Section 2, Chapter 5
Implementation of Site-Specific Practices

Written by Rebecca Olson

Introduction

Chapter 4 detailed the steps needed to implement the watershed-wide practices. This chapter similarly provides necessary details about site-specific projects recommended in Chapter 2. Support resources for financial and technical needs to implementing these projects and practices are found in the next chapter.

In order to implement both site-specific projects and practices in a planned manner, we need to better understand the locations and sizes of projects, benefits in terms of pollution load reduction estimates, and costs such as total cost and cost effectiveness. With this information, we can plan a schedule over the next ten years and be able to predict improvement to be experienced along the way.

The following pages illustrate the locations and sizes of projects; estimate how much sediment, phosphorus, and nitrogen would be removed from the water utilizing each of the proposed site-specific best management practices; and then estimate the cost of implementing each practice. The costs are analyzed per pound of nutrient or ton of sediment to determine how cost effective each practice would be to implement. Determining both the most effective and most cost-effective methods of keeping pollutants out of the water can give us needed direction.

Site-Specific Practice Locations and Sizes

Stakeholders chose locations of site-specific projects within the Lake Carroll Association, including an interpretive trail, ravine and stream bank stabilization, native plantings, vegetated swales, prairie preservation and plantings, and floating islands as described below.

- A 3-acre interpretive trail highlights some of the site-specific projects as accessed from the Lake Carroll Clubhouse.
- The 16 mapped ravine stabilization sites recognize opportunity to help heal a little more than 24,700 feet of severely eroded bank.
- Two mapped streambank stabilization projects have opportunity to stabilize an estimated 15,000 feet of severely eroding bank.
- Six riparian buffer strips covering a combined seven acres would treat pollutants draining from 5,517 acres of surrounding residences and open space, usually filling in vegetation near forested riparian corridors.
- Three vegetated swales covering 10 acres treat drainage from about 130 acres of surrounding lands before it enters the stream.
- Four native wetland plantings create a series of filtration wetlands along a stream leading a main inlet to the lake known as Three Tubes.
- The preservation of three existing prairies and one landscape prairie feature combine for 56 acres of native vegetation plantings.
- Ten coves fitted with floating treatment wetlands are spread throughout 10 prime locations, each of which house 300 square feet (225 cubic feet each) of floating treatment wetlands for a total of 3,000 square feet (2,250 cubic feet).

Figure 5.1 illustrates the overall arrangement of best management practices throughout the Association. In *Figures 5.2* through *5.7*, portions of the watershed are magnified and projects are labeled. Maps are followed by benefit and cost estimates and a schedule of implementation.

