Lost Island Lake

Watershed Management Plan

To encourage and promote the high environmental quality of Lost Island lake and its watershed and continue the areas rich conservation history.

Prepared By: Palo Alto County Soil and Water Conservation District and Iowa Department of Natural Resources

Financial support provided by EPA-Section 319 Program, Iowa DNR, Lost Island Protective Association, Iowa Trust and Savings Bank, and Natural Resource Conservation Service.

Plan Timeframe: 2022-2051

Plan Revisions: 2027, 2032, 2037, 2042, 2047

Contents

Introduction

Lost Island Lake has been a fixture of northwest Iowa since the early 1900's. While lesser known that the Okoboji Chain of lakes to the northwest, the lake and its surrounding area has attracted families, sportsman, and vacationers alike for generations.

While Lost Island Lake and its watershed have seen many conservation efforts over the years. In 1988 lake residents came together and constructed a sewer system to service all residences near the lake. This project eliminated all septic systems.

The latest push started in 2008 with the completion of a Total Maximum Daily Load (TMDL) report. This report was to serve as a guide for public and private partners to come together to combat the poor water clarity in the lake. The TMDL also satisfied the Clean Water Act requirement for waterbodies on the impaired waterways list.

This report led to a large-scale restoration project in 2010 and 2011. The aim of this effort was to restore and enhance both Barringer Slough and the Blue Wing Marsh complex. This project brough together the IDNR, Palo Alto County Conservation Board, Lost Island Protective Association, Ducks Unlimited, and other local stakeholders. Through their efforts and $1.3 million, they restored more than 1000 acres of wetland habitat. Fish barriers were also installed during this project to confine the excessive carp population to the main basin and deny access to spring spawning areas.

Watershed Planning Process

Watershed projects like this cannot succeed without the buy in on the local community. People living within the watershed have a direct link to the water quality in Lost Island Lake.

Community support for water quality has been strong in the Lost Island Watershed. In 2007, prior to the publishing of the TMDL, a meeting was held at the Palo Alto Nature Center. The meeting was attended by 37 stakeholders and included an initial discussion about the TMDL as well as a presentation about rough fish management strategies (Table 1).

Table 1. Lost Island Lake Watershed Group Members

Name	Affiliation/Title	Committee
Jeremy Thilges	NRCS	TAT
Craig Merrill	Palo Alto BOS	WAC
Jerry Joyce	SWCD	WAC
Kim Kibbie	City of Emmetsburg	WAC
Kathy Mehan	Resident	WAC
Joel Horsley	Palo Alto SWCD	TAT
Lucas Straw	DNR - Wildlife	TAT
Michael Gunderson	Palo Alto SWCD	WAC
Mike Hawkins	DNR - Fisheries	TAT
Mary Barrick	Palo Alto CCB	TAT
Kyle Ament	DNR – Water Quality	TAT
George Antonio	DNR – Lake Restoration	TAT
Michelle Balmer	DNR – Lake Restoration	TAT
Linus Solberg	Palo Alto BOS	WAC

Dean Gronemeyer	**NRCS**	**TAT**
Warren Jennings	**Watershed Coordinator**	**TAT**
	Lost Island Protective Association	**TAT/WAC**

Public Willingness to Participate

Public input and participation are crucial to the success of a watershed project. Watershed residents were surveyed in 2020 to better understand their positions on water quality and gauge interest in participating in water quality improvement projects. Two surveys were distributed, one for urban residents one for rural residents. Of rural residents 13 responded. There were 23 responses from urban residents(Table 2).

Rural residents were first asked to describe themselves.

Landowner not farming land - 8

Landowner farming - 2

Tennant farming rented land – 3

Survey participants were then asked to indicate their level of agreement or disagreement with the following statements.

Table 2. 2020 Survey of Residents

	Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
Water quality in Lost Island needs Improvement		1	3	7	2
Ag fertilizers have impacted water quality in Lost Island		1	2	9	1
Eroded soil and sediments have impacted water quality in Lost Island Lake		2	3	6	2
Improperly functioning septic systems have impacted water quality in Lost Island Lake	3	7	2	1	
Urban issues have impacted water quality in Lost Island Lake	1	3	6	2	1
Poor water quality effects economic development in the area		2	5	4	2
I know what steps to take to better conserve soil and water on my land			1	8	4

I would be willing to work with others to develop strategies that protect our watershed		2	4	6	1

Survey participants were also asked which sources of information that use or would use to make decisions about their farming operation or land management strategy. Participants could select as many options as applied to them, their answers are as follows.

Face -to-face contacts - 12

Information meetings -10

Field days - 6

Demonstration projects - 8

Newsletters - 4

Newspapers - 3

Internet - 5

Farm Magazines - 1

Other: - 1 ISU extension

Survey participants were then asked their opinions on current use and interest in future use of conservation practices if they were offered at 75% cot share rate. The practices in question were selected based on their effectiveness improving water quality and applicability to the watershed's land scape (Table 3).

Table 3. BMP Interest in Lost Island Lake Watershed

	Would not work on my land	**Not at all Interested**	**Somewhat interested**	**Very interested**	**Already adopted**
No-till / Strip Till	2	3	5	2	1
Mulch-Till	2	1	5	3	2
Buffers / Filter Strips / Prairie Strips	5	3	3	1	1
Livestock Exclusion from Streams	10	2			1
Streambank Stabilization	11	1	1		
Cover Crops	3	5	3	1	1

Grass Waterways	2	1		2	8
Wetlands	4	5	1		3
Pasture Management	11	1	1		
Variable Rate Fertilizer Application	1		3	8	1
Livestock Waste Systems	12		1		
CRP	1	1	2		9

Urban respondents were first asked to describe where their property was located.

One the water, lake front - 14

In the watershed but not directly on the lake - 1

Unsure – 1

They were then asked about the condition of the lake and describe the water quality they observed over the past 10-15 years.

Worse – 1

Unchanged – 6

Improved – 7

Unsure - 2

Next, they were asked if they felt the need for continued water quality improvements for Five Island Lake.

Yes – 14

No – 1

Unsure – 1

Finally, people were asked which conservation practices they would be interested in adopting or learning more about. Participants were allowed to select as many options as they wished.

Phosphate free fertilizer voucher - 16

Information and cost share on rain gardens - 4

Free or reduced cost rain barrels - 14

Information and cost share on previous pavers - 4

Information and cost share on native turf grass - 6

Information and cost share on native shoreline – 9

Informational meeting and Q&A with an urban conservationist – 2

I'm not sure what any of these practices are - 1

About Lost Island Lake Watershed

Lost Island Lake is a one of Iowa's natural lakes and is located predominantly western Palo Alto County, with a smaller section extending into eastern Clay County. There are no incorporated towns within the watershed. The closest town is Ruthven, Iowa which lies three miles to the south. Most of the lake is ringed with homes of both seasonal and permanent residents, as well as three resorts. The east side of the lake is home to Huston County Park and Prairie. The park boasts a 24-spot campground, double boat ramp, nature center, and recreation trails. Usage data collected by Iowa State University has shown that the lake averages about 86,000 visits a year. The Iowa DNR has classified Lost Island lake a Significant Publicly Owned Lake. Its designated uses are Class A1 Primary Contact Recreation, Class B Aquatic Life, and HH (Human Health).

Lost Island's watershed (Figure 1) encompasses 5,122 acers not including the lake itself which has a surface area of 1151 acres. This yields a watershed to lake ratio of 4.5 to 1. Lake restoration efforts are usually successful when the watershed to lake ratio is under 20 to 1. Lost Island's low ratio means there is a high likelihood of improved water quality if a tailored plan of best management practices (BMPs) and restoration efforts.

Figure 1. Lost Island Lake Watershed.

2019 Iowa Lake Survey

The 2019 Iowa Lakes Survey, conducted between December 2019 and March 2020, aimed to document lake usage information of 139 Iowa lakes and the value lake users place on water quality. This study also revealed policy-relevant trends in users' attitudes towards water quality as well as demographics of lake visitors. Below are some highlights:

- Sixty-five percent of Iowa respondents reported at least one single-day trip, while about 20% reported taking at least one overnight trips to Iowa Lakes.
- Iowa respondents took around 8 trips and traveled 48 miles to visit lakes in 2019.
- An estimated total statewide expense from all single-day trip taker was $1.023 billion, or an average of $7.4 million per lake.
- Iowans feel water quality is the most important factor when choosing a lake for recreation
- Eighty-three percent of Iowa respondents checked the DNR website when looking for water quality information and another 32% of Iowa respondents used DNR social media platforms.
- Fifty-eight percent of Iowa respondents have heard of harmful algal blooms and 32% reported observing a large algal bloom while fishing or visiting a lake.
- In 2019 an estimated singe day trips to Lost Island Lake were 53,859, resulting in $1.7 Million in direct spending.

<u>Lost Island Lake Physical Properties</u>

The following table shows the relevant lake and watershed characteristics as of the 2008 TMDL date.

