Storm Lake Watershed Management Plan 2012-2032

A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature.
~Henry David Thoreau

Pollutants of Concern: Sediment and Phosphorus
Approved: June 2012

Developed by the Iowa Lakes RC&D in collaboration with:
Iowa Department of Natural Resources
Storm Lake-Lake Preservation Association
Storm Lake-Lake Improvement Commission
Buena Vista County Soil and Water Conservation District
Natural Resource Conservation Service
Iowa Department of Agriculture Land Stewardship
Buena Vista University
City of Storm Lake
Buena Vista County

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Contents

Introduction

Storm Lake and its watershed have a long history of watershed awareness and protection, efforts have included organizing local community leaders, informing and educating watershed residents, agricultural producers and other businesses, and implementing conservation practices. As a result of these efforts the groundwork has been set for continued water quality improvements in both urban and agricultural areas of the watershed.

Sail boats on Storm Lake. Photo Julie Sievers.

In August of 2010 the Iowa Department of Natural Resources (DNR) awarded a Watershed Management Planning Grant to the Iowa Lakes Resource Conservation & Development (RC&D). The grant was used to develop this watershed management plan. In an effort to continue watershed protection and water quality improvement this document has been developed to help guide watershed efforts for the next 20 years and ultimately lead to Storm Lake meeting Iowa's water quality standards. Due to the high levels of phosphorus and suspended solids in Storm Lake this document targets phosphorus and sediment as the pollutants of concern. Watershed and water quality modeling conducted during the development of this document revealed the following actions will be necessary to achieve water quality standards for Storm Lake: 1) a 60% reduction in sediment and phosphorus loading from the watershed, 2) a 20% reduction in internal loading from within Storm Lake and 3) continued dredging of Storm Lake to an average depth of 9.5 feet.

Public involvement is an extremely important component of watershed planning. Efforts have been underway for over 20 years to include both urban and agricultural stakeholders in decision making within the Storm Lake Watershed, the development of this document has been no exception. The Iowa Lakes RC&D formed a steering committee who worked to develop this document; members included the Lake Preservation Association (LPA), Lake Improvement Commission (LIC), Soil and Water Conservation District (SWCD), Natural Resource Conservation Service (NRCS), Buena Vista University (BVU), and Iowa Department of Natural Resources (DNR). A smaller core team helped coordinate the watershed planning process and incorporate public comments input into the planning process. This team was made up of Iowa Lakes RC&D Staff, Storm Lake residents, Iowa DNR staff including those that live in Storm Lake, NRCS staff, and the Mississippi River Basin Initiative Coordinator who has been working in the Storm Lake watershed.

Chapter 1: Watershed Inventory

Storm Lake is located in Buena Vista County in northwest Iowa. The watershed is approximately 17,835 acres with Storm Lake itself accounting for 3,150 acres. The lake is surrounded by the City of Storm Lake, the City of Lakeside, Buena Vista County, as well as King's Pointe Water Park and Resort, two marinas, and several parks. Storm Lake is the fourth largest natural lake in Iowa and one of 34 natural, glacial lakes in Iowa. The lake and park areas provide facilities for fishing, camping, boating and picnicking. Park use is approximately 267,000 visits per year. Storm Lake has an adjoining 190 acre marsh called Little Storm Lake located at the northwest corner of the main lake. The marsh is fed mostly by Powell Creek, which drains the largest portion of the watershed. Over thirty percent of the lake's shoreline is public land, and includes two state areas, Little Storm Lake Management Area and Storm Lake Marina, one county park (South Cove Park), five Storm Lake city parks, one Storm Lake city campground, two City of Lakeside parks and four boat ramps.

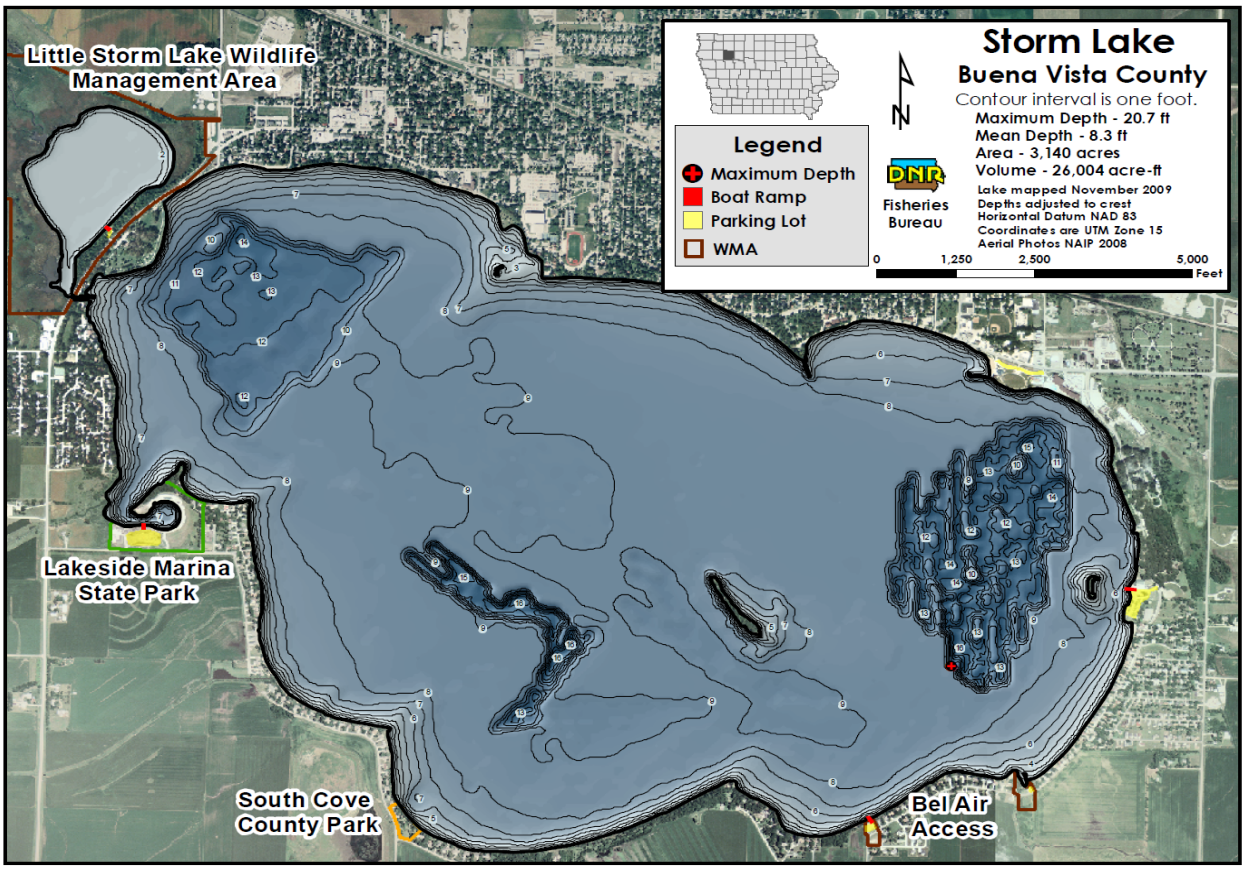


Figure I. Storm Lake.

Waterbody Name	Storm Lake
Hydrologic Unit Code (HUC)	HUC 10 0710000603
Use Designation Class	Primary contact recreation, A1 Aquatic life, B (LW)
IDNR Waterbody ID	IA 04-RAC-00530-L
Location	Section 10 T90N R37W
Tributaries	Powell Creek
Receiving Waterbody	Outlet Creek to North Raccoon River
Watershed Land Area	14,700 acres
Lake Surface Area	3,150 acres
Lake Volume	26,004 acres-ft (30.8 million m^3)
Detention Time, based on outflow	2.6 years
Maximum Depth	20.7 feet in 2009 (not including recent or planned dredging)
Mean Depth	8.3 feet in 2009(not including recent or planned dredging)
Length of Shoreline	52,500 feet
Watershed/Lake Area Ration	4.4:1

Table 1: Watershed Characteristics

Land Use

The watershed is approximately 60% row crop agriculture; of the row crop land approximately two thirds receives some level of fall tillage. Other land uses in the watershed include water, residential, commercial, roads, farmsteads, and golf courses. Other land uses account for the remaining 5.5%. See Table 2 and Figure 2. There are currently four sizable livestock facilities located in the watershed, however, with an abundance of hog and turkey facilities near the watershed more and more livestock manure is used for fertility needs in the watershed. Most hog manure is injected but turkey and poultry manure can only be spread on the surface and later tilled into the soil.

The urban areas of the watershed constitute 1,894 acres, which includes the unincorporated housing developments on the south and west sides of the lake, the Lake Creek development, part of the City of Storm Lake along the north side of the lake, the city of Lakeside to the east, and part of the city of Alta. There are currently two projects underway to bring sanitary sewer to unincorporated residents in the watershed. The fist area is on the south and west sides of the lake, which, has been a major concern for many years since many housing lots do not have adequate room for septic drain fields or soils are not appropriate for drainage fields. The second area is the Lake Creek Golf Course development.

2011 Land Use	Acres	% of Total
Corn	5,303.9	29.70%
Beans	5,236.5	29.32%
Water	3,155.2	17.67%
Residential	873.8	4.89%
Grass	573.9	3.21%
Commercial	393.0	2.20%
Roadway	365.4	2.05%
Corn Bean Strips	348.0	1.95%
Farmstead	336.7	1.89%
Golf Course	278.4	1.56%
Other Land Uses	996.2	5.58%

Table 2. 2011 Land Uses.

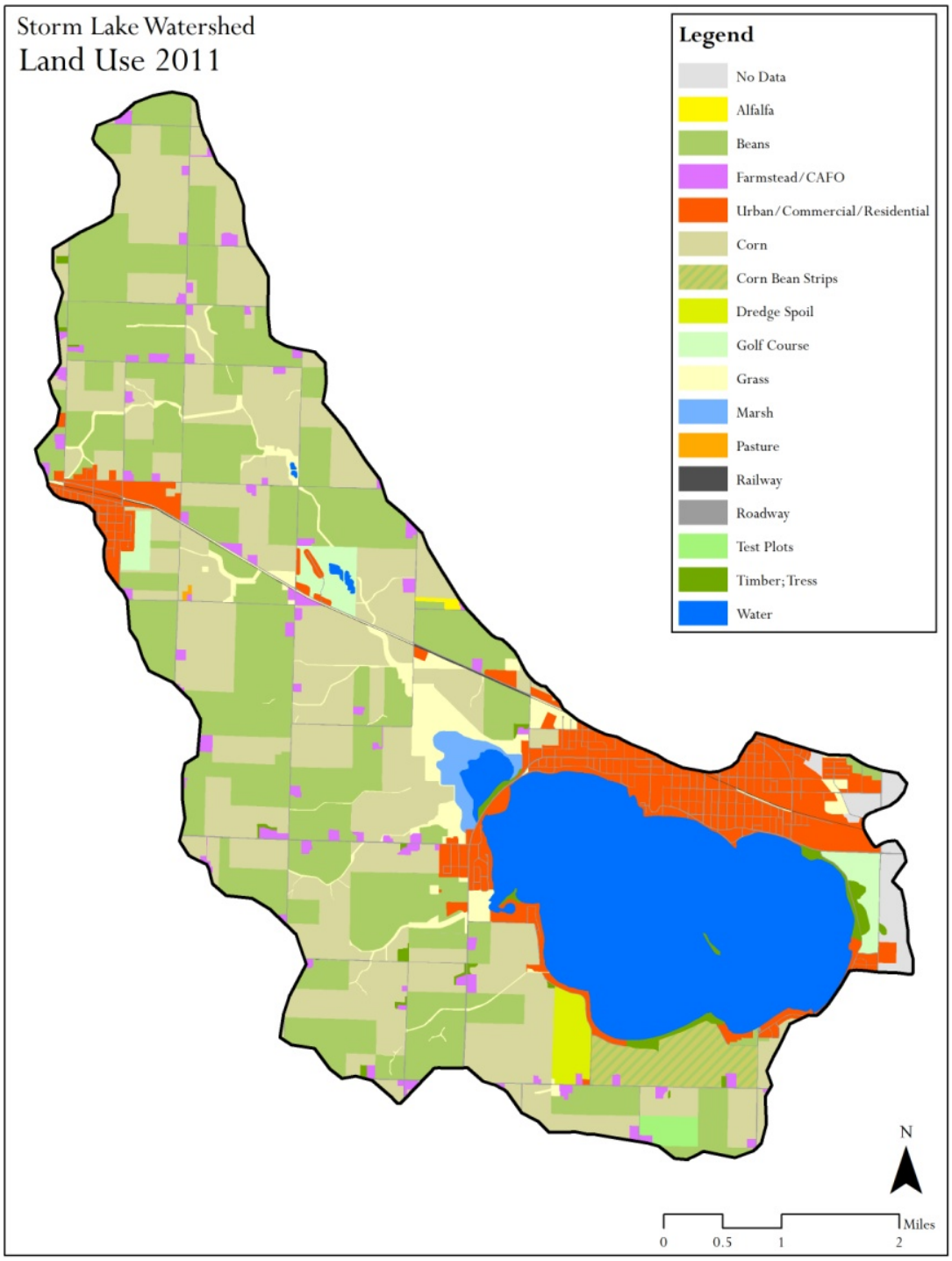


Figure 2. Storm Lake watershed land cover/use 2011.

Soils

Two soil associations dominate the Storm Lake watershed: the Sac-Primghar-Galva and the Colo-Calco-Spillville. Of these the Sac-Primghar-Galva association comprises the largest portion of the watershed. The Sac-Primghar-Galva association is characterized by well-drained and somewhat poorly drained, moderately fine textured, nearly level to moderately sloping soils on loess-mantled uplands. The Colo-

Calco-Spillville association is made up of poorly drained and somewhat poorly drained, moderately fine textured and medium-textured, nearly level and gently sloping soils on bottom lands.

Soil Series	% of Land Area
Sac Loam Sub	31.68%
Primghar	30.82%
Galva	14.86%
Marcus	11.40%
Afton	3.80%
Colo	2.56%
Calco	1.15%
Wadena	1.15%
Other Soils	2.57%

Table 3. Soils in the Storm Lake watershed.

Topography

Topography of the watershed varies from level to moderate slopes. The highest elevation of the watershed is approximately 1,523' above sea level.

Slope Range	Acres	% of Watershed Area
0-2%	8,577	48.0%
2-5%	7,974	44.6%
5-9%	819	4.6%
9-14%	268	1.5%
14-18%	99	0.6%
18-25%	76	0.4%
25+	49	0.3%

Table 4. Slopes.