Figure 5.1

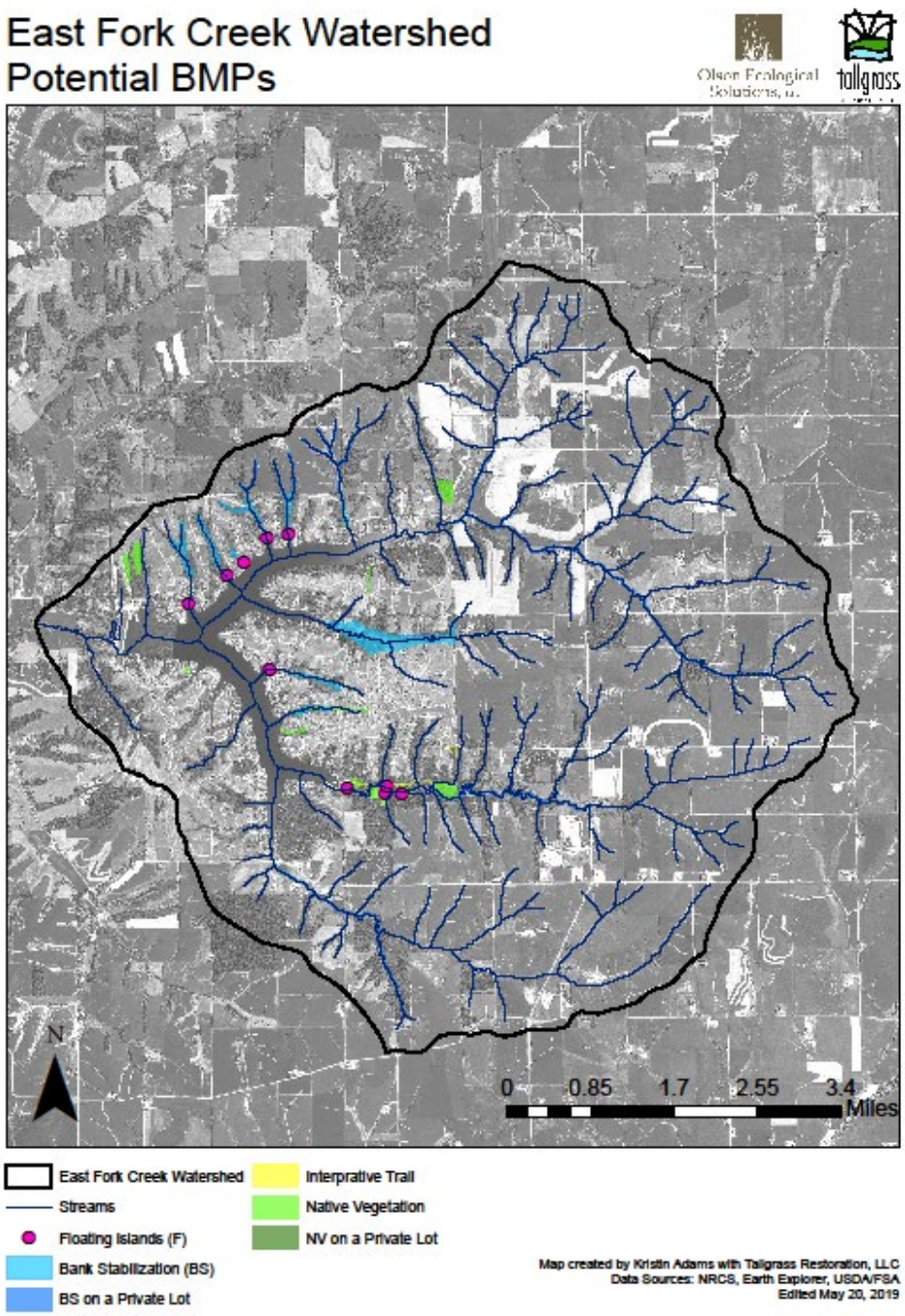


Figure 5.2

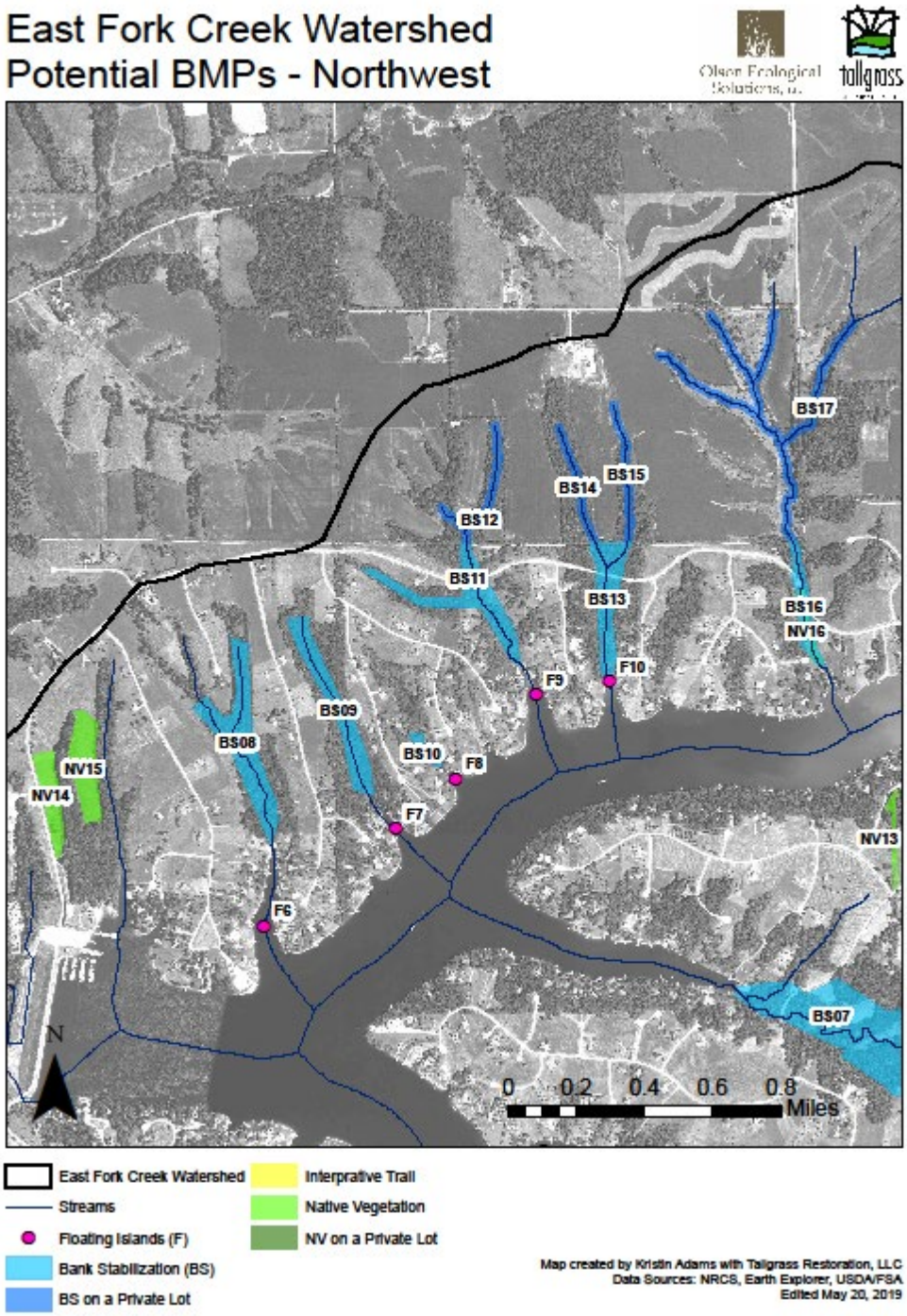

East Fork Creek Watershed
Potential BMPs - Northwest
Olson Ecological Solutions, LLC
tallgrass
BS17
BS15
BS14
BS12
BS11
BS13
BS16
NV16
F10
F9
BS09
BS08
BS10
F8
NV15
NV14
F7
NV13
F6
BS07
N
0 0.2 0.4 0.6 0.8
Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Figure 5.3

