Otter Lake Shoreline Erosion Control & TMDL Implementation Project

Section 319 Project Final Report; Agreement # 3191612

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1.0 Introduction & Background

Otter Lake is located in Macoupin County, Illinois and is approximately 770 surface acres in size. The 13,000 acre watershed area is made up primarily of agricultural ground with forested areas surrounding the lake. Agricultural areas make up 75% of the watershed or approximately 10,000 acres. Otter Lake like many lakes in Illinois has experienced excessive levels of sedimentation and nutrient loading. Otter Lake is a source of drinking water, fishing, and boating for local and regional residents and stakeholders. Nutrient induced algae blooms have occurred in the past, impacting the use of the lake for recreation and drinking water.

In 1996, Otter Lake was listed as "Impaired". In 2002, Otter Lake was again listed with impairments of concern. The 2004 EPA 303(d) list classified Otter Lake as "Impaired" with a high priority ranking. As a result of this, a TMDL was developed and approved in 2006 for Hodges Creek/Otter Lake; Hodges Creek for low Dissolved Oxygen and Otter Lake for manganese. Table 1 outlines Otter Lake (RDF) impairments. During 2006-2012, Otter Lake did not support Public and Food Processing Water Supplies and was listed for Manganese, Mercury, Total Phosphorus, and Aquatic Algae. In 2014, Otter Lake achieved full use support for Public and Food Processing Water Supplies and was no longer impaired for Manganese or Aquatic Algae although impairments for Mercury and Total Phosphorus remained.

Table 1 - Otter Lake Impairments

Year Listed	Listed For	Use Support
1996	Manganese, Excessive Algae Growth	Aquatic life (F), Fish consumption (F), Overall use (P), Primary contact (P), Secondary contact (P), Public water supply (P)
2002	Pesticides, Excessive Algae Growth	Aquatic life (F), Fish consumption (F), Overall use (P), Primary contact (P), Secondary contact (P), Public water supply (P)
2004	Manganese, Excessive Algae Growth	Aquatic life (F), Fish consumption (F), Overall use (P), Primary contact (P), Secondary contact (P), Public water supply (P)
2006	Manganese, Aquatic Algae	Aquatic life (F), Fish consumption (F), Public and Food Processing Water Supplies (N), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2008	Manganese, Mercury, Aquatic Algae	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (N), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2010	Manganese, Mercury, Aquatic Algae	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (N), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2012	Manganese, Mercury, Total Phosphorus, Aquatic Algae	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (N), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2014	Mercury, Total Phosphorus	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (F), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2016	Mercury, Total Phosphorus	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (N), Primary Contact (X), Secondary Contact (X), Aesthetic Quality (N)
2018	Mercury, Total Phosphorus	Aquatic life (F), Fish consumption (N), Public and Food Processing Water Supplies (N), Primary Contact (X), Aesthetic Quality (N)

"Pollutant sources are natural background sources including runoff and soil erosion, and release from sediments under hypolimnetic anoxic conditions. Otter Lake is ranked high priority on the 2004 Illinois EPA 303(d) list. The water quality standard for manganese in Illinois waters designated as public water supply is 150 ug/l, and the general use standard is 1,000 ug/l. The primary source of manganese to the lake is the release of manganese from lake sediments during periods when there is no dissolved

> oxygen in lake bottom waters. The lack of dissolved oxygen in lake bottom waters is presumed to be due to the effects of nutrient enrichment, as there are no significant sources of oxygen demanding materials to the lake. For this reason, release from the lake sediments is considered a controllable source, and attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target for dissolved oxygen is therefore set as a total phosphorus concentration of 0.050 mg-P/l. The water quality model BATHTUB was applied to determine that the average allowable phosphorus load that will eliminate the excess release of manganese from lake sediments is 3.86 kg/day between March and August, with the total load not to exceed 710 kg over this period. This corresponds to a 66 percent reduction of existing loads." (Limno-Tech, Inc, 2006)

