SILVER LAKE
WATERSHED PROJECT

Silver Lake Watershed Management Plan

Submitted by: Dickinson Soil & Water Conservation District

Revision January 1, 2016
Future Revisions – 2021, 2026, 2031—(if needed)

Welcome

This document is intended to aid watershed groups in targeting watershed activities and practices to improve water quality. Planning serves as a road map for turning today's problems into tomorrow's solutions. Water quality improvement is a big task, and trying to tackle it all at once can be daunting. This Management Plan encourages a logical approach to implementation to ensure incremental progress is made within the framework of big picture goals for the watershed.

This Management Plan does not contain an exhaustive list of management alternatives but rather a starting place. The table of contents provides an outline for what is covered in the document. Additionally, examples (hypothetical and/or from past plans) are cited for illustrative purposes.

The more time and effort invested in watershed planning, the greater the chance of success. The planning process consists of fact-finding, analysis, and interpretation of information and trends concerning the local political, social, environmental, and economic aspects of the watershed. The planning process takes into consideration viable alternatives and their cost effectiveness to create recommendations to meet present and future needs in a comprehensive plan. Planning is a continuous process where progress and goals need to be revisited and revised at least every five years.

The following are symbols for contact resources and agencies used throughout the plan.

Federal Agencies:

United States Environmental Protection Agency

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

State Agencies:

DNR

Iowa Department of Agriculture and Land Stewardship

Iowa State University
University Extension

Local Agencies and groups:

United to keep our lakes alive!
Dickinson County Clean Water Alliance

Ducks Unlimited

Dickinson Soil and Water Conservation District

Silver Lake Park Improvement Assoc

Pheasants Forever

City of Lake Park Iowa
Incorporated July 1, 1892

List of Acronyms/Abbreviations

Term	Acronym/Abbreviation
Agricultural Environmental Management Plans	AEM
Best Management Practice	BMP
Colony Forming Unit	CFU
Chain Of Custody	COC
Cooperative Lakes Area Monitoring Project	CLAMP
Clean Water Alliance	CWA
County Conservation Board	CCB
Data Quality Objective	DQO
Department of Natural Resources	DNR
Dickinson County Conservation Board	DCCB
Dissolved Oxygen	DO
East Okoboji Beach	EOB
Environmental Protection Agency	EPA
Geographic Information System	GIS
Iowa Lakes Community College	ILCC
Iowa Department of Natural Resources	IDNR
Iowa Great Lakes Watershed	IGLW
Iowa Lakeside Laboratory	ILL
Iowa Watershed Improvement Review Board	WIRB
IOWATER Program	IOWATER
Nephelometric Turbidity Unit	NTU
Nitrate Nitrogen	NO_3-N
Natural Resources Conservation Services	NRCS
Quality Assurance Coordinator	QAC
Quality Assurance Manual	QAM
Quality Assurance/Quality Control	QA/QC
Quality Assurance Project Plan	QAPP
Resource Conservation and Development	RCD
Resource Management Area	RMA
Relative Percent Difference	RPD
Relative Standard Deviation	RSD
Standard Operating Procedure	SOP
Standard Methods	SM
Soil and Water Conservation District	SWCD
STORage and RETrieval	STORET
Total Maximum Daily Load	TMDL
Total Phosphorus	TP
Total Suspended Solids	TSS
United States Department of Agriculture	USDA
University of Iowa Hygienic Laboratory	UHL
Watershed Management Plan	WMP

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Executive summary

In 2010, the first edition of the Silver Lake Watershed Management Plan (WMP) was completed and the purpose of that plan was to develop a methodology to treat the watershed in a logical manner. Prior to that, the Silver Lake Watershed was treated in a random manner for several years. Silver Lake has not shown a significant chemical or physical change over the years of watershed treatment. The WMP that was written in 2010 was meant to target the work of the watershed in a way that provides the greatest benefit in the areas of the greatest pollutant production.

This WMP is an improvement from the last plan in that load reductions are targeted for specific areas of the watershed along with estimated costs. In the past, the efforts within Silver Lake Watershed have been managed in a fashion that allowed for watershed work to be complete but did not target any one specific area. As a result of this lack of targeting, projects were complete and good was done within the watershed, but no chemical or physical results were seen in the those same properties of the lake and its watershed.

In the previous WMP there were three sub-watersheds identified as Resource Management Areas (RMA's). The WMP gave an end result for what needed to happen in each of those RMA's but did not have timelines or specific treatment practices. This WMP is specific in giving dates and practices that will be completed using the best science available as well as a cost estimate based on pounds of Phosphorus removed; the primary pollutant of concern in the Watershed and the lake. In addition, the Iowa Nutrient Reduction Strategy is being used as the basis for this plan in estimating pollutant reduction and costs. Thus the Silver Lake plan is in concert with the State Nutrient Reduction Strategy at all levels. This plan also uses the Iowa Department of Natural Resources Non-Point Roadmap to Success plan for nonpoint source pollutants causing problems in our lakes.

This WMP lays out a specific and quantifiable plan from 2016 to 2028 to reduce the primary pollutant, phosphorus that enters the lake and causes the problems within it. Using modeling and approximations, we can estimate a reduction of phosphorus that enters the lake of 12,331 pounds during the upcoming years of the project by completing the practices suggested. By enacting this plan and reducing the P by the amounts planned within this WMP the quality of the water in the lake will improve and it will fully recover from its impaired state and become fully functional and supporting once again.

This WMP will call for the treatment of the entire Watershed, in an effort to reduce pollutants in the lake. Each of the Resource Management Areas (RMA) throughout the watershed has been assigned a total amount of Phosphorus to be removed. In addition, each RMA also has a set number of practices that can remove Phosphorus; the important fact is not to rely on the installation of a set number of practices, but rather on the amount of **phosphorus reduced**.

With that, this plan calls for a total reduction of around 1,579 pounds of phosphorus from cropland. This reduction is a 60% reduction of phosphorus from agricultural lands. In lake reduction, will cover the remaining reduction in phosphorus that is needed through carp exclusion and reduction, and shallow lake management. The TMDL provides an example that

80% of the internal loading must be reduced in order to meet the requirement set forth. The amount of reduction to achieve that loading is 10,682 pounds of phosphorus. Urban areas contribute a small amount of phosphorous but the reduction of P in these areas will be 69.6 pounds. In addition, septic tank renovations and inspections will be used to correct possible septic tank contributions to the Phosphorus loading. The TMDL does not directly address the Drainage Ditch that runs the extent of the Trappers Bay RMA as a source of sediment and pollutants directly. This plan addresses the ditch as a source of sediment and phosphorous and addresses the ditch only as far as its contribution is concerned as part of the Trappers Bay RMA. A drainage ditch study was completed during 2015 and shows a significant amount of sediment deposition from the stream bank itself.

The Silver Lake Watershed project is credited with stopping 215 tons of sediment from reaching the lake which equates to 494.5 pounds of phosphorous from reaching the lake since 2012. These reductions include both Management practices such as cover crops and Sediment Control practices such as Sediment Basins. These pollution reduction numbers come from the State of Iowa's Pollution Reduction Calculator.

Shoreline erosion was not included in the original WMP or the TMDL and it has been found to be a significant source of pollution to the lake. The shoreline was evaluated in both 2012 and again in 2014 to determine the significance in the shorelines causing sediment pollution. That evaluation is significant and is reflected within this WMP.

Finally the internal load is significant and is reflected within this WMP. Several studies have shown that once phosphorous is within a lake there are not a lot of practices that can be used to reduce or inhibit it. One such study recently released puts down the idea that wind/wave action suspends sediment so the attached phosphorous can be used in algae production. Rather this article points more towards fish rooting at the bottom, boats, and algae growth as being the key components of reduced visibility in a shallow lake. (John A. Downing, Christopher T. Filstrup, and Clayton J. Williams, 2015)

1. Introduction

Silver Lake is a natural lake that borders the west edge of the City of Lake Park, located in Dickinson County in northwest Iowa. Trappers Bay State Park borders the northeast corner of the lake. The Iowa Department of Natural Resources (IDNR) owns and operates the Silver Lake Wildlife Management Area (WMA), which is also adjacent to the lake. The Center for Agricultural and Rural Development (CARD) at Iowa State University estimates that between 2002 and 2005, Silver Lake averaged over 47,000 annual visitors, which is well below the state average for Iowa lakes over the same period (CARD, 2008). The number of annual visitors to the lake and water quality has both decreased in recent years. (Ikenberry, 2009) Silver Lake consists of 17,025 acre watershed in Northwest Iowa and Southwest Minnesota. The total surface area of the lake is 1,066, including a 34 acre marsh on the northeast corner of the lake known as Trappers Bay.

The purpose of this management plan is to work with the total watershed. The management plan has been written to assist with any water quality work that individuals, public or private groups and governmental entities wish to do within the watershed. This management plan will continue to evolve to allow for new technologies and studies that are still yet to come; to be taken into consideration for improvements that will greatly help the efforts to clean up the water flowing into and out of the lake system.

The original Silver Lake Watershed Management Plan was approved by the Iowa DNR in 2010 and is required to be rewritten every 5 years. This rewrite relies heavily upon the release of the Iowa Nutrient Reduction Strategy, which is drawn upon a great deal in the writing of this document for scientific background in reduction amounts and costs. The areas of the watershed are further broken down and described and listed later.

The watershed of the lake has been broken into 6 sub-watersheds known Resource Management Areas (RMA's). These RMA's are more easily monitored for water quality improvements and protection. In addition, successes in these smaller "sub-watersheds" can be more easily monitored and documented as they occur.

The following RMA's will be discussed further in the plan:

RMA	Page	Total Size (acre)
South Bay	76	1,001
West Bay	43	2,936
Trappers Bay West Basin	54	4,720
Trappers Bay Central Basin	61	3,641
Trappers Bay East Basin	68	3,471
Urban RMA	90	1,220

Table 1: Resource Management Areas, page number, and total size of RMA

Impaired Waters

Every two years, the Iowa Department of Natural Resources derives a list of Impaired Water Bodies that have been tested and shown to consistently have poor water quality due to one or more reasons that are regarded as poor water quality indexes. The goal of this plan is to remove and prevent Silver Lake from being listed by improving the water quality and managing the watershed to the point where the pollutants are taken out of the system well before the water reaches the lake or the pollutant is insignificant enough to no longer affect the lake. Within the individual RMA plans, it will be discussed how the practices implemented will reduce the excess nutrients reaching the lake in order to reach a point where the impaired status can be removed by the Iowa DNR.

Silver Lake is not supporting its Class A1 (primary contact recreation) designated use. Primary contact recreation includes activities that involve human contact with the water such as swimming, wading, and water skiing. This use is not supported in Silver Lake due to poor water transparency, which violates the narrative water quality criterion for surface waters to be free of "aesthetically objectionable conditions." (Ikenberry, 2009)

The goal of this plan is to improve the water quality of Silver Lake to support multiple uses, to benefit fish and wildlife resources, and to improve the quality of life for those who use the lake and the watershed. To achieve these results, sediment and phosphorus need to be reduced and prevented from reaching Silver Lake.

> *A thing is right when it tends to preserve the integrity,*
> *stability and beauty of the biotic community. It is*
> *wrong when it tends otherwise.*
> ***Aldo Leopold***

2. Best Management Practices (BMP's)

Throughout this plan, many different practices will be mentioned to help "clean" the water flowing into the lake. These practices have been studied and tested extensively and have been proven to improve water quality in many settings. Several are described here with an explanation of how they help but new technology and new thought process may provide for additional practices that are not listed within this plan. The Iowa Nutrient Reduction Strategy has been used as a guide to determine the Best Management Practices (BMP's) and the amounts of nutrient reduction for those practices. Iowa's Nutrient Reduction Strategy is based on the best science available and peer reviewed data that gives us reliable information to make informed decisions.

Based on the Nutrient Reduction Strategy we will use a treatment strategy that is broken into 6 categories. Those categories include Phosphorus Management, Land Use Change, Edge of Field, Shallow Lake Treatment, Education, and Monitoring. Although many practices have been identified in this plan, it is important to understand the practice is not as important as the reduction in Phosphorus and that is where our concentration should be focused.

BMP's based on the Iowa Nutrient Reduction Strategy:

Phosphorus Management —

Reduced Tillage Incentive (Conservation, strip-, ridge-, no-till): Conservation tillage consisting of Conservation tillage, Strip-tillage, ridge-tillage and no-tillage practices is one of the best tools to keep soil from eroding and becoming sediment in the lake. These practices allow agricultural crops to be planted with minimal disturbance to the soil and removing little to no residue. The main focus would be on land that is targeted throughout the RMA's as highly erodible or easily erodible.

P Rate Reduction: This practice involves not applying P, reducing the amount of P, or placing the P within the root zone of the target crop on fields where soil tests values exceeds the upper boundary of the optimum level for corn and soybeans in Iowa, which is 20 parts per million. This reduction would be continued until the soil test values drop below or equal to the optimal values. This practice would be a cost benefit to landowners and operators as well as reduce the available phosphorus that could enter the waterbody.

Cover Crops: The late summer or early fall planting of cover crops (primarily winter rye in Dickinson County and Osceola County, Iowa) provides a benefit of improved soil quality, improved water retention in the soil, reduction in disease and insect pressure, and reduced erosion and reduced nitrogen and phosphorus loss from the field. This practice can provide a reduction of up to 50% phosphorus loss from a field each year the practice is applied.

Land Use Change —

Grassed Waterway: Grassed waterways are placed in areas which have significant water flow to reduce soil erosion and prevent ephemeral gulley's from forming. One advantage to this practice allows the farmer to make up for lost crop production by entering the area affected into a Conservation Reserve Program (CRP) and receive rental payments for not farming the ground.

The roots from the grass hold the soil in place preventing it from running off the field into nearby streams, rivers and lakes.

Sediment Basin: Sediment basins are structures that are used to hold back water carrying sediment and allow the sediment to drop out of the water and allow the water to leave in an improved state. Sediment basins will be used where wetlands are not wanted by landowners who don't want to give up land to upland plantings and wetland soils. Basins are an effective alternative which allows the landowner to maintain a farmable row pattern. These basins will be strategically located in small drainage areas where significant loading is occurring and will be utilized in the more traditional sense as a catchment to trap pollutants and slow water.

Grade Stabilization Structures: Grade stabilization structures are built across gullies or grassed waterways and drops flowing water to a lower elevation to protect soil in a gully from eroding into a nearby water way.

Land Retirement: Land Retirement would be used in specific areas with the highest erodible soils (mainly on steep hillsides) to remove this land from production and keep it in permanent tall grass prairie. This might include permanent protection to stop erosion from highly erodible soils by paying landowner 100% of appraised value for the land plus restoration costs for these tracts of land. In addition, land retirement might be required in wetland restorations to "square fields up" and provide an easy to farm solution to a farmer. The Conservation Reserve Program may be part of the land retirement practice as well as conservation easements and land acquisition.

Low Impact Development Practices (LID): Practices such as rain gardens, bio-cells, and pervious pavers will be used. These practices are favored among people living in cities to handle storm water runoff. Bio-cells and rain gardens have soil that has been replaced with an engineered mix of soil, compost and sand to allow for better infiltration of surface water into the ground water system. Native plants are encouraged to be planted because they are tolerant of extreme wet/dry cycles rain gardens typically experience and they help to maintain a high organic content of the engineered soil and keep the soil porous and able to handle the water flow with restored hydrology. Pervious pavers similar to conventional paver systems, this practice places individual pavers slightly more spaced out over a bed of crushed rock layers instead of sand to allow better percolation of water into the ground beneath the pavers to reduce surface runoff and to catch and trap sediments and excess nutrients preventing them from entering the ground water system. This system is typically used for patios, driveways and parking lots. The entire suite of LID practices will be used to reduce, slow, and prevent runoff to the lake.

Construction Site Management: Urbanization is an ongoing issue in the Silver Lake Watershed and construction site development can be a significant source of pollution, often greater than a farm field Development BMP's. Construction site practices such as silt fence, seeding, and redirecting water flow should be used as BMP's for construction sites.

Septic System Inspection and Septic System Renovation Demonstration: Rural residence septic systems throughout the watershed, in some instances, have not been adequately maintained and may not be functioning properly. This may be a significant issue due to impermeable soils found throughout the region, which may result in systems being connected directly to field drainage tile. Due to the difficult nature of assessing and detecting these faulty systems, project sponsors intend to launch a voluntary inspection incentive campaign to encourage rural residents to begin to address the issue.

Edge of Field —

Wetland Restoration: The land use of the Silver Lake Watershed has undergone dramatic changes post settlement with the bulk of the wetlands that once dominated the landscape now drained and converted to row crop production. These areas that once stored and filtered water are now left with straightened drainage ditches and tile lines leading to the lakes or a small number of over-stressed wetlands. The goal of this practice is to restore wetlands with upland buffers to filter water and assist with restoring historic hydrology where possible. This will be done with native prairie seeding on the upland, surfacing of tile lines, tile line breaks and wetland basin native seeding of a diverse hydrologic plant community. These should be large shallow basins focused only towards water quality and most likely to go nearly dry seasonally. Some of these wetlands may require structures to maximize the wetland restoration to have little to no impact on neighboring properties that don't want to participate with a wetland restoration. Wetlands within the plan have been prioritized by sediment delivery models and wetland to upland ratio. A more intense survey of the land and discussion with private landowners is needed to determine the best option whether it be wetland restoration or to look at other options.

Sediment control practices: This practice includes waterways, sediment basins, and grade stabilization structures and other practices, but these are on the edge of a field rather than part of the field. This practice is flexible and intended to be only in the field margins and the edge of the field as the water moves away from the field.

Filter Strips: Filter strips promoted in critical locations and funded through the CRP program or similar programs. Filter strips are used to slow runoff water and allow it to infiltrate into the soil. Filter strips can be used on streams, lakeshores, tile inlets, storm sewers, and other areas with direct access to surface water.

Underground Outlet: This practice focuses on replacing traditional Hickenbottom intake risers with an underground system to drain excess water from depressions in the field. Traditional riser systems can be tricky to farm around, get stuck in equipment and allow for unfiltered water to drain directly into the field tile without addressing nutrient and sediment concerns. Underground Outlets bury the intakes and allow for the same infiltration as Hickenbottom intakes but also allow for sediments to naturally settle out before reaching the tile line reducing the chance for pollutants to reach the drainage system. This alternative has become popular among farmers as the maintenance is minimal compared with traditional systems. Underground outlets have the potential to reduce 85 percent of the sediment delivery over conventional intakes.

Shallow Lake Restoration —

Shoreline Restorations: Shoreline work is necessary to address shoreline erosion and to help reduce internal loading of phosphorus within the lakes. The restoration of native prairie buffers around the lakes has reduced shoreline erosion in some areas by up to one foot per year. The deep rooted native vegetation holds the shoreline soils in place better than short rooted turf. Shoreline restoration projects also help reduce internal phosphorus loading by re-establishing plants to use up some of the phosphorus. Native emergent plants like bulrushes, arrowhead plant, bur-reed and sedges help tie down loose sediments on the lake bottoms near the shore where most stirring and re-suspension of sediment takes place. The re-establishment of these plants along with native prairie buffers should eliminate almost all shoreline erosion in areas where they are re-established.

Shallow Lake Restoration Practices: Watershed restorations and reductions in nutrient and sediment loading are not enough to restore water quality in the shallow lakes of some RMA's. Development of long-term management strategies to improve aquatic plant diversity and density and manage common carp populations are needed to complete a holistic plan. The feasibility of using water level management (shallow lake management strategies) to positively affect water quality in Silver Lake should be explored.

Water-level drawdowns result in consolidation of bottom sediments, germination and growth of emergent aquatic plant species, and management of common carp populations. In shallow lakes, common carp can root up aquatic vegetation and their feeding habits can stir up bottom sediments leading to high turbidity and the release of nutrients into the water. Additionally, installation of fish barriers will help to slow the re-infestation of adult common carp and maximize the period between drawdowns. Electric pumping stations and intake lines will most likely be needed to facilitate temporary drawdowns in some shallow lake systems. It will be important to maintain some connectivity of these systems to the larger lake system providing spawning and nursery habitat for a number of native fish species.

Carp Exclusion/Reduction: Recent research has indicated that successful common carp reproduction is associated with predator fish free shallow marshes and sloughs connected to natural lakes. By blocking adult spawning carp from entering these areas, reproduction can be controlled. If reproduction can be controlled, physical removal of adult fish can be used as a viable means of significantly reducing the biomass of common carp and minimizing their impact on water quality and nutrient cycling.

3. Water Monitoring Plan

The water monitoring for the Silver Lake Watershed will focus on the impairments for the lake. Monitoring research will be conducted to get data to determine load reductions in a lake from practices completed within the watershed. This is necessary to show load reductions that are required in the Silver Lake Watershed to make the needed impact on the lake itself.

The sampling within Silver Lake will be conducted by local volunteers and staffs from Dickinson Soil and Water Conservation District, the State Hygienic Laboratory (SHL) at the University of Iowa and/or Iowa DNR monitoring and fisheries. The hydrology of the Silver Lake Watershed is unique; therefore sampling frequency will be determined on a site by site basis. Samples will be collected on a regular basis if hydrologic conditions permit as well as after storm events. Sampling locations will be based on BMP installation and hydrologic conditions within each RMA.

The water quality indicators that have been selected for Silver Lake Watershed Management Plan are nutrients and sediment. The parameters to be included are total phosphorus, nitrate plus nitrite nitrogen, E. coli, and total suspended solids (TSS). The monitoring in each RMA is designed to capture conditions prior to and after BMP installation at locations where the impacts can be measured. Over the short-term, these monitoring locations will be able to show the effectiveness of the BMP's. Additional long-term, ambient monitoring throughout the watershed will also demonstrate the overall effectiveness of BMPs in the RMA's.

Standard Methods for Collection

Sampling is designed to collect baseline data that will aid in the identification of problems that exist in the watershed. This data will serve as a guideline for future implementation of suggested conservation practices. The sampling design will allow for collection of data during varying flow conditions, including ambient, base flow, and storm conditions. Storm conditions that will be sampled include any storm with over 1.25 inches of rain or a significant amount of rain in a 24 hour period. The samples will be taken using first flush samplers, grab samples, automatic samples, and visual samples.

Depending on the sampling site and conditions, samples will either be collected directly from the stream or lake. Prior to sample collection, each lab sample container is labeled with a permanent waterproof marker. Lab sample container labels include site name, date and time of sample collections, and the collector's name. Equipment cleaning and decontamination and preservation methods as will be instructed by the analyzing laboratory.

Sampling will be conducted in a manner that minimizes the chances of contamination. Lab samples will be collected in sterile, unused sample containers provided by SHL. Sample collection personnel will be instructed not to touch the insides of the sample containers or caps. Lab sample containers will be filled without pre-rinsing the container. Some lab sample containers contain a preservative. When collecting samples in these containers, a small amount of air space will be left to ensure that the preservative is not lost or diluted.

When grab sampling is suitable, samples should be collected along the sample site cross-section. A sample is taken at a point that best represents the water quality of the total flow at the cross section of the stream. A sampling point should be avoided if it is poorly mixed or if it is affected by local temporary conditions such as ponding across part of the stream width, if there is an obviously disproportionate sediment load or backwater conditions. If a site is poorly mixed across the stream, an integrated sample from across the stream width should be used, or another site should be chosen that is well mixed across the stream width.

If the lab sample is collected directly from the stream, it will be collected in the middle of the channel facing upstream. If the lab sample is taken from a bridge, the sample will be collected on the upstream side of the bridge over the middle of the channel or wherever the flow is the greatest. Regardless of collection method, the grab sample is stored and transported in a clean, labeled container. Samples will be collected directly into the lab sample container, immediately capped, and then stored on ice until packaged for delivery to the lab. Field parameters are then measured for dissolved oxygen, water temperature, chloride, and turbidity. The turbidity sample will be analyzed immediately at the site after calibrating the turbidity meter.

To prevent contamination, the glass vial the turbidity sample is measured in will be rinsed with distilled water three times before each use. The remaining water in the water collection container is discarded and “fresh” sample is collected. This water is then used for the chloride test. Chloride is measured using a HACH Quantab test strip. The dissolved oxygen/water temperature probe is lowered into the stream, ensuring that the probe is not making direct contact with the stream bed. Before making the field measurements, the sensors must be allowed to equilibrate with the water being monitored. The sensors have equilibrated adequately when the temperature measurement variance is within ±0.2 ºC and the dissolved oxygen measurement variance is within ±0.5 mg/L. The dissolved oxygen and water temperature measurements will be recorded on the field form.

A reassessment of a lake will either be completed once 25% of the BMP’s have been implemented in an RMA or at the end of five years. A reassessment of the lake may be needed if the lake has been found to have enough water quality violations to impair the lake. The reassessment may also be needed if water monitoring finds new water quality violations or if a new problem is found that was not originally evaluated for the current plan.

Local Watershed Monitoring

Beginning in 2007, the Dickinson Soil & Water Conservation District formed a partnership with the Silver Lake Park Improvement Association (SLPIA) and the Dickinson County Water Quality Commission to conduct an on-going monitoring program at key locations within the Silver Lake Watershed. Although several years of in-lake monitoring data were available, little effort had been given to monitoring the quality of water entering the lake from its watershed. The partnership realized that if they were to expect financial assistance for the installation of conservation best management practices (BMP’s) and other water quality improvements, they would need data from the watershed itself. To date, this data has been used to provide a baseline in evaluating the overall health of the watershed, as well as helping pinpoint critical areas which should be targeted with incentives for the implementation of BMP’s.

Figure 1: Silver Lake Watershed monitoring locations

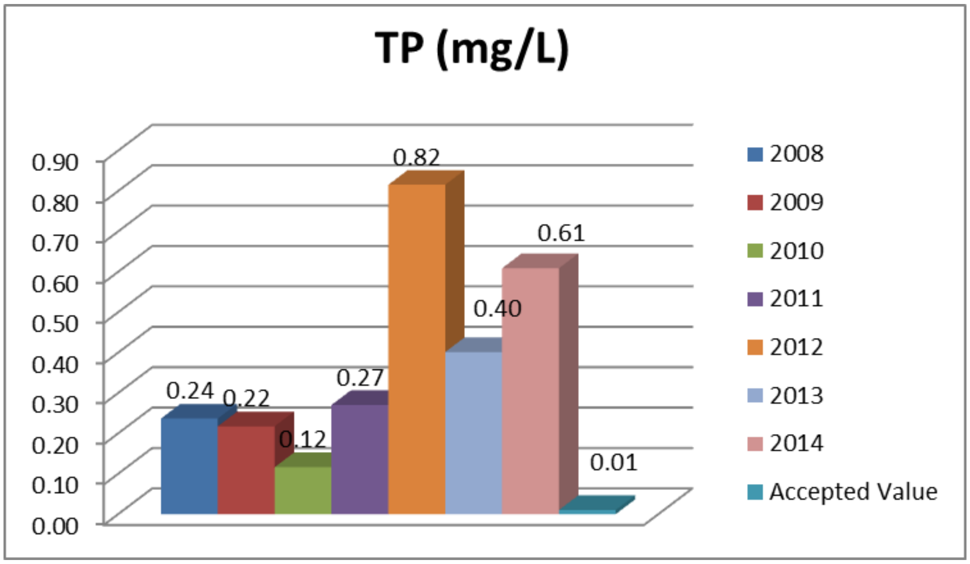


Figure 2: 2008-14 Average Values of all Watershed Monitoring Sites for given Year; Total Phosphorus: Silver Lake Watershed sampling sites (accepted value < 0.01) mg/L)

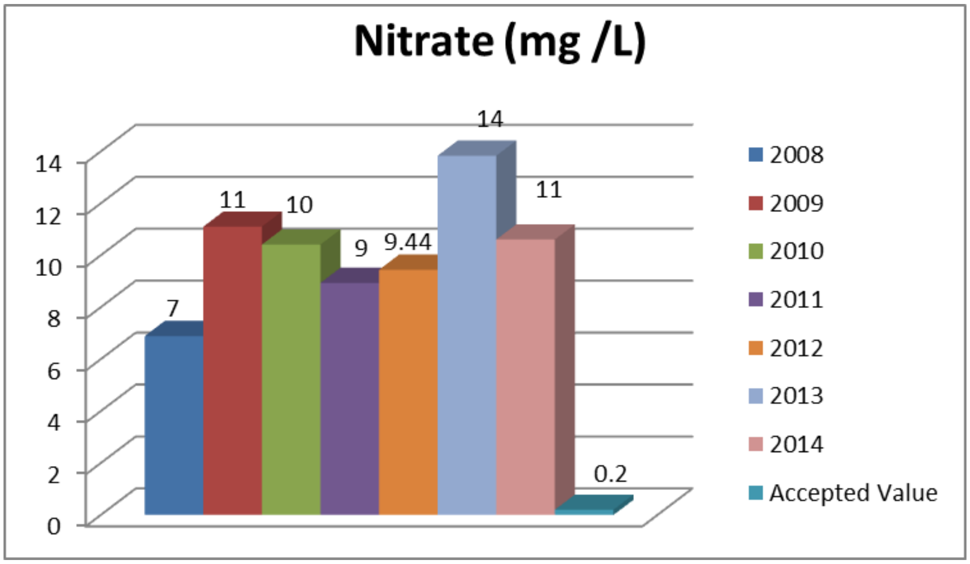


Figure 3: 2008-14 Average Values of all Watershed Monitoring Sites for given Year**; Nitrate (accepted value < 0.2 mg/L)**

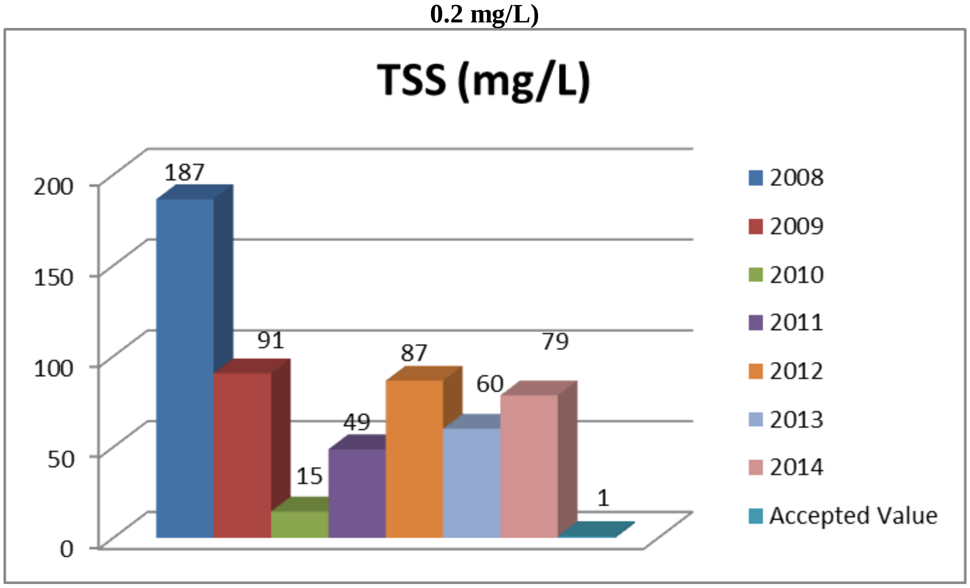


Figure 4: 2008-14 Average Values of all Watershed Monitoring Sites for given Year**; Total Suspended Solids: (accepted value < 1 mg/L)**

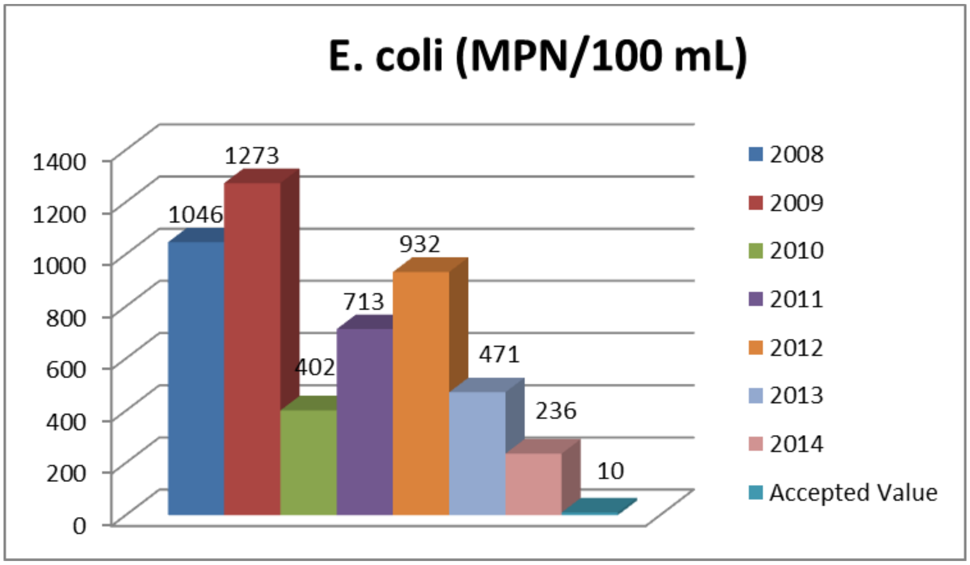


Figure 5: 2008-14 Average Values of all Watershed Monitoring Sites for given Year; **E. coli (accepted value < 10 MPN/100 mL)**

Cooperative Lakes Area Monitoring Project (CLAMP)

CLAMP began in 1999 as an inspiration of the Friends of Lakeside Lab, local lake organizations and the Dickinson County Clean Water Alliance. The goal was to address the need for a long-term, unified approach to monitoring Dickinson County lakes. CLAMP is coordinated by Iowa Lakeside Laboratory, and supported by many local partners. (Laboratory, 2008)

Over 100 volunteers have trained and participated in CLAMP since its inception in 1999. CLAMP volunteers sample nine lakes in Dickinson County: Big Spirit Lake, Center Lake, East Okoboji Lake, Little Spirit Lake, Lower Gar Lake, Minnewashta Lake, Silver Lake, Upper Gar Lake, and West Okoboji Lake. Volunteers collect field data including Secchi depth, dissolved oxygen and temperature, and collect water samples for laboratory analysis including total nitrogen, ammonia nitrogen, total phosphorus, chlorophyll “a”, phytoplankton and microcystin analysis.

Figure 6: CLAMP monitoring locations on Silver Lake

Parameter	2007	2006	2005
Secchi Disk Depth (m)	0.7	0.6	0.7
Dissolved Oxygen (mg/L)	8.5	8.7	8.1
Dissolved Oxygen Saturation (%)	96.9	100.0	94.1
Chlorophyll a (µg/L)	58.0	60.3	143.9
Total Phosphorus as P (µg/L)	83	95	118
Total Nitrogen as N (mg/L)	2.31	3.34	2.99
Microcystin (ng/L)	8.4	3.0	1.9
Carlson Trophic State Index (Secchi)*	66	67	65
Carlson Trophic State Index (Chl a)*	70	71	79

Table 2: 2005-2007 water monitoring results in Silver Lake (CLAMP) (Laboratory, 2008)

Year/ **Principal Investigator**	**Sampling Period**	**Number sampling sites**	**Total samples collected**	**Avg Total P (mg/L)**	**SE**
1979 Bachmann	June -- October	1	10	**0.097**	**0.012**
1990 Bachmann	5/26 -- 7/28	1	9	**0.105**	**0.004**
1999 CLAMP	7/30 -- 8/26	4	12	**0.123**	**0.008**
2000 CLAMP	6/6 -- 8/22	4	23	**0.164**	**0.015**
2001 CLAMP	6/5 -- 8/28	4	28	**0.209**	**0.017**
2002 CLAMP	6/11 -- 8/20	4	24	**0.185**	**0.029**
2003 CLAMP	6/10 -- 8/19	4	24	**0.170**	**0.017**

Table 3: CLAMP data median values 1979-2003 (Laboratory, 2008)

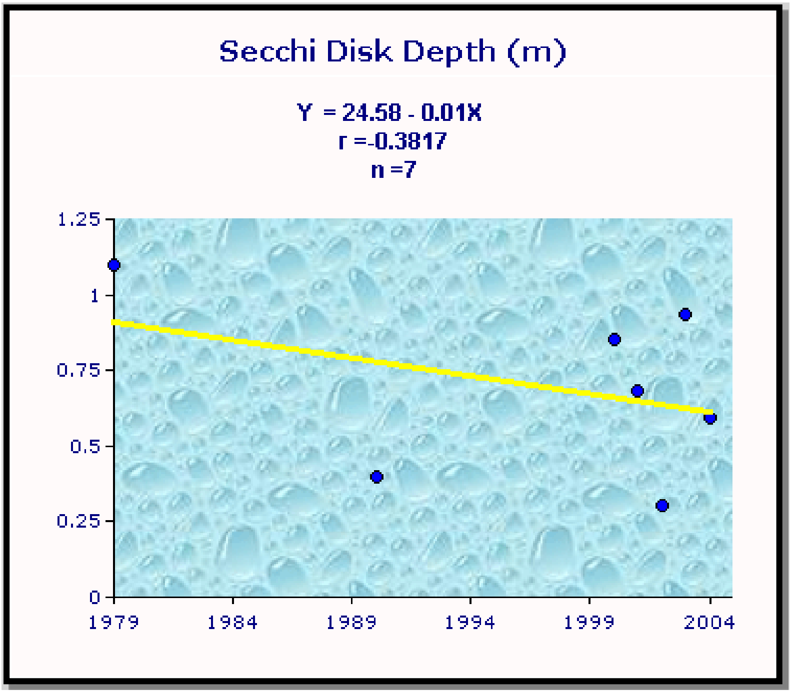


Figure 7: 1979-2004 trend in Secchi Depth, showing the decline in water quality (Roger Bachman, John R. Jones, 1974)

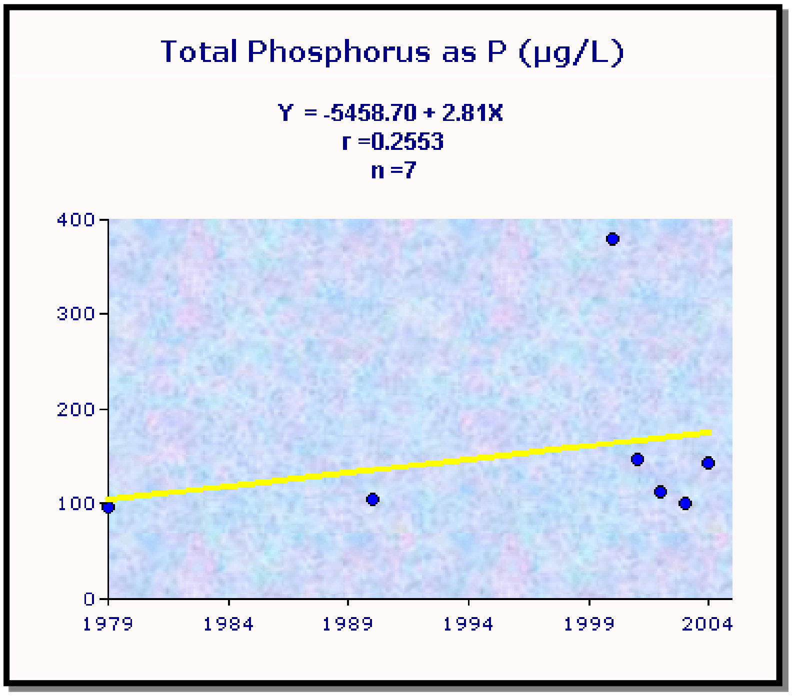


Figure 8: 1979-2004 trend in Total Phosphorus, showing the increase in P (Roger Bachman, John R. Jones, 1974)

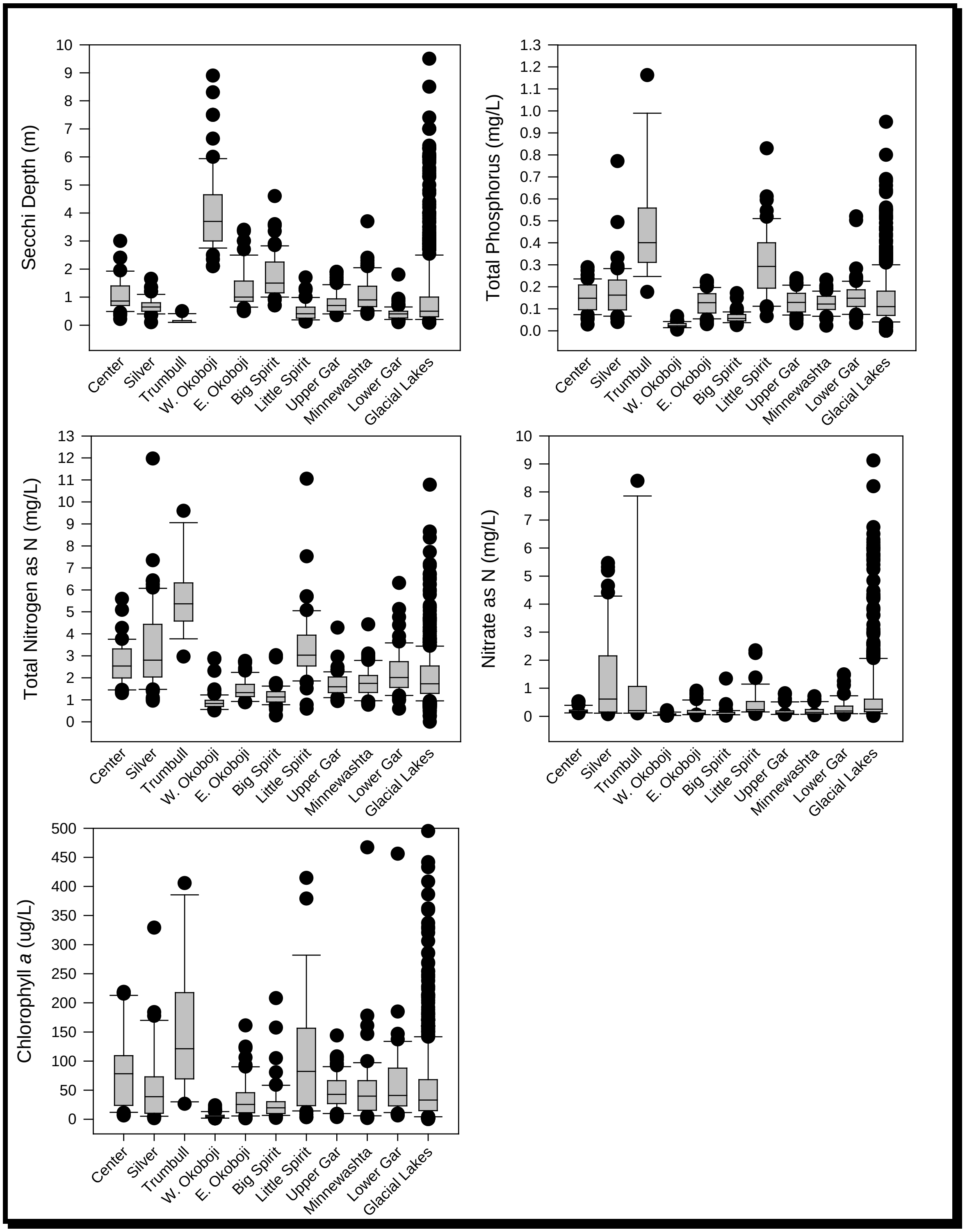


Figure 9: 1999-2006 Dickinson County CLAMP data (Laboratory, 2008)

Silver Lake CLAMP Data Summary

Secchi depth ranged from 0.1 m to 1.7 m, with the deepest Secchi depths occurring in the spring, and the shallowest in late summer. Overall, Secchi depths in Silver Lake were shallower than most other CLAMP lakes and similar to the median for all monitored, glacial lakes in Iowa (Figure 9).

