Load Sources 2010



BACTERIA SOURCES

Efforts to limit bacteria loading so beach bacteria readings remain within guidelines is a primary goal of the Advisory teams, as described in Section 7. In order for Clear Lake to remain a popular recreational resource, bacteria sources need to be reduced so the public feels safe recreating at Clear Lake. Sufficient data to determine bacteria sources to Clear Lake does not exist at this time. Local knowledge of the watershed allowed the advisory groups to develop a list of likely sources, however quantifying the amount of loading from each source was not possible. An investigation into bacteria loading sources would be beneficial in order to better target bacteria load reductions. The lake association and other local partners plan to conduct bacteria source tracking to assist in gathering this information. The WMP may be updated in the future when this data is available.

Table 11: Potential Sources of Bacteria Loading to Clear Lake

Type	Source A	Source B	Source C
Human	Septic Systems	Private Sewer Lines	Municipal Sewer Lines
Wildlife	Water Birds	Furbearers	
Livestock	Manure Application	Cattle	Horse
Pets	Dog		

7 Watershed Management Plan Goals and Objectives

7.1 Statement of Goals and Objectives

The overarching goal of removing Clear Lake from the Impaired Waters list and ensuring all designated uses of the lake are met can be achieved by completing the goals described below.

Goal 1: Improve water clarity to an average minimum depth of 1.5 m so that the lake is aesthetically pleasing for all recreational activities.

Goal 2: Reduce bacteria inputs to Clear Lake so that swim advisories posted no more often than 5% of the time at the three swimming beaches on Clear Lake.

Goal 3: Reduce levels of nutrient (phosphorus) and sediment loading from both internal and external sources and maintain existing best management practices.

Goal 4: Improve fish and wildlife habitat at Clear Lake by reducing rough fish populations and increasing aquatic vegetation and fish diversity.

Goal 5: Continue water monitoring at Clear Lake so changes in water quality can be tracked.

Goal 6: Continue information and education activities to ensure the public and partners understand the importance of lake improvement activities.

Goal 7: Ensure Clear Lake remains a top tourism destination in north central Iowa by providing long term protection of Clear Lake.

7.2 Targets and Load Reductions

WATER QUALITY TARGETS:

Targets outlined in the TMDL for total phosphorus, chlorophyll a, and Secchi disk depth are currently being met, as shown in Table12. Although the TMDL goals are being achieved, they are not yet resulting in the level of water clarity desired by the watershed advisory council. Recent monitoring has indicated that total phosphorus (TP) concentrations have already been reduced more than expected, and there is potential for further reduction. For example, the Clear Lake Diagnostic and Feasibility Study determined that a realistic goal for TP concentrations at Clear Lake after all recommendations were implemented would be 100 µg/L. Likewise, the TMDL stated that if a 50% reduction in TP loading was achieved, a realistic TP concentration goal would be 96 µg/L. However, water monitoring data is currently showing that TP levels have already been reduced to less than 60 µg/L, and are still declining. Further reductions in phosphorus loading which will result in improved water clarity are achievable, but will require additional efforts. The long term goal will be to reach total phosphorus concentrations of less than 50 µg/L as further watershed and lake improvements are made.

A TMDL for bacteria has not yet been developed, however the typical recommendation is no more than 10% of weekly samples exceed the one time standard. A more stringent goal of only 5% of weekly samples exceeding the one time standard has been set by the watershed advisory team. A summary of the water quality goals is provided in Table 12.

Table 12: Summary of Clear Lake Water Quality Goals:

Parameter	TMDL Goal	Current Water Quality (2008-2010)	CLEAR Goal	% Further Improvement
Total Phosphorus	96 µg/L	58 µg/L	<50 µg/L	14%
Chlorophyll a	33 µg/L	22 µg/L	<15 µg/L	32%
Secchi Disk Depth	0.7 m	0.75 m	>1.5 m	33%
Total Suspended Solids	NA	15 mg/L	<10 mg/L	33%
Beach Bacteria*	90% weekly monitoring samples safe	87% weekly monitoring samples safe	>95% weekly monitoring samples safe	8%

* No TMDL has yet been developed for the bacteria impairment at Clear Lake, the TMDL Goal listed is that which is in accordance with current State water quality standards.

WATER QUALITY TARGET MILESTONES:

The watershed management plan has been designed to span twenty years and was broken into four phases. The water quality goals for each phase shown in Table 13 can be used to track progress towards overall project goals. Due to the fact that many of the original primary restoration activities will have been completed by the end of phase I, it is anticipated that further water quality improvements will take place more gradually than seen in the previous ten years.

Table 13: Clear Lake Water Quality Milestones by Phase

Parameter	CLEAR Goal Phase I 2011-2015	CLEAR Goal Phase II 2016-2020	CLEAR Goal Phase III 2021-2025	CLEAR Goal Phase IV 2026-2030
Total Phosphorus	54 µg/L	52 µg/L	50 µg/L	<50 µg/L
Chlorophyll a	20 µg/L	19 µg/L	17 µg/L	<15 µg/L
Secchi Disk Depth	0.9 m	1.1 m	1.3 m	>1.5 m
Total Suspended Solids	13 mg/L	11 mg/L	10 mg/L	<10 mg/L
Beach Bacteria % weekly monitoring below EPA guideline	90%	92%	94%	>95%

7.3 Load Allocations

TMDL TOTAL PHOSPHORUS LOAD ALLOCATION:

In 2005, the Environmental Protection Agency (EPA) approved a water quality improvement plan for Clear Lake, formerly known as a total maximum daily load (TMDL). The TMDL set load allocations for total phosphorus (TP). The TMDL determined that there are no point source discharges to Clear Lake and therefore the entire TP load allocation is attributed to watershed, internal, and background loading. The TMDL estimated the current loading to be 18,600 lbs/year of total phosphorus based on measured loading amounts during the Clear Lake Diagnostic and Feasibility Study, and on empirical lake modeling. The background sources (precipitation and groundwater) were estimated to contribute 5,400 lbs/year. The remaining 13,200 lbs/year were therefore attributed to watershed and internal loading. Lake modeling was then utilized to determine the necessary load reductions to meet the TMDL target of a TSI <70 (96 µg/L) for total phosphorus. After reviewing the results of multiple empirical lake models, the Vollenweider 1982 Combined OECD Lake Model was chosen as it most accurately predicted the lake water quality conditions and phosphorus loading that was determined by the Clear Lake D&F Study. The model determined a reduction of 9,100 lbs/year of total phosphorus was needed to meet the TP load allocation of 9,500 lbs/year.

Table 14. Clear Lake TMDL Total Phosphorus Load Allocations 2005

Total Phosphorus Load Description	Load Allocations
Existing Total Phosphorus Load	18,600 lbs/year
Allowable Total Phosphorus Load	9,500 lbs/year
TP Load Reduction to Achieve Target	9,100 lbs/year
TP Wasteload Allocation	0
Background TP Load Allocation (Precipitation)	4,500 lbs/year
Background TP Load Allocation (Groundwater)	900 lbs/year
Watershed/Internal TP Load Allocation	3,700 lbs/year
TP Load Allocation	9,100 lbs/year
Margin of Safety	400 lbs/year

2010 UPDATED TOTAL PHOSPHORUS LOADING ALLOCATION:

After performing the updated phosphorus loading assessment in 2010, it was apparent that a new loading estimate was needed. Similar to the strategy used in the TMDL, modeling was utilized to determine future needed loading reductions. The Wisconsin Lake Modeling Suite (WILMS) was chosen due to its ability to run several empirical lake models simultaneously to determine which model most accurately predicts observed lake TP concentrations based on current phosphorus loading and hydrologic information. The inputs for the WILMs modeling are shown in Appendix 5 and the results are presented in Appendix 6. WILMS showed that the Vollenweider 1982 Shallow Lakes Model predicted the lake total phosphorus concentration at 60 µg/L based on the 2010 phosphorus loading estimate of 6,410 lbs. This is within 2% of the observed current lake TP concentration (58 µg/L), indicating a good fit of the model. The Vollenweider 1982 Shallow Lakes Model can then be used to back calculate needed phosphorus loading reductions in order to achieve desired lake TP concentrations. The model predicted future phosphorus loading reductions of 1,100 lbs/year were needed to achieve the target value of 50 µg/L. The updated loading allocation indicates that the allowable total phosphorus loading is 5,300 lbs/year. The previous load allocation in the Clear Lake TMDL was 9,100 lbs/year, so the new allocation represents a 42% reduction. A comparison between the TMDL TP load allocation and the 2010 TP load allocation is shown in Table 15 and the calculations on how the estimate was derived follows.