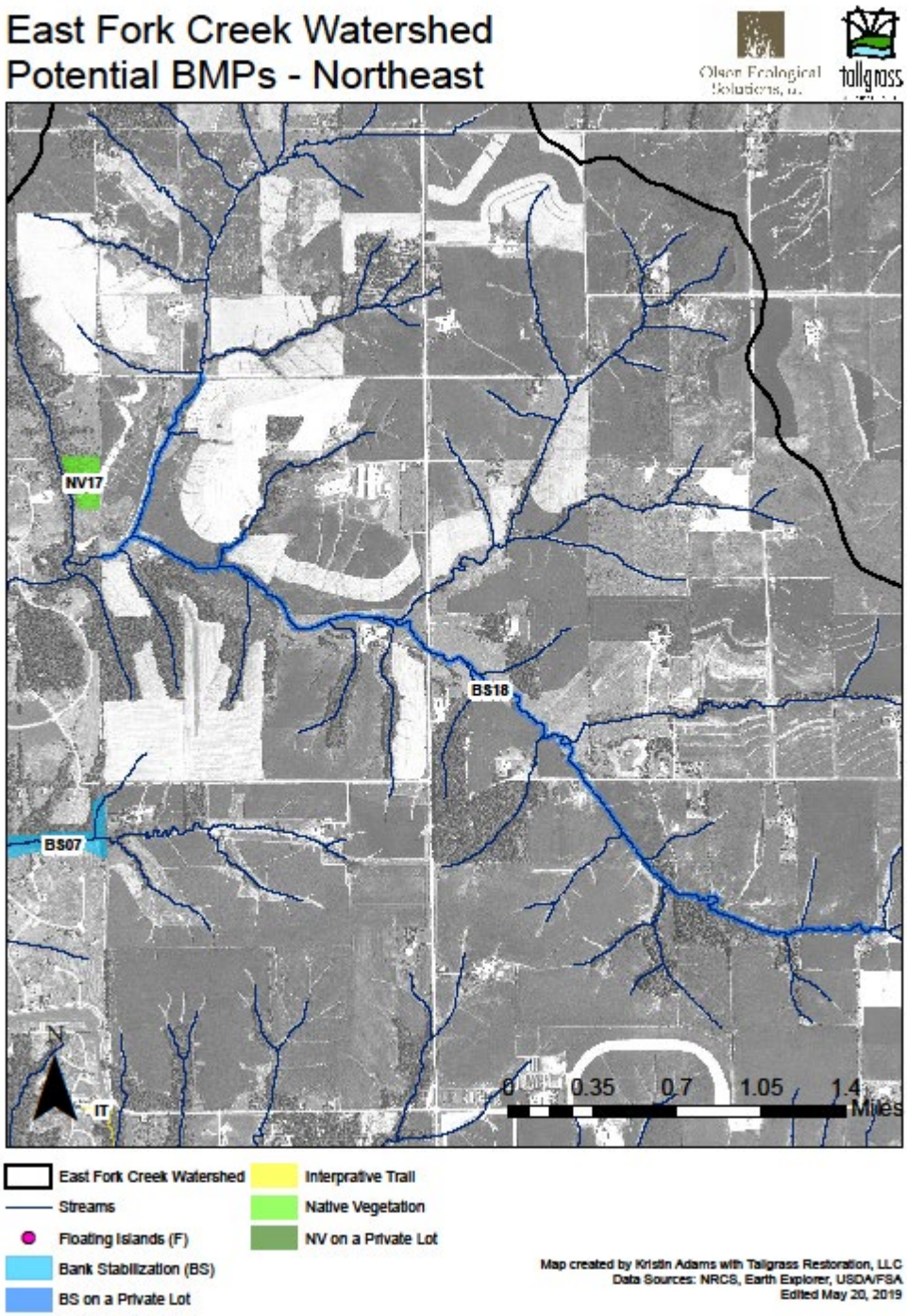

East Fork Creek Watershed
Potential BMPs - Northeast
Olson Ecological Solutions, LLC
tallgrass
NV17
BS18
BS07
IT
N
0 0.35 0.7 1.05 1.4
Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Figure 5.4

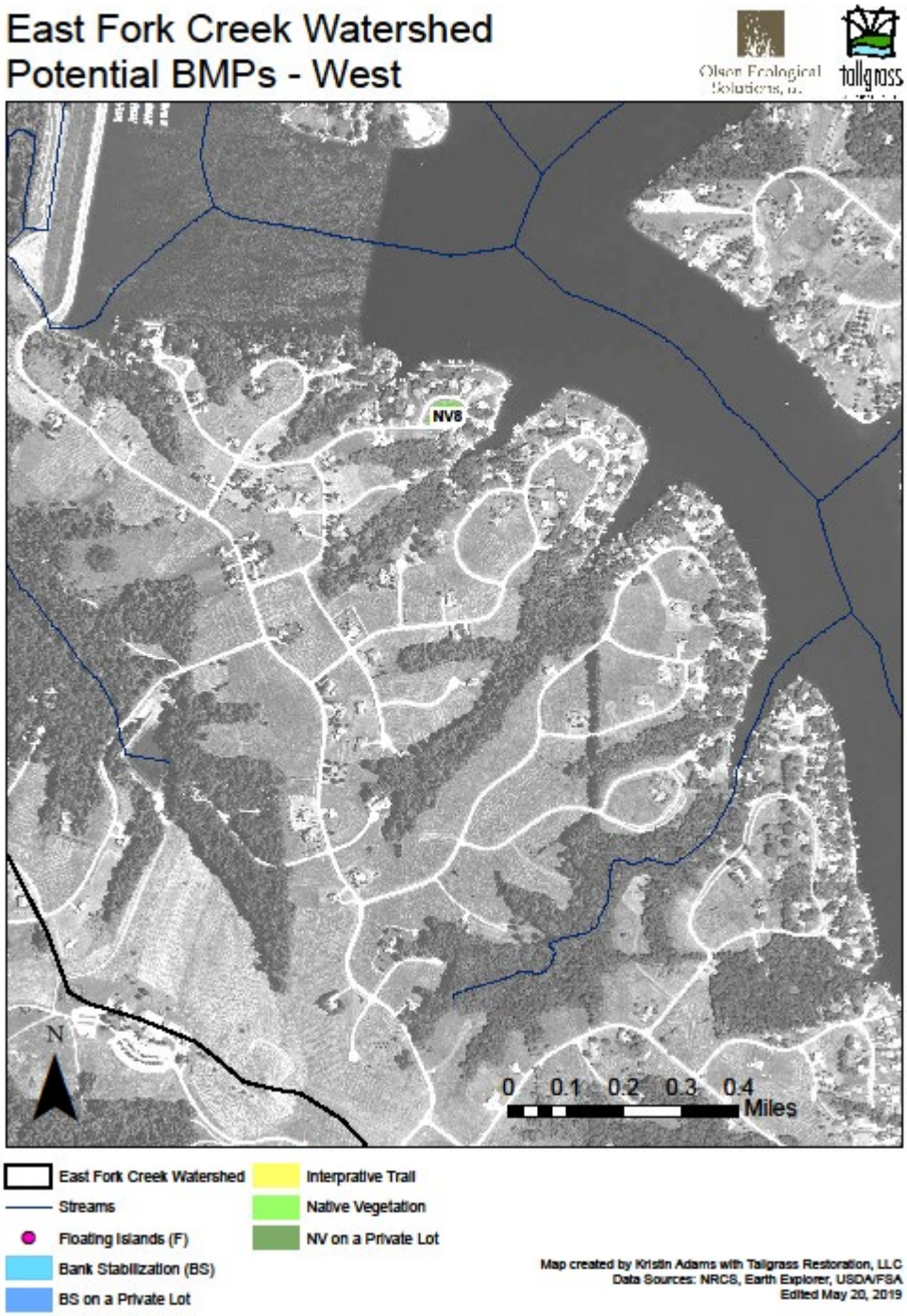

East Fork Creek Watershed
Potential BMPs - West
Olson Ecological Solutions, LLC
tallgrass
NV8
N
0 0.1 0.2 0.3 0.4
Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Figure 5.5