Total phosphorus concentrations ranged from 0.03 mg/L to 0.3 mg/L. The median total phosphorus concentration for Silver Lake was higher than all other CLAMP lakes with the exception of Trumbull and Little Spirit and higher than the median for all monitored, glacial lakes. Total nitrogen concentrations in Silver Lake were also higher than most other CLAMP lakes and the median for all monitored, glacial lakes (Figure 3).

Chlorophyll *a* concentrations ranged from 3 µg/L to 753 µg/L. The median chlorophyll *a* concentration for Silver Lake was similar to Upper Gar, Minnewashta, and Lower Gar as well as the median for all monitored, glacial lakes (Figure 3).

"Ambient Lake Monitoring Program"

The Iowa Department of Natural Resource's ambient lake monitoring program began in 2000. One hundred thirty-one lakes located throughout the state are monitored between 3 and 5 times during the summer by Iowa State University (2000-2007) and University of Iowa Hygienic Laboratory (2005-2007). Big Spirit, Little Spirit, East Okoboji, West Okoboji, Lower Gar, Upper Gar, Minnewashta, Center, and Silver Lake are all monitored as part of this program.

Through the ambient lake monitoring program the lakes are monitored for a number of physical, chemical, and biological parameters. Physical parameters include: temperature, dissolved oxygen, specific conductivity, pH, Secchi depth, turbidity, total suspended solids, total fixed suspended solids, and total volatile suspended solids. Chemical parameters include: total nitrogen, nitrate + nitrite, ammonia, total phosphorus, soluble reactive phosphorus, silica, alkalinity, total organic carbon, and total dissolved solids. Biological parameters include: chlorophyll *a*, phytoplankton biomass and composition, and zooplankton biomass and composition. The ambient monitoring program characterizes current water quality in the monitored lakes and will provide an opportunity to track trends in lake water quality.

The ambient lake monitoring program differs from the CLAMP program in that the samples are collected and analyzed by professionals. The ambient program, however, only samples the lakes three to five times throughout the summer, while the CLAMP program is able to sample the lakes more frequently. The ambient program also only samples one location on the lake (deep spot) so that the data from each lake can be compared to other lakes in the state. The CLAMP program samples multiple locations on each lake, which allows for a more complete spatial characterization of the lakes.

The ambient program tests for more parameters than are feasible through the CLAMP program. This allows for a greater understanding of the characteristics of each of the lakes. The CLAMP program includes Secchi depth, total phosphorus, total nitrogen, nitrate plus nitrite nitrogen, and chlorophyll *a*, which are all explained above. The additional parameters monitored by the ambient lake monitoring program are explained below.

Physical Parameters

Temperature and Dissolved Oxygen (DO) profiles are measured at the sampling location. A probe is lowered in the water column and a reading is taken at regular intervals to determine if the lake is thermally stratified. Thermal stratification occurs when surface waters warm and the density difference between the cooler, deeper water and the warm surface water prevents mixing. One potential consequence of thermal stratification is anoxia (or low oxygen conditions) in the hypolimnion (the deep cold water area) due to respiration. Hypolimnetic anoxia can lead to release of phosphorus from the sediment which can lead to algae blooms. The extent of thermal stratification depends on several factors including depth, wind fetch, wind exposure, and spring temperatures. West Okoboji is the only lake in the Iowa Great Lakes that stratifies regularly. The other lakes are too shallow and are susceptible to mixing by the windy conditions in that area of the state.

Turbidity is a reduction in clarity that results from the presence of suspended particles. Turbidity usually consists of inorganic particles, such as sediment, and organic particles, such as algae. In general, the lakes in the Iowa Great Lakes region have lower turbidities than other natural lakes in the state with the exception of Little Spirit, Lower Gar, Upper Gar and Silver Lake.

Total Suspended Solids (TSS) includes all suspended particles in water that will not pass through a filter. Silver Lake (17.1 mg/L) has the highest TSS concentrations of the lakes in Dickinson County.

Biological Parameters

Phytoplankton wet mass and composition are measured to get a better understanding of the biological dynamics of each lake. Phytoplankton or algae are the photosynthetic organisms that form the base of the food chain in lakes. The median phytoplankton wet mass ranged from 9.1 mg/L in West Okoboji to 36.0 mg/L in Upper Gar. Silver Lake had a lower median concentration than the median for all monitored, natural lakes in Iowa (39.7 mg/L). Most phytoplankton samples were dominated by cyanobacteria, which often dominate summer plankton in productive lakes.

Lake Name	Secchi Depth (m)	Total Phosph-orus (mg/L)	Soluble Reactive Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate +Nitrite (mg/L)	Chloroph-yll *a* (ug/L)	Dissolved Oxygen (mg/L)
Silver Lake	**0.6**	**0.114**	**0.043**	**1.4**	**2.183**	**14**	**8.7**

Lake Name	Turbidity (NTU)	Total Suspended Solids (mg/L)	Total Fixed Suspended Solids (mg/L)	Total Volatile Suspended Solids (mg/L)	pH
Silver Lake	**33.9**	**17.1**	**11.4**	**6.1**	**8.4**

Lake Name	Phytoplankton Wet Mass (mg/L)	Zooplankton Wet Mass (mg/L)	Carlson Trophic State Index (Secchi)	Carlson Trophic State Index (Total Phosphorus)	Carlson Trophic State Index (Chlorophyll)
Silver Lake	**21.1**	**169.5**	**68**	**72**	**56**

Table 4: 2001-2006 median values in CLAMP monitoring data (Laboratory, 2008)

Nutrient Budget Summary

Lake nutrient budgets indicated that rainfall and dry deposition are major sources of total phosphorous (TP) and total nitrogen (TN) to Silver Lake. Surface water runoff contributes a substantial proportion of nutrients to the lake but there is considerable annual variability in contribution from runoff depending on the amount of precipitation between dry and wet years.

Generally, Silver Lake's sediment appears to be a source of nutrients to the water column. The sediment in Silver Lake does not settle to the bottom never to be seen again as it does in deep water lakes such as West Okoboji. Rather, the sediment in Silver Lake, and other shallow lakes of its kind, is re-circulated by wind and wave action, prop disturbance, and the "rooting" of rough fish such as carp and buffalo.

The significance of this circulation of sediment is that it carries with it the essential nutrient, phosphorous, that is a major producer of algae. Because the sediment continues to bring the phosphorous to the surface it is a constant source of nutrient for algae, which then grows, dies and settles to the bottom only to be circulated again the next time there is a significant wind. In addition, there is additional phosphorus being brought into the lake via the three major drainage ditches and through the Lake Park storm sewer system.

Turbidity

In general, Silver Lake has a higher turbidity and concentration of total suspended solids (TSS) than other natural lakes in the state. Silver Lake ranks in the bottom 25th percentile for average chlorophyll A concentrations, Secchi, average Carlson TSI, and average total phosphorous.

Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO.

Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding stream banks, large numbers of bottom feeders (such as carp), which stir up bottom sediments, and excessive algal growth.

Cyanobacteria

Sometimes called blue-green algae, cyanobacteria are organisms that naturally occur in fresh, brackish, and marine water. Cyanobacteria have many characteristics of bacteria, but they also contain chlorophyll, and can photosynthesize like algae and plants. Cyanobacteria often have a blue-green color, which is why they are also called blue-green algae. Cyanobacteria come in many sizes and shapes including microscopic single cells as well as filaments and colonies that are easily visible to the naked eye.

Photo 1: Cyanobacteria in Silver Lake, Dickinson County. Photo courtesy of J. Graham, U.S. Geological Survey.

Cyanobacteria occur naturally in most lakes, but under the right conditions cyanobacteria may grow excessively causing massive accumulations (called blooms) of the algae. Many different factors may lead to cyanobacteria blooms including excessive nutrients, low light levels, elevated temperatures, and low water levels.

Cyanobacteria blooms are unsightly and caused low dissolved oxygen levels and reduced water quality. In addition, cyanobacteria have the potential to produce toxins (called Cyanotoxins), that are potent enough to poison aquatic and terrestrial organisms, including animals and humans. Alteration, degradation, and eutrophication of aquatic ecosystems have lead to an increasing occurrence of cyanobacteria blooms worldwide. Blooms have occurred everywhere from Brazil to China, Australia to the United States.

During 2006, cyanobacteria made the news in at least twenty-one states; seven of those in the Midwest including Minnesota, Wisconsin, Illinois, Iowa, Missouri, Kansas, and Nebraska. Even more startling is the statistic that at least 33 States have anecdotal reports of human or animal poisonings associated with Cyanotoxins.

Photo 2: Cyanobacteria blooms in Silver Lake. Photos courtesy of Steve Anderson

Photo 3: Cyanobacteria blooms in Silver Lake. Photos courtesy of Steve Anderson

There are many different ways that the algae can be transferred between ecosystems including flow from one lake to the next or from one reservoir to the next, transport of live cells or spores by animals, and people, and transport of spores by wind.

There are several factors complicating our understanding of how and how often cyanobacteria are transferred among water bodies including: cyanobacteria spores may be dormant in lake sediments for many years or the cyanobacteria may typically be present in the water column at levels that are too low to detect until conditions become ideal for cyanobacteria growth. Transfer probably isn't as much of a concern in Silver Lake as water quality – from what biologists can see most of the lakes has the same cyanobacteria species present, although the dominant species may vary from lake to lake.

Concerns

There are four main concerns with cyanobacteria:

1. Cyanobacteria may potentially produce taste-and-odor compounds and toxins that are poisonous to both aquatic and terrestrial organisms.
2. Cyanobacteria blooms may form in warm, slow-moving waters that are rich in nutrients such as fertilizer runoff or septic tank overflows.
3. Cyanobacteria blooms in Silver Lake may occur at any time, but most often occur in late summer or early fall.
4. Unsightly, potentially toxic, cyanobacteria blooms may lead to a loss of recreational revenue.

Solutions

A long-range strategic plan developed by the Dickinson Clean Water Alliance has identified four main watershed goals for Silver Lake and other lakes in Dickinson County:

1. Native biological diversity is respected and encouraged
2. Infiltration practices are promoted throughout the watershed
3. Impaired waters are protected and improved
4. High quality waters are maintained and improved

These goals will assist in reduction of the number of occurrences of cyanobacteria blooms. They can be achieved by protecting and improving water quality, which could reduce sediment and nutrient loads, which may decrease the low light/high nutrient conditions favored by the cyanobacteria; and native diversity of aquatic plants may discourage the growth of cyanobacteria.

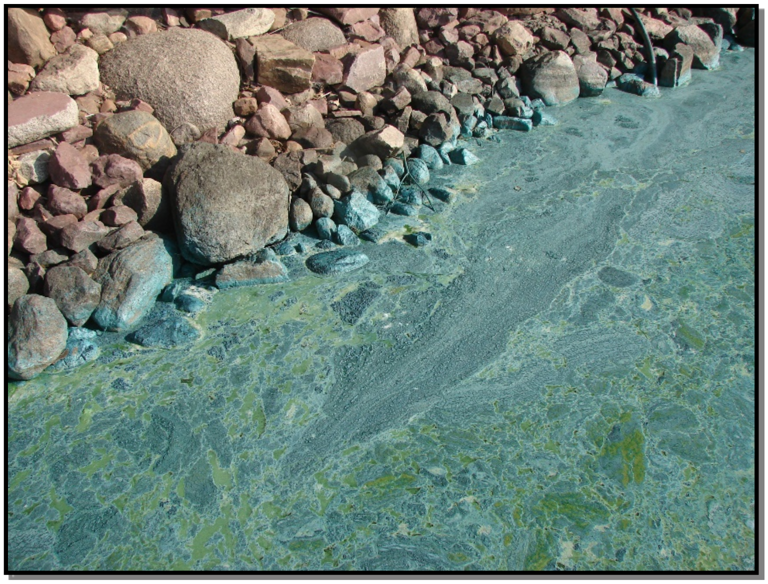


Photo 4: Cyanobacteria bloom on an area lake (courtesy John H. Wills)

4. Marketing Plan

A group of Clean Water Alliance members worked cooperatively, but informally, to communicate Management Plan efforts and assist in the developing Marketing materials that included press releases, PowerPoint presentations, website pages, Frequently Asked Questions, and other tools. This public outreach model will consist of a phased approach to marketing the tremendous efforts at providing for sustainable clean water in the Iowa Great Lakes.

This Management Plan calls for the formalization of the Silver Lake Watershed Marketing Team by July 2016. The Silver Lake Marketing Team would include professionals as well as partner organizations. The Team's role and responsibilities will include:

- Develop key messages and education/outreach materials
- Support the education and outreach efforts of the clean water efforts
- Develop a communications strategy and plan with measurable outcomes
- Develop a watershed wide outreach program that encourages and inspires individuals to take actions for cleaner water.
- Maintain the flow of information and provide liaison between: Federal and state agencies; state and local governments; stakeholder groups; media outlets; collaborating agencies and organizations; and the general public.
- Strengthen and/or create partnerships with other agencies/stakeholders, public and private, and solicit volunteers from these partnerships.

Phase I Development

During the development of the draft Phase I additional stakeholders will be invited to participate in marketing efforts. Staff will also conduct presentations for interested parties outside of the marketing group.

Phase II Outreach

The marketing "team" will develop following communications, education and outreach materials, activities and efforts.

Development of Communications, Education and Outreach Materials

- Brochures: "Get in the Boat – Our role in cleaning up Silver Lake"
- Frequently Asked Questions – Phase II Watershed Management Plan
- Fact Sheet: "The Silver Lake "Pollution Diet" – What it Means for our Lake"
- Iowa's Nutrient Reduction Strategy and what it means to Silver Lake.
- PowerPoint: Phase II WMP Guidance, Milestones, Path Forward
- The Lakes Barometer – A Health and Restoration Assessment of the Silver Lake and Watershed – Silver Lake Program document
- Posters: WIP Phase II highlighting: partners; partner responsibilities; goals/strategies; progress made; what needs to be completed; and contact information: Stormwater; Agriculture; Public Lands; Wastewater; Planning and Land Use; Restoration; and Information and Technology
- An educational poster, "Where Silver Lake pollution comes from," explaining the origins of

pollution and how excess nutrients pollute our Lakes. The poster also outlines relative pollution rates for different land uses.

- An educational poster, “Protecting our Silver Lake waterways,” showing areas of concern in the Silver Lake Watershed and the sources of pollution and impacts on water quality
- An education poster, “”In this together,” highlighting the role of homeowners, agriculture, builders/developers and governments in cleaning up our waterways.

Press Releases
Press releases will be used to highlight success and problematic areas and the actions being taken to protect or fix the area.

Public Workshops and Forums

- Highlighting Phase I Accomplishments and introducing Phase II and Subcommittees

Other Major Outreach/Education Efforts (examples are below of such outreach efforts)

o Education and outreach at local Agricultural programs
o Media event to announce Clean Water Efforts
o Rain Gardens for the Lakes program.
o Native prairie planting demonstration.
o Rain barrel educational program to encourage Silver Lake and Lake Park residents to purchase and use rain barrels to improve water quality and conserve water.
o Media event with the Iowa DNR highlighting the Trappers Bay Renovation.
o A Public Workshop highlighting the Sediment and Stormwater Regulations.
o Dickinson County and Clay County Fairs
o “Liveable Lawns” program
o Pollution reduction education on the value of buffers
o Silver Lake Onsite Wastewater Systems and the problems with them.
o Presentation on Silver Lake Watershed Land use and the benefits and problems with that use.
o Urban tours to farm land
o Presentations to State and Local groups
o Community Outreach Initiative.
o Agriculture Week Programs
o Targeted areas with homeowners living in the Silver Lake Watersheds with failing or out-of-compliance septic systems.
o Women in Agriculture Conference.
o Meeting with the Dickinson County League of Local Governments
o Work with the local colleges and Lakeside lab to develop
o Non-credit Classes at Local Colleges and Lakeside Lab — “Choose Clean Water.” The course will cover the Silver Lake Watershed from the pristine conditions described in the late 1800’s to the current application of a “pollution diet” designed to improve water quality throughout the Silver Lake Watershed

Phase III
Follow-up and re-evaluate the success and challenges of the marketing plan. Continue the

successes and evaluate why challenges occurred and do the failures differently. This should occur every 6 months of the marketing plan.

Partnerships and Volunteers

There are several nonprofit environmental and watershed-based organizations active in the Iowa Great Lakes Watershed. Two organizations, the Clean Water Alliance and the Dickinson Soil and Water Conservation District, have extensive experience with education and outreach efforts, which will help inform residents, businesses and visitors within the Watershed of actions that they can take to improve water quality.

The following Stakeholders and partners are considered the Target Audiences:

Stakeholders in this plan are varied and come from all lifestyles. The bottom line for each stakeholder is that they have a stake in what happens with the Iowa Great Lakes. There are five groups of Stakeholders that have been identified. Those five groups are federal, State, local government, non-governmental organizations (NGO), and private citizens.

Federal Stakeholders:
U.S. EPA, Region 7 Non-point Source Region Headquarters (Section 319 Non-point Source Pollution Program)
U.S. Fish and Wildlife Service, Desoto Bend Wildlife Area (Private Lands Biologist)
USDA, Natural Resource Conservation Service, Dickinson County, District Conservationist (Wetlands Restoration Program, Wildlife Habitat Incentive Program, Environmental Quality Incentives Program)

State Stakeholders:
Iowa Department of Natural Resources, Bureaus of Fisheries, Wildlife, and Water Resources (Private Lands Wildlife Biologist)
Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, Field Services Bureau. (Resource Enhancement and Protection Funds, Watershed Protection Funds, Iowa Financial Incentives Program, Watershed Improvement Review Board)
Iowa Department of Economic Development

Local Government Stakeholders:
City of Orleans, Spirit Lake, Okoboji, Arnolds Park, Milford, West Okoboji, and Wahpeton
Dickinson Soil and Water Conservation District, Commissioners (Local Grants)
Jackson (MN) Soil and Water Conservation District, Commissioners (Local Grants)
Dickinson County, Supervisors
Jackson County Commissioner
Spirit Lake School District (Future Farmers of America)
Okoboji School District (Future Farmers of America)
Iowa Great Lakes Sanitary Sewer District
Public Utilities, Alliant Energy
Dickinson County Conservation Board

Non-governmental Organizations:
Dickinson County Clean Water Alliance (Coordination and local funding)
Iowa Natural Heritage Foundation (Easement funds)
The Nature Conservancy (Habitat Restoration Program)
Pheasants Forever (Build A Wildlife Area)
Ducks Unlimited, (Wetland Restoration Assistance)
Dickinson County Water Quality Commission (Water Quality Grants)

Private Citizens:
Property owners (urban and agricultural)
Fishermen, Hunters, Investors, Farmers, Developers, Boaters, Swimmers, Marinas, Resort owners, Bankers, Chambers of Commerce, Golf Courses/clubs, Visitors/tourists

Dickinson County Water Quality Commission was established in 2001 to provide a steady funding source, using local money as a match to state and federal revenues for water quality projects for lakes in Dickinson County. This one-of-a-kind organization in the state is comprised of 18 commissioners who represent the county and its ten municipalities. Among the many objectives of the WQC are: to bring a minimum of $3 in federal, state and private matching funds to communities that are looking for money to improve water quality. In the first year of operation in 2001, the WQC had a pool of $100,000 to grant to water quality projects to improve lakes in Dickinson County. In each subsequent year, the WQC has administered $200,000 in water quality projects. To date the Water Quality Commission has awarded nearly 1 million dollars in grant funds that have been matched with over 14 million dollars by the grantees. The 28-E agreement that created the WQC is in effect until 2009, and automatically renews for a two-year period thereafter.

Dickinson County Clean Water Alliance coordinates the efforts of governmental agencies, non-profit and private organizations through the help of a branch of the Dickinson County Soil and Water Conservation District (SWCD). Its slogan is, “united to keep our lakes alive.” The CWA is an uncommon federation of over 80 groups working in harmony to protect the water resources of the area. The CWA was formed in 1990 by the Dickinson County SWCD and the INHF, the area lake protective associations and the Iowa DNR. They continue to coordinate activities for water quality.

The long-range strategic plan developed by the CWA has identified four main watershed goals for lakes in Dickinson County:

- Native biological diversity is respected and encouraged
- Infiltration practices are promoted throughout the watershed
- Impaired waters are protected and improved
- High quality waters are maintained and improved

The Dickinson County Clean Water Alliance Vision Statement is:
Clean and clear water in every lake of the county.

The Mission Statement is:
Through commitment to people and technology, the Clean Water Alliance leads the way in providing clean water for the stakeholders of each of the lakes in the county, by communicating, educating, coordinating, and funding projects that improve the clarity of the water in our lakes.

The Alliance recognizes that a successful watershed approach to protecting and enhancing the water quality in the Great Lakes region requires clearly identifying needs and goals, selection of management alternatives based on good science, and a genuine stakeholder partnership. The Alliance promotes a voluntary conservation program driven by landowners, lake and park users, and public and private organizations that will reduce or prevent negative impacts to water, land, and economic resources within Dickinson County.

Support for the Silver Lake Watershed Project is tremendous. The members of the Clean Water Alliance fully support this project. Groups and individuals in Lake Park and around Silver Lake are excited about the opportunities this project will bring them. Landowners in the watershed are already investigating the opportunities available to them as a result of this project.

Silver Lake Park Improvement Association has a mission to protect and enhance water quality in Silver Lake. Other protective associations in Dickinson County have agreed to assist the Silver Lake Park Improvement Association in its efforts. The oldest of these is the Okoboji Protective Association, which celebrated its 100th anniversary in the summer of 2005. Many of the lake associations' projects are held around their individual lakes (e.g. clean-ups, education classes for Girl Scouts & Boy Scouts.)

Iowa Lakeside Laboratory (ILL) is a year-round environmental education facility with over 40 buildings on a 143-acre campus on West Lake Okoboji. Classes held at the lab serve numerous students from various universities throughout the state. Iowa Lakeside Laboratory is responsible for conducting the CLAMP water monitoring in Silver Lake.

Iowa DNR Northwest Regional Headquarters houses the Spirit Lake Fish Hatchery, and is the only cool water hatchery in the state. This hatchery is noted for its walleye, northern pike and muskellunge production which help to sustain healthy game fish populations in the lakes, streams and reservoirs of Iowa. The DNR regional headquarters also has offices dedicated to management of fisheries and wildlife resources in NW Iowa and the research of Iowa's natural lakes.

5. Watershed Characteristics

Photo 5: Silver Lake Sunset

Land Use
The predominant land use in the Silver Lake Watershed is row crop agriculture, most of which is in a corn-soybean rotation. There is some cropland in a corn-soybean-oats-meadow rotation, but this accounts for only five percent of the total cropland in the watershed. Conservation Reserve Program (CRP) ground makes up a very small portion (less than one percent) of the area typically in crop production. Other land uses include farmsteads, timber, grasslands, wildlife area, urban, and roads. Table 2 reports the generalized land uses by acre and by percentage of watershed. Figure 1 shows a more detailed distribution of land use throughout the watershed using 2012 observed land use data.

The total land use breakdown for the Silver Lake Watershed is as follows:

General Land Use	Description	Area (Acres)	% of Watershed
Row Crops	corn, beans, oats, alfalfa, CRP	14,521.1	85.3
Conservation Areas	timber, grassland, wildlife areas	1,471.3	8.6
Farmsteads	homes, yards	269.3	1.6
Water	wetlands, ponds (excludes lake)	320.5	1.9
Urban/Roads	residential, commercial, roads	442.8	2.6
Total		**17,025**	**100.0**

Table 5: Land Use data for 2007 (Ikenberry, 2009) Updated with 2012 data

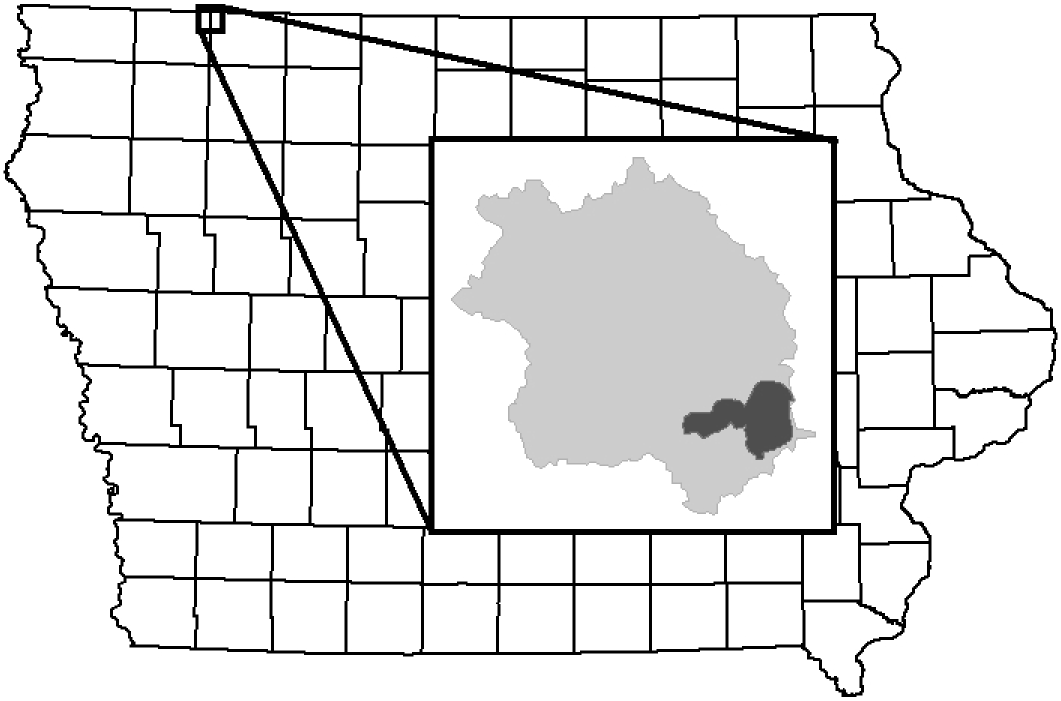


Figure 10: Location of Silver Lake Watershed in Dickinson and Osceola Counties

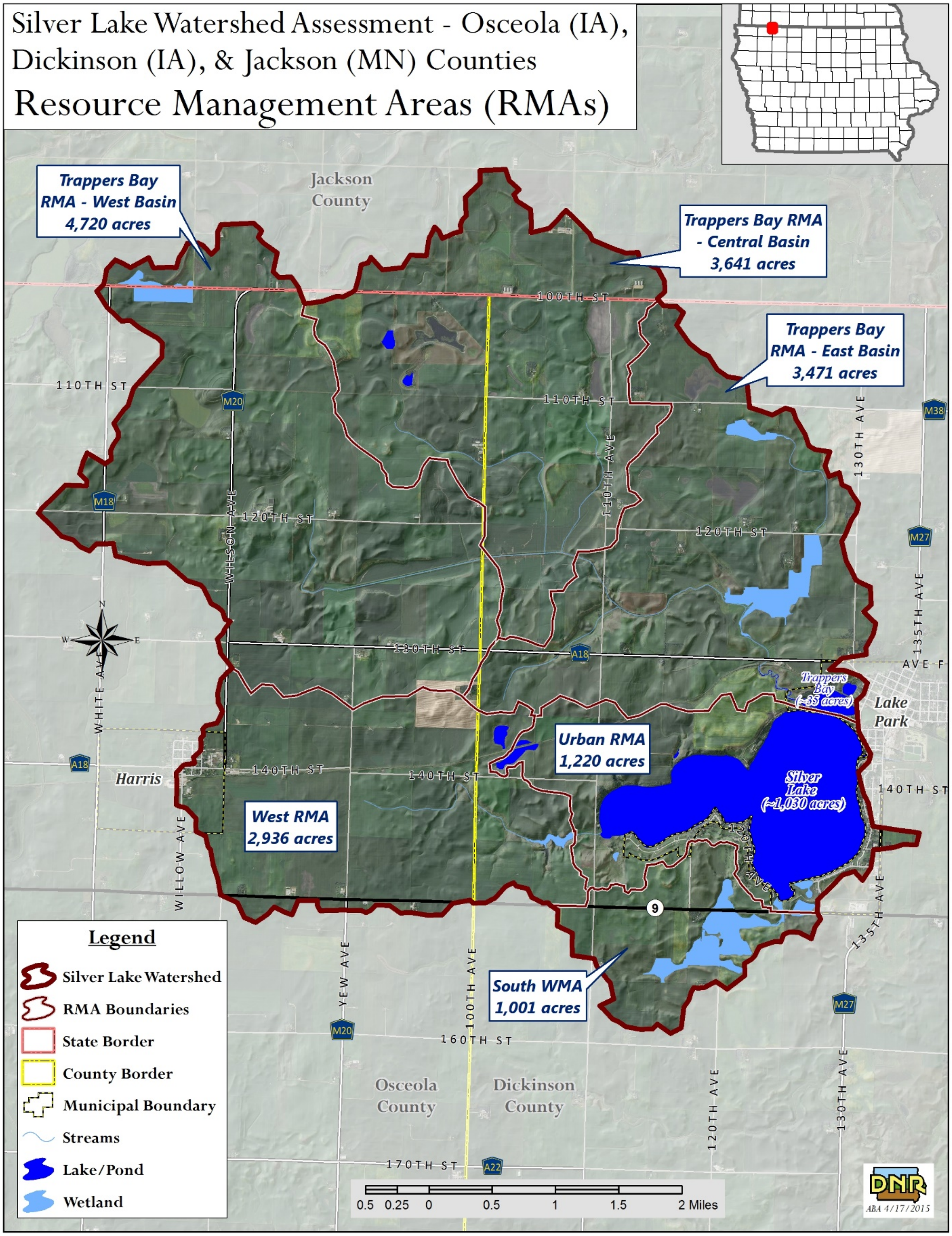


Figure 11: Silver Lake Resource Management Areas Including the Trappers Bay RMA's (IA DNR)

The watershed of Silver Lake is interesting and unique in many aspects. In addition to the parks and recreational facilities within the county, one of the state's most interesting natural area, the Silver Lake Fen, is located on the West edge of Silver Lake. The fen is one of the rarest forms of habitat in the State and perhaps one of the least well-known systems in Iowa. The Iowa Department of Natural Resources owns and operates 38 public areas, including the Silver Lake Fen, encompassing 19,911 acres within Dickinson County.

Population Dynamics

As of the census of 2010, in Dickinson County, Iowa there were 16,667 people, 7,554 households and 5,883 families residing in the county. The median income for a household in the county was $39,020 and the median income for a family was $47,739. The per capita income for the county was $21,929; 6 percent of the population and 4 percent of families were below the poverty line including, 6 percent of those under the age of 18 and 7 percent of those age 65 and older. (U.S. Census Bureau, 2010)

As of the census of 2010, in Osceola County, Iowa there were 6,462 people, 2,990 households and 2,108 families residing in the county. The median income for a household in the county was $34,274, and the median income for a family was $41,977. The per capita income for the county was $16,463. About 6 percent of families and 7 percent of the population were below the poverty line, including 7.9 percent of those under age 18 and 9.8 percent of age 65 or over. (U.S. Census Bureau, 2010)

Climate

The climate of the Silver Lake region is classified as humid-continental. Seasonal temperatures range from highs of 110 degrees Fahrenheit to lows of -40 F, while daily variations may be as much as 50 F. Annual precipitation is 27.62 inches, two-thirds of which falls between May and September. Summer precipitation ranges from severe storms to occasional drought. High summer temperatures produce evaporation levels typical of the prairies, discouraging forest growth.

The average frost free season is approximately 150 days, with a maximum growing season of 225 days from March 29 to November 9. The climate is dry enough to have aided the development of the prairie soils and humid enough to support a highly productive agricultural economy.

Geology

Geological events have been a primary driver in the natural features of the region, which in turn have influenced the development pattern. The simple geological resource (lakes) of the area is a reason the lakes have developed as a tourist and recreational area. The geologic history of the area has affected the surface contours of the land, the formation of soil types, and location of minerals, groundwater, lake basins and stream channels. During the ice ages, massive glaciers moved across the region, carrying with them boulders, gravel, sand and clay, and organic remains. As the glaciers melted, millions of tons of debris were deposited (glacial drift). The glacial drift forms a 200-to 300-foot cover over the region's bedrock.

The glacial drift in the Silver Lake area was deposited in the Wisconsin Age of the Pleistocene Epoch. The Wisconsin glacier was the last of at least three major ice sheets to cover the area. The Des Moines lobe of the Wisconsin glacier, which originated in the Keewatin District west of Hudson Bay in Canada, pushed down into north-central Iowa across an area 70 to 80 miles wide. As the glaciers receded, the glaciers occasionally left large blocks of ice, which melted and formed basins for future lakes. The rugged bottom of West Okoboji Lake in Dickinson County suggests it may have been formed in this manner.

Water from the melting glaciers also cut new drainage patterns in the deposits below the ice. Outwashes of sand and gravel were carried by streams that drained glacial melt and deposited it in the valleys, which the glaciers had formed. Underlying the glacial drift are shale's and sandstone created in the Cretaceous Age. The shale's vary in thickness and are found exceeding several hundred feet just north of the northern boundary of the watershed. The sandstones vary in thickness but generally do not exceed the thickness of the shale's.

Below the Cretaceous units, data regarding the age of the soil is limited. However, it appears that Ordovician and Cambrian Age sediment underlie the Cretaceous units in the southeastern half of the watershed. A few miles north of the northern boundary there also exists a buried northwest-southeast trending quartzite ridge of Pre-Cambrian Age.

Soils

Soils in the Silver Lake watershed are derived from Wisconsin (glacial) till on the Cary Lobe, within the Des Moines Lobe landform region. Depressional and calcareous soils are common in the region. The topography of the region is relatively flat, with some gently rolling hills and depressed areas that form isolated basins within the watershed. In its natural state, the watershed contained many wetlands in these low-lying depressed areas. However, due to its topography and poorly drained soils, approximately 85 percent of the watershed is tile drained, which enables the land to be agriculturally productive.

The heavier textured glacial soils occur within the Silver Lake watershed. These soils are not as erosive as the predominantly lighter textured loess soils found 50 miles to the southwest, but the soils do erode–especially during periods of abnormal rainfall or excessively high winds. Water erosion takes a toll on the steeper lands that are being row-cropped. The flatter land is more subject to wind erosion when it is left over winter without a cover of crop residue. The predominant soil types are listed below:

Soil Name	Description	Typical Slopes (%)
Nicollet	loam, somewhat poorly drained	1-3
Okoboji	silty clay loam, very poorly drained	0-1
Clarion	loam, moderately eroded, well drained	2-9
Webster	silty clay loam, poorly drained	0-2
Canisteo	silty clay loam, poorly drained	0-2

Table 6: Silver Lake Watershed predominant soil types. Courtesy of NRCS.

Topography

The topography of the watershed can be characterized as gently rolling. Lakes and wetlands lie within the hollows of the terrain. Runoff from precipitation drains into the lakes, evaporates, or percolates into the soil where it recharges the groundwater. Water draining into the lakes and streams carry contaminants from the land, which affect the water quality of the lakes.

Surface Water

Surface waters consist of tributaries, streams, drainage ditches, and lakes that make up the Little Sioux River drainage basin. The Little Sioux River and several tributary streams of the river flow year-round. Most creeks are intermittent and carry water only in periods of heavy rainfall or spring thaw. Runoff corresponds to the annual precipitation rate. The large lake and wetlands make up a unique lake watershed.

Groundwater Resources

The Dakota sandstone and the Ordovician and Cambrian Age sandstones are the most important of the deep flow systems. The well source in the watershed is mainly from the Dakota sandstone aquifer. The wells in the region average 130-500 feet in depth. The gradient of the groundwater is generally south but local high water levels are found throughout the area following land surface contours. Ground water highs are found below the hills east and west of West Okoboji Lake and east of East Okoboji Lake. Topographic high areas are recharge areas and low lying marshes and wetlands are discharge areas.

Shallow flow systems found in glacial drift have the most impact on area lakes and streams. Depth to the water table near the lakes varies from flowing springs to depths 50 feet below the ground surface. In areas adjacent to the Little Sioux River, the contour configuration indicates the river receives groundwater discharge. The lakes also receive base flow from groundwater.

Pollutant Sources

The primary threats to the water quality of Silver Lake are sedimentation, excess nutrients, human and livestock waste, stormwater contaminants and loss of natural wetlands. Agricultural runoff contributes contaminants such as sediment, commercial fertilizers, pesticide, herbicides and animal wastes. Potential spills of hazardous waste and invasion of Aquatic Invasive Species are also a concern.

The prairie potholes and marshes adjacent to Silver Lake are ground water recharge areas, and serve as a natural filtration system by filtering and capturing contaminants carried in stormwater runoff, and infiltrating runoff from surrounding developed land. In the past, wetlands have been drained in favor of agriculture and urban developments, but it has more recently been recognized that wetlands are an integral part of a complex ecological system.

Increased urban development has presented stormwater quality and quantity problems. Urban stormwater runoff carries contaminants such as sediment, excess nutrients, pesticides and herbicides, heavy metals, and road salt. There is increasing pressure on drinking water supplies by the growing permanent population base and an expanding summer seasonal population. Good water quality is vital to the region’s economy and quality of life for those who visit or live within the area.

6. Sediment/Nutrient Loading

Using the NRCS Revised Universal Soil Loss Equation (RUSLE), it has been estimated that a total of 0.0433 tons per acre per year of soil is delivered to Silver Lake. These figures only allow for sheet and rill erosion and do not include figures for ephemeral or gully erosion. This model, therefore, shows a total sediment delivery (with sheet and rill erosion) of 1,089 tons per year to Silver Lake. This model was prepared by the Iowa Department of Natural Resources Watershed Resources Bureau using the best Science of the day.

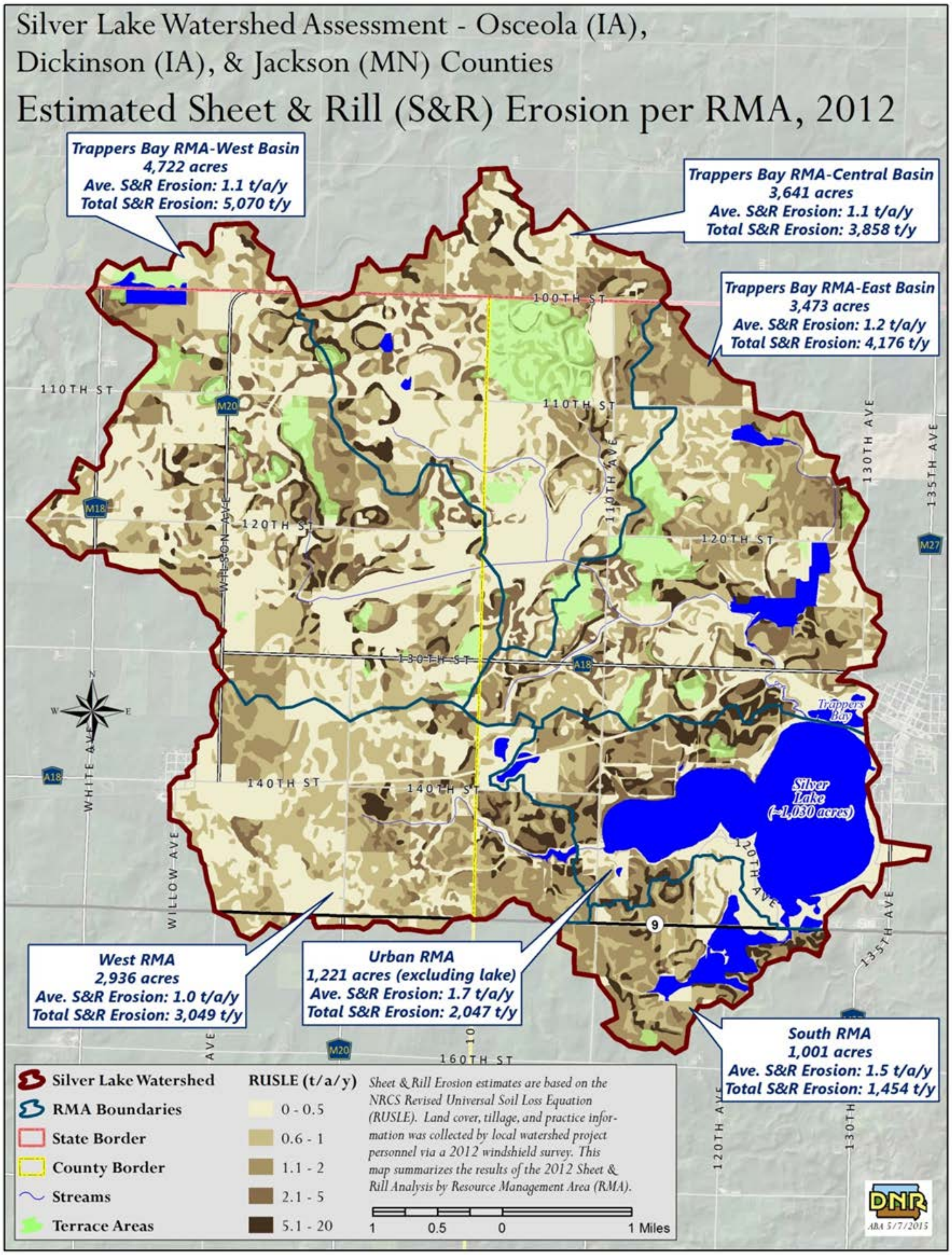
Sub	Acres	Avg Sheet & Rill (t/a/y)	Total Sheet & Rill (t/y)	Sediment Delivery Ratio	Avg Sediment Delivery (t/a/y)	Total Sediment Delivery (t/y)	Percent Reduction Needed	Reduced Delivery (t/y)
South WMA	1,001	1.5	1,454	6.19%	0.02	22.5	60%	13.5
Trappers Bay RMA - Central Basin	3,641	1.1	3,858	4.02%	0.04	144	60%	86.6
Trappers Bay RMA - East Basin	3,473	1.2	4,176	4.02%	0.05	159	60%	95.1
Trappers Bay RMA - West Basin	4,722	1.1	5,070	4.02%	0.04	189	60%	113.2
Urban RMA	1,221	1.7	2,047	5.98%	0.10	121	25%	30.1
West RMA	2,936	1.0	3,049	5.13%	0.01	39	60%	23.4
Totals	16,993	1.3	19,655		0.0433	674		

Table 7: Sediment Delivery from Sheet and Rill Erosion and reduction needed by RMA

Using RUSLE we are able to see a part of the sediment delivery problem but not a complete picture. When considering sediment and erosion one must account for gully erosion as well. In some instances, a gully can produce more tons of erosion per acre than an entire field. Traditionally grassed waterways, one of the best ways to prevent or stop gully erosion, have not been widely accepted in the Silver Lake Watershed. A general shift toward larger equipment and more linear rows has resulted in fewer producers willing to consider waterways.

Approximately fifty areas have been identified within the watershed where gullies have begun to form. These gullies are providing direct sedimentation and in large amounts in comparison to the rest of the field. In these 50 sites, if grassed waterways and sediment basins were built the reduction of sedimentation would be a vast improvement. An important note is these gullies are not included in any of the following sediment delivery models as those only use RUSLE2 which does not figure gully erosion, only sheet and rill erosion.

Using the model and GIS technology and modeling, we see the total sediment delivery to the Lake from only sheet and rill erosion is 674 tons per year (see Figure 12). The average sediment delivery (without the gully erosion factored in) is .04 tons per acre per year. This means there is more sediment delivery than we can currently account for reaching Silver Lake.