Zoning & Land Ownership

Within the Storm Lake watershed there are a total of 3,652 parcels of land. Of the watershed land area 84% is zoned agricultural, 6% residential, 4.6% park/school, 3.5% commercial/industrial and 1.5% other. See Figure 2 for a map of watershed land classes (zoning). Agricultural land class account for 11,700 acres of the watershed and records indicate approximately 135 different landowners own this land. Nearly 1,000 acres of agricultural land is owned by 16 landowners who live outside the Iowa. Another 2,000 acres of agricultural land is owned by 16 landowners who live in Iowa but not within twenty miles of the Storm Lake watershed. 6,000 acres of agricultural land is owned by 79 landowners who live within 20 miles of the Storm Lake watershed. 2,700 acres of agricultural land does not have an owner address available at the time of analysis.

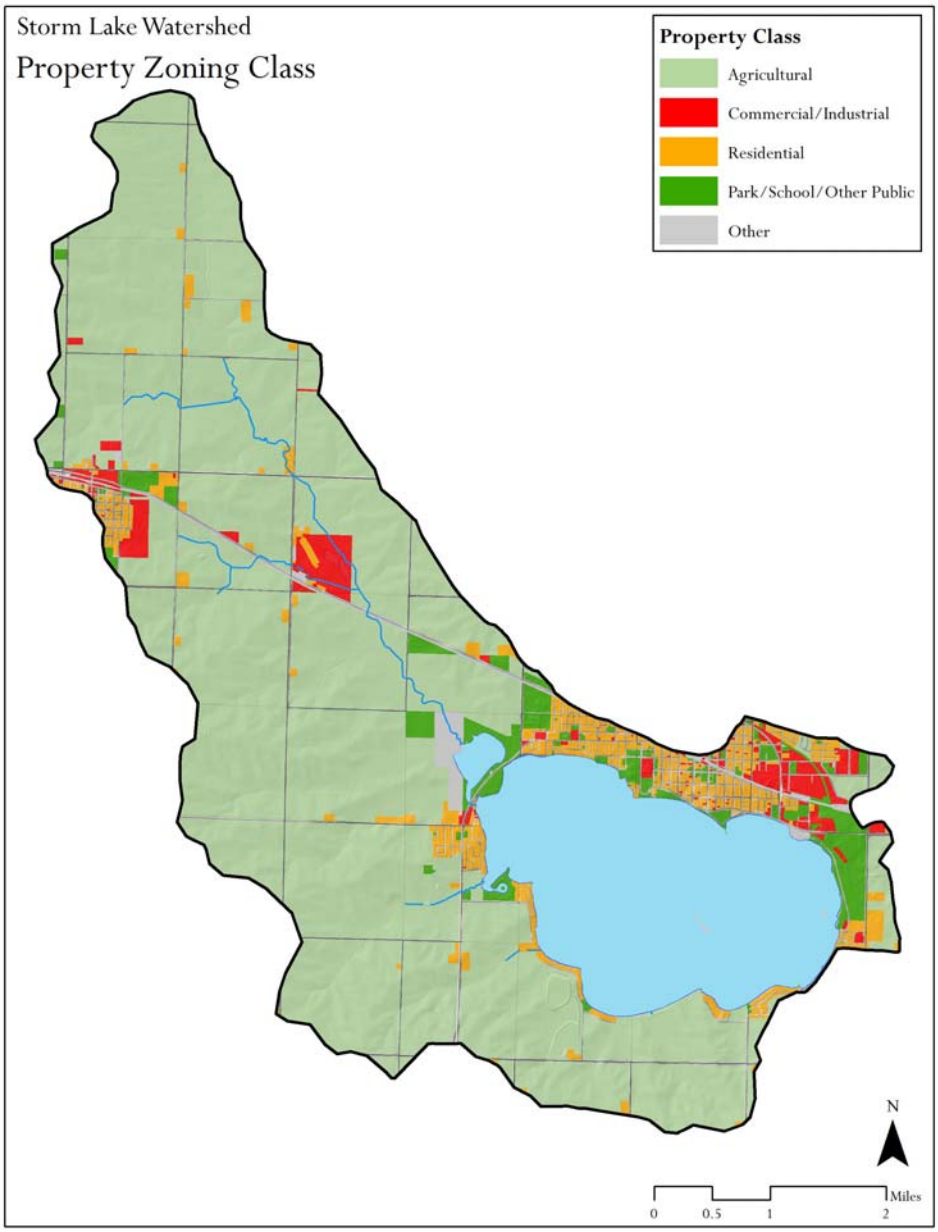


Figure 3. Land classification (aka zoning).

Demographics

As of 2010 the City of Storm Lake is home to approximately 10,600 people. The population is increasing and becoming more ethnically diverse. This diversity while good at times does present many challenges to the community, school district, and overall ability to conduct outreach efforts especially when it comes to water quality education. This diversity will mean that a priority will need to be placed on translating materials relating to the watershed to meet the needs of the community. As of early 2012, over five languages were spoken in the Storm Lake School District.

In 2009, the population was about 56.3 % White; 32.9 % Hispanic; 6.5% Asian; 2.7% Black; and 1.6% represented two or more races. The number of languages spoken in Storm Lake speaks to the diversity that currently exists. Today the average class in the Storm Lake Middle School is 20% white Caucasian and 80% minority.

Chapter 2: TMDL Assessment & Water Quality Conditions

Storm Lake was first placed on Iowa 303(d) Impaired Waters List in 2002 due to the partial support of the primary contact recreation use designation. The cause of the impairment was determined to be aesthetically objectionable turbidity that is a combination of inorganic material and algae blooms. Turbidity is a reduction in clarity that results from the presence of suspended particles. As a result of being placed on the 303(d) Impaired Waters List a Total Maximum Daily Load (TMDL) was completed by the Iowa DNR and approved by the Environmental Protection Agency (EPA) in 2005. The TMDL set the following targets for water quality in Strom Lake:

1) Secchi depth of 0.7 meters or greater
2) Total suspended solids (TSS) concentration of 20 mg/L or less

Secchi depth used to measure transparency in waterbodies. The greater the Secchi depth (typically measured in meters), the more transparent the water. Total Suspended Solids (TSS) is a quantitative measure of matter (organic and inorganic material) suspended, rather than dissolved, in the water column.

The 2010 Iowa DNR water quality assessment of Storm Lake found that the primary contact recreational uses at Storm Lake continue to be "not supported." Using data from lake water quality surveys from 2004 through 2008 (approximately 24 samples), Carlson's (1977) trophic state indices for Secchi depth, chlorophyll a, and total phosphorus were 73, 60, and 67 respectively for Storm Lake. According to Carlson the Secchi depth value places Storm Lake in the hypereutrophic category, the chlorophyll a value places Storm Lake in the eutrophic category, and the total phosphorus value places Storm Lake in between the eutrophic and hypereutrophic categories. See table 5 for attributes associated with eutrophic and hypereutrophic conditions. These values suggest moderately high levels of chlorophyll a and suspended algae in the water, very poor water transparency, and high levels of phosphorus in the water column. See Appendix 2 for a the full 2010 water quality assessment.

Table 5. TSI value attributes.

TSI Value	Attributes	Primary Contact Recreation	Aquatic Life (Fisheries)
50-60	eutrophy: anoxic hypolimnia; macrophyte problems possible	[none]	Warm water fisheries only; [1]percid fishery; bass may be dominant
60-70	blue green algae dominate; algal scums and macrophyte problems occur	weeds, algal scums, and low transparency discourage swimming and boating	[2]Centrarcid fishery
70-80	hyper-eutrophy (light limited). Dense algae and macrophytes	weeds, algal scums, and low transparency discourage swimming and boating	Cyprinid fishery (e.g., common carp and other rough fish)
>80	algal scums; few macrophytes	algal scums, and low transparency discourage swimming and boating	rough fish dominate; summer fish kills possible

[1]Fish commonly found in percid fisheries include walleye and some species of perch
[2]Fish commonly found in centrarcid fisheries include crappie, bluegill, and bass

The level of inorganic suspended solids is very high at Storm Lake and suggests that non-algal turbidity contributes to the impairment. The median inorganic suspended solids concentration at Storm Lake was 14.5 mg/L, which was the 11th highest of the 132 monitored lakes.

Storm Lake was also placed on the 2010 303(d) Impaired Waters List for violations of the Iowa water quality standard for indicator bacteria. Beach water quality monitoring at Awaysis Beach in 2008 and 2009 found E. coli geometric means that violate the state water quality standard of 126 E. coli organisms per 100 milliliters. This impairment was found during the planning process therefore will not be addressed in this document.

Lake and Watershed Monitoring

Storm Lake has been included in Iowa Lake Monitoring Program since 2000 and has been sampled at least three times a year ever since. Sampling rounds are designed to capture seasonal variability in the lakes, with samples being taken in spring-early summer, mid-summer, and late summer-fall. The Iowa DNR with the assistance of Iowa State University continues to gather samples three times a year from Storm Lake. The sampling point for Storm Lake is near the deepest point in the lake. The results of this sampling are presented below.

Secchi Depth

The ambient monitoring results for Secchi depth are presented in Figure 4. Since 2000 there has been a increasing trend in Secchi depths but improvements still need to be made to reach the TMDL target of 0.7 meters.

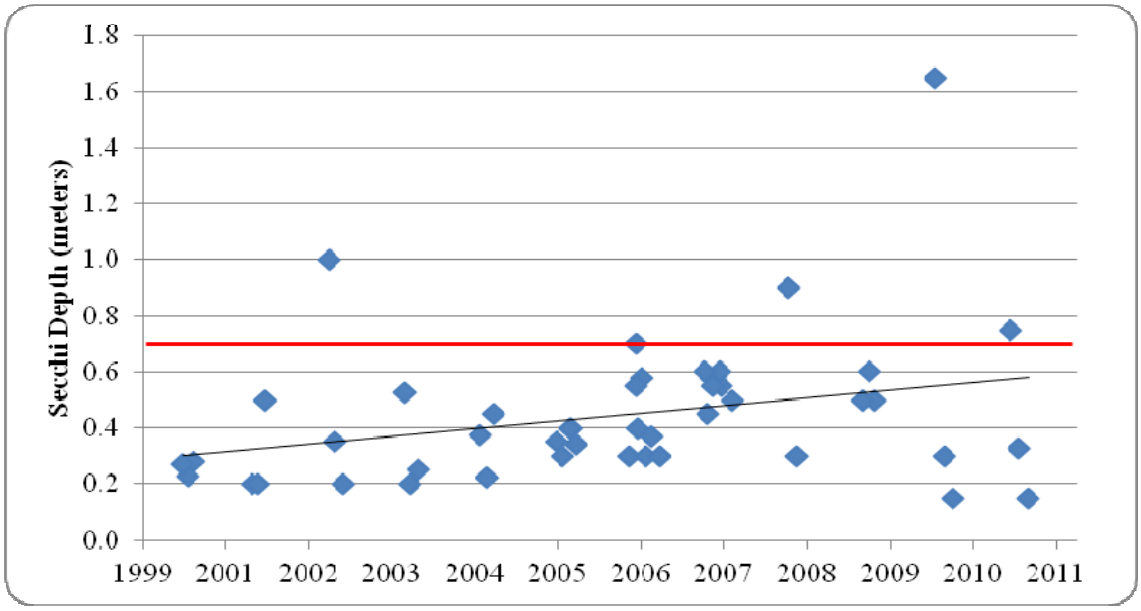


Figure 4. Storm Lake secchi depths 2000-2011. Red line indicates the TMDL target of 0.7 meter secchi depth (or greater). The black line is a linear trend line.

Total Suspended Solids (TSS)

The ambient monitoring results for TSS are presented in Figure 5. Since 2000 TSS has been trending towards the TMDL target of 20 mg/L but results in 2010 and 2011 are widely variable.

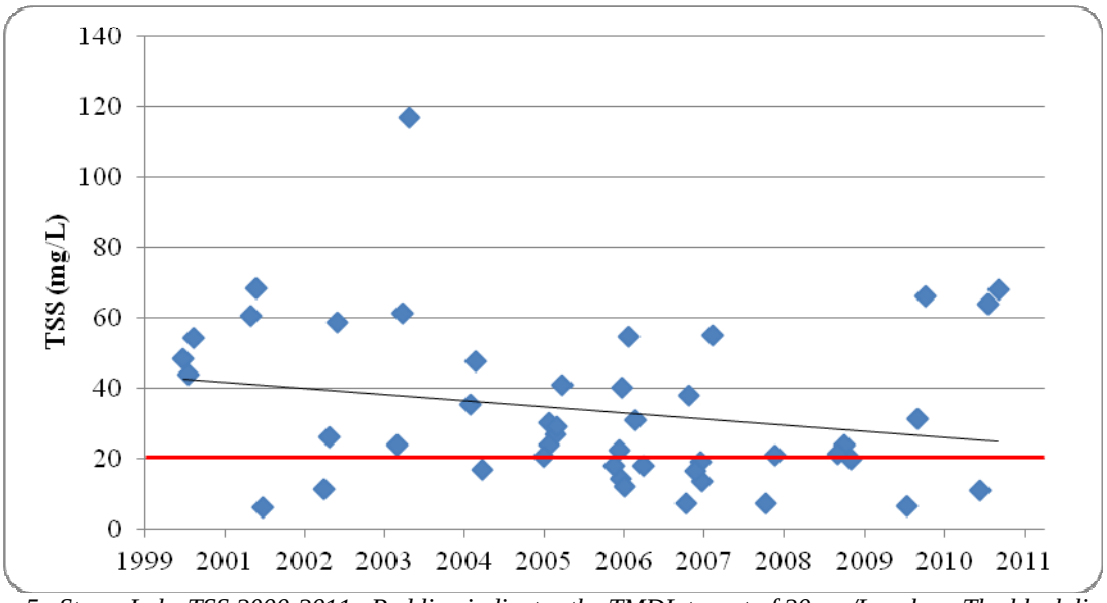


Figure 5. Strom Lake TSS 2000-2011. Red line indicates the TMDL target of 20 mg/L or less. The black line is a linear trend line.

Chapter 3: Pollutant Sources

As previously mentioned the primary cause of the impairment in Storm Lake is poor turbidity caused by a combination of inorganic material and algae blooms. According the TMDL non-algal turbidity is thought to be the primary cause of turbid conditions in Storm Lake. Wind re-suspension was cited in the TMDL as the primary cause for in-lake turbidity, watershed nonpoint source pollutions were listed as a secondary cause of turbidity in Storm Lake. This chapter is divided into four sections discussing various sources of sediment and phosphorus within the Storm Lake watershed. Chapter 5 presents modeling results that identify sources of sediment and phosphorus.

Little Storm Lake

Aerial view of Little Storm Lake in the foreground and Storm Lake in the background.