Table 15: Updated Clear Lake Total Phosphorus Load Allocation

Total Phosphorus Load Description	TMDL Estimates Vollenweider 1982 OECD	2010 Estimates Vollenweider 1982 Shallow Lakes
Existing Total Phosphorus Load	18,600 lbs/year	6,400 lbs/year
Allowable Total Phosphorus Load	9,500 lbs/year	5,300 lbs/year
TP Load Reduction to Achieve Target	9,100 lbs/year	1,100 lbs/year
TP Wasteload Allocation	0	0
Background TP Load Allocation (Precipitation)	4,500 lbs/year	970
Background TP Load Allocation (Groundwater)	900 lbs/year	700
Watershed/Internal TP Load Allocation	3,700 lbs/year	3,630 lbs/year
TP Load Allocation	9,100 lbs/year	5,300 lbs/year
Margin of Safety	400 lbs/year	NA

Vollenweider 1982 Shallow Lake and Reservoir Model Equation:

$$P = 1.02\left[\frac{\left(LTw/_{z}\right)}{1+\sqrt{Tw}}\right]^{0.88}$$

Where:
P = predicted in-lake total phosphorus concentration (µg/L)
L = areal total phosphorus load (mg/m2 of lake area per year)
Tw = lake hydraulic residence time (years)
z = lake mean depth (meters)

The calculations for the Vollenweider 1982 Shallow Lake and Reservoir Model existing total phosphorus concentration in Clear Lake is as follows:

$$P = 60\ \mu g/L = 1.02\left[\frac{\left(200\ (mg/m2)\ 5.00(yr)/_{2.99(m)}\right)}{1+\sqrt{5.00\ (yr)}}\right]^{0.88}$$

The calculation for the Vollenweider 1982 Shallow Lake and Reservoir Model desired total phosphorus concentration in Clear Lake is as follows:

$$P = 50\ \mu g/L = 1.02\left[\frac{\left(\frac{162\ (mg/m2)\ 5.00(yr)}{2.99(m)}\right)}{1 + \sqrt{5.00\ (yr)}}\right]^{0.88}$$

BACTERIA LOAD ALLOCATION

A TMDL has not yet been prepared for the bacteria impairment at Clear Lake, so no current loading data exists. Recent beach water monitoring data indicates that substantial bacteria loading to Clear Lake is taking place at times. The methodology required for developing accurate bacteria loading estimates exceeded both the time and financial constraints of the Watershed Management Plan. Although a bacteria load allocation has not yet been calculated, the WMP does include recommended best management practices that are commonly used to reduce bacteria loading. Bacteria loading reduction is a primary goal of the Advisory teams and should be pursued even without specific load allocation data. The strategy for reducing bacteria will rely on current available data and on local knowledge of the Advisory Team. When a TMDL is completed for the bacteria impairment, or other source tracking data becomes available, the loading allocation information can be added and the watershed management plan adjusted accordingly.

7.4 Best Management Practices

The watershed advisory team worked with the technical advisory team to develop the below list of best management practices necessary for meeting the watershed management plan goals. The best management practices were divided into the sections of: watershed improvements, in-lake improvements, maintenance, and information and education. If all best management practices are implemented, the goal of reducing total phosphorus loading by 1,100 lbs/year will be achieved.

Table 16: Clear Lake Potential Restoration Activities

CLEAR LAKE POTENTIAL RESTORATION ACTIVITIES FOR WMP		
Watershed Improvements	Amount	Estimated TP Annual Loading Reduction
Shoreline Stabilization	2,700 ft	182 lbs
Septic System Update Program	35 systems	125 lbs
Sewer Line Repair	As needed	NA
Wetland/Prairie Restoration	1,000 acres	410 lbs
Filter Strips	3,000 ft	56 lbs
Infiltration Based Practices	20 practices	24 lbs
Permeable Street Pavement	1,500 sq ft	NA

Urban Ordinances	As needed	NA
Ventura Marsh Water Management	Annually	300 lbs
Lake Improvements		
Rough Fish Control	50,000 lbs removed/yr	NA
Aquatic Vegetation Experiments	3 areas	NA
Water Monitoring	4 sites; 14 times/year	NA
Phosphorus Budget Investigation	1 investigation	NA
Beach Bacteria Investigation	1 investigation	NA
Beach Waterfowl Management	As needed at beaches	6 lbs
Beach Cleaner Machine	2 machines	NA
No Wake Buoys	10	NA
Review Need for Alum Treatment	Ongoing	NA
Review Need for Aeration	Ongoing	NA
Maintenance		
Grit Collection Chambers & Infiltration Trenches	32 units	NA
Rain Gardens	6 gardens	NA
Pervious Pavement	3 units	NA
CRP Re-enrollment	500 acres	NA
Information and Education		
Invasive Species Education	Ongoing	NA
Newsletters	4 annually	NA
Newspaper	5 annually	NA
TV/Radio	1 annually	NA
Flyers, special mailings	1 annually	NA
Community Presentations	10 annually	NA
School Activities	2 annually	NA
Lakeshore Homeowner Manual	1	NA
Improved Signage at Boat Ramps	4	NA
Personnel		
CLEAR Coordinator	½ time annually	NA
TOTAL		**1,103 lbs**

NA – not applicable

BEST MANAGEMENT PRACTICES LOAD REDUCTIONS:

SHORELINE STABILIZATION

Clear Lake's shoreline is 14.6 miles long, and about 80% of it is in private ownership. A concerted effort to place fieldstone riprap along the shoreline that is in public ownership has taken place and over 3,000 feet has been completed. A survey of Clear Lake's shoreline was completed in the fall of 2010 to review the need for further shoreline stabilization. It was determined that a total of about 2,700 feet of shoreline would benefit from stabilization (Figure 9). An average bank height of 3 feet with an annual recession rate of 0.3 feet was used to estimate the sediment delivery rate from the 2,700 feet of shoreline to be 114 tons of sediment each year. When all shoreline erosion areas are protected, TP loading will be reduced by 182 lbs per year.

SEPTIC SYSTEM UPDATE PROGRAM

Although attempts have also been made to limit bacteria inputs to the lake, one obvious source that has not been adequately addressed is un-permitted septic systems in the watershed. An assessment completed in 2010 indicated there are 31 known unpermitted septic systems in the watershed (Figure 10). This most likely means those systems have no secondary treatment (leach field). In most cases, these septic systems are connected to field tile which drain directly into a tributary and then to the lake. This provides a direct conduit for fecal bacteria, pathogens, and nutrients to enter the lake. Inspections of septic systems are not typically completed unless a visible problem is identified, an addition to the home is made, or the property is sold. While these mechanisms will eventually catch all of the un-permitted systems, it will take several years, or possibly decades to achieve. The watershed advisory group is in favor of offering an incentive program with the goal of updating the 31 unknown systems. The program would provide a $3,000 grant to any watershed landowner that updates their currently unpermitted septic system. Nutrient reductions were calculated using a value of 1.5 grams/person/day of P export from septic tanks as estimated in the EPA Onsite Wastewater Manual. A value of 2.5 residents for each septic system occupying the home 365 days/year results in a total phosphorus loading of 125 lbs/year that could be reduced if all systems are upgraded. The improvements would also provide significant bacteria loading reductions.

SEWER LINE REPAIR PROGRAM

There are about 150,000 lineal feet of sewer mains in the Clear Lake watershed. The City of Clear Lake, City of Ventura, and Clear Lake Sanitary District inspect and repair or replace the mains as needed. This work is often completed in conjunction with street repair programs to make it more cost effective. As further street improvements take place, the inspection and repair of sewer mains will also continue. Recently, lining sewer mains in the watershed has been used more frequently and allows for repairs to be made independent of street repair. The goal will be to inspect and repair as needed all sewer mains in the Clear Lake watershed. In addition to the sewer main repairs, it is likely that many private sewer lines that run from the residence to the sewer main are also in need of repair. It is very difficult to estimate the number of private sewer lines that are in need of repair in the watershed. The City of Clear Lake is considering selecting a neighborhood to conduct inspections on to help develop a better estimate of the amount of needed repairs. After this is completed, an incentive program to assist with funding of repairs will also be considered by the City and Association for the Preservation of Clear Lake. The repair of leaky sewer lines will undoubtedly reduce bacteria and phosphorus loading, but it is not possible to estimate a reduction without knowing the extent of the problem.

WETLAND/PRAIRIE RESTORATION

Wetland and prairie vegetation establishment has been very successful so far in the Clear Lake watershed with over 750 acres of restoration already having taken place and another 240 acres scheduled for future restoration. Despite this success, there are well over 1,000 acres still eligible for current wetland restoration programs (Figure 7). Additionally, about 350 acres of those currently restored are in programs that will expire within the next 10 to 15 years. It is recommended that there continues to be an emphasis on promoting wetland and prairie vegetation restoration to producers in the Clear Lake watershed. Continuing these efforts will be important to making sure further wetland

and prairie restoration takes place in the Clear Lake watershed. The 2010 total phosphorus loading assessments estimated that TP loading from agricultural areas averaged 0.41 lbs/acre. If 1,000 acres of row crop were converted to prairie and wetland, there would therefore be a reduction of 410 lbs/year of TP loading to Clear Lake. This is likely an underestimate as there would also be some trapping of TP from a small amount of upland agricultural areas that flow into the wetland restoration sites.

FILTER STRIPS

There are only two small tributaries totaling about 1,500 feet in length in the Clear Lake watershed that are not currently buffered by vegetation (Figure 8). Placing a 100 ft. filter strip on both sides of the two tributaries would result in about seven acres of land being seeded to perennial vegetation. The sediment delivery calculator was used to determine that the practice would result in a sediment delivery reduction of 35 tons/year, corresponding to a TP loading reduction of about 56 lbs/year.