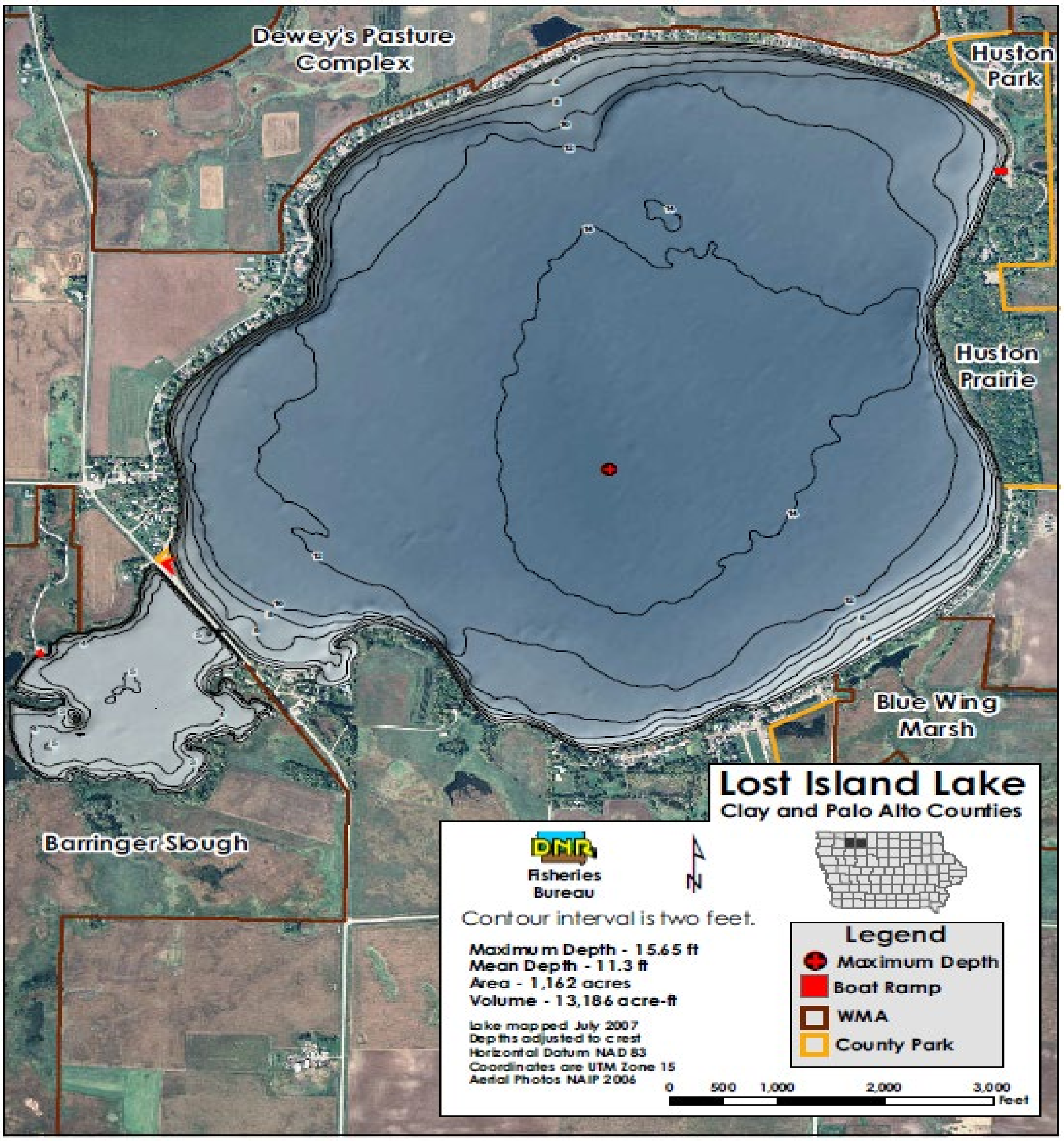
Table 4: Watershed Characteristics

Iowa DNR Waterbody ID	IA 06-LSR-02390-L_0
12 Digit Hydrologic Unit Code (HUC)	102300030704 Lost Island Lake
Location	Palo Alto County S31 T97N R34W
Latitude	43.1720
Longitude	94.9059
Designated Uses	Class A1 – Primary Contact Recreation Class B(LW) – Aquatic Life HH – Human Health (fish consumption)
Tributaries	Blue Wing Marsh
Receiving Waterbody	Little Sioux River via Barringer Slough
Lake Surface Area	1151 acres
Maximum Depth	15.7 feet
Mean Depth	10.3 feet
Volume	11,870 acre-feet
Length of Shoreline	14.5 miles
Watershed Area	5122 acres (excludes lake)
Watershed/Lake Ratio	4.5 to 1
Lake Detention Time	3 years

Hydrology

Lost Island Lake (Figure 2) is located within the Little Sioux River HUC-8 and Lost Island Outlet HUC-10. Lost Island does have a man-made outlet structure located at its outflow in the Barringer Slough complex. An outlet structure has been present on the lake since the late 1800’s. The structure was updated in 2010 to incorporate a rough fish barrier and modern control structure. The only major surface inflow to the lake comes from the Blue Wing Marsh complex which lies to the east of the lake. Lost Island outlets into Barringer Slough via a concrete damn and outlet structure. Discharged water then flows nine miles to the south west where is meets the Little Sioux River which eventually joins the Missouri River. The average annual precipitation is 29.0 inches/year and the lake retention time is 3.0 years based on outflow (2008 TMDL).

Figure 2: Lost Island Lake Topo Map



Soils, Climate, Topography

Lost Island Lake is within the Des Moines Lobe. This area is dominated by glacial till soils that are typically somewhat poorly drained to very poorly drained. Lost Island is also located in the Prairie Pothole region, an area known for being speckled with small wetlands or marshy areas and occasionally larger lakes like Lost Island itself.

Since Lost Island's watershed lies almost exclusively to the east, the watershed is dominated by a single soil association. The Storden-Nicollet-Clarion association makes up 76.2% of the total watershed area. Slopes range from nearly level to moderately steep (Table 5). Drainage is somewhat well drained to poorly drained. Most of the lake's wetlands, like Blue Wing March, are located within this association.

Other soil associations in the watershed include Wadena-Coland-Clarion. This association makes up the southern edge of the lake shore and makes up only 3.1% of the watershed. Soils of this type range from well drained to poorly drained and are comprised of fine loam and glacial outwash.

The soil association along the west shoreline about a quarter mile wide is WadenaTalcot-Cylinder-Biscay. This soil is well drained to poorly drained, medium textured and moderately fine textured, nearly level to strongly sloping soils on benches. This soil association makes up 1.9 percent of the basin area.

The soil association along the northwest shoreline about a quarter mile wide is Webster Nicollet-Clarion-Canisteo (S1750). This soil is poorly drained to somewhat poorly drained with a moderate to very high available water capacity. Texture of the surface layer ranges from moderately coarse to fine. This soil association makes up 1.1 percent of the basin area.

Table 5: Topography

Slope (%)		**Watershed Area (%)**
0-2	Level to nearly level	53.9
2-5	Gently sloping	42
5-9	Modernly sloping	3.2
>9	Strongly sloping to very steep	.9

Land Use

A land use assessment was conducted for by SWCD and IDNR staff in the spring of 2020 (Figure 3). This windshield survey collected landcover data and tillage type at a field level. As expected, most of the watershed is used for row crop production of corn and soybeans. Because of the soil types present and most slopes being below 5% much of the row crop acres in the watershed are drained by tile (Table 6). Lost Island's watershed contains no drainage district associations, though it is bordered by some. Large portions of the watershed are publicly owned. Most of these areas have been restored with native prairie grasses or wetland species.

Waterbody to be addressed:

In 2008 the Iowa DNR completed a TMDL to address the excessive algae growth and non-algal suspended solids causing an impairment for turbidity. The nuisance algae growth is caused by excessive phosphorus that comes from the resuspension of bottom sediment, mostly by carp, and from nonpoint sources in the watershed. Phosphorus is usually the limiting nutrient for excessive algal growth. Most of the phosphorus in this water body comes from the resuspension of lake bottom sediment by carp and other bottom feeding fish. Other sources are watershed agricultural activities and runoff from other land cover types.

In 2020 Lost Island Lake was officially removed from the impaired waters list, but could easily flip back to impaired status if the watershed is not further protected from phosphorus runoff. This plan will focus on protecting the watershed. Due to the small size of the watershed, all tillable acres and tile lines will be consider high priority areas for treatment.

Figure 3: 2020 Land Use

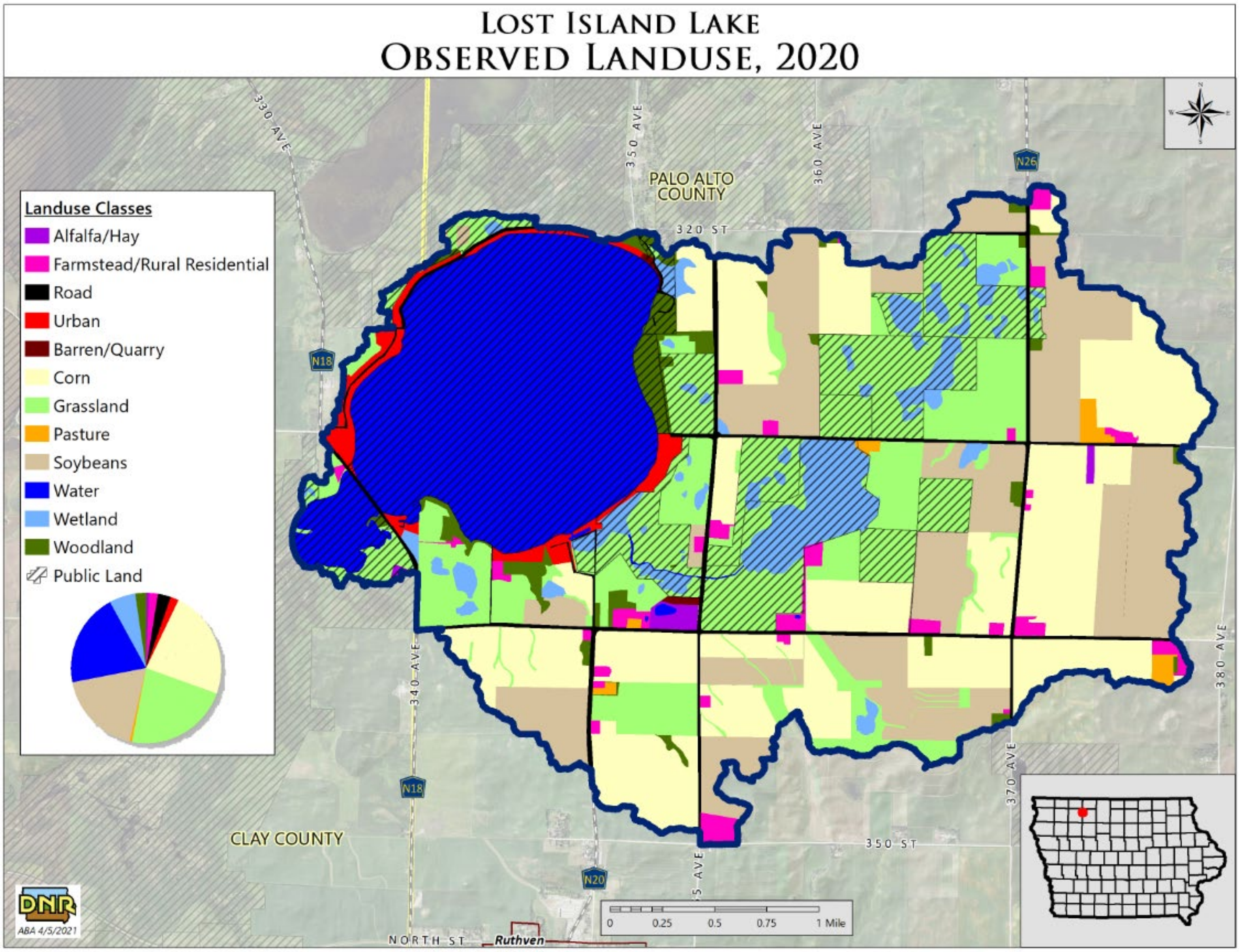


Table 6: 2020 Land Use

2020 Land Use	Description	Area (ac)	% Watershed
Corn/Beans	--	2485	52%
Grass, Hay, Pasture	Grassland, pasture, alfalfa, parks	1405	29%
Woodland	Timber, timber savannah	159	3%
Wetland	Wetlands, ponds (excludes lake)	328	7 %
Urban	Residences, Roads, Parking lots	319	7%
Other	Farm lots, Farmstead	76	2%

Population and Land Ownership

Lost Island's watershed does not contain any incorporated towns. However, the lake is encircled with home of bother permanent and seasonal residents. Ruthven, Iowa just south of the lake is a small town of 751 according to the 2019 census. Excluding the lake, roughly 21% (1080 acres) of the watershed consists of publicly owned land.