Little Storm Lake is adjacent to the northwest side of Storm Lake and is the receiving waterbody for Powell Creek, the main tributary with in the Storm Lake watershed. The TMDL discussed the impact of Little Storm Lake on water quality in Storm Lake. Little Storm Lake has been found to have a significant impact on TSS levels entering Storm Lake especially during rain events. Until a recently completed renovation of Little Storm Lake this was a contributing factor to the overall turbidity conditions in Storm Lake. According to the TMDL, the estimated TSS concentration for the Little Storm Lake outlet during precipitation events is 300 mg/l. The goal of the Little Storm Lake renovation was to reduce sediment and TSS concentration leaving Little Storm Lake. Water quality monitoring above and below Little Storm Lake prior to the renovation showed TSS levels averaged 4 times higher exiting Little Storm Lake than water entering Little Storm Lake. One sample collected on October 26th, 2010 showed TSS levels in water entering Little Storm Lake to be 3 mg/L, the water leaving Little Storm Lake had TSS readings of 430 mg/L. For the purposes of this watershed management plan it is assumed the renovation of Little Strom Lake will negate any TSS loading that had been occurring in Little Storm Lake and will begin to treat water entering from Powell Creek, this will be further explained in Chapter 4.

Storm Lake Resuspension

The 1994 Diagnostic/Feasibility Study and the 2005 TMDL indentify the primary source of evaluated turbidity to be suspended matter caused by the resuspension of bottom sediments. To support this conclusion the TMDL used bathymetric surveys from 1916, 1935, 1972, and 1993 were used to evaluate historic siltation rates and the watershed model AGNPS (Agricultural Non-Point Source) was used to

estimate watershed sediment delivery. The bathymetric data show that sediment delivery to Storm Lake is minimal since the estimated water volume hasn't varied much from 20,000 acre-feet since the first survey in 1916. The report concludes that the negligible sediment delivery to the lake is because the major tributary, Powell Creek, discharges into Little Storm Lake where most sediment settles before runoff enters Storm Lake.

Runoff from urban area. Photo Julie Sievers.

Watershed Point Sources

The City of Storm Lake has a Municipal Storm Water NPDES Permit and discharges to Storm Lake through 54 outfalls. Of these outfalls, four flow continuously due to elevated groundwater. Some monitoring has been conducted on these four outfalls, although TSS has not been one of the parameters analyzed. The permit covers approximately four square miles within the boundaries of Storm Lake. The potential impact with this permit and the allowances is the potential to discharge pollutants that are not intended to be discharged and that they make it into the Storm Lake watershed.

The only permitted point source discharges to Storm Lake is from the City of Storm Lake Storm water permit. The waste load allocation for the turbidity TMDL is zero.

Watershed Nonpoint Sources

The TMDL stated a secondary source of sediment is in runoff from the watershed, both agricultural and urban. Watershed sources of sediment and phosphorus include streambank erosion, sheet and rill erosion, gully erosion, shoreline erosion, and runoff from urban areas. For the purposes of this watershed management plan sediment and phosphorus will be the focus. All sources have been assessed and watershed conditions have been input into the STEP-L model. Chapter 4 presents the modeled estimated sediment and phosphorus loading by source and watershed area.

Gully erosion in the Storm Lake watershed. Photo Julie Sievers.

Chapter 4: Pollutant Modeling

Two water quality models were used to estimate watershed and in-lake pollutant sources and water quality conditions within Storm Lake and the watershed. STEP-L was used to model pollutant loading from the watershed. The BATHTUB water quality model was used to estimate the in-lake water quality conditions and responses to watershed contributions and changes. For the purposes of modeling Little Storm Lake, post renovation, is assumed to reduce sediment and phosphorus reaching Storm Lake by 35%. This reduction efficiency was based on a best professional judgment. Future water quality monitoring will be necessary to confirm this assumption.

Corn residue in Storm Lake after runoff event. Photo Julie Sievers.

Watershed Nonpoint Sources

Table 5 presents the STEP-L pollutant sources and model estimated pollutant loads delivered to Storm Lake on an annual basis from watershed sources. These numbers are current as of 2011. Figures 6 and 7 spatially display the phosphorus and sediment loading from the watershed on an annual per acre basis.

Sources	Phosphorus Load (lb/yr)	Sediment Load (t/yr)
Cropland	49,941	7,444
In-Field Gullies	15,330	5,110
Urban	1,861	278
Streambank	1,789	596
Groundwater	1,506	0
Septic	1,247	0
Grassland	141	6
Feedlots	83	0
Forest	16	1
Pastureland	2	0
Total	**71,914**	**13,435**

Table 6. STEP-L predicted watershed pollutant loading by source.

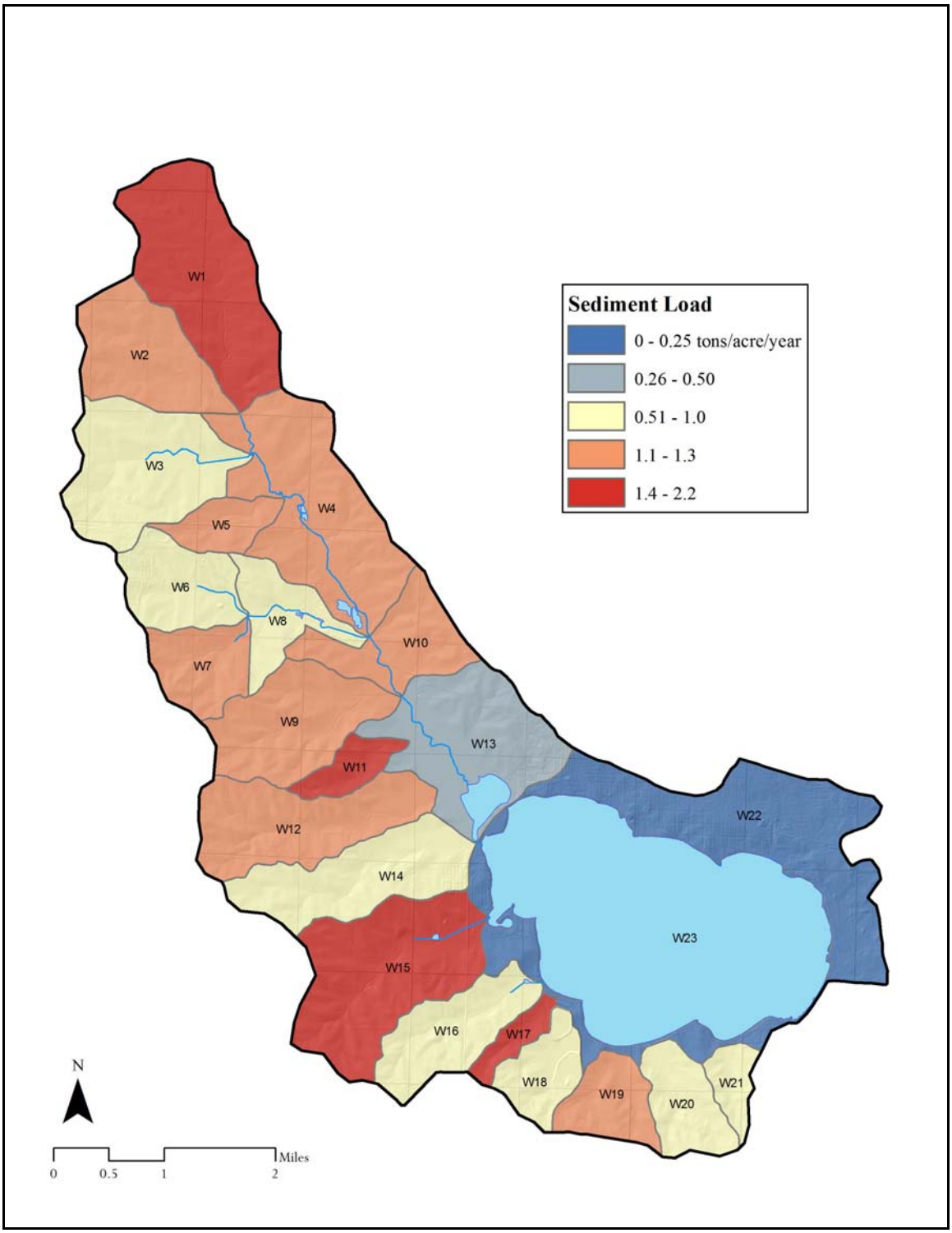


Figure 6. STEP-L predicted sediment loading per acre by subwatershed from all sources.

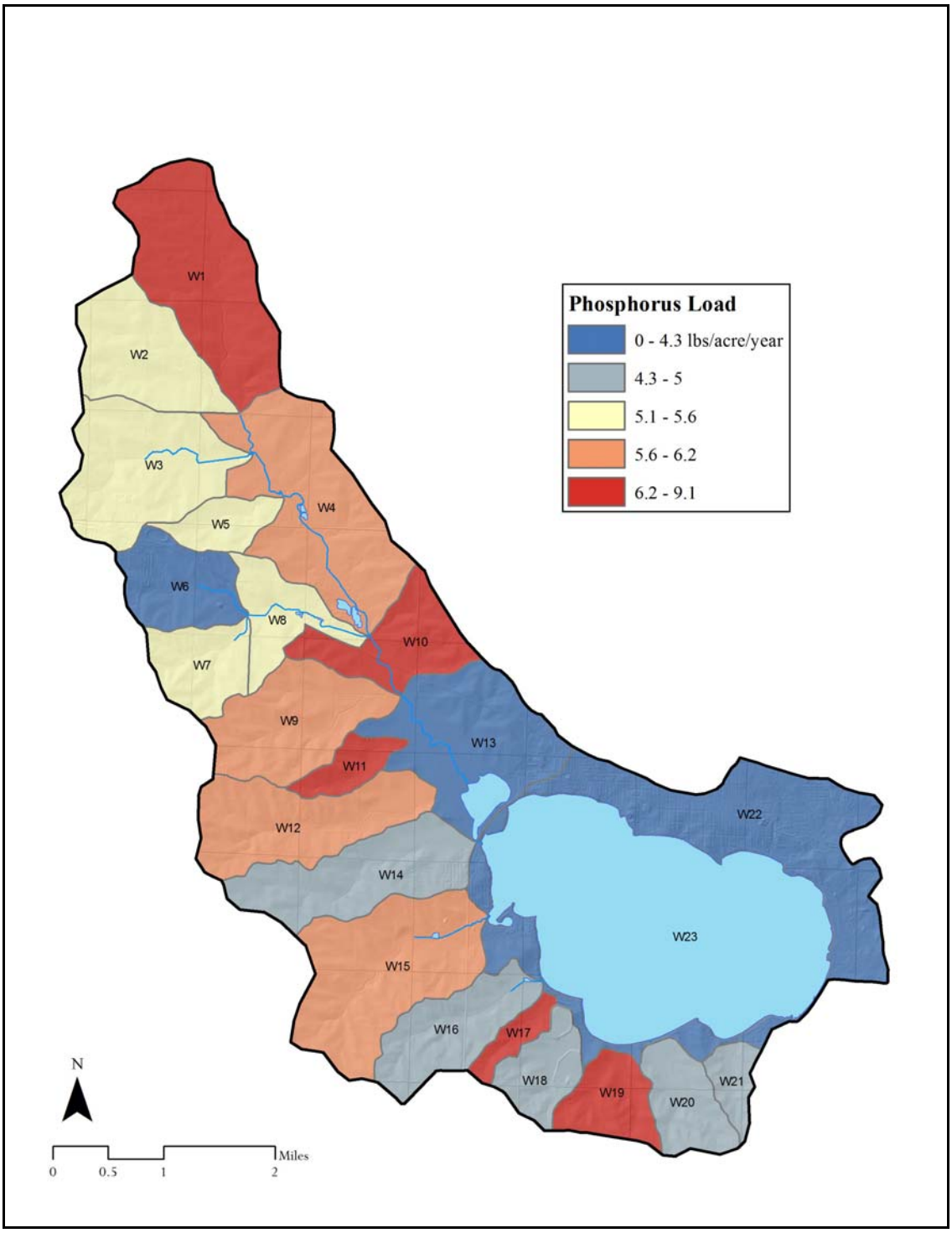


Figure 7. STEP-L predicted phosphorus loading per acre by subwatershed from all sources.

Chapter 5: Past Water Quality Improvement Efforts

Work in the Storm Lake watershed was formally started by the Buena Vista Soil and Water Conservation District in 1990, shortly after the watershed project had started the Lake Preservation Association (LPA) was formed and incorporated in 1991. The LPA and the local SWCD have worked together on efforts to educate watershed residents, agricultural producers and businesses on the importance of watershed protection. Implementation of conservation has also been a priority. Several watershed protection grants have awarded to the SWCD and other groups to encourage and assist landowners with conservation work on private land.

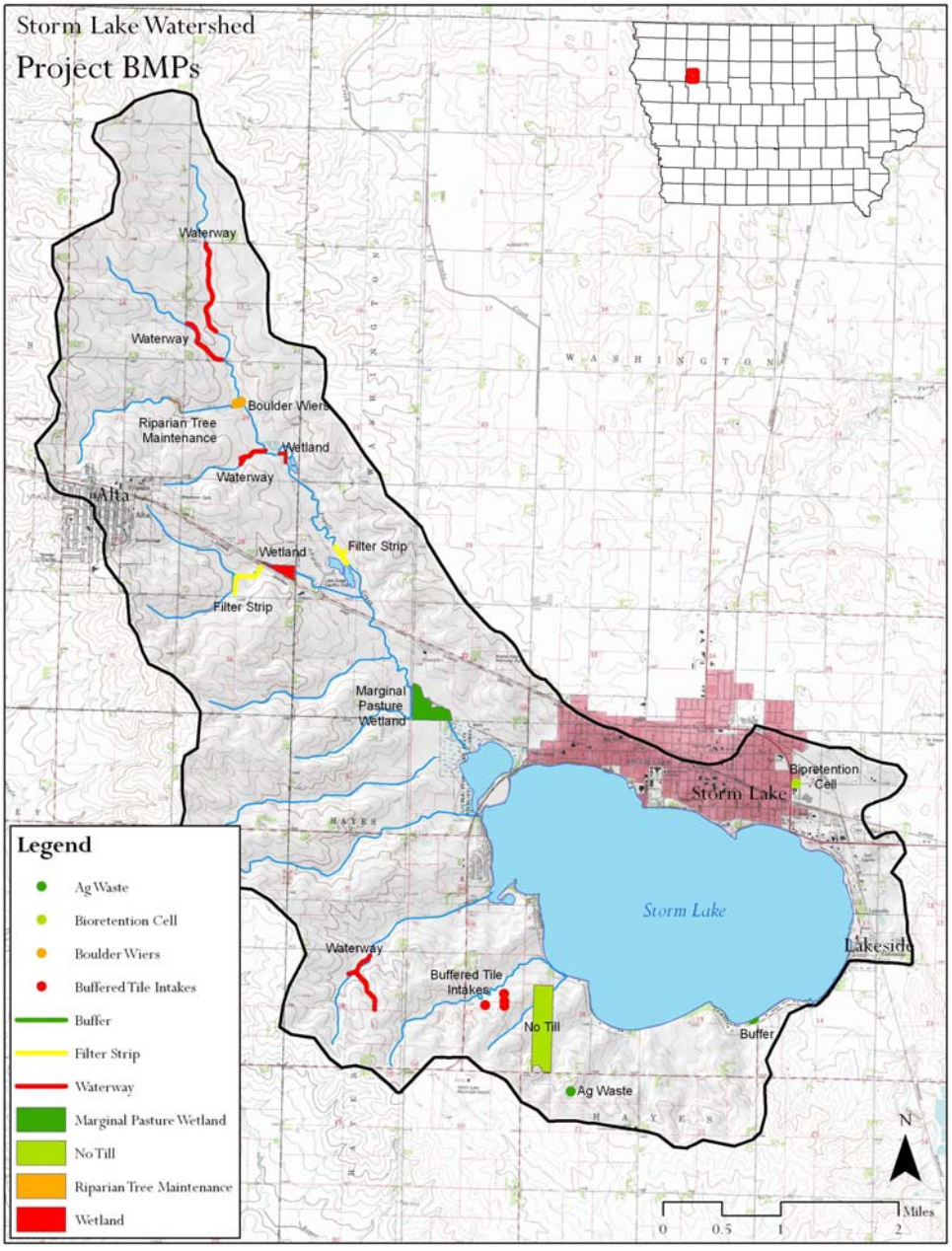


Figure 8. Conservation practices installed as part of a watershed project ending in 2010.