The TMDL indicated that by reducing sediment and nutrients such as phosphorus entering the lake, the target for manganese can be achieved as well as the problem of excessive algae growth. One of the primary reasons for lake impairments relates to sedimentation and erosion. Steep slopes directly adjacent to the lake and a high percentage of surrounding agricultural ground are helping to increase the rate and amount at which soil is transported to the lake. Approximately 25% of all soils in the watershed can be classified as highly erodible, most of which occur on slopes adjacent to or within a short distance of the lake. Recent estimates of only sheet and rill erosion indicate that just over 32,000 tons of sediment is eroded from agricultural ground within the Otter Lake watershed on an annual basis; approximately 10,000 tons of this will be delivered to the Lake annually assuming a 39% watershed transport efficiency as noted in a 1999 report completed by the Illinois State Water Survey. In addition 6,000 ac/ft of runoff translates into 33,000 lbs/yr of nitrogen and 5,070 lbs/yr of phosphorus from surface runoff alone. Reducing a significant portion of these overall loadings into the lake will continue to address the manganese impairment as noted in the TMDL and help to reduce the current phosphorus impairment. Significant progress has already been made in reducing phosphorus loading and the current project aims to achieve further reductions in loading.

1.1 Previous Projects

The 2013-2015 Otter Lake Shoreline Erosion Control & TMDL Implementation Project has improved water quality in Otter Lake (RDF; HUC 071300120201) by reducing sediment and nutrient loads from the watershed. The 2013-2015 project builds off of past efforts and further improved lake water quality. It encompassed critical BMPs located on private ground and property owned by the Otter Lake Water Commission. Each individual project was designed to reduce or store surface runoff and eroded sediment prior to reaching Otter Lake. Shoreline erosion control practices were targeted to high priority areas.

Lake impairments of manganese and excessive algae growth were quantified in the 2006 TMDL study. The current project has been successful in addressing these impairments by reducing sediment and nutrients and by relying on recommendations set forth in the TMDL Plan. A review of recent water

quality data from 2011 through 2013 indicates below average annual sediment and phosphorus levels in two out of the last three years.

The 2013-2015 Otter Lake TMDL implementation program and shoreline stabilization project targeted BMPs to areas directly adjacent to, and within the lake experiencing the greatest rates of upland, sheet and rill, gully and lake-bank erosion. A series of individual projects were engineered, designed and constructed to stabilize eroding lake banks, trap and retain surface runoff and control sheet, rill and gully erosion from highly erodible soils. Practices included: Water and Sediment Control Basins (WASCBs), treatment wetlands, ponds, and grade control structures/riffles.

1.2 Current Project

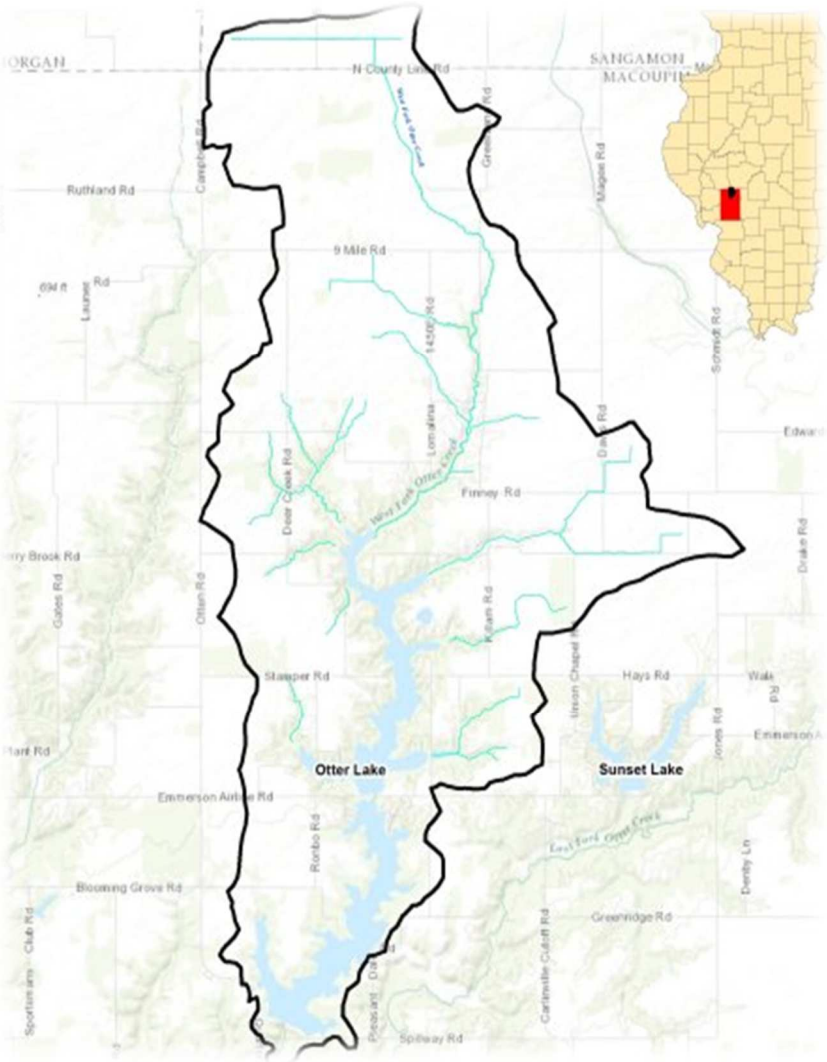
The project in this grant; the "Otter Lake Watershed Plan and TMDL Implementation Project" built upon previous similar efforts presented above by:

1. Installing 8 BMPs including ponds, cover crops, and the maintenance of old practices that have outlived their effective life spans.

2. Protecting 2,413 linear feet of heavily eroded shoreline and shoreline mapping.

3. Comprehensive Watershed Implementation Plan was completed. This plan will serve as a roadmap to future activities in the watershed.

2.0 Watershed Description



Otter Lake is located west of Girard, Illinois and about 20 miles southwest of Springfield. The lake is 765 acres in size and its watershed is approximately 13,000 acres in size. An impoundment on Otter Creek, Otter Lake's construction was completed in 1968. The Otter Lake Water Commission (OLWC) owns and manages Otter Lake and a strip of land around the lake's perimeter. More than 90 percent of this ground is forested. Otter Lake is a public water supply and it also supports recreational activities such as camping, fishing and boating. The average depth is 19.7 feet, and at its deepest point, the lake is approximately 50 feet deep.

The soils of the Otter Lake watershed are predominantly Ipava-Virden and Hickory-Rozetta-Keomah Associations. These soils are formed in loess, alluvium, and glacial material.

Inflow to the lake is primarily from surface drainage from Otter Creek and smaller tributaries, runoff and direct precipitation. Groundwater inflow to the lake is believed to be limited.

The Otter Lake watershed is primarily 77% agriculture, with roughly 9% being forested and the remainder in water, grassland, wetland and urban. The primary agricultural land use is corn (56%) and soybeans (42%), with lesser amounts of winter wheat, other small grains and hay.

Table 2 - Otter Lake Landuse

Landuse	Area (acres)	Percent of Watershed
Row Crops	8,948	69%
Forest	1,533	12%
Grassland	855	7%
Open Water Pond / Reservoir	816	6%
Urban Open Space	352	3%
Pasture[1]	145	1%
Roads	89	1%
Rural Residential	51	0.4%
Wetland	32	0.2%
Farm Building	23	0.2%
Open Water Stream	22	0.2%
Camp Ground	17	0.1%
Utilities	10	0.1%
Feed Area	3	0.02%
Cemetery	0.9	0.01%
Total	**12,897**	**100%**

1 – Exact livestock numbers are unknown total number estimated to be 150 - 200.

Approximately 25% of all Otter Lake soils are classified as highly erodible; significant erosion potential exists in areas directly adjacent to the lake. Average watershed slope is just over 1%, however, those soils directly adjacent to the lake average over 5% with some slopes upwards of 10%. Enrollment into CRP within Otter Lake has been successful with almost 400 acres implemented over the last 15-years.

3.0 Project Description & Goals

Located in Macoupin County, Illinois Otter Lake is a public water supply and a local recreational resource. Previous studies, including a TMDL identified Otter Lake as being impaired for nutrients, and manganese as well as mercury, and aquatic algae. According to the most recent (2014) IEPA 303(d) list, manganese is no longer an impairment; phosphorus is currently listed and has been specifically addressed with current implementation efforts. In 2015 when this project was initially being developed, Otter Lake was impaired for manganese, mercury, phosphorus, and aquatic algae; now only mercury and phosphorus remain on the list and recent data suggests a positive trend toward improving water quality.