INFILTRATION BASED PRACTICES

Grit collection chambers have been installed at about 30 storm drain outlets in the Clear Lake watershed. The storm drain outlets were analyzed and ranked according to phosphorus loading potential. The outlets with the highest phosphorus loading potential were given first priority for improvement. In addition to these structures, infiltration based practices such as rain gardens, bioretention cells, infiltration trenches, and permeable pavers have also previously been installed in the Clear Lake watershed. These sites were not individually ranked as most infiltration practices have small drainage areas and provide a similar amount of sediment and phosphorus reduction. Most of the practices have been installed on public property. There has also been interest in these BMPs from private landowners, however many have been reluctant to construct them due to the cost involved. Continuing to make cost share available to landowners at a rate of 50-75% will be necessary to see more infiltration based practices installed. It will also be necessary to continue information and education activities that will promote the benefits of these practices. The sediment and phosphorus reductions from infiltration based practices are often low due to the small drainage areas they treat. Most of the infiltration based practices installed to date treat an area of about 1 acre. If 20 more practices were installed, a total reduction of 24 lbs/year would take place, based on current estimated TP loading from developed areas (1.7 lbs/acre) and percent of TP loading reduced by the BMPs (70%) (Veensta & Kimm, 2008). These practices also provide significant reduction in bacteria and would allow stormwater to infiltrate instead of becoming runoff.

PERMEABLE STREET DEMONSTRATION

In a meeting held with City of Clear Lake officials to discuss future improvements, there was interest in performing a permeable pavement demonstration on a section of a street in the watershed. Permeable paver blocks have been used in parking lots and public approaches at Clear Lake, but have not yet been used on a street. The City is interested in testing a permeable pavement on about a 1,500 sq ft stretch of street to determine if future applications of the practice can be utilized. Implementing this practice over a small area will provide limited TP load reduction, but could lead to further applications of the practice which would provide measurable reductions. Infiltration of stormwater runoff would also provide reductions in bacteria loading to Clear Lake.

URBAN ORDINANCES

The City of Clear Lake currently has an ordinance that requires new development or improvements to existing development to not increase storm water runoff above what the pre-existing conditions are. This ordinance effectively results in storm water either being stored on site or allowed to infiltrate. An area where further improvement is needed is construction site erosion control as no ordinances outside of existing state regulations exist. City of Clear Lake officials are willing to review options for erosion control, but are cautious about developing ordinances that will be viewed as hindering future development. Providing improved information and education to contractors regarding erosion control methods will be a short term goal as a method of reducing pollutant loading. Developing actual erosion control ordinances will be a long term goal.

VENTURA MARSH WATER LEVEL CONTROL

The primary purpose of controlling water levels at Ventura Marsh is to reduce carp populations and increase vegetation growth. The manipulation of water levels at Ventura Marsh is expected to result in at least a 75% reduction in common carp. The Ventura Marsh TMDL determined that phosphorus export from Ventura Marsh is currently being primarily driven by bioturbation from common carp (EPA, 2010). Carp removal experiments were conducted as part of the Clear Lake D&F Study. After the final carp biomanipulation was completed in which more than 75% of the population was eradicated, the average TP concentration in Ventura Marsh declined by 115-184 µg/L compared to pre-biomanipulation conditions (Schrage and Downing, 2004). This equates to an average TP concentration of 260 µg/L in Ventura Marsh after the biomanipulation, and a 31-41% reduction in total phosphorus concentration as a result of carp reduction. This level of TP concentration reduction will not meet the water quality goals established in the Ventura Marsh TMDL initially. However, it is expected that consistent management of Ventura Marsh in a relatively carp free and vegetated condition for several years will provide further reductions and allow the TMDL goals to be met. For the purpose of developing future reduction estimates for the WMP, it was estimated that the removal of common carp would therefore result in an initial reduction of 36% in total phosphorus concentrations in Ventura Marsh. Utilizing the 2008-2010 mean Ventura Marsh TP concentration (250 µg/L) and assuming the outflow data for Ventura Marsh measured in the Clear Lake D&F Study also reflects current conditions, it was estimated that a reduction of 300 lbs/year of TP loading will occur as a result of Ventura Marsh water level management.

ROUGH FISH CONTROL

Benthic (bottom dwelling) fish like carp and bullhead can have a major impact on internal loading of nutrients in shallow lakes due to the resuspension of bottom sediments they cause. At the time of the D&F Study, the density of bullheads was 150-300 lbs/acre and the density of carp was 100 to 200 lbs/acre. Over the past ten years, the populations of both species have declined. Bullhead populations have declined dramatically and are at historically low levels. Although a formal population estimate has not been conducted, Clear Lake DNR Fisheries staff believes the density of bullheads in the lake today is < 20 lbs/acre. The reason for the decline is primarily due to poor spawning success. The introduction of flathead catfish may have also played a small role in the reduction. Common carp levels actually increased for a few years after the D&F Study was written to a density of around 400 lbs/acre. However, continued commercial fishing and environmental factors have led to a significant decline over the past few years. A population estimate conducted by ISU and the DNR in 2010 showed a current density of about 200 lbs/acre. Continued efforts to reduce carp density are being planned. A new jetty was installed in 2009 adjacent to an existing jetty as a means of trapping carp for removal by commercial fishermen. The goal will be to maintain carp populations at less than 100 lbs/acre, or roughly 10% of the total fish biomass in Clear Lake. Although it is common knowledge that reducing carp populations will also reduce internal loading of total phosphorus in Clear Lake, insufficient data exists to put an exact number on the amount of reduction expected from a 50% decrease in carp biomass.

AQUATIC VEGETATION ESTABLISHMENT

Improving the density and diversity of aquatic vegetation at Clear Lake will have water quality benefits. The vegetation will help dissipate waves and hold down bottom sediments that would normally be stirred on windy days. It will also provide improved habitat for several fish, waterfowl, and wildlife species. One of the comments received from the Wisconsin DNR review was that Clear Lake exhibited a lower amount of aquatic vegetation than what would be expected for the amount of current water clarity. It was recommended that experiments be conducted to determine potential reasons for the lack of vegetation. A carp exclusion and a wave barrier were recommended, as carp and wave action are the two most common inhibitions to vegetation establishment. The IDNR plans to perform these experiments during the first phase of the watershed management plan. As water clarity continues to improve, it is expected that aquatic vegetation will also continue to increase. The specific amount of phosphorus loading reduced by increased aquatic vegetation was not estimated, but will certainly produce some reduction in internal loading.

WATER MONITORING

Future water monitoring is described in depth in Section 8 of the report.

PHOSPHORUS BUDGET INVESTIGATION

In addition to the lake and marsh monitoring, developing an updated phosphorus budget for Clear Lake based on monitoring data should be considered. The phosphorus loading assessments completed for the WMP indicate that significant changes in TP loading have taken place over the last ten years. After the Ventura Marsh restoration activities are completed, conducting a new phosphorus budget for Clear Lake would be valuable so the primary nutrient sources can again be determined and the WMP updated if needed. Developing an updated monitoring based nutrient budget was also a recommendation that was made by the external review from the Wisconsin DNR.

BEACH BACTERIA INVESTIGATION

Plans to limit bacteria loading are currently hindered by a lack of knowledge regarding the source of the bacteria. This information is very important so best management practices can target the appropriate sources. The IDNR beach monitoring staff conducted a brief investigation into bacteria sources at Clear Lake using fluorometry. The concentration of materials that fluoresce in lake water is an indication of human waste water entering the lake. The data was insufficient to determine what the primary bacteria source was, but did indicate that there was some evidence of human waste being a source. A more intensive investigation is needed to better quantify the sources of bacteria entering Clear Lake. The

University Hygienic Laboratory in Iowa City would be utilized to help develop a monitoring plan in attempt to answer these questions.

BEACH WATERFOWL MANAGEMENT

A correlation between geese use and elevated bacteria levels appeared to exist at McIntosh Woods swim beach in 2010. When the beach was being heavily used by geese and goose fecal matter on the beach was prevalent, bacteria levels became greatly elevated. Reducing the usage of geese at the beach during the recreational season is an important goal not only from a bacteria and phosphorus loading standpoint, but also from an aesthetic standpoint. The local Iowa DNR wildlife and fisheries staff is considering testing the use of diversion or relocation techniques to reduce the geese use at the beaches. Since the diversions would only be used for short periods of time during the year, it is hoped that the geese will not become acclimated to the diversions. Annually relocating the geese to another area outside of the watershed is also being considered. Research has shown that each goose excretes 0.49 grams of phosphorus a day (Marion and others, 1994). There are about 30 geese that use the McIntosh swim beach for about 6 months of the year. The total phosphorus loading from these geese would therefore be reduced by 6 lbs/year if they were removed from the beach. It should be noted that other waterfowl and birds such as gulls are also often present in near shore areas and may be contributing to bacteria loading as well.

BEACH CLEANING MACHINE

Although efforts will be made to reduce the geese use at the swim beaches, it is unlikely that diversion techniques will completely eliminate the problem. Currently, goose litter that is deposited on the beach is raked into the sand when the beaches are groomed. This process makes the beach look cleaner, but does not actually remove the litter or the bacteria. Instead, the bacteria continues to grow in the sand and can contribute to swim advisories. A beach cleaner, or sand sifting machine, picks up the top four inches of sand, removes the litter, and returns the sifted sand. This process not only removes the litter, but also exposes the sand to sunlight, which helps kill bacteria growing in the sand. Two machines would be needed to service the beaches at Clear Lake.

"NO WAKE" BUOYS

Current regulations require boat speed to be below 10 mph within 300 feet of shore at Clear Lake. Improved demarcation of this slow speed area, sometimes referred to as a "no wake zone", on Clear Lake was a recommendation in the D&F Study that has not yet been implemented. Protection of this shallow water area is necessary to reduce sediment nutrient re-suspension caused by boating activities and to increase aquatic vegetation growth in those areas. Current state law regarding boat speeds in near shore areas are being reviewed and will possibly be revised to even lower speed limits. The APCL has had preliminary discussions with the Iowa DNR enforcement section to place additional buoys where appropriate to reduce excessive boat speed in the near shore zone. This action is certain to reduce the internal loading of phosphorus and sediment to Clear Lake, although it is difficult to quantify the amount of reduction that would take place.