Figure 4. Sheet and Rill Erosion

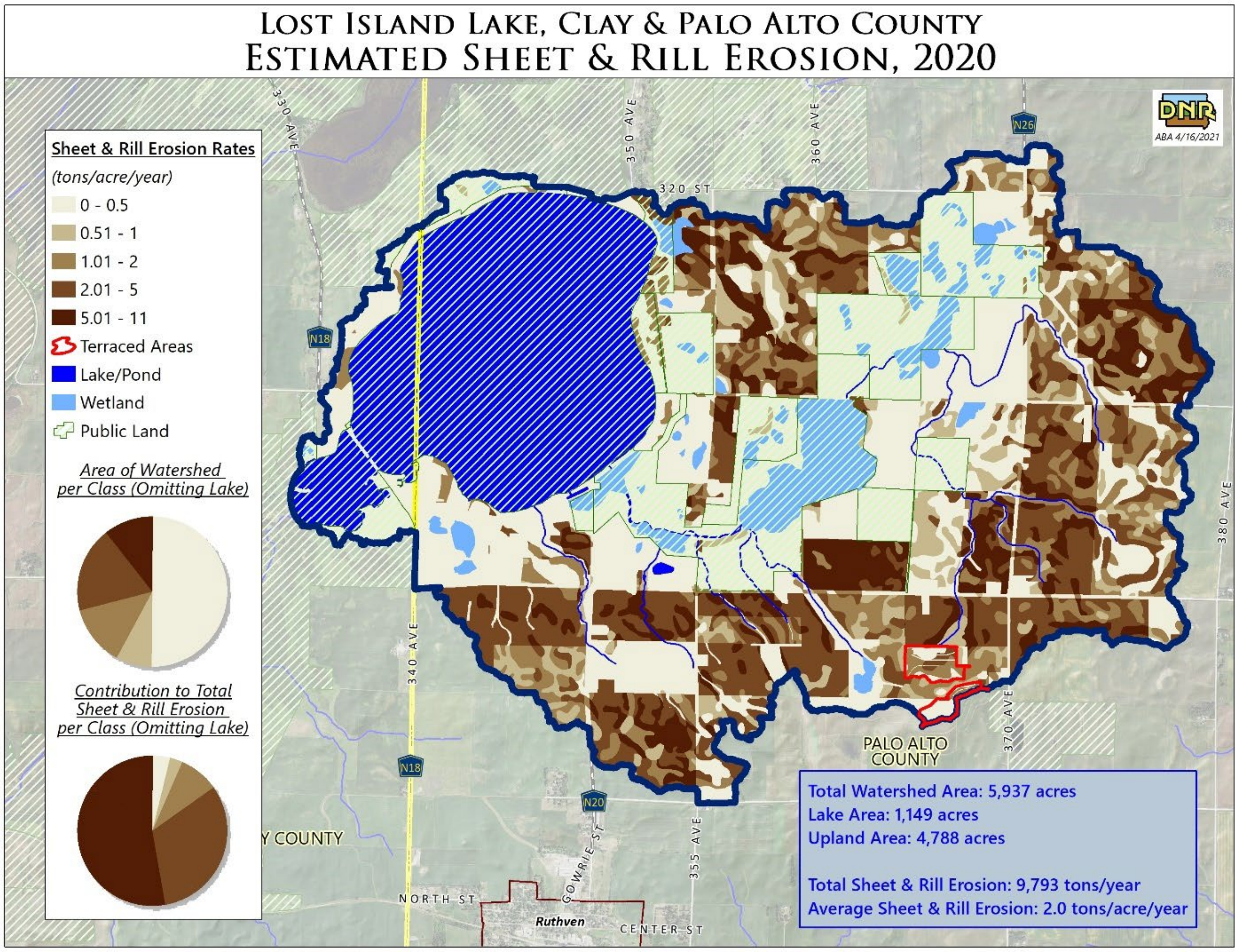


Figure 5. Sediment Delivery The majority of sediment and phosphorus delivery from the watershed is limited to three areas. Areas with sediment delivery rates above .10 tons/acre/year will be prioritized during implementation.

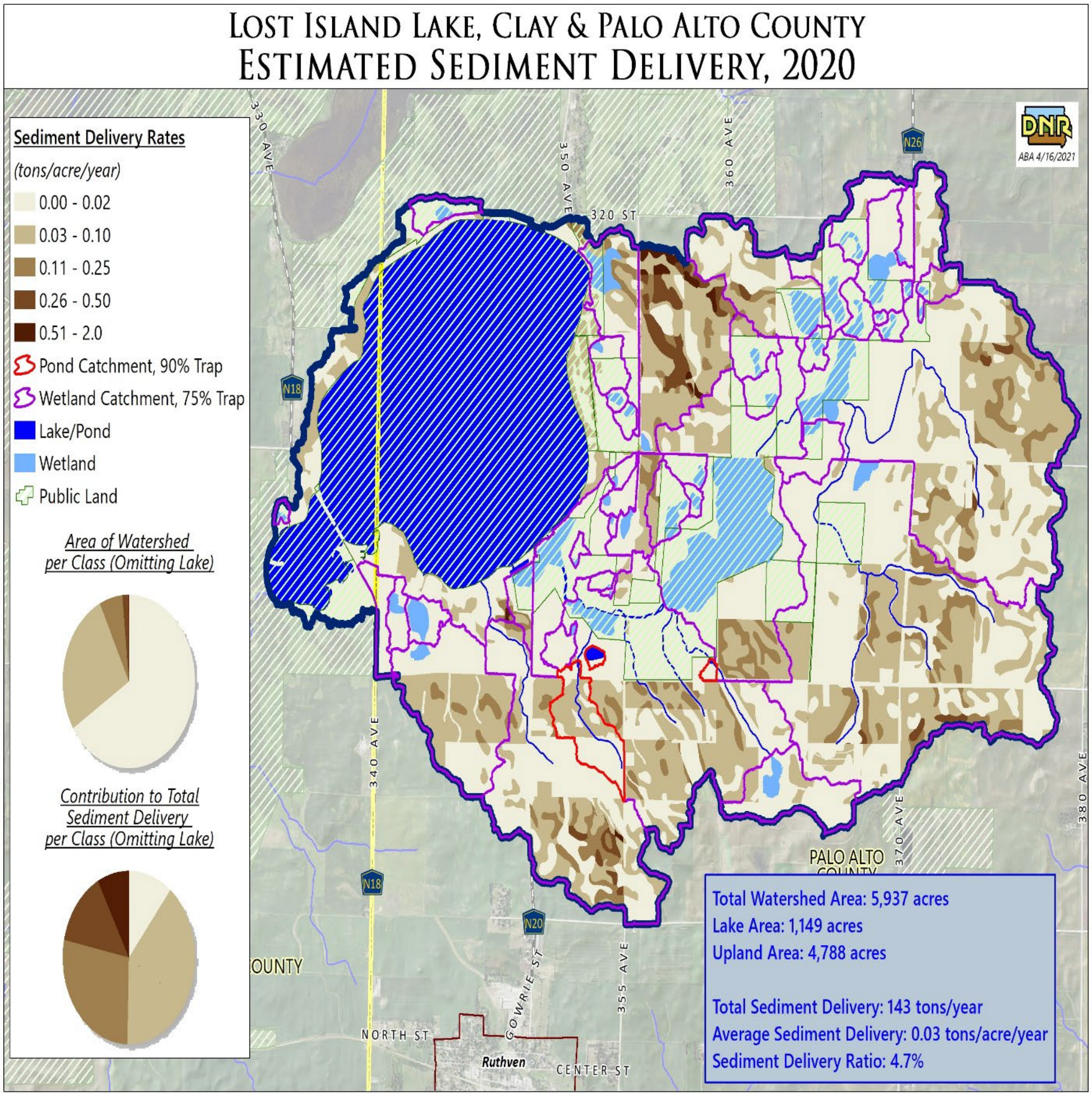
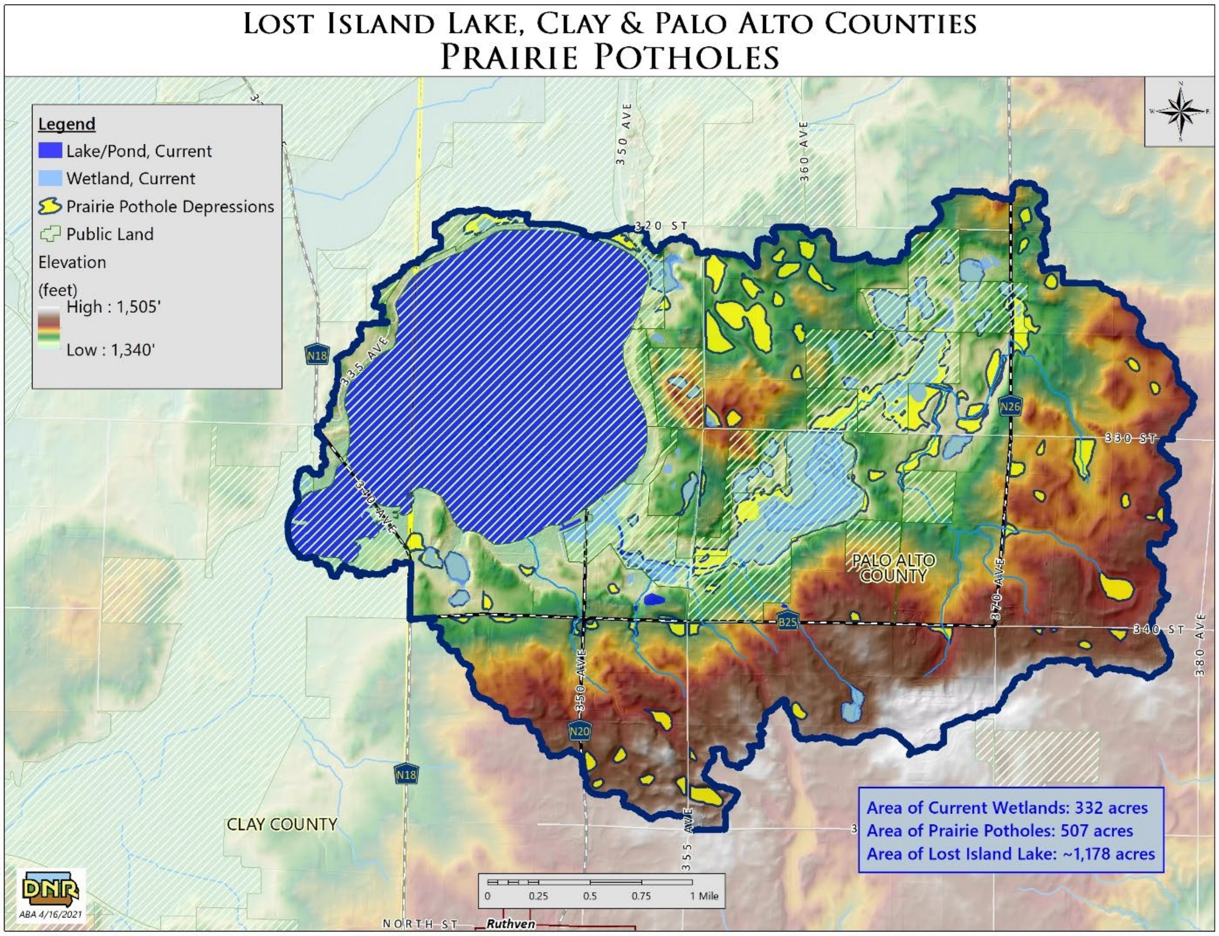


Figure 6:Upland areas are the primary focus of watershed work since they account for the majority of tillable acres and loading.



Partnerships

Several partners are involved with the watershed planning process. These partners have been and will continue to serve a critical role in the watershed improvement process.

Palo Alto Soil & Water Conservation District

Palo Alto Shallow Lakes Advisory Board

Iowa Department of Natural Recourses

Watershed Improvement

Water Monitoring

Fisheries

Wildlife

Landowners

Iowa Department of Agriculture & Land Stewardship (IDALS)

Palo Alto Conservation Board

Lost Island Lake Protection

United States Department of Agriculture – Natural Resource Conservation Service (NRCS)

Environmental Protection Agency (EPA)

Water Quality Findings

Lost Island Lake has had in lake monitoring data going back to the 1990's. Additionally, other wetland and marsh sites have also been monitored. Most of these samples were taken just the TMDL date and were part of the restoration efforts on Blue Wing March and Barringer Slough. Detailed monitoring results for both the lake and the watershed can be found at www.aquia.com.