To address water quality issues, a coordinated effort to reduce both in-lake and upland pollution loading was initiated in 2016. The project included two major components or outcomes:

1. Installation of 2,000 feet of in-lake bank stabilization
2. Installation of 8 separate upland BMPs systems on private ground
3. Development of a written Watershed Plan

Overall project goals Include:

1. Reduce sedimentation to Otter Lake
2. Reduce phosphorus nutrient loading to Otter Lake

Given that Otter Lake now fully supports the Public and Food Processing Water Supply designated use and now that manganese and aquatic algae are no longer impairments, it is very likely that all the efforts over the years to improve water quality have had significant positive benefits. It is anticipated that this trend of improving water quality will continue as the benefits of the most recent BMPs begin to have an impact.

3.1 Project Cost Breakdown

Total budget grant amount; upland BMPs and shoreline stabilization - **$ 300,635.00**

Final Shoreline Stabilization Costs:

- $ 118,306.47 – includes: labor, supplies and subcontracts

Final Upland BMP Construction & Engineering Costs:

BMP # 1 – $ 21,562.65
BMP # 2 – $ 23,843.75
BMP # 3 – $ 27,308.00
BMP # 4 – $ 750.00
BMP # 5 – $ 2,479.72
BMP # 6 – $ 16,762.89
BMP # 7 – $ 33,850.00
BMP # 8 – $ 7,260.00
BMP # 9 – $ 4,250.00

Project Management Total - $ 8,561.12
Upland BMP Total - $ 138,067.01
Shoreline Total - $ 118,306.47
Watershed Plan - $ 62,000.00
Sediment Evaluation - $ 4,605.00
Outreach - $ 206.38

Total Project Cost (actual) - $ 331,745.98

3.2 Outreach

The Otter Lake Water Commission and project partners participated in numerous outreach efforts to support implementation activities and to share project attributes and lessons learned. Over the last two years, partners have conducted numerous presentations at events such as the Illinois Lake Management Association conference and the Illinois Section of the American Water Works Association Watercon conference. Prior to initiating work on this project, the Otter Lake Water Commission and project consultant, Northwater Consulting hosted a watershed luncheon to thank participating landowners and showcase recently completed BMPs to other stakeholders, agencies and public water supplies.

3.3 Shoreline/Bank Stabilization

Lake banks were assessed in April of 2011 using a boat and a Trimble GPS unit. Data points collected in the field were transferred into ArcMap 10.0 (Geographic Information Software - GIS) and processed into a line file representing erosion severity or ranks with 1 representing low erosion rates and 9 representing extreme erosion rates. Using information collected in the field, a GIS model was developed to quantify soil loss and nutrient loading from eroding banks. Total net erosion in tons/year and estimates of nitrogen and phosphorus loading were calculated using GIS and a detailed report was produced. The purpose of this project was to characterize the shoreline of the lake, identify critical areas, and evaluate the success of previously implemented stabilization projects. This report was used to target and track the most recent stabilization efforts.