ALUM TREATMENT

Alum (aluminum sulfate) is a compound frequently used in lake restoration to reduce the availability of phosphorus in the water, thereby reducing algae production. Alum treatments typically are effective at controlling phosphorus levels and reducing algae for about ten years in shallow lakes. Alum does not treat external phosphorus loading from the watershed, but can be effective in reducing internal loading. The source of internal phosphorus loading is lake sediments, which release phosphorus especially during anoxic conditions. Alum should be considered as a future treatment alternative if it is found that water quality improvements are not as good as expected and if internal loading is now a significant source of phosphorus loading. Alum treatment may be especially beneficial in areas of the lake where deep water exists and anoxic conditions take place. Alum restricts the release of phosphorus from these areas by forming a “floc” that settles to the lake bottom, creating a layer that acts as a barrier to phosphorus. Alum treatment of Clear Lake was investigated as part of a lake restoration plan prepared by the U.S. Army Corps of Engineers, and should be revisited if water clarity does not respond as expected to other restoration activities.

AERATION

According to the Clear Lake D&F Study, aeration of Little Lake should be considered now that the lake has been dredged. The deeper water in the dredged area may create anoxic conditions in the lake sediment, which results in phosphorus release from the sediment. One method to deal with anoxic conditions is to aerate the water near the sediment. Hypolimnetic aeration is not always able to oxygenate the sediment well enough to slow the release of phosphorus, so this activity would need to be researched more carefully to ensure the desired results are achieved. The dissolved oxygen levels should be monitored in the Little Lake to determine if aeration of the dredged area should be considered.

8 Water Monitoring Plan

8.1 Quality Assurance Project Plan

A Quality Assurance Project Plan was prepared and approved by the Iowa DNR. The plan covered monitoring of three lake sites, two sites on Ventura Marsh, and 9 tributary sites. The document (QA/WM/11-01) is on file with the DNR and also with the CLEAR Project. The water monitoring procedures outlined in the QAPP will be followed for future monitoring activities.

8.2 Water Monitoring Plan

Continued water monitoring is an activity that should be carried through all four phases outlined in this plan. It is especially important to continue monitoring the lake intensively for the first phase of the plan as it is likely that fluctuations in water quality will take place during that time period since the lake appears to be transitioning towards a clear water state. The current level of monitoring that should be continued during phase I consists of collecting samples from three sites on Clear Lake and one site on Ventura Marsh twice per month from May through September. If water monitoring data shows the lake stabilizing during that time period, a less intensive monitoring program could be developed for the remaining phases. An approach similar to the existing DNR lakes monitoring program design of collecting three samples a year from the central sample site on Clear Lake may be appropriate. The intensity of the monitoring can be adjusted accordingly, but a minimum of three samples per year should be collected from Clear Lake and Ventura Marsh. The nine tributary sites will not be monitored each year, but will be monitored at least one year of each phase to provide a snapshot of watershed water quality changes. The tributary sites will be monitored once per month from May to September and up to four rain event samples will be collected. Monitoring results from lake, marsh and tributary sites will be compared to previous data collected by Iowa State University, the IDNR, and the CLEAR Project. A list of parameters previously monitored is provided in Table 18 and 19. Funding may not allow for all the parameters to be monitored in the future, the recommended parameters are therefore shaded in tan. A summary of the water monitoring results will be prepared annually and made available to the public.

Additionally, developing a new nutrient loading budget for Clear Lake should be conducted near the end of phase 1. This research would take place outside the scope of the typical water monitoring plan as it would require a large amount of additional monitoring and data collection. A beach bacteria investigation is also recommended, as described on page 45.

Table 17: Water Monitoring Timeline

Activity	Timeline	Performing Agency
Lake/Marsh Monitoring	May - September	CLEAR/IDNR/ISU
Tributary Monitoring	May - September	CLEAR Project
Report Preparation	March of following year	CLEAR Project

Table 18: Parameter Objectives for Lab Analyses

Analyte	Matrix	Method Detection Limit	Estimated Accuracy of True Value	Accuracy Protocol	Estimated Precision (Relative % Difference)
Alkalinity, Total	Water	1 mg/L	+/- 5% (Running 30 sample average)	Commercial Standards Analysis	RPD <20%
Ammonia Nitrogen as N	Water	0.05 mg/L	+ 14%	Recovery on spikes	RPD < 20%
Chlorophyll A	Water	1 µg/L	+/- 10%	Standards, lab blanks, splits, duplicates	RPD <20%
Cyanobacteria	Water	0.15 µg/L for microcystin LR	+/- 15%	Recovery on Spikes	RPD < 15%
E. coli Bacteria	Water	10 CFU	NA	NA	Three-year Average = 0.21
Microcystin	Water	0.15 µg/L for microcystin LR	+/- 15%	Recovery on Spikes	RPD < 15%
Nitrate+Nitrite Nitrogen	Water	0.05 mg/L	±0.1 low level	Recovery on spikes	RPD < 20%
Orthophosphate as P	Water	0.02 mg/L	+5%	Recovery on spikes	RPD <20%
Silica	Water	1 mg/L	+/- 7% (Running 30 sample average)	Commercial Standards Analysis	RPD <20%
Suspended Solids, Fixed	Water	1 mg/L	+ 20%	EPA check samples	RPD <20%
Suspended Solids, Total	Water	1 mg/L	+ 20%	EPA check samples	RPD <20%
Suspended Solids, Volatile	Water	1 mg/L	+ 10%	EPA check samples	RPD <20%
Total Kjeldahl Nitrogen	Water	0.1 mg/L	+/- 10%	Recovery on spikes	RPD <20%
Total Organic Carbon	Water	0.5 mg/L	+/- 10%	Recovery on spikes	RPD <20%
Total Phosphorus	Water	0.02 mg/L	+5%	Recovery on spikes	RPD <20%
Total Phytoplankton Wet Mass	Water	NA	NA	Split samples with additional analyst	RPD < 20%
Total Zooplankton Wet Mass	Water	NA	NA	Recounts by additional analyst	RPD < 20%

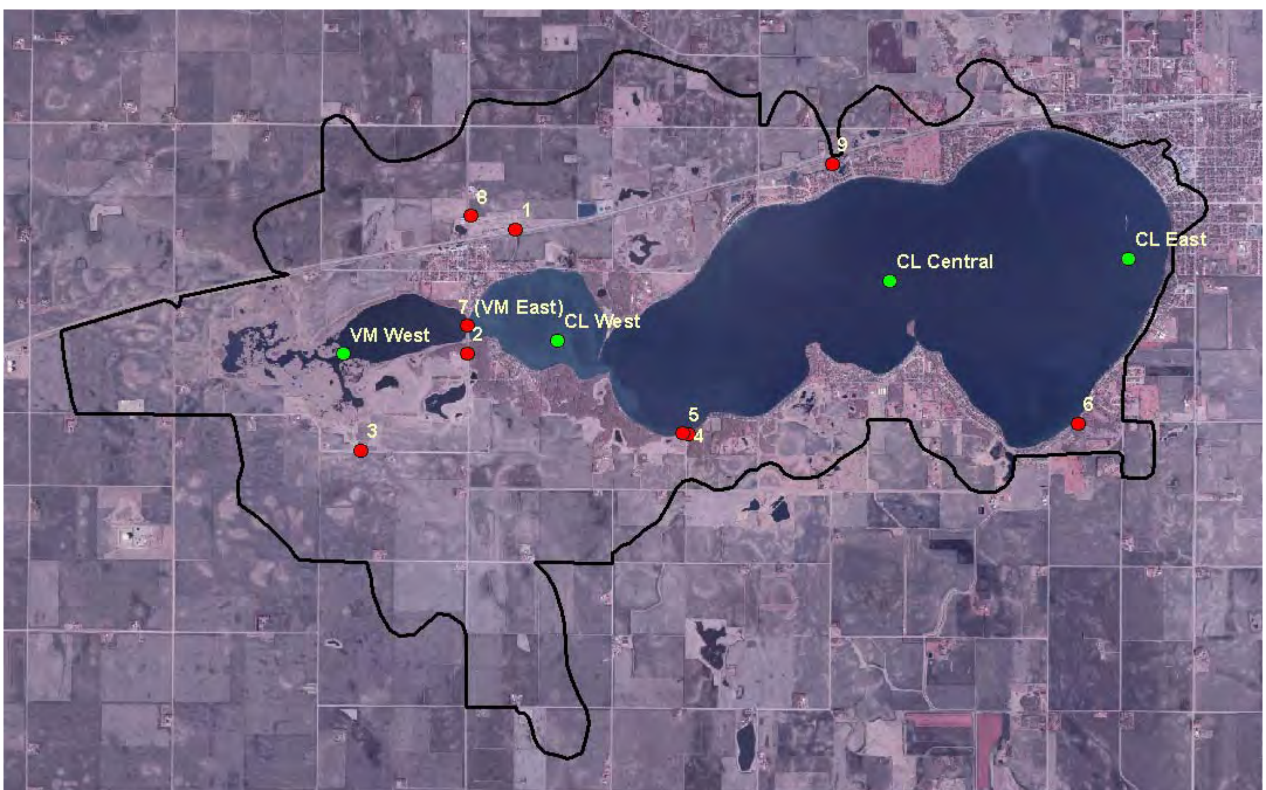
CFU – Colony Forming Unit; mg/L – milligrams per liter; µg/L – micrograms per liter; NA – not applicable; RPD – Relative % Difference