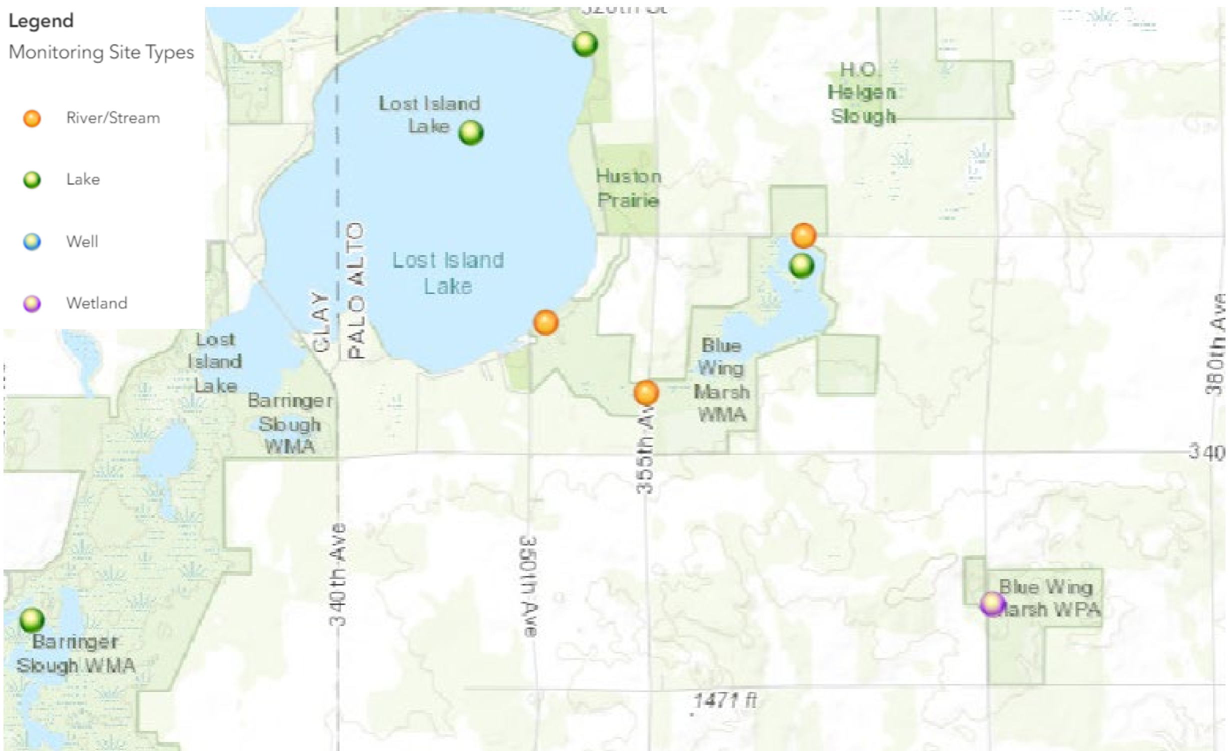


Figure 7: Existing Water Quality Sampling Points.

Watershed Monitoring

While there has been some monitoring in the watershed it has mostly focused on the major wetland areas. The bulk of this monitoring happened during the warm months of 2010 as part of the wetlands restoration project that was taking place.

In-Lake Monitoring

Lost Island Lake has ambient lake monitoring date dating back to 2000. The results of this monitoring program led to Lost Island being added to the Iowa 303(d) Impaired Waterways list in 2002. Lost Island was added because the Class A1 designated uses of Lost Island were not being met due to turbidity. Turbidity in Lost Island comes from multiple sources. The first being excessive Algal growth due to high levels of nutrient loading in the lake. The second source comes from the resuspension of sediments from the lake bottom.   Lake water quality parameters improved following the 2012 lake renovation project leading to improved Secchi Disk Depth and Phosphorus loading (Figure 8 & 9).

Figure 8: Lost Island Secchi Disk Depth

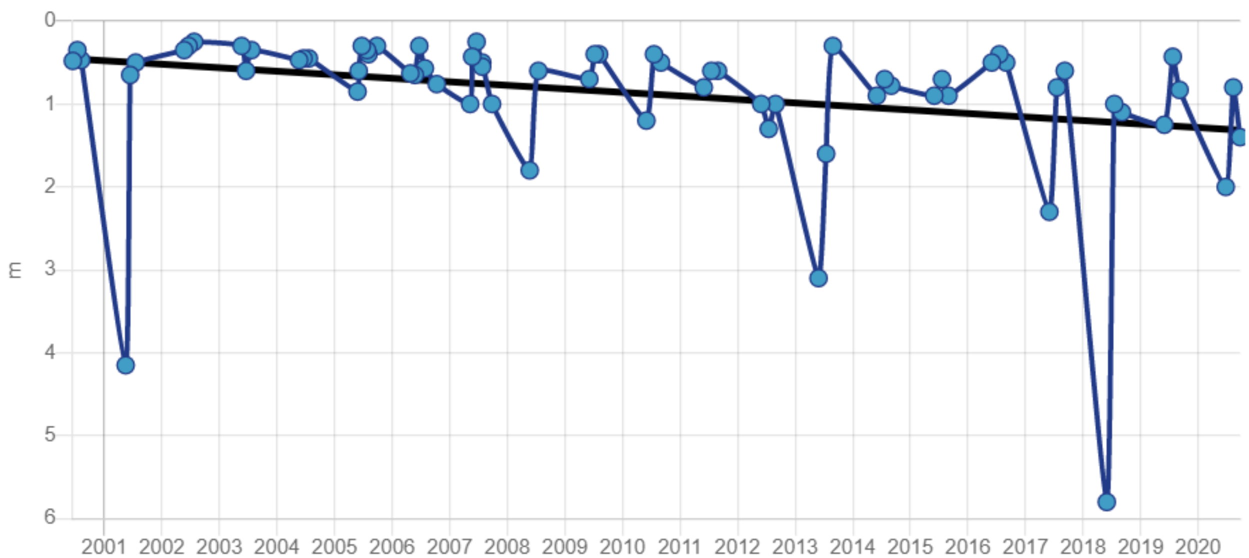
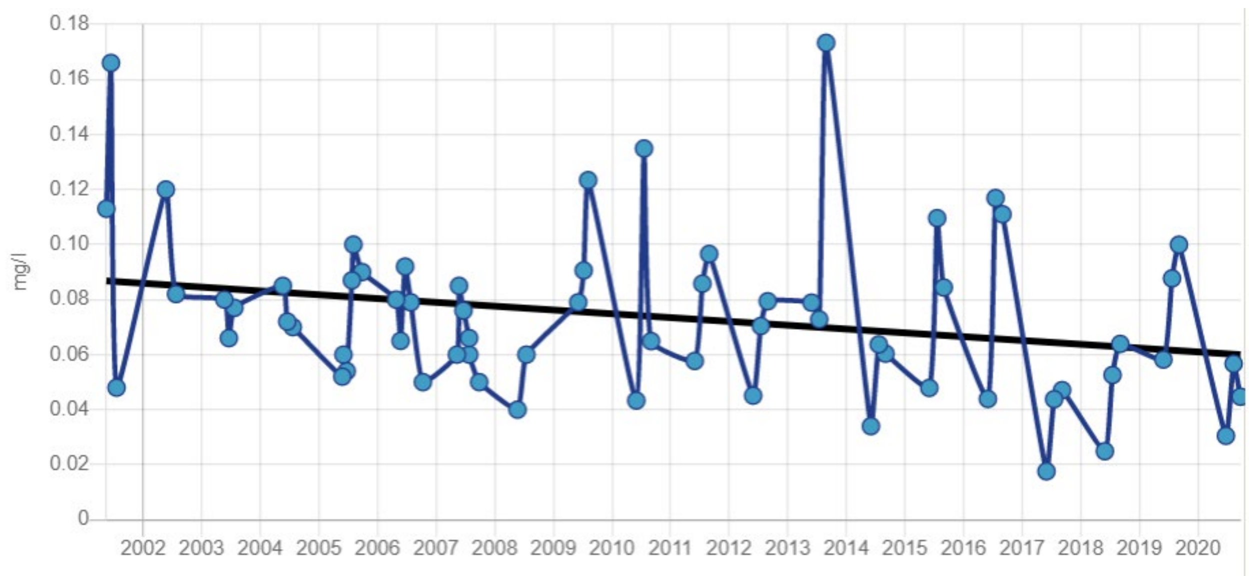


Figure 9: Lost Island Phosphorous-Phosphate Levels



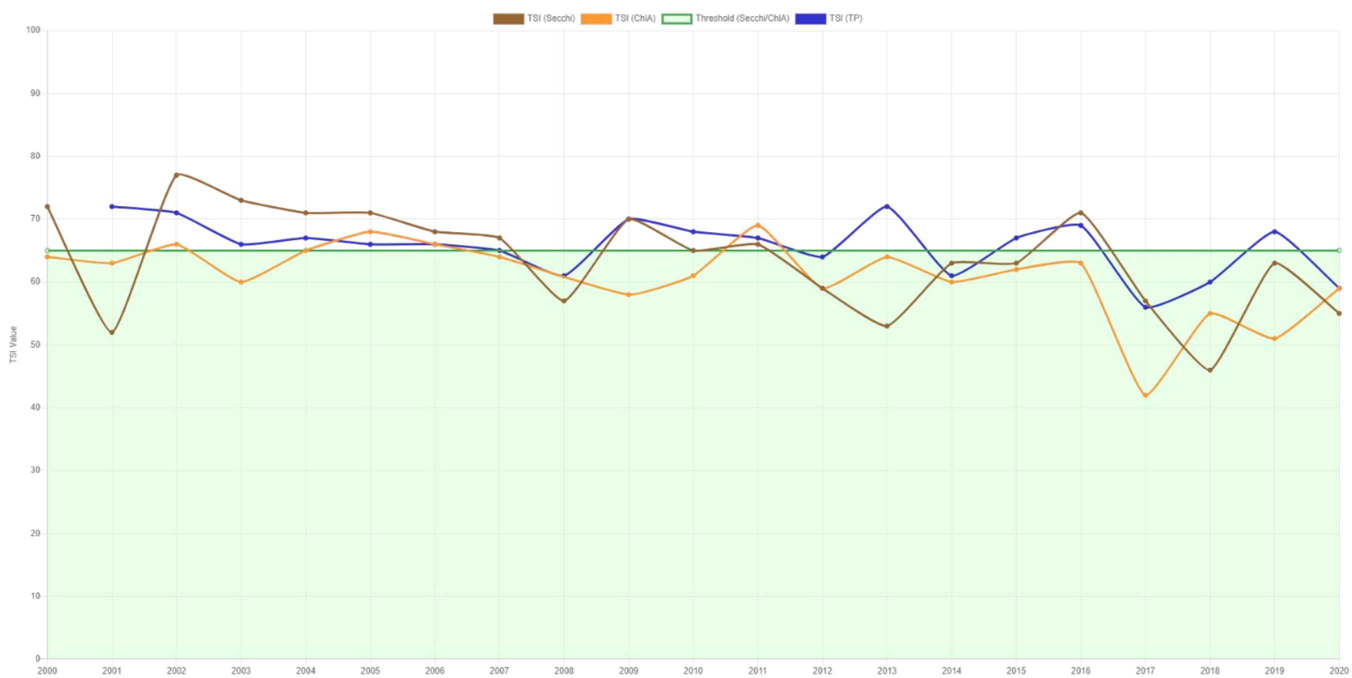


Figure 10: TSI Value: Iowa DNR Ambient Monitoring Program: Green line represents threshold for Secchi Depth and Chlorophyll A.

Primary Source of Pollutants:

Internal resuspension and phosphorous runoff from agricultural landscape.