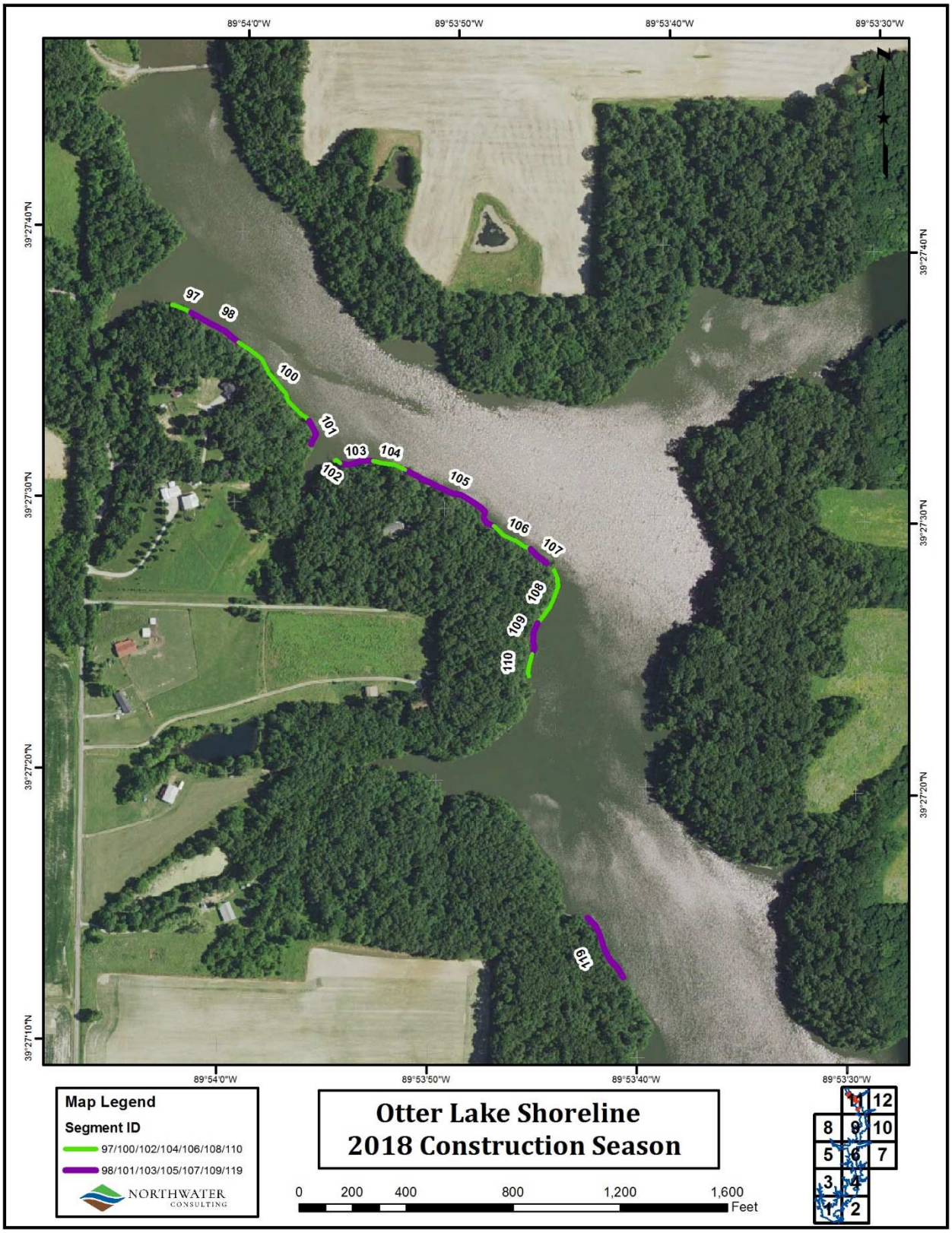
The Otter Lake shoreline erosion component consisted of 2,413 Feet of bank stabilization throughout the lake. Figure 1 shows the location stabilized shoreline and Table 3 provides load reductions achieved.

Table 3 - Shoreline Stabilization Load Reductions

Segment ID	Length (ft)	Nitrogen Reduction (lbs/yr)	Phosphorus Reduction (lbs/yr)	Sediment Reduction (tons/yr)
97	76	5.17	3.84	4.57
98	211	91.36	67.92	80.85
100	406	37.15	27.62	32.88
101	96	0.13	0.10	0.12
102	24	1.60	1.19	1.41
103	126	45.60	33.90	40.35
104	125	8.45	6.28	7.48
***105*[1]**	*417*	*238.8*	*171.06*	*207.03*
106	162	146.29	108.75	129.46
107	81	5.57	4.14	4.93
108	221	24.85	18.47	21.99
109	121	1.65	1.22	1.45
110	84	7.61	5.66	6.74
119	263	142.6	106	126.19
Total	**2,413**	**757**	**556**	**665**

1 – Rock was placed across a small inlet draining approximately 5 acres at the most downstream extent of this segment. This resulted in additional load reductions of 10.7 lbs/yr for nitrogen, 1.49 lbs/yr for phosphorus and 5.16 tons/yr for sediment.