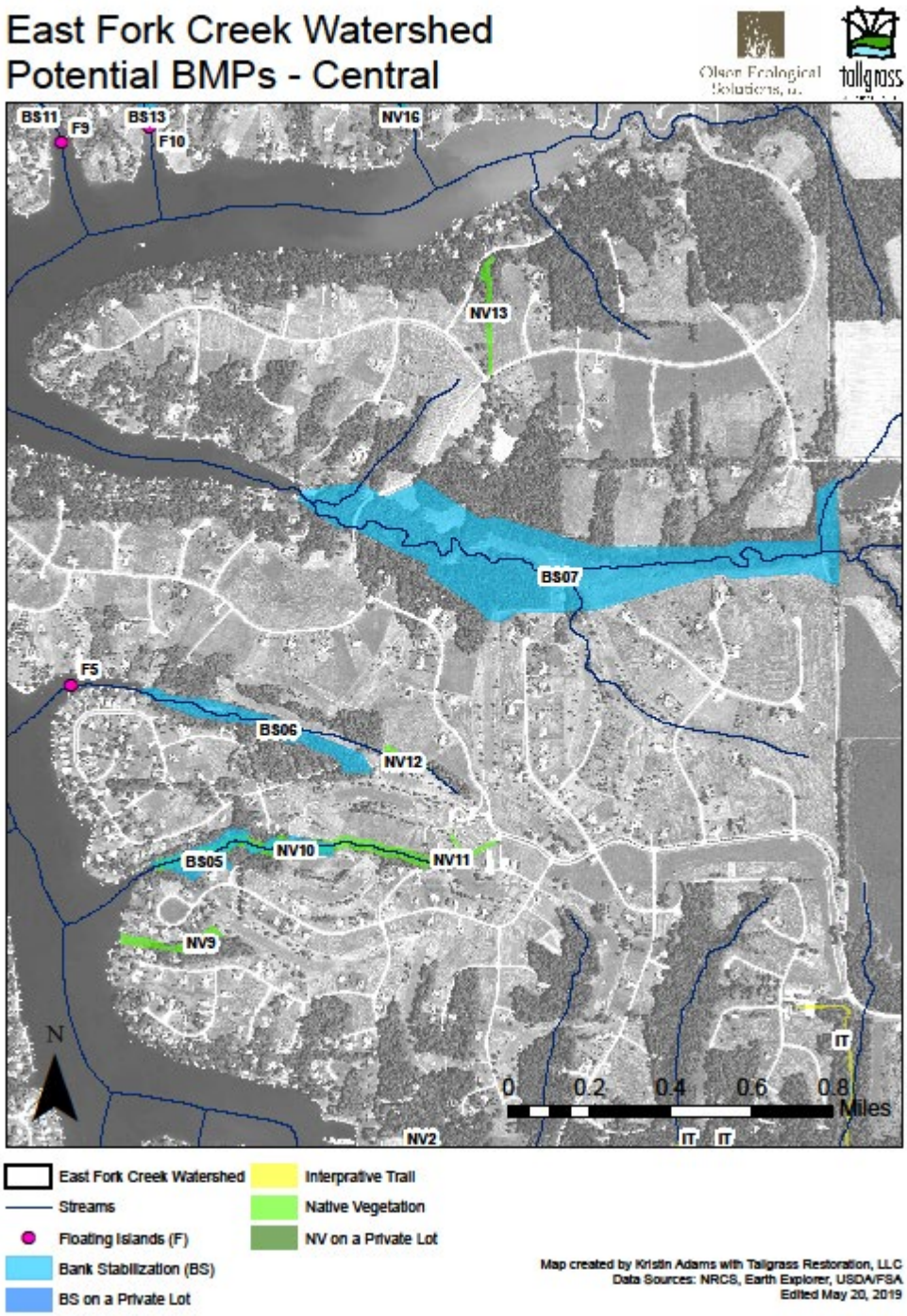

East Fork Creek Watershed
Potential BMPs - Central
Olson Ecological Solutions, LLC
tallgrass
BS11
F9
BS13
F10
NV16
NV13
BS07
F5
BS06
NV12
BS05
NV10
NV11
NV9
IT
NV2
N
0 0.2 0.4 0.6 0.8 Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Figure 5.6