Lost Island lake was delisted back in 2010 (https://programs.iowadnr.gov/adbnet/Segments/1632/Assessment/2010). The TMDL written in 2009 removed the lake from the category 5 list (impaired, TMDL needed) to the category 4 list (impaired, TMDL written). The lakes impairments were moved out of category 4 in 2018 (https://programs.iowadnr.gov/adbnet/Segments/1632/Assessment/2018). Based on improving Secchi values the lake the Cat 4 impairments moved to category 2, however, there were a couple of 3b potential impairments. 3b potential impairments are not impaired water list impairments as they do not meet the rigorous requirements to be on there. The 3b potential Algal growth impairment were removed Class A1 based on chlorophyll-a data in 2020 allowing the lake to make it to the Category 2 list (some of the designated uses are met, but there are insufficient data to determine if the remaining designated uses are met.) Something of note, the watershed is not assessed in the delisting process, only the segment (the lake in this case).

2008 Lost Island Lake – Total Maximum Daily Load

Existing load (Based on 2007 model)
The annual total phosphorus load to Lost Island Lake consists of external watershed loads and internal resuspension loads. The Loading Function model existing load is 2,228 lbs/year and the existing internal resuspension load is 3,748 lbs/year. Adding in the atmospheric deposition load of 308 lbs/year gives a total existing TP load of 6,284lbs/year. Figure 11 & 12 shows the load distribution.

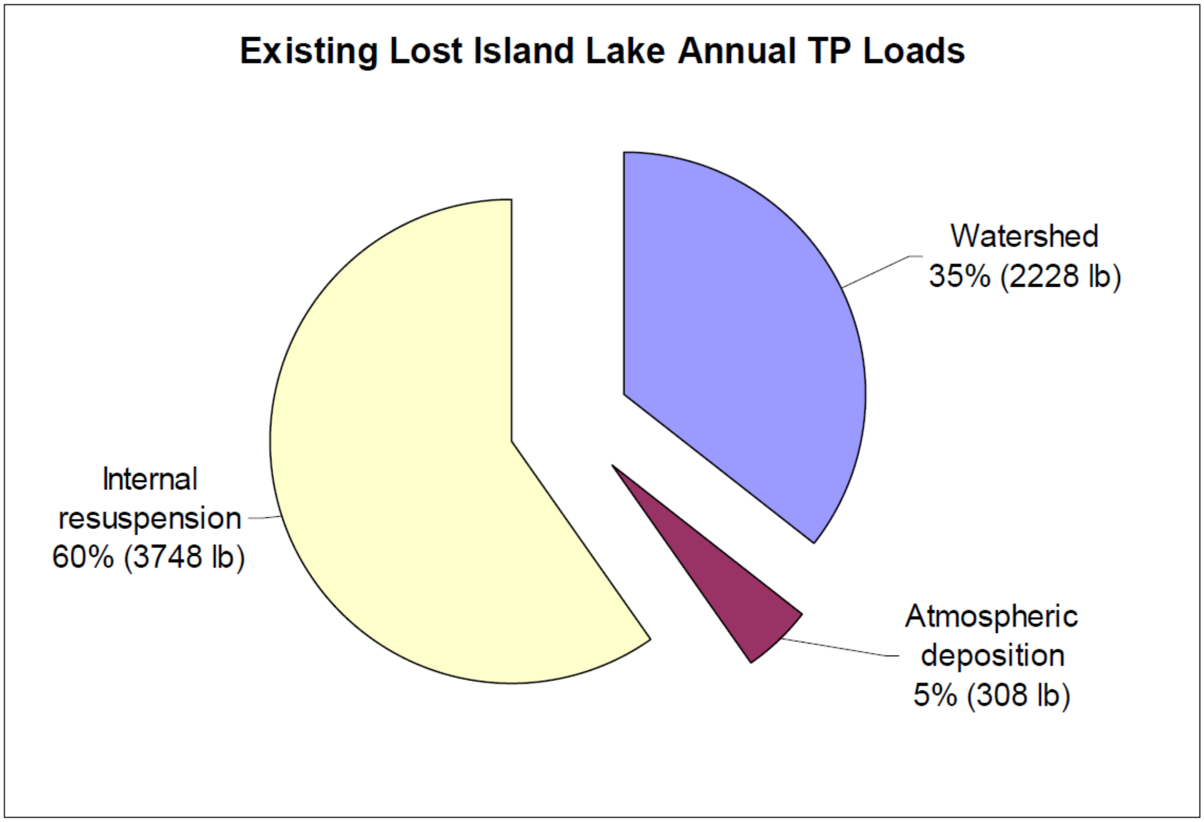


Figure 11: Lost Island Lake Annual Phosphorus Load (TMDL 2008). For reference only. Watershed goals are defined on page 26.

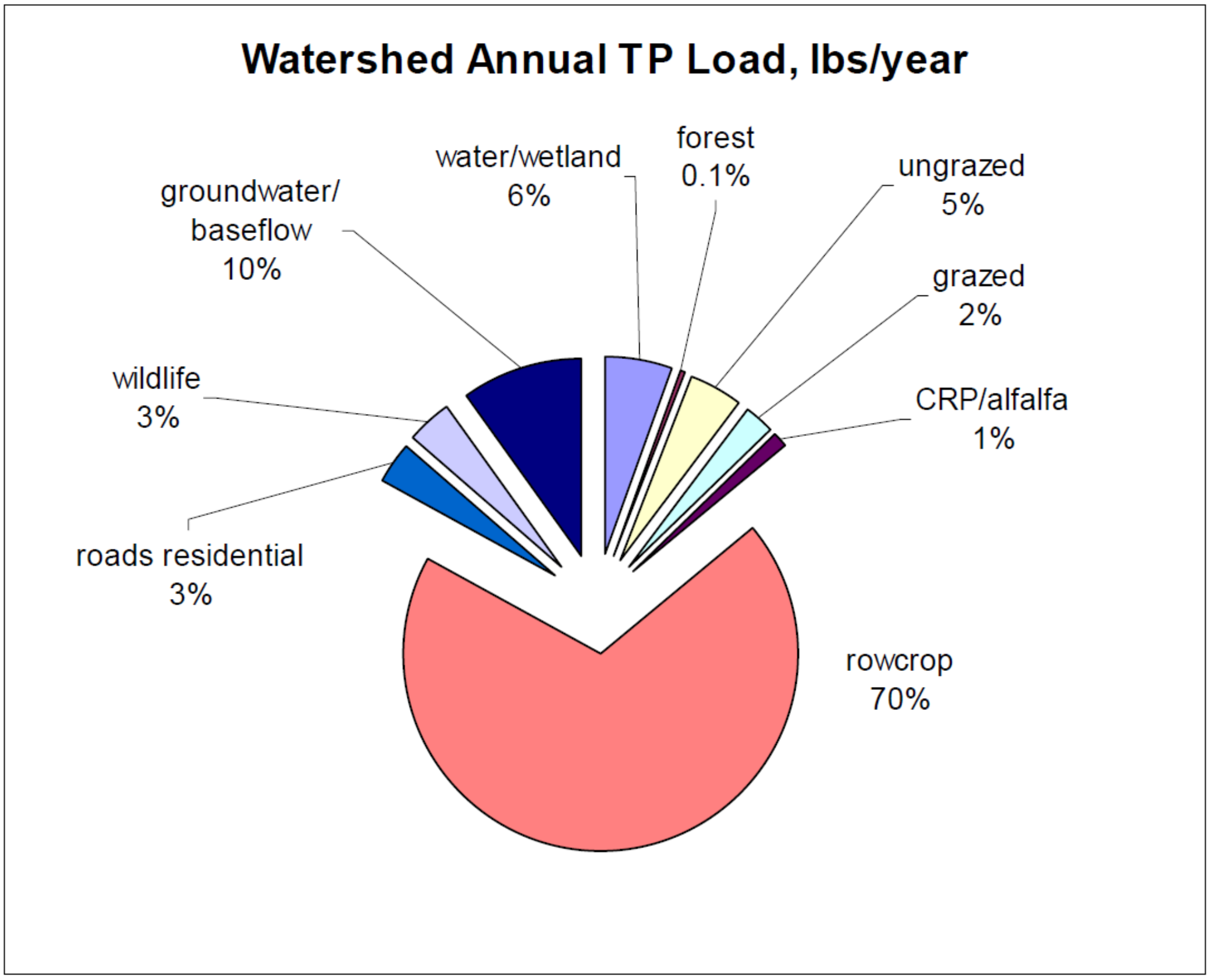


Figure 12: Lost Island Lake TMDL Watershed Phosphorus Loading(2008)

The table on the preceding page (Figure 12) illustrates the relative contributions of generalized phosphorus sources. The predominant source of phosphorus in the watershed is land in row crop production. Soil erosion results in phosphorus-laden sediment being washed into Lost Island Lake. Phosphorus levels in sediment and runoff are increased by the application of chemical and organic fertilizers, such as di-ammonium phosphate and swine manure. Runoff from row crops also carries soluble phosphorus into the stream network. Row crops comprise approximately 70 percent of the land use in the watershed and contribute an estimated 35 percent of the TP load. The entire area around the lake is sewered so there are not any septic tank system sources.

Table 7: TMDL Load reduction scenario by land use. For reference only. Actual reduction goals in plan are different.

Source category	Existing Total-P Load (lbs/yr)	Allocated Total-P Load (lbs/yr)	Percent reduction needed
water/wetland	125	100	20%
forest	3	3	0%
ungrazed	103	50	51%
grazed	54	20	63%
CRP/alfalfa	27	15	43%
row crop	1542	325	79%
roads residential	73	36	51%
wildlife	78	78	0%
groundwater/baseflow	224	175	22%
TOTAL	**2228**	**802**	**64%**

When the Lost Island Lake TMDL was finalized in 2008, internal resuspension accounted for 60% of the phosphorus load. With the completion of the fish barrier structure in 2011, the majority of the internal loading issues have been addressed. The remaining load reductions needed to address the TMDL are now focused on upland treatment of the watershed (30% of annual phosphorus load).

In Lake Accomplishments:

The goal of the 2012 Lost Island Lake Watershed Enhancement Project was to restore ecological health to Lost Island Lake and its intricate watershed resulting in improved water quality and a diverse native plant and wildlife community. In 2009 a Watershed Improvement Review Board (WIRB) Grant was to obtained for the construction of two combination fish barrier/water control structures placed at key locations in the watershed within the Blue Wing Marsh complex. The two structures are referred to as the Barrier Marsh structure and the Blue Wing Marsh structure. These two structures are part of a larger construction project that involved a total of four combination fish barrier/water control structures and one additional fish barrier. Construction of these structures was designed to aid restoration efforts by preventing spawning common carp from entering wetlands in the watershed and to establish the ability to manage water levels in the large wetland areas. Water level management is critical to wetland health and common carp control. In addition to structural components, project partners implemented incentivized commercial harvest of common carp to reduce the overall population number and biomass in an effort to reduce the effects of this fish on water quality.

Construction

• Construction completed on five fish barriers, four of which incorporate water level control capabilities for the lake and associated wetland complexes (Figures 1, 2 and 3)

• The Blue Wing Marsh Complex, Barringer Slough, and DU Marsh have all been dewatered, eliminating spawning areas for common carp, eliminating resident populations of common carp, and allowing for restoration of aquatic plants.

• Project goal of reducing access of common carp to key spawning areas has been met.

Biological

• Population and biomass estimates were completed yearly from 2008 – 2011 (Figure 4)

• 891,000 lbs of common carp and buffalo were removed from the lake in 2010 and 2011 through a subsidized commercial harvest program (Figure 13)

• Common carp population and biomass levels have been reduced to within objective levels (< 100 lbs/acre, Figure 4). This is a 90% reduction in population and an 80% reduction in carp density. Project goal was to reduce common carp density in Lost Island Lake by 75-80%.