As work has progressed in the watershed we have learned more about both watershed and in-lake factors affecting water quality in Storm Lake. One of the results of this is a multiyear project to dredge approximately 1,300 acres of Storm Lake. Since much of the lake's turbidity results from in-lake re-suspension caused by wave action the goal is to deepen large portions of the lake thus reducing lake bottom sediment movement. Dredging on Storm Lake has been on-going since 2002 and there are plans to continue this effort. Each dredging season begins in April or once the lake has thawed and runs until the end of October.

Storm Lake dredge in operation.

Year	Days	Cubic Yards Pumped	Average Clarity in Inches
2002		1,320,000 +	
2003		50,000	
2004	136	699,112	10
2005	125	548,389	12
2006	138	573,225	14
2007	111	527,837	17
2008	69	244,450 ++	19
2009	143	559,966	21
2010	156	579,673	18
TOTALS	579	5,102,652	

Table 7. Dredge annual summary. + State of Iowa. ++Repairing damage to dredge from late 2007 incident

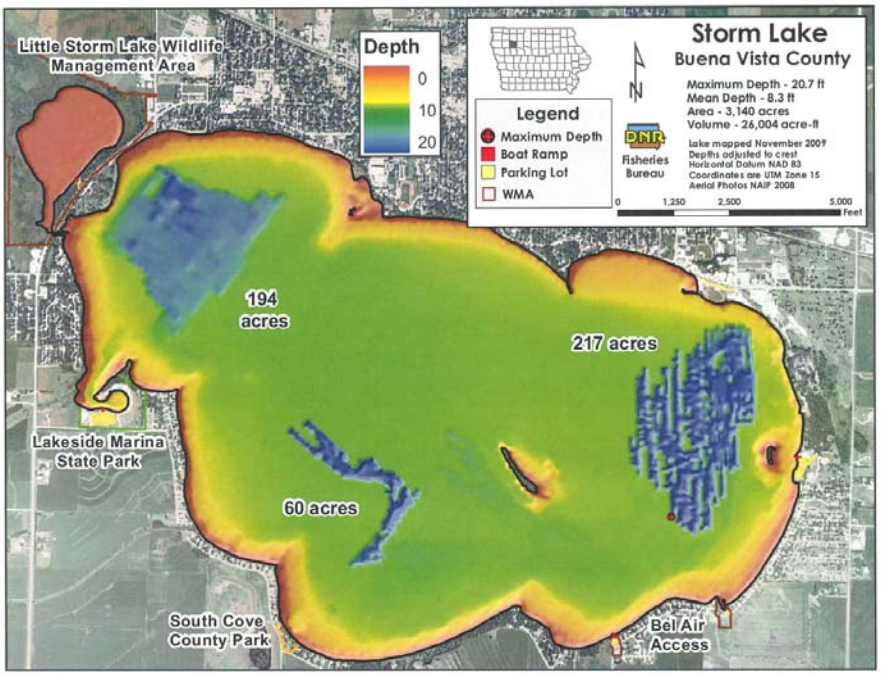


Figure 9. Dredged areas of Storm Lake in blue.

Funding for the Storm Lake dredging project has come from a number of sources, Table 7 summaries the funding to date.

State Allocation	$4,942,920
Federal Allocation	$1,765,000
City of Storm Lake	$1,378,995*
City of Lakeside	$110,477**
Buena Vista County	$680,000***
Private Pledges	$1,385,964
TOTAL	$10,263,356

*Table 8. Dredging project funding sources. *Annually contributes a portion of the Hotel/Motel Tax. **Annually contributes a portion of Local Option Sales Tax. ***Annually contributes insurance for the dredge and related equipment*

Additionally, these amounts above do not include the $4,000,000 spent by the state in 2002. The costs from 2003 to December 2010 were $6,646,623 and annual dredging operations costs about $1,000,000/year. The Lake Improvement Commission (LIC) recently purchased 67 acres for a future spoil site. The engineer's estimate is that the site will hold 2.8 million cubic yards of spoil, possibly more if the sites are rotated. The goal is to dredge about 500,000 cubic yards per year so the new site would extend the project 5 to 6 years. The plan for 2011 and 2012 dredging is to remove another 1.6 million cubic yards. The third year (2013) would focus on any additional work needed at Little Storm Lake and would allow the sediment in the spoil site to settle. The fourth year (2014) would include the final year of dredging the lake. The desire is for the continued improvement in the water quality, to be at or close to the water clarity goal of 28". Continued funding for the project is needed to ensure that a maximum benefit can be obtained with the resources currently employed in the restoration efforts.

Chapter 6: Watershed Social Assessment

During the watershed planning process one public meeting was held in December 2010, at this meeting a SWOT (Strength, Weaknesses, Opportunities, Threats) analysis was conducted where problems and solutions were discussed among meeting attendees.

A few of the problems and solutions that were identified include:

Weaknesses/Opportunities

- A need to promote use of cover crops and other "innovative" practices.
- Erosion: agricultural and urban
- A lack of support for conservation from agricultural sources
- A lack of long-term watershed coordination
- Concern over loss of rental income from production land put into conservation
- Limited cost share to install (conservation) practices
- A perception of yield loss when adopting new conservation crop production techniques
- Absentee land owner communication and education problems
- Concern over potential loss of crop production land from conservation activities
- Difficulty in selling conservation activities to nonfarm background absentee landowners
- The loss of available urban land to install conservation practices due to new buildings and roads
- Availability issue of seasonal or absentee property owners
- Language barriers among the various urban stakeholders

Opportunities

- FUNDING: county, city, John Deere, CASE IH, Ag Partners, Elevators, Coops, Farm Bureau, State, Federal, corporate sponsors
- Identify solutions for critical areas of erosion in Storm Lake Watershed
- Thank and acknowledge producers who implement BMPs
- Host demonstration projects and provide locations that are viewable during the entire year.
- Assistance with paperwork associated with conservation programs (ea. cost-share BMPs)
- Provide and/or increase cost share rates for conservation practices in the watershed
- Leverage programs and multiple funding sources
- Hold recognition and award ceremony for watershed participants
- Provide education and demonstration opportunities

The solutions mentioned above are the result of public meeting discussion.

Watershed Surveys

After the public meeting in December 2010, a fact sheet was developed as well as two similar, but different surveys that were conducted through phone calls or in-person interviews. The target audience for these surveys included community leaders, farmers, rural landowners, lake protection groups, government officials, recreational users and urban residents. A full report of the survey results is provided in Appendix XX. Some questions and responses have been provided below.

Urban Survey Reponses

Question: What is your connection to the lake and water quality?

"The connection to the watershed for most of the urbanites is different. For one business they are working on storm water management due to the city's new illicit discharge ordinance and therefore is seeking ways to treat runoff. They are finding that their only options are filtration or chemical treatment. Currently, there are two outfalls, but they will go down to one. They are working with a consultant to determine their best options; however, they understand already that these options are going to cost in the range of $300,000-$400,000. Both large and small businesses are interested in grants and cost-share options to help with large projects. Others have been involved with the watershed for years through education efforts, research, holding positions on city and state boards and committees, and personal enjoyment/recreation."

"We need safe water and that is everyone's right! This may include having more recreation and activities around the lake, after all recreation is a reflection upon water quality. There should also be a third party that is educated and can be a resource for businesses and industry. It is also important to understand that just because you throw money at a problem, it won't necessarily be fixed. We need to have better resources and tools to solve issues."

"We are at a unique location in the Des Moines lobe; we need to realize the resources that we have. People enjoy the natural beauty of the area, and also enjoy the access (trails, parks, etc) and opportunities (boating, fishing, etc). There are opportunities for education of all types of freshwater systems. We could showcase our watershed. If efforts are dove-tailed with tourism, we could have an 'eco-tourism' approach that would capitalize on the resource and educate many."

"We need citizen buy-in as well as a non-government feel or approach. Suggestions include: implementation of rain gardens, where BVU students could offer advice and assist homeowners/landowners in indentifying locations and completing projects. Also Little Storm Lake is almost the number one issue--we need to clean it up and keep it clean, but that will require landowners who are on board. Finally, we always need more education, especially need to reach Storm Lakes' diverse population."

"We need to keep public land available so we don't become Okoboji."

Question: When you think about the watershed are there other things that could be done as a collective effort?

"We should have representatives form industry on a watershed committee. Also, everyone needs to be educated and get all entities on the same page to then move forward."

"We should develop a central activity, such as earth week and continue and further develop education and outreach as a collective group. A science center (Discovery Center) would be a great hub. People need something physical to connect with, then they will come and then they may donate money to the cause."

"Everyone needs to understand their role and their responsibility; this can be done through outreach and education."

What questions/suggestions do you have? Or what can we do to help?

"Searching for grant opportunities would be an asset to large businesses undertaking projects that would positively impact the watershed. Additionally, large businesses are going to stay in

touch with USDA/NRCS and the Buena Vista County SWCD and seek our advice when bringing in a filtration system company. The watershed should also utilize the local university and the expertise that is in residence. The city needs to continue to dredge and work with the state and work on a coordinated effort when it comes to funding water quality improvement projects."

Additional comments from urban survey:

"While water quality is improving is it also still hard to measure since reliable and plentiful data does not go back that many years, but general awareness has increased and the city has made steps to improve water quality. Also, responsibility of funding projects as well as general water quality improvements should be a combination of government and private industry. The RC&D needs to be more involved. The watershed needs to fund a watershed coordinator for consistency in the ongoing effort. There has been a collective effort to improve the watershed; however more collaboration, education and outreach are always needed. Responsibility and buy in of the local people is necessary as well as collaboration amongst government entities. This may aid in driving the watershed efforts."

"At first, dredging seemed like an overwhelming task, but now it has been going on successfully for years. Dredging has increased awareness and sensitivity to water quality issues in Storm Lake. Improved water quality gave rise to the idea of a resort, which needs a user friendly lake. At first it seemed impossible to have a resort, but it has been successful. Dredging has really increased awareness of the lake and water quality, and spurred discussion. Additionally, it has helped that the City has done a lot, including rain gardens, bio retention, and that project have a storm water management plan."

Famer/Land Owner Survey Responses

The following are a few general responses found when surveying the landowner and operators in the watershed. The sampling is a small percentage of owner/operators in the watershed, however, based on general discussions with this audience over the last several years it appears that these responses are fairly well representative of the group of the overall group.

What is your connection to the lake and water quality?

The respondents were landowners and operators. They lived in the area and were interested in protecting the watershed at least in part because they also enjoyed the lake as a recreational resource and for quality of life reasons.

What is your vision for Storm Lake?

Most people's vision for Storm Lake involves finding a happy medium between agriculture and lake protection. The people surveyed were willing to take part in conservation activities and practices as long as it did not affect their crop productivity and profit levels.

Who do you think should provide you with information regarding conservation and water quality in the Storm Lake watershed or what mechanism should be used?

Comments were varied including that it appears there are too many government agencies. Most owners and operator's voiced confusion regarding government bureaucracy. There is confusion and sometimes frustration regarding who is doing what for whom. There are

> *several entities in the watershed that at different times provide or dictate owner operator activities. They include: USDA/NRCS, USDA/FSA, IDALs/SWCD, Buena Vista County, City of Storm Lake and although it is non-gov. the Lake Preservation Association. It appears that for the most part farmers look toward the NRCS which also mean SWCD to most farms for leadership when it comes to guidance on conservation needs, planning and cost-share assistance.*

Of the practices we just discussed (question 10) are there any practices that you would consider implementing on your land or land you manage?

> *One comment included that they were interested in learning more about Conservation Easements and that they had already implemented terraces, riparian strips, reduced tillage and waterways.*

The survey of owner/operators also firmed up that absentee owners are disconnected from the watershed and the community; therefore, they tended to be less interested and not cooperative. There are negative feeling toward government entities and their level of involvement—no one wants to be told what to do! A committee should be responsible for providing information, as long as it is not made up of only supervisors. The committee needs a leader that is knowledgeable, especially in agronomy, there needs to be representatives from businesses, the chamber, BVU, city, farmers etc. Collectively, groundwork is started within the different committees that are established. People from different backgrounds serve on these community committees mentioned above, so work should continue with these groups.

While there is a need to continue water quality maintenance, individuals don't want to see the lake being dredged past historic/natural depths.

It was also noted that algae appears to have become a bigger problem with less turbidity.

At least one owner/operator noted that they try to do the right thing, and implement conservation without getting involved in government programs. The sentiment was that conservation methods could be anything that controls erosion. It doesn't need to cost a lot and that localized efforts and money are more effective, not necessarily federal. It was evident that owner/operators are getting tired of government intervention.

Finally, similar to the urban individuals who were surveyed, many owner/operators would like to see more data on the watershed. What has changed? And why has it changed? What (BMPs) have worked so far? There is a common feeling that there is more awareness about the lake and water quality and that farmers are becoming more conscious about the future, but that this needs to be carried over to the urban areas as well.