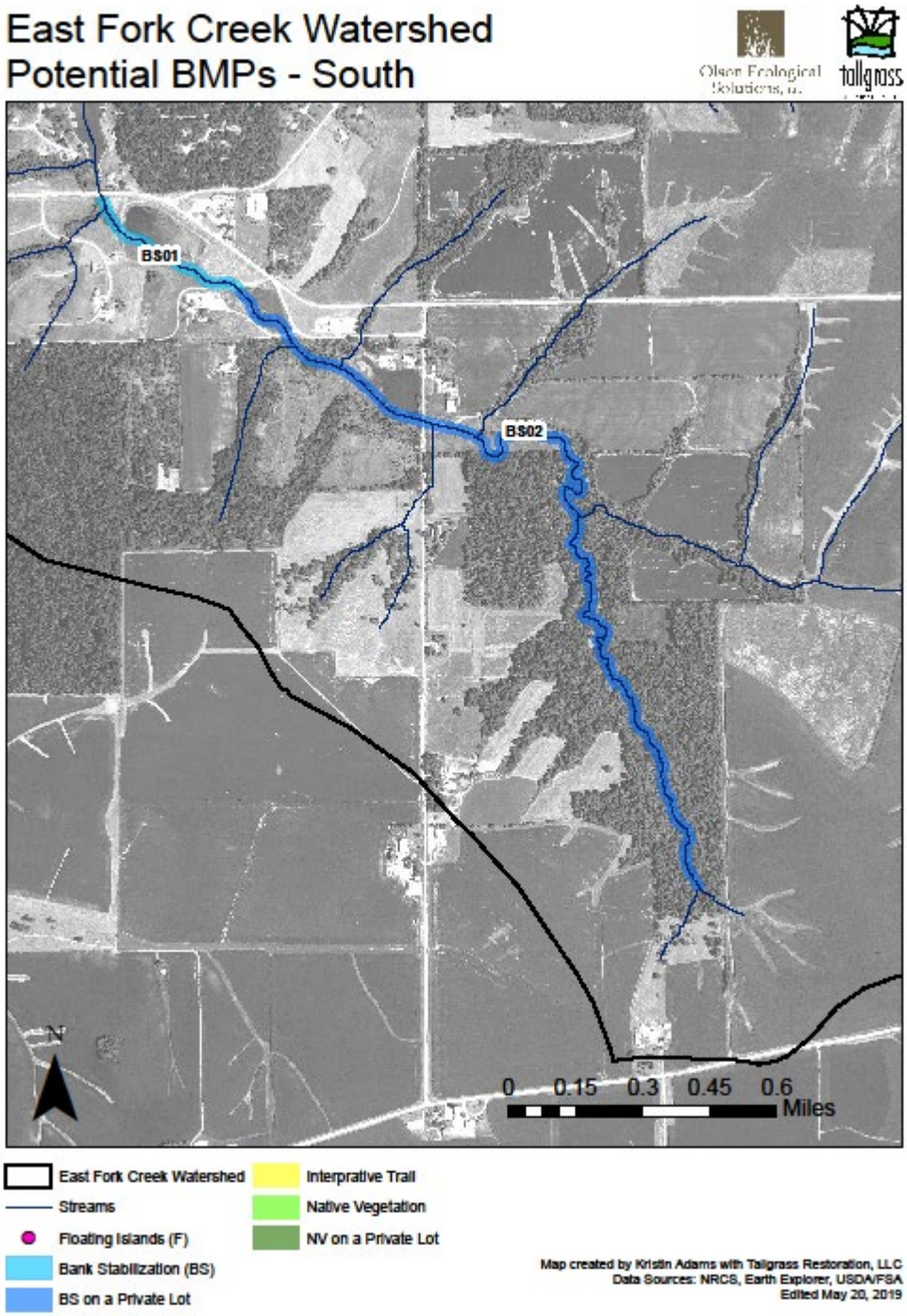
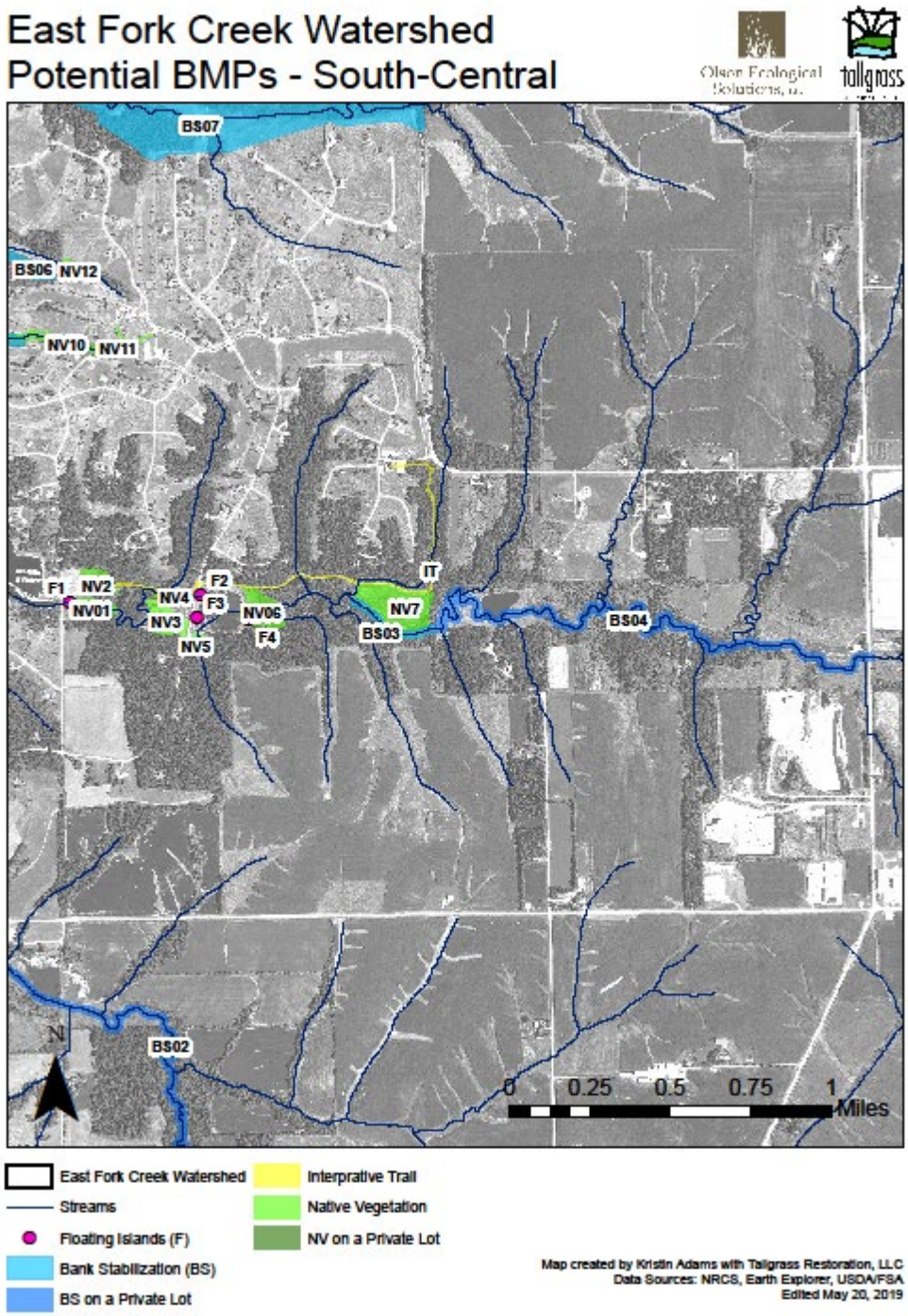