Silver Lake Watershed Assessment - Osceola (IA), Dickinson (IA), & Jackson (MN) Counties

Estimated Sheet & Rill (S&R) Erosion per RMA, 2012

Trappers Bay RMA-West Basin
4,722 acres
Ave. S&R Erosion: 1.1 t/a/y
Total S&R Erosion: 5,070 t/y

Trappers Bay RMA-Central Basin
3,641 acres
Ave. S&R Erosion: 1.1 t/a/y
Total S&R Erosion: 3,858 t/y

Trappers Bay RMA-East Basin
3,473 acres
Ave. S&R Erosion: 1.2 t/a/y
Total S&R Erosion: 4,176 t/y

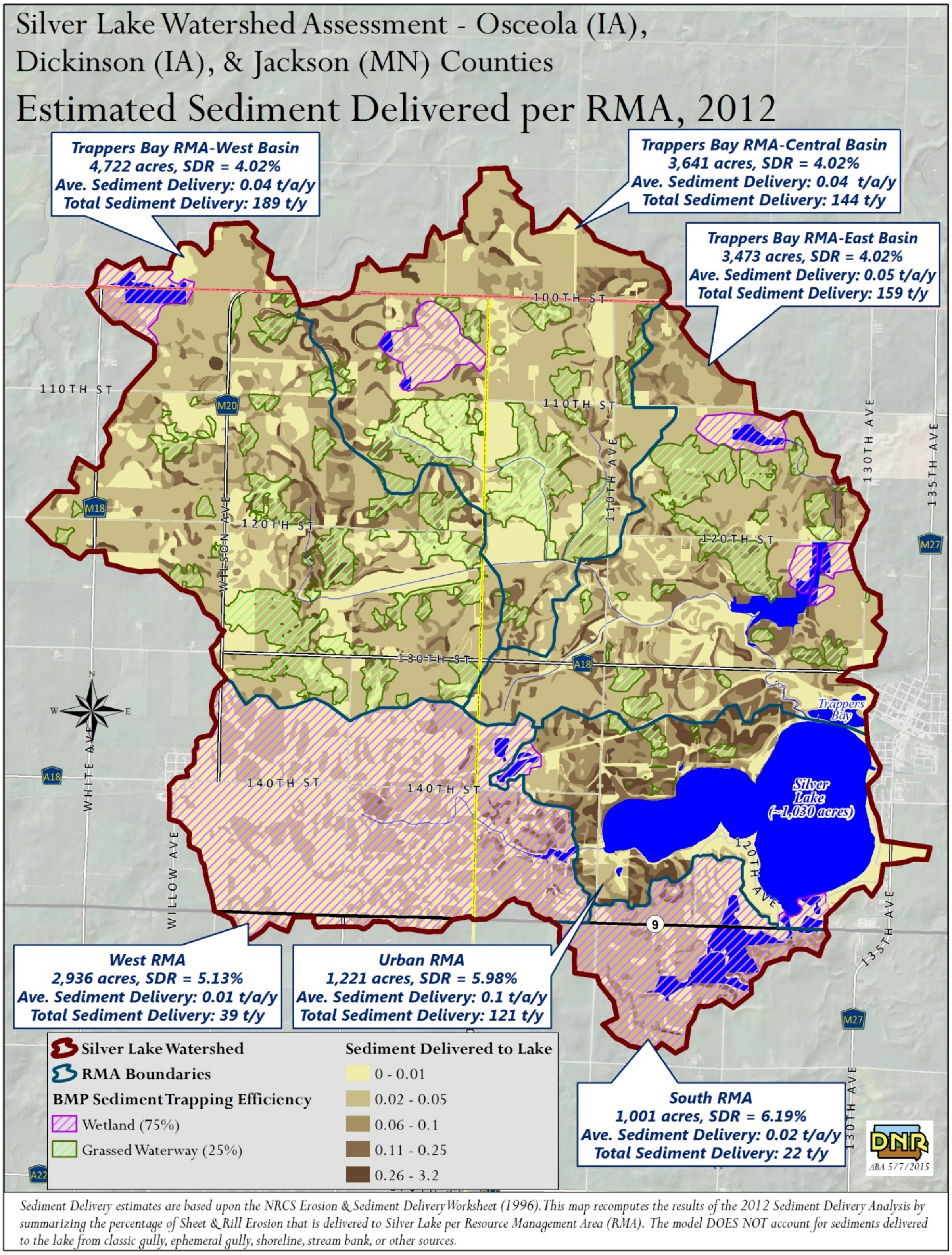
West RMA
2,936 acres
Ave. S&R Erosion: 1.0 t/a/y
Total S&R Erosion: 3,049 t/y

Urban RMA
1,221 acres (excluding lake)
Ave. S&R Erosion: 1.7 t/a/y
Total S&R Erosion: 2,047 t/y

South RMA
1,001 acres
Ave. S&R Erosion: 1.5 t/a/y
Total S&R Erosion: 1,454 t/y

Sheet & Rill Erosion estimates are based on the NRCS Revised Universal Soil Loss Equation (RUSLE). Land cover, tillage, and practice information was collected by local watershed project personnel via a 2012 windshield survey. This map summarizes the results of the 2012 Sheet & Rill Analysis by Resource Management Area (RMA).

Figure 12: Estimated Sheet & Rill Erosion in Silver Lake Watershed (Iowa DNR)



Silver Lake Watershed Assessment - Osceola (IA), Dickinson (IA), & Jackson (MN) Counties

Estimated Sediment Delivered per RMA, 2012

Trappers Bay RMA-West Basin
4,722 acres, SDR = 4.02%
Ave. Sediment Delivery: 0.04 t/a/y
Total Sediment Delivery: 189 t/y

Trappers Bay RMA-Central Basin
3,641 acres, SDR = 4.02%
Ave. Sediment Delivery: 0.04 t/a/y
Total Sediment Delivery: 144 t/y

Trappers Bay RMA-East Basin
3,473 acres, SDR = 4.02%
Ave. Sediment Delivery: 0.05 t/a/y
Total Sediment Delivery: 159 t/y

West RMA
2,936 acres, SDR = 5.13%
Ave. Sediment Delivery: 0.01 t/a/y
Total Sediment Delivery: 39 t/y

Urban RMA
1,221 acres, SDR = 5.98%
Ave. Sediment Delivery: 0.1 t/a/y
Total Sediment Delivery: 121 t/y

South RMA
1,001 acres, SDR = 6.19%
Ave. Sediment Delivery: 0.02 t/a/y
Total Sediment Delivery: 22 t/y

Sediment Delivery estimates are based upon the NRCS Erosion & Sediment Delivery Worksheet (1996). This map recomputes the results of the 2012 Sediment Delivery Analysis by summarizing the percentage of Sheet & Rill Erosion that is delivered to Silver Lake per Resource Management Area (RMA). The model DOES NOT account for sediments delivered to the lake from classic gully, ephemeral gully, shoreline, stream bank, or other sources.

Figure 13: Estimated Sediment Delivery to Silver Lake, Dickinson County (Iowa DNR)

Land Use Inventory

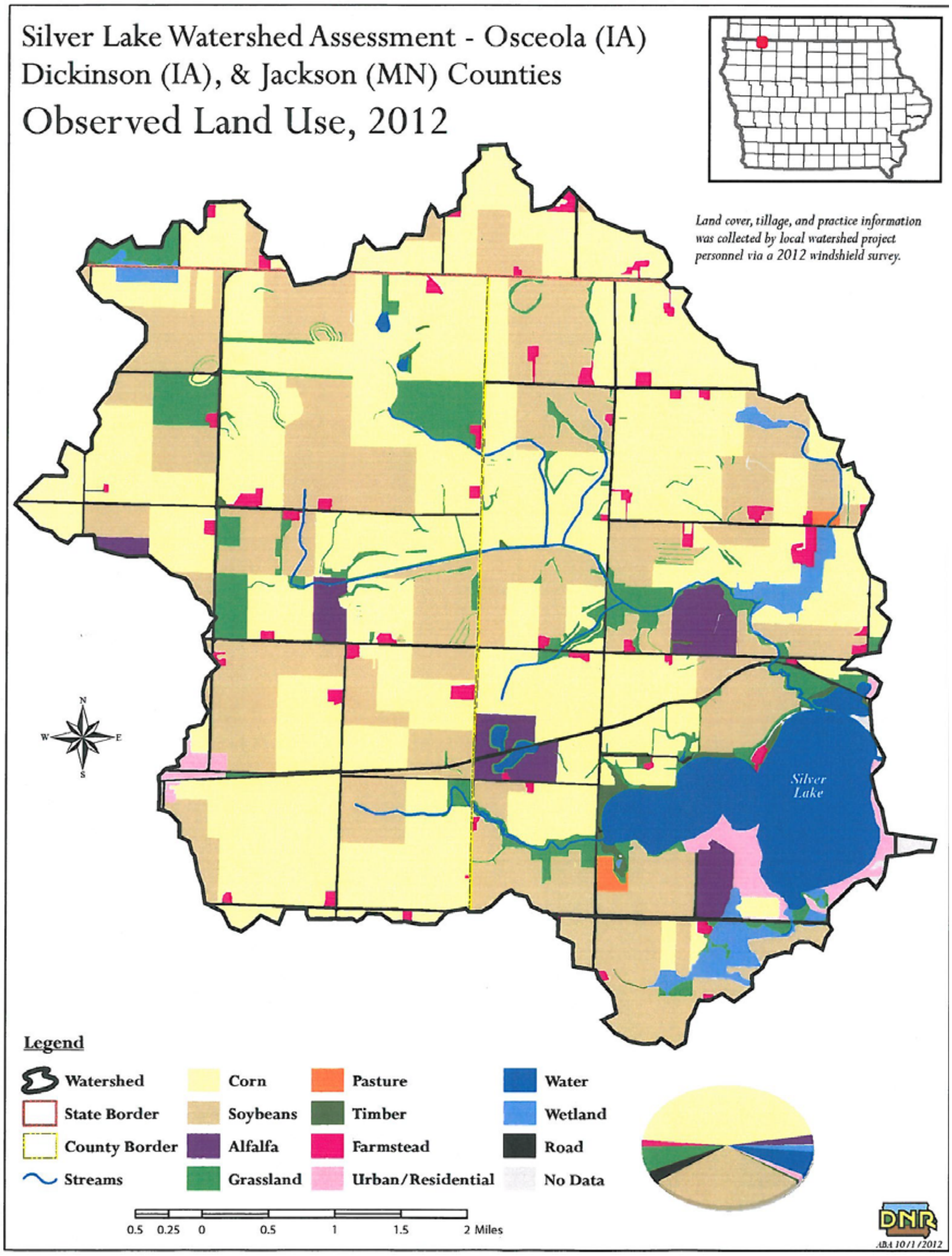


Figure 14: 2012 Land Use Modeling in Silver Lake Watershed (Iowa DNR)

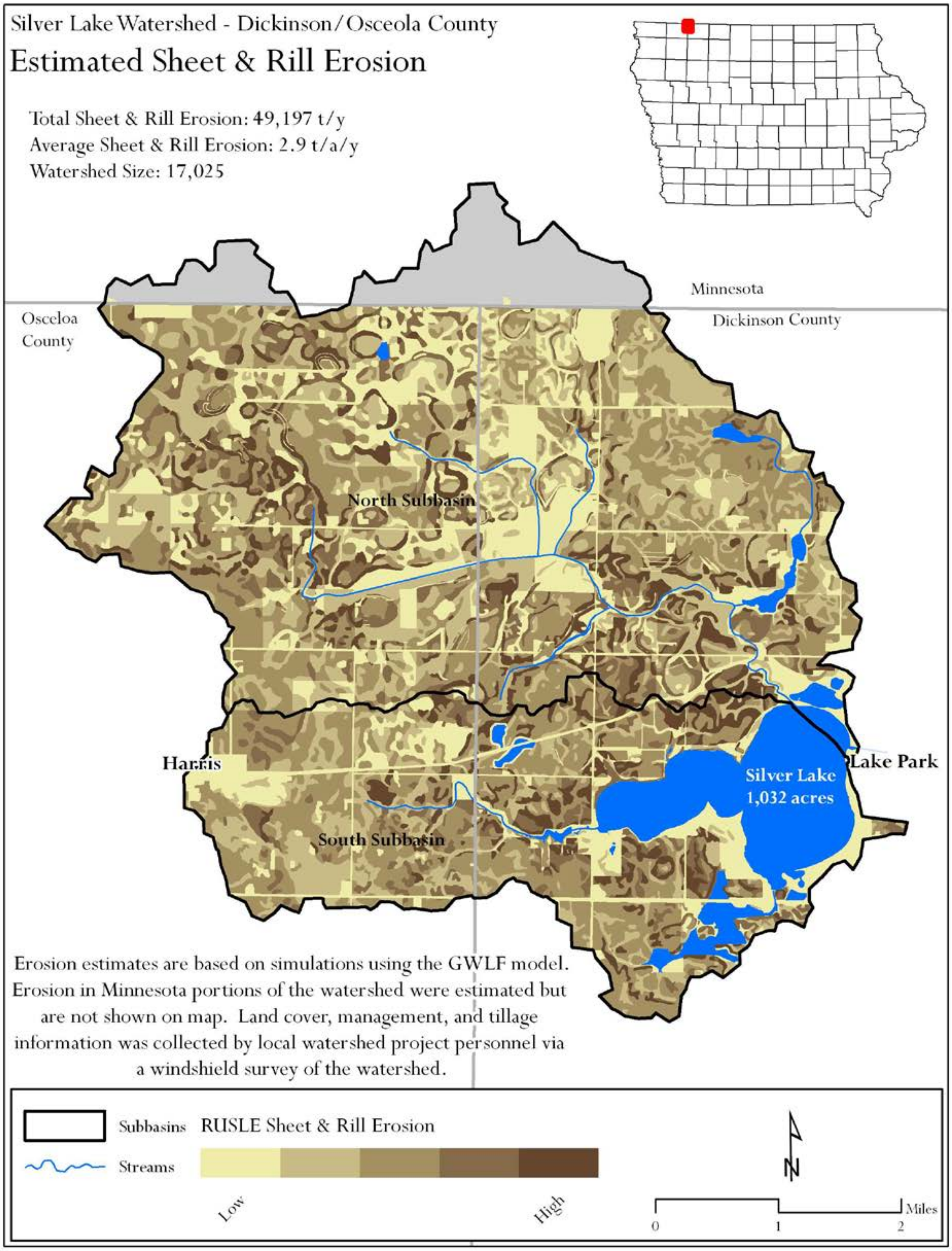


Figure 15: Estimated Sheet and Rill Erosion based on 2012 Land use Survey

7. Pollutant Loading Reductions

Silver Lake is listed on the State of Iowa's Impaired Waters List for sediment and water clarity. A Total Maximum Daily Load (TMDL) for Turbidity has recently been completed by the Iowa DNR. According to this document, inorganic suspended solids and high phosphorous levels are the cause of the poor water quality conditions documented within the Lake, which frequently result in excessive algal blooms. These conditions are affecting the Class A1 (Primary Contact Recreation) and the Class B(LW) (Aquatic Life) designated uses. Data from the Iowa Lakes Information System shows that out of 132 lakes surveyed, Silver Lake ranked 104th for turbidity, 102nd for total phosphorus, and 100th for Secchi disk reading.

Nonpoint sources of phosphorous and sediment loading from the watershed are the primary pollutants causing the impairment. With the bulk of the watershed in some form of agricultural production, the majority of these loads most likely stem from those acres in row crop production. Soil erosion as a result of crop production aids in the transport of phosphorous to the lake. This phosphorous-laden sediment is often enriched by the land application of nutrients and manure during production. These contaminants are also likely transported through an extensive tile drainage system that has been installed to drain the landscape for increased crop production. The TMDL for Silver Lake suggests that the two largest sources of phosphorus loading to Silver Lake are runoff from row crop agriculture (46.1 percent) and phosphorus that is recycled within the lake (39.0 percent), which is often called internal loading.

In shallow lakes that have accumulated large amounts of sediment at the lake bottom over time, phosphorus can mix into the water column from these sediments. Silver Lake is shallow, susceptible to wind-induced mixing, provides power-boating and personal watercraft recreation, and has a large carp and bullhead population. All of these facts support the assumption that internal TP loading is problematic. The water quality model for Silver Lake indicated that internal loading comprises approximately 39 percent of the existing TP load. This relative contribution is consistent with internal loading rates reported for other shallow lakes in Iowa.

According to the Iowa DNR Total Maximum Daily Load (TMDL), the existing annual average TP load to Silver Lake from April 2005 through March 2008 was estimated to be 19,980 lbs/yr, or 54.7 lbs/day. This period was selected for two primary reasons: (1) annual GWLF simulations must begin on April 1 and end on March 31, and (2) water quality monitoring data from UHL during the 2005-07 growing seasons were utilized in the calibration of the BATHTUB water quality. The existing daily maximum load is estimated at 107.8 lbs/day.

The existing average annual TP load to Silver Lake is an estimated 19,980 lbs/year. The TP target load, also referred to as the loading capacity, is 8,499 lbs/yr (average annual) and 45.9 lbs/day (maximum daily). To meet the target loads, a reduction of 12,380 lbs/yr, or 61.8 percent, is required.

The following table shows the estimated contribution of each pollutant source to the total phosphorus load entering Silver Lake on an annual basis. Also shown are load reductions for each pollutant source that would provide a practical solution to reducing the total phosphorus load entering Silver Lake down to an acceptable level.

Source of Total Phosphorus	Existing Load (lb/yr)	Total Load Reduced	LA (lb/yr)	Load Reduction (%)
Row Crops	8,527	5,543	2,984	65
Conservation Areas	166	17	149	10
Farmsteads	70	0	70	0
Urban/Roads	152	35	117	23
Groundwater	1,996	0	1,996	0
Geese	42	0	42	0
Septic Systems	61	59	2	97
Atmospheric Deposition	255	0	255	0
Internal Load	7,213	5,843	1,370	81
Shoreline Erosion	1,498	884	614	59
Total	**19,980**	**12,380**	**7,600**	**61.8**

Table 8: Estimated TP loading to Silver Lake, and desired loading reductions. (Ikenberry, 2009 adjusted from orgional TMDL to incorporate streambank erosion updated numbers)

RMA	Acres	Total Sediment Delivered	Total Sediment Reduction Needed	Total Phosphorous Reduced
South WMA	1,001	30.5	19.8	46.6
Trappers Bay RMA - Central Basin	3,641	154.0	100.1	235.2
Trappers Bay RMA - East Basin	3,473	189.7	123.3	289.8
Trappers Bay RMA - West Basin	4,722	209.0	135.9	319.2
Urban RMA	1,221	121.0	30.3	71.1
West RMA	2,936	47.0	30.6	71.8
Drainage Ditch	30	541.0	324.6	762.8
Shoreline	25	2222.0	1377.6	3,209.9
Internal Load	1,066	4007.0	3205.6	7,372.9
Totals	18,114	7521.2	5,348	12,379.3

Table 9: Total Load Reductions by Location (according to DNR Modeling in Maps above)

8. Project Goals

The Silver Lake Water Quality Project has as a goal to reduce sediment and phosphorous from reaching Silver Lake. The primary reason for these two pollutants being targeted is the TMDL showing a need to reduce both in order for the lake to become a water body that reaches its highest and best use. The TMDL shows the total phosphorous source existing load and possible reduction percent to be:

Source of Total Phosphorus	Existing Load (lb/yr)	Total Load Reduced	LA (lb/yr)	Load Reduction (%)
Row Crops	8,527	5,543	2,984	65
Conservation Areas	166	17	149	10
Farmsteads	70	0	70	0
Urban/Roads	152	35	117	23
Groundwater	1,996	0	1,996	0
Geese	42	0	42	0
Septic Systems	61	59	2	97
Atmospheric Deposition	255	0	255	0
Internal Load	7,213	5,843	1,370	81
Shoreline Erosion	1,498	884	614	59
Total	**19,980**	**12,380**	**7,600**	**61.8**

Table 10: Annual total load allocation and reduction of TP sources (Ikenberry, 2009 adjusted from orgional TMDL in 2012 to incorporate streambank erosion updated numbers)

The TMDL that was written for Silver Lake states that "No single BMP will be able to reduce pollutant loads to Silver Lake. Rather, a comprehensive package of BMPs will be required to address poor water transparency that has caused "aesthetically objectionable conditions" and impaired primary contact recreation. The majority of the phosphorus and sediment entering Silver Lake is from agricultural land uses and internal recycling; however, some urban area drains to the lake as well. Therefore, potential BMPs for water quality improvement in Silver Lake are grouped into three components: agricultural, urban, and in-lake".

Areas that are identified on the Sediment Delivery Map, Figure 13, located on page 35 as producing higher sediment delivery rates will be the areas that will be prioritized by the stakeholders and personnel working to correct the problems in Silver Lake. It is clear to see where the priority areas will be or where the water moves from those priority areas. The prevention of the delivery of sediment and the nutrients it carries will be a key to the success of this project. This WMP has broken each RMA into a separate "watershed" and has separate goals for each watershed. In the same sense the total reduction in phosphorous is 12,380 pounds of P.

Margin of safety. To account for uncertainties in data and modeling, a margin of safety (MOS) is a required component of all TMDLs. An explicit MOS of 10 percent was utilized in the development of this TMDL. The 10 percent MOS is equivalent to 850 lbs/yr, or 4.6 lbs/day when expressed in terms of a daily maximum load. When added together the Load Allocation and the Margin of Safety equals 8,499 that is expressed as the Maximum Daily Load or 45.9 lbs total phosphorous per day.

9. Targeted Implementation

Following are comprehensive Resource Management Plans for each of the six "Resource Management Area's (RMA's)" which comprise the Silver Lake Watershed.

Although each subwatershed has its own unique set of characteristics and challenges, the general plan to treat each area will be similar in many ways. BMP's such as residue and nutrient management, grassed waterways, filter strips, sediment basins, and tile intake treatments will be used to reduce soil erosion and impede sediment and nutrient delivery to the various drainages of the Silver Lake Watershed.

To accompany these erosion and sediment delivery control practices, we will also focus on wetland restoration in several key basins. This involves the first phase of the comprehensive plan to remove Silver Lake from the State of Iowa 303(d) Impaired Waters List, which is already in motion. Not only do the restored wetland basins capture and hold excess sediment and nutrients upstream of Silver Lake, but they also offer a significant decrease in flow velocity following rainfall events. These wetlands will act as a crucial filter for loading that we were not able to prevent via erosion control practices.

The total maximum daily load of phosphorous delivered to the lake is 45.9 pounds per day or 8,499 pounds per year that would be delivered to the lake. This WMP targets specific load reductions by location and practice to provide for intermittent goals. However, large gains can be made by using other practices than those targeted in this plan. It is felt the reductions and practices used in this WMP are realistic and possible. In addition, this WMP utilizes Iowa's Nutrient Reduction Strategy to provide scientifically proven and sound practices and pollution reduction numbers.

The reasoning for Sheet and Rill Erosion rates came from modeling at the Iowa DNR using proven modeling techniques. The load allocation rates were adjusted from the suggested TMDL that was written in 2008. The same reasoning for urban rates was used. The drainage ditch pollution loading comes from an adjustment to the TMDL made in 2012 by the Iowa DNR staff.

Ephemeral and Gully rates were identified by looking at all row crop soils in the watershed with a C-slope or greater according to the soils inventory conducted by the Natural Resources Conservation Service. The soils having a slop that is greater than 5% was assigned an erosion rate of 1 ton per acre of erosion. To convert gross erosion to sediment delivery, a factor of 0.7 is used, according to the NRCS Field Office Technical Guide.

Shoreline erosion was quantified by exploring the lakeshore and determining the approximate erosion rate of those shorelines. That amount was subtracted from the Internal Load in the TMDL figuring the two are tied closely together. The internal load was figured by subtracting all the other erosion rates and determining what was left. There was not a good method for determining what the internal load rate is.

West Bay Resource Management Area (RMA)

Objective – To prevent sediment and excess nutrients from reaching Silver Lake in excess amounts so the lake will be removed from the State's list of impaired water bodies. The sediment reductions in this RMA will assist with the 60% target reduction of phosphorus in Silver Lake (12,331 pounds of Phosphorus per year) in accordance with the approved TMDL

Description – The Silver Lake watershed has undergone many hydrological changes in the past 100 years. The reduction of wetlands and the switch from prairies to farmland has left this area degraded in a hydrological sense. This area represents approximately 17% of the watershed flowing into Silver Lake, and is vital to the direct input of Phosphorus. Historically, a long series of pothole wetlands and prairie uplands provided important watershed protection to Silver Lake and provided critical wildlife habitat. A holistic approach is needed to restore ecological health and water quality to this area. A combination of both watershed practices and cultural change is needed to reach the project objective. The following pollution reduction estimates are reflected in the State of Iowa Nutrient Reduction Strategy. The Nutrient Reduction Strategy uses science based fact to determine the best scientifically based conservation practices to remove phosphorous from the watershed of Silver Lake. In addition, the practices that are used in this WMP come from the Nutrient Reduction Strategy.

Restoration Planning Components

Phosphorus Management

A combination of Conservation Tillage, No-till systems, Phosphorous Rate Reduction, and Cover Crops will reduce approximately 27.1 pounds of Phosphorus from entering Silver Lake each year. The Spreadsheet that follows details the number of acres and level of treatment. However, it is significant to understand that the important figure to reach is not acres of a practice but rather the pounds of phosphorus reduction.

Land Use Change

A combination of Grassed Waterways, Sediment Basins, Grade Stabilization, Structures, and land retirement will prevent approximately 32.9 pounds of Phosphorus from entering Silver Lake. The spreadsheet that follows will detail the number of acres and the level of treatment necessary to get the required level of reduction. However, it is significant to point out that the pound of Phosphorus is the important factor in the reduction.

Edge of Field

A combination of wetland restorations, sediment control practices, vegetative buffers, and tile intake treatments will be used to prevent approximately 11 pounds of Phosphorus from reaching Silver Lake. It is significant to note that the acres and number of practices is not as important as is the pounds of Phosphorus reduced.

Shallow Lake Treatment

Shoreline restoration and carp exclusion and reduction are used in this category to reduce the in-lake contribution of sediment and Phosphorus from being re-suspended into the lake and a continual problem. It is estimated that these practices will eliminate an unknown amount of

Phosphorus from entering Silver Lake.

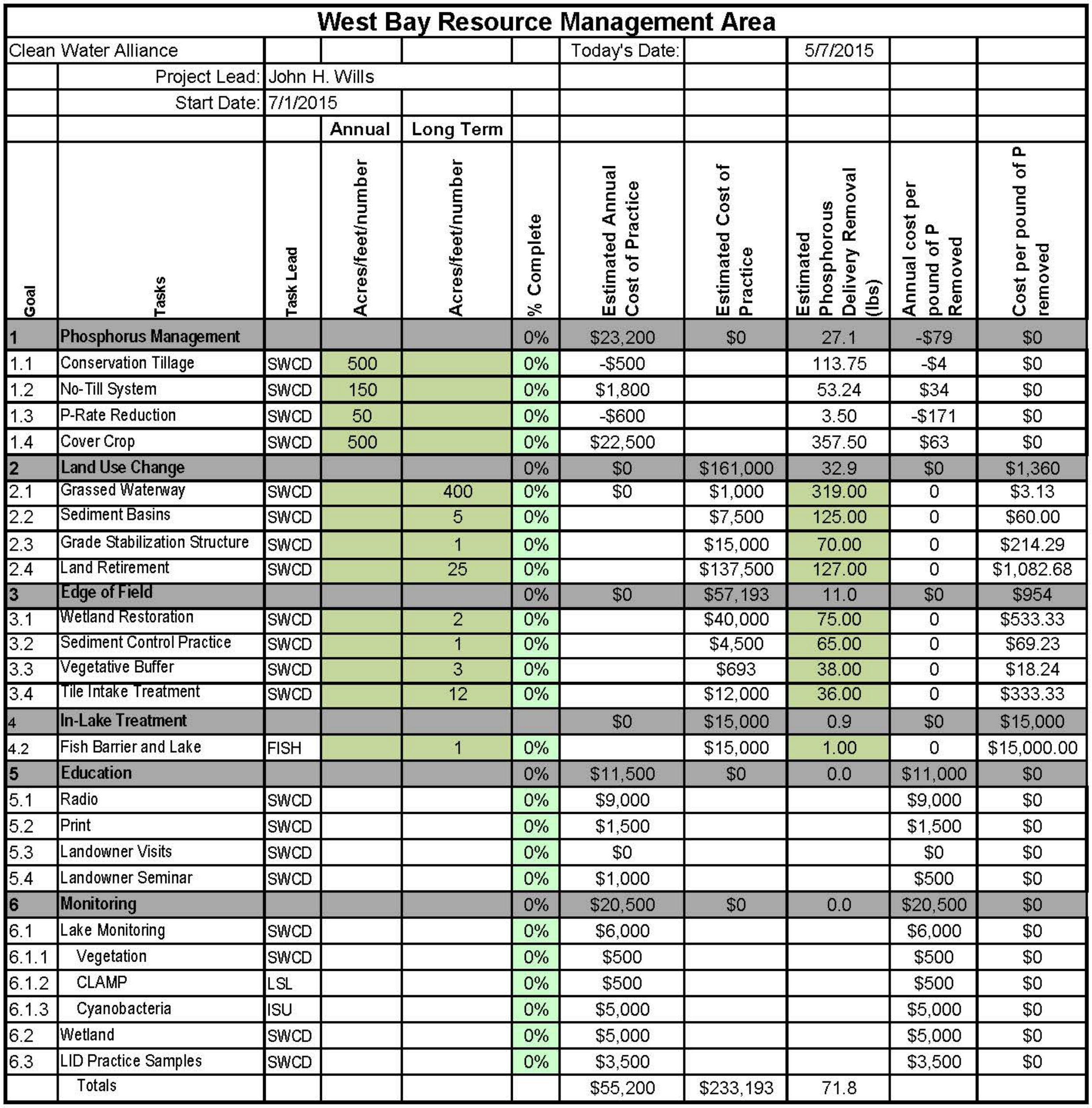
Education

An intensive education campaign to change attitudes and the culture that has been formed over time will be implemented. The education campaign will closely follow the Public Outreach program that is outlined on page 22 of this Management Plan. The campaign will specifically target the landowners and operators of this RMA but will be done in a way that anyone can use the information.

Monitoring

Water monitoring of this RMA will be vital in providing a baseline and documentation of any improvements that are realized by the cultural practices and the erosion control practices that are installed as part of the plan. The water monitoring will be inclusive and follow the QuAPP that has been developed specifically for this RMA.

West Bay Project Implementation



West Bay Resource Management Area										
Clean Water Alliance						Today's Date:		5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Delivery Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	**Phosphorus Management**				0%	$23,200	$0	27.1	-$79	$0
1.1	Conservation Tillage	SWCD	500		0%	-$500		113.75	-$4	$0
1.2	No-Till System	SWCD	150		0%	$1,800		53.24	$34	$0
1.3	P-Rate Reduction	SWCD	50		0%	-$600		3.50	-$171	$0
1.4	Cover Crop	SWCD	500		0%	$22,500		357.50	$63	$0
2	**Land Use Change**				0%	$0	$161,000	32.9	$0	$1,360
2.1	Grassed Waterway	SWCD		400	0%	$0	$1,000	319.00	0	$3.13
2.2	Sediment Basins	SWCD		5	0%		$7,500	125.00	0	$60.00
2.3	Grade Stabilization Structure	SWCD		1	0%		$15,000	70.00	0	$214.29
2.4	Land Retirement	SWCD		25	0%		$137,500	127.00	0	$1,082.68
3	**Edge of Field**				0%	$0	$57,193	11.0	$0	$954
3.1	Wetland Restoration	SWCD		2	0%		$40,000	75.00	0	$533.33
3.2	Sediment Control Practice	SWCD		1	0%		$4,500	65.00	0	$69.23
3.3	Vegetative Buffer	SWCD		3	0%		$693	38.00	0	$18.24
3.4	Tile Intake Treatment	SWCD		12	0%		$12,000	36.00	0	$333.33
4	**In-Lake Treatment**					$0	$15,000	0.9	$0	$15,000
4.2	Fish Barrier and Lake	FISH		1	0%		$15,000	1.00	0	$15,000.00
5	**Education**				0%	$11,500	$0	0.0	$11,000	$0
5.1	Radio	SWCD			0%	$9,000			$9,000	$0
5.2	Print	SWCD			0%	$1,500			$1,500	$0
5.3	Landowner Visits	SWCD			0%	$0			$0	$0
5.4	Landowner Seminar	SWCD			0%	$1,000			$500	$0
6	**Monitoring**				0%	$20,500	$0	0.0	$20,500	$0
6.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
6.1.1	Vegetation	SWCD			0%	$500			$500	$0
6.1.2	CLAMP	LSL			0%	$500			$500	$0
6.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
6.2	Wetland	SWCD			0%	$5,000			$5,000	$0
6.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$55,200	$233,193	71.8		

Table 11: BMP's & TP load reductions in West Bay Subwatershed (Wills, 2012)