Figure 1 - Otter Lake 2018 Shoreline Stabilization



3.4 Upland BMP Implementation

Five major landowners (including the Otter Lake Water Commission) within close proximity to the lake participated in a cost-share program to install/maintain:

- 1 Water and Sediment Control Basins (WASCBs)
- 5 sediment retention basins or ponds
- 1 cover crop
- 1 wetlands

Upland BMP implementation resulted in the following pollutant load reductions:

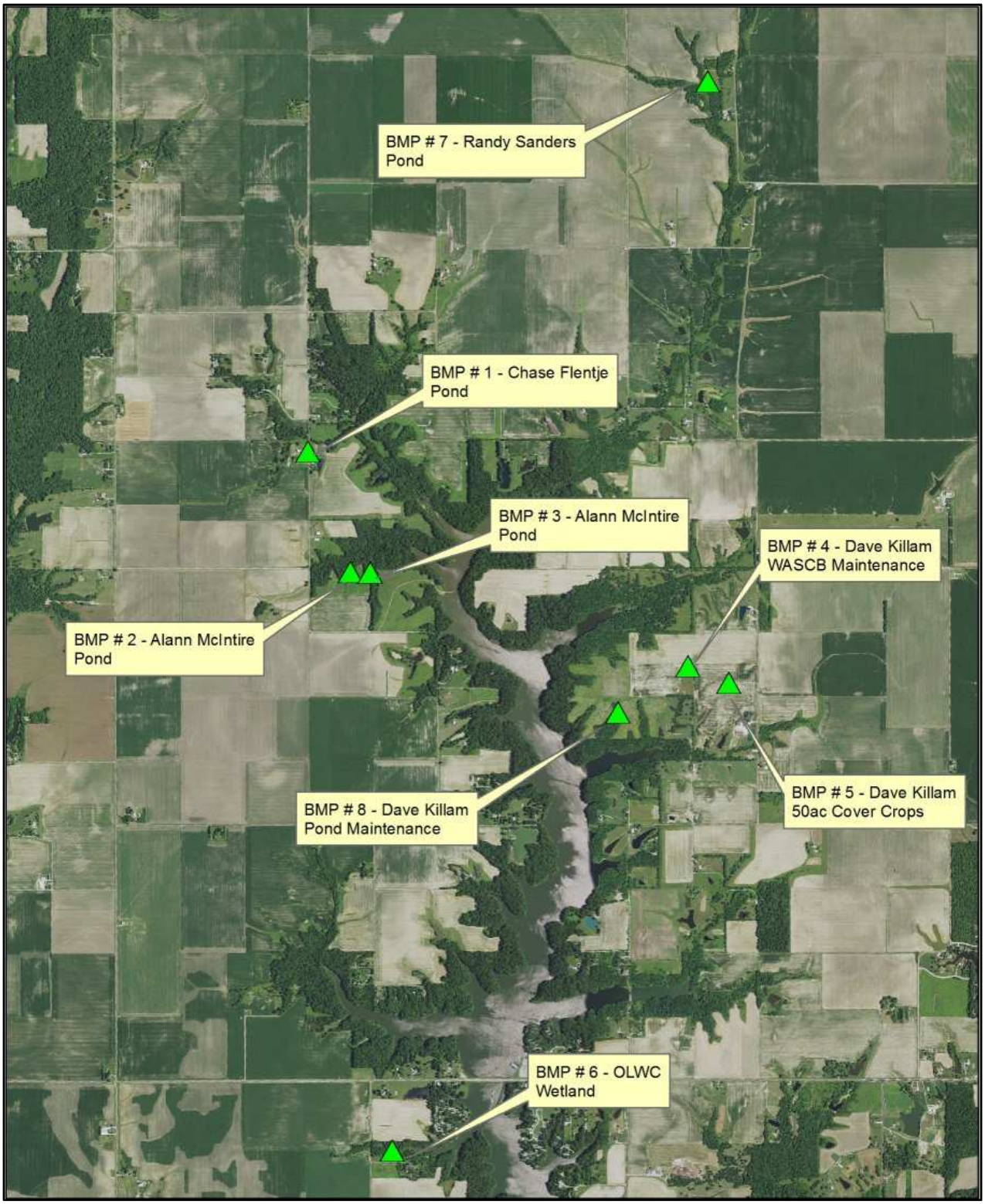
- 427.25 tons sediment
- 2,038 lbs nitrogen
- 497 lbs phosphorus