East Fork Creek Watershed
Potential BMPs - South
Olson Ecological Solutions, LLC
tallgrass
BS01
BS02
N
0 0.15 0.3 0.45 0.6
Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Figure 5.7


East Fork Creek Watershed
Potential BMPs - South-Central
Olson Ecological Solutions, LLC
tallgrass
BS07
BS06
NV12
NV10
NV11
F1
NV2
NV01
NV4
F2
F3
NV3
NV5
NV06
F4
IT
NV7
BS03
BS04
BS02
N
0
0.25
0.5
0.75
1
Miles
East Fork Creek Watershed
Streams
Floating Islands (F)
Bank Stabilization (BS)
BS on a Private Lot
Interpretive Trail
Native Vegetation
NV on a Private Lot
Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, Earth Explorer, USDA/FSA
Edited May 20, 2019

Pollution Load Reduction Estimates for Site-Specific Practices

All of the site-specific projects and practices are highly prioritized by stakeholders, and they would add significant value to the efforts of reducing sediment and nutrients in Lake Carroll. The main concern for stakeholders is sedimentation to Lake Carroll, followed by excess phosphorus loading responsible for nuisance algae blooms. Excess nitrogen, although high at times, does not contribute to any of the concerns of stakeholders. Therefore, its reduction is noted but not a focus of this plan. Pollution load reduction estimates for each site-specific project are listed below in *Table 5.1* through *Table 5.9*.

From the summaries provided in *Tables 5.1* and *5.2*, some best management practices seem to remove more sediment, phosphorus, and nitrogen better than others. For example, of the land use-based options below in *Table 5.1*, wetland restoration and native plantings have the greatest potential to remove sediment, followed by vegetated filter strips and then vegetated swales. However, the area proposed for each practice varies widely. Ravine and streambank stabilization are not land-use based and therefore do not have the same percent efficiency comparison.

As evident in *Table 5.*2, stabilization of ravines and streambanks give the greatest sediment reduction, followed by vegetated filter strips along streambanks and wetland restoration. Minimal sediment reduction is offered by vegetated filter strips along shorelines, vegetated swales, native plantings, and floating treatment wetlands. The larger opportunity area covered by ravine and streambank stabilization explains the difference. The breakdown of areas and pollutant load reduction estimates for each practice are presented in *Table 5.3* through *Table 5.10.* All pollutant load reduction estimates were calculated using Illinois EPA Region 5 STEPL Modeling Worksheets (US EPA, 2018).

Phosphorus and nitrogen reduction estimated per best management practice are also led by ravine and streambank stabilization, followed by floating treatment wetlands. It is notable that FTWs take up very little area and are easy to install compared to bank stabilization projects. However, FTWs are meant to be combined with preventative measures, as they are located within the lake itself. Vegetated filter strips along streambanks and wetland restoration also provide significant nutrient removal. Vegetated filter strips along shorelines, vegetated swales, and native plantings do not provide significant nutrient reduction when considering each project type fully implemented. Again, it is important to consider the variation in the amount of each project type recommended when comparing the summative pollutant load reduction estimates.

Table 5.1 Pollution Load Reduction Efficacy per Site-Specific Practice

Recommended BMPs -Site-Specific	Sediment Reduction Efficiency (%)	Phosphorus Reduction Efficiency (%)	Nitrogen Reduction Efficiency (%)	Source of Reduction Efficiency Information
Ravine Stabilization	N/A	N/A	N/A	N/A - Not a land use-based BMP, no Region 5 percent reduction est.
Streambank Stabilization - Severe	N/A	N/A	N/A	N/A - Not a land use-based BMP, no Region 5 percent reduction est.
Vegetated Filter Strips - Stream	73%	45%	40%	Region 5 - Urban Runoff Loading Rate Worksheet
Vegetative Filter Strips - Shoreline	73%	45%	40%	Region 5 - Urban Runoff Loading Rate Worksheet
Vegetated Swales	65%	25%	10%	Region 5 - Urban Runoff Loading Rate Worksheet
Wetland Restoration	86%	69%	55%	Region 5 - Urban Runoff EMC Worksheet (Ext. Wet Detention)
Native Plantings	87%	67%	92%	Region 5 - Conservation Easements Worksheet (Residential, Unsewered)
Floating Islands	TSS: 26 lb/yr/ft3	0.47 lb/yr/ft3	1.47 lb/yr/ft3	Apex Engineering

Table 5.2 Pollution Load Reduction Estimates Summary of Site-Specific Best Management Practices

#	See Table #	Site-Specific BMP Type	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
BS	5.2	Streambank Stabilization	2289	4576	2692
BS	5.3	Ravine Stabilization	3600	7201	3777
NV	5.4	Vegetated Filter Strips - Streambank	474	4378	247
NV	5.5	Vegetated Filter Strips - Shoreline	6	41	2
NV	5.6	Vegetated Swales	4	6	1
NV	5.7	Wetland Restoration	318	2722	131
NV	5.8	Native Plantings	0	2	0
F	5.9	Floating Treatment Wetlands	1060	3310	30
TOTAL			**7751**	**22236**	**6880**

The following *Table 5.3* through *Table 5.10* provide the size needed and the pollutant load reduction estimate calculated for each individual project. First, streambank stabilization is tabulated (*Table 5.3*), then ravine stabilization (*Table 5.4*), vegetated filter strips along streambanks (*Table 5.5*), vegetated filter strips along shorelines (*Table 5.6*), vegetated swales (*Table 5.7*), wetland restoration (*Table 5.8*), native plantings (*Table 5.9*), and floating treatment wetlands (*Table 5.10*). All projects are mapped in *Figure 5.1* through *Figure 5.7.* Reference numbers from the tables can be found on the figures.