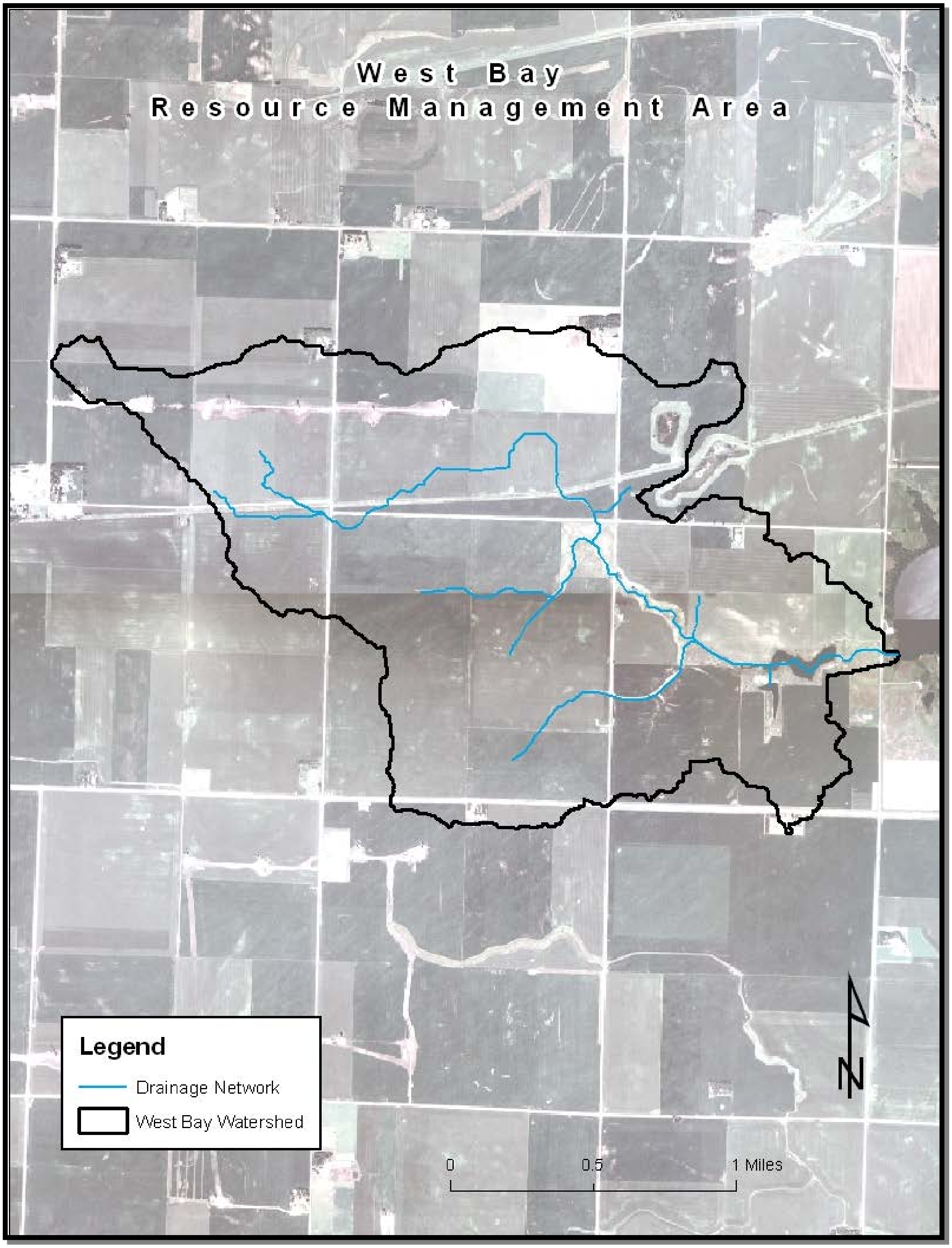


Figure 16: West Bay drainage, Courtesy Iowa DNR

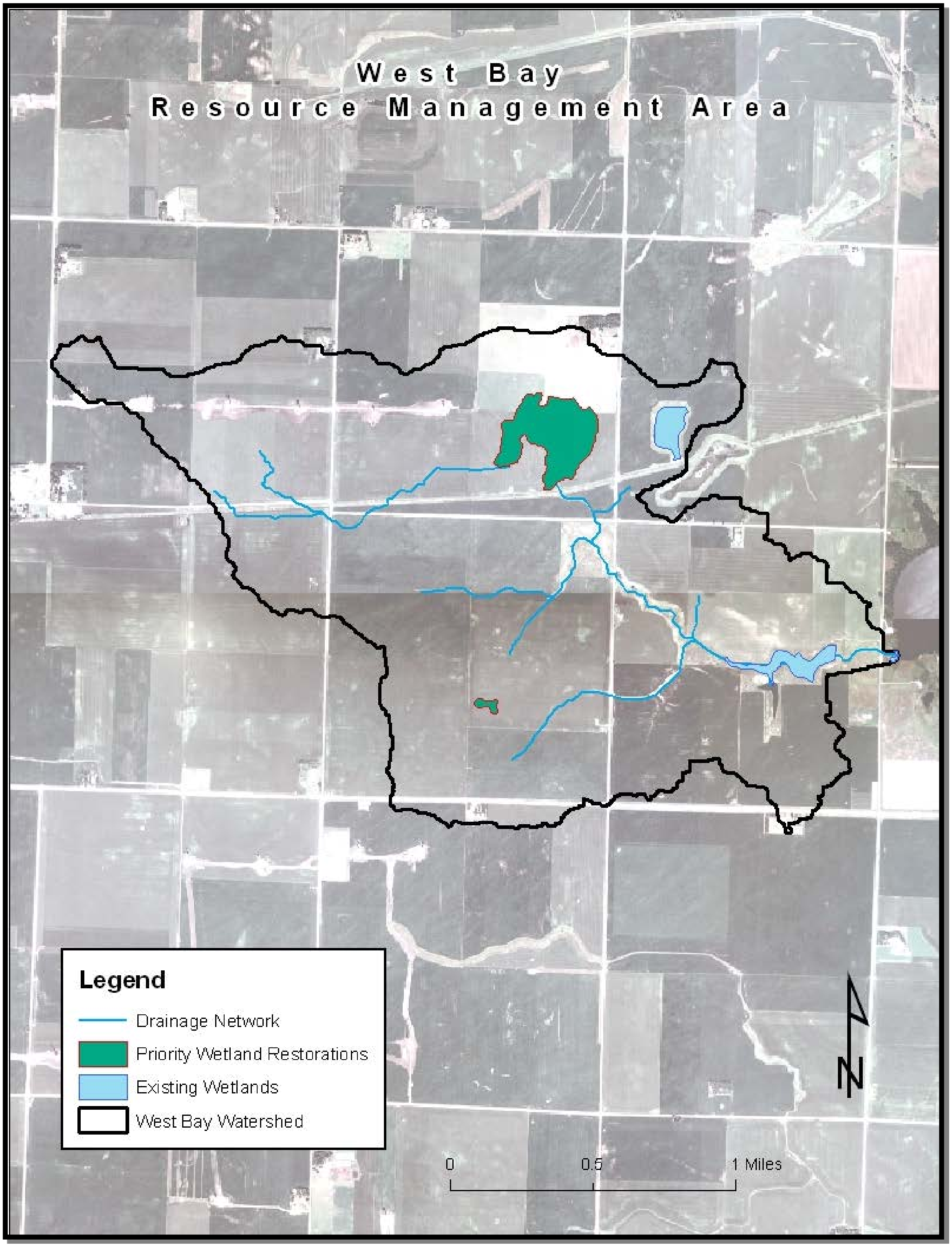


Figure 17: West Bay wetland basins, Courtesy Iowa DNR

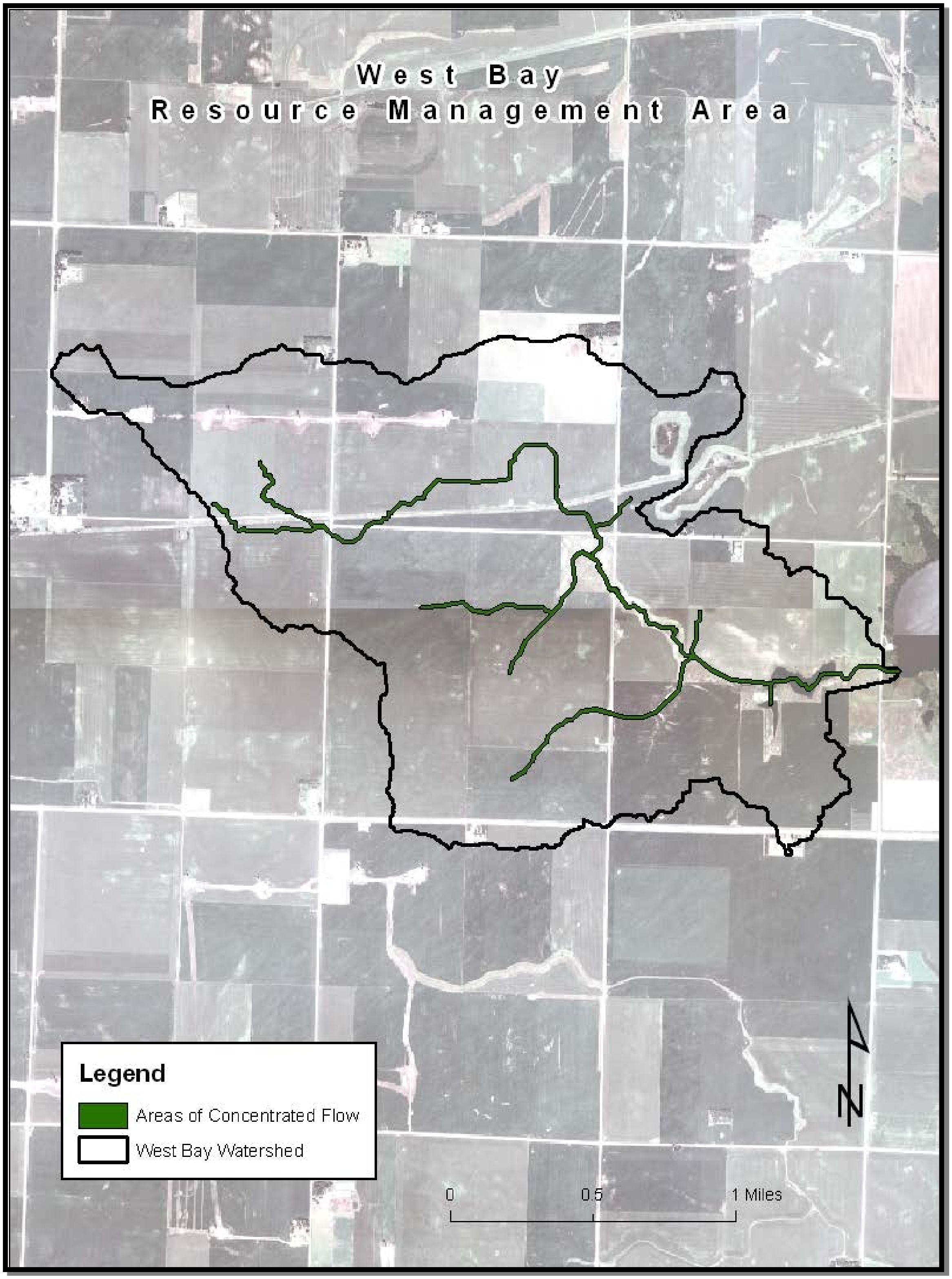


Figure 18: West bay concentrated surface flow, Courtesy Iowa DNR

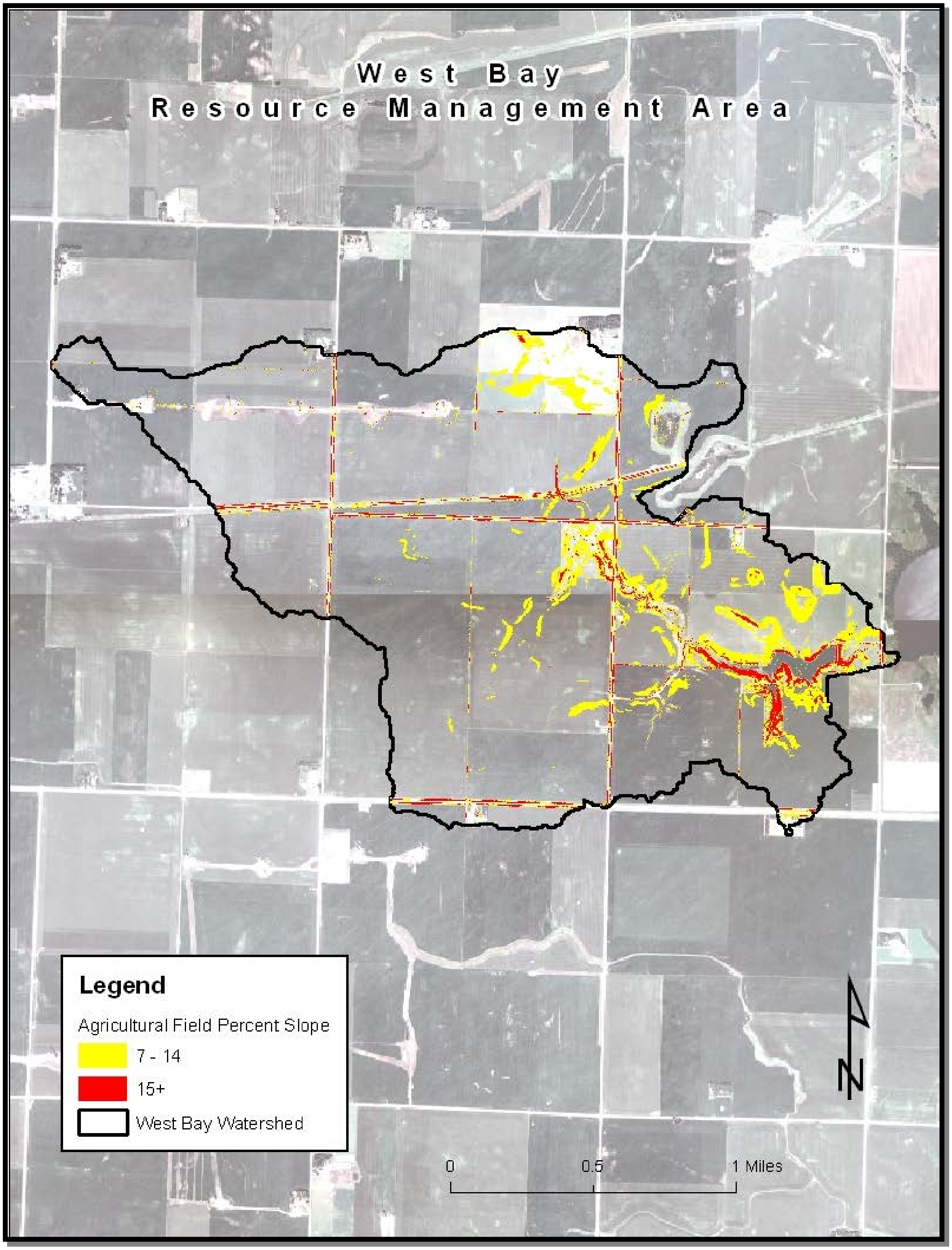


Figure 19: West Bay highly erodible slopes, Courtesy Iowa DNR

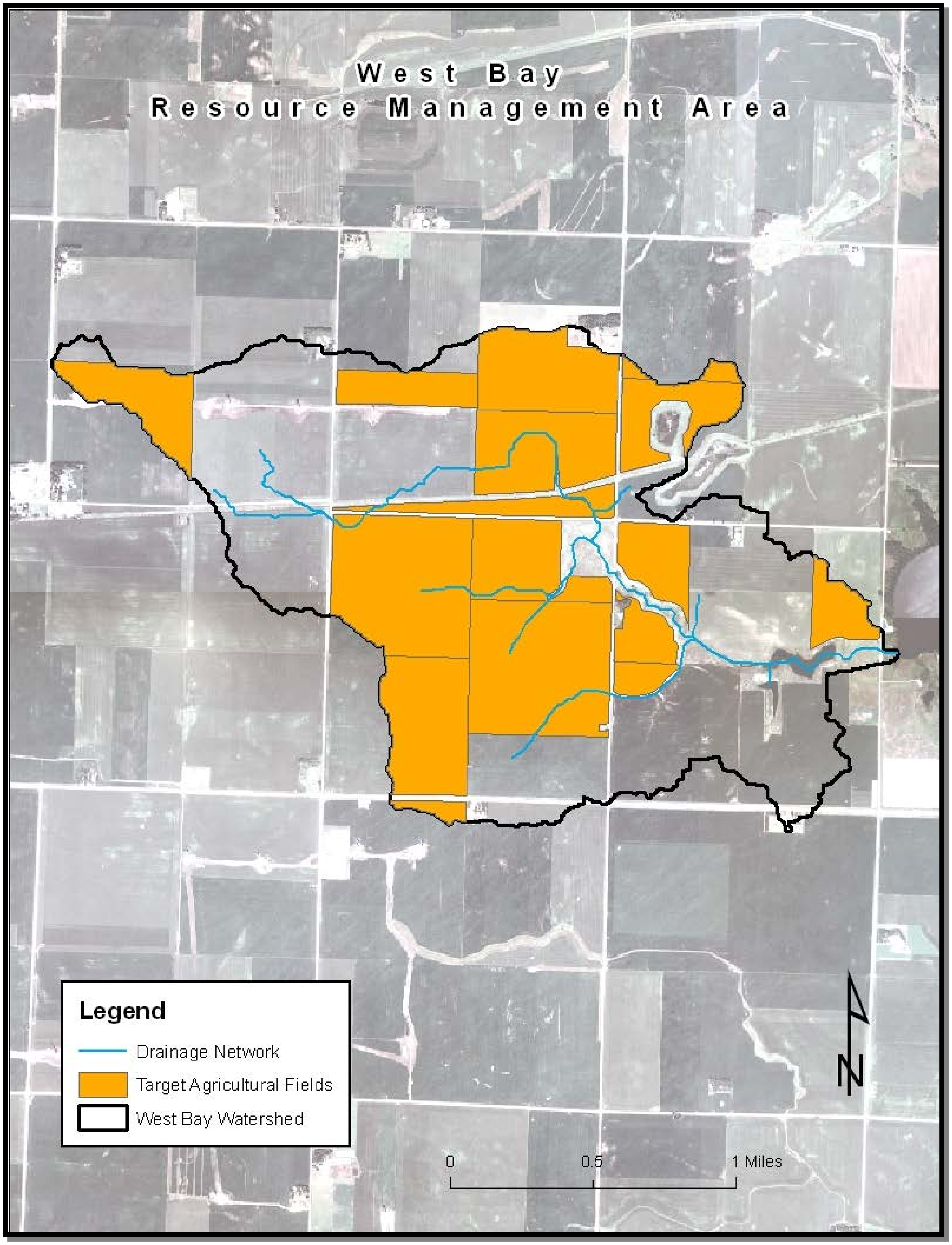


Figure 20: West Bay agricultural fields of highest priority, Courtesy Iowa DNR

Trapper’s Bay Resource Management Area (RMA)

***Objective* –** To prevent sediment and excess nutrients from reaching Silver Lake in excess amounts so the lake will be removed from the State’s list of impaired water bodies. The sediment reductions in this RMA will assist with the 60% target reduction of phosphorus in Silver Lake (12,331 pounds of Phosphorus per year) in accordance with the approved TMDL

***Description* –** The Silver Lake watershed has undergone many hydrological changes in the past 100 years. The reduction of wetlands and the switch from prairies to farmland has left this area degraded in a hydrological sense. This area represents approximately 70% of the watershed flowing into Silver Lake, and is vital to the direct input of Phosphorus. Historically, a long series of pothole wetlands and prairie uplands provided important watershed protection to Silver Lake and provided critical wildlife habitat. A holistic approach is needed to restore ecological health and water quality to this area. A combination of both watershed practices and cultural change is needed to reach the project objective. The following pollution reduction estimates are reflected in the State of Iowa Nutrient Reduction Strategy. The Nutrient Reduction Strategy uses science based fact to determine the best scientifically based conservation practices to remove phosphorous from the watershed of Silver Lake. In addition, the practices that are used in this WMP come from the Nutrient Reduction Strategy.

Merged Basins within Trappers Bay RMA

Because Trappers Bay RMA is over one half of the Silver Lake Watershed, it becomes too large to manage in the scope of this plan as one single RMA. Since it is large a decision was made to break this RMA into smaller, more manageable portions. The method in which to do this was to use the concept of “Merged Basins”. These merged basins are small watersheds within this RMA and by grouping a number of these basins together we are able to develop a more manageable size and we are able to prioritize these basins based on the data we have gleaned through watershed modeling and through watershed monitoring.

The Trappers Bay RMA has been divided into 3 basins:

West Basin of Trappers Bay RMA = 4,720 acres and encompasses the western most portion of the RMA and is shown in the following pages. (40% of Trappers Bay RMA)

Central Basin of Trappers Bay RMA = 3,641 acres and encompasses the central portion of the Trappers Bay RMA and is shown in the following pages. (31% of Trappers Bay RMA)

East Basin of Trappers Bay RMA = 3,506 acres and encompasses the eastern most portion of the RMA and the main part of the City of Lake Park and is shown in the following pages. (30% of Trappers Bay RMA)

Altogether Trappers Bay RMA encompasses 11,867 acres in size by subdividing this larger watershed into sub-basin’s we are able to achieve manageable results.

One key feature within the Trappers Bay RMA is the Drainage Ditch that was dug in the 30s to drain a lake that can still be seen in aerial photos to this date. That Drainage Ditch known as the

West Branch of the Little Sioux River drains thousands of acres of farmland Directly into Silver Lake. The stream bank of this ditch is not stable and contributes many tons of sediment that is heavily laden with Phosphorus to Silver Lake each year. No management plan would be complete without removal of this contribution of sediment from this ditch. As part of Trappers Bay RMA we will discuss treatment of this ditch in Trappers Bay West RMA.

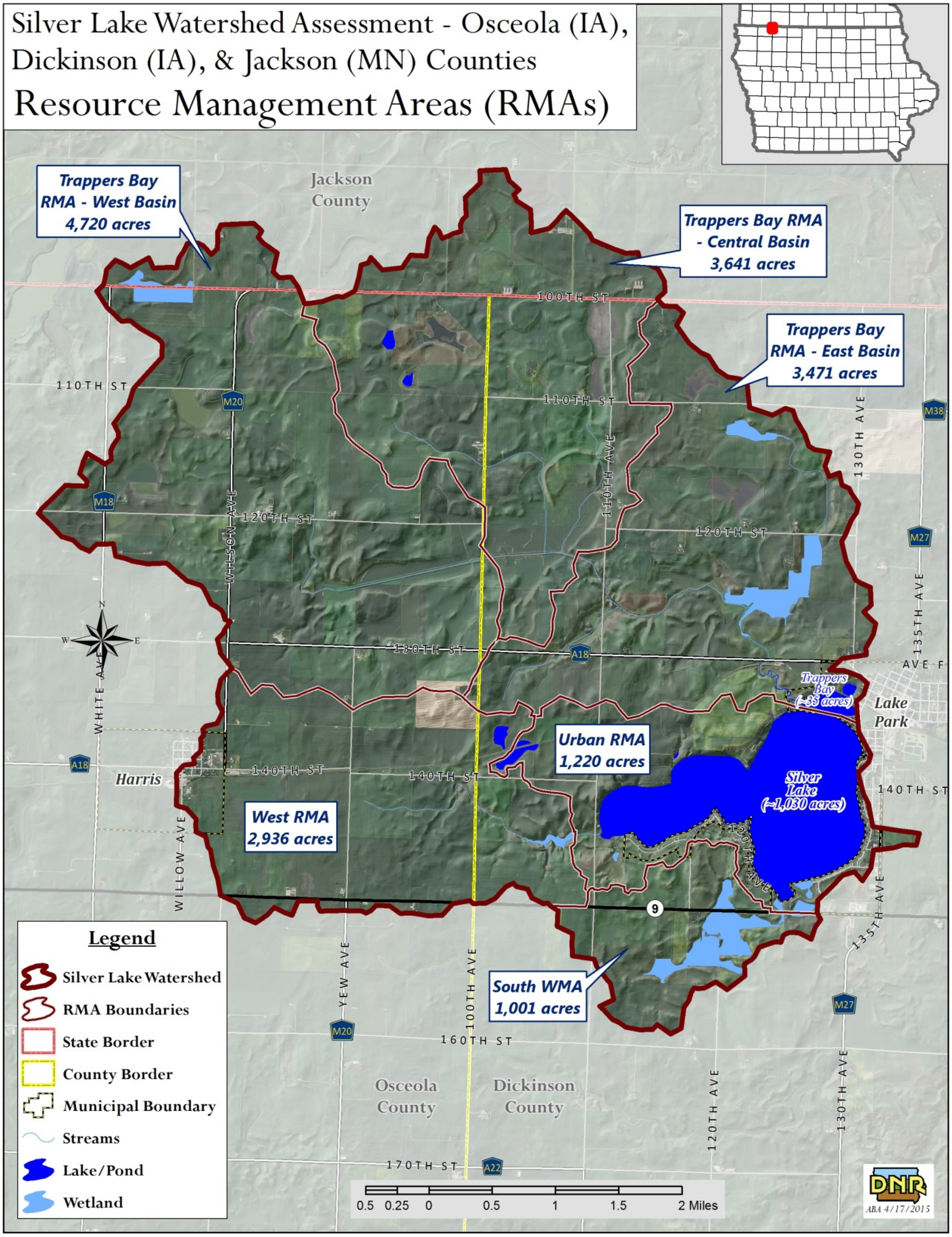


Figure 21: Sub-watershed Acres

Trappers Bay RMA, West Basin

Restoration Planning Components

Phosphorus Management

A combination of Conservation Tillage, No-till systems, Phosphorous Rate Reduction, and Cover Crops will reduce approximately 48.9 pounds of Phosphorus from entering Silver Lake each year. The Spreadsheet that follows details the number of acres and level of treatment. However, it is significant to understand that the important figure to reach is not acres of a practice but rather the pounds of phosphorus reduction.

Land Use Change

A combination of Grassed Waterways, Sediment Basins, Grade Stabilization, Structures, and land retirement will prevent approximately 172.7 pounds of Phosphorus from entering Silver Lake. The spreadsheet that follows will detail the number of acres and the level of treatment necessary to get the required level of reduction. However, it is significant to point out that the pound of Phosphorus is the important factor in the reduction.

Edge of Field

A combination of wetland restorations, sediment control practices, vegetative buffers, and tile intake treatments will be used to prevent approximately 99.1 pounds of Phosphorus from reaching Silver Lake. It is significant to note that the acres and number of practices is not as important as is the pounds of Phosphorus reduced.

Drainage Ditch Repair

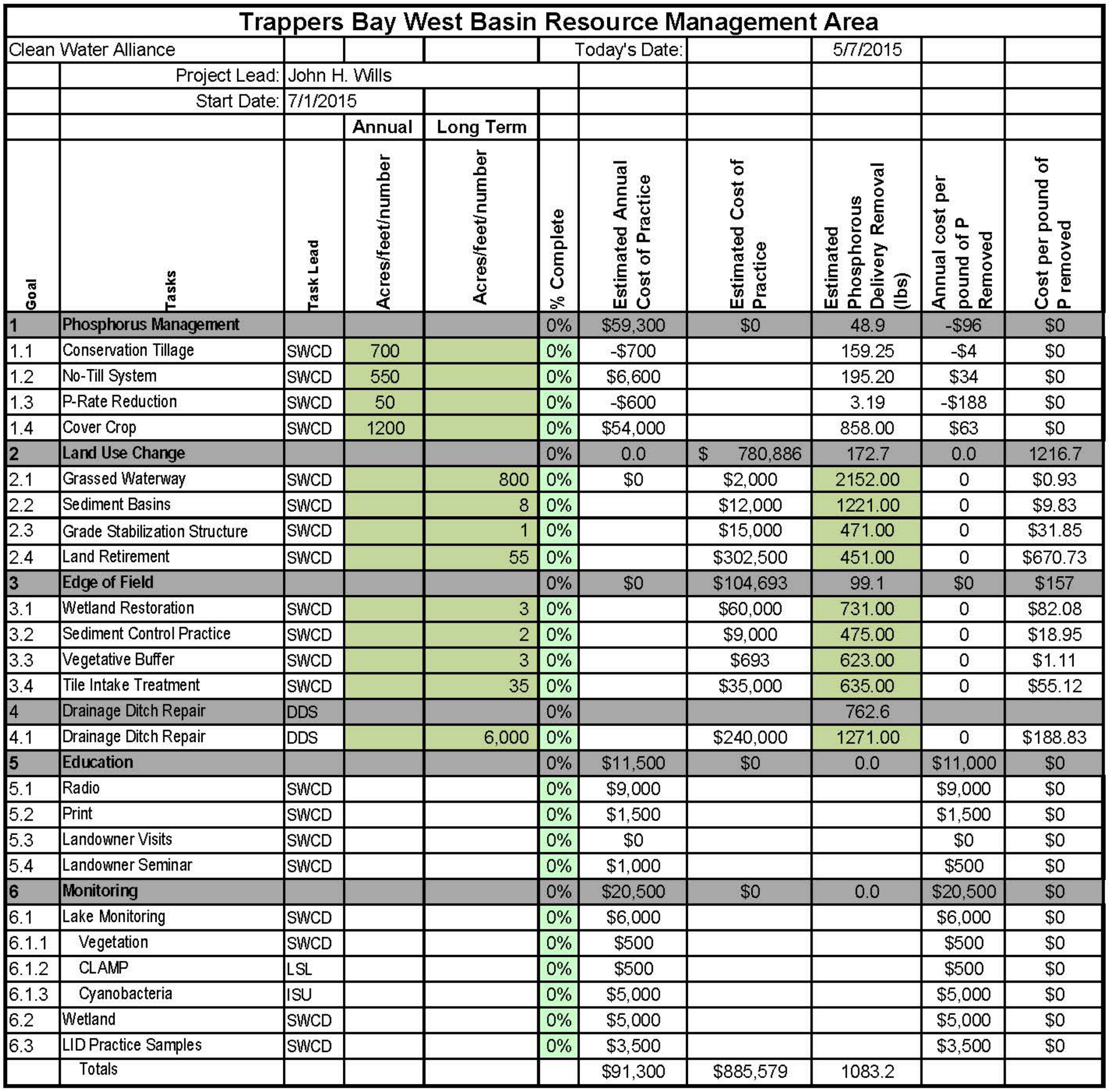
The Joint Drainage Ditch 1 travels through all three of the sub-basins in Trappers Bay, but to divide that amount up presented a staggering task. Therefore, the drainage ditch repair that is proposed and currently moving forward has been planned in this sub-basin as it starts in this basin and travels through all three sub-basins. The total savings of phosphorous that would be realized from completing this drainage ditch project would be 762.6 pounds each year that would be prevented from reaching the lake.

Education

An intensive education campaign to change attitudes and the culture that has been formed over time will be implemented. The education campaign will closely follow the Public Outreach program that is outlined on page 22 of this Management Plan. The campaign will specifically target the landowners and operators of this RMA but will be done in a way that anyone can use the information.

Monitoring

Water monitoring of this RMA will be vital in providing a baseline and documentation of any improvements that are realized by the cultural practices and the erosion control practices that are installed as part of the plan. The water monitoring will be inclusive and follow the QUAPP that has been developed specifically for this RMA.



Trappers Bay West Basin Resource Management Area										
Clean Water Alliance						Today's Date:		5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Delivery Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	**Phosphorus Management**				0%	$59,300	$0	48.9	-$96	$0
1.1	Conservation Tillage	SWCD	700		0%	-$700		159.25	-$4	$0
1.2	No-Till System	SWCD	550		0%	$6,600		195.20	$34	$0
1.3	P-Rate Reduction	SWCD	50		0%	-$600		3.19	-$188	$0
1.4	Cover Crop	SWCD	1200		0%	$54,000		858.00	$63	$0
2	**Land Use Change**				0%	0.0	$ 780,886	172.7	0.0	1216.7
2.1	Grassed Waterway	SWCD		800	0%	$0	$2,000	2152.00	0	$0.93
2.2	Sediment Basins	SWCD		8	0%		$12,000	1221.00	0	$9.83
2.3	Grade Stabilization Structure	SWCD		1	0%		$15,000	471.00	0	$31.85
2.4	Land Retirement	SWCD		55	0%		$302,500	451.00	0	$670.73
3	**Edge of Field**				0%	$0	$104,693	99.1	$0	$157
3.1	Wetland Restoration	SWCD		3	0%		$60,000	731.00	0	$82.08
3.2	Sediment Control Practice	SWCD		2	0%		$9,000	475.00	0	$18.95
3.3	Vegetative Buffer	SWCD		3	0%		$693	623.00	0	$1.11
3.4	Tile Intake Treatment	SWCD		35	0%		$35,000	635.00	0	$55.12
4	Drainage Ditch Repair	DDS			0%			762.6		
4.1	Drainage Ditch Repair	DDS		6,000	0%		$240,000	1271.00	0	$188.83
5	**Education**				0%	$11,500	$0	0.0	$11,000	$0
5.1	Radio	SWCD			0%	$9,000			$9,000	$0
5.2	Print	SWCD			0%	$1,500			$1,500	$0
5.3	Landowner Visits	SWCD			0%	$0			$0	$0
5.4	Landowner Seminar	SWCD			0%	$1,000			$500	$0
6	**Monitoring**				0%	$20,500	$0	0.0	$20,500	$0
6.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
6.1.1	Vegetation	SWCD			0%	$500			$500	$0
6.1.2	CLAMP	LSL			0%	$500			$500	$0
6.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
6.2	Wetland	SWCD			0%	$5,000			$5,000	$0
6.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$91,300	$885,579	1083.2		

Table 12: BMP’s & TP load reductions in Trapper’s Bay West Basin Sub-watershed (Wills, 2012)

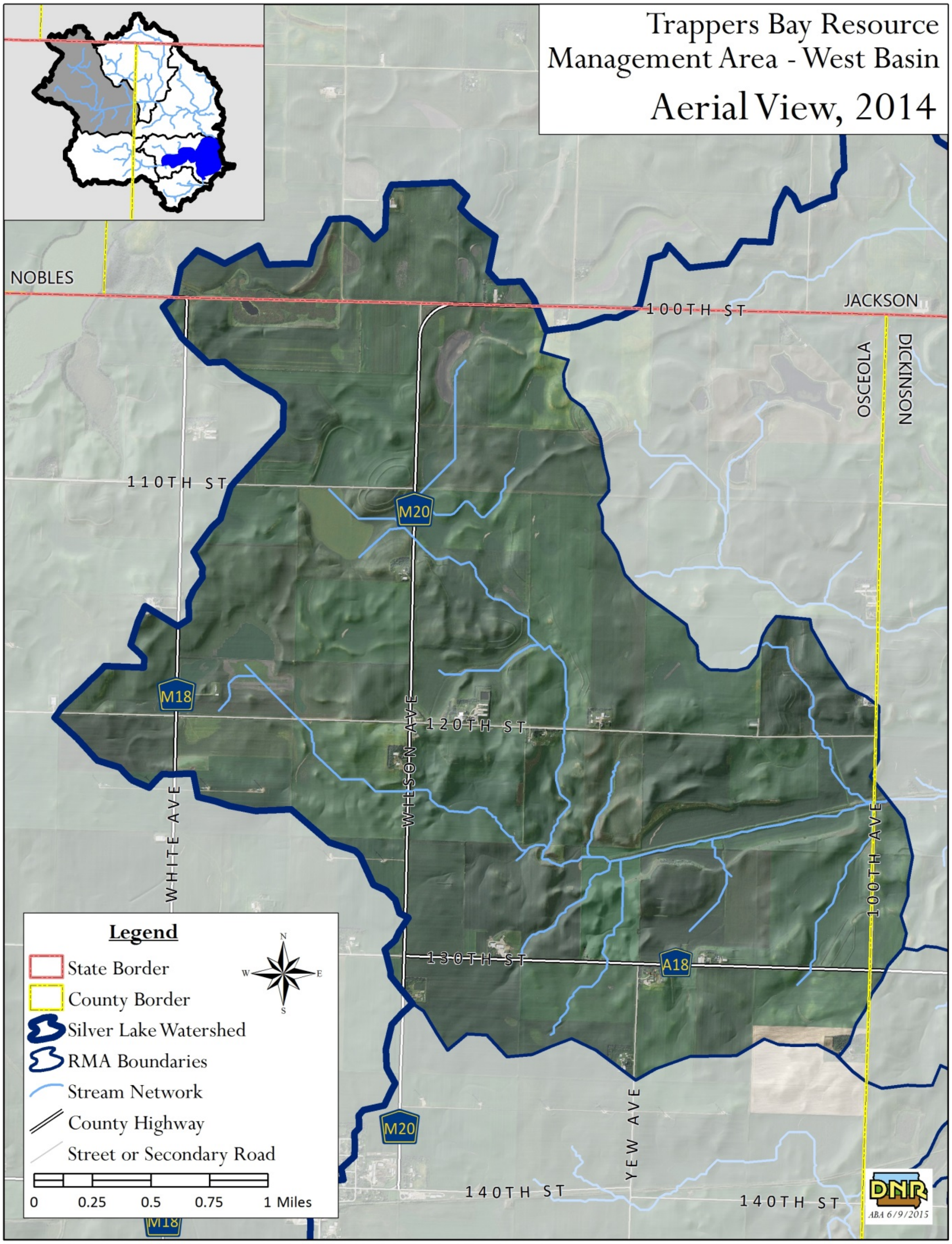


Figure 22: Trapper's Bay West Basin Drainage, Courtesy Iowa DNR

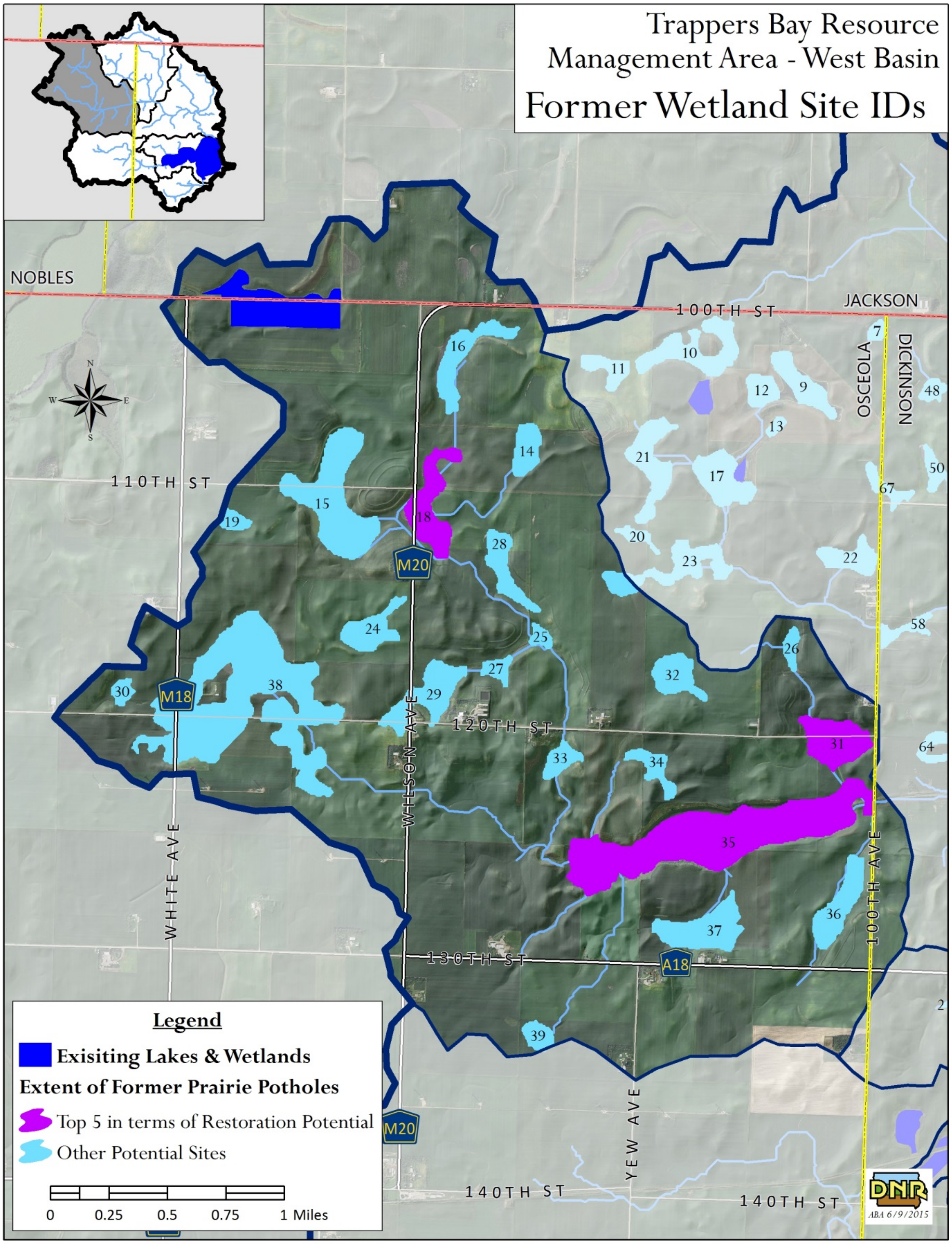


Figure 23: Trapper's Bay West Basin Wetland basins, Courtesy Iowa DNR

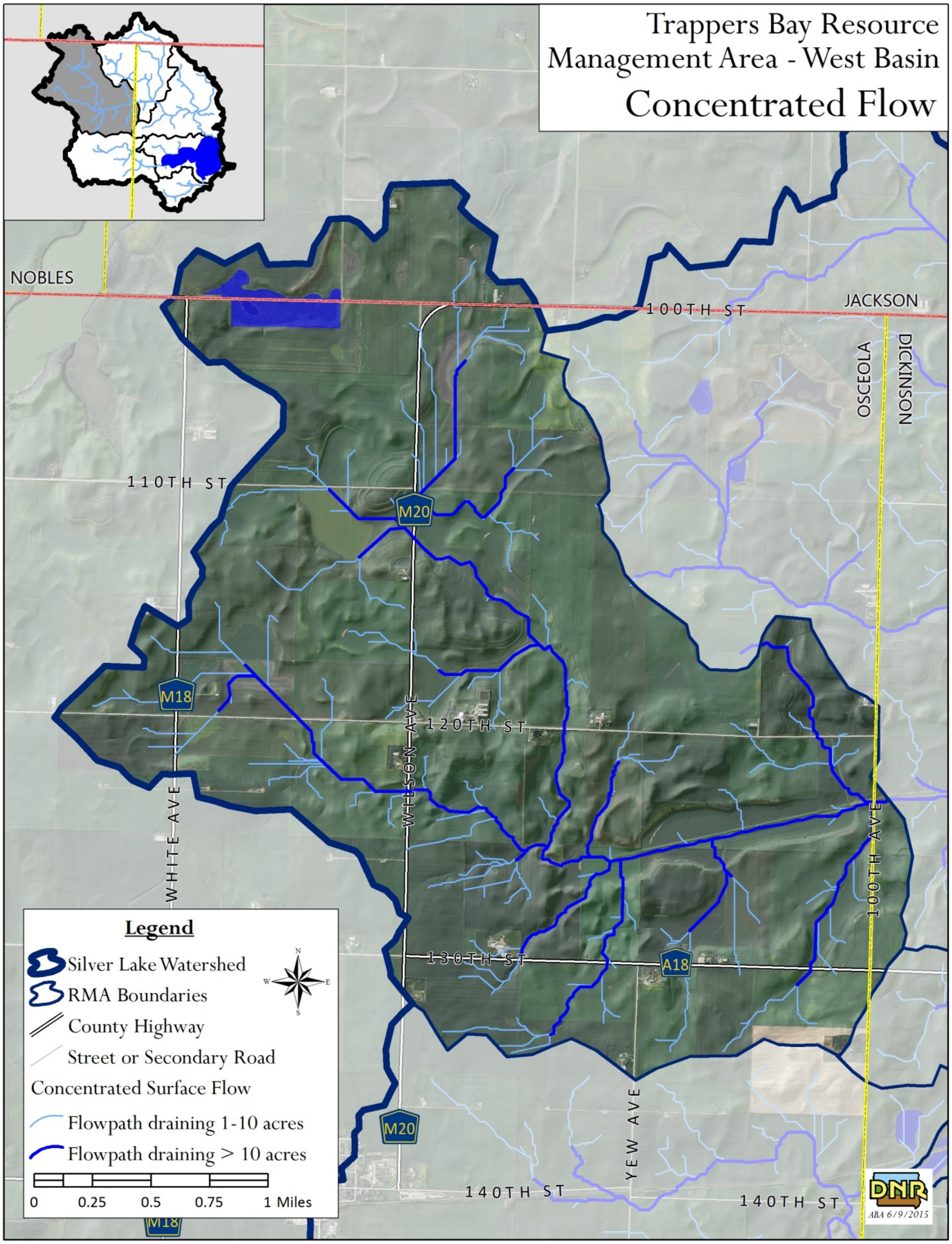


Figure 24: Trapper's Bay West Basin Concentrated Surface Flow, Courtesy Iowa DNR

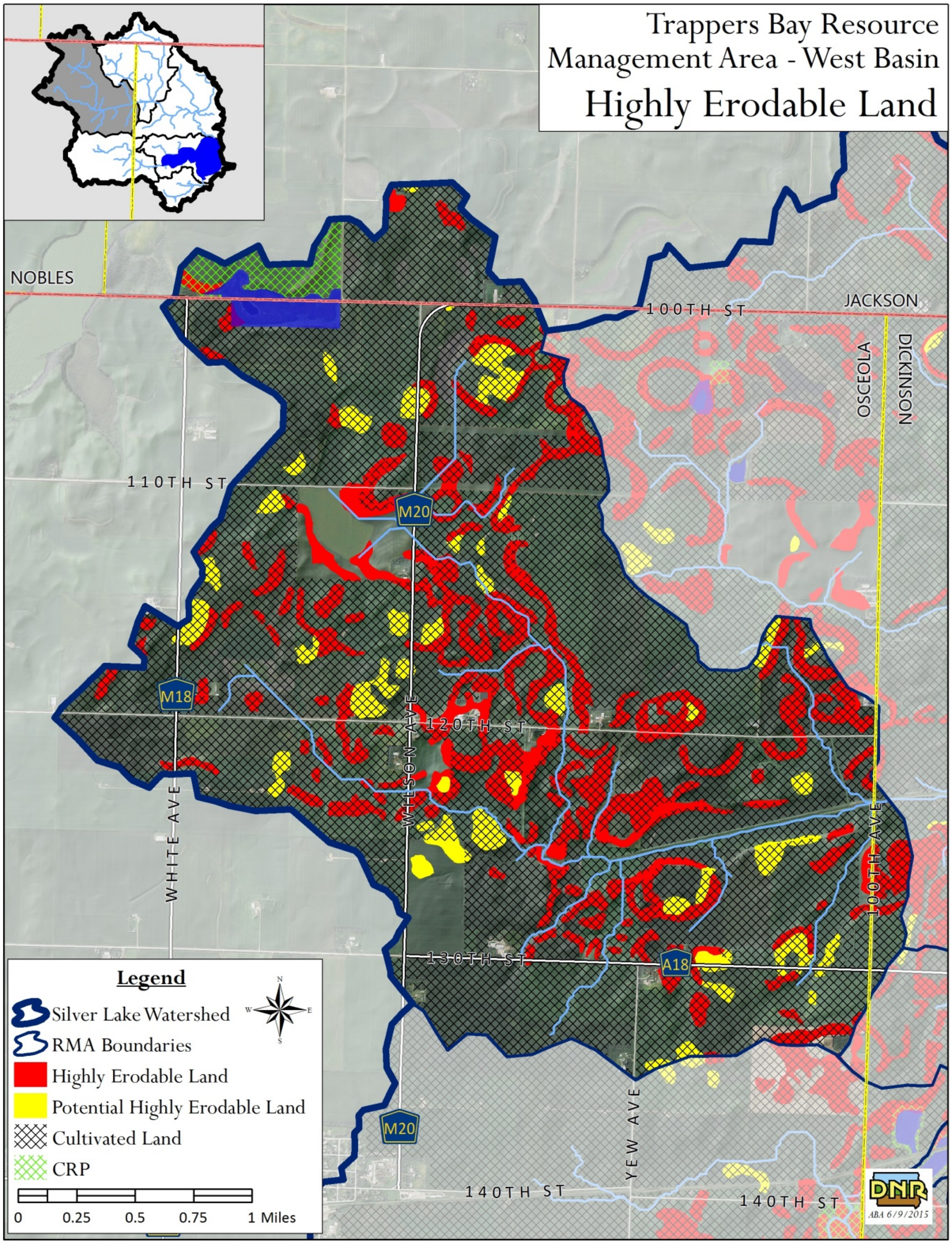


Figure 25: Trapper's Bay West Basin Highly Erodible Slopes, Courtesy Iowa DNR

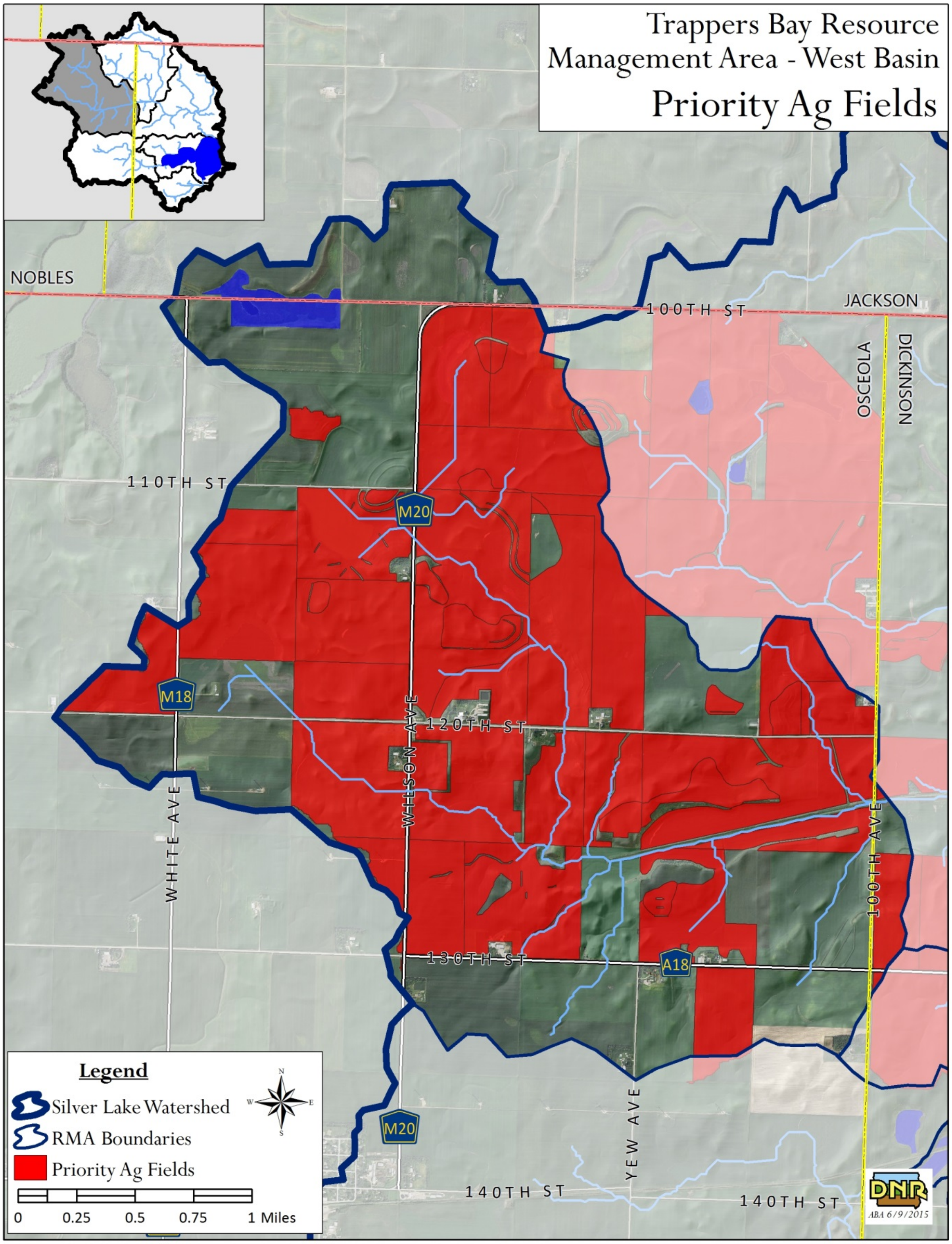


Figure 26: Trapper's Bay West Basin agricultural fields of highest priority, Courtesy Iowa DNR

Trappers Bay RMA, Central Basin

Restoration Planning Components

Phosphorus Management

A combination of Conservation Tillage, No-till systems, Phosphorous Rate Reduction, and Cover Crops will reduce approximately 85.7 pounds of Phosphorus from entering Silver Lake each year. The Spreadsheet that follows details the number of acres and level of treatment. However, it is significant to understand that the important figure to reach is not acres of a practice but rather the pounds of phosphorus reduction.

Land Use Change

A combination of Grassed Waterways, Sediment Basins, Grade Stabilization, Structures, and land retirement will prevent approximately 105.9 pounds of Phosphorus from entering Silver Lake. The spreadsheet that follows will detail the number of acres and the level of treatment necessary to get the required level of reduction. However, it is significant to point out that the pound of Phosphorus is the important factor in the reduction.