Chapter 7: Goals and Objectives

The goals of this watershed management plan and subsequent improvement projects are to improve water quality in Storm Lake such that the impairment can be removed. This will be accomplished through a combination of watershed and in-lake improvements. The following goals and objectives have been developed by the Storm Lake Watershed Steering Committee with input from landowners, farmers and residents of the watershed. A 20 year time frame has been established to meet the following goals. See Implementation Schedule and Resource Needs chapters for more information.

Goal 1: Meet Secchi depth target of 0.7 meters or greater and TSS target of 20 mg/L or less as set in the 2005 TMDL.

Objective 1: Implement conservation practices within the watershed to reduce phosphorus and sediment delivery to Storm Lake by 60%.

Tasks: See Chapter 8, Best Management Practice Implementation Schedule

Objective 2: Identify opportunities to address internal nutrient loading and attempt to achieve a 20% internal phosphorus loading reduction. Work with the partners to implement in-lake reduction practices.

Tasks 1: Since the only practical method to reduce in-lake phosphorus loading currently is through dredging, assistance will be provided as needed and appropriate to support the current dredging project by providing information and education on the project.

Objective 3: Work with project partners to complete dredging Storm Lake to an average lake depth of 9.5 feet.

Tasks1: As in the task for Goal 1, Objective 2 assistance will be provided to City and LPA as needed and is appropriate to continue dredging project to me dredging goals.

Goal 2: Increase public awareness and understanding of Storm Lake water quality issues and provide opportunities for public involvement and consistently over time.

Objective 1: Work with local and state partners to coordinate outreach activities to farmers, residents, landowners, businesses and others.

Task 1: Continue dialogue with City of Storm Lake and Buena Vista County officials about the importance of long-term funding for watershed coordination.

Task 2: Inform agricultural landowners and operators of water quality issues by holding educational seminars, mailings, news releases, personal contacts, etc.

Task 3: Educate and inform urban homeowners, businesses and municipalities by holding seminars, providing news releases, mailings, and personal contacts on a routine basis.

Task 4: Encourage adoption of BMP practices through demonstrations, field days, one-on-one contacts, third party influences, park days, public releases and social networking.

Task 5: Highlight efforts to improve water quality by installing signage identifying those implementing water quality improvement projects or practices.

Chapter 8: Best Management Practice Implementation Goals

Best management practices presented in this chapter have been divided into agricultural and urban practices. Water quality modeling has revealed watershed practices (agricultural and urban) need to achieve a 60% reduction in sediment and phosphorus load. In-lake management practices are also needed to achieve water quality goals but the difficult nature of modeling in-lake practices does not allow specific load reductions to be tied to individual practices, as a result this watershed management plan calls for at least a 20% reduction in internal nutrient recycling. In addition to the 20% reduction it is recommended that Storm Lake be dredged to an average depth of 9.5 feet. It will be up to watershed project partners to develop a plan to achieve both the internal load reduction and the average depth goal.

The following best management practices have been selected to reduce sediment and phosphorus from the Storm Lake watershed to achieve a 60% reduction but due to changing technology, water quality conditions and landowner/farmer acceptance other practices may be added to either this document or future grant applications. For additional practices to be considered sediment and phosphorus reductions must be evident.

Agricultural Best Management Practices

Water and Sediment Control Basin
Phosphorus reduction efficiency: Varies
Sediment delivery reduction efficiency: High
Implementation goal: 11 basins

Grassed Waterways
Phosphorus reduction efficiency: 85%
Sediment delivery reduction efficiency: Moderate/High
Implementation goal: 8,450 feet

Filter Strips
Phosphorus reduction efficiency: 45%
Sediment delivery reduction efficiency: High
Implementation goal: 44 acres of filter strips along stream channels

CREP Wetlands
Phosphorus reduction efficiency: 20-30%
Sediment delivery reduction efficiency: 20-30%
Implementation goal: 1

No-Till
Phosphorus reduction efficiency: 70%
Sediment delivery reduction efficiency: High
Implementation goal: 3,939 acres

High Residue Mulch Till 50% Res or Greater
Phosphorus reduction efficiency: 50%
Sediment delivery reduction efficiency: Moderate/High
Implementation goal: 2,369 acres

Mulch Till 30% to 50% Residue
Phosphorus reduction efficiency: Moderate

Sediment delivery reduction efficiency: Moderate
Implementation goal: 3,057 acres

Cover Crops
Phosphorus reduction efficiency: 50%
Sediment delivery reduction efficiency: 50%
Implementation goal: 1,630 acres

Terraces
Phosphorus reduction efficiency: 50%
Sediment delivery reduction efficiency: High
Implementation goal: Additional 1,000 feet of terraces

Livestock Waste Total Containment
Phosphorus reduction efficiency: Varies
Sediment delivery reduction efficiency: 0%
Implementation goal: 4

Urban Best Management Practices
Rain Gardens
Phosphorus reduction efficiency: Varies
Sediment delivery reduction efficiency: 0%
Implementation goal: 20

Rain Barrels
Phosphorus reduction efficiency: Varies
Sediment delivery reduction efficiency: 0%
Implementation goal: 100

In-Lake Practices
Hydraulic Dredging
Reduction potential efficiency: Medium - High

Goal: 1,600,000 cu yd

Example of a rain garden to capture runoff.

Rough Fish Management
Turbidity reduction potential efficiency: Medium - High
Goal: Reduced population of rough fish (install fish barrier at inlet bridge)

In Lake Best Management Practices Explanation
At this time there isn't a plan for in-lake BMPs and time_everything that Iowa DNR Fisheries Management Biologist would like to see done is being done already. However, to improve water quality, from an in-lake standpoint, these practices are generally what Iowa DNR looked at:

Shoreline Armoring: Wind and wave action can erode banks which deposits silt into the lake basin. Protecting shorelines with hard armor (i.e., rock rip rap) can help stabilize banks and dissipate wave energy. Storm Lake, for the most part, has fairly well protected shorelines. A tour of the lake could identify some areas of the shore that are in need of protection. Normally, if there is a riparian owner in an area that is need of shoreline protection, it is their responsibility to protect that shoreline.

Rough Fish Management: Although rough fish are present in the system, they are not as prolific as they are in other lakes throughout Iowa. Generally, Iowa DNR tries to manage rough fish numbers through heavy predator stockings and exclusion to prime spawning areas. Storm Lake receives heavy stockings of walleye already and there is a large population of white bass, which are voracious predators. Little Storm Lake serves as the prime spawning habitat for common carp right now. There is a currently a fish barrier in place to keep carp from moving into Little Storm Lake. By excluding fish from these spawning grounds, reproductive potential is decreased and forces them to spawn in the lake where the predators have full access to the carp's offspring. The other tool used to manage rough fish is rotenone. Rotenone is a chemical used to kill off fish and start over from scratch. This chemical kills every fish, though. It is not selective towards carp. The use of rotenone on Storm Lake is not being considered for two reasons: the walleye fish are far too good to sacrifice and those same fish are used as broodstock for the hatchery. Also, Storm Lake is far too large and it would cost around 2.4 million dollars just for the chemical.

Winter Aeration: Winter aeration serves as a tool to maintain good water quality because it prevents winterkill. In winterkill situations the desirable fish tend to die off and the carp and other rough fish survive and then thrive in the void that was created through the winter die off. Currently, Storm Lake doesn't need winter aeration. There is enough water volume that, even in harsh winters, there is more than enough dissolved oxygen. Winter aeration also creates a safety hazard because it creates open pockets of water during ice conditions. Therefore, it is only used on lakes that have a history of winterkill.

Dredging: Iowa DNR looks at dredging in the shallower lakes to create fish habitat, reduce the potential for winterkill, and reduce sediment re-suspension from wind action and boat activity. This is already being done at Storm Lake.

Stream bank Protection

A stream assessment was completed in 2010/2011 on Powell and Episcopal Creeks. There were no major concerns identified with regard to stream bank or channel erosion. There have been no stream bank protective measures incorporated into this plan for that reason. There are areas of minor channel meandering causing small amounts of stream bank erosion. Powell Creek can be benefited most by installation of more filter strips along the creek. These filter strips will provide protection from surface water running off cropland into Powell Creek and at the same time filter sediment and other pollutants.

Chapter 9: Implementation Schedule & Milestones

Watershed Best Management Practices & Implementation Schedule

Using the STEP-L model all proposed best management practices have been modeled to determine the efficacy at reaching the 60% watershed sediment and phosphorus delivery reduction needed to achieve water quality goals.

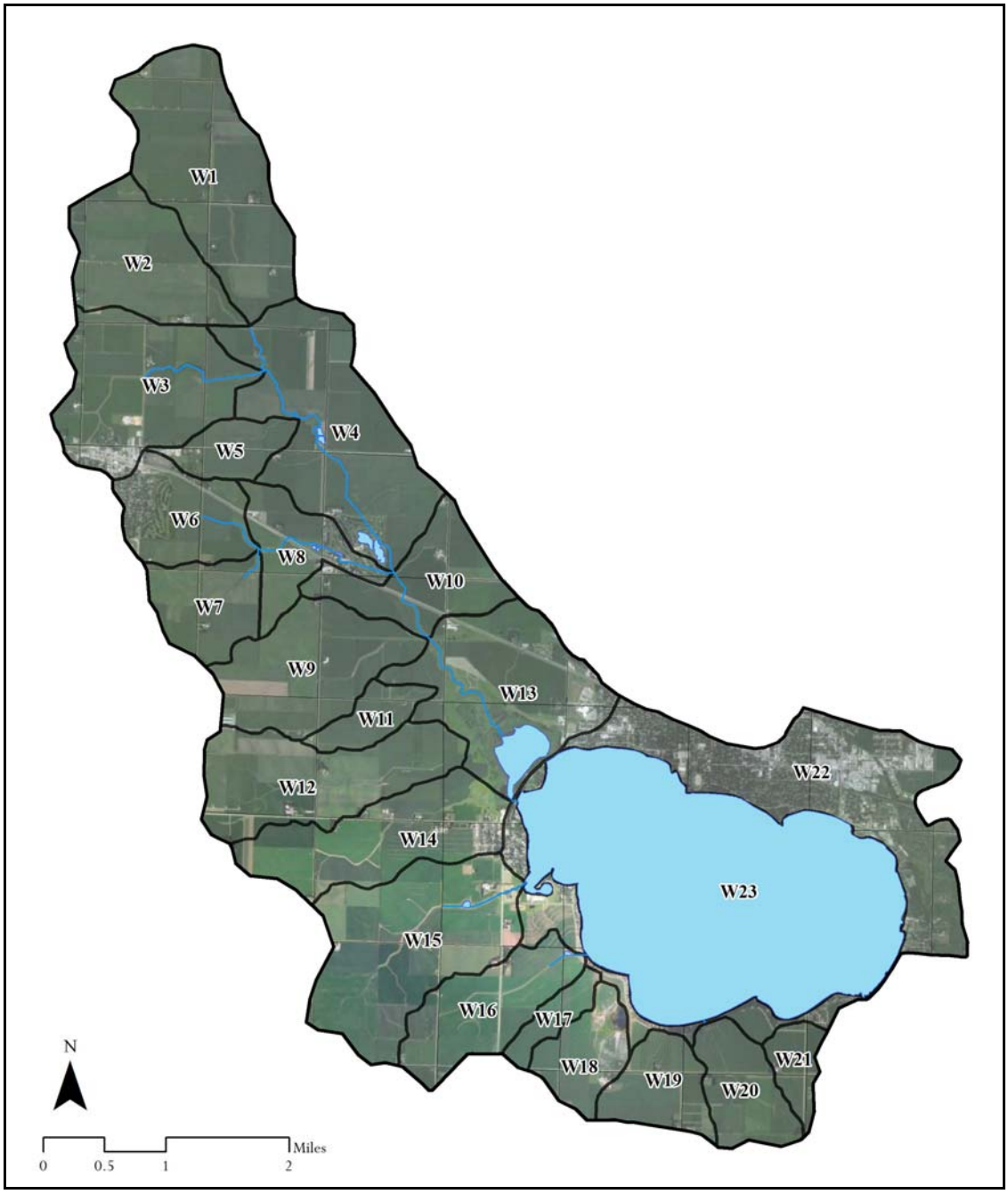


Figure 10. Subwatersheds used for modeling.

Subwatershed	Water and Sediment Control Basins	Grassed Waterway	Filter Strips	CREP Wetlands	No Till	Mulch Till High Residue	Mulch Till Moderate Residue	Cover Crops	Terraces	Livestock Waste System	Rain Gardens	Rain Barrels	Pervious Pavement	Storm Sewer Outlet Treatment	Storm Water Detention Structures
	No.	*Feet*	*Acres*	*No.*	*Acres*	*Acres*	*Acres*	*Acres*	*Feet*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
W1	0	0	0	0	150	130	816	80	0	0	0	0	0	0	0
W2	0	0	0	0	150	130	362	80	0	1	0	0	0	0	0
W3	0	500	0	1	463	200	110	100	0	1	3	10	1	0	0
W4	0	0	30	0	180	130	450	160	0	0	0	0	0	0	0
W5	0	0	0	0	148	50	0	0	0	0	0	0	0	0	0
W6	0	850	0	0	100	0	176	40	0	0	0	0	0	0	0
W7	1	700	0	0	200	120	54	40	150	0	0	0	0	0	0
W8	0	0	4	0	148	120	0	40	0	0	0	0	0	0	0
W9	1	850	0	0	457	220	60	100	170	0	0	0	0	0	0
W10	0	0	10	0	0	0	0	40	0	0	0	0	0	0	0
W11	0	0	0	0	0	120	68	0	0	0	0	0	0	0	0
W12	1	850	0	0	520	200	70	100	0	0	0	0	0	0	0
W13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
W14	1	850	0	0	200	200	229	40	0	0	0	0	0	0	0
W15	1	900	0	0	320	350	339	40	170	0	0	0	0	0	0
W16	1	850	0	0	317	93	87	140	170	0	0	0	0	0	0
W17	1	0	0	0	25	80	30	30	0	0	0	0	0	0	0
W18	1	800	0	0	108	70	0	445	0	1	0	0	0	0	0
W19	1	900	0	0	190	56	77	115	170	0	0	0	0	0	0
W20	1	900	0	0	263	100	129	40	170	0	0	0	0	0	0
W21	1	0	0	0	0	0	0		0	0	0	0	0	0	0
W22	0	0	0	0	0	0	0	0	0	0	17	90	3	10	10
W23 (Lake)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**11**	**8,450**	**44**	**1**	**3939**	**2369**	**3057**	**1630**	**1000**	**4**	**20**	**100**	**4**	**10**	**10**

Table 9. Best management practice implementation levels by subwatershed.