Table 19: Field parameters measured as part of the Clear Lake Watershed project

Manufacturer and Model	Matrix	Parameter	Range	Accuracy	Precision
Hach Sension 156 Multiprobe Meter	Water	Temperature	-10 to 110 °C	± 0.3 °C	+/- 20%
	Water	Dissolved Oxygen	0 to 20 mg/L	± 1 mg/L	+/- 20%
	Water	pH	0 to 14	± 0.1 pH Unit	+/- 20%
	Water	Specific Conductance	0 to 199.9 mS/cm	± 0.5 % of reading	+/- 20%
	Water	Total Dissolved Solids	0-50,000 mg/L as NaCl	± 0.5 % of full scale	+/- 20%
Hach 2100 P Turbidimeter	Water	Turbidity	0-1,000 NTU	± 2 % of reading	+/- 20%
Secchi Disk	Water	Secchi Depth	0-30 m	± 0.01 m	NA
Flow Meter	Water	Flow	NA	NA	NA

mS/cm – milliSiemens per centimeter; NTU – Nephelometric Turbidity Units; NA- Not Applicable

Figure 15: Map of monitoring sites



Green = Limnological monitoring sites on Clear Lake and Ventura Marsh
Red = Tributary monitoring sites in the Clear Lake watershed
*Tributary Site 7 same as Ventura Marsh East site, also monitored as limnological

9 Implementation Schedule and Resource Needs

Table 20: Clear Lake Watershed Management Plan Implementation Schedule and Resource Needs

Watershed Improvements	Phase I 2011 – 2015	Phase I Costs	Phase II 2016 – 2020	Phase II Costs	Phase III 2020 - 2025	Phase III Costs	Phase IV 2026 – 2030	Phase IV Costs	Total Costs	Potential Funding Sources
Shoreline Stabilization	X	$105,000	X	$97,500					$202,500	WIRB, landowner, IDNR Lakes, 319
Septic System Update Program	X	$280,000							$280,000	APCL, Landowner
Sewer Line Repair	X	$250,000	X	$250,000	X	$250,000	X	$250,000	$1,000,000	City of CL, Ventura, CLSD, Landowner
Wetland/Prairie Restoration	X	$125,000	X	$125,000	X	$125,000	X	$125,000	$500,000	USDA (CRP, WRP, CREP)
Filter Strips	X	$15,000	X	$15,000					$30,000	USDA (CRP)
Infiltration Based Practices	X	$50,000	X	$50,000	X	$50,000	X	$50,000	$200,000	WIRB, 319, City of CL, Ventura, Cerro Gordo
Permeable Street Demo	X	$225,000							$225,000	WIRB, 319, City of CL
Urban Ordinances			X							City of CL, Ventura Cerro Gordo
Ventura Marsh Water Management	X	$50,000	X	$50,000	X	$50,000	X	$50,000	$200,000	APCL, IDNR Wildlife
Lake Improvements										
Rough Fish Control	X	$37,500	X	$37,500	X	$37,500	X	$37,500	$150,000	IDNR Fisheries, APCL
Aquatic Vegetation Experiments	X	$5,000							$5,000	IDNR Lakes, APCL
Water Monitoring	X	$50,000	X	$50,000	X	$50,000	X	$50,000	$200,000	319, IDNR Lakes, APCL
Phosphorus Budget	X	$50,000							$50,000	319, IDNR Lakes, APCL
Beach Bacteria Investigation	X	$25,000							$25,000	APCL, 319, IDNR Lakes
Beach Waterfowl Management	X	$2,500	X	$2,500	X	$2,500	X	$2,500	$10,000	IDNR Wildlife, APCL
Beach Cleaner Machine	X	$50,000	X		X		X		$50,000	WIRB, APCL, IDNR Parks

Lake Improvements (Continued)	Phase I 2011 – 2015	Phase I Costs	Phase II 2016 – 2020	Phase II Costs	Phase III 2020 - 2025	Phase III Costs	Phase IV 2026 – 2030	Phase IV Costs		Potential Funding Sources
No Wake Buoys	X	$2,500							$2,500	APCL, IDNR Enforcement
Review Need for Alum Treatment	X	$0	X	$0	X	$0	X	$0	$0	Part of IDNR and CLEAR duties
Review Need for Aeration	X	$0	X	$0	X	$0	X	$0	$0	Part of IDNR and CLEAR duties
Maintenance										
Grit Collection Chambers	X	$25,000	X	$25,000	X	$25,000	X	$25,000	$100,000	City of CL, Ventura, Cerro Gordo
Rain Gardens	X	$2,500	X	$2,500	X	$2,500	X	$2,500	$10,000	Volunteers
Pervious Pavement			X	$10,000			X	$10,000	$20,000	City of CL
CRP Re-enrollment			X		X		X		$0	Part of CLEAR duties
Other										IDNR, APCL
Public Outreach	X	$20,000	X	$10,000	X	$10,000	X	$10,000	$50,000	319, APCL
Personnel	X	$150,000	X	$150,000	X	$150,000	X	$150,000	$600,000	DSC, APCL, City of CL
TOTAL		**$1,520,000**		**$875,000**		**$752,500**		**$762,500**	**$3,910,000**	NA

9.1 Technical Assistance

The majority of the technical assistance will be provided by staff of the partner agencies such as IDALS, DNR, NRCS, EPA, Corps of Engineers, City of Clear Lake, etc… These partners have expertise in several disciplines that are necessary for a successful lake restoration project such as: agricultural practices, urban practices, fisheries, wildlife, water quality, limnology, etc… The CLEAR Project has partnered with staff of local, state, and federal agencies for the past several years and has built strong partnerships with them that will continue into the future. The CLEAR Project Coordinator will also provide technical assistance and overall coordination of lake and watershed restoration activities.

Table 21: Detailed View of Phase I Implementation Practices Schedule and Resource Needs

Watershed Improvements	2011	2012	2013	2014	2015	Total Cost
Shoreline Stabilization	1,000 ft	100 ft	100 ft	100 ft	100 ft	$105,000
Septic System Update Program	15 systems	15 systems	5 systems	0	0	$280,000
Sewer Line Repair Program	X	X	X	X	X	$250,000
Wetland/Prairie Restoration	50 acres	50 acres	50 acres	50 acres	50 acres	$125,000
Filter Strips				750 ft	750 ft	$15,000
Rain Garden/Permeable Pavement	1 unit	1 unit	1 unit	1 unit	1 unit	$50,000
Permeable Street Demo				X	X	$225,000
Ventura Marsh Water Mgmt.	X	X	X	X	X	$50,000
Lake Improvements						
Rough Fish Removal	50,000 lbs	50,000 lbs	50,000 lbs	50,000 lbs	50,000 lbs	$37,500
Aquatic Vegetation Experiments	X	X	X			$5,000
Water Monitoring	X	X	X	X	X	$50,000
Phosphorus Budget Investigation	X					$50,000
Beach Bacteria Investigation	X	X				$25,000
Beach Waterfowl Management	X	X	X	X	X	$2,500
Beach Cleaner Machine	2 units	X	X	X	X	$50,000
No Wake Buoys						$2,500
Review Need for Alum Treatment	X	X	X	X	X	$0
Review Need for Aeration	X	X	X	X	X	$0
Maintenance						
Grit Collection Chambers	X	X	X	X	X	$25,000
Rain Gardens	X	X	X	X	X	$2,500
Other						
Public Outreach	X	X	X	X	X	$20,000
Personnel	X	X	X	X	X	$150,000
TOTAL						**$1,520,000**

10 References

Anderson, K.A. and J.A. Downing (2006). Dry and wet atmospheric deposition of nitrogen, phosphorus, and silicon in an agricultural region. *Water, Air, and Soil Pollution* 176 (1-4): 351-374.

Colvin, M.E., E. Katzenmeyer, T. Stewart and C. Pierce (2010). The Clear Lake Ecosystem Simulation Model (CLESM) Project. Technical Report, Iowa State University

CARD (2008). Iowa Lakes Valuation Project, Center for Agriculture and Rural Development, Iowa State University

Downing, J., J. Kopaska, and D. Bonneau (2001). Clear Lake Diagnostic and Feasibility Study. Technical report, Iowa Department of Natural Resources.

Knoll, D.A. and Seigley, L. (2010). Clear Lake Enhancement and Restoration Project Quality Assurance Project Plan, QA/WM/11-01

Iowa Department of Natural Resources (2010). Clear Lake Water Monitoring Project Data, Cerro Gordo County, Iowa.

Iowa Department of Natural Resources (2005). Total Maximum Daily Load for Nutrients and Algae Clear Lake Cerro Gordo County, Iowa.

Iowa State University (2005). Center for Agricultural Research and Rural Development (CARD) Resource and Environmental Policy Division. Iowa Lakes Valuation Project. Available at http://www.card.iastate.edu/lakes/

Marion, L., Clergeau, P., Brient, L., and Bertu, G., 1994, The importance of avian-contributed nitrogen (N) and phosphorus (P) to Lake Grand-Lieu, France: Hydrobiologia,v. 279/280. p. 133–147.