Edge of Field

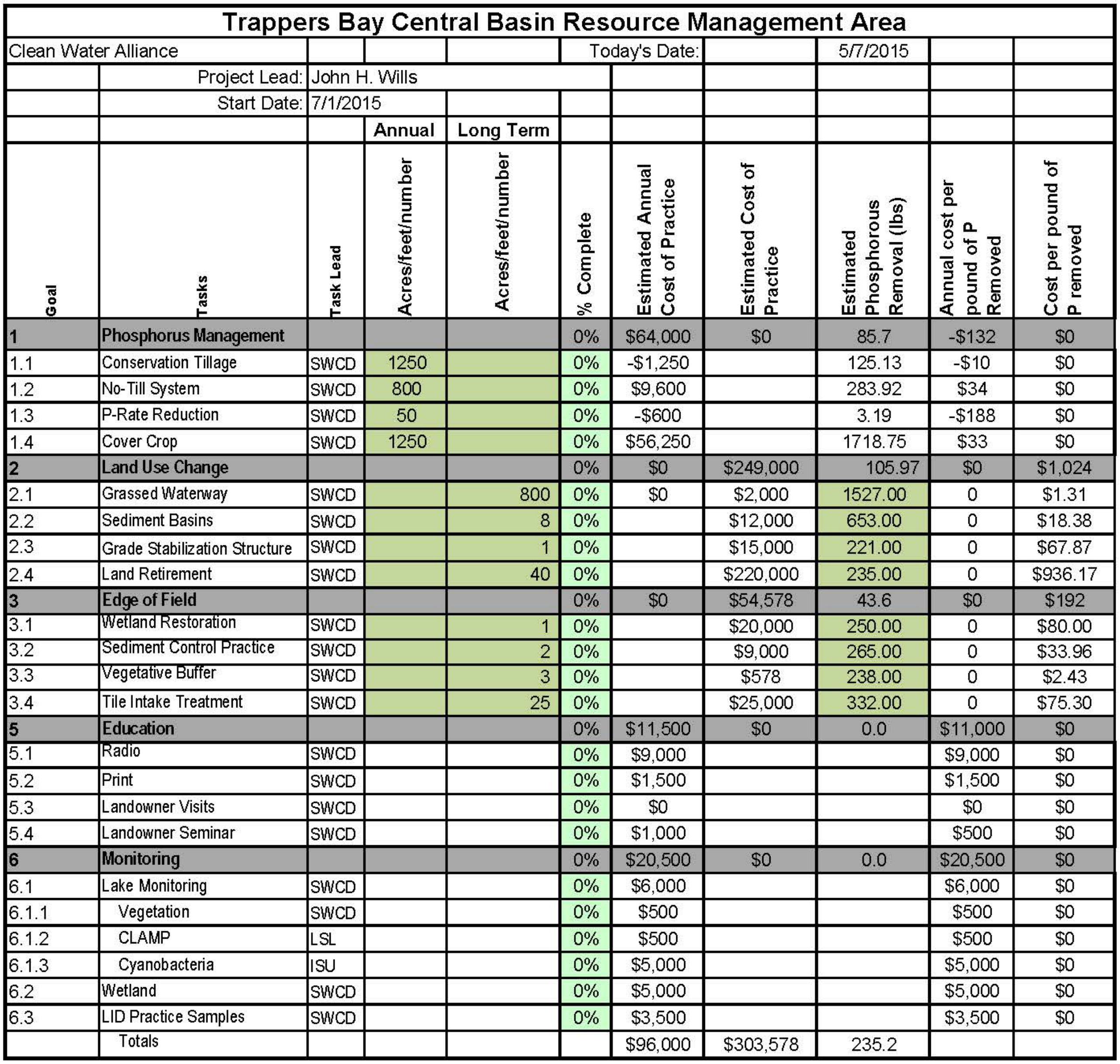
A combination of wetland restorations, sediment control practices, vegetative buffers, and tile intake treatments will be used to prevent approximately 43.6 pounds of Phosphorus from reaching Silver Lake. It is significant to note that the acres and number of practices is not as important as is the pounds of Phosphorus reduced.

Education

An intensive education campaign to change attitudes and the culture that has been formed over time will be implemented. The education campaign will closely follow the Public Outreach program that is outlined on page 22 of this Management Plan. The campaign will specifically target the landowners and operators of this RMA but will be done in a way that anyone can use the information.

Monitoring

Water monitoring of this RMA will be vital in providing a baseline and documentation of any improvements that are realized by the cultural practices and the erosion control practices that are installed as part of the plan. The water monitoring will be inclusive and follow the QUAPP that has been developed specifically for this RMA.



Trappers Bay Central Basin Resource Management Area

Clean Water Alliance					Today's Date:			5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	**Phosphorus Management**				0%	$64,000	$0	85.7	-$132	$0
1.1	Conservation Tillage	SWCD	1250		0%	-$1,250		125.13	-$10	$0
1.2	No-Till System	SWCD	800		0%	$9,600		283.92	$34	$0
1.3	P-Rate Reduction	SWCD	50		0%	-$600		3.19	-$188	$0
1.4	Cover Crop	SWCD	1250		0%	$56,250		1718.75	$33	$0
2	**Land Use Change**				0%	$0	$249,000	105.97	$0	$1,024
2.1	Grassed Waterway	SWCD		800	0%	$0	$2,000	1527.00	0	$1.31
2.2	Sediment Basins	SWCD		8	0%		$12,000	653.00	0	$18.38
2.3	Grade Stabilization Structure	SWCD		1	0%		$15,000	221.00	0	$67.87
2.4	Land Retirement	SWCD		40	0%		$220,000	235.00	0	$936.17
3	**Edge of Field**				0%	$0	$54,578	43.6	$0	$192
3.1	Wetland Restoration	SWCD		1	0%		$20,000	250.00	0	$80.00
3.2	Sediment Control Practice	SWCD		2	0%		$9,000	265.00	0	$33.96
3.3	Vegetative Buffer	SWCD		3	0%		$578	238.00	0	$2.43
3.4	Tile Intake Treatment	SWCD		25	0%		$25,000	332.00	0	$75.30
5	**Education**				0%	$11,500	$0	0.0	$11,000	$0
5.1	Radio	SWCD			0%	$9,000			$9,000	$0
5.2	Print	SWCD			0%	$1,500			$1,500	$0
5.3	Landowner Visits	SWCD			0%	$0			$0	$0
5.4	Landowner Seminar	SWCD			0%	$1,000			$500	$0
6	**Monitoring**				0%	$20,500	$0	0.0	$20,500	$0
6.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
6.1.1	Vegetation	SWCD			0%	$500			$500	$0
6.1.2	CLAMP	LSL			0%	$500			$500	$0
6.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
6.2	Wetland	SWCD			0%	$5,000			$5,000	$0
6.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$96,000	$303,578	235.2		

Table 13: BMP's & TP load reductions in Trapper's Bay Central Basin subwatershed (Wills, 2012)

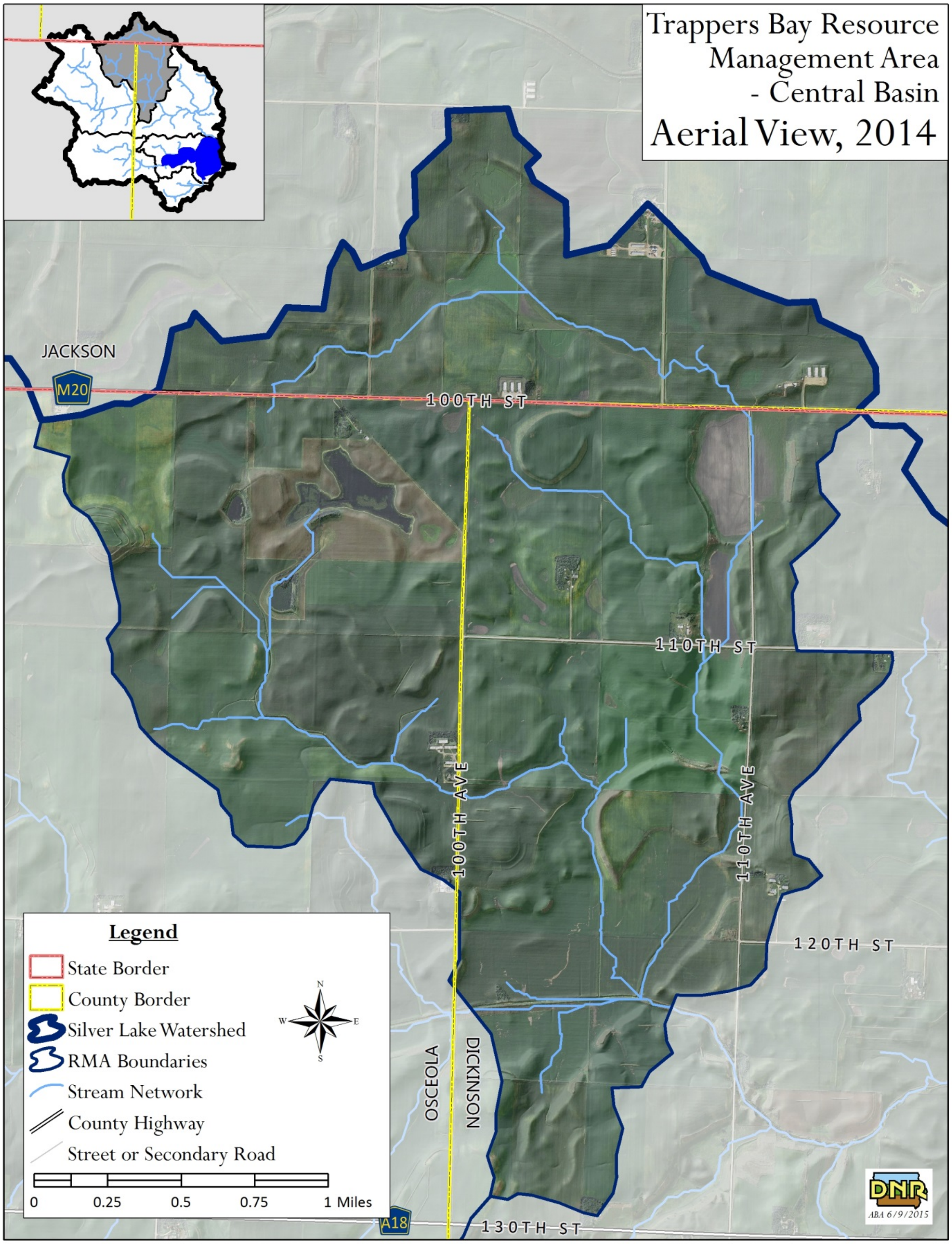


Figure 27: Trapper's Bay Central Basin Drainage, Courtesy Iowa DNR

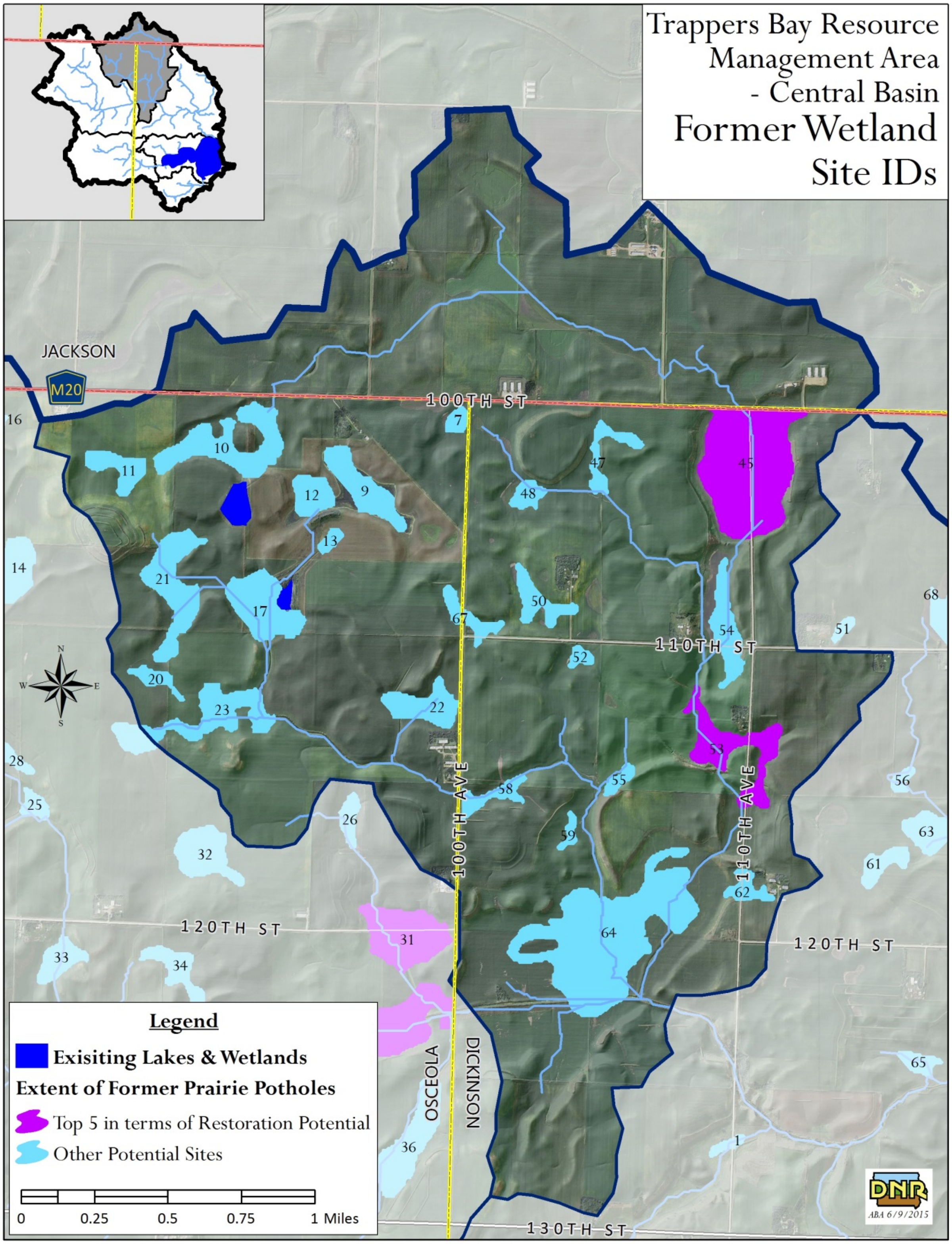


Figure 28: Trapper's Bay Central Basin Wetland Basins, Courtesy Iowa DNR

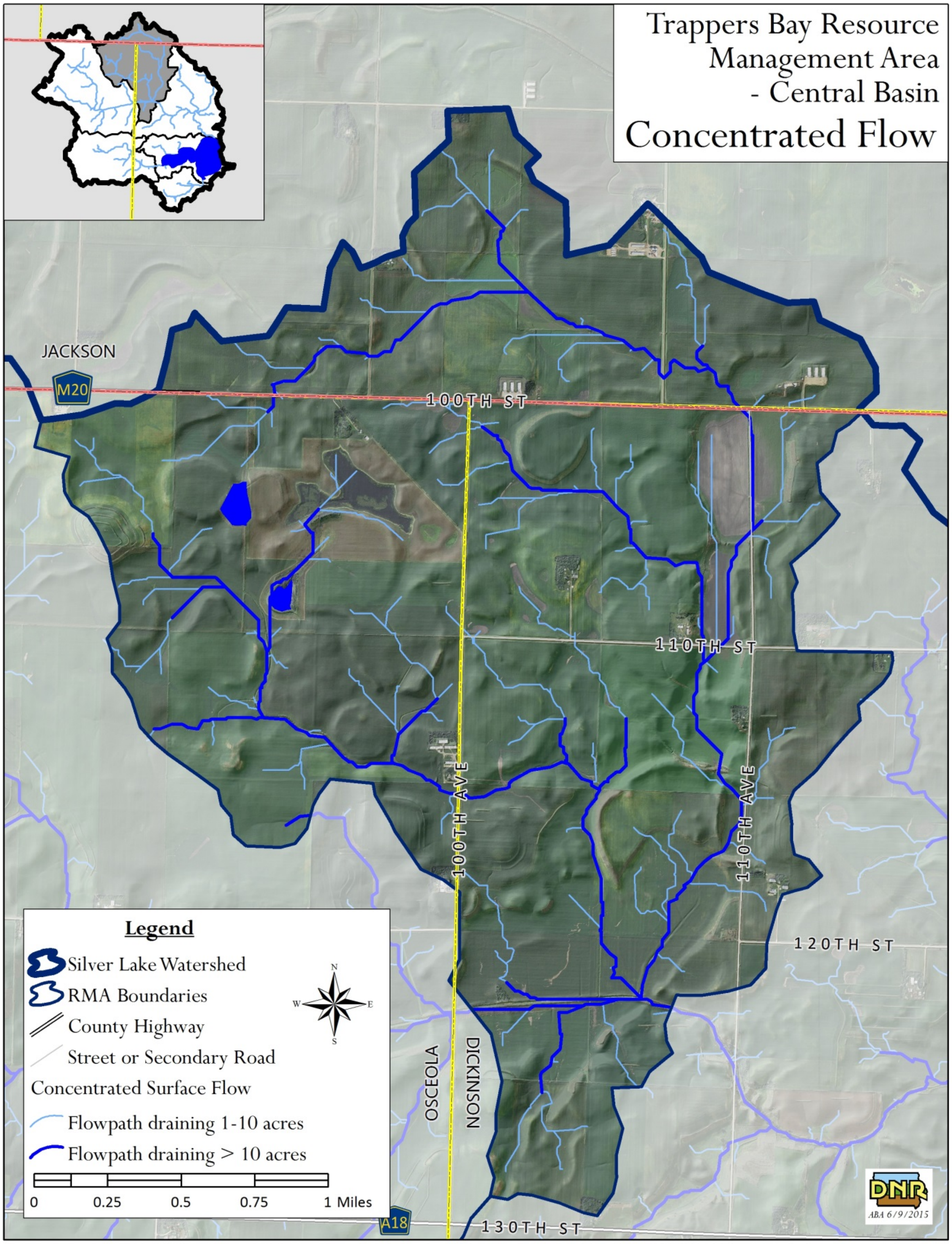


Figure 29: Trapper's Bay Central Basin Concentrated Surface Flow, Courtesy Iowa DNR

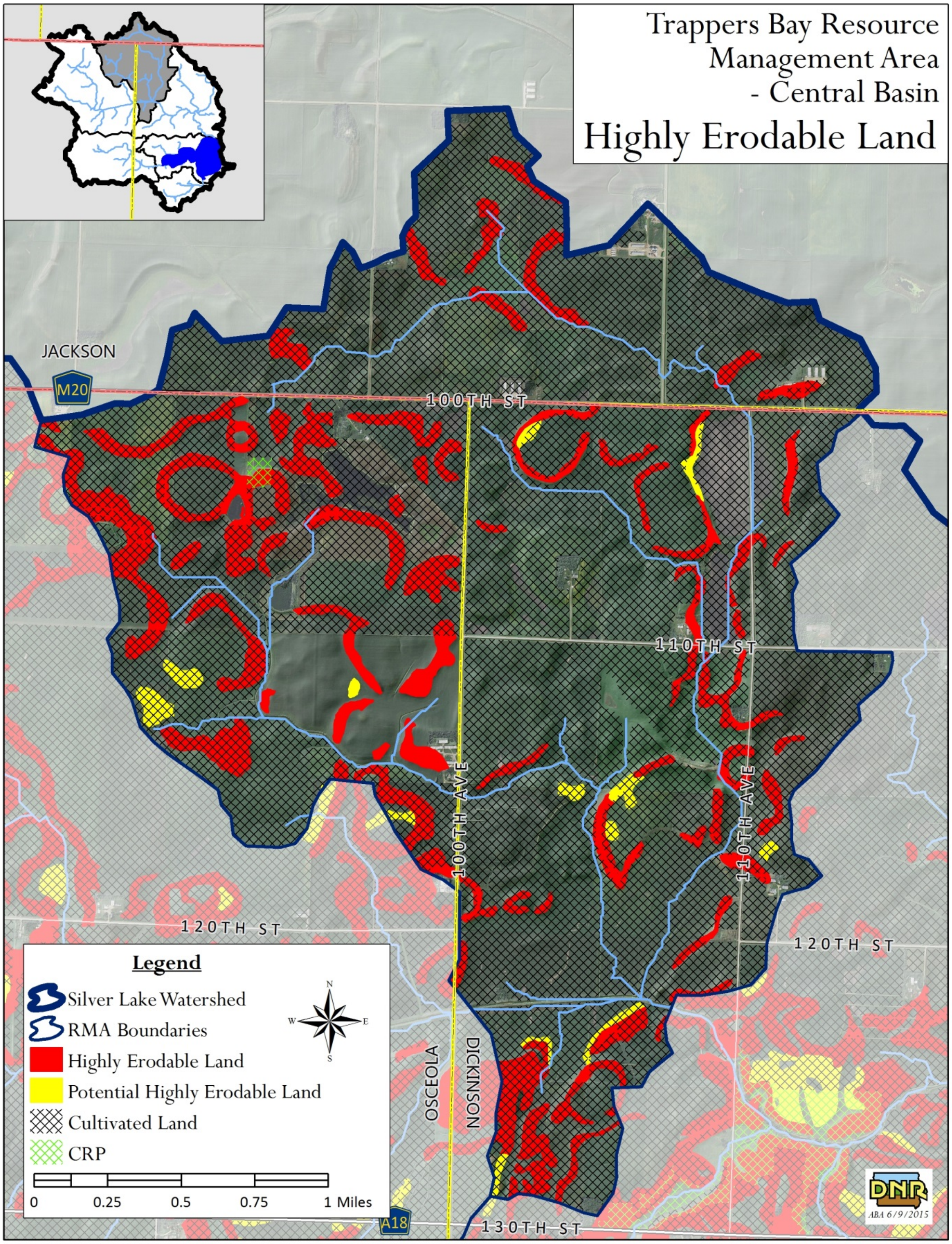


Figure 30: Trapper's Bay Central Basin Highly erodible slopes, , Courtesy Iowa DNR

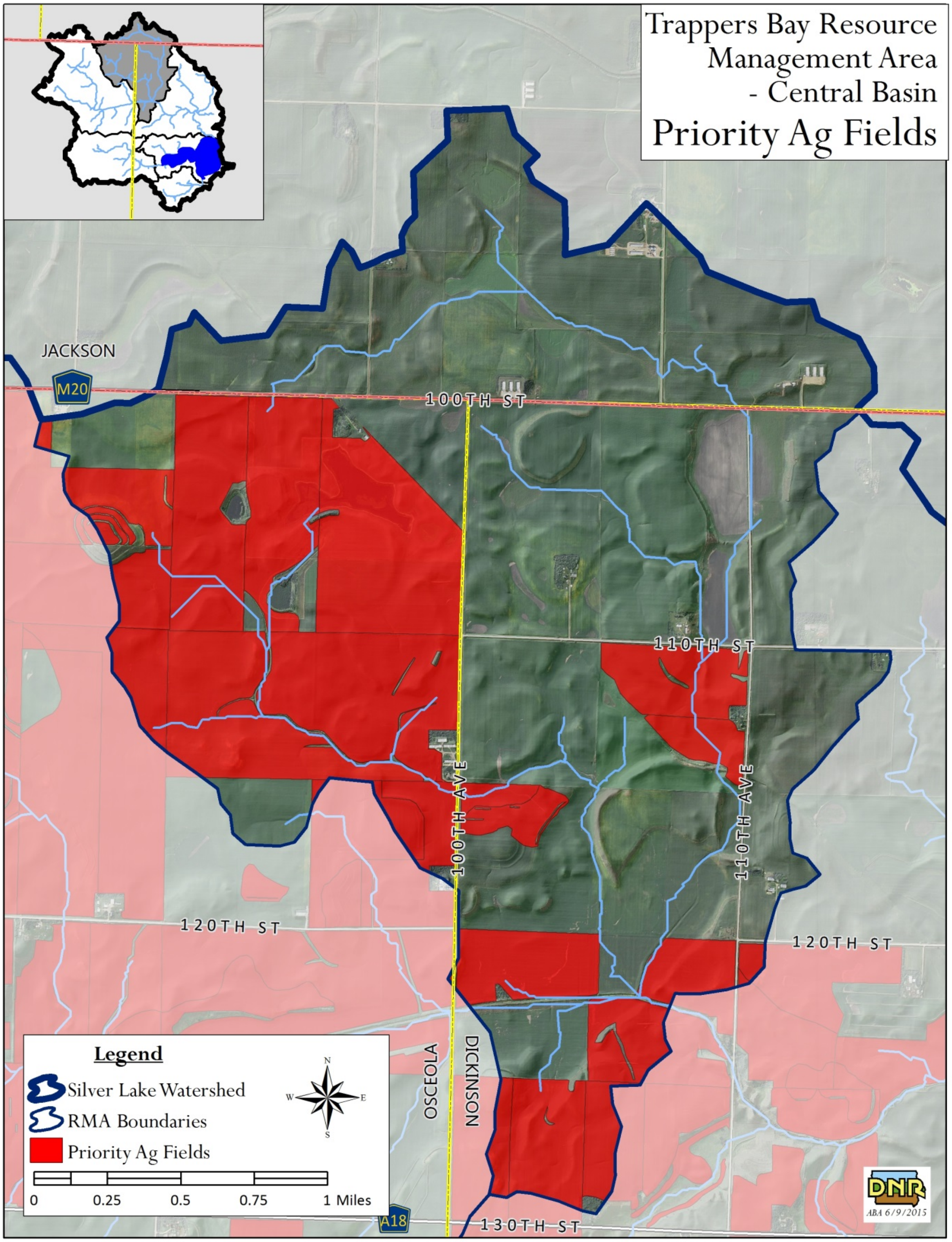


Figure 31: Trapper's Bay Central Basin Agricultural Fields of Highest Priority, Courtesy Iowa DNR

Trappers Bay RMA, East Basin

Restoration Planning Components

Phosphorus Management

A combination of Conservation Tillage, No-till systems, Phosphorous Rate Reduction, and Cover Crops will reduce approximately 91.7 pounds of Phosphorus from entering Silver Lake each year. The Spreadsheet that follows details the number of acres and level of treatment. However, it is significant to understand that the important figure to reach is not acres of a practice but rather the pounds of phosphorus reduction.

Land Use Change

A combination of Grassed Waterways, Sediment Basins, Grade Stabilization, Structures, and land retirement will prevent approximately 84.7 pounds of Phosphorus from entering Silver Lake. The spreadsheet that follows will detail the number of acres and the level of treatment necessary to get the required level of reduction. However, it is significant to point out that the pound of Phosphorus is the important factor in the reduction.

Edge of Field

A combination of wetland restorations, sediment control practices, vegetative buffers, and tile intake treatments will be used to prevent approximately 30.9 pounds of Phosphorus from reaching Silver Lake. It is significant to note that the acres and number of practices is not as important as is the pounds of Phosphorus reduced.

Shallow Lake and Shoreline Treatment

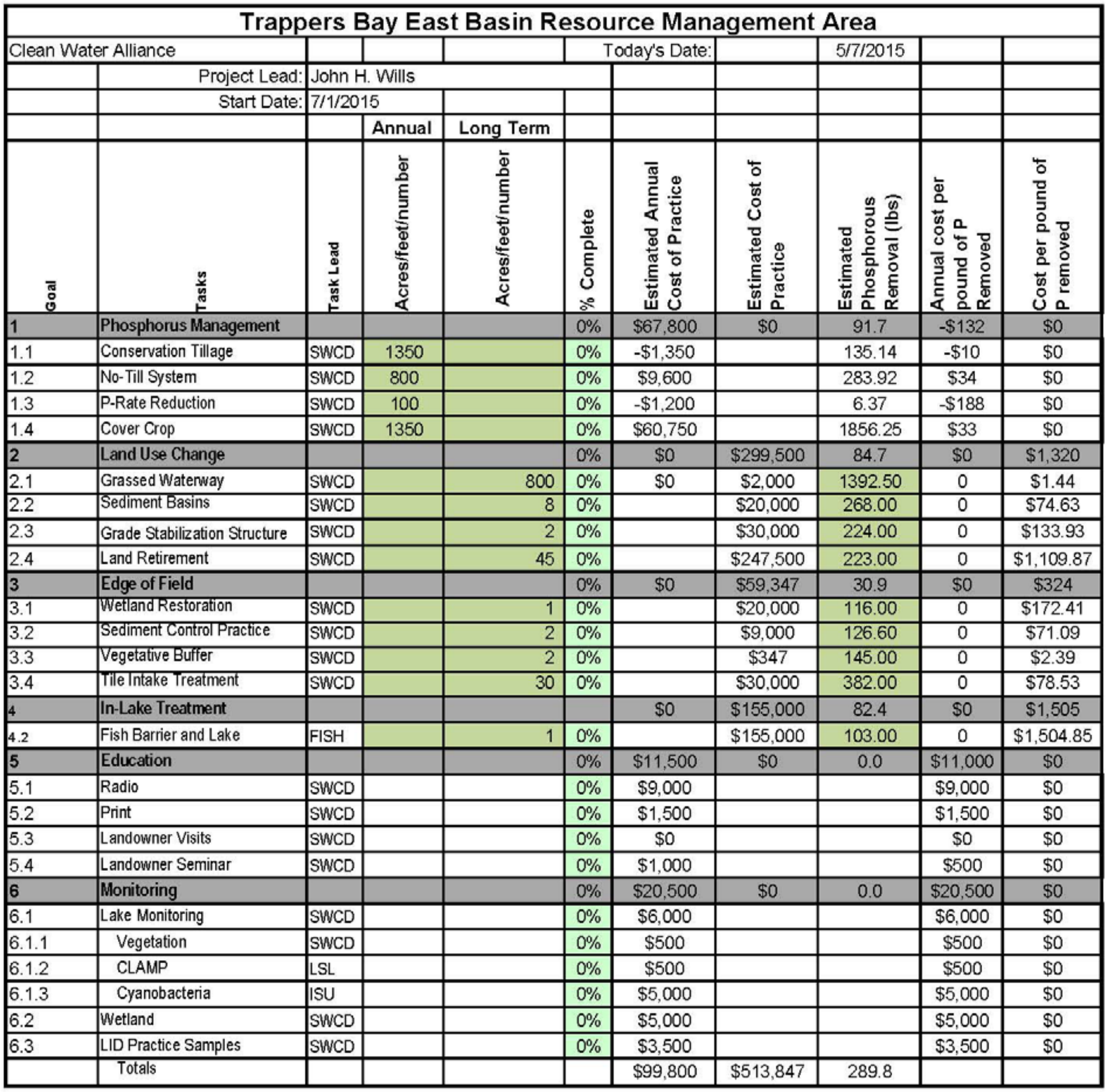
Shoreline restoration and carp exclusion and reduction are used in this category to reduce the in-lake contribution of sediment and Phosphorus from being re-suspended into the lake and a continual problem. It is estimated that these practices will eliminate 82.4 pounds of Phosphorus from entering Silver Lake

Education

An intensive education campaign to change attitudes and the culture that has been formed over time will be implemented. The education campaign will closely follow the Public Outreach program that is outlined on page 22 of this Management Plan. The campaign will specifically target the landowners and operators of this RMA but will be done in a way that anyone can use the information.

Monitoring

Water monitoring of this RMA will be vital in providing a baseline and documentation of any improvements that are realized by the cultural practices and the erosion control practices that are installed as part of the plan. The water monitoring will be inclusive and follow the QUAPP that has been developed specifically for this RMA.



Trappers Bay East Basin Resource Management Area										
Clean Water Alliance					Today's Date:			5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	**Phosphorus Management**				0%	$67,800	$0	91.7	-$132	$0
1.1	Conservation Tillage	SWCD	1350		0%	-$1,350		135.14	-$10	$0
1.2	No-Till System	SWCD	800		0%	$9,600		283.92	$34	$0
1.3	P-Rate Reduction	SWCD	100		0%	-$1,200		6.37	-$188	$0
1.4	Cover Crop	SWCD	1350		0%	$60,750		1856.25	$33	$0
2	**Land Use Change**				0%	$0	$299,500	84.7	$0	$1,320
2.1	Grassed Waterway	SWCD		800	0%	$0	$2,000	1392.50	0	$1.44
2.2	Sediment Basins	SWCD		8	0%		$20,000	268.00	0	$74.63
2.3	Grade Stabilization Structure	SWCD		2	0%		$30,000	224.00	0	$133.93
2.4	Land Retirement	SWCD		45	0%		$247,500	223.00	0	$1,109.87
3	**Edge of Field**				0%	$0	$59,347	30.9	$0	$324
3.1	Wetland Restoration	SWCD		1	0%		$20,000	116.00	0	$172.41
3.2	Sediment Control Practice	SWCD		2	0%		$9,000	126.60	0	$71.09
3.3	Vegetative Buffer	SWCD		2	0%		$347	145.00	0	$2.39
3.4	Tile Intake Treatment	SWCD		30	0%		$30,000	382.00	0	$78.53
4	**In-Lake Treatment**					$0	$155,000	82.4	$0	$1,505
4.2	Fish Barrier and Lake	FISH		1	0%		$155,000	103.00	0	$1,504.85
5	**Education**				0%	$11,500	$0	0.0	$11,000	$0
5.1	Radio	SWCD			0%	$9,000			$9,000	$0
5.2	Print	SWCD			0%	$1,500			$1,500	$0
5.3	Landowner Visits	SWCD			0%	$0			$0	$0
5.4	Landowner Seminar	SWCD			0%	$1,000			$500	$0
6	**Monitoring**				0%	$20,500	$0	0.0	$20,500	$0
6.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
6.1.1	Vegetation	SWCD			0%	$500			$500	$0
6.1.2	CLAMP	LSL			0%	$500			$500	$0
6.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
6.2	Wetland	SWCD			0%	$5,000			$5,000	$0
6.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$99,800	$513,847	289.8		

Table 14: BMP's & TP load reductions in Trapper's Bay East Basin Sub-watershed (Wills, 2012)