• An aggressive stocking schedule was implemented to increase predator fish populations and reduce common carp reproduction potential

Water quality

• Lost Island Lake is part of on-going monitoring by Iowa State University, three times per open water season, for a variety of chemical, physical and biological parameters and this information will be the primary source of information to track changes in lake water quality.

• Although 2011 Secchi depth (water clarity) averaged only 2 feet, our goal is to still attain 4.5 feet average Secchi depth throughout the open water season in the future. It is important to keep in mind that the lake will take time to respond to recent intensive fish removal and initial work to re-establish healthy wetland systems above the lake. In lake turbidity trends indicate reduced turbidity and support that we are observing improved water clarity in recent years (Figure 6).

Photo: Water Control and Fish Barriers installed in 2011.

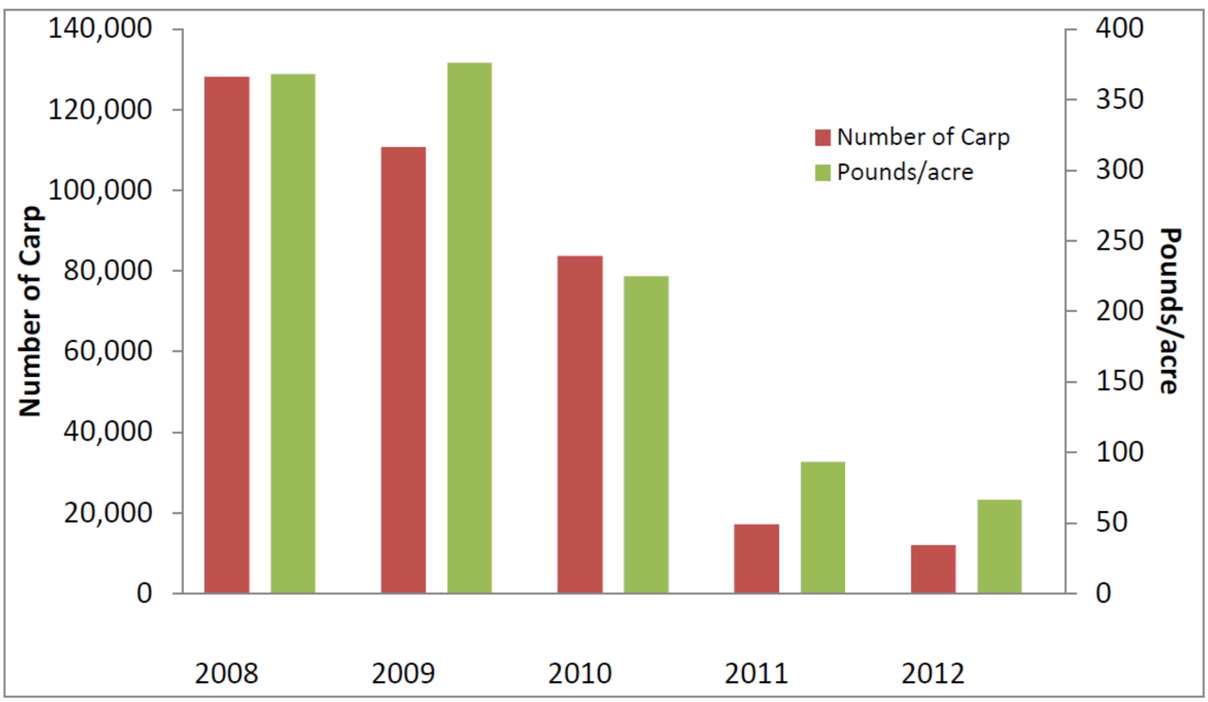


Figure 13: Population and biomass estimates for common carp in Lost Island Lake (Hawkins, DNR)

Water Quality Goals & Objectives

This Water Quality Management Plan and subsequent projects seek to protect the water quality in Lost Island Lake so it can stay off the Iowa Impaired Waters List. These goals will be accomplished using a comprehensive plan of Best Management Practices in the watershed. These goals have been created with the help of the Watershed Action Group, watershed residents, and partner organizations. As of this writing these goals are set to be completed within 30 years.

Goal 1 – Increase local ownership and awareness within the watershed

> Objective: inform landowners of water quality issues through news releases, mailings, social media, personal contacts.
>
> Objective: Provide additional information and displays at the Palo Alto CCB Nature Center located at Lost Island Lake.
>
> Objective: Encourage adoption of Phosphorus reducing practices by hosting field days, field visits with landowners, and Social Media.

Goal 2 – Improve the current Trophic State Index values to ensure the waterbody does not return to impaired water status

Objective 1: Implement conservation practices on priority agriculture acres. Focus on areas in the watershed that were identified as having a high erosion rate and P load. Also give special attention to areas in close proximity to the lake that could have high P loads during storm events.

Objective 2: Install conservation practices in urban landscapes. Inform and encourage landowners to better understand their role in phosphorus delivery to the lake and the practices they can install on their property.

Objective 3: Enhance public land within the watershed.

A target load reduction for the watershed is a 30% reduction in phosphorus loading (Table 8).

Water Quality Milestones

Water quality goals based on models and TSI scores form the baseline for assessing improvement in water quality projects like this one. The following goals have been established based off the target TSI values to ensure Lost Island Lake remains off the impaired waters list in the future.

Table 8: Water Quality Goals for total phosphorus and secchi depth

% P Load Reduction	TP		Secchi	
	µg/L	TSI	ft	TSI
0%	62	59	1.5	57
5%	61	59	1.6	57
10%	55	57	1.8	56
20%	52	55	2	55
25%	50	54	2.3	53
30%	46	52	3.5	52

Best Management Practices

Ag BMPs

No-Till
Phosphorous Reduction Potential: 90%
Goal: 1700 acres
Target: Row crop land with highest potential for nutrient delivery and close proximity to the lake
Payment Rate/Incentive: Section 319 funds and State Water Quality Initiative Funding. $25/acre incentive

Cover Crops
Phosphorous Reduction Potential: 90%
Goal: 1700 acres
Target: High load areas in the north end of the watershed
Payment Rate/Incentive: Section 319 funds and State Water Quality Initiative Funding. $45/acre incentive

Waterways
Phosphorous Reduction Potential: Depends on location
Goal: 3000 ft
Target: Areas showing signs of gully erosion
Payment Rate/Incentive: CRP plus Section 319 Funding

Pothole Wetland Restoration
Phosphorous Reduction Potential: 20%
Goal: 15 acres
Target: historical pothole areas east of the lake
Payment Rate/Incentive: CRP plus Section 319 Funding

Blue Wing March

Phosphorus Reduction: Moderate
Goal: 32 acres of Native Grass/Shrub Removal/wetland restoration
Target: Priority areas identified by DNR Wildlife
Payment/Incentive:80-100% total cost. Section 319 Funding

__Urban BMPs__

Phosphorous Free Fertilizer Program
Phosphorous Reduction Potential: Medium to High
Goal: 50 vouchers
Target: All residents that use fertilizer especially lake side.
Payment Rate/Incentive: voucher toward P-free fertilizer purchase. Section 319 Funding

Residential Rain Gardens
Phosphorous Reduction Potential: Depends on location
Goal: 10
Target: Watershed residents, new development
Payment Rate/Incentive: 50% of total cost. Section 319 Funding

Rain Barrels
Phosphorous Reduction Potential: Variable
Goal: 50 rain barrels
Target: Watershed residents
Payment Rate/Incentive: $50 toward purchase of rain barrel. Section 319 Funding

Bioswales
Phosphorous Reduction Potential: Depends on location

Water Quality Monitoring

Water monitoring is an important tool in all watershed improvement projects. Monitoring tracks the progress of the project and allows for future changes and improvements. This water monitoring plan will collect data from both from within the watershed and Lost Island Lake.

Site Locations

In-Lake: The ambient lake location will continue to be monitored by Iowa State through the IDNR's ambient lake monitoring program. Lost Island's Beach is currently enrolled in the IDNR's beach monitoring program and is tested weekly.

Watershed Tributaries: Lost Island only has one major tributary, the Blue Wing Marsh Complex. Continuing and or restart monitoring of Blue Wing Marsh at the locations depicted in table 9 and 10 would yield data for the health of the wetland and Lost Island Lake.

Frequency

In-Lake: Monthly (April through October)

Tributary: Twice per month (April through October) and try to include some samples taken during heavy rain events to better understand high load conditions.

Parameters

In-lake: Chlorophyll a, chloride, total suspended solids, , nitrates + nitrite nitrogen, total phosphate, orthophosphate, Secchi depth, dissolved oxygen, temp, pH, and turbidity.

Tributary: total suspended solids, nitrates + nitrite nitrogen, total phosphate, orthophosphate, Secchi depth, dissolved oxygen, temp, pH, and turbidity.

Lab Analysis Budget

Table 9: In-lake monitoring

Parameter	Cost per sample	# of sites	# of samples	Total cost
Chlorophyll a	45	1	12	540
Chloride	15	1	12	180
Total Suspended Solids	16	1	12	192
Total Fixed Suspended Solids	30	1	12	360
Nitrate + Nitrite	16	1	12	192
Total Phosphate	16	1	12	192
Orthophosphate	16	1	12	192
			Total:	$1,848

Table 10: Tributary monitoring

Parameter	Cost per sample	# of sites	# of samples	Total cost
Chlorophyll a	45	3	36	1620
Chloride	15	3	36	540
Total Suspended Solids	16	3	36	576
Total Fixed Suspended Solids	30	3	36	1080
Nitrate + Nitrite	16	3	36	576
Total Phosphate	16	3	36	576
Orthophosphate	16	3	36	576
			Total:	$5,544

Public Outreach Plan

Public input and involvement are crucial to the success of watershed projects like this one. Landowners who live in and own land in the watershed have directly influence the water quality in (Five Island / Silver Lake) through their land management decisions. It is crucial to maintain their involvement in the planning process, even with the additional challenges of COVID-19.

Goals

- Education: Increase the public knowledge of the specific factors impacting water quality in (Five Island / Silver Lake)
- Utilize public input to shape the Best Management Practices Targeting plan

Target Audiences

People directly responsible for implementing practices to improve the land and water

- Ag landowners
- Ag tenants
- Residents and surrounding developments
- Year-round residents around Lost Island
- Seasonal residents around Lost Island
- Rural residents
- Public land managers (Palo Alto County Conservation and IDNR)
- Local business that benefit from the lake
- City of Ruthven

Groups needed to advance the project

- Palo Alto SWCD
- Palo Alto County Conservation Board
- Iowa DNR
- NRCS
- City of Ruthven
- Lost Island Lake Protective Association

Target Audience Outreach Strategy and Tactics

All audiences are different and come with their own preconceptions and challenges. This section will explore ways to contact and work with the many unique audiences that will be involved with this project. It will address key messaging and contact strategies as well as each groups barriers to participation and ways to overcome them.

Potential Barriers to Participation by Group

Ag Landowners

- Loss of land in production and therefore income from implementing conservation practices

- Cost share rates on conservation practices
- Perception of yield loss when transitioning a new system such as no-till or implementing cover crops
- Absentee landowner contacts and education

Ag tenants

- Loss of acres in production and therefore income
- Perception of yield loss when implementing a new practice such as no-till or cover crops
- Convincing absentee landowners to participate in conservation practices
- Cost share rates for conservation practices
- Uncertainty about continuing to farm the land in the future

Urban Property Owners

- Loss of property to install conservation practices
- Cost share to install practices
- Maintenance of conservation practices
- City and HOA codes
- Neighbors
- Seasonal resident availability
- Visual appeal of conservation practices

Potential Solutions, Motivators, Incentives and Benefits to Participate

- Provide or increase cost share rates for conservation practices
- Utilized multi-program funds / stack benefits where possible
- Participation recognition/ awards
- Educational projects and demonstrations

Keeping in mind the potential barriers to participation as well as ways to mitigate them, outreach tactics are being developed to specific audiences preferred methods of communication. These include one-on-one contacts, smaller group meetings (e.g. attending an HOA meeting), direct mail, email, and press (e.g. local papers). Also included are general communication elements that will assist the advancement of all public outreach efforts in the future.