Rowden, R.D. (2010). The Iowa State-Wide Trace Element Soil Sampling Project: Design and Implementation. A Report of the Iowa component of the United States Geological Survey National Geochemical Survey, Iowa Department of Natural Resources.

Schrage, L.J. and J.A. Downing (2004). Pathways of increased water clarity after benthivorous fish removal from Ventura Marsh; a shallow, eutrophic wetland. *Hydrobiologia* 511: 215-231

U.S. Census Bureau (2009). Fact Sheet, American Community Survey 5-Year Estimates 2005-2009.

U.S. Department of Agriculture (1998) Field Office Technical Guide, Erosion and Sediment Delivery, Natural Resources Conservation Service, Cerro Gordo County

U.S. Environmental Protection Agency (2002). Onsite Wastewater Treatment Systems Manual, Office of Water. EPA/625/R-00/008

U.S. Environmental Protection Agency (2010). Total Maximum Daily Load for Algae and Turbidity, Ventura Marsh, Cerro Gordo/Hancock Counties, Iowa. IA-02-WIN-00456-L_0

Veenstra & Kimm, Inc. (2008). Clear Lake 2008 Stormwater Improvement Investigation. Technical Report.

Wisconsin Department of Natural Resources (2003). Wisconsin Lake Modeling Suite Program Documentation and User's Manual. 2003 PUBL-WR-363-94

Appendix 1: Clear Lake Water Quality Project Independent Review Summary

Paul Garrison and Buzz Sorge of the Wisconsin DNR were asked to perform a peer review of the lake restoration activities and provide input on further potential lake and watershed improvements. A meeting with the Wisconsin DNR officials was held on June 1st, 2010 to discuss the results of their peer review findings. Their comments focused primarily on "in-lake" restoration since that is where their expertise is. Below is a list of comments and suggestions they shared at the meeting.

1. Their overall message was that the lake restoration efforts and changes in water quality have been impressive and finishing the remaining features of the plan, primarily the restoration of Ventura Marsh should continue to provide water quality benefits.
2. After the marsh restoration is complete, they recommended redoing a nutrient budget for the lake to determine current loading estimates.
3. Utilize models such as the BATHTUB model, which provides evaluations of relations between nutrient loading, transparency and hydrology, and eutrophication responses. Contact Bill James with the US Army COE for more information about this model.
4. A water quality response model could also be utilized to predict what water quality parameters should be according to current nutrient and sediment loading data. Comparing the modeling results to water monitoring results will help determine if the lake is responding to restoration activities as would be expected. Contact Mike Colvin (ISU) about this type of modeling.
5. Internal loading can often be a significant source of nutrients for shallow lakes. Reducing wind resuspension by having more aquatic plants and keeping carp population low will be important.
6. Reducing sediment resuspension by boat traffic should also be a goal, utilizing methods such as marking shallow areas where boat speed should be reduced.
7. Aquatic vegetation growth in the lake was less than they expected for the amount of water clarity. Possible explanations for this were wave action being too great to allow for vegetation establishment, turbidity levels in the shallow areas hindering light penetration, or lake bottom substrate not suitable for vegetation growth.
8. Enclosures and temporary breakwater structures could be established on an experimental basis to determine what may be limiting the aquatic vegetation growth.
9. Aquatic Invasive Species (AIS) education will be an important effort to continue and possibly enhance. Improved water clarity will increase the risk of AIS such as Eurasian water milfoil becoming established. Fortunately, only 10% of all Eurasian water milfoil infestations in WI lakes become problematic.
10. Continue performing activities in the watershed to reduce nutrient and sediment loading. The P-Index may be useful in predicting areas of high priority.

Appendix 2: Threatened and Endangered Species List for Cerro Gordo and Hancock County

Summary by Species Report

Total Unique Listed Species In This County: 56

County	Common Name	Scientific Name	Class	State Status	Federal Status
CERRO GORDO	Black Tern	Chlidonias niger	BIRDS	S	
CERRO GORDO	Forster's Tern	Sterna forsteri	BIRDS	S	
CERRO GORDO	Northern Harrier	Circus cyaneus	BIRDS	E	
CERRO GORDO	American Brook Lamprey	Lampetra appendix	FISH	T	
CERRO GORDO	Topeka Shiner	Notropis topeka	FISH	T	E
CERRO GORDO	Creek Heelsplitter	Lasmigona compressa	FRESHWATER MUSSELS	T	
CERRO GORDO	Creeper	Strophitus undulatus	FRESHWATER MUSSELS	T	
CERRO GORDO	Cylindrical Papershell	Anodontoides ferussacianus	FRESHWATER MUSSELS	T	
CERRO GORDO	Ellipse	Venustaconcha ellipsiformis	FRESHWATER MUSSELS	T	
CERRO GORDO	Yellow Sandshell	Lampsilis teres	FRESHWATER MUSSELS	E	
CERRO GORDO	Acadian Hairstreak	Satyrium acadicum	INSECTS	S	
CERRO GORDO	Arogos Skipper	Atrytone arogos	INSECTS	S	
CERRO GORDO	Baltimore	Euphydryas phaeton	INSECTS	T	
CERRO GORDO	Broad-winged Skipper	Poanes viator	INSECTS	S	
CERRO GORDO	Dion Skipper	Euphyes dion	INSECTS	S	
CERRO GORDO	Powesheik Skipperling	Oarisma powesheik	INSECTS	T	
CERRO GORDO	Regal Fritillary	Speyeria idalia	INSECTS	S	
CERRO GORDO	Spotted Skunk	Spilogale putorius	MAMMALS	E	
CERRO GORDO	Bog Bedstraw	Galium labradoricum	PLANTS (DICOTS)	E	
CERRO GORDO	Bog Willow	Salix pedicellaris	PLANTS (DICOTS)	T	
CERRO GORDO	Brook Lobelia	Lobelia kalmii	PLANTS (DICOTS)	S	
CERRO GORDO	Buckbean	Menyanthes trifoliata	PLANTS (DICOTS)	T	
CERRO GORDO	Common Mare's-tail	Hippuris vulgaris	PLANTS (DICOTS)	S	
CERRO GORDO	Earleaf Foxglove	Tomanthera auriculata	PLANTS (DICOTS)	S	
CERRO GORDO	Flat Top White Aster	Aster pubentior	PLANTS (DICOTS)	S	
CERRO GORDO	Fragrant False Indigo	Amorpha nana	PLANTS (DICOTS)	T	
CERRO GORDO	Golden Corydalis	Corydalis aurea	PLANTS (DICOTS)	T	
CERRO GORDO	Hill's Thistle	Cirsium hillii	PLANTS (DICOTS)	S	
CERRO GORDO	Lesser Bladderwort	Utricularia minor	PLANTS (DICOTS)	S	
CERRO GORDO	Prairie Bush Clover	Lespedeza leptostachya	PLANTS (DICOTS)	T	T
CERRO GORDO	Purple Angelica	Angelica atropurpurea	PLANTS (DICOTS)	S	
CERRO GORDO	Rush Aster	Aster junciformis	PLANTS (DICOTS)	T	
CERRO GORDO	Sage Willow	Salix candida	PLANTS (DICOTS)	S	
CERRO GORDO	Sand Cherry	Prunus pumila	PLANTS (DICOTS)	S	
CERRO GORDO	Shadbush	Amelanchier sanguinea	PLANTS (DICOTS)	S	
CERRO GORDO	Shining Willow	Salix lucida	PLANTS (DICOTS)	T	
CERRO GORDO	Small Fringed Gentian	Gentianopsis procera	PLANTS (DICOTS)	S	
CERRO GORDO	Swamp Thistle	Cirsium muticum	PLANTS (DICOTS)	S	
CERRO GORDO	Valerian	Valeriana edulis	PLANTS (DICOTS)	S	
CERRO GORDO	Water Marigold	Megalodonta beckii	PLANTS (DICOTS)	E	
CERRO GORDO	Arrow Grass	Triglochin maritimum	PLANTS (MONOCOTS)	T	
CERRO GORDO	Beakrush	Rhynchospora capillacea	PLANTS (MONOCOTS)	T	
CERRO GORDO	Large-leaf Pondweed	Potamogeton amplifolius	PLANTS (MONOCOTS)	S	
CERRO GORDO	Leafy Northern Green Orchid	Platanthera hyperborea	PLANTS (MONOCOTS)	T	
CERRO GORDO	Slender Arrow Grass	Triglochin palustris	PLANTS (MONOCOTS)	T	
CERRO GORDO	Slender Cotton Grass	Eriophorum gracile	PLANTS (MONOCOTS)	T	

CERRO GORDO	Small White Lady's Slipper	Cypripedium candidum	PLANTS (MONOCOTS)	S	
CERRO GORDO	Smith Bulrush	Scirpus smithii	PLANTS (MONOCOTS)	S	
CERRO GORDO	Straight-leaf Pondweed	Potamogeton strictifolius	PLANTS (MONOCOTS)	S	
CERRO GORDO	Tall Cotton Grass	Eriophorum angustifolium	PLANTS (MONOCOTS)	S	
CERRO GORDO	White-stem Pondweed	Potamogeton praelongus	PLANTS (MONOCOTS)	S	
CERRO GORDO	Meadow Spikemoss	Selaginella eclipes	PLANTS (PTERIODOPHYTES)	E	
CERRO GORDO	Blanding's Turtle	Emydoidea blandingii	REPTILES	T	
CERRO GORDO	Ornate Box Turtle	Terrapene ornata	REPTILES	T	
CERRO GORDO	Smooth Green Snake	Liochlorophis vernalis	REPTILES	S	
CERRO GORDO	Wood Turtle	Clemmys insculpta	REPTILES	E	