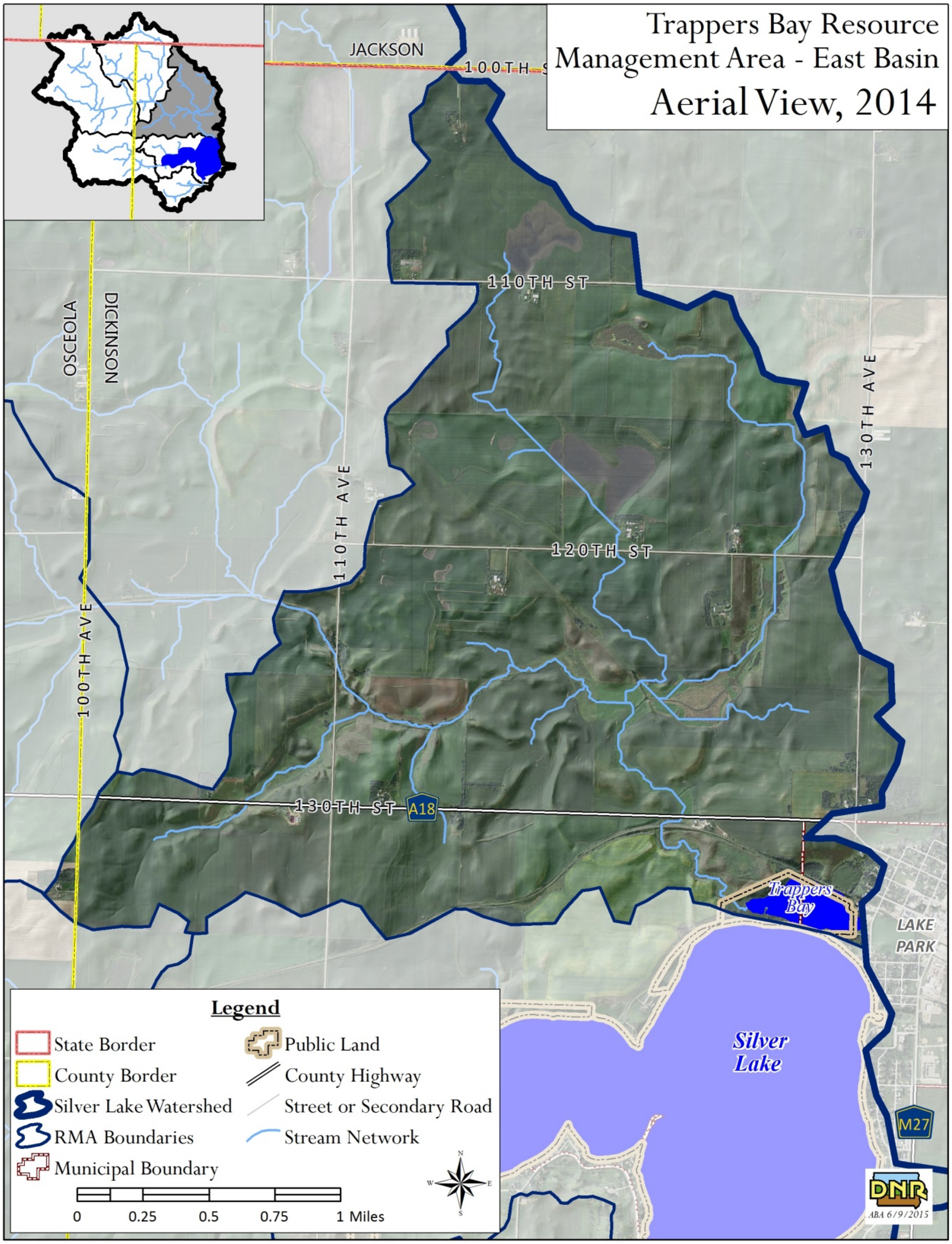


Figure 32: Trapper's Bay East Basin Drainage, Courtesy Iowa DNR

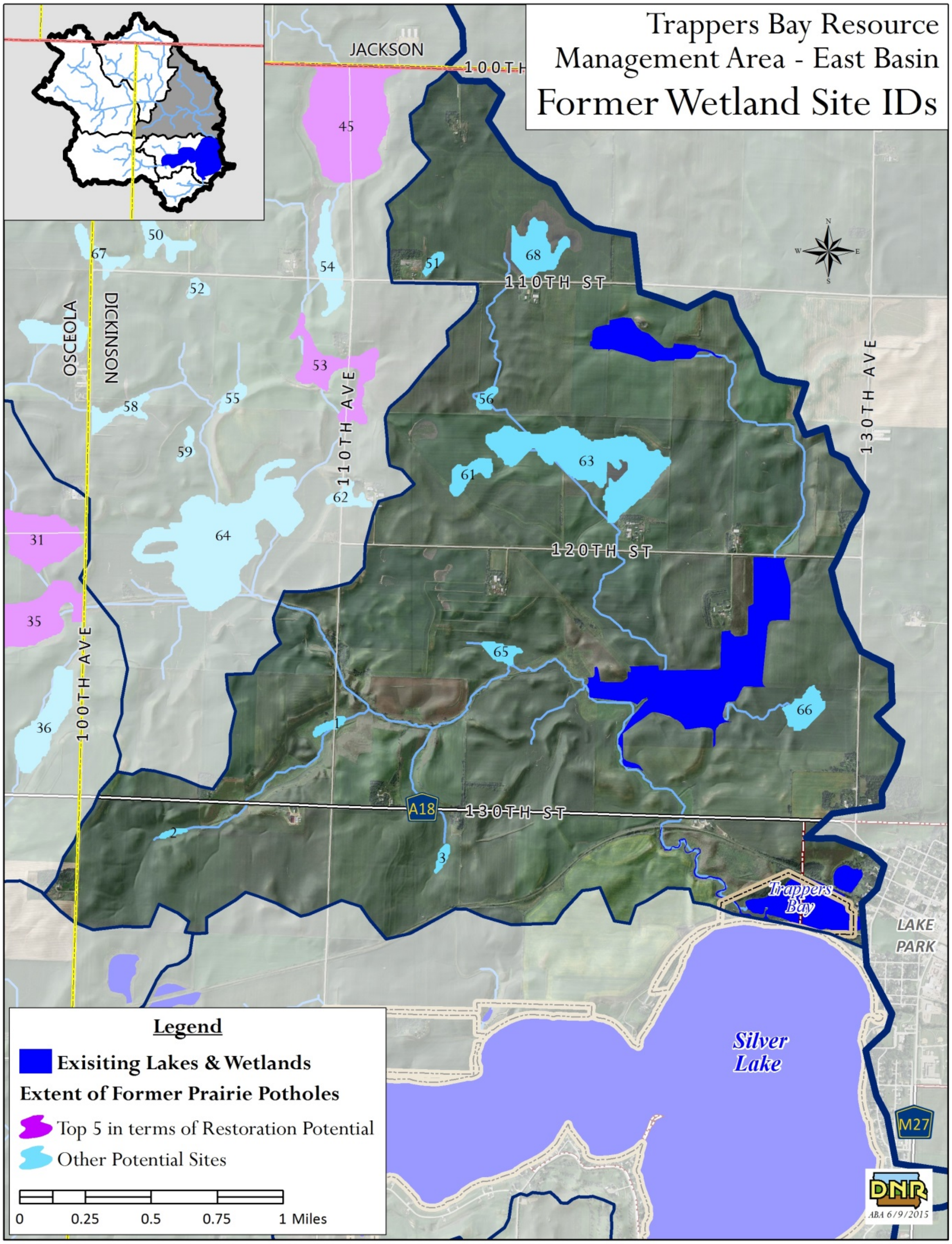


Figure 33: Trapper's Bay East Basin Wetland Basins, Courtesy Iowa DNR

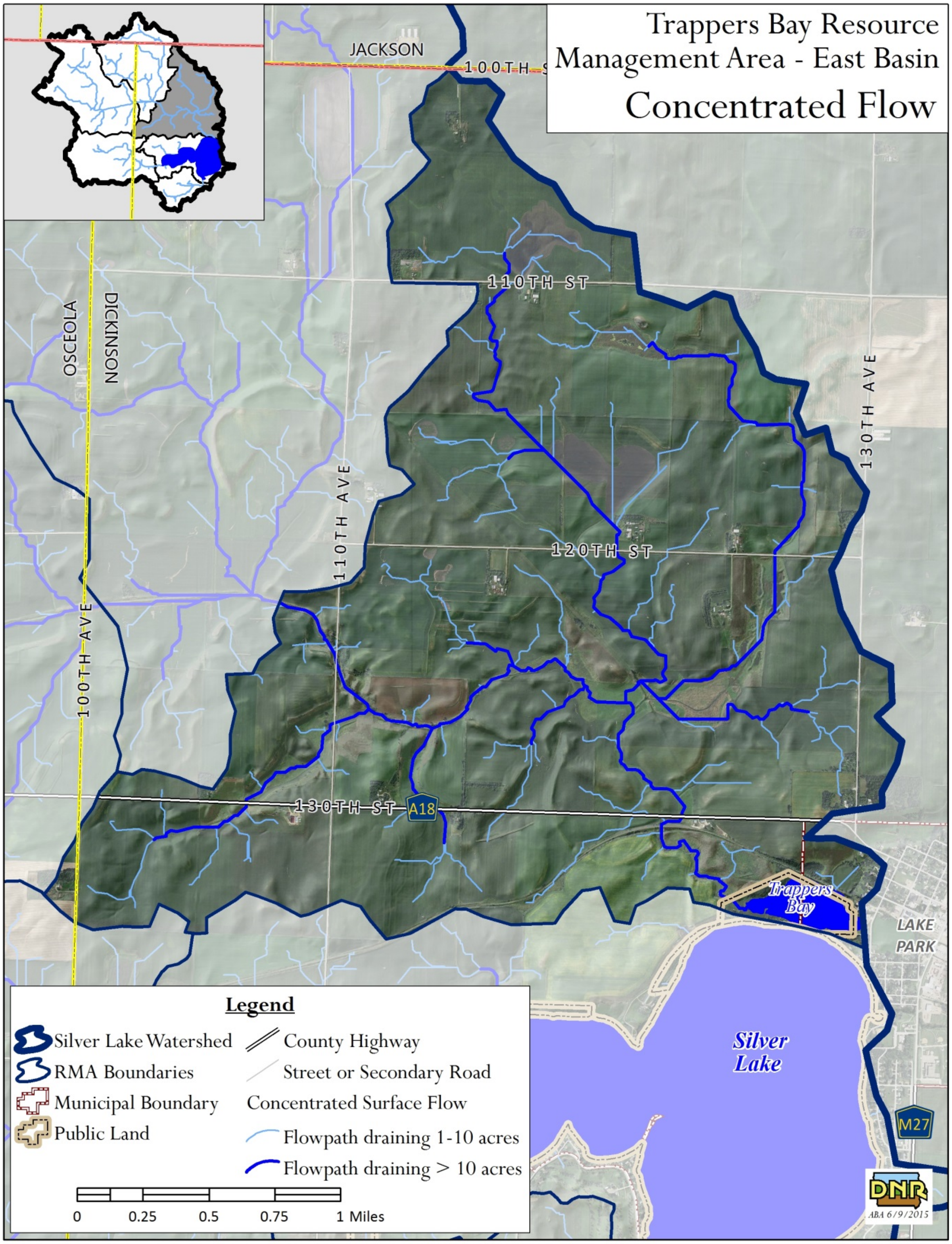


Figure 34: Trapper's Bay East Basin Concentrated Surface Flow, Courtesy Iowa DNR

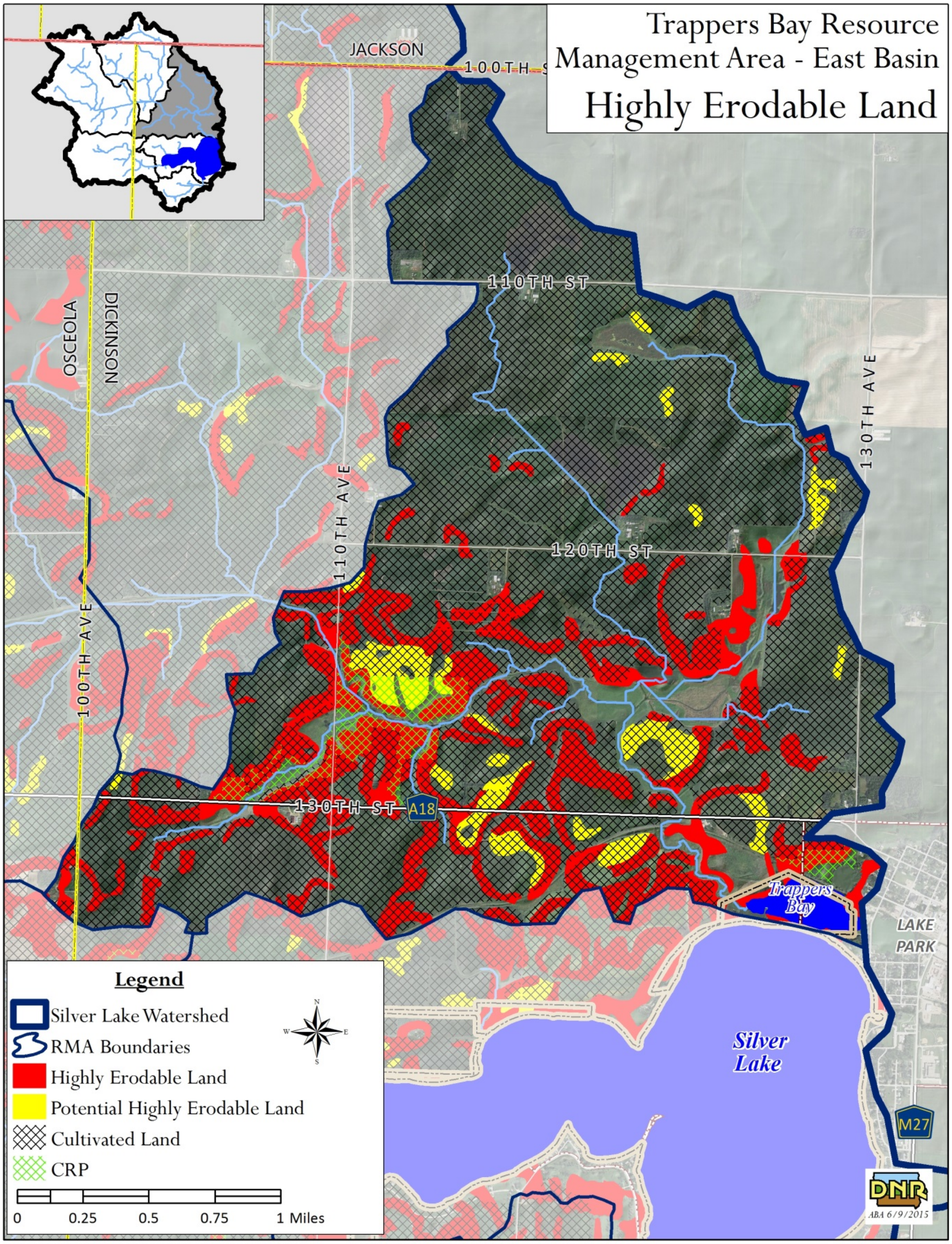


Figure 35: Trapper's Bay East Basin Highly Erodible Slopes, Courtesy Iowa DNR

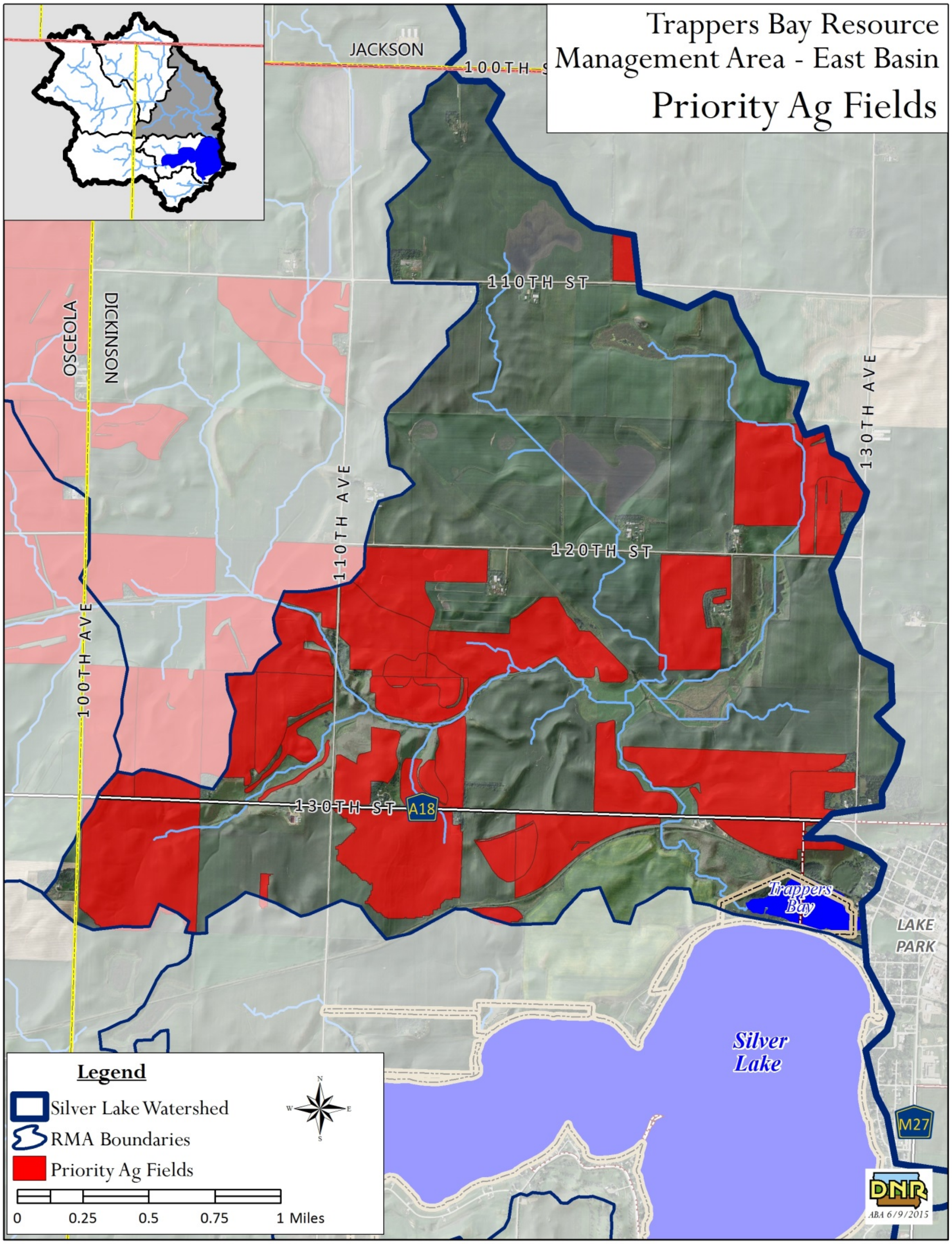


Figure 36: Trapper's Bay East Basin Agricultural Fields of Highest Priority, Courtesy Iowa DNR

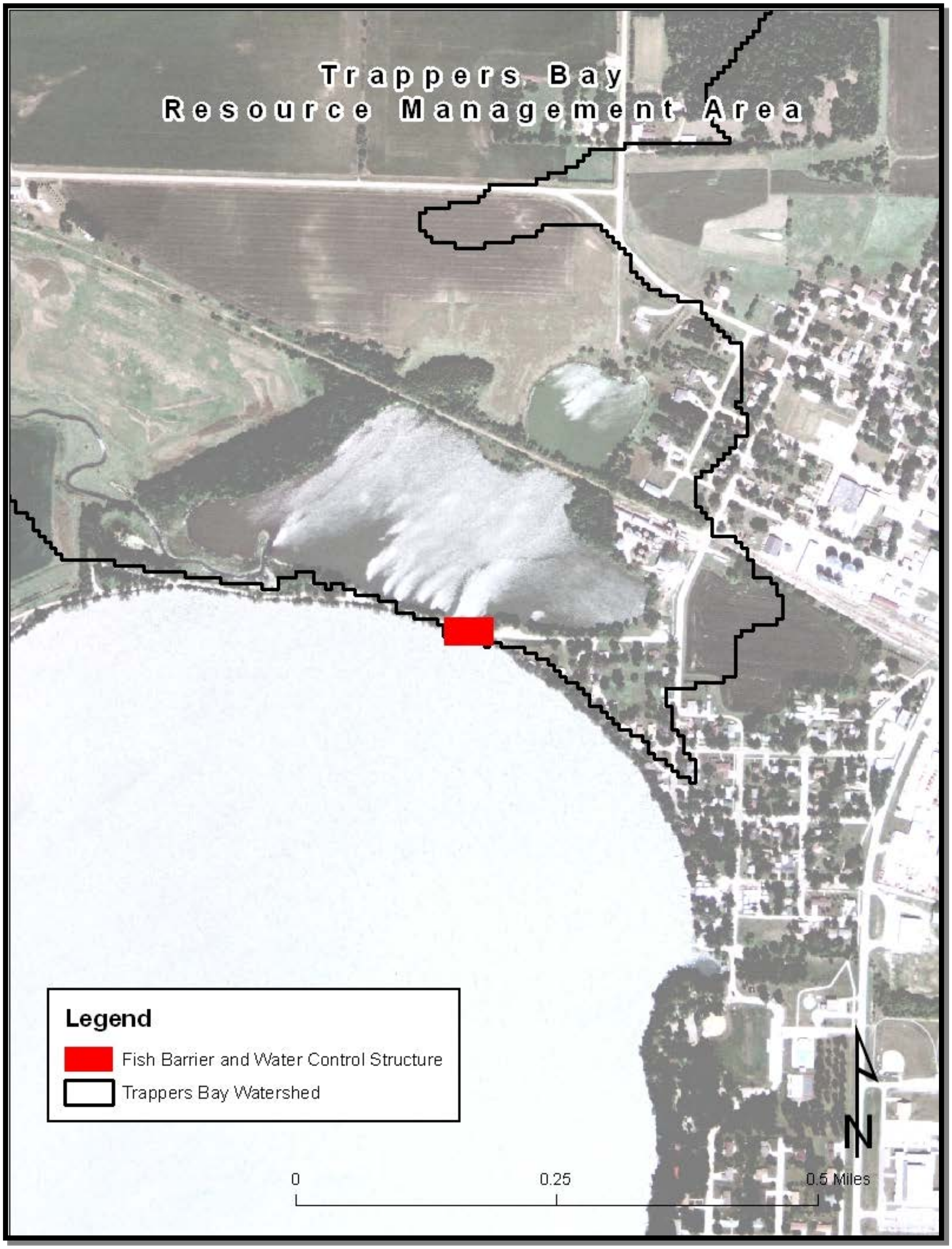


Figure 37: Trapper's Bay fish barrier, Courtesy Iowa DNR

South Bay Resource Management Area (RMA)

Objective – To prevent sediment and excess nutrients from reaching Silver Lake in excess amounts so the lake will be removed from the State's list of impaired water bodies. The sediment reductions in this RMA will assist with the 60% target reduction of phosphorus in Silver Lake (12,331 pounds of Phosphorus per year) in accordance with the approved TMDL

Description – The Silver Lake watershed has undergone many hydrological changes in the past 100 years. The reduction of wetlands and the switch from prairies to farmland has left this area degraded in a hydrological sense. This area represents approximately 6% of the watershed flowing into Silver Lake, and is vital to the direct input of Phosphorus. Historically, a long series of pothole wetlands and prairie uplands provided important watershed protection to Silver Lake and provided critical wildlife habitat. A holistic approach is needed to restore ecological health and water quality to this area. A combination of both watershed practices and cultural change is needed to reach the project objective. The following pollution reduction estimates are reflected in the State of Iowa Nutrient Reduction Strategy. The Nutrient Reduction Strategy uses science based fact to determine the best scientifically based conservation practices to remove phosphorous from the watershed of Silver Lake. In addition, the practices that are used in this WMP come from the Nutrient Reduction Strategy.

Restoration Planning Components

Phosphorus Management

A combination of Conservation Tillage, No-till systems, Phosphorous Rate Reduction, and Cover Crops will reduce approximately 25.1 pounds of Phosphorus from entering Silver Lake each year. The Spreadsheet that follows details the number of acres and level of treatment. However, it is significant to understand that the important figure to reach is not acres of a practice but rather the pounds of phosphorus reduction.

Land Use Change

A combination of Grassed Waterways, Sediment Basins, Grade Stabilization, Structures, and land retirement will prevent approximately 16.3 pounds of Phosphorus from entering Silver Lake. The spreadsheet that follows will detail the number of acres and the level of treatment necessary to get the required level of reduction. However, it is significant to point out that the pound of Phosphorus is the important factor in the reduction.

Edge of Field

A combination of wetland restorations, sediment control practices, vegetative buffers, and tile intake treatments will be used to prevent approximately 4.3 pounds of Phosphorus from reaching Silver Lake. It is significant to note that the acres and number of practices is not as important as is the pounds of Phosphorus reduced.

Shallow Lake and Shoreline Treatment

Shoreline restoration and carp exclusion and reduction are used in this category to reduce the in-lake contribution of sediment and Phosphorus from being re-suspended into the lake and a continual problem. It is estimated that these practices will eliminate 1.0 pounds of Phosphorus from entering Silver Lake

Education

An intensive education campaign to change attitudes and the culture that has been formed over time will be implemented. The education campaign will closely follow the Public Outreach program that is outlined on page 22 of this Management Plan. The campaign will specifically target the landowners and operators of this RMA but will be done in a way that anyone can use the information.

Monitoring

Water monitoring of this RMA will be vital in providing a baseline and documentation of any improvements that are realized by the cultural practices and the erosion control practices that are installed as part of the plan. The water monitoring will be inclusive and follow the QUAPP that has been developed specifically for this RMA.

South Bay Implementation Plan

South Bay Resource Management Area										
Clean Water Alliance					Today's Date:			5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	Phosphorus Management				0%	$12,020	$0	25.1	-$132	$0
1.1	Conservation Tillage	SWCD	250		0%	-$250		25.03	-$10	$0
1.2	No-Till System	SWCD	100		0%	$1,200		35.49	$34	$0
1.3	P-Rate Reduction	SWCD	15		0%	-$180		0.96	-$188	$0
1.4	Cover Crop	SWCD	250		0%	$11,250		343.75	$33	$0
2	Land Use Change				0%	$0	$3,750	16.3	$0	$87
2.1	Grassed Waterway	SWCD		300	0%	$0	$750	227.00	0	$3.30
2.2	Sediment Basins	SWCD		2	0%		$3,000	36.00	0	$83.33
3	Edge of Field				0%	$0	$29,616	4.3	$0	$1,860
3.1	Wetland Restoration	SWCD		1	0%		$20,000	25.00	0	$800.00
3.2	Sediment Control Practice	SWCD		1	0%		$4,500	9.00	0	$500.00
3.3	Vegetative Buffer	SWCD		1	0%		$116	26.00	0	$4.44
3.4	Tile Intake Treatment	SWCD		5	0%		$5,000	9.00	0	$555.56
4	In-Lake Treatment					$0	$15,000	1.0	$0	$15,000
4.2	Fish Barrier and Lake	FISH		1	0%		$15,000	1.00	0	$15,000.00
5	Education				0%	$11,500	$0	0.0	$11,000	$0
5.1	Radio	SWCD			0%	$9,000			$9,000	$0
5.2	Print	SWCD			0%	$1,500			$1,500	$0
5.3	Landowner Visits	SWCD			0%	$0			$0	$0
5.4	Landowner Seminar	SWCD			0%	$1,000			$500	$0
6	Monitoring				0%	$20,500	$0	0.0	$20,500	$0
6.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
6.1.1	Vegetation	SWCD			0%	$500			$500	$0
6.1.2	CLAMP	LSL			0%	$500			$500	$0
6.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
6.2	Wetland	SWCD			0%	$5,000			$5,000	$0
6.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$44,020	$48,366	46.6		

Table 15: BMP's & TP load reductions in South Bay Subwatershed (Wills, 2012)

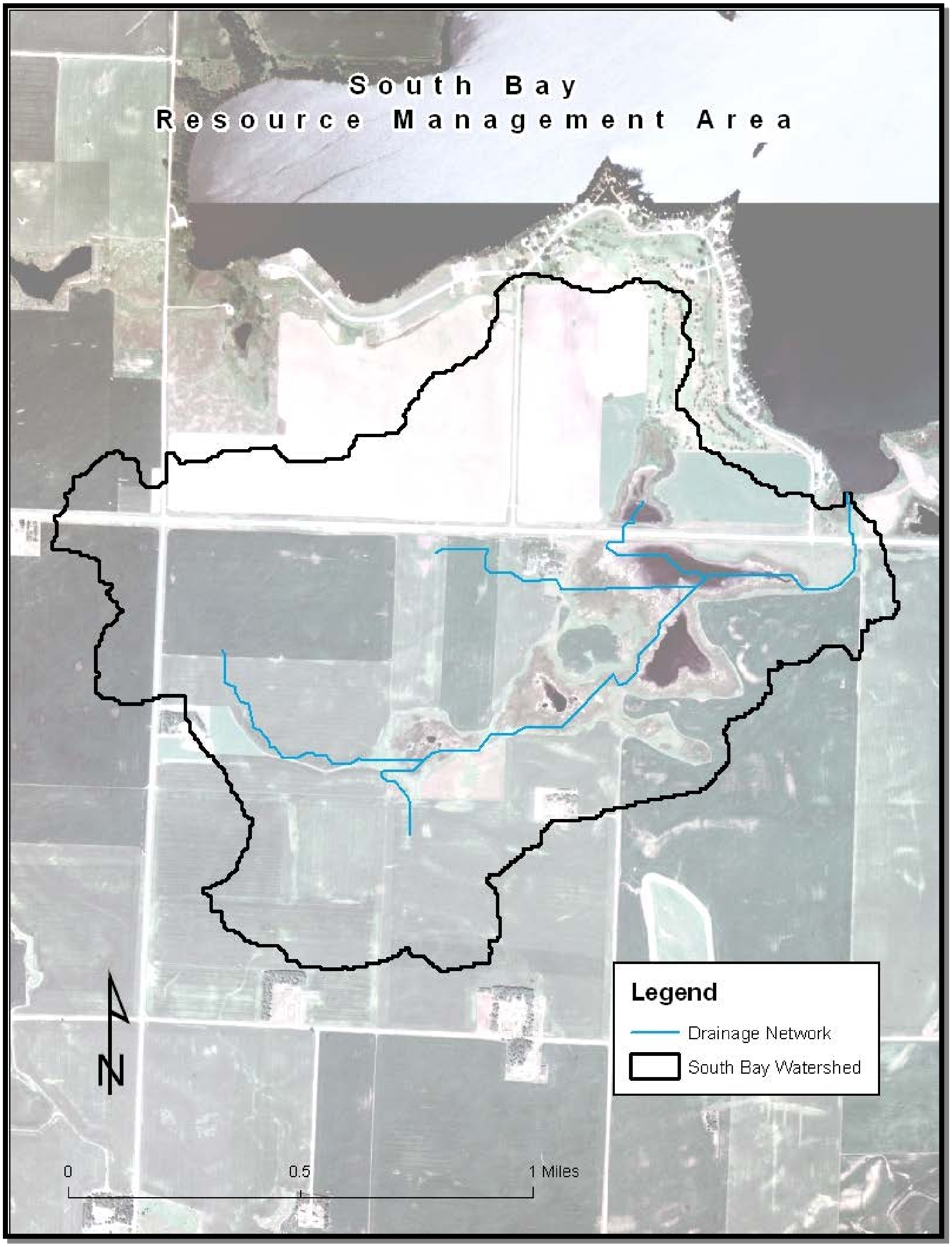


Figure 38: South Bay drainage, Courtesy Iowa DNR

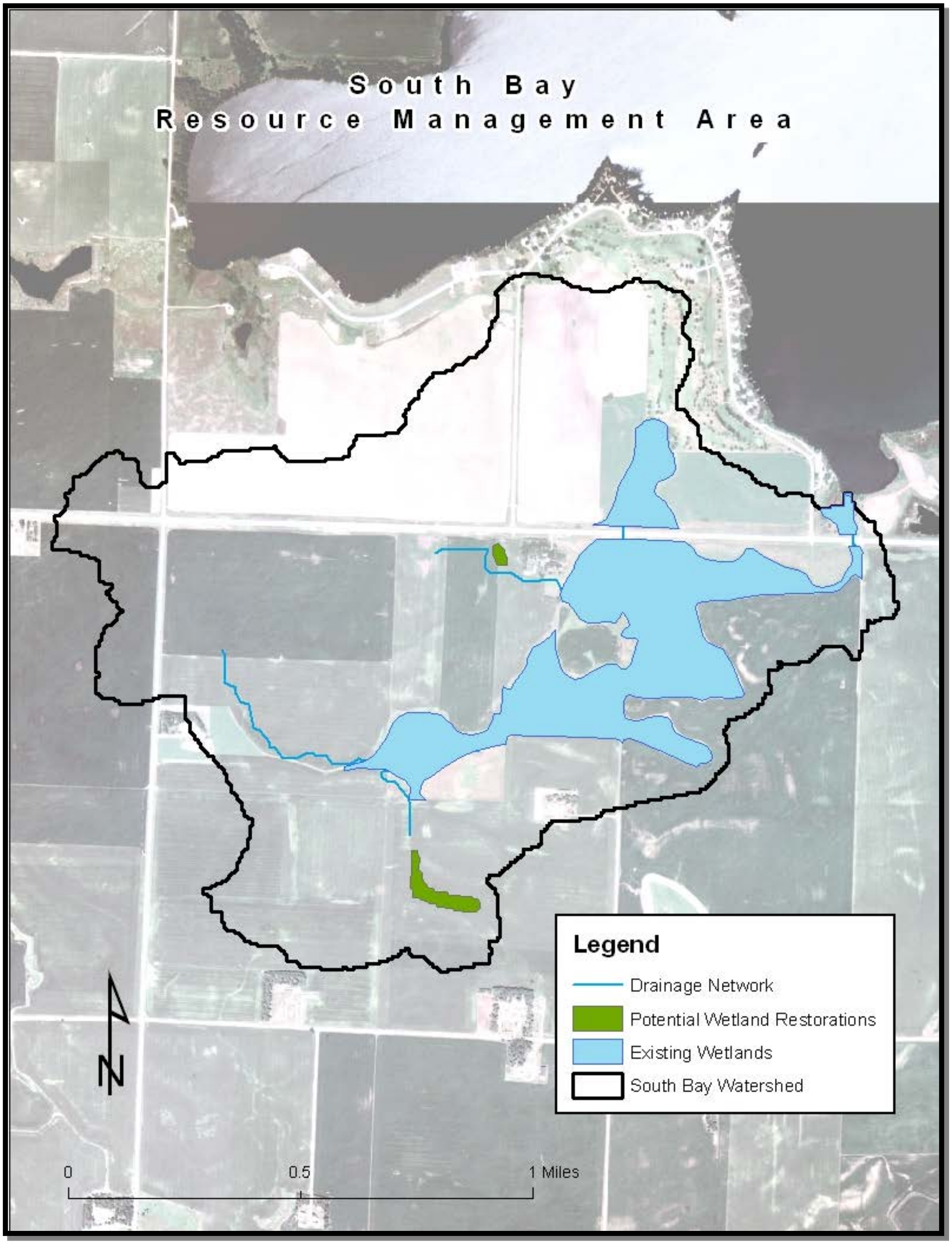


Figure 39: South Bay wetland basins, Courtesy Iowa DNR

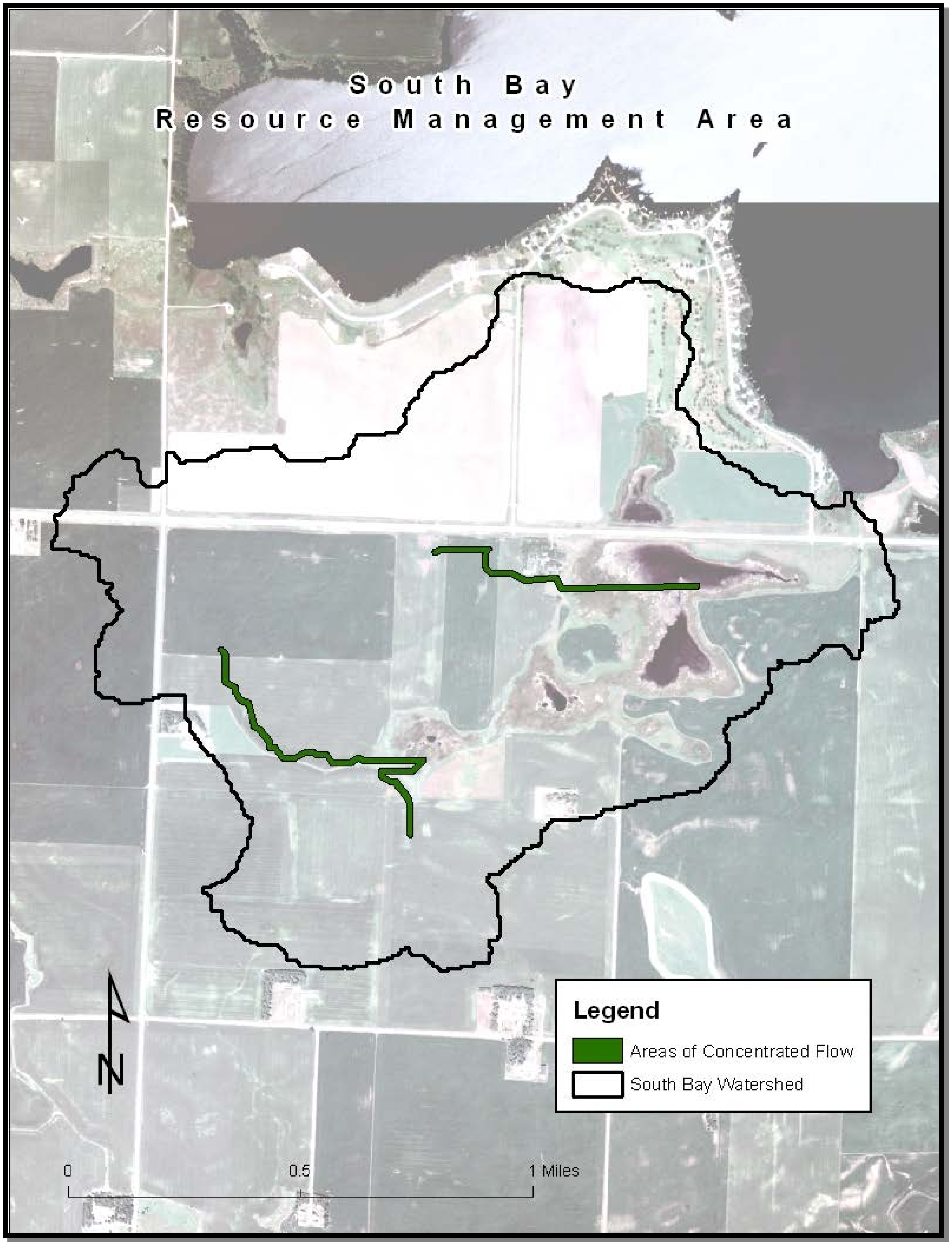


Figure 40: South Bay concentrated surface flow, Courtesy Iowa DNR

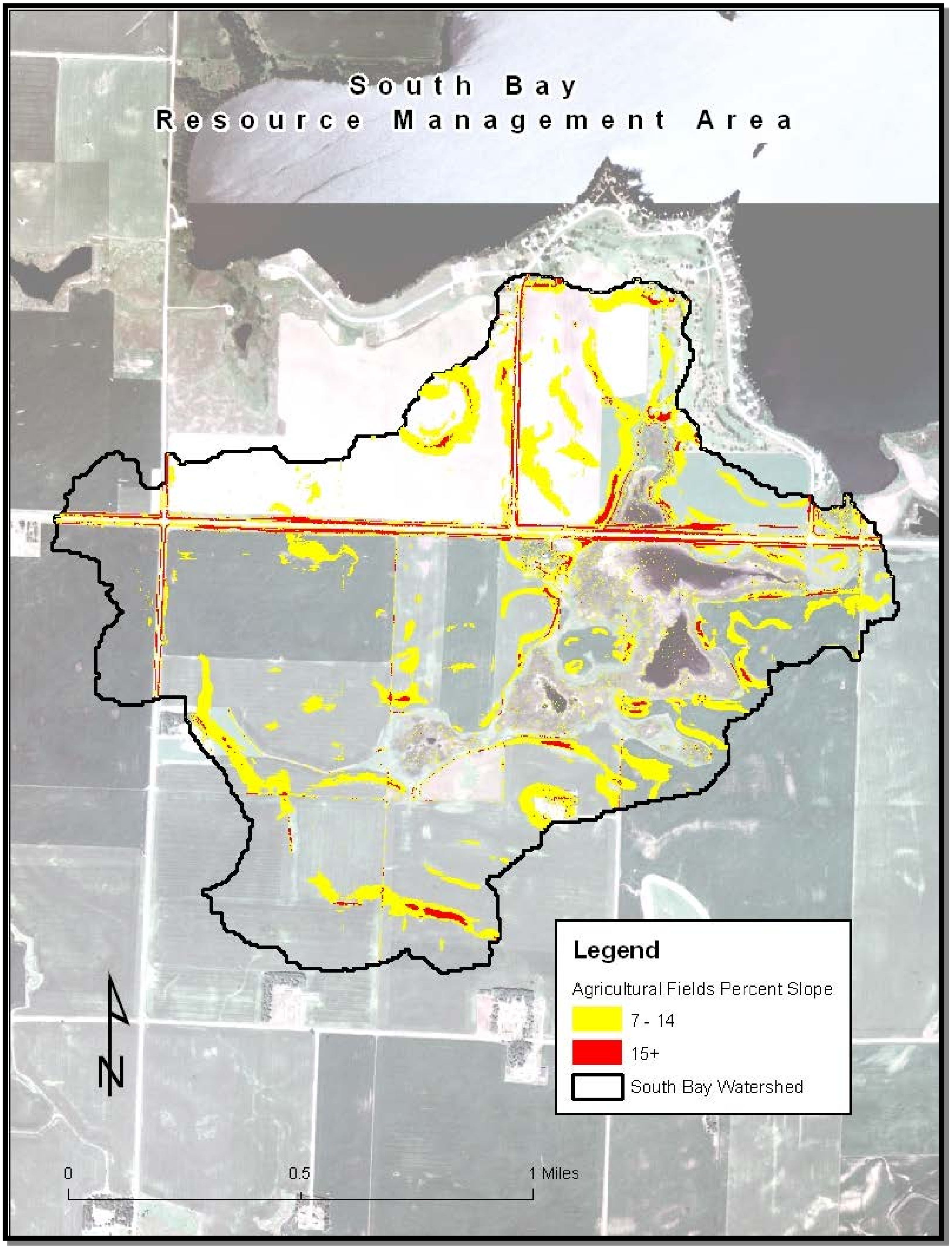


Figure 41: South Bay highly erodible slopes, Courtesy Iowa DNR

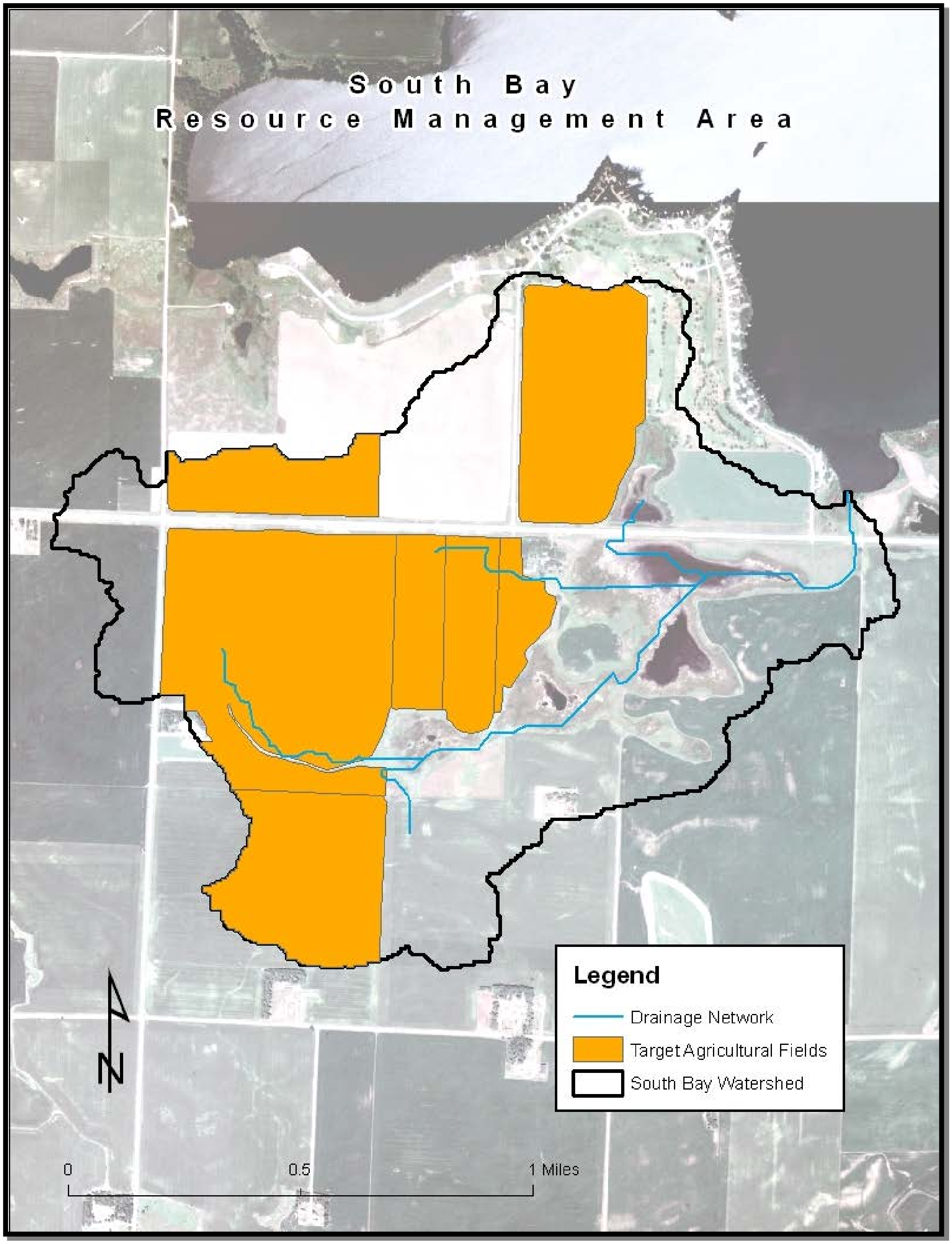


Figure 42: South Bay agricultural fields of highest priority, Courtesy Iowa DNR

10. Wetland Prioritization

Below is a chart that was prepared utilizing GIS assessment of watershed drainage and wetland basins in the Silver Lake Watershed. This information has provided us an extremely beneficial management tool when determining which wetland basins will give our project the highest water quality benefits per dollar invested.

By examining this chart, we are able to determine how many acres would be impacted by restoration of a particular wetland basin, as well as estimate a quantitative reduction in sediment delivery and nutrient catchment. As each wetland basin is restored, we are able to run new calculations factoring in that particular restoration. Because restoration of a particularly large or high priority basin may impact the priority of several associated basins, our focus may shift to other areas of the watershed following restoration of key wetland basins.

Silver Lake Watershed Wetland Prioritization

Wetland ID Green = Dickinson Blue = Osceola	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Water shed Area (acres)	Wetland Size (acres)	Watershed minus wetland (acres)	Watershed to Wetland Ratio	Watershed Ratio < 75:1	GIS/RUSLE Priority	Restored (X)
🟩 64									8,430.4	99.8	8,330.6	83.5			
🟦 35	64								5,219.0	149.8	5,069.2	33.9	*	1	
🟦 33	35	64							2,115.6	9.4	2,106.2	225.2			
🟦 25	33	35	64						1,991.8	4.3	1,987.5	462.3			
🟦 28	25	33	35	64					1,682.7	17.8	1,664.9	93.8			
🟩 53	64								1,519.4	25.1	1,494.2	59.4	*	2	
🟩 54	53	64							1,425.3	15.8	1,409.5	89.2			
🟦 18	25	28	33	35	64				1,391.6	31.1	1,360.4	43.7	*	4	
🟦 31	35	64							1,255.4	29.4	1,226.0	41.8	*	5	
🟦 44									1,070.3	1.7	1,068.6	637.2			
🟦 26	31	35	64						1,070.0	5.4	1,064.6	198.1			
🟩 45	54	53	64						955.1	75.2	879.8	11.7	*	6	
🟦 23	26	31	35	64					840.5	30.1	810.4	26.9	*	10	
🟩 63									845.4	66.0	779.3	11.8	*	9	
🟦 16	18	28	25	33	35	64			678.0	24.2	653.9	27.1	*	8	
🟩 59	64								566.5	2.5	564.0	224.9			
🟦 15	18	28	25	33	35	64			554.3	64.8	489.4	7.5	*	11	
🟩 56	63								468.1	2.7	465.4	170.5			
🟦 40									493.6	44.9	448.7	10.0	*	19	
🟩 1									465.0	31.4	433.5	13.8	*	7	
🟦 41	44								396.9	1.6	395.4	252.0			
🟦 36	64								348.2	24.4	323.8	13.3	*	13	
🟩 58	59	64							328.0	7.4	320.6	43.3	*	14	
🟩 68	56	63							302.8	18.0	284.9	15.9	*	26	

43	44	0							283.3	3.1	280.2	90.7			
27	25	33	35	64					270.3	6.1	264.2	43.5	*	12	
47	54	53	64						270.6	8.2	262.4	32.1	*	20	
13	23	26	31	35	64				263.4	2.7	260.7	96.9			
24	15	18	28	25	33	35	64		264.4	18.6	245.8	13.2	*	15	
12	13	23	26	31	35	64			226.7	10.1	216.6	21.4	*	27	
48	47	54	53	64					209.0	5.3	203.7	38.4	*	25	
37	35	64							226.4	32.4	194.1	6.0	*	17	
22	58	59	64						192.2	15.1	177.1	11.7	*	21	
66									183.0	9.8	173.2	17.6	*	28	
39	35	64							174.7	8.0	166.7	20.9	*	35	
29	27	25	33	35	64				192.1	30.2	161.9	5.4	*	18	
24	23	26	31	35	64				264.4	18.6	245.8	13.2	*	15	
42	43	44							156.5	2.0	154.5	75.8			
2	1								152.5	1.3	151.2	120.4			
65									135.7	4.8	130.9	27.3	*	23	
38	35	64							305.5	178.1	127.3	0.7			
61	63								123.4	7.5	115.9	15.5	*	30	
14	28	25	33	35	64				125.4	13.6	111.8	8.2	*	29	
7	48	47	54	53	64				96.3	3.4	92.9	27.5	*	31	
49	68	56	63						92.7	2.9	89.8	30.8	*	40	
10	12	13	23	26	31	35	64		114.4	31.4	83.0	2.6	*	32	
3									82.6	2.0	80.6	39.5	*	22	
34	35	64							74.7	10.9	63.8	5.9	*	24	
8	16	18	28	25	33	35	64		70.5	6.8	63.8	9.4	*	34	
11	21	23	26	31	35	64			73.7	10.2	63.5	6.2	*	36	
9	12	13	23	26	31	35	64		78.1	18.2	59.9	3.3	*	42	
52									62.1	2.7	59.3	21.6	*	43	

32	26	31	35	64					72.4	17.7	54.7	3.1	*	33	
5									56.7	3.3	53.4	16.3	*	37	
53									1,519.4	25.1	1,494.2	59.4	*	2	
55	59	64							52.3	3.4	48.9	14.4	*	38	
19	15	18	28	25	33	35	64		42.1	5.8	36.4	6.3	*	47	
51	68	56	63						38.5	2.2	36.2	16.3	*	48	
30	38	35	64						40.7	5.0	35.7	7.2	*	39	
38	24	15	18	28	25	33	35	64	305.5	178.1	127.3	0.7			
50									41.4	10.4	31.0	3.0	*	46	
62	64								36.8	6.0	30.8	5.1	*	44	
4									34.3	4.0	30.2	7.5	*	41	
67	22	58	59	64					36.8	7.9	28.9	3.7	*	45	
46	41	44							131.8	105.4	26.5	0.3			
20	23	26	31	35	64				16.9	4.8	12.1	2.5	*	49	

Table 16: Prioritization and expected benefits of wetland restorations in the Silver Lake Watershed (Iowa DNR)

11. Urban Best Management Practices

Urban areas in Dickinson County have been expanding at a significant rate when compared to other rural counties in Iowa. Most of that urban expansion and construction has been occurring in the Iowa Great Lakes Region. However, recent lakeshore and urban developments in the City Lake Park have begun to change that. With the recent addition of two new developments, Lake Park has put itself on the map as having a significant beginning to urban development. Future plans in these new areas calls for even more progression adjacent to or near the lakeshore of Silver Lake.

A majority of the existing City of Lake Park drains away from Silver Lake and is outside the actual watershed boundary. The biggest portion of Lake Park does not negatively affect Silver Lake. Existing houses on the lakeshore and those within the boundary of the watershed have the potential for negative impact on the lake. As with any urban areas, the primary problems are sediment from construction, lawn fertilizers and pesticides, lawn clippings, and chemicals associated with household residences. Urban areas within the watershed total 7% of the watershed area.

Storm sewer inlets within the incorporated area of Lake Park, for the most part, drain away from the lake and out of the watershed. The following map shows the location of each storm sewer within the incorporated city which drains to the lake, and functions as a direct conduit for pollutants.