General Communication Elements

- Project Identity: developing an identity for the project that will provide consistency to all public outreach so it can be tied back to the project
- Online presence: Maintain and enhance a web presence to provide basic information about the watershed and project activities. Utilize online platforms that appeal to a wide range of people. (e.g. Facebook, Town website, YouTube, Zoom etc.)
- Photography: Take photos of watershed projects that can show progress and be used to educate other interested groups.

- Communication schedule: Create an annual outreach plan that focuses on key seasons / events to reach target audiences and ensure that the project remains relevant (e.g. summer events that target seasonal residents)

One-on-One Personal Contact

- Personal meeting/phone calls: Schedule private meeting or phone calls with individuals to educate them about the project and explain methods and cost share options in detail. Focus on influential landowners and community members.
- Field Days: arrange at least one annual field day to increase awareness of watershed projects and show off project progress. Tours should include representatives from as many partner groups as possible to demonstrate cooperation on the project. Schedule additional field days that showcase specific projects or groups (e.g. spring ag tour by SWCD or Master Gardeners open house)
- Other educational events: Take advantage of any opportunity to expose the technical advisory team or watershed advisory group to the public. Encourage member to build relationships with other agencies and have one-on-one conversations with public (e.g. Summer Water Quality Festival modeled after the Okoboji one)

Direct Mail/Email

- Annual letter: Draft and annual letter or brochure to raise awareness and education. The Five Island Lake Association has already started this process.
- Email newsletter: Create an E-newsletter that can be used for project updates, watershed news, and educational pieces.

Press/Publicity

- News articles: Send quarterly press releases to media outlets (Local newspapers/websites) with project news and updates. Focus on including pictures or other visuals when possible. Additional write a few columns for the Five Island Lake Association's bimonthly spot.
- Public recognition/awards: Create and present urban and rural watershed awards to publicly recognize participating landowners and partners.
- Publicity Events: Hold events and educational activities that have a "feel good" spin, like field days or watershed tours mentioned previously. Also plan events that include other key audiences (e.g. youth events with local 4-H and FFA, county conservation programs, local high school or college environmental science classes)

Other

- Partnerships: Develop good relationships with local groups and organizations that have platforms that can be utilized to communicate watershed information to the public. (e.g. Lost Island Lake Preservation Board)
- Committee and Public Meetings
    - Hold quarterly watershed advisory committee meetings

- Hold annual project review meeting
- Hold annual public meeting

Evaluation/measurement

- Keep track of meeting attendance and participation
- Follow-up surveys (e.g. hand out a survey at the annual meeting and public meeting, post online surveys periodically do gauge public opinion)
- Follow-up phone calls with key partners and landowners
- Follow-up one-on-one interviews
- Conservation practice participation reports
- Press hits/media coverage

Load Reduction Milestones

Load reduction milestones have been set based on the proposed implementation schedule.

Phosphorus Loading Goals to reach 30% reduction on Phosphorus Delivery to Lake. Total P load reduction needed is 669lbs (Table 11).

Table 11: Load Reduction Milestones

	Watershed TP Load	% Reduction Goal
Current load conditions	2228	
End of Phase 1	200	9
End of Phase 2	450	20
End of Phase 3	669	30
Ending Phosphorus Load	1559	

Implementation Schedule

Component	**Units**	**Phase One (Years 1-5)**	**Phase Two (Years 6-15)**	**Phase 3 (Years 15-30)**	**Total**
CRP/WRP	AC	20	70	70	160
Waterways	FT	500	1000	1500	3000
Blue Wing Marsh Enhancement	Ac	32	0	0	32
Pothole Wetland Restoration	Ac	5	5	5	15
No-till/Strip till	Ac	450	500	750	1500
P Removal Bioreactor	Each	1	1	2	4

Cover Crops	Ac	450	500	750	1500
Bioswale	Each	1	1	1	3
Rain Barrels	Each	3	3	2	8

Table 12: 30 Year BMP implementation schedule

Implementation Schedule (Years 1-5)

Goal 1 – Increase local ownership and awareness within the watershed

Table 13: Short term implementation schedule

		Metric	Total	FY22	FY23	FY24	FY25	FY26
Objective 1	Inform Landowners of WQ Issues							
Task1	Utilize Social Media	Online Postings	60	12	12	12	12	12
Task 2	Draft Annual Letter to Landowners	Mailings	5	1	1	1	1	1
Task 3	Meet one on one with Landowners	Contact	50	20	10	10	10	
Task 4	Kickoff Open House Event	Event	1	1				
Objective 2	Provide information at Palo Alto CCCB Nature Center							
Task 1	Create Kiosk and Handouts for visitors	Informational	1	1	1			
Objective 3	Inform Visitors with Educational information	Informational	5	1	1	1	1	1

Task 1	Create Handout about watershed and cost share	Handout	1	1				
Task 2	Signage at stream crossings and watershed boundaries	Signs	20	20				
Task 3	Host field days	Events	4		1	1	1	1

Goal 2 – Improve the current Trophic State Index values to ensure the waterbody does not return to impaired water status

		Metric	Total	FY22	FY23	FY24	FY25	FY26
Objective 1	Implement conservation on Agriculture Lan							
Task 1	Grassed Waterways	Feet	500	0	250	250	0	0
Task 2	No-Till	Acres	450	50	100	100	100	100
Task 3	Pothole Wetland Restoration	Acres	5	0	2	3	0	0
Task 4	Cover Crops	Acres	450	50	100	100	200	0
Task 5	Phosphorus Reducing Bioreactor	No.	1	0	0	1	0	1
Task 5	Water and Sediment Basin	No.	1	0	0	1	0	0
Task 6	CRP/WRP	Ac.	0	10	10	0	0	0
Objective 2	Urban Practices							
Task 2	Rain Barrels	No.	3	0	3	0	0	0
Task 4	Biocell	No.	0	0	1	1	1	0

Objective 3: Enhance public land within the watershed.

Objective 3	Public Lands Enhancement							
Task 1	Blue Wing Marsh	Ac.	32	0	15	17	0	0

Resource Needs

The estimated cost, in 2020 dollars to achieve a 30% reduction in phosphorus loading is $1,547,610 (Table 17). Practices listed below will be adopted on a voluntary basis. Palo Alto Soil and Water Conservation District in Emmetsburg, Iowa will handle the technical and financial assistance associated with the project. In addition, the project coordinator will be located in the district office.

Table 14: Lost Island Watershed Resource Needs

Lost Island Lake Watershed Resource Needs					
BMP	Unit Cost	Unit	Planned Amount	Total Cost	P Reduction (lbs)
No Till	$ 30.00	acre	1700	$ 51,000.00	150
Cover Crops	$ 40.00	acre	1700	$ 68,000.00	162
CRP/WRP	$ 800.00	acre	160	$ 128,000.00	35
Grassed Waterways	$ 6.00	feet	3000	$ 18,000.00	165
Pothole Wetland Restoration	$ 500.00	acre	15	$ 7,500.00	75
No Phosphorus Fertilizer	$15	each	50	$ 750.00	10
Bioswale	$ 1,200.00	each	3	$ 3,600.00	3
Rain Gardens	$ 400.00	each	10	$ 4,000.00	3
Rain Barrels	$ 80.00	each	50	$ 4,000.00	1
Blue Wing Marsh Enhancement	$ 1,500.00	acre	32	$ 48,000.00	30
Phosphorus Removing Bioreactor	$12,000.00	each	4	$ 48,000.00	35
Water Quality Monitoring	$ 7,392.00	year	30	$ 221,760.00	
Public Outreach	$ 1,500.00	year	30	$ 45,000.00	
Project Coordinator (1/3 time)	$30,000	year	30	$ 900,000.00	
				$ 1,547,610.00	669

Funding Sources

In order to obtain the goals/objective of this plan, multiple funding sources will need to be utilized. Below is a list of funding possibilities.

EPA Section 319 Funding, managed by Iowa DNR: The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program Section 319 addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, states, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.

Iowa DNR – Lake Restoration Funding: The goal is to invest money on projects with multiple benefits such as improved water quality and increased public use, while considering feasibility of restoration. Science based prioritization has been our most effective tool in targeting projects of value to the state. Funding for the Lake Restoration Program (LRP) is currently appropriated on an annual basis. We anticipate that at the current annual level of $9.6 million per year the DNR can stay on schedule with implementing restoration efforts at the significant publicly-owned lakes and publicly-owned shallow lakes/wetlands currently prioritized in the five-year plan.

Iowa Department of Agriculture and Land Stewardship:

Conservation Reserve Enhancement Program (CREP) - The Iowa Conservation Reserve Enhancement Program is a state, federal, local, and private partnership that provides incentives to landowners who voluntarily establish wetlands for water quality improvement in the tile-drained regions of Iowa. The goal of the program is to reduce nitrogen loads and movement of other agricultural chemicals from croplands to streams and rivers. In addition to improving water quality, these wetlands will provide wildlife habitat and increase recreational opportunities.

Water Quality Initiative (WQI) -The Iowa Water Quality Initiative (WQI) is the action plan for the Iowa Nutrient Reduction Strategy (NRS) established in 2013. The WQI improves water quality through a collaborative, research-based approach that is evaluated and reported by a team of independent researchers from multiple institutions, led by Iowa State University. This comprehensive approach allows farmers and cities alike to adopt conservation practices that fit their unique needs, lands, and budgets.

Natural Resource Conservation Service (NRCS):

Environmental Quality Incentive Program (EQIP)- The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion and sedimentation, and improved or created wildlife habitat.

Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment.

Farm Service Agency (FSA):

Conservation Reserve Program (CRP) - CRP is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are from 10 to15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

Local Partners and Funding Sources: As opportunities present themselves, local partners will contribute funds to the projects.

BMP Descriptions and Definitions

Row Crop

Description – Incorporation of additional conservation practices in lands supporting row crop production will improve soil health and water quality. Many nonstructural management practices reduce soil erosion and increase infiltration, which reduces sediment and phosphorus transported to the lake. Structural conservation practices provide the next level of protection that intercept and trap/ treat pollutant loads during transport. In the poorly drained landscape surrounding Five Island Lake, subsurface tile drainage has been used extensively to improve row crop production. This feature alters water and nutrient transport and must be considered when selecting and locating conservation practices.