Existing Conditions			**Reductions from BMPs**		**Conditions after BMPs**		**% Reductions from Existing**	
Sub-Watershed	P Load (no BMP)	Sediment Load (no BMP)	P Reduction	Sediment Reduction	P Load (with BMP)	Sediment Load (with BMP)	%P Reduction	% Sed Reduction
	lb/year	t/year	lb/year	t/year	lb/year	t/year	%	%
W1	7,213	1,443	4,185	720	3,028	723	58	50
W2	3,797	703	2,528	447	1,270	256	67	64
W3	4,878	930	3,657	661	1,221	270	75	71
W4	7,713	1,518	3,995	681	3,718	837	52	45
W5	1,334	265	982	210	352	55	74	79
W6	2,100	428	1,172	223	928	206	56	52
W7	2,185	401	1,611	306	574	95	74	76
W8	2,033	367	1,461	300	572	67	72	82
W9	4,379	821	3,249	647	1,130	174	74	79
W10	3,340	656	1,104	155	2,236	501	33	24
W11	1,306	270	862	173	445	97	66	64
W12	5,170	900	4,144	763	1,026	137	80	85
W13	2,802	481	1,570	236	1,232	246	56	49
W14	3,632	621	2,102	368	1,529	253	58	59
W15	7,287	1,502	4,145	834	3,142	669	57	55
W16	2,641	417	1,685	283	956	134	64	68
W17	1,310	319	980	260	330	60	75	81
W18	1,443	312	1,071	254	372	58	74	81
W19	2,228	414	1,444	281	784	133	65	68
W20	1,815	286	1,217	202	598	84	67	71
W21	727	106	347	52	380	54	48	49
W22	2,569	271	90	15	2,479	257	4	5
W23	10	1	0	0	10	1	0	0
Total	**71,914**	**13,435**	**43,602**	**8,071**	**28,312**	**5,363**	**61**	**60**

Table 10. STEP-L load reductions by subwatershed. BMPs include a 35% reduction from Little Storm Lake.

As previously mentioned a 35% reduction from the Little Storm Lake project is anticipated, this reduction combined with the other proposed watershed BMPs is estimated to achieve a 60% reduction in sediment and phosphorus loading from the Storm Lake watershed. Table 11 outlines the watershed load reductions resulting from best management practice implementation by phase. Little Storm Lake is shown separately in tables 13 and 14 as the project will be completed in the summer of 2012 and will not be included in future phases. Please note tables 13 and 14 show a 23% phosphorus reduction and 24% sediment reduction for Little Storm Lake, this lower number is due to the fact that Little Storm Lake only captures water from a portion of the larger Storm Lake watershed, subwatersheds 1-13 of Figure 10. Each phase represents five years of work in the watershed. The actual time to implement each phase will depend greatly on landowner, farmer and resident adoption of conservation practices therefore completion of phases may be more or less than five years.

Practice	Phase 1 (5 yrs)	Phase 2 (5 yrs)	Phase 3 (5 yrs)	Phase 4 (5 yrs)
Water and Sediment Control Basins	1	2	4	4
Grassed Waterway	1000	3000	2000	2450
Filter strips	8	12	12	12
CREP Wetland	1			
No till/strip till	1000	1000	970	969
High Res Mulch Till 50% Res or >	1000	500	500	369
Mulch till (345) 30% to 50% Res	2500	200	200	157
Cover Crops	300	400	400	530
Terraces	200	400	200	200
Livestock Total Containment	1	1	1	1
Rock Riffles	1	1	1	0
Pervious Paving	2	1	1	0
Rain Gardens	6	7	4	3
Rain Barrels	10	40	20	20
Storm Sewer Outlet Treatment	1	3	3	3
Storm Water Detention Structures	1	3	3	3

Table 11. Best management practice amounts by phase.

	P Load	Sediment Load
	lb/yr	ton/yr
Existing Conditions	71,914.4	13,434
Reductions from Watershed BMPs (including Little Storm Lake)	43,602	8,071
Conditions after BMPs	28,312	5,363
% Reductions from Existing	61%	60%

Table 12. Summary of watershed phosphorus and sediment loading reductions.

	Little Storm Lake Phase	Phase 1	Phase 2	Phase 3	Phase 4	Entire Plan
P Load to Start Phase (lbs/year)	71,914	55,027	46,745	39,799	33,654	71,914
P Load Reduction (lbs/year)	16,887	8,282	6,946	6,145	5,343	43,602
P Load to End Phase (lbs/year)	55,027	46,745	39,799	33,654	28,311	28,312
% Reduction from Watershed	23%	12%	10%	9%	7%	61%

Table 13. Phosphorus load reductions by phase.

	Little Storm Lake Phase	Phase 1	Phase 2	Phase 3	Phase 4	Entire Plan
Sediment Load to Start Phase (tons/year)	13,434	10,220	10,932	8,834	6,977	13,434
Sediment Load Reduction (tons/year)	3,214	1,506	1,263	1,117	971	8,071
Sediment Load to End Phase (tons/year)	10,220	10,932	8,834	6,977	5,363	5,363
% Reduction from Watershed	24%	11%	9%	8%	7%	60%

Table 14. Sediment load reductions by phase.

Water Quality Milestones

This watershed management plan presents a 20 year timeframe for implementing conservation practices in the Storm Lake watershed to achieve a 60% reduction from watershed loading of sediment and phosphorus. In addition to the watershed reduction a 20% reduction of in-lake sources will be needed as well as a recommended average depth of 9.5 feet. Secchi depth will be used as the metric to determine if water quality targets are being achieved. The 2005 TMDL target of 0.7 meter Secchi depth which is equivalent to a Carlson's Trophic State Index (TSI) score of 65. The following table sets TSI milestones by phase. The starting TSI score is the average results from 2008-2011in-lake ambient monitoring data. Due to the difficult nature of in-lake improvements the 20% in-lake reduction and dredging to an average depth of 9.5 feet was equality distributed across the four phases.

	Watershed P Load (lbs/year)	Watershed Sediment Load (lbs/year)	Storm Lake Secchi Depth (meters)	TSI Secchi
Existing Conditions 2008-2011	71,914	13,434	0.56	72
Little Storm Lake Phase	55,027	10,220	0.62	69
End of Phase 1	46,745	10,932	0.64	68
End of Phase 2	39,799	8,834	0.66	67
End of Phase 3	33,654	6,977	0.68	66
End of Phase 4	28,311	5,363	0.70	65
TMDL Target	NA	NA	0.70	65

Table 15. Water Quality Milestones.

Chapter 10: Water Monitoring Plan

The water monitoring plan for the Storm Lake Watershed is comprised of four objectives:

Objective 1) Continue IDNR ambient in-lake monitoring site to track progress towards removal of turbidity impairment.

The ambient lake monitoring program began in 2000 as an effort to better understand and characterize lake water quality in Iowa. The objective of this program is to sample 131 of Iowa's recreational lakes and to describe current water quality and trends in water quality. Because temporal variability of Iowa's watersheds is great, samples are collected 3 times a summer at each of the 131 lakes from May through September. Monitoring crews navigate to the deepest point in the lake where they collect water samples for numerous chemical, physical, and biological parameters (see Table 16). The IDNR ambient monitoring program is administered through the Water Monitoring and Assessment Section of the IDNR and is anticipated to continue. See Figure 11 for locations of all monitoring sites in the Storm Lake watershed.

Chemical	Physical	Biological
Total Phosphorus	Secchi depth	Chlorophyll *a*
Orthophosphate (Soluble Reactive Phosphorus)	Temperature	Phytoplankton Mass and Composition
Total Nitrogen	Turbidity	Zooplankton Mass and Composition
Total Kjeldahl Nitrogen (UHL only)	Total Suspended Solids	
Ammonia	Total Fixed Suspended Solids (Inorganic Suspended Solids)	
Unionized Ammonia	Total Volatile Suspended Solids	
Nitrate + Nitrite Nitrogen	Specific Conductivity	
Alkalinity	Lake Depth	
pH	Thermocline Depth	
Silica		
Total Organic Carbon (UHL only)		
Total Dissolved Solids (UHL only)		
Dissolved Organic Carbon		

Table 16. Parameters collected through the IDNR ambient lake monitoring program.

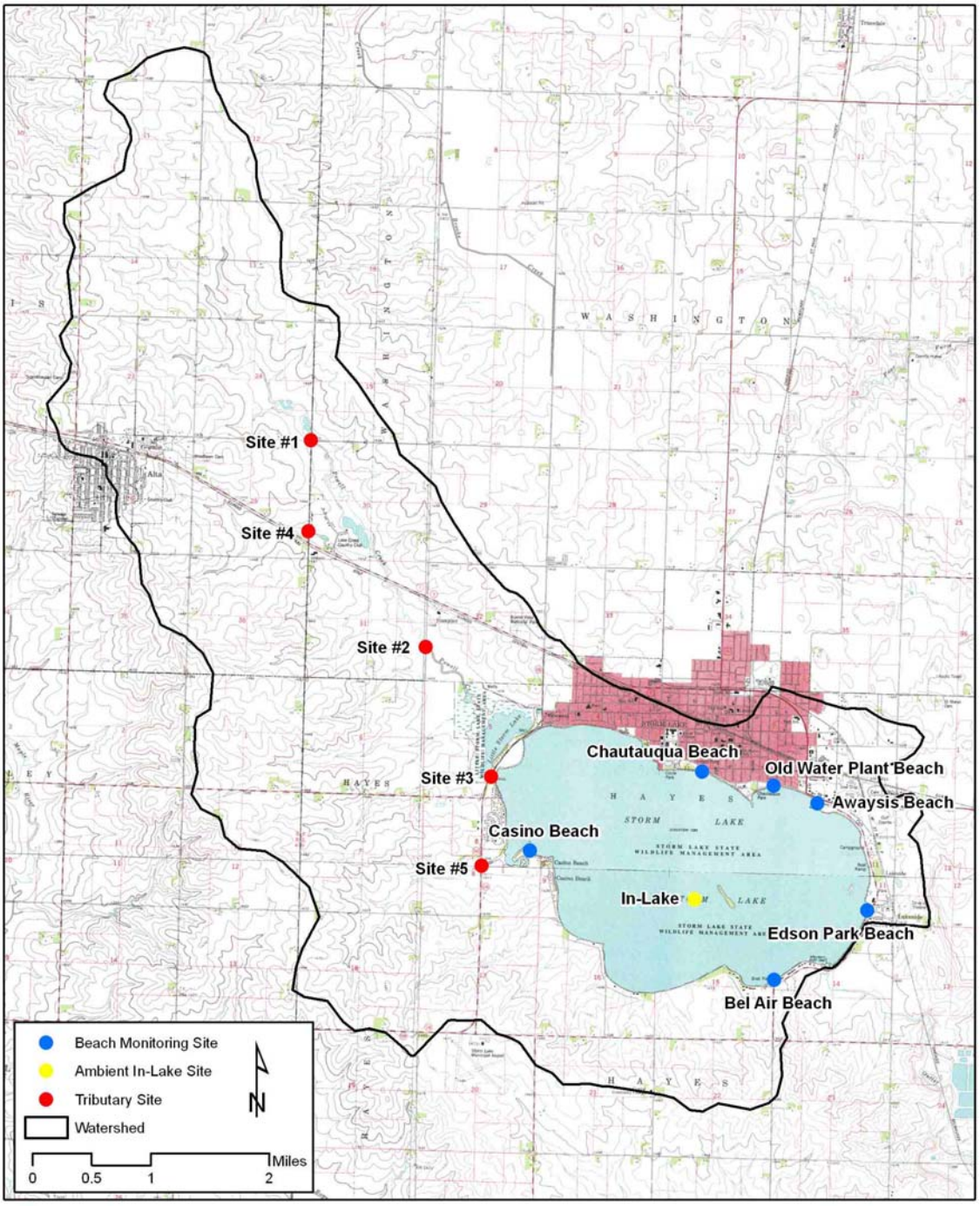


Figure 11. Monitoring sites.

Objective 2) Monitor Storm Lake tributaries to identify priority areas and to track water quality improvements.

Through consultation with IDNR Water Monitoring and Assessment Section staff five sites have been selected in the Storm Lake watershed to monitor pollutant contribution form tributaries in the watershed. These five sites will used to identify hot-spots for pollutant contributions as well as to track reductions in pollutant loading to Storm Lake resulting from best management practice implementation. The monitoring site locations are shown on Figure 11, a description of the site locations is listed in Table 16.

Site ID	Site Description	UTM X	UTM Y
Site #1	Powell Creek at 70th Avenue and 580th Street	314010.4	4727399.0
Site #2	Powell Creek at 80th Avenue	315572.5	4724589.0
Site #3	Outlet from Little Storm Lake to Storm Lake (at bridge)	316461.3	4722828.5
Site #4	Tributary to Powell Creek west of golf course at 70th Avenue	313979.7	4726157.6
Site #5	Episcopal Creek	316332.6	4721612.7

Table 16. Tributary monitoring site descriptions and locations

These five sites will be monitored twice per month April through October. Six samples per year will be collected during or immediately following storm events. All samples will be analyzed for the following parameters: Total phosphate, orthophosphate, total Kjeldahl nitrogen, nitrate + nitrite nitrogen, ammonia nitrogen, total suspended solids, E. coli, field chloride, field temperature, field dissolved oxygen, field pH and flow. Samples will be sent to the State Hygienic Laboratory for analysis. Costs were estimated using a 2011 fee schedule provided by the State Hygienic Laboratory. The table below is a one year estimate of analysis costs, this includes both the twice monthly and event samples.

Parameter	Cost per sample	# of sites	# of samples	Total cost
Total phosphate Orthophosphate	$26	5	20	$2,600
Total Suspended Solids	$13	5	20	$1,300
E. *coli*	$16	5	20	$1,600
Nitrate + Nitrite Ammonia Total Kjeldahl Nitrogen	$59	5	20	$5,900
			TOTAL	**$11,400**

Table 17. Estimate of lab analysis costs.

Objective 3) Monitor to assess conditions at beaches on Storm Lake.

Although Storm Lake is not impaired for bacteria monitoring bacteria and cyano-bacteria levels at the high use beaches is important from a public health standpoint. There are no state park beaches monitored on Storm Lake but the City of Storm Lake and the IDNR have partnered to monitor bacteria levels at Awaysis, Bel Air, Casino, Chautauqua, Edson Park and Old Water Plant beaches. Awaysis beach is monitored weekly during the beach monitoring season which runs from the week leading up to Memorial Day through Labor Day. The other beaches are typically monitored every other week during that same time frame. Weekly results are made available on the IDNR Beach Monitoring website and historical results can be found using STORET. All costs are covered by IDNR and the City of Storm Lake.

Objective 4) Monitor to provide information for education and outreach

Water quality improvements in Storm Lake and tributaries will be monitoring using approved lab techniques outlined in Objectives 1, 2 and 3, but it is also important to involve the public in water monitoring activities. IOWATER is a volunteer water quality monitoring program that empowers citizens to take a proactive approach to water quality. Past IOWATER efforts in the Storm Lake watershed have

resulted in 20 sites being registered by various volunteers. See Table 18 for a list of sites and Figure 11 for a map of sites.