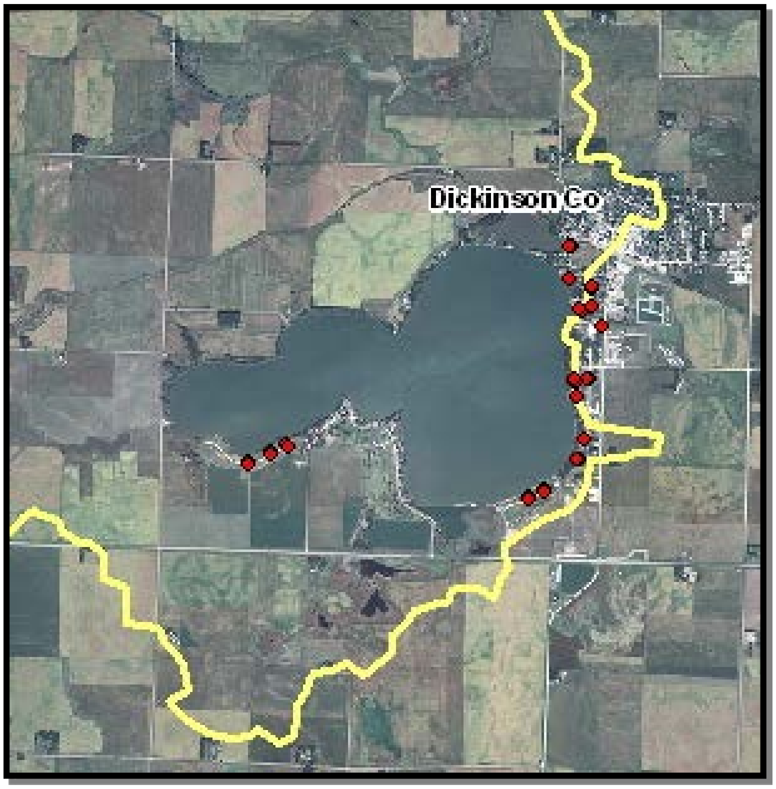


Figure 43: Lake Park storm sewer inlets entering Silver Lake

With the construction of new development areas around Silver Lake, there will no doubt be a rise in storm sewer installation around Silver Lake. Considering there are few places, excluding the lake itself, for storm water to flow, it is likely that with new development will cause an even greater storm sewer concerns for Silver Lake.

Sanitary Sewer
The sanitary sewer in Lake Park was recently expanded to include all the lakeshore that once held properties with septic systems, including the new developments on the South side of the lake.

The city of Lake Park, Iowa DNR and Dickinson County SWCD worked diligently over seven years to ensure the entire city of Lake Park was able to connect to the sanitary sewer. In 2003, the city started construction of an extension of the sanitary sewer system to ensure the entire lake had access to the system. As of 2008, only one or two houses out of approximately 35 are not connected to the sanitary sewer system and the city of Lake Park is in the process of taking action to get those connected. This work has been done to connect the new sub-divisions as well as existing developed areas within the jurisdiction of the city.
Adjacent to the lake there is only one residence on the north shoreline, which has an individual septic system. Within the watershed there is one septic system, which is suspected of not functioning correctly or meeting current standards requirements for septic tanks and drainage fields.

Urban Residential Development
The drainage from urban areas can be broken down into the following four locations:

- Firstly, an area which is north of the Silver Lake outlet;
- secondly, an area south of the Silver Lake outlet;
- thirdly and area from Silver Shores to West Bay sub-divisions;
- And finally, areas which are undeveloped but may be developed in the future.

Each of these areas has different features and will have different impacts on the water quality of the lake. The four urban drainage areas mentioned above are prioritized differently based on the problems associated with them.

The first area mentioned above is the north drainage and encompasses the most highly developed portion of Lake Park. This drainage area has the largest impervious surface, and should be considered the highest priority for retrofitting Low Impact Development Practices. The drainage consists of residential properties, a school with a large parking area, as well as commercial and industrial buildings. Storm water drainage entering Silver Lake will need to be addressed as upgrades are made to streets and properties in this area. Work with private landowners and businesses will be required to ensure the installation of urban BMP’s.

The second area mentioned above is the area south of the outlet, the storm sewer systems are minimal and usually have pipes that drain a short distance to the lake. This is currently a lower priority because the areas have the least amount of impervious surface and drainage. If more construction takes place or a new sub-division is proposed in the watershed of these drainages then it may become a higher priority. The city of Lake Park should consider addressing the drainage going to Silver Lake and using infiltration based storm water management practices as they upgrade streets and drainage systems in this area.

A third area mentioned above is the Silver Shores development and is a recent development in the West Bay RMA. This area is the second highest priority urban area of the Watershed. A portion of the drainage in the two sub-divisions goes to wetland areas before going to Silver Lake. At this time, these wetlands are helping to protect the lake but as these sub-divisions are constructed, the wetlands when used in this manor, usually get stressed and lose their filtering ability. Enlisting infiltration practices to help infiltrate water before it gets to storm sewer systems will help buffer the wetlands and extend the life of their filtering capabilities.

The last urban drainage area is future sub-divisions. The areas that are not defined can have protection through ordinance changes that would require storm water management based on water quality and flood control. Currently, the storm sewer systems are designed for flood control but no water quality requirements. The City of Lake Park should look at adopting ordinances similar to the Cities of Spirit Lake, Okoboji, and Wahpeton, or Dickinson County. The Dickinson County Low Impact Development Ordinance, passed in June of 2008 will cover any unincorporated sub-divisions around Silver Lake.

Incorporated Area

The current incorporated areas in the City of Lake Park are shown below in Figure 41. As you can see, most of the city does not fall within the watershed boundary of Silver Lake. These areas have remained constant until just a few years ago when the entire south shore of Silver Lake was annexed into the city along with 2 large developments. There are future annexation plans and future developments already in the works Figure 42 shows potential future annexation plans, however, there are even more annexation plans in the works than what is shown.

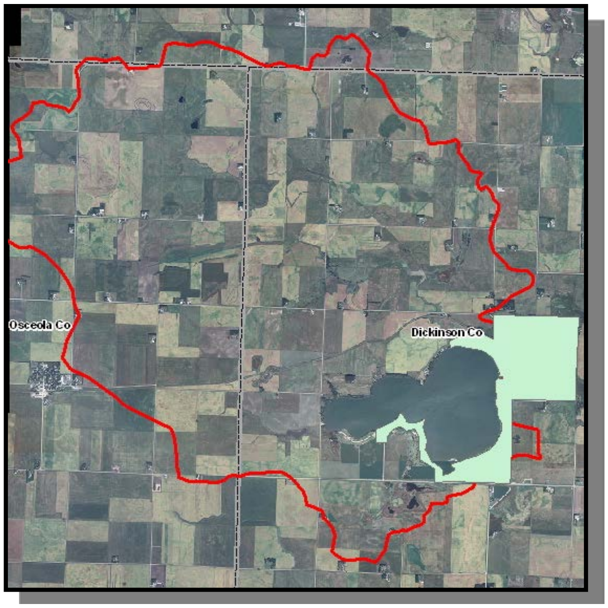


Figure 45: Current Incorporated Area of Lake Park

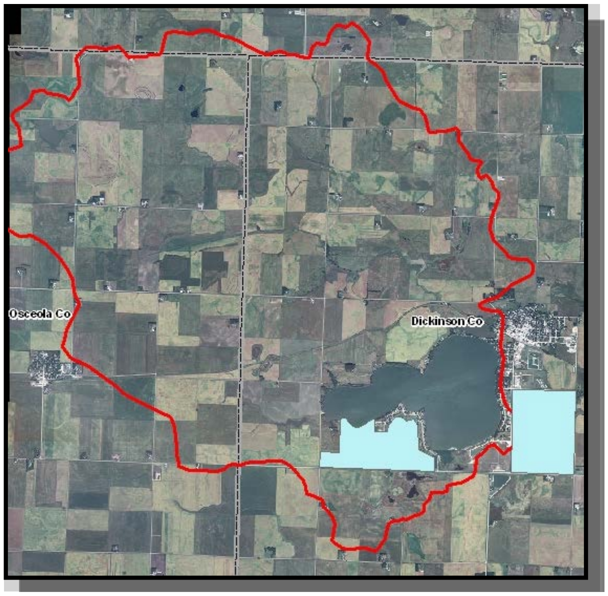
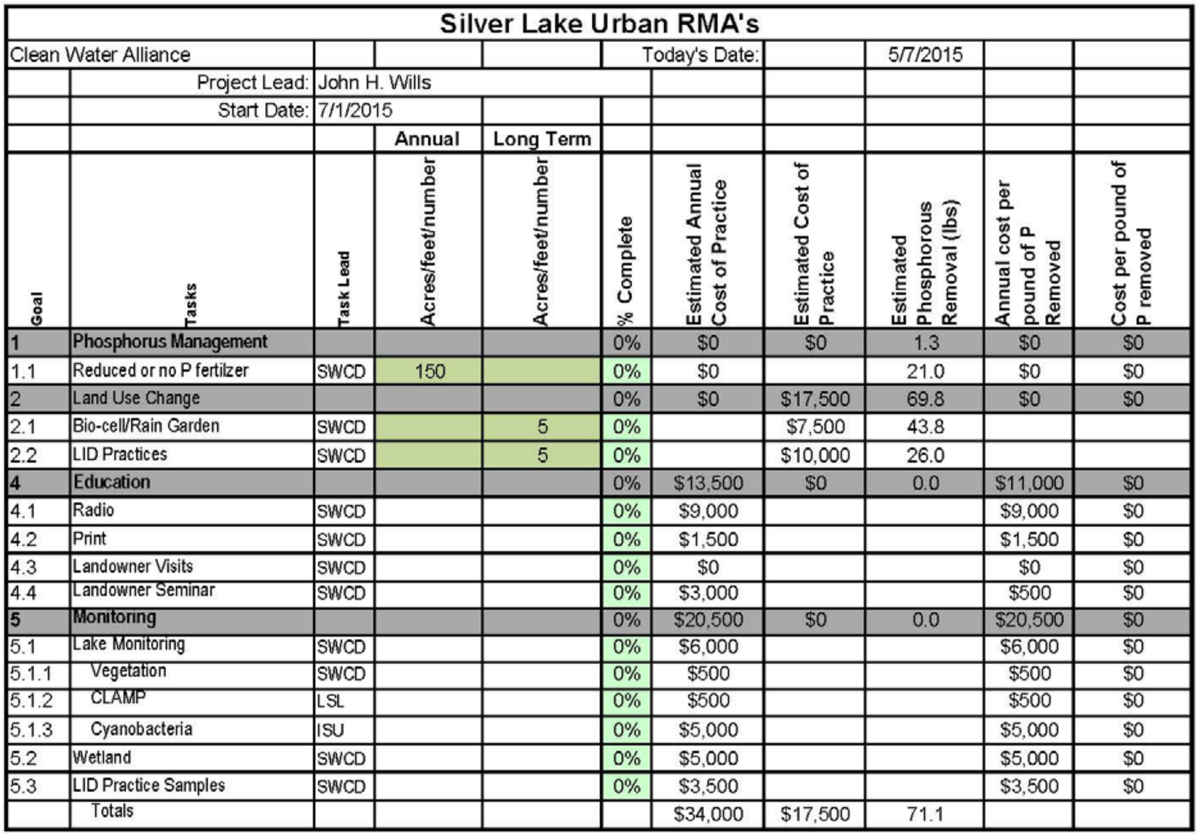


Figure 45: Potential Incorporated Area of Lake Park

Below is a list of urban and shoreline-based BMP’s plan for implementation:



Silver Lake Urban RMA's

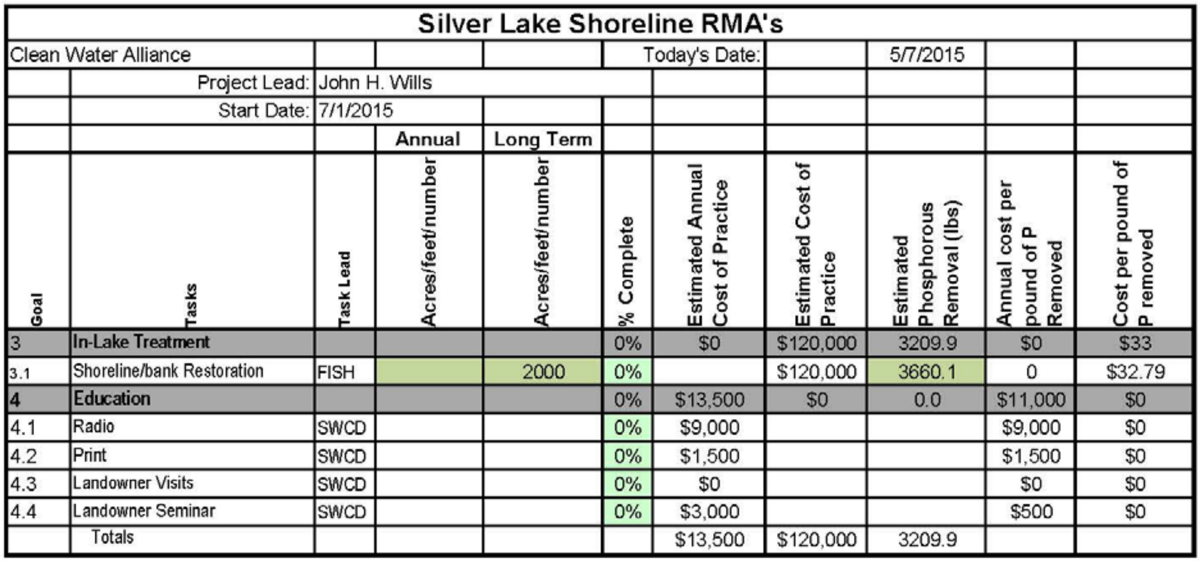
Clean Water Alliance					Today's Date:			5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	Long Term						
Goal	Tasks	Task Lead	Acres/feet/number	Acres/feet/number	% Complete	Estimated Annual Cost of Practice	Estimated Cost of Practice	Estimated Phosphorous Removal (lbs)	Annual cost per pound of P Removed	Cost per pound of P removed
1	Phosphorus Management				0%	$0	$0	1.3	$0	$0
1.1	Reduced or no P fertilzer	SWCD	150		0%	$0		21.0	$0	$0
2	Land Use Change				0%	$0	$17,500	69.8	$0	$0
2.1	Bio-cell/Rain Garden	SWCD		5	0%		$7,500	43.8		
2.2	LID Practices	SWCD		5	0%		$10,000	26.0		
4	Education				0%	$13,500	$0	0.0	$11,000	$0
4.1	Radio	SWCD			0%	$9,000			$9,000	$0
4.2	Print	SWCD			0%	$1,500			$1,500	$0
4.3	Landowner Visits	SWCD			0%	$0			$0	$0
4.4	Landowner Seminar	SWCD			0%	$3,000			$500	$0
5	Monitoring				0%	$20,500	$0	0.0	$20,500	$0
5.1	Lake Monitoring	SWCD			0%	$6,000			$6,000	$0
5.1.1	Vegetation	SWCD			0%	$500			$500	$0
5.1.2	CLAMP	LSL			0%	$500			$500	$0
5.1.3	Cyanobacteria	ISU			0%	$5,000			$5,000	$0
5.2	Wetland	SWCD			0%	$5,000			$5,000	$0
5.3	LID Practice Samples	SWCD			0%	$3,500			$3,500	$0
	Totals					$34,000	$17,500	71.1		

Table 17: Urban BMP’s to be installed (Wills, 2012)

12. Shoreline Erosion

The following pollution reduction estimates are reflected in the State of Iowa Nutrient Reduction Strategy. The Nutrient Reduction Strategy uses science based fact to determine the best scientifically based conservation practices to remove phosphorous from the watershed of Silver Lake. In addition, the practices that are used in this WMP come from the Nutrient Reduction Strategy.

Shoreline protection consists of restoring and protecting banks against scour and erosion by using vegetative plantings, soil bioengineering, and structural systems. These systems can be used alone or in combination.



Silver Lake Shoreline RMA's										
Clean Water Alliance					Today's Date:			5/7/2015		
	Project Lead:	John H. Wills								
	Start Date:	7/1/2015								
			Annual	**Long Term**						
Goal	**Tasks**	**Task Lead**	**Acres/feet/number**	**Acres/feet/number**	**% Complete**	**Estimated Annual Cost of Practice**	**Estimated Cost of Practice**	**Estimated Phosphorous Removal (lbs)**	**Annual cost per pound of P Removed**	**Cost per pound of P removed**
3	**In-Lake Treatment**				0%	$0	$120,000	3209.9	$0	$33
3.1	Shoreline/bank Restoration	FISH		2000	0%		$120,000	3660.1	0	$32.79
4	**Education**				0%	$13,500	$0	0.0	$11,000	$0
4.1	Radio	SWCD			0%	$9,000			$9,000	$0
4.2	Print	SWCD			0%	$1,500			$1,500	$0
4.3	Landowner Visits	SWCD			0%	$0			$0	$0
4.4	Landowner Seminar	SWCD			0%	$3,000			$500	$0
	Totals					$13,500	$120,000	3209.9		

Table 18: Shoreline Pollution Reduction BMP's to be installed

There are two basic categories of protections measures that are those that work by reducing the force of water against the shoreline and those that increase the resistance of the erosive forces of the lake. These measures can be combined into a system that works to reduce both.

Storm water reduction methods, grade reduction, and reduction of flow velocity all fall into the first category of reducing the force of water against the shoreline. Examples of practices that fit into reducing the force of water against the shoreline include: tree revetments, groins, jetties, root wads, and boulder combinations. The second category includes grass covered channels, riprap, gabions, concrete, and other revetment designs. These measures can be used alone on in combination. Most designs that use brushy vegetation, either alone or in combination with structures, protects from erosion both ways.

When selecting a site for treatment, it is most effective to select areas within relatively healthy systems. Projects that are planned and installed in this context are more likely to be successful and it is critically important to prevent the decline of these healthy systems.

After deciding that rehabilitation is needed, a variety of remedies are available to minimize the susceptibility of stream banks or shorelines to disturbance-caused erosive processes. They range from vegetation oriented remedies such as soil bio-engineering to engineered grade stabilization structures.

As a first priority we must consider those measures that:

- Are self-sustaining or reduce requirements for future human support;
- Use native, living materials for restoration;
- Restore the physical, biological, and chemical functions and values of the shoreline;
- Improve water quality through reduction of temperature and chronic sedimentation;
- Provide opportunities to connect fragmented riparian areas; and
- Retain or enhance the shoreline system.

Shoreline erosion results primarily from erosive forces in the form of waves. As the wave moves toward shore, it begins to drag on the bottom, dissipating energy. This eventually causes it to break or collapse. This major turbulence stirs up material from the shore bottom or erodes it from banks and bluffs. Systems for the shoreline can be living or non-living. They consist of vegetation, soil bioengineering, structures, or a combination of these.

The following need to be considered when planning shoreline protection:

1. Watershed data
2. Causes and extent of erosion problems
3. Hydrologic/hydraulic data
4. Shoreline characteristics
5. Soils
6. Climatic and vegetative conditions
7. Habitat Characteristics
8. Environmental Data
9. Social and economic factors
10. Beach Slope
11. Offshore depth and wave height
12. Water surface
13. Littoral Transport
14. Foundational Material
15. Adjacent shoreline structures
16. Existing vegetation.

The analysis of shoreline protection measures are often complex and require special expertise. For this reason, this management plan is limited to revetments, bulkheads, and groins no higher than 3 feet above the mean high water, as well as soil bioengineering and other vegetative systems used alone or in combination with structural measures. Consideration must be given to the possible effects that erosion control measures can have on adjacent areas, especially adjacent wetlands.

Groins are somewhat permeable to impermeable finger-like structures that are installed perpendicular to the shore. They generally are constructed in groups called groin fields, and their primary purpose is to trap littoral drift. The trapped sand/sediment between the groins acts as a buffer between the incoming waves and the shoreline by causing the waves to break on the newly deposited sand and expend most of their energy there.

Groins are applicable and effective when site conditions are such that sand and sediment will be deposited in the littoral drift that moves in one direction. Filling the groin with borrowed sand may be necessary, if the littoral transport is clay or silt rather than sand.

Photo 6: Typical Groin

Bulkheads are vertical structures of timber, concrete, steel or aluminum sheet piling installed parallel to the shoreline. Bulkheads are applicable and effective when they are constructed where wave action will not cause overtopping of the structure (this could cause bank erosion)(and where scour at the base of the bulkhead causes it to fail.

Photo 7: Bulkhead Construction

Revetments are protective structures of rock, concrete, blocks, or other material that is installed to fit the slope and shape of the shoreline. Their application and effectiveness is great in that they are flexible and not impaired by slight movement, preferred to bulkheads, local damage is easily repaired, and there is no special equipment is needed for construction. They are, however, subject to scour at the toe and flanking areas and are complex and expensive.

Photo 8: Wooden Revetments

There are many vegetative measures that can be used in combination or alone to protect a shoreline. If some vegetation exists on a shoreline the problem may simply be solved with more vegetation. The first step is to determine if the vegetation disappeared because of storms, it is being shaded out by over story, or some other reason. In any case, vegetation is a viable alternative.

A shoreline problem is often isolated and requires only a simple patch to repair. The characteristics that indicates a patch is needed in Silver Lake include good overall protection from wave action, slight undercutting in spots with an occasional slide on the bank, and fairly good vegetative growth on the shoreline. The problems that cause this spotty erosion include boat wake, excessive upland runoff, or underground water movement causing slumping of the bank. The undercut areas should be filled with stone or some other method of hardening the shoreline. These areas should then be repaired with grass transplants, reed clumps, branch packing, vegetated geo-grid, or vegetated riprap.

Slides that occur because of saturated soil conditions are best alleviated by providing subsurface drainage or a diversion. Leaning trees or slipping trees may need to be removed or “dropped into the lake” because their weight and the forces they exert on the soil. Once the saturated condition is remedied disturbed areas should be re-vegetated with native trees, shrubs, and grasses to establish cover.

Soil bioengineering systems that are best suited to reducing erosion along shorelines are live stakes, live fascines, brush mattresses, live siltation, and reed clump structures.

Live Stakes offer no stability until they root into the shoreline area, but over time they provide excellent soil reinforcement. To reduced failure until root establishment occurs installations may be enhanced with a layer of long straw mulch covered with jute mesh or a more natural geotextile fabric.

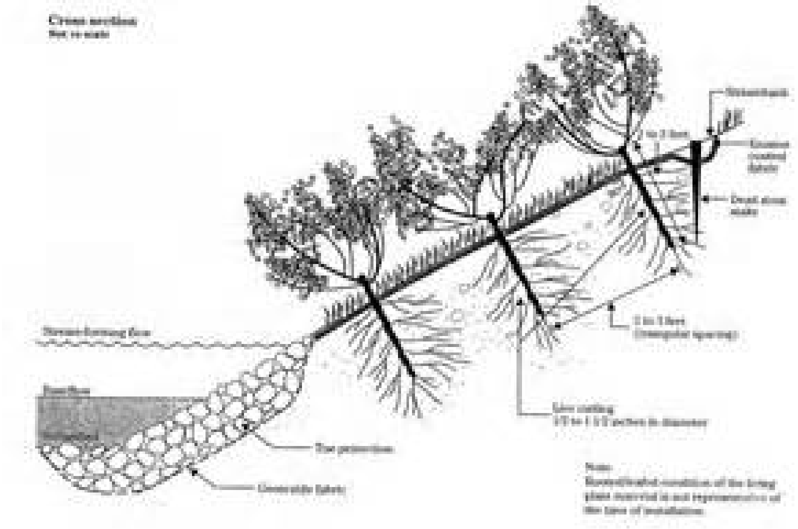


Photo 9: Live Stakes

Live Fascines work best in shoreline applications where the ground between them is also protected. Natural geotextiles such as those manufactured from coconut husks are strong, durable, and work well to protect the ground. The fascines should be constructed of live cuttings approximately 8 inches in diameter. Live stakes should be about 3 feet long.

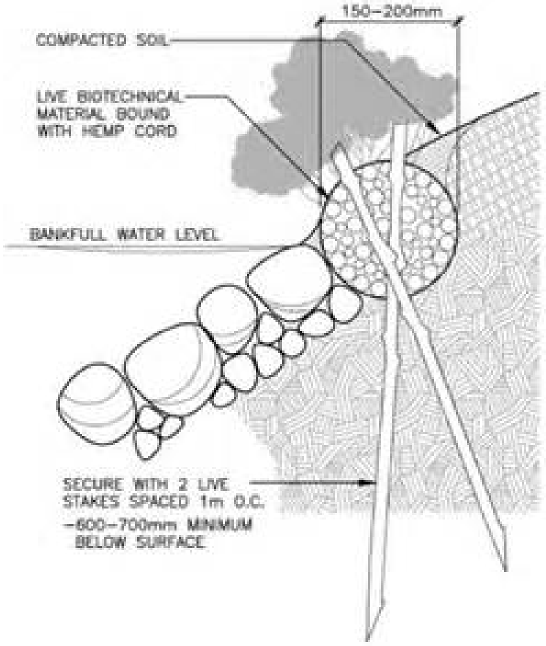


Photo 10: Live Fascines

Brush Mattress may be effective in lakes that have fluctuating water levels since they are able to protect the shoreline and continue to grow and they are able to filter incoming water because they also establish a dense healthy shoreline vegetation.

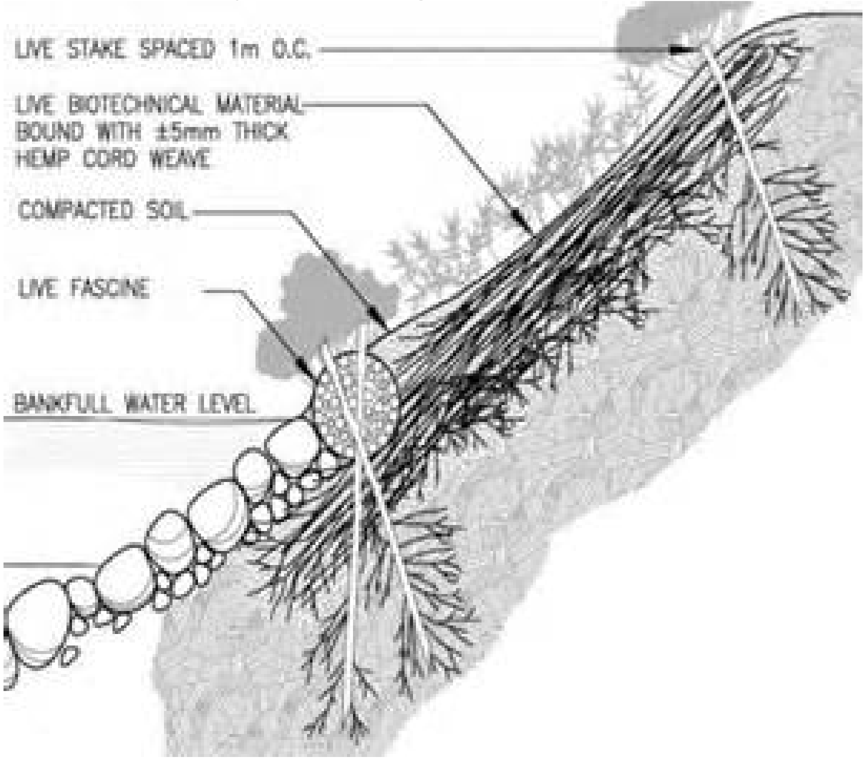


Photo 11: Brush Mattress

Live Siltation is similar to brush layering except that the orientation of the branches are more vertical. Live siltation systems are approximately perpendicular to the prevailing winds. The branch tips should slope upwards at 45 to 60 degrees.

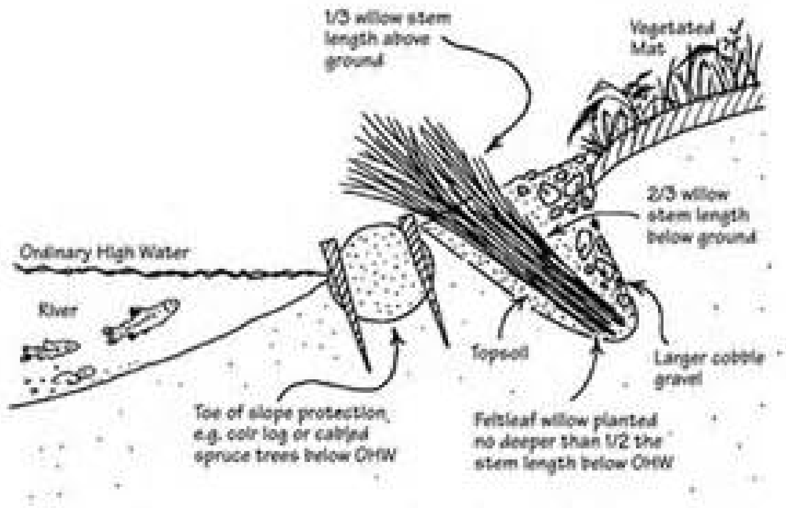


Photo 12: Live Siltation

Reed Clumps consists of root divisions wrapped in natural geotextile fabric and then placed in trenches, which are then staked down. The resulting root mat reinforces soil particles and extracts excess moisture through transpiration. Reed clump systems are typically installed at the water's edge or on shelves in the littoral zone. Reed clumps reduce toe erosion, are relatively inexpensive, useful on shore sites where rapid repair of spot damage is required, retains soil and transported sediment a the shoreline, reduces a long beach wash into a series of shorter sections capable of retaining surface soils, enhances conditions for natural colonization and establishment of vegetation from the surrounding plant community, and grows in water and survives fluctuating water levels.

Photo 13: Reed Clumps

Coconut Fiber Rolls have been used with great success in many lakes in the Midwest. They are bound together with twine that is woven from coconut. They are especially effective in lakes where the water level fluctuates because it protects the shoreline and encourages new vegetation. These logs can be expensive, however and its life expectancy is around 6 to 10 years.

Photo 14: Coconut Fiber Logs

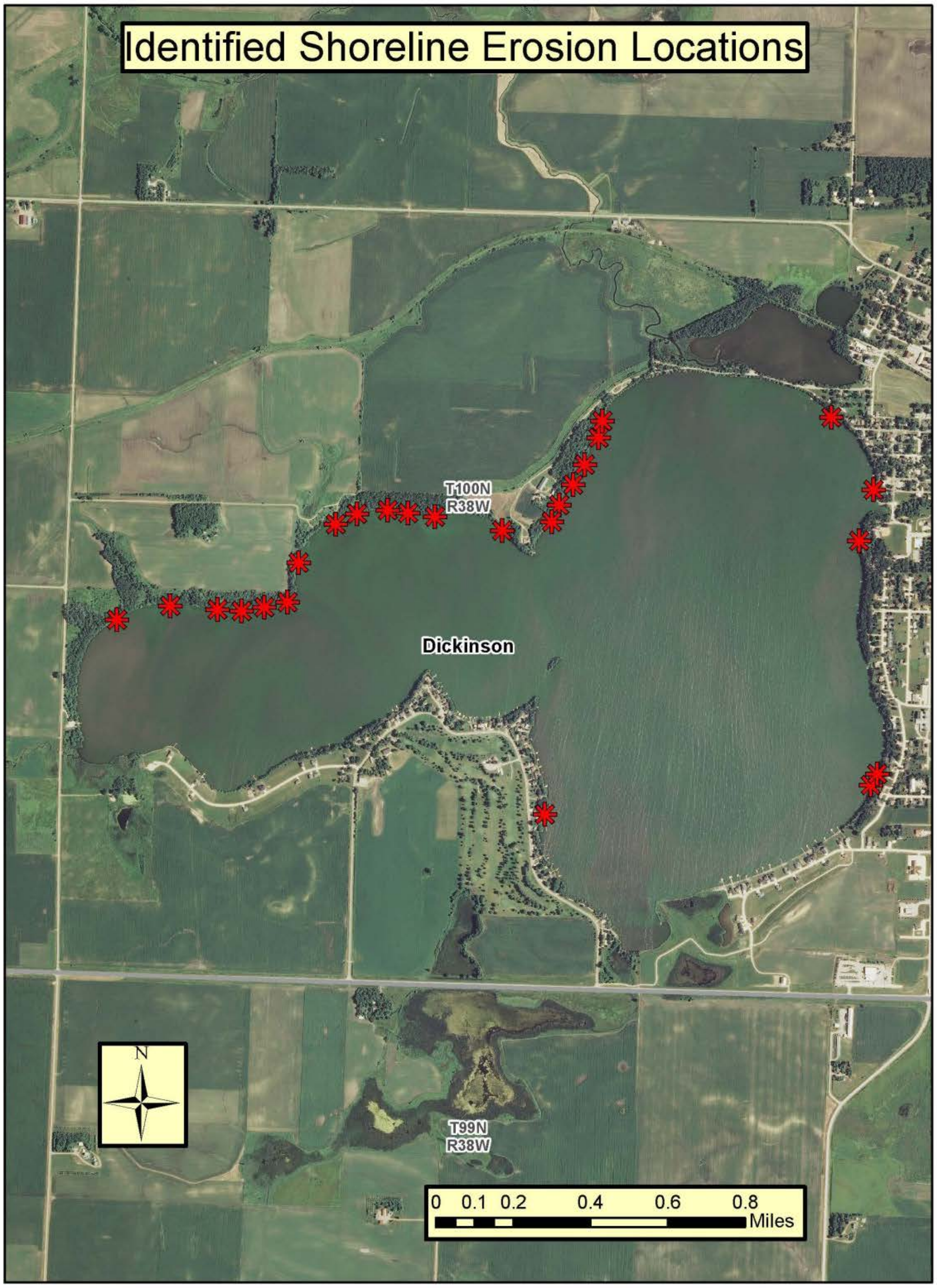
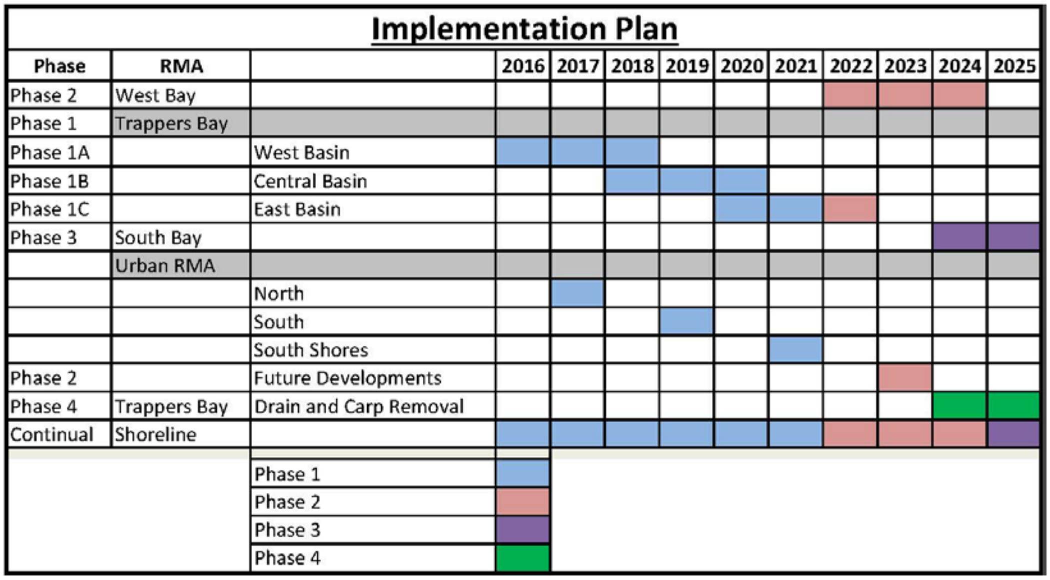


Figure 46: Shoreline Erosion Locations on Silver Lake

13. Implementation Schedule and Totals

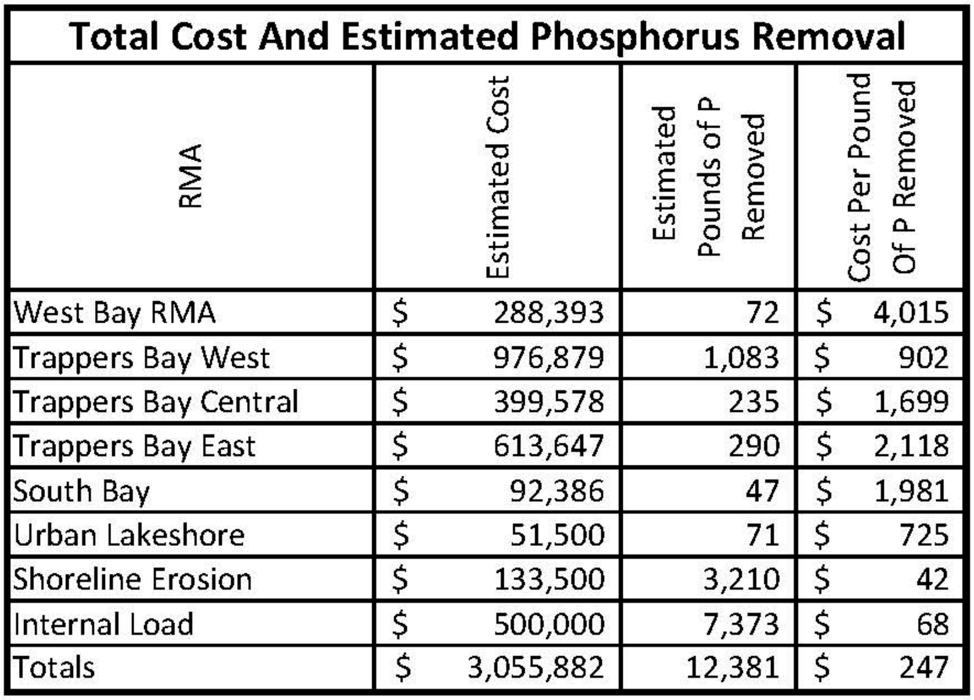


Implementation Plan

Phase	RMA		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Phase 2	West Bay								🟥	🟥	🟥	
Phase 1	Trappers Bay											
Phase 1A		West Basin	🟦	🟦	🟦							
Phase 1B		Central Basin			🟦	🟦	🟦					
Phase 1C		East Basin					🟦	🟦	🟥			
Phase 3	South Bay										🟪	🟪
	Urban RMA											
		North		🟦								
		South				🟦						
		South Shores						🟦				
Phase 2		Future Developments								🟥		
Phase 4	Trappers Bay	Drain and Carp Removal									🟩	🟩
Continual	Shoreline		🟦	🟦	🟦	🟦	🟦	🟦	🟥	🟥	🟥	🟪

Phase 1	🟦
Phase 2	🟥
Phase 3	🟪
Phase 4	🟩

Table 19: Implementation Plan for Silver Lake Watershed



Total Cost And Estimated Phosphorus Removal

RMA	Estimated Cost	Estimated Pounds of P Removed	Cost Per Pound Of P Removed
West Bay RMA	$ 288,393	72	$ 4,015
Trappers Bay West	$ 976,879	1,083	$ 902
Trappers Bay Central	$ 399,578	235	$ 1,699
Trappers Bay East	$ 613,647	290	$ 2,118
South Bay	$ 92,386	47	$ 1,981
Urban Lakeshore	$ 51,500	71	$ 725
Shoreline Erosion	$ 133,500	3,210	$ 42
Internal Load	$ 500,000	7,373	$ 68
Totals	$ 3,055,882	12,381	$ 247

Table 20: Total Cost and Estimated Pollution Removal

14. Water Quality Milestones

Numeric water quality targets and load reductions are important to measure the success of the watershed quality improvement efforts. The following milestones have been established for each phase of the Watershed Management Plan. Phase 1 is years one to six, Phase 2 is year's seven to ten, and Phase 3 is years ten through twelve. As the plan is revised every five years the phases may be modified to better align with water quality improvement progress and funding sources and availability. Load reduction milestones have established using BMP implementation goals for each phase modeled.

The goal of this plan is to improve in-lake water quality measures, specifically Trophic State Index (TSI) scores for chlorophyll-a and Secchi depth to levels below the impairment trigger of 65. Tables 21 and 22 provide phosphorous load reductions and associated in-lake water quality target by phase.

Milestones and associated reductions are presented in phases, rather than individual BMPs. There are several practical reasons for this methodology. Many of the BMPs specified in this plan work in concert with each other to form comprehensive "treatment trains" of BMPs. The performance (i.e., the load reduction) achieved by each BMP is dependent on one or more other BMPs implemented as part of the same phase of improvements. This makes quantifying the load reduction of each individual BMP difficult. It is more realistic to utilize a watershed-scale modeling tool, such as the one used in the development of this plan, to simulate the potential reductions of each package or phase of BMPs. This approach also provides the planning group with a more realistic and accurate way of projecting and tracking water quality improvement throughout the implementation process.

	Phosphorus Loading					
Scenarios	Watershed TP Load (lbs/season)	Internal TP Load (lbs/season)	Atmospheric (lbs/season)	Total TP Load (lbs/season)	Reduction (%)	Reduction (lbs)
Baseline Conditions	11,906	7,798	276	19,980	--	0
End of Phase 1	6,572	3,743	276	10,315	48	9,665
End of Phase 2	6,614	2,213	276	8,827	56	11,153
End of Phase 3	6,089	1,560	276	7,649	61.7	12,331

Table 21: Phosphorous Load Reduction Goals

Scenarios	Total Phosphorous	Chlorophyll-a	Secchi Depth
	(ug/L)	(ug/L)	(m)
Baseline Conditions	119.8	41.9	0.7
End of Phase 1	95	38	0.8
End of Phase 2	75	36	0.9
End of Phase 3	68	34	1
Baseline TSI	73	67	65
Target TSI	65	65	60
Improvement Needed	Decrease 43%	Decrease 19%	Increase 43%

Table 22: In Lake Water Quality Goals

The watershed and in-lake models used to develop the TMDL were also utilized to develop this WMP. It should be noted that the projected load reduction in this plan is less than the target set forth in the TMDL.

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Appendix A

Subject: ENG—GEOLOGY—Fluvial Geomorphology and Channel Erosion Assessment
West Branch Little Sioux River—
Silver Lake Watershed—
Dickinson County, IA

Date: October 10, 2012

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Federal Building
210 Walnut Street, Ste. 693
Des Moines, IA 50309-2180

To: Allen Gehring, State Conservation Engineer, NRCS, Des Moines, IA

File Code: 210-16-13-7

Participants: Catherine Sereg, Silver Lake Watershed Coordinator, Dickinson Soil and Water Conservation District, Spirit Lake, IA
Joe Thompson, Geologist, Des Moines, IA

Background: Iowa NRCS was asked to perform a stream channel assessment of the West Branch of the Little Sioux River, which empties into Silver Lake in Dickinson County, by the Dickinson Soil and Water Conservation District. The assessment was requested in order to determine channel erosion rates for the eventual purposed of reducing sediment and phosphorus delivery to Silver Lake. Phosphorus is attached to sediment that enters the lake as a result of soil erosion in the watershed, including channel erosion and sheet and rill erosion.

Field Observations: A geomorphic assessment of West Branch Little Sioux River in Dickinson County was conducted on October 3 by Joe Thompson, Iowa-NRCS Geologist accompanied by Catherine Sereg, Silver Lake Watershed Coordinator. The purpose of the field visit was to observe channel bank erosion and to quantify that erosion along the main channel. The assessment began at the far downstream end of the channel where it empties into Silver Lake at Trappers Bay (point A1) and continued to the furthest upstream point in the channel at A^ (Figure 1). For this report the channel is separated into two segments, the downstream segment between points A1 and A13 (Figure 2) and the upstream segment between points A13 and the terminal point A^ (Figure 3). The entire main channel was assessed during the field visit on October 3rd, consisting of approximately 28,482 feet (5.4 miles) of channel.