Summary by Species Report

Total Unique Listed Species In This County: 31

County	Common Name	Scientific Name	Class	State Status	Federal Status
HANCOCK	Bald Eagle	Haliaeetus leucocephalus	BIRDS	S	
HANCOCK	Black Tern	Chlidonias niger	BIRDS	S	
HANCOCK	Forster's Tern	Sterna forsteri	BIRDS	S	
HANCOCK	Topeka Shiner	Notropis topeka	FISH	T	E
HANCOCK	Powesheik Skipperling	Oarisma powesheik	INSECTS	T	
HANCOCK	Southern Red-backed Vole	Clethrionomys gapperi	MAMMALS	E	
HANCOCK	Bog Willow	Salix pedicellaris	PLANTS (DICOTS)	T	
HANCOCK	Buckbean	Menyanthes trifoliata	PLANTS (DICOTS)	T	
HANCOCK	Flat Top White Aster	Aster pubentior	PLANTS (DICOTS)	S	
HANCOCK	Lesser Bladderwort	Utricularia minor	PLANTS (DICOTS)	S	
HANCOCK	Queen-of-the-prairie	Filipendula rubra	PLANTS (DICOTS)	T	
HANCOCK	Ragwort	Senecio pseudaureus	PLANTS (DICOTS)	S	
HANCOCK	Roundleaf Sundew	Drosera rotundifolia	PLANTS (DICOTS)	E	
HANCOCK	Rush Aster	Aster junciformis	PLANTS (DICOTS)	T	
HANCOCK	Sage Willow	Salix candida	PLANTS (DICOTS)	S	
HANCOCK	Saskatoon Service-berry	Amelanchier alnifolia	PLANTS (DICOTS)	S	
HANCOCK	Showy Milkweed	Asclepias speciosa	PLANTS (DICOTS)	T	
HANCOCK	Swamp Thistle	Cirsium muticum	PLANTS (DICOTS)	S	
HANCOCK	Water Shield	Brasenia schreberi	PLANTS (DICOTS)	S	
HANCOCK	Creeping Sedge	Carex chordorrhiza	PLANTS (MONOCOTS)	E	
HANCOCK	Green's Rush	Juncus greenei	PLANTS (MONOCOTS)	S	
HANCOCK	Large-leaf Pondweed	Potamogeton amplifolius	PLANTS (MONOCOTS)	S	
HANCOCK	Ovate Spikerush	Eleocharis ovata	PLANTS (MONOCOTS)	S	
HANCOCK	Philadelphia Panic Grass	Panicum philadelphicum	PLANTS (MONOCOTS)	T	
HANCOCK	Sedge	Carex cephalantha	PLANTS (MONOCOTS)	S	
HANCOCK	Slender Cotton Grass	Eriophorum gracile	PLANTS (MONOCOTS)	T	
HANCOCK	Tall Cotton Grass	Eriophorum angustifolium	PLANTS (MONOCOTS)	S	
HANCOCK	Western Prairie Fringed Orchid	Platanthera praeclara	PLANTS (MONOCOTS)	T	T
HANCOCK	Oak Fern	Gymnocarpium dryopteris	PLANTS (PTERIODOPHYTES)	T	
HANCOCK	Blanding's Turtle	Emydoidea blandingii	REPTILES	T	
HANCOCK	Smooth Green Snake	Liochlorophis vernalis	REPTILES	S	

Appendix 3: IDNR Fisheries Clear Lake Young of the Year Survey Results

COMPARISONS OF REPRODUCTIVE SUCCESS OF CLEAR LAKE FISHES AS DETERMINED BY NIGHT BAG-SEINING (1/4"x1/8"x50') AT SEVEN SAMPLING LOCATIONS

YEAR	WALL	CRAP SPP	YELL PERCH	W/Y BASS	BG/ PUMP	BLACK BULL	LMB	CARP/ BUFF	C CAT	MUSKY N PIKE	SPOT SHIN	WHITE SUCK	TOTAL	
1972	121	82	294	23	102	563	3	0	0	0		0	625	
1973	16	229	120	97	76	TNC	1	5	0	0		0	544	* a
1974	8	252	523	1342	1493	291	2	0	0	0		0	3620	
1975	36	134	519	686	1187	1545	0	0	5	0		0	2567	
1976	25	3	481	10	253	TNC	6	1	1	0		0	780	* b
1977	14	14	325	839	68	175	0	37	0	0		0	1297	* c
1978	25	2	3	25	99	87	0	3	0	1		0	245	
1979	242	8	92	0	0	108	0	20	0	0		0	687	* d
1980	142	9	193	9	4	40	0	4	1	0	47	2	451	
1981	0	11	101	16	8	68	0	5	2	0	131	9	351	
1982	112	1	591	60	6	78	0	7	19	1	222	4	1101	
1983	298	24	488	277	30	393	0	6	4	1	324	1	1846	
1984	166	4	164	324	12	83	0	0	6	0	661	0	1420	
1985	36	5	3	22	55	2	0	0	0	0	240	0	363	
1986	264	1	59	1464	3	196	0	17	8	0	517	7	2563	
1987	1	3	8	530	2	1	0	1	7	0	32	3	588	
1988	11	0	0	43	240	9	0	0	3	0	22	0	328	
1989	13	0	0	903	3	1	0	0	0	0	23	0	943	* e
1990	2	0	0	708	3	12	0	2	0	0	6	0	733	* f
1991	21	42	5	530	205	2	1	0	4	8	52	0	870	
1992	8	1	3	25	9	0	2	0	0	0	19	0	67	
1993	14	8	3	11	91	0	1	0	0	1	0	1	133	
1994	150	62	18	812	119	225	2	0	1	0	96	0	1487	
1995	163	347	334	3165	637	4094	4	20	1	0	884	0	9649	
1996	17	5	6	257	300	0	0	0	0	0	264	0	849	
1997	78	1	0	607	12	0	0	0	6	0	215	0	919	
1998	42	6	0	418	109	0	0	0	4	0	107	0	686	
1999	32	1	0	488	20	281	0	0	7	0	488	0	1317	* g
2000	22	0	0	826	17	7	0	2	2	0	767	0	1643	
2001	84	0	0	251	11	0	0	0	4	0	567	0	917	
2002	150	3	0	45	44	120	0	0	0	0	707	0	1069	
2003	3	17	3	5780	103	583	0	1	33	0	729	0	7252	
2004	4	9	0	190	27	0	0	0	0	0	139	0	369	
2005	113	35	22	1177	528	49	5	3	12	0	600	0	2544	
2006	59	10	1	1004	49	120	0	0	5	0	184	0	1432	
2007	26	49	56	283	855	137	0	1	10	0	235	0	1652	
2008	16	6	1	76	151	0	0	0	3	0	104	0	357	* h
2009	49	37	161	2148	1154	0	4	1	1	0	298	1	3853	
2010	81	233	248	1151	2763	0	0	26	6	0	340	0	4848	
MEAN	68	42	124	683	278	238	1	4	4	0	291	1	1614	

*a - TNC= too numerous to count; total excludes B. bullheads.

*b - TNC= too numerous to count; total excludes B. bullheads.

*c - Lake 30+ inches low. Could not seine Ventura access. Data bases on 12 hauls.

*d - Could not seine Ventura access in October. Data based on 13 hauls.

*e - Lake 40 inches low. Could not seine Ventura access. Data bases on 12 hauls.