Of the 29,407 feet of streambank to be stabilized, 51% (14,998 feet) are likely severely eroded based on average from streambank survey reported in Section 1 (Watershed Resource Inventory).

Table 5.3 Pollution Load Reduction Estimates for Site-Specific Streambank Stabilization (BS)

#	Riparian Area (ac)	Length of Bank (ft)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
BS04	19.1	8,530	720	1,439	847
BS18	47.3	20,877	1,569	3,137	1,845
TOTAL	**66.4**	**29,407**	**2,289**	**4,576**	**2,692**

Of the 48,446 feet of ravine to be treated, approximately 51% (24,707 feet) are severely eroded. Forest stand improvement on 184 acres of riparian area would provide the pollutant load reductions in areas of limited access for installation of grade stabilization structures.

Table 5.4 Pollution Load Reduction Estimates for Site-Specific Ravine Stabilization (BS)

#	Riparian Area (ac)	Length of Bank (ft)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
BS01	3.6	1,563	102	204	120
BS02	20	8,865	578	1,156	680
BS03	2.7	1,173	99	198	116
BS05	6.8	1,856	141	282	141
BS06	7.7	2,346	401	802	401
BS07	66.5	8,104	690	1,380	690
BS08	14.1	3,057	262	524	262
BS09	9.9	2,217	152	304	152
BS10	1.5	517	41	81	41
BS11	10.3	3,024	183	367	183
BS12	4.4	1,975	120	240	120
BS13	8.6	2,001	89	179	105
BS14	3.3	1,428	64	128	75
BS15	3.8	1,653	74	148	87
BS16	5	1,504	105	210	105
BS17	15.9	7,163	499	998	499
TOTAL	**184.1**	**48,446**	**3,600**	**7,201**	**3,777**

Table 5.5 Pollution Load Reduction Estimates for Site-Specific Streambank Vegetated Filter Strips (NV)

#	BMP Area (ac)	Treated Drainage Area (ac)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
NV01	1.6	2,574	226	2,069	116
NV04	0.9	2,487	217	2,027	114
NV05	0.8	69	5	34	2
NV16	2	345	26	248	15
TOTAL	**5.3**	**5,475**	**474**	**4,378**	**247**

Table 5.6 Pollution Load Reduction Estimates for Site-Specific Shoreline Vegetated Filter Strips (NV)

#	Riparian Area (ac)	Treated Drainage Area (ac)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
NV11	0.8	9	0	0	0
NV12	0.8	33	6	41	2
TOTAL	**1.6**	**42**	**6**	**41**	**2**

Table 5.7 Pollutant Load Reduction Estimates for Site-Specific Vegetated Swales (NV)

#	Area (ac)	Treated Drainage Area (ac)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
NV09	1.9	22	0	1	0
NV10	6.6	95	2	5	1
NV13	1.2	12	2	0	0
TOTAL	**9.7**	**129**	**4**	**6**	**1**

Table 5.8 Pollutant Load Reduction Estimates for Site-Specific Wetland Restoration (NV)

#	Area (ac)	Treated Drainage Area (ac)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
NV02	2.8	31	6	34	1
NV03	3.3	73	7	45	2
NV06	3.7	2313	301	2620	127
NV07	8.1	45	4	23	1
TOTAL	**17.9**	**2462**	**318**	**2722**	**131**

Table 5.9 Pollution Load Reduction Estimates for Site-Specific Native Plantings (NV)

#	Area (ac)	Treated Drainage Area (ac)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
NV08	0.6	N/A	0	2	0
TOTAL	**0.6**		**0**	**2**	**0**

The floating treatment wetlands in *Table 5.10* are of uniform size: 300 square feet per location (225 cubic feet per location). The square footage at each location can be made up of one or several floating wetlands. It is most effective to incorporate smaller floating wetlands with more edge in an archipelago arrangement, and the cost estimate remains the same as it is based on square footage or cubic footage. For example, three 100-sf islands, six 50 sf islands, or some combination of varying sizes could be arranged within a cove instead of one 300-sf island.

Table 5.10 Pollution Load Reduction Estimates for Site-Specific Floating Treatment Wetlands (F)

#	BMP Size (ft^2)	BMP Size (ft^3)	Total Phosphorus Reductions (lb/yr)	Total Nitrogen Reduction (lb/yr)	Sediment Reduction (ton/yr)
F01	300	225	106	331	3
F02	300	225	106	331	3
F03	300	225	106	331	3
F04	300	225	106	331	3
F05	300	225	106	331	3
F06	300	225	106	331	3
F07	300	225	106	331	3
F08	300	225	106	331	3
F09	300	225	106	331	3
F10	300	225	106	331	3
TOTAL	**3000**	**2250**	**1060**	**3310**	**30**

Cost Estimates for Site-Specific Projects

Cost estimates applied to the opportunities for implementing each type of site-specific project provided total costs as shown in *Table 5.11*. Cost estimates were considered for the total amount of each best management practice proposed for implementation during the life of the plan. Valuation for each project was estimated using per unit cost estimates as provided in *Table 5.12*.

Some of the projects have significant cost when compared to others. This may be that they are more expensive, but more likely there is better opportunity and more of this type of practice is slated for implementation. Another way to look at costs is dollars per pound of pollutant removed. The chart below in *Table 5.13* presents cost per pound of each pollutant removed, utilizing the information provided in the tables above. In most cases, the dollars per ton of sediment removed will be most important to stakeholders.