An effort will be made to organize the various volunteers that have participated in IOWATER sampling in the Storm Lake watershed to ensure no duplication of sampling exists and that ample opportunities exist for new volunteers to join in the effort. See Public Outreach section for specific goals.

Site No.	Site Name	UTM X	UTM Y	Date Registered
911003	Storm Lake site #2	320732	4722588	07/11/2002
911004	Storm Lake site #1	320863	4722505	07/11/2002
911005	Storm Lake site #3	319356	4722505	07/11/2002
911006	Storm Lake site #4	318289	4723406	07/11/2002
911013	Pasture	315652	4724556	09/08/2005
911014	Briggs/Lake Creek	314350	4725949	09/08/2005
911015	Highway 110-Brecher Site	316323	4721609	09/08/2005
911016	Powell Creek Villa580	313995	4727410	09/09/2005
911017	Powell Creek - Lake Creek C.C. Entrance	314482	4726566	09/20/2005
911018	Powell Creek - Exiting Lake Creek C.C.	314811	4726163	09/20/2005
911019	Outlet Little Storm Lake	316492	4722817	11/14/2005
911020	Turnquist Riparian Buffer	312415	4728342	11/14/2005
911021	Hwy 7 Bridge KM	315070	4725538	11/14/2005
911022	60th Ave Stream	312408	4726541	02/20/2006
911023	Corner Pasture	313970	4726145	02/20/2006
911024	Highway 110/Casino	316377	4721613	04/12/2006
911025	D. Jackson	320156	4719201	04/24/2006
911030	Dredge Site	318005	4720091	08/15/2007
911040	Radio Park Inlet	320747	4722751	07/22/2009
911041	Radio Park Outlet	320756	4722630	07/22/2009

Table 18. IOWATER site descriptions within the Storm Lake watershed.

Chapter 11: Public Outreach Plan

Public outreach or information and education is a large part of any community wide project. It is important in the process since it is the land owners, tenants, and citizens who directly manage land and live in the watershed that determines the water quality for Storm Lake. During the development of this plan, efforts were made to ensure that local stakeholders were involved in the decision-making process regarding goals and required actions for improving water quality in the Storm Lake Watershed. The following plan will guide public outreach activities in the watershed. In the case of Storm Lake, it is crucial and extremely challenging due to the mix of agriculture and urban land as well as the cultural diversity and language barriers. A key element to the entire public outreach section will be to constantly ensure that there are translators available at events and that any printed or electronic material can be translated into a few languages that may include: Spanish, Laotian, and Somali.

TARGET AUDIENCES

The target audience for the Storm Lake Watershed Management Plan is one of the most diverse of any in the state due to the complexity of the potential non-point contaminant sources, the differing land uses from which these sources derive, and the wide variety of individuals that utilize these aquatic resources. Therefore, an effective information and education campaign must establish a connection with a wide cross-section of stakeholders in the effort to influence the targeted audience. Those entities listed below are the immediate target audiences for which the information and education campaign must be directed, but it is important that an adaptive management approach be taken to ensure that the intended audience is receiving the intended message throughout the course of this project. The targeted audience at this venture is as follows:

Target Audience #1: Land Owners

- Agricultural and Urban Land Owners and Private Citizens (Property owners-urban and agricultural; Fishermen, Hunters, Investors, Developers, Boaters, Swimmers, Marinas, Resort Managers, Bankers, Chamber of Commerce, Golf Courses/clubs, Visitors/tourists)

Target Audience #2: Partners

- NRCS
- BV County Supervisors
- Iowa DNR
- IDALS
- EPA
- IDED
- SWCD
- Storm Lake School District (Future Farmers of America)
- Alta School District (Future Farmers of America)
- Public Utilities
- Buena Vista County Conservation Board
- Iowa Natural Heritage Foundation
- Pheasants Forever
- Ducks Unlimited
- Lake Improvement Commission
- Lake Preservation Association
- Iowa Learning Farm and ISU Extension
- Cities of Storm Lake, Lake Creek and Alta
- 4H
- Farm Bureau

- Iowa Water Volunteers
- Master Gardeners
- Local Agricultural Suppliers

Target Audience #3: Potential Project Funders

- Iowa DNR
- IDALS
- EPA
- State and/or Federal Programs and/or Local Legislators

Target Audience #4: Media

- Storm Lake Times, Storm Lake Pilot Tribune
- Farm Bureau Spokesman
- Iowa Farmer Today
- KAYL Storm Lake

Target Audience Outreach Strategy & Tactics

This plan identified a number of barriers and potential strategies which if implemented would engage stakeholders in making water quality improvements. This plan will serve as the framework for connecting with the Storm Lake targeted audiences. The following section outlines potential solutions and/or motivators that could help overcome barriers to the target audiences.

Potential Barriers to Participation

- Loss of rental income from production land put into conservation
- Cost share to install (conservation) practices
- Perception of yield loss when adopting new conservation crop production techniques
- Absentee land owner contact and education problems
- Loss of crop production land
- Selling conservation practices to nonfarm background absentee landowners
- Loss of Urban property to install conservation practices
- Seasonal or absentee property owners availability
- Language barriers amongst the various urban stakeholders

Below is a list of potential solutions, incentives or benefits to encourage participation

- Provide and/or increase cost share rates for conservation practices in the watershed
- Leverage multi-program funds
- Participation recognition and award ceremony
- Education and demonstration opportunities

With knowledge of the potential barriers and motivators, public outreach tactics are being developed around the target audiences' preferred means of receiving information, which include: personal contact, press and publicity efforts, and other means such as a watershed specific newsletter.

General Elements

- Project identity – Develop an identity for the project that can be used consistently in all public outreach efforts so it all can be recognized as coming from the same place and tied back to the project.

- Online presence – Create and maintain a basic website to provide information about watershed activities and explore other online communication tools that allow for an ongoing dialogue with all target audiences

• Photography – Capture photos of project activities that can be used to educate target audiences to gain and maintain support by demonstrating project progress.

• Comprehensive communication schedule – Develop an annual outreach plan that takes key dates into account to ensure messaging is relevant and activities for the various audiences are complimentary.

Personal Contact

• Personal meetings and phone calls – Plan for private meetings or phone calls to educate individuals about the project and explain cost sharing options in detail. This will be especially beneficially to those in agricultural production.

• Field days – Arrange an annual field day to increase awareness of watershed activities and practices and show project progress. Demonstrations and tours could be conducted in cooperation with all project partners to demonstrate the level of participation from stakeholders, including rural landowners and/or residents, urban residents, DNR staff, City officials, County officials, etc.

• Other educational events – Any opportunities that allow the watershed coordinator to have a few moments to brief the community and stakeholders on the progress that is occurring in the watershed.

Press & Publicity Efforts

• News releases – Send press releases to media outlets (e.g. newspapers and radio stations) with newsworthy project information and updates, including photographs to visually demonstrate information whenever possible.

• Public recognition/awards – Develop and present "Watershed Warrior" of the year awards to publicly acknowledge project participants and supporters.

• Publicity events – Stage events and educational activities that have a news or "feel good" angle, such as a field day or events that involve other key audiences (e.g. youth involved in the local FFA chapter, 4-H group, or local high school environmental science class).

Other

• Partnerships – Develop strong relationships with local organizations that have forums and tools to help communicate watershed messages to the public.

• Committee & Public Meetings

-Hold quarterly watershed advisory committee meetings

-Hold an annual public meeting

Evaluation/Measurement

The ongoing measure of success and plan evaluation will be carried out by the local Lake Preservation Association (LPA). The LPA publishes newsletters and other alerts throughout each year. There is also an annual meeting held each summer where members and general public can attend. The plan progress and I & E will be evaluated by using both of these activities to measure public perception and knowledge of watershed activities through surveys and also from word of mouth. A survey will be included with the LPA newsletter mailing at the appropriate time during each phase of the plan to measure changes in behavior. Also during the LPA annual meeting there will be opportunities to survey general public

through a similar written survey. This evaluation process will be carried out two times during each five year phase of the watershed plan by the LPA. Depending on the success of surveying through the LPA activities the other option will be to work with the City of Storm Lake and Alta to include an urban survey with the monthly water bill at appropriate times.

Chapter 12: Resource Needs

The estimated cost, in 2012 dollars, to accomplish a 60% reduction of sediment and phosphorus delivery into Storm Lake its watershed is $2,864,725 plus yearly expenses for project coordinator salary, water monitoring and education and outreach. The following table outlines costs by component.

Component	Total Cost
Water and Sediment Control Basins	$66,000
Grassed Waterway	$27,300
Filter strips	$116,600
CREP Wetland	$370,000
No till/strip till	$787,800
High Res Mulch Till 50% Res or >	$177,675
Mulch till 30% to 50% Res	$152,850
Cover Crops	$81,500
Terraces	$5,000
Livestock Total Containment	$300,000
Rock Riffles	$15,000
Pervious Paving	$200,000
Rain Gardens	$40,000
Rain Barrels	$5,000
Storm Sewer Outlet Treatment	$400,000
Storm Water Detention Structures	$120,000
Total	**$2,864,725**

Table 19. Practice cost estimates.

Component	Cost
Education and Outreach	$4,000/yr
Water Monitoring	$11,400/yr
Project Coordinator Salary and Benefits	$75,000/yr
Total	**$90,400/yr**

Table 20. Project administration and monitoring costs.

Potential Funding Sources
POL = Public Owned Lakes
WPF = Water Protection Fund
WSPF = Watershed Protection Fund
EQIP = Environmental Quality Incentive Program
319 = EPA Section 319 Funds via the IDNR
LRP = Lake Restoration Program
CREP = Conservation Reserve Enhancement Program
CRP = Conservation Reserve Program
City = Communities in Black Hawk Lake watershed

Watershed Management Plan Summary

Since the watershed plan spans 20 years into the future there is no way to know how technology, farm equipment and grain markets will affect farming practices. Because of this we recommend that this plan be updated periodically preferably on a five year schedule. This schedule will call for timely adjustments to practices and timelines.

The Storm Lake Watershed has been drastically changed since it was once covered in prairie grasses. There have been significant changes to the landscape because of agricultural conversion. The current land uses and hydrology of the watershed makes it will be very difficult to significantly change existing farming practices used by producers based solely on stewardship. In order for long-term soil stewardship philosophies to be adopted they will also need to be complemented by changes in technology, genetics and economics of crop production that will reinforce good soil and water conservation practices. Some of these changes are occurring now and more are needed to totally protect our soil resources.

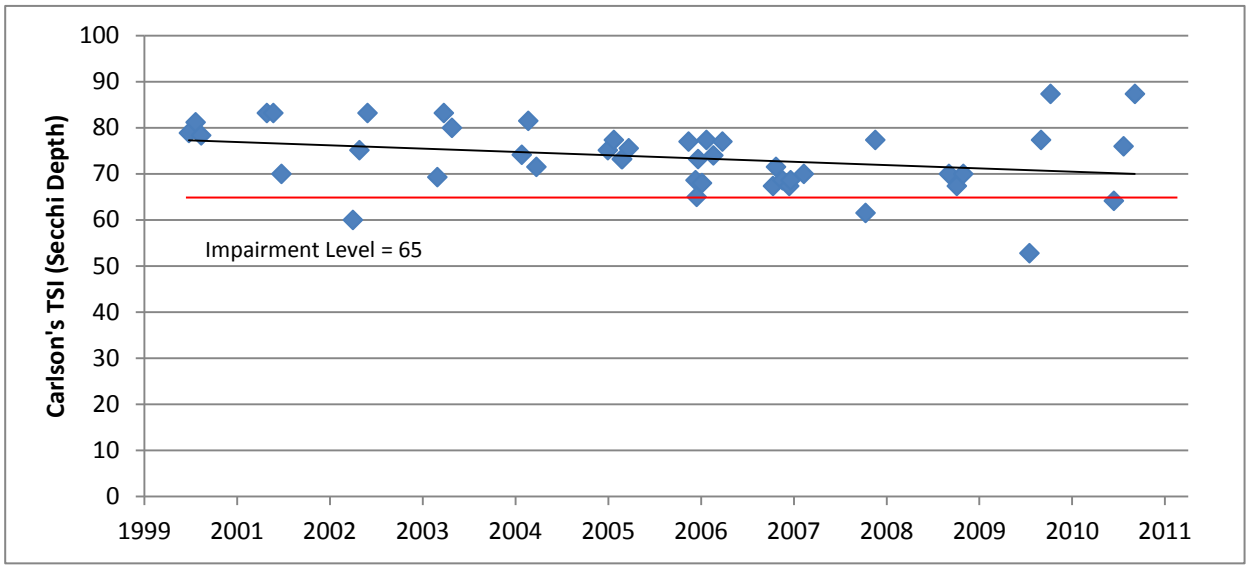
We feel this plan lays out an aggressive path toward extending the lifespan of Little Storm and Big Storm Lake. This plan needs to be laid out and marketed to watershed stakeholders in order for expanded conservation work to be adopted within the Storm Lake Watershed.