Appendix 4: Clear Lake Water Quality Project – Practices Installed FFY2001-2010

ID	Year	Practice	Funding	Amount	Location
1	2001	Storm Water Filtration	City of Clear Lake	1 unit	4th Ave S
2	2001	Storm Water Filtration	City of Clear Lake	1 unit	1st Ave N
3	2002	Storm Water Filtration	Cerro Gordo County	1 unit	Linden
4	2002	Storm Water Filtration	Cerro Gordo County	1 unit	Oak
5	2002	Storm Water Filtration	Cerro Gordo County	1 unit	Hill
6	2002	Storm Water Filtration	Cerro Gordo County	1 unit	Walnut
7	2002	Storm Water Filtration	Cerro Gordo County	1 unit	Maple
8	2003	Wetland/Prairie Restoration	FWP	23 acres	CL Section 29
9	2003	Rain Garden/Storm Water	Bell Harbor Assoc.	1 unit	Epworth
10	2003	Shoreline Stabilization	Iowa DNR	400 ft	Ventura Heights
11	2004	Wetland/Prairie Restoration	WRP	190 acres	CL Section 20
12	2004	Wetland/Prairie Restoration	WRP	110 acres	CL Section 22
13	2004	Shoreline Stabilization	Hanson Foundation	400 ft	CL Section 20
14	2005	Storm Water Filtration	City of CL/ 319	1 unit	1st Ave S
15	2005	Storm Water Filtration	City of CL/ 319	1 unit	1st Ave N
16	2005	Rainwater Garden	City of CL/ WSPF	1 unit	Yacht Club
17	2005	Wetland/Prairie Restoration	FWP, CRP	50 acres	Concord Sec. 23
18	2005	New No-Till	EPA 319	47.5 acres	Concord Sec. 24
19	2005	Terrace	POL	2000 ft	Concord Sec. 24
20	2006	Storm Water Filtration	319/Hanson/City of CL	1 unit	All Vets Golf Course
21	2006	Storm Water Filtration	319/Hanson/City of CL	1 unit	7th Ave S
22	2006	Storm Water Filtration	319/Hanson/IDNR	1 unit	Ventura Cove Park
23	2006	Storm Water Filtration	319/Hanson/IDNR	1 unit	Ventura Marsh Lot
24	2006	Storm Water Filtration	319/Hanson/CG County	1 unit	Bayside Ave
25	2006	Storm Water Filtration	319/Hanson/CG County	1 unit	Ventura Heights
26	2006	Shoreline Stabilization	IDNR	400 ft	Ventura Cove Park
27	2006	Shoreline Stabilization	Winnebago/IDNR	350 ft	Lynn Lorenzen Park
28	2006	Shoreline Stabilization	City of CL	20 ft	7th Ave S
29	2006	Rain Garden	CLTel	1 unit	CLTel Parking Lot
30	2006	Rain Garden	WSPF/City of CL	1 unit	7th Ave S
31	2006	Wetland/Prairie Restoration	FWP, CRP	40 acres	Concord Section 23
32	2006	Wetland/Prairie Restoration	FWP, CRP	48 acres	Concord Section 23
33	2007	Porous Pavement	319/City of CL	1 unit	S 3rd St
34	2007	Shoreline Stabilization	Iowa DNR	350 ft	Harbourage
35	2007	Shoreline Stabilization	Winnebago/IDNR	100 ft	Dead Man's Curve
36	2008	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	Clark Road
37	2008	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	18th St
38	2008	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	S 3rd St
39	2008	Storm Water Filtration	WIRB/319/Hanson/CG	1 unit	Bayside Ave
40	2008	Storm Water Filtration	WIRB/319/Hanson/CG	1 unit	Elm St
41	2008	Storm Water Filtration	WIRB/319/Hanson/CG	1 unit	240th St SW
42	2008	Storm Water Filtration	WIRB/319/Hanson/Ven	1 unit	2nd St
43	2008	Rain Garden	WSPF/City of CL	1 unit	S 3rd St
44	2009	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	6th Ave S
45	2009	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	7th Ave S
46	2009	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	2700 N Shore Dr
47	2009	Rain Garden	WSPF/City of CL	2 units	8th Ave S
48	2009	Rain Garden	Hanson Foundation	1 unit	N 3rd St
49	2009	Porous Pavement	WSPF/City of CL	1 unit	8th Ave S
50	2009	Shoreline Stabilization	Winnebago/Camp	120 ft	Camp Tanglefoot
51	2009	Wetland/Prairie Restoration	CREP	35 acres	Clear Lake Section 29
52	2009	CREP Berm	EPA 319	1 unit	Clear Lake Section 29
53	2009	Wetland/Prairie Restoration	CRP	50 acres	Clear Lake Section 18
54	2009	Wetland/Prairie Restoration	FWP, CRP	20 acres	Clear Lake Section 18

55	2010	Storm Water Filtration	WIRB/319/Hanson/ CL	1 unit	2nd Ave N
56	2010	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	17th St W
57	2010	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	All Vets Golf Course
58	2010	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	Fairway Dr
59	2010	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	N Shore Dr
60	2010	Storm Water Filtration	WIRB/319/Hanson/CL	1 unit	4th Ave N
61	2010	Storm Water Filtration	WIRB/319/Hanson/Ven	1 unit	E Lake St
62	2010	Storm Water Filtration	IDNR	1 unit	Lynne Lorenzen Park
63	2010	Shoreline Stabilization	Winnebago	10 ft	Hackberry Ave
64	2010	Wetland/Prairie Restoration	FWP, CRP	136 acres	Clear Lake Section 29

Appendix 5: WILMS Modeling Inputs

Hydrologic and Morphometric Data
Tributary Drainage Area: 8456.0 acre
Total Unit Runoff: 11.09 in.
Annual Runoff Volume: 7814.8 acre-ft
Lake Surface Area <As>: 3625.0 acre
Lake Volume <V>: 35580.0 acre-ft
Lake Mean Depth <z>: 9.8 ft
Precipitation - Evaporation: -2.3 in.
Hydraulic Loading: 7120.0 acre-ft/year
Areal Water Load <qs>: 2.0 ft/year
Lake Flushing Rate <p>: 0.20 1/year
Water Residence Time: 5.00 year
Observed spring overturn total phosphorus (SPO): 60.0 mg/m^3
Observed growing season mean phosphorus (GSM): 58.0 mg/m^3

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading (kg/ha-year) ----|**				**|----- Loading (kg/year) ----|**		
Row Crop AG	4318.0	0.40	0.46	0.60	27.7	699	804	1048
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	811.0	0.01	0.03	0.06	0.3	3	10	20
HD Urban (1/8 Ac)	1298.0	0.80	1.04	1.20	18.8	420	545	630
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	137.0	0.05	0.07	0.10	0.1	3	4	6
Wetlands	0.0	0.10	0.10	0.10	0.0	0	0	0
Forest	448.0	0.02	0.03	0.10	0.2	4	5	18
Ventura Marsh	719.0	1.00	1.25	1.50	12.5	291	363	436
CRP/WRP	723.0	0.03	0.05	0.10	0.5	7	15	29
Shoreline Erosion	0.0	10.00	20.00	30.00	0.0	0	0	0
Groundwater	1.0	700.00	780.00	900.00	10.9	283	316	364
Internal	1.0	800.00	863.00	900.00	12.0	324	349	364
Lake Surface	3625.0	0.20	0.30	0.40	15.1	293	440	587

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.50	0.80	0.10	
# capita-years	75.0				
% Phosphorus Retained by Soil		0.0	5.0	10.0	
Septic Tank Loading (kg/year)		37.50	57.00	6.75	2.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	5214.3	6409.2	7738.1	100.0
Total Loading (kg)	2365.2	2907.2	3510.0	100.0
Areal Loading (lb/ac-year)	1.44	1.77	2.13	
Areal Loading (mg/m^2-year)	161.23	198.17	239.26	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	4484.7	5313.2	6429.5	98.0
Total NPS Loading (kg)	2034.3	2410.1	2916.4	98.0

Appendix 6: WILMS Modeling Results

WILMS Version 3.3.18.1 Phosphorus Prediction and Uncertainty Analysis Module
Phosphorus Prediction and Uncertainty Analysis Module
Observed spring overturn total phosphorus (SPO): 60.0 mg/m^3
Observed growing season mean phosphorus (GSM): 58.0 mg/m^3
Back calculation for SPO total phosphorus: 60.0 mg/m^3
Back calculation GSM phosphorus: 58.0 mg/m^3
% Confidence Range: 70%

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	67	82	100	24	41
Canfield-Bachmann, 1981 Natural Lake	45	51	57	-7	-12
Canfield-Bachmann, 1981 Artificial Lake	39	43	47	-15	-26
Rechow, 1979 General	13	16	19	-42	-72
Rechow, 1977 Anoxic	136	167	202	109	188
Rechow, 1977 water load<50m/year	34	41	50	-17	-29
Walker, 1977 General	99	122	147	62	103
Vollenweider, 1982 Combined OECD	58	69	80	10	17
Dillon-Rigler-Kirchner	63	77	93	17	28
Vollenweider, 1982 Shallow Lake/Res.	50	60	71	1	2
Larsen-Mercier, 1976	83	102	124	42	70
Nurnberg, 1984 Oxic	52	64	77	6	10

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	57	114	Tw	2046	GSM
Canfield-Bachmann, 1981 Natural Lake	16	147	FIT	3521	GSM
Canfield-Bachmann, 1981 Artificial Lake	13	124	FIT	5306	GSM
Rechow, 1979 General	11	23	qs	10481	GSM
Rechow, 1977 Anoxic	119	227	FIT	1008	GSM
Rechow, 1977 water load<50m/year	28	58	Pin	4065	GSM
Walker, 1977 General	72	195	FIT	1428	SPO
Vollenweider, 1982 Combined OECD	38	116	FIT	2409	ANN
Dillon-Rigler-Kirchner	55	105	P qs p	2259	SPO
Vollenweider, 1982 Shallow Lake/Res.	34	99	FIT	2901	ANN
Larsen-Mercier, 1976	75	135	P Pin	1705	SPO
Nurnberg, 1984 Oxic	40	98	P	2633	ANN

Phosphorus Prediction and Uncertainty Analysis Module

Date: 10/31/2010   Scenario: 20
Observed spring overturn total phosphorus (SPO): 60.0 mg/m^3
Observed growing season mean phosphorus (GSM): 58.0 mg/m^3
Back calculation for SPO total phosphorus: 50.0 mg/m^3
Back calculation GSM phosphorus: 50.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	57	114	Tw	1764	GSM
Canfield-Bachmann, 1981 Natural Lake	16	147	FIT	2748	GSM
Canfield-Bachmann, 1981 Artificial Lake	13	124	FIT	3851	GSM
Rechow, 1979 General	11	23	qs	9035	GSM
Rechow, 1977 Anoxic	119	227	FIT	869	GSM
Rechow, 1977 water load<50m/year	28	58	Pin	3505	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	72	195	FIT	1190	SPO
Vollenweider, 1982 Combined OECD	38	116	FIT	1968	ANN
Dillon-Rigler-Kirchner	55	105	P qs p	1882	SPO
Vollenweider, 1982 Shallow Lake/Res.	34	99	FIT	2402	ANN
Larsen-Mercier, 1976	75	135	P Pin	1421	SPO
Nurnberg, 1984 Oxic	40	98	P	2269	ANN