Table 5.11 Cost Estimates for Site-Specific Practices

Site-Specific BMP	Amount	Unit	Cost Estimate ($)
Streambank Stabilization	14,998	ft.	$ 870,000
Ravine Stabilization	24,707	ft.	$ 1,433,000
Vegetated Filter Strips - Stream	5.3	ac.	$ 5,000
Vegetated Filter Strips - Shorelines	1.6		$ 1,500
Vegetated Swales	10	ac.	$ 920,000
Wetland Restoration	18	ac.	$ 45,000
Native Planting	0.6	ac.	$ 1,500
Floating Islands	2,250	ft^3	$ 150,750
TOTAL			**$3,426,750**

Table 5.12 Cost Estimates for Site-Specific Practices per Unit

Recommended BMPs -Site-Specific	Cost Est. per Unit	Unit	Source of Cost Estimate Information
Ravine Stabilization	$ 58	ft.	Olson Ecological Solutions
Streambank Stabilization - Severe	$ 58	ft.	Stephenson Co. NRCS*
Vegetated Filter Strips - Stream	$ 919	ac.	Stephenson Co. NRCS*
Vegetative Filter Strips - Shoreline	$ 919	ac.	Stephenson Co. NRCS*
Vegetated Swales	$ 2.11	sf	Olson Ecological Solutions
Wetland Restoration	$ 2,500	ac.	Olson Ecological Solutions
Native Plantings	$ 2,500	ac.	Olson Ecological Solutions
Floating Islands	$ 67	ft^3	Midwest Floating Island

*Source of cost estimates: Illinois CPPE. 2015. Provided by Stephenson Co. NRCS. Cost of site preparation and installation with 10% added for inflation/buffering.

Table 5.13 Cost per Unit of Reduced Pollutants

Site-Specific BMP	Cost to Remove 1 lb TP ($/lb)	Cost to Remove 1 lb TN ($/lb)	Cost to Remove 1 ton Sediment ($/ton)
Ravine Stabilization	$ 380	$ 190	$ 323
Streambank Stabilization	$ 398	$ 199	$ 379
Vegetated Filter Strips – Streambank	$ 11	$ 1.50	$ 20
Vegetated Filter Strips - Shoreline	$ 250	$ 36.50	$ 750
Vegetated Swales	$ 230,000	$ 153,333	$ 920,000
Wetland Restoration	$ 141	$ 16.50	$ 344
Native Planting	N/D	$ 750	N/D
Floating Treatment Wetlands	$ 142	$ 46	$5,025

Looking at projects and practices in terms of the cost to remove one pound of nutrient or one ton of sediment provides us with a different perspective regarding the cost of pollutant removal. Focusing on sediment, vegetated filter strips along streambanks, ravine and streambank stabilization, and wetland restoration were the most cost-effective solutions, ranging from $20 to $344 per ton of sediment. Vegetated filter strips along shorelines were moderately priced at $750 per ton. Vegetated swales and floating islands were not cost effective to remove sediment.

Cost estimates can range based on the type of plant material and implementation technique. It is likely that ravine stabilization using drop boxes and other grade stabilization structures could reduce the cost of the overall project using plan details not available at the time this plan was written. It is also possible that vegetated swales could be installed for much less; however, their pollutant load reduction estimates were also very low.

The removal of nutrients, also important to stakeholders, was most cost effective using vegetated filter strips, wetland restoration, and floating treatment wetlands with costs ranging from $11 to $250 per pound of phosphorus and $1.50 to $121 per pound of nitrogen. Streambank and ravine stabilization were moderately cost effective for phosphorus removal at $380 to $398 per pound and nitrogen removal at $190 to $199 per pound. Vegetated swales were not cost effective, and the native planting was too small to reliably detect nutrient reductions in order to calculate costs per pound.

Overall, planting vegetated filter strips along the streambanks clearly was the most cost-effective way to treat sediment and both nutrients. All best management practices had strengths and are worthy of consideration. Vegetated swales have such comparatively high costs that we question the modeling tool used to predict pollutant load reductions. Therefore, we do not want to dismiss them as applicable projects.

Schedule of Implementation of Site-Specific Practices

To implement the proposed projects and practices over a ten-year time frame, we plan to spread the budget evenly at about $342,675 per year. Grants and financial assistance organization usually will require some type of matching funds, although amounts vary. One grant may require 40% match, which would require local sources to spend $137,070 while obtaining $205,605 from grant sources. Another may require 20% or 50%, creating a range of match needed per year. The schedule of implementation for site-specific practices is presented in *Table 5.14*. More detail about abbreviated funding and technical support is offered in Chapter 6.

Within the ten-year life of the plan, a simple schedule depicts one-tenth of each best management practice being implemented. This allows stakeholders to set up a program that will work year after year, and it offers flexibility for homeowner cooperation given a variety of participation choices. During the first year, we plan to plant the 0.6-acre native planting in addition to the following annual schedule. Therefore, costs in Year 1 would be $344,025, $1,500 higher than the $342,525 suggested annual budget for the remaining nine years.

Table 5.14 Schedule of Implementation of Site-Specific Projects

Year(s)	Interim, Measurable Milestone	Potential Funding/ Tech. Support	Annual Cost Estimate ($/yr)
1-10	Stabilize 1,500 ft of severely eroded streambank per year.	IEPA	$ 87,000
1-10	Stabilize 2,470 ft of severely eroded ravines per year.	IEPA	$ 143,300
1-10	Install vegetated filter strips along streambanks in 0.53 ac. per year.	IEPA, Trees Forever	$ 500
1-10	Install vegetated filter strips along shorelines in 0.16 ac. per year.	IEPA	$ 150
1-10	Install vegetated swales in 1 ac. per year	IEPA, Patagonia, Wyss	$92,000
1-10	Restore wetlands and other native vegetation in 1.8 ac. each year.	IEPA, IDNR, USFWS, PF, TU, DU	$ 4,500
1-10	Create native plantings on 0.06 ac. or more per year.	JDCF, NLI	$150
1-10	Install 300 sf (225 ft3) of floating islands at one location per year.	IEPA, Patagonia, DU	$15,075
	Total per Year		**$ 342,675**

Responsible Parties

Since all of the site-specific projects are within the boundaries of the Lake Carroll Association, we hope that they will take on the responsibility of implementing these projects within their existing structure. We ask that all homeowners within the association to do what they can to help implement the plan.