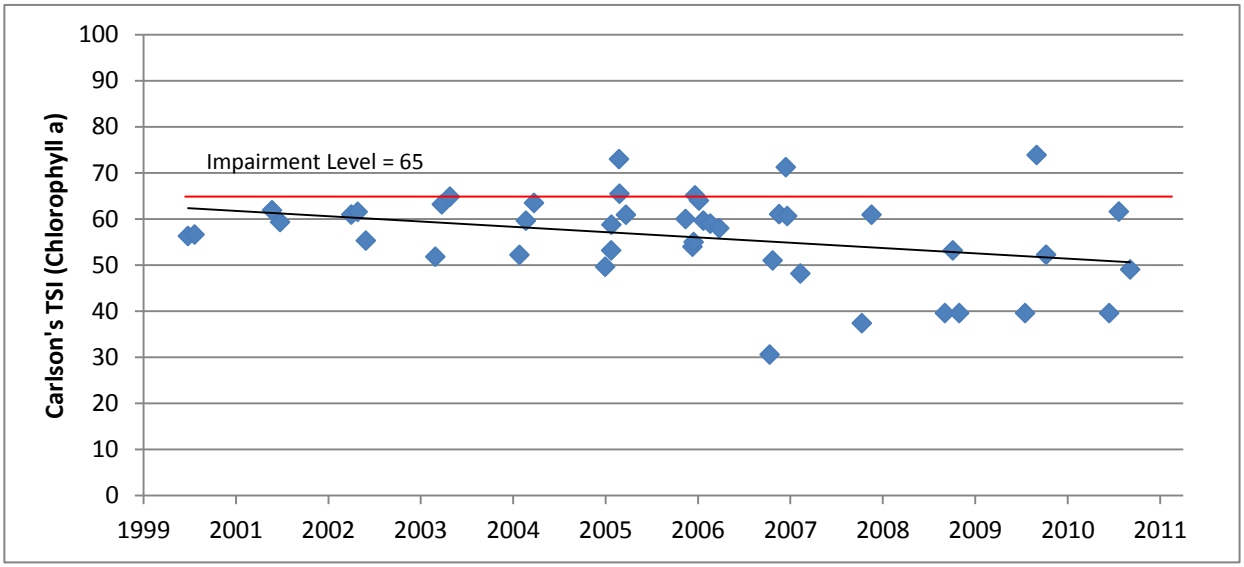
Appendix 1

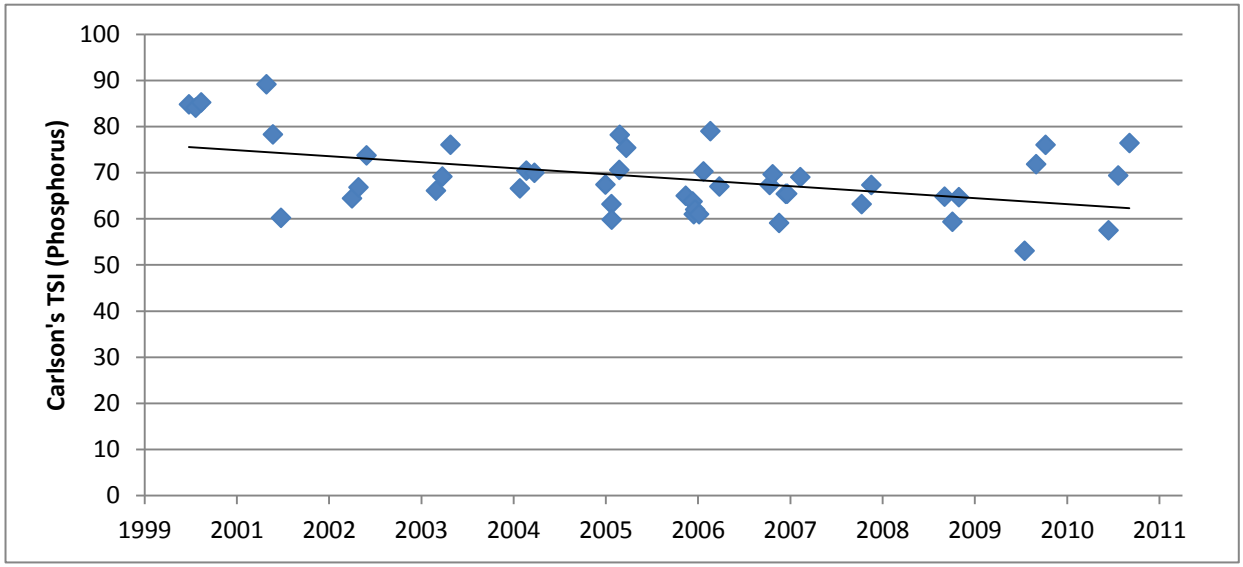
Storm Lake Ambient Monitoring Program TSI Scores

Shaded cells for TSI secchi and chlorophyll a indicate impairment threshold has been achieved.

STORET	LAKE NAME	DATE	TSI SECCHI	TSI CHL	TSI TP
22110001	Storm Lake	15-Jun-00	79	56	85
22110001	Storm Lake	14-Jul-00	81	57	84
22110001	Storm Lake	07-Aug-00	78		85
22110001	Storm Lake	17-May-01	83		89
22110001	Storm Lake	14-Jun-01	83	62	78
22110001	Storm Lake	19-Jul-01	70	59	60
22110001	Storm Lake	23-May-02	60	61	64
22110001	Storm Lake	20-Jun-02	75	62	67
22110001	Storm Lake	25-Jul-02	83	55	74
22110001	Storm Lake	22-May-03	69	52	66
22110001	Storm Lake	19-Jun-03	83	63	69
22110001	Storm Lake	24-Jul-03	80	65	76
22110001	Storm Lake	20-May-04	74	52	67
22110001	Storm Lake	17-Jun-04	81	60	70
22110001	Storm Lake	22-Jul-04	72	63	70
22110001	Storm Lake	26-May-05	75	50	67
22110001	Storm Lake	21-Jun-05	77	53	63
22110001	Storm Lake	22-Jun-05		59	60
22110001	Storm Lake	25-Jul-05	73	73	71
22110001	Storm Lake	27-Jul-05	73	65	78
22110001	Storm Lake	24-Aug-05	76	61	75
22110001	Storm Lake	09-May-06	77	60	65
22110001	Storm Lake	08-Jun-06	69	54	64
22110001	Storm Lake	13-Jun-06	65	55	61
22110001	Storm Lake	19-Jun-06	73	65	62
22110001	Storm Lake	06-Jul-06	68	64	61
22110001	Storm Lake	25-Jul-06	77	60	70
22110001	Storm Lake	24-Aug-06	74	59	79
22110001	Storm Lake	02-Oct-06	77	58	67
22110001	Storm Lake	08-May-07	67	31	67
22110001	Storm Lake	21-May-07	72	51	70
22110001	Storm Lake	18-Jun-07	69	61	59
22110001	Storm Lake	17-Jul-07	67	71	65
22110001	Storm Lake	23-Jul-07	69	61	65
22110001	Storm Lake	18-Sep-07	70	48	69
22110001	Storm Lake	10-Jun-08	62	37	63
22110001	Storm Lake	22-Jul-08	77	61	67
22110001	Storm Lake	04-Jun-09	70	40	65
22110001	Storm Lake	08-Jul-09	67	53	59
22110001	Storm Lake	05-Aug-09	70	40	65
22110001	Storm Lake	17-May-10	53	40	53
22110001	Storm Lake	06-Jul-10	77	74	72
22110001	Storm Lake	16-Aug-10	87	52	76
22110001	Storm Lake	16-May-11	64	40	58
22110001	Storm Lake	27-Jun-11	76	62	69
22110001	Storm Lake	15-Aug-11	87	49	76


Carlson's TSI (Secchi Depth)
Impairment Level = 65
100
90
80
70
60
50
40
30
20
10
0
1999
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


Carlson's TSI (Chlorophyll a)
Impairment Level = 65
100
90
80
70
60
50
40
30
20
10
0
1999
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


Carlson's TSI (Phosphorus)
100
90
80
70
60
50
40
30
20
10
0
1999
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Appendix 2

Storm Lake 2010 Water Quality Assessment: Assessment results from 2006 through 2008

Segment Summary

Waterbody ID Code: IA 04-RAC-00530-L_0
Location: Buena Vista County, S14,T90N,R37W, at Storm Lake.
Waterbody Type: Lake
Segment Size: 3147 Acres
This is a Significant Publically Owned Lake

Segment Classes:
Class A1
Class B(LW)
Class HH

Assessment Comments

Assessment is based on: (1) results of the statewide survey of Iowa lakes conducted from 2004 through 2007 by Iowa State University (ISU), (2) results of the statewide ambient lake monitoring program conducted from 2005 through 2008 by University Hygienic Laboratory (UHL), (3) information from the IDNR Fisheries Bureau, (4) results of U.S. EPA/IDNR fish contaminant (RAFT) monitoring in 2001, and (5) results of beach monitoring in 2008 and 2009.

Assessment Summary and Beneficial Use Support

Overall Use Support - Not supporting	Assessment Type: Monitored
Aquatic Life Support - Partial	Integrated Report Category: 5a
Fish Consumption - Fully	Trend: Stable
Primary Contact Recreation - Not supporting	Trophic Level: Hypereutrophic

Basis for Assessment and Comments

SUMMARY: The Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" due to (1) poor water transparency caused by inorganic suspended solids that violates Iowa's narrative water quality standard protecting against aesthetically objectionable conditions and (2) levels of indicator bacteria at a swimming beach that exceed state water quality criteria. The Class B(LW) (aquatic life) uses are assessed (evaluated) as "partially supported" due to excessive nutrient loading to the water column, nuisance blooms of algae, and re-suspension of sediment. Fish consumption uses are assessed (evaluated) as "fully supported" based on results of fish contaminant monitoring in 2001. Sources of data for this assessment include (1) results of the statewide survey of Iowa lakes conducted from 2004 through 2007 by Iowa State University (ISU), (2) results of the statewide ambient lake monitoring program conducted from 2005 through 2008 by University Hygienic Laboratory (UHL), (3) information from the IDNR Fisheries Bureau,(4) results of U.S. EPA/IDNR fish contaminant (RAFT) monitoring in 2001, and (5) results of IDNR city/county beach monitoring in 2008 and 2009.

Note: A TMDL for turbidity at Storm Lake was prepared by IDNR and approved by EPA in 2005; thus, this impairment is placed in IR Category 4a (impaired; TMDL approved) for the 2010 cycle. Because, however, the bacteria impairment is not addressed by the TMDL, this impairment will be placed in Category 5a of the 2010 Integrated Report (i.e., Section 303(d) list).

EXPLANATION: Results from the ISU and UHL lake surveys suggest that the Class A1 uses at Storm Lake are "not supported." Using the median values from these surveys from 2004 through 2008 (approximately 24 samples), Carlson's (1977) trophic state indices for Secchi depth, chlorophyll a, and total phosphorus were 73, 60, and 67 respectively for Storm Lake. According to Carlson (1977) the Secchi depth value places Storm Lake in the hypereutrophic category, the chlorophyll a value places Storm Lake in the eutrophic category, and the total phosphorus value places Storm Lake in between the eutrophic and hypereutrophic categories. These values suggest moderately high levels of chlorophyll a and suspended algae in the water, very poor water transparency, and high levels of phosphorus in the water column.

The level of inorganic suspended solids is very high at Storm Lake and suggests that non-algal turbidity contributes to the impairment. The median inorganic suspended solids concentration at Storm Lake was 14.5 mg/L, which was the 11th highest of the 132 monitored lakes.

Data from the 2004-2008 ISU and UHL surveys suggest a moderate population of cyanobacteria exists at Storm Lake, which does not contribute to the impairment at this lake. These data show that cyanobacteria comprised 72% of the phytoplankton wet mass at this lake. The median cyanobacteria wet mass (10.6 mg/L) was also the 48th lowest of the 132 lakes sampled.

Results of IDNR county beach monitoring in 2008 and 2009 suggest that the Class A1 uses should be assessed (monitored) as "not supported." Levels of indicator bacteria at Awaysis Beach were monitored approximately once per week during the primary contact recreation seasons (May through August) of 2008 (10 samples) and 2009 (13 samples) as part of the IDNR county beach monitoring program. According to IDNR's assessment methodology, two conditions need to be met for results of beach monitoring to indicate "full support" of the Class A1 (primary contact recreation) uses: (1) all thirty-day geometric means for the assessment period are less than the state's geometric mean criterion of 126 E. coli orgs/100 ml and (2) not more than 10 % of the samples during any one recreation season exceeds the state's single-sample maximum value of 235 E. coli orgs/100 ml. If a 5-sample, 30-day geometric mean exceeds the state criterion of 126 orgs/100 ml during the three-year assessment period, the Class A1 uses should be assessed as "not supported." Also, if significantly more than 10% of the samples in any one of the recreation seasons assessed exceed Iowa's single-sample maximum value of 235 E. coli orgs/100 ml, the Class A1 uses should be assessed as "partially supported." This assessment approach is based on U.S. EPA guidelines (see pgs 3-33 to 3-35 of U.S. EPA 1997b).

At Awaysis Beach, the geometric means of 5 thirty-day periods during summer 2008 and 7 thirty-day period during summer 2009 exceeded the Iowa water quality standard of 126 E. coli orgs/100 ml. The percentage of samples exceeding Iowa's single-sample maximum criterion (235 E. coli orgs/100 ml) was less 30% during summer 2008 and was 54% during summer 2009. According to IDNR's assessment methodology and U.S. EPA guidelines, violation of both the geometric mean and single-sample maximum criteria suggest impairment of the Class A1 (primary contact recreation) uses at this beach.

The Class B(LW) (aquatic life) uses are assessed (evaluated) as "partially supported" due to excessive nutrient loading to the water column, nuisance blooms of algae, and re-suspension of sediment although information from the IDNR Fisheries Bureau suggests that water quality is generally improving at this lake. The ISU and UHL lake surveys results, however, show relatively good chemical water quality at Storm Lake. During 2004-2008 there were no violations of the Class B(LW) criterion for ammonia in 23

samples, no violations for dissolved oxygen in 24 samples, and one violation for pH in 24 samples (4%). Based on IDNR's assessment methodology the one violation for pH is less than 10% of the samples and therefore does not suggest an impairment of the Class B(LW) uses at Storm Lake.

Fish consumption uses were assessed (evaluated) as "fully supported" based on results of U.S. EPA/IDNR fish contaminant (RAFT) monitoring at Storm Lake in 2001. Because these data are now considered too old (greater than five years) to accurately characterize current water quality conditions, the assessment category is considered "evaluated" (indicating an assessment with relatively lower confidence) as opposed to "monitored" (indicating an assessment with relatively higher confidence). The existence of, or potential for, a fish consumption advisory is the basis for Section 305(b) assessments of the degree to which Iowa's lakes and rivers support their fish consumption uses. The fish contaminant data generated from the 2001 RAFT sampling conducted at Storm Lake showed that the levels of contaminants do not exceed any of the advisory trigger levels, thus suggesting no justification for issuance of a consumption advisory for this waterbody.

Monitoring and Methods

Assessment Key Dates

8/23/2001 Fish Tissue Monitoring
5/20/2004 Fixed Monitoring Start Date
9/2/2009 Fixed Monitoring End Date

Methods

- Surveys of fish and game biologists/other professionals
- Non-fixed-station monitoring (conventional during key seasons and flows)
- Primary producer surveys (phytoplankton/periphyton/macrophyton)
- Fish tissue analysis
- PATHOGEN MONITORING

Causes and Sources of Impairment

Causes	Use Support	Cause Magnitude	Sources	Source Magnitude
Turbidity	Primary Contact Recreation	High	Sediment resuspension Natural Sources	High Slight
Turbidity	Aquatic Life Support	Moderate	Sediment resuspension Natural Sources	High Slight
Pathogens	Primary Contact Recreation	Moderate	Source Unknown	Moderate
Nutrients	Aquatic Life Support	Moderate	Agriculture Internal nutrient cycling (primarily lakes) Natural Sources	Moderate Moderate Slight

Suspended solids	Aquatic Life Support	Moderate	Sediment resuspension	Moderate
Algal Grwth/Chlorophyll a	Aquatic Life Support	Slight	Internal nutrient cycling (primarily lakes)	Moderate
Algal Grwth/Chlorophyll a	Primary Contact Recreation	Not Impairing	Internal nutrient cycling (primarily lakes)	Moderate