The following table summarizes participating landowners, BMP's installed and pollutant load reductions

Table 4 - Upland BMP Load Reductions

BMP number	Landowner	BMP Type	Sediment Load Reductions Achieved (tons/yr)	Nitrogen Load Reductions Achieved (lbs/yr)	Phosphorus Load Reductions Achieved (lbs/yr)
1	Chase Flentje	Pond	18.3	142	28
2	Alan McIntire	Pond	76.3	296	90
3	Alan McIntire	Pond	184.6	534	199
4	Dave Killam	WASCB Maintenance	6.63	23	9
5	Dave Killam	Cover Crop (50ac / 1 yr)	5	143	15
6	Otter Lake Water Commission	Wetland	46.7	552	87
7	Randall Sanders	Pond	84.42	298	58
8	Dave Killam	Pond Maintenance	5.3	50	11
	Total		**427.25**	**2,038**	**497**

Figure 2 - Otter Lake Upland BMP Project Locations & Details



Completed BMP's in 2017 – 2018. Grant # 3191612

4.0 Project Photographs; Upland Best Management Practices

Chase Flentje; BMP # 1 (Pond)

Completed Pond BMP # 1 – Prior to Filling

Alan McIntire; BMP # 2 (Pond)

Completed Pond BMP # 2

Otter Lake Water Commission & Alan McIntire; BMP # 3 (Pond)

Completed Pond BMP # 3

Dave Killam; BMP # 4

WASCB Maintenance BMP # 4

Otter Lake Water Commission; BMP # 6 (Wetland)

Construction Phase of BMP # 6

Randall Sanders; BMP # 7 (Pond)

Completed Pond BMP # 7

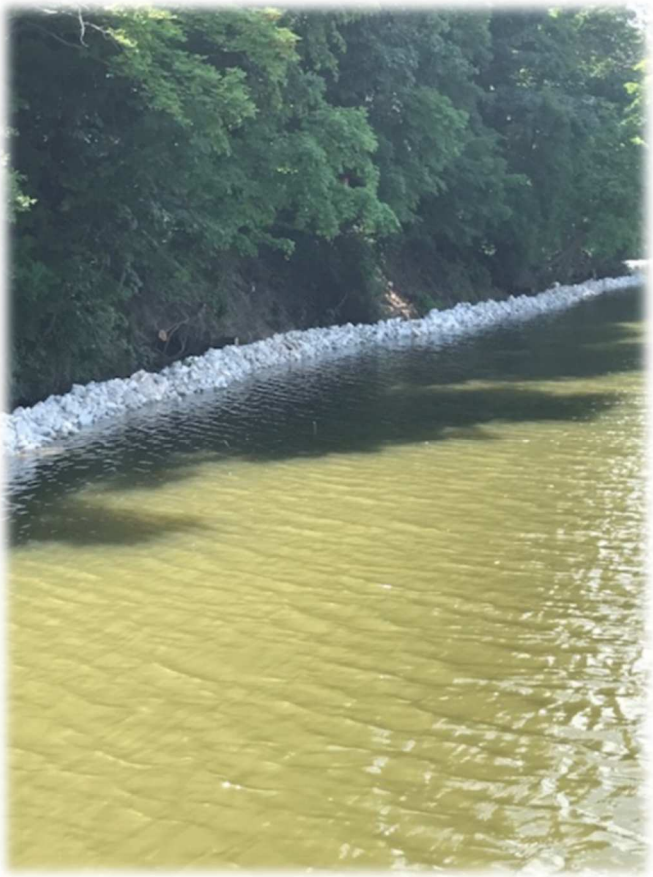
Dave Killam; BMP # 8 (Pond)

Construction Phase of BMP # 8

5.0 Project Photographs; Shoreline Stabilization

Mobilization of the Mechanical Barge for Rip Rapping

Before



After