The assessment was conducted by walking upstream from the starting point and using a GPS to record the locations where channel erosion changed appreciably; primarily where erosional bank height increased or decreased but also where the qualitative category (slight, medium, severe, or very severe) of the bank erosion changed. The two bank heights and erosional recession rates of the two banks were then described between the two marking points using the direct volume method (USDA, 1998). So, for instance, the portion of the channel evaluated between points A1 and A2 is described in the table shown in Figure 2 as reach A1. This entire reach between points A1 and A2 is non-eroding (NE). For any given reach the channel typically has one bank that is slightly (or in some cases appreciably) higher than the other. For descriptive ease this lower bank is described in the tables as the “left” bank even though the lower bank may change from left to right as the channel meanders.

The surrounding topography of the channel was very flat, for the most part, and there were consequently no observed tributary channels entering the main channel. Additionally, there were no gullies observed along the main channel with the exception of the furthest upstream point where the main channel began. These conditions would indicate that sheet and rill erosion upslope from the main channel would constitute a relatively minor proportion of the sediment and phosphorus being delivered to Silver Lake. Due to the drought conditions of the previous summer the channel contained very little running water, especially downstream of point A14. Due to the lack of running water in the channel bank conditions have somewhat stabilized compared to conditions observed the previous spring where vegetation growth has increased along the eroding banks. Some slumping has occurred along the channel banks, primarily between points A15 and A18, but the portions of the slumped banks that would probably be underwater (or nearer the waters’ edge) during more typical conditions have stabilized somewhat as vegetation growth has occurred.

Current conditions of the channel have an overall slight to moderate erosion rate. This rate is probably skewed slightly lower due to the lack of running water in the channel, and the subsequent lack of physical channel erosion that would occur with more frequent rain events and a continuous flow of water in the channel. As stated previously, the banks have also stabilized with very recent vegetation growth that has occurred much lower on the banks than what would normally take place if the water level in the channel was more typical.

The channel itself appears to be relatively stable, with very little evidence of active down cutting. The channel bottom is covered by recent deposits consisting of primarily sand and gravel, with lesser proportions of silt and clay. Channel sinuosity is greater further downstream but the channel is only eroding slightly (erosion rates <7 tons/year downstream from reach A6) where meandering is strongest, and is non-eroding in reach A1 and A5. In addition, the inside meander banks are generally sloped rather than vertical, also indicating a relatively stable bottom.

Erosion rates begin to increase upstream from reach A6, mostly due to increasing erosional bank height but other bank widening indicators (more predominant bare banks with exposed roots and recent bank slumps and slips) are also present. Upstream from point A15 channel bank height, particularly in reaches A14, A15, and A17 increases, but only over relatively short horizontal distances. Upstream from point A16 the channel has been noticeably straightened. There was a relatively short (<2 foot) over-fall observed at point A16, but there was a beaver dam at this point as well. The channel is probably down cutting slightly, but not appreciably at this point. No channel down cutting indicators were present upstream from point A16, but channel widening is occurring as evidenced by slumping, particularly in the higher banks. However, as indicated previously, these slumps have been somewhat stabilized by active vegetation growth.

Conclusions:

Channel erosion observed in the West Branch Little Sioux River and subsequent sediment delivery to Silver Lake is affected by a variety of factors, including but not limited to – (a) the relatively low relief landscape of the watershed, (b) channel straightening that has occurred in the upstream portion of the channel, and (c) atypical streamflow within the channel that is significantly lower than normal due to drought conditions of the previous summer. These factors all contribute to a lack of observed channel down cutting in the watershed. Channel widening, however is occurring at a few locations primarily indicated by channel bank slumping and sliding. These areas probably contribute the greatest percentage of sediment to the channel and Silver Lake.

The amount of eroded sediment in the system is difficult to quantify do to the atypical bank conditions observed on October 3rd. Channel observations from earlier in the spring indicated much more bare bank with several feet of water in the channel. Though the banks have stabilized with vegetation growth over the last several months trying to assign an erosional recession rate to the banks based on these “snapshot” conditions is probably not realistic. An attempt was therefore made to take into account conditions observed earlier in the year when the banks were more bare and unstable.

Method Reference:

U.S. Department of Agriculture, Natural Resources Conservation Service. 1998. Erosion and Sediment Delivery Procedure. Field Office Technical Guide No. IA-198, Section I, Erosion Prediction.

Joe Thompson
Geologist

Cc: Catherine Sereg, Silver Lake Watershed Coordinator, Spirit Lake, IA

Figure 1 - Silver Lake Watershed

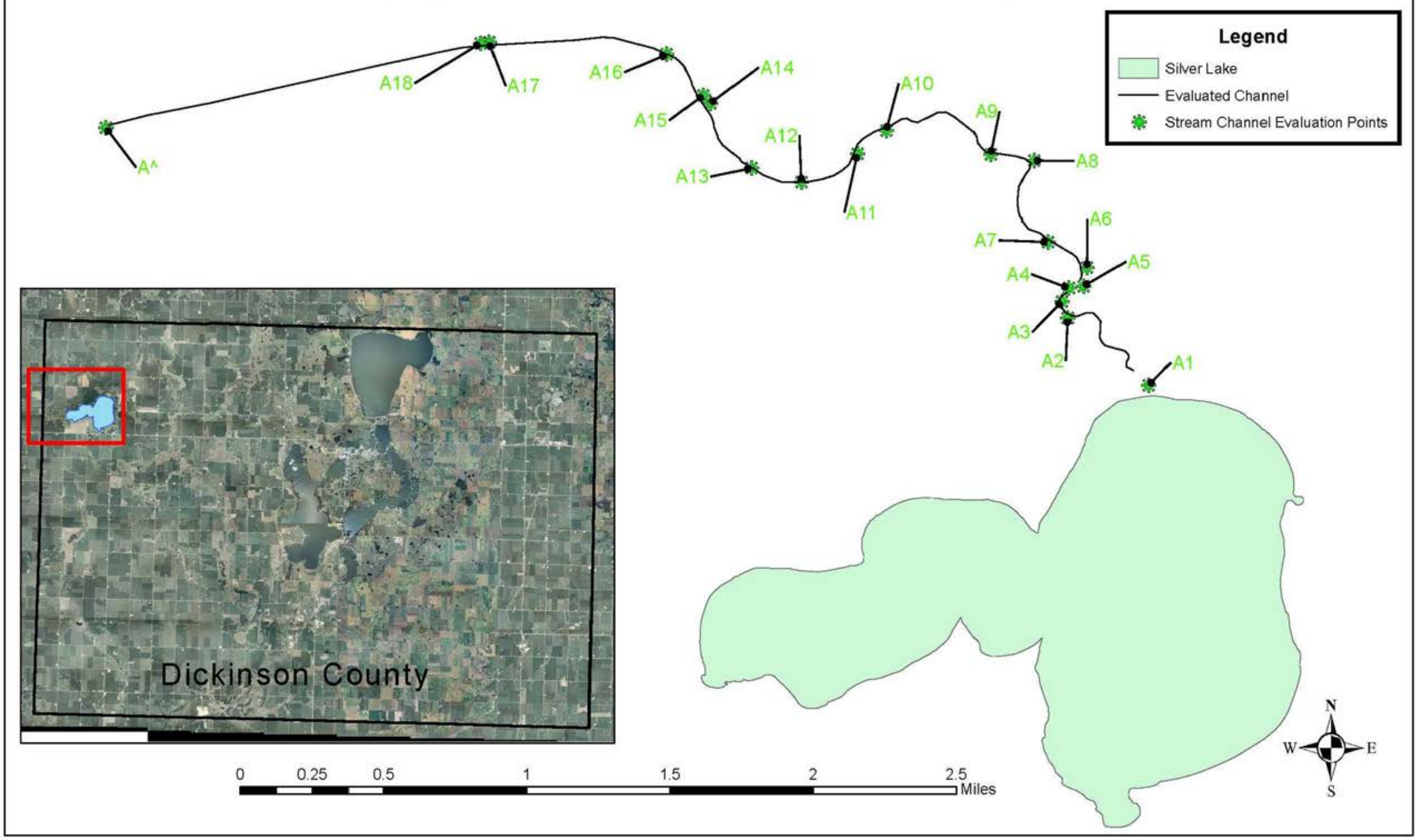
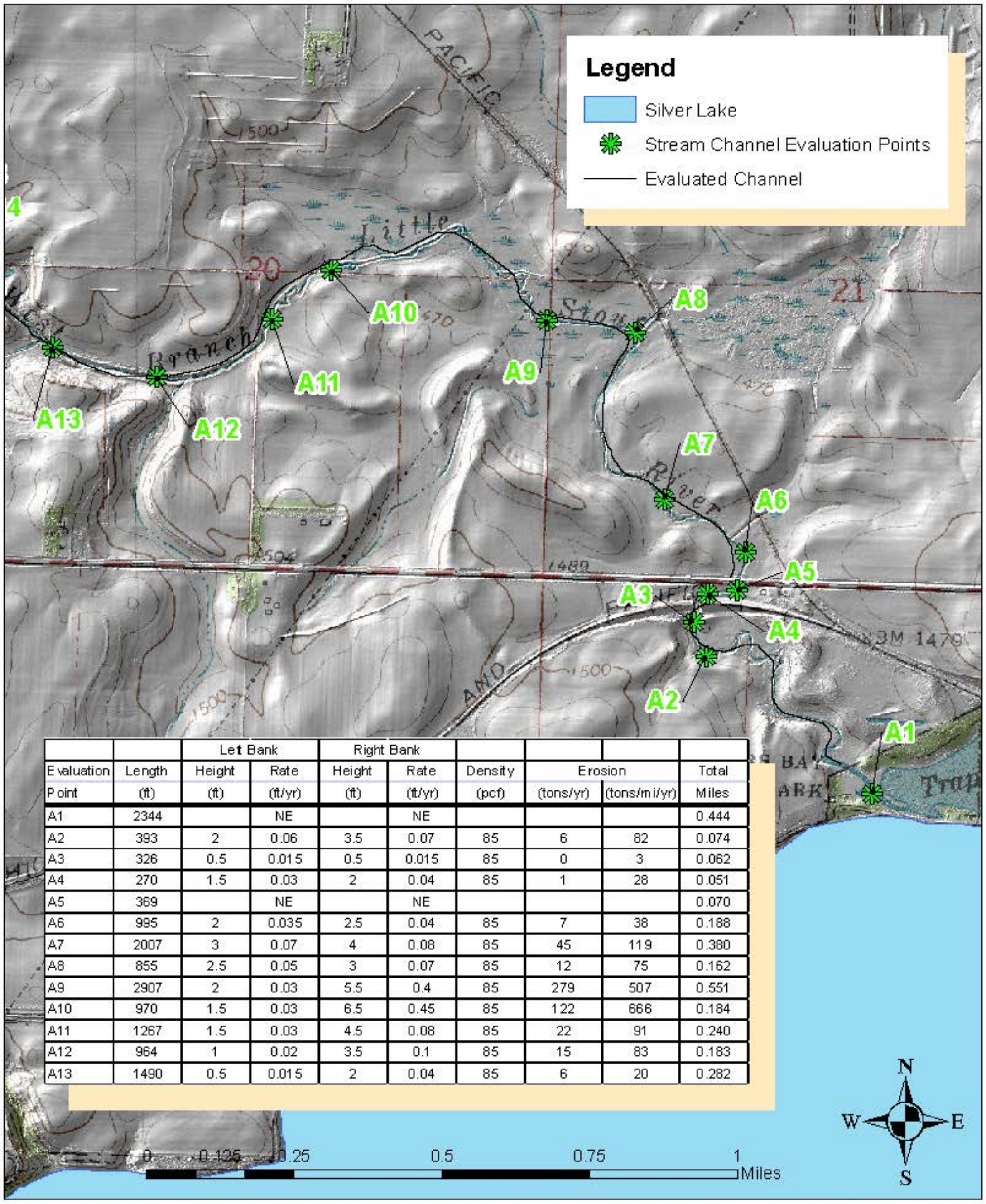
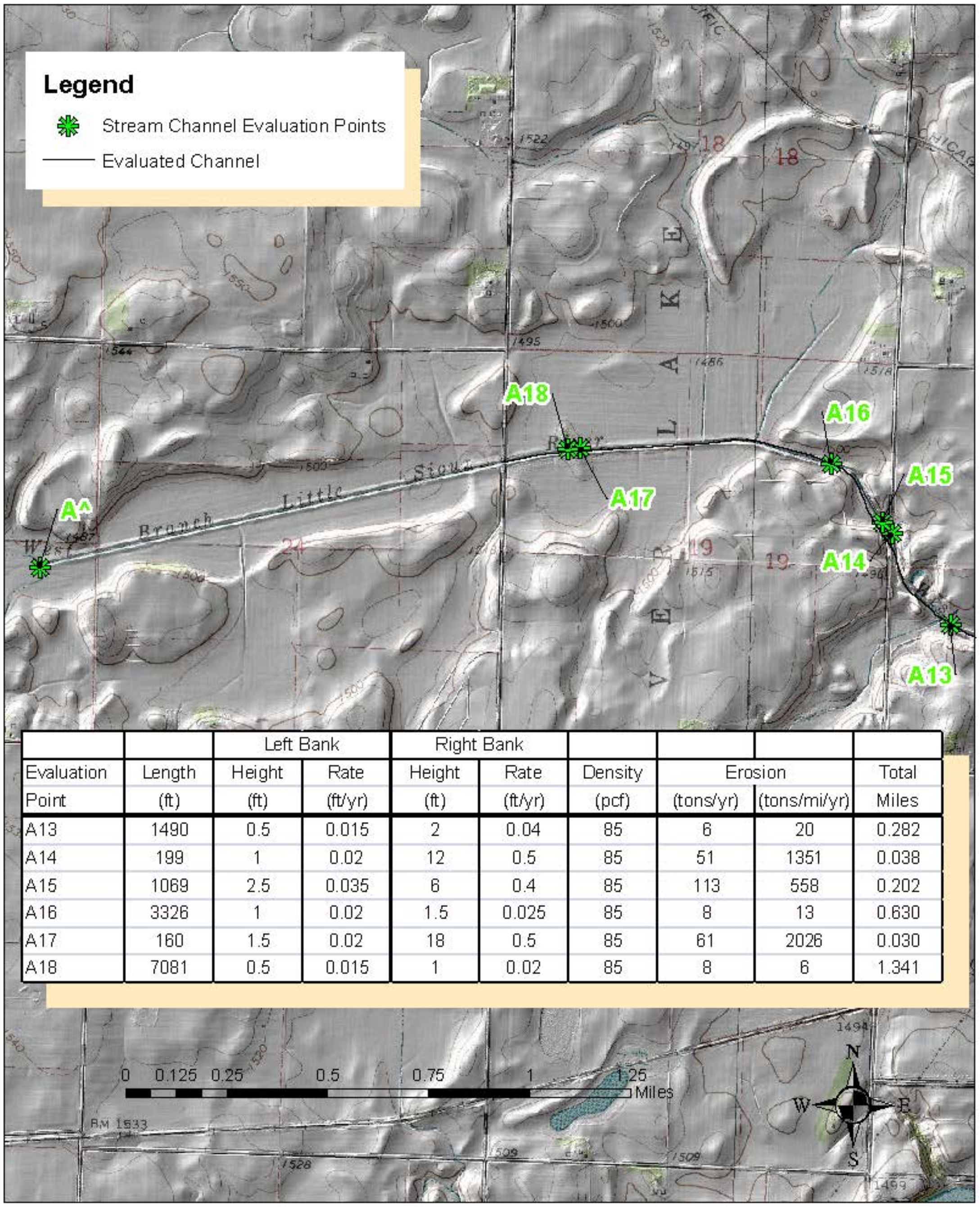


Figure 2 - West Branch Little Sioux River - Downstream Reach



		Left Bank		Right Bank					
Evaluation Point	Length (ft)	Height (ft)	Rate (ft/yr)	Height (ft)	Rate (ft/yr)	Density (pcf)	Erosion (tons/yr)	(tons/mi/yr)	Total Miles
A1	2344		NE		NE				0.444
A2	393	2	0.06	3.5	0.07	85	6	82	0.074
A3	326	0.5	0.015	0.5	0.015	85	0	3	0.062
A4	270	1.5	0.03	2	0.04	85	1	28	0.051
A5	369		NE		NE				0.070
A6	995	2	0.035	2.5	0.04	85	7	38	0.188
A7	2007	3	0.07	4	0.08	85	45	119	0.380
A8	855	2.5	0.05	3	0.07	85	12	75	0.162
A9	2907	2	0.03	5.5	0.4	85	279	507	0.551
A10	970	1.5	0.03	6.5	0.45	85	122	666	0.184
A11	1267	1.5	0.03	4.5	0.08	85	22	91	0.240
A12	964	1	0.02	3.5	0.1	85	15	83	0.183
A13	1490	0.5	0.015	2	0.04	85	6	20	0.282

Figure 3 - West Branch Little Sioux River - Upstream Reach



		Left Bank		Right Bank					
Evaluation Point	Length (ft)	Height (ft)	Rate (ft/yr)	Height (ft)	Rate (ft/yr)	Density (pcf)	Erosion (tons/yr)	(tons/mi/yr)	Total Miles
A13	1490	0.5	0.015	2	0.04	85	6	20	0.282
A14	199	1	0.02	12	0.5	85	51	1351	0.038
A15	1069	2.5	0.035	6	0.4	85	113	558	0.202
A16	3326	1	0.02	1.5	0.025	85	8	13	0.630
A17	160	1.5	0.02	18	0.5	85	61	2026	0.030
A18	7081	0.5	0.015	1	0.02	85	8	6	1.341

Trappers Bay RMA, West Branch Little Sioux River (Drainage Ditch)

Restoration Planning Components

The areas indicated in Figure 30 by the red “targets” have been identified as having greater than 40 pounds, or more, of phosphorus contribution per year and are considered the highest priorities of the drainage ditch. When combined the 6 “target areas” notated on the map that follows contribute 671 tons of sediment into the drainage ditch each year. Because the drainage ditch flows directly to Silver Lake, a good portion of that sediment will make the trip to Silver Lake each year and bring with it Phosphorus and other pollutants.

The goal of this plan is to stabilize the target areas with vegetation, two stage ditches, and other methods during the course of this implementation plan. It is not desired to see the entire ditch become re-vegetated or developed into a two stage ditch because both would be excessively expensive and not necessary. The desired outcome of this plan would be to develop the target areas that are identified in figure 30 in a way that reduces or eliminates the erosion and cutting of the bank that is currently occurring. Appendix A contains the entire report as prepared by The Natural Resources Conservation Service Geologist. Table 22 shows the target areas along with the eroding length and estimated erosion per year.

West Branch, Little Sioux River			
Evaluation Point	**Eroding Length (ft)**	**Sediment Tons/yr**	**LBS Phosphorus Contribution per year**
A7	2007	45	81
A10	970	279	502.2
A11	1267	122	219.6
A14	199	51	91.8
A15	1069	113	203.4
A17	160	61	109.8

Table 13: Target Sites on Drainage Ditch and contribution of Phosphorus per year (Thompson, 2012)

Each of the target areas have different challenges and problems associated with them. They are each unique and one set plan will not be adequate for each of the sites. Sites A10, A14, and A17 are the worst contributors of sediment on a per foot basis and should be the first three locations that are treated. It is estimated that 1,498 pounds of Phosphorus is contributed to Silver Lake due to erosion of this drainage ditch.

The targeted sites of the drainage ditch listed in Table 22 above contribute approximately 1,200 pounds of that Phosphorus. A load reduction of 59% of the total contribution from the drainage ditch is required to reach the 61.8 percent load reduction. Working in the targeted sites listed in Table 22 would easily allow for the reduction of 884 pounds of Phosphorus within those targeted sites.

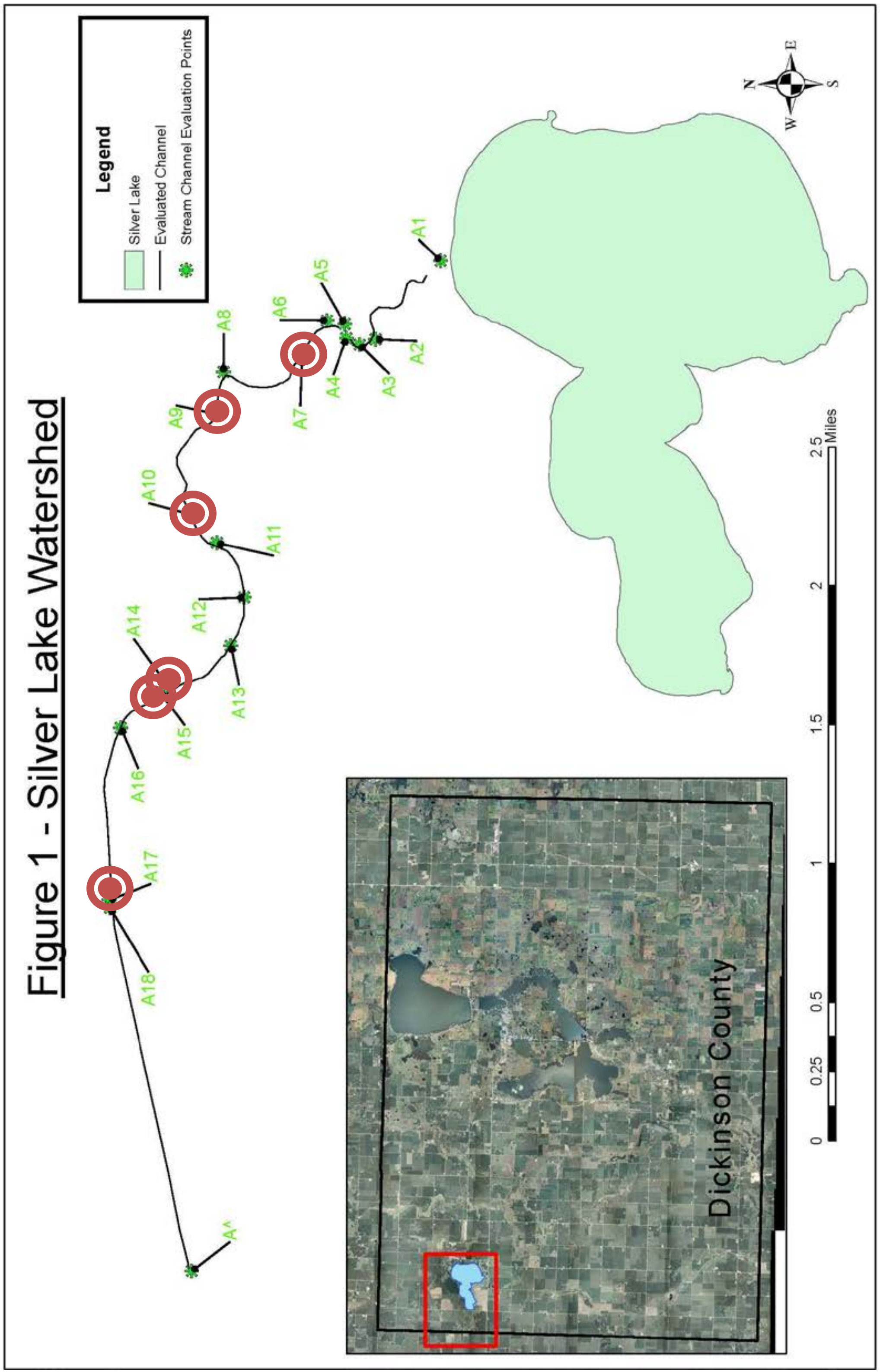


Figure 29: Trapper's Bay drainage, Courtesy Iowa DNR (Thompson, 2012)

Appendix B

Aquatic Invasive Species

Introducing non-native species into Iowa waters can upset the balance of the ecosystem, hurting the environment. Aquatic Invasive species (AIS), which include plants, animals and other organisms, may dominate aquatic ecosystems where they are introduced because they are freed from natural competitors, predators and diseases.

Presidential Executive Order 13112 of February 3, 1999 - Invasive Species defines an *invasive species* as “an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.” The Executive Summary of the National Invasive Species Management Plan, developed by the federal interagency National Invasive Species Council (NISC) further clarifies and defines an invasive species as “a species that is *non-native to the ecosystem under consideration* and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.”

Congress established the Aquatic Invasive Species (AIS) Task Force with the passage of the Non-indigenous Aquatic Invasive Species Prevention and Control Act in 1990 and reauthorized it with the passage of the National Invasive Species Act in 1996 (Act). The Act charges the AIS Task Force with developing and implementing a program for waters of the United States to prevent introduction and dispersal of aquatic Invasive species; to monitor, control and study such species; and to disseminate related information. Some states, including Iowa, are strengthening their own invasive species laws, regulations, or policies instead of awaiting stronger federal action.

Successful AIS reproduce early, often, in large numbers and in multiple ways, out-competing or consuming native species to the point of extinction. Their ability to grow rapidly, colonize disturbed sites, and tolerate a wide range of environmental conditions can be disastrous for the natural environment, economies, and/or public health.

Once established in a new location, AIS may:

- Negatively impact economies of nearby communities
- Decrease waterfront property values
- Reduce populations of native species
- Reduce fish spawning areas
- Interfere with boating, fishing, swimming and other water recreation
- Clog drinking water plants, power plants, and dams, substantially increasing operating and maintenance costs
- Affect human health
- Be impossible to eradicate

Aquatic Invasive species cost billions of dollars annually in damage and control measures. Zebra mussels alone are estimated to have cost the United States $750 million to $1 billion from 1989 to 2000. Because of the negative impacts to water quality, economies, and public health, both aquatic and terrestrial invasive species have gained new prominence in federal and state policy. There is increased cooperation among environmental nonprofits, government agencies, and trade organizations to halt or slow the spread of invasive species.

The United States has the interagency NISC and a National Invasive Species Management Plan, Federal Inter- agency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), and federal AIS Task Force in place to combat invasive species and promote state/interstate invasive species management plans.

(USDA, 2007)

IOWA AQUATIC INVASIVE SPECIES PROGRAM

The Iowa Department of Natural Resources Aquatic Invasive Species Program (DNR-AIS) is responsible for monitoring and managing AIS in Iowa. Bighead carp, silver carp, Eurasian water milfoil, zebra mussels and other nonnative aquatic species threaten Iowa waters.

The Iowa AIS Program aims to:

Reduce the risk of further introductions of AIS in Iowa

Limit the spread of established populations of AIS into un-infested
waters in Iowa Eradicate or minimize the impacts resulting from
infestations of AIS in Iowa

(IA DNR, 2005)

In 2005, the Iowa Great Lakes Water Safety Council raised $32,000 to fund three DNR Law Enforcement Bureau Water Patrol Officers. Funding for the positions was donated by the Messengers of Healing Winds, Okoboji Protective Association, Alliant Energy Foundation, East Okoboji Lakes Improvement Corporation, Spirit Lake Protective Association, Conservation Foundation of Dickinson County, Mau Marine, Oak Hill Marina, Bridgewater Boats, and an individual donor. The funding was supplemented by DNR to hire eight additional summer officers. While the officers have the authority to issue citations for violations, the program emphasis is soft enforcement through education and voluntary compliance. The DNR-AIS focuses on raising public awareness to prevent the spread of AIS, monitoring state water bodies for AIS introductions, and control of AIS infestations.

In 2006, the DNR-AIS program targeted twelve high and medium priority boat ramps on the Iowa Great Lakes for inspections and public education because of greater boater activity and/or the greater likelihood boaters could be coming from lakes known to have invasive species. Intervention through early detection and rapid response is a critical strategy for preventing the establishment of new AIS populations. Early detection and rapid response efforts increase the likelihood that invasions will be addressed successfully while populations are still localized and population levels are not beyond that, which can be contained and eradicated.

In addition to the boat ramps listed above, there are eighteen smaller, less well known Dickinson County lakes and sloughs with boat ramps, including Christopherson, Diamond, Grovers, Hottes, Jemmerson, Lilly, Little Spirit, Marble, Prairie, Spring Run, Sunken, and Yeager.

Because of the critical need for early detection, the DNR-AIS and its local partners have identified the need for increased measures to prevent the spread of AIS in Iowa.

A successful AIS program must include:

A comprehensive public outreach effort-including but not limited to, facilitated public meetings, distribution of fact sheets, public service announcements, newspaper advertisements, rest area displays, traveler information systems, and gas pump toppers.

Active local partnerships to assist with developing watershed AIS management plans Permanent DNR-AIS program staff to conduct public education and volunteer programs Seasonal officers to conduct watercraft inspections and on-site public education

Support for research that identifies pathways to limit the spread of AIS and identifies new AIS control methods Education of recreational users (boaters and anglers). (IA DNR, 2005)

What the public can do

Some things the public can do to reduce the chance of spreading AIS in the Iowa Great Lakes and they include:

- Personal watercraft users should avoid running the engine through aquatic plants. When they are finished riding, they should run the engine for 5-10 seconds on the trailer to blow out excess water and vegetation from the internal drive, then turn off the engine.
- Sailors should remove aquatic plants and animals from the hull, centerboard or bilge board wells, rudderpost area and trailer.
- Boaters should inspect their boats after taking them out of the lake and remove any vegetation caught on the trailer or anything attached to the boat. Drain all water from the boat. In addition, boaters should rinse the boat and trailer with a high-pressure washer or hot tap water above 104 degrees before the boat is used somewhere else, or allow the boat to dry for up to five days.
- Anglers should throw away unwanted bait by putting it in the trash, rather than throwing it into the water.
- Waterfowl hunters should remove all plant and animal material and mud from their boats, motors, trailers, waders or hip boots, decoy lines and anchors, and cut cattails or other plants above the waterline when they are used for camouflage or blinds.

Photo 1: Shows the recent AIS signs posted at all lakes.

Important Fish AIS in Iowa

Bighead and Silver Carp

(Hypophthalmichthys nobilis, Hypophthalmichthys molitrix)

Photo 2: Bighead Carp. Photo courtesy of David Riecks.

Asian Carp are native to central and southern China (bighead) and eastern Asia (silver). These carp were introduced in the 1970's by fish farmers in Arkansas and other southern states. Currently Asian Carp have spread to 23 states and are found in the Mississippi River and the Missouri Rives. They are found in the Des Moines River, Iowa River, Chariton River, Platte River, Cedar River, Nodaway River, Nishnabotna River, Little Sioux River, and the Big Sioux River and smaller tributaries.

Asian Carp can be identified by deep, laterally compressed bodies with large mouth and no teeth. They have tiny scales and their eyes are far forward and project downward. See Photo 2 above

Asian carp cause impacts in streams of the United States because they complete with native filter feeders such as buffalo and paddlefish as well as mussels and larval fish. Asian Carp disrupt commercial fishing and can be hazardous when, Silver Carp in particular, leap out of water when boats approach causing vibrations and a fright response.

Other AIS Fish species of concern include: White Perch, Round Goby, Rudd, Ruffe, and Black Carp.

Important Plant AIS in Iowa

Eurasian Watermilfoil

It can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. In shallow areas, the plant can interfere with water recreation such as boating, fishing, and swimming. The plant's floating canopy can also crowd out important native water plants.

<u>Eurasian Watermilfoil Infestations in Iowa through 2007</u>

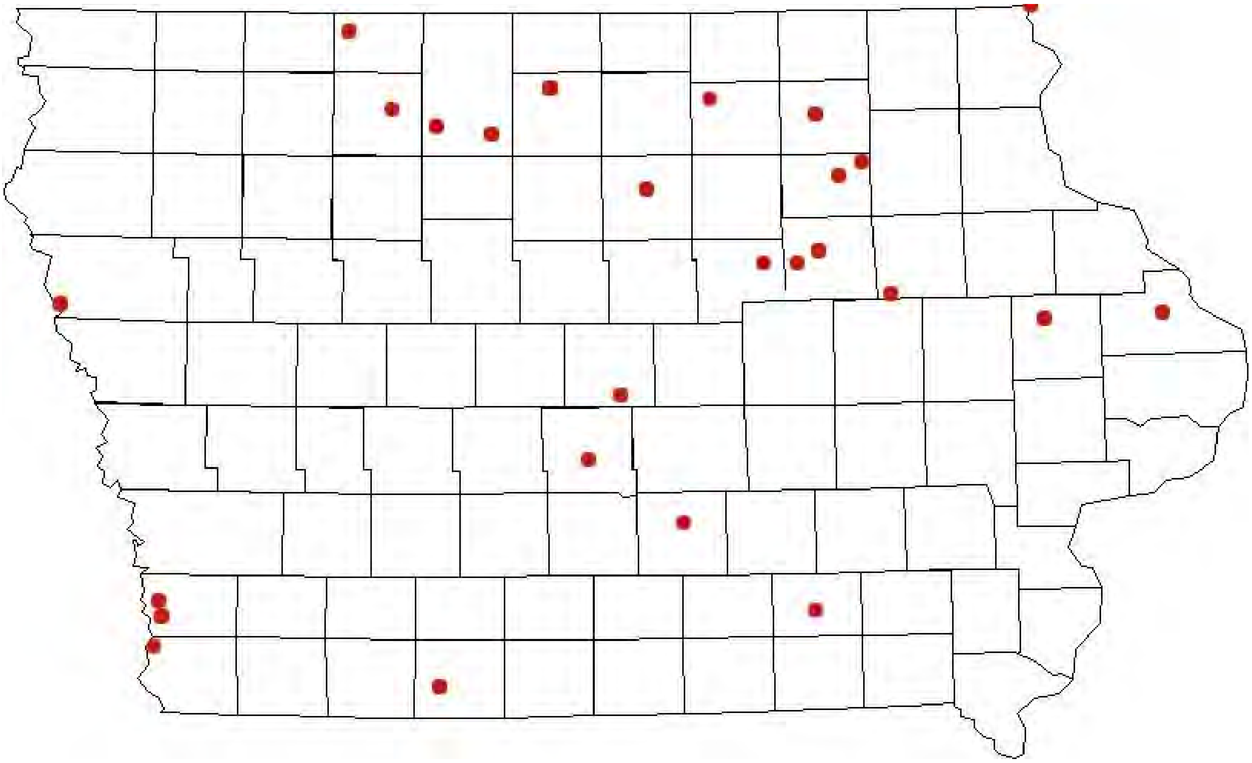


Figure 1: Eurasian Watermilfoil Infestations in Iowa through 2007. Map and locations of Eurasian Watermilfoil provided by Kim Bogenshutz with the Iowa DNR, 2007.

Eurasian watermilfoil (Myriophyllum spicatum)

Photo 3: Eurasian Watermilfoil. Photo courtesy of Minnesota DNR.

Eurasian Watermilfoil is native to Europe and Asia and was introduced into North America in the 1940's. It has thus far invaded at least 45 states and three Canadian provinces.

To identify Eurasian Watermilfoil see Photo 15 above. It has 12 to 21 pairs of leaflets that collapse against the stem when it is removed from the water. The plant branches profusely at water surface and forms dense mats.

Photo 4: Eurasian Water milfoil. Photo courtesy of Iowa DNR.

The impacts of Eurasian Water milfoil includes displacing native aquatic vegetation, forming dense mats on the surface which restricts boating, water skiing, and other aquatic recreation. It also tends to lower the value of lakefront property, and it spreads easily by vegetative propagation from lake to lake simply by breaking off and a small portion starting a new infestation.

Purple Loosestrife (Lythrum salicaria)

Photo 5: Purple Loosestrife much as it would appear in the IGL. Photo courtesy of the Iowa DNR.

Purple Loosestrife is native to Europe and Asia and was established along the east coast of the U.S. by the 1800's. It is currently found in almost all states and all Canadian provinces.

It can be identified easily as it stands 2 to 7 feet tall, has linear leaves with smooth edges that are usually opposite and has long spikes of purple or magenta flowers with 5-6 petals each. The plants flowers in July and August but depending upon the year could be earlier or later.

The impact of Purple Loosestrife is its ability to create dense stands and displace native vegetation and wildlife. It can clog drainage ditches and become a nuisance as it "takes over" areas where it becomes established.

A single plant of Purple Loosestrife can produce up to two million seeds each year and will root and underground shoots also produce new plants. It is tolerant of a wide variety of growing conditions

Brittle Naiad (Najas minor)

Photo 6: Brittle Naiad. Photo courtesy of North Carolina State University.

Brittle Naiad is a native to Europe and was introduced into North America in the 1930s. Thus far, it has invaded at least 24 states in the eastern and southern United States. It was first identified in Iowa in 2003.

Easy to identify, it has stems up to four feet long and is highly branched with crowded terminal nodes. The leaves are opposite and about one inch long. It has prominent marginal teeth that are often re-curved.

Brittle Naiad displaces native aquatic vegetation and forms dense mats which restrict boating, water skiing, fishing and other recreation. It reproduces by fragmentation and seeds. The plant is very brittle and breaks apart and spreads from lake to lake by watercraft and water movement. A key factor in the plant's success is its ability to reproduce through stem fragmentation and underground runners. A single segment of stem and leaves can take root and form a new colony. Fragments clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of weed beds for beaches, docks, and landings creates thousands of new stem fragments that can drift with the wind and current. Removing native vegetation creates perfect habitat for invading Eurasian water milfoil and Brittle Naiad.

Other Plant AIS that are of concern include Curly-leaf Pondweed, Flowering Rush and Salt Cedar.

Important Invertebrate AIS in Iowa

Zebra Mussel (Dreissena polymorpha)

Photo 7: Adult Zebra Mussel

Photos 8, 9, 10: Zebra Mussels at various stages of development.

Zebra Mussels were first found in Iowa in 1992 in the Mississippi River. In just one year they spread through- out the entire Mississippi River along Iowa. Veliger's (Juvenile Zebra Mussels) were collected in 2003 from Missouri River in South Dakota. The first lake they were documented in was Clear Lake where they were dis- covered in 2005. In 2006, they were discovered in Lake Delhi.

Zebra Mussels are easy to identify in that they have yellow or brown D-shaped shells that are up to two inches long with alternating light and dark bands. They usually grow in clusters containing numerous individuals and they are the only freshwater mollusk that attaches themselves to solid objects.

Zebra Mussels are sexually mature within one year and can produce up to one million eggs each year. These eggs hatch into what is known as veliger's which are free swimming and can move easily with the currents.

Veliger's fall out of the water column after 2—4 weeks and attach themselves in shady areas where they begin to filter water through their feeding system.

Zebra Mussels impacts include clogging pipes, hampering boating, clogging beaches, kill and outcompete native mussels, crayfish, and they compete with small fish and mussels for food. A series of invaders to the Iowa Great Lakes, including the rusty crayfish, silver carp, and zebra mussels could introduce new parasites and diseases causing catastrophic declines in populations of native species.

Other Invertebrate species of concern include: Other Invertebrate AIS include Quagga Mussel, Rusty Crayfish, fishhook water flea, and the spiny water flea. Zebra mussels can spread rapidly in the United States because they have no natural enemies here. Clear Lake–less than 100 miles from the Iowa Great Lakes - pro- vides a textbook example of the threat. In 2005, two adult zebra mussels were found. Two years later there is a wide spread outbreak of zebra mussels in Clear Lake. In 2012 one zebra mussel was discovered in a sampler similar to the one shown in Photo 9 near Triggs Resort on Upper Gar Lake. During the fall of 2012 the DNR looked at boat hoists that had been removed from the lakes of the region and discovered 3 additional juveniles from those hoists from the area of Hattie Elston Boat Ramp on East Okoboji. See Photo 10 for an example of was searched by the DNR.

Photo 11: Plate sampler at Clear Lake.

Photo 12: Zebra Mussels on boat hoist

When docks and hoists were removed from Clear Lake in the fall of 2007, the exponential increase of zebra mussels became readily apparent. The boat hoist at left shows what was found in the fall of 2007 as docks and hoists were removed from the lake. In comparison, only 2005 two adult Zebra Mussels were found in Clear Lake in 2005. In 2006, juvenile Zebra Mussels were found in the same area of Clear Lake.

To monitor the mussels, the DNR set out five plate samplers around Clear Lake and checked them monthly during summer 2007. All of the plate samplers had zebra mussels. The plate at left had the most, with more than 500 zebra mussels on it in July. The Zebra Mussels in Clear Lake probably arrived on or in a boat that had picked up the mussels in an infested water body. Young Zebra Mussels are microscopic and can be unintentionally transported on boats or trailers.

Our environment, particularly our public lands and waters, is facing many different, complex threats like expanding pollution impacts, invasive species, urban sprawl and the consequences feeding off of our culture's insatiable demand for petroleum-based products (ethanol). All of these issues threaten our natural resources; however, when they are combined with greater demands on our public resources and a scarcity of public funding to support traditional resource management, the sustainability of our natural resource base is being questioned by taxpayers who wonder why tax dollars are going towards acquisition of public land. (Starinchak, 2006)

How to Battle Invasive Species

Iowa Department of Natural Resources officials are asking people who recreate in Iowa waters, as well as in other states, to take precautions to help prevent the spread of invasive species like big-head carp, silver carp, Eurasian water milfoil, curly-leafed pondweed and zebra mussels.

To decrease the chances of spreading some of these invasive species:

Clean your equipment and boat, Drain your boat and equipment, Dry your equipment, and Dump any left-over bait or vegetation that you do not want. The slogan Clean, Drain, Dry, and Dump is an easy way to remember the steps involved in avoiding AIS.

Drain water from all equipment- motor, live well, bilge, transom well. Clean and dry anything that is exposed to water - equipment, boots, clothing, and pets. Before transporting to a different water body, rinse boat and equipment with water 104 degrees or hotter, spray boat and trailer with high-pressure water at a car wash, or dry boat and equipment for at least five days. Never release fish, animals or plants into a water body unless they came from that water body. Empty unwanted bait in trash. Learn to identify aquatic invasive species and report any suspected infestations to the nearest DNR fisheries station. People who shore and fly-fish should remove aquatic plants, animals and mud from waders and hip boots and drain water from bait containers.

SUMMARY

Aquatic Invasive species greatly affect the balance of the ecosystem. These AIS choke native species so that they cannot thrive in their natural environment. More times than not, people are at fault for unknowingly transporting these species. Understanding what we can do to keep our ecosystem clean will ensure that the same outdoor activities can be experienced for generations to come.

Appendix C

To date the Silver Lake Watershed Project has accomplished much. During the first portion of first WMP, the project experienced the upbeat of the farm economy with 7 and 8 dollar corn prices. In addition, the parameters of the project were not attained to the level that we had hoped.

In the past 7 years the following projects were attained:

- 190 acres of prairie and wetland restorations with a pollution reduction of 2 tons of sediment delivery stopped and 3 pounds of phosphorous delivery was stopped.
- 947 acres over 4 years in cover crop with a pollution reduction of 54 tons of sediment delivery stopped and 71 pound of phosphorus delivery stopped.
- 12 Water and Sediment Control Basins constructed, stopping 168 tons of sediment from being delivered to the lake and 218 pounds of phosphorus stopped from being delivered to the lake.
- 1 Grade Stabilization Structure built stopping 86 tons of sediment and 111 pounds of phosphorous from reaching the lake each year.
- 1 Bio-retention Cell preventing urban pollution from reaching the lake which reduced 17 tons of sediment from reaching the lake and 22.1 pounds of phosphorous stopped each year.
- 300 feet of Shoreline Erosion Control stopping 17 tons of sediment per year from reaching the lake and 22.1 pounds of phosphorous is prevented from reaching the lake.

These practices that have been quantified equal 215 tons of sediment have been stopped from being delivered to Silver Lake and 494.5 pounds of phosphorous from reaching the lake.