Ability to Assist in Achieving Goals – Because cropland comprises most of the drainage area to the lake, and hence the largest source of phosphorus from the watershed, implementation of agricultural conservation practices provides significant opportunities to reduce phosphorus losses to the lake. Non-structural management practices that are most applicable to the Five Island Lake watershed include (but are not limited to):

- Conservation tillage and no-till farming
- Cover crops
- Extended crop rotations (to include small grains and/or hay)
- Fertilizer and manure management
- Increased perennial vegetation using the Conservation Reserve Program (CRP) or Wetland Reserve Program (WRP)

Structural conservation practices can be implemented by private landowners on fields and waterways on their property. The watershed for Five Island Lake is dominated by gently sloped terrain with many low-lying depressions and a subsurface tile drainage. Consequently, commonly-used structures such as terraces and farm ponds are not suitable in much of the watershed. Practices that focus on filtration and nutrient uptake are more appropriate for this watershed include:

- Grassed waterways
- Riparian buffer strips (traditional and saturated buffers)
- Restoration of pothole wetlands
- Phosphorus removal bioreactor

Qualitative Description of Cost – The cost of implementing non-structural conservation practices varies widely depending by practice type and position in the landscape. There are a wide range of Federal programs available largely through USDA-NRCS that provide cost-share for conservation practices, but the implementation is voluntary through landowner participation. Applications to the NRCS Environmental Quality Incentives Program (EQIP) that are located within the drainage area to Five Island Lake will be given priority points when applications are evaluated. The iron-enhanced sand filter is not an approved practice for cost sharing and is not a traditional practice commonly applied in the watershed. Implementation of this alternative would require additional education and design assistance, which could be a task for a watershed coordinator. A watershed coordinator would also assist USDA-NRCS employees with landowner/operator outreach and education. This focused attention on the drainage area to Five Island Lake should increase the rate of adoption and implementation of voluntary conservation practices.

Phosphorus removal bioreactor –

Information Provided by Ohio State University Extension: https://agbmps.osu.edu/bmp/phosphorus-removal-structure-nrcs-782

A Phosphorus Removal Structure (PRS) is an edge of field practice that removes dissolved phosphorus (DP) from drainage water leaving the field. The practice is best suited to sites where a history of DP concentrations in water leaving the site are measured at 0.2 mg/L DP or greater. These sites are best candidates for the P Removal Structure practice due to efficiency of filtration and the capital cost involved with the installation.

The practice requires the ability to divert concentrated flows of water into a structure containing P absorbent media. The water flows through the media where the DP attaches to a media lowering P levels of the treated water leaving the site.

The structures can take on many styles and forms, but each possesses the following core components:

1. Enough of an unconsolidated Phosphorus Sorption Material (PSMs). PSMs are usually industrial by-products or manufactured materials composed of Fe, Al, or Ca with different P adsorptive characteristics.

2. Water with high DP concentration flow through the PSM in the structure at a suitable flow rate while allowing enough contact time based on the PSM characteristics.
3. Plan for the ability to remove and replace PSM after it is no longer effective at removing P at the minimum desired rate. Some materials are available that allow renewing the adsorptive capacity without removal of the PSM.

Structure placement is site dependent. Structures can generally be placed in non-production spaces such as buffer areas near the field tile outlet or surface concentrated flow. In some cases, field edges may need to be taken out of production to accommodate the structure. There are several media types available with different absorbance efficiencies which allow some design flexibility. This provides options to adjust filter size to conform to the space available. This is an engineered practice, and it is recommended to consult with a Professional Engineer for design and installation recommendations. An online tool P-Trap is available from USDA-ARS to use as a planning tool. Natural Resources Conservation Service has an interim standard 782 Phosphorus Removal System that can be consulted.

Where is it used:

The Phosphorus Removal Structure can be utilized for many situations where DP is a resource concern in receiving waters: urban, agricultural, golf course, horticultural, and wastewater. Much of the early work using P removal structures were done with municipal, domestic, and agricultural wastewater where the structures were often used in conjunction with treatment wetlands. Phosphorus Removal Structures have been placed in line with surface drainage water, in conjunction with drainage tile, or in ditch areas; it is possible to "stack" this practice with nitrogen bioreactors. Placement is only limited by the practicality of directing enough high concentration DP water through the filter material while allowing for a functional drainage system.

In a field setting, it is best to measure water leaving a field site at several different flow conditions to quantify the actual DP concentrations leaving a site. Taking a grab samples under a high, moderate and low flow conditions is a reasonable method to use. The best sites for a PRS have water with DP concentrations greater than 0.2 mg/L which is four times the desired DP concentration target (0.05 mg/L) for many receiving water bodies such a streams, rivers and lakes.

These field sites are often associated with high Soil Test Phosphorus (STP) levels, generally 2-3 times the agronomic STP need of many crops grown. Fields with a STP value of 100 mg/kg Mehlich 3 or greater would be a candidate for water testing to confirm DP concentrations. Fields with high STP will remain high for many years due to the P buffering capacity of soils. In these high STP field situations there are few conservation practice alternatives to reduce DP losses. The long term needs at these sites make the PRS a cost-effective option.

Why install it:

Sites with high concentrations of DP in drainage water are often associated with high STP levels from past field management. Phosphorus removal structures can be installed to trap the lost P while in-field practices to lower STP are implemented for reducing the source of DP. More information on the relationship of soil test level to DRP losses can be found on this site.

The PRS immediately removes DP from drainage water and surface runoff at the edge of a field. The ideal field site is where high levels of DP (>0.2 mg/L) are measured in water and other conservation practices cannot be effectively deployed to reduce DP in sensitive watersheds. The practice will be most cost effective when implemented at sites where long-term DP reduction are needed while infield practices are used to reduce DP sources in the field. The primary in-field practice for reducing the source of DP is reduced or no application of additional P while drawing down STP levels to environmentally acceptable levels.

What do I need to know about it:

Effectiveness

Properly designed P Removal Structures can result in reductions of 16-71% in DP concentration and loading. These results were from a summary of 40 different field scale trials using various designs and PSM materials. (Penn, et al, 2017) Water 2017, 9, 583; doi:10.3390/w9080583

Considerations

Characteristics of the ideal site for construction of a P removal Structure include:

Flow convergence to a point where water can be directed into a structure, or the ability to manipulate the landscape to concentrate water flows.

Dissolved P (DP) in water of at least 0.2 mg/L.

Hydraulic head required to "push" water through structure which is a function of elevation change or drainage ditch depth.

Sufficient space to accommodate PSM chosen.

P removal structures require careful design to reach peak absorption efficiencies and maintain subsurface tile drainage. Design inputs needed to determine size and function for a PRS fall into three categories.

Site hydrology and water quality characteristics Target removal and Lifetime needs

PSM characteristics.

Site characteristics will determine the amount of water that flows to potential installation locations. Measurements of the DP concentration over several different flow conditions combined with estimates of annual flow volume can be used to estimate the load (mass) of DP that is delivered. Sizing of a P removal structure is a function of the annual P load, the chosen P removal amount and lifetime, and the characteristics of the PSM to be used. The most important PSM characteristic is its ability to remove P, as quantified by a "P removal curve". The P removal curve is simply a mathematical description of P removal under flowing conditions for a given P inflow concentration and retention time (RT), expressed as a function of P loading (i.e., P added per unit mass of PSM). Physical characteristics of the PSM, especially porosity and saturated hydraulic conductivity (i.e. its ability to conduct water) are especially important when it comes to designing PRS to achieve the desired P removal at the chosen flow rate and RT.

An important factor in design is PSM selection. Generally, any product with a high affinity for P, suitable physical characteristics, and is safe for use in waterways can work as a PSM. Types of PSMs available include drinking water treatment residuals, fly ash, mine drainage residuals (Fe oxides), steel slag, metal filings, and manufactured PSM. The most cost effective PSM known at this point, is metal filings/turnings mixed (5-8%) with clean pea-gravel. A graphic of PSM's is found in Figure 2.

Manufactured PSMs tend to absorb P more efficiently but are higher cost products. While manufactured PSMs are higher cost, less material mass is needed to perform the desired P capture, lowering the amount of space needed for the PRS. For example, a subsurface tile drain filter designed to remove 35% of a 5-year Dissolved P load using treated steel slag would require 40 tons while a manufactured Fe-rich PSM would only require 2-5 tons.

When treating subsurface tile drainage water do not use untreated electric arc furnace slag or blast furnace slag. The bicarbonate contained in the tile water will cause premature failure with these PSM options. Aluminum-treated slag can be used for tile drains if properly sieved to removed fines. Regular non-treated sieved slag works well for treating surface water, especially when used as the gravel in blind inlets.

A variety of materials have been evaluated and are included in the P-Trap software database. New materials are always being evaluated at USDA Agricultural Research Service, National Soil Erosion Research Laboratory in West Lafayette, IN. Contact the USDA Erosion Laboratory if your PSM of interest is not found in the P-Trap database.

Urban Land Practices

Description – There are a different set of practices that are suitable for urban area, but like cropland practices, there are non-structural and structural opportunities. Non-structural practices or ordinances can be implemented to reduce the amount of nutrients introduced into the runoff. Structural practices provide the next level of protection that trap and/or treat pollutant loads that are generated from urban land uses and transported with overland runoff.

Ability to Assist in Achieving Goals – Since urban area is a small portion of the land use in the watershed, it is not a major contributor of phosphorus to the lake. However, the phosphorus loading rate (pounds per acre) is high, so efforts to reduce the amount of nutrients generated from urban land have some water quality benefit. Further, cooperation and adoption by urban landowners often increases participation by rural residents and farmers. Non-structural management practices that are most applicable to urban areas in the Five Island Lake watershed include (but are not limited to):

- Use of no-phosphorus fertilizer

- Pet waste management
- Soil quality restoration

Structural conservation practices can be implemented by private landowners to treat runoff from individual properties. Similar to the bioswale implemented in the Five Island Lake Campground, larger properties that have the space and ability to treat concentrated flow are encouraged. The local golf course may have these opportunities and a watershed coordinator could also help identify and orchestrate urban practices. Structural practices that focus on filtration and nutrient uptake that would be highly suitable for this watershed include:

- Rain Gardens
- Bioswales

Qualitative Description of Cost – Costs will vary depending upon the practice. Stormwater ordinances may cost little to implement, with only minor costs required for public outreach and education. Iowa's Resource Enhancement and Protection (REAP) program will provide cost-share for some urban practices. A watershed coordinator would help identify opportunities, coordinate activities, and educate the public on the benefits of urban practices.

Near-Lake Management Practices

Near-lake alternatives, which are capable of treating large drainage areas, provide good opportunities for significant load reductions at improved economies of scale. These features are sometimes installed on private land with potential cost-share dollars, but the City could implement several alternatives by acquiring the necessary land rights. Examples of some near-lake strategies include:

- Constructed/CREP wetlands
- Detention basins or
- Sediment forebays

Constructed Wetlands

Description – Wetlands can provide uptake of dissolved phosphorus via the growth of aquatic vegetation and adsorption to wetland soils. Secondary benefits include aquatic habitat and a more diverse ecosystem around the lake. Wetlands initially have relatively high phosphorus removal rates; however, over time phosphorus-binding decreases as the wetland soils "fill up" with phosphorus. Additionally, phosphorus taken up by plants is released when the plants die and decay. Research suggests the phosphorus removal efficiency in unmanaged wetlands begins to decrease after 5-10 years. During periods of vegetation die-off, nutrients can be released, making the wetland a temporary source of phosphorus to the lake. Ideally, this die-off would occur only after the recreation season has ended, therefore impacts to algal growth and recreational uses should be minimal. With proper management, which may require occasional harvest and removal of wetland vegetation, nutrient uptake can be enhanced and sustained over time.

Ability to Assist in Achieving Goals – Constructing large wetlands at major inlets to the lake could provide substantial phosphorus load reduction. A wetland design that provided treatment of tile drain outlets would have the greatest potential water quality benefits.

Qualitative Description of Cost – Costs associated with constructing wetlands are primarily earthwork and water level control structures. If this is pursued by the City and land rights need to be acquired, that would also be a factor in the cost. If implemented through the Iowa Conservation Reserve Enhancement Program (CREP) and IDALs or the local conservation district, financial incentives are provided to private landowners. Constructed wetlands are also eligible for EQIP funding through USDA-NRCS. If the City pursued a constructed wetland, grant opportunities through REAP, IDALs and/or the Casino Grant should be investigated.