East Fork Creek Watershed Inventory

Section 1

Rebecca Olson, Kristin Adams, and Steve Yost

11/26/2018

Olson Ecological Solutions, LLC

tallgrass RESTORATION, LLC

JadEco
LAKES AND NATURAL RESOURCES CONSULTATION AND MANAGEMENT

This report was prepared using United States Environmental Protection Agency funds under Section 319 of the Clean Water Act distributed through the Illinois Environmental Protection Agency. The findings and recommendations contained herein are not necessarily those of the funding agencies.

Executive Summary

The watershed of the East Fork Creek supplies water to Lake Carroll and drains surrounding agricultural and residential landscapes. Having clean water in the streams and lakes of this watershed is integral to the health, safety, and quality of life for residents and visitors in the decades to come.

As a first step of a watershed planning process, an inventory of the East Fork Creek Watershed's existing conditions and features is enclosed within the following pages. This inventory provides a snapshot of the East Fork Creek Watershed as of 2018. The people who live, work, and play in the East Fork Creek Watershed are in the process of developing a watershed plan based upon this inventory. It will include a vision, goals, and recommended best management practices, and it will help to guide land use and land and water stewardship activities toward a vision for the watershed.

The East Fork Creek Watershed (HUC 070600050801), located in northwest Illinois along the borders of Carroll and Stephenson Counties, fed the East Fork of the East Plum River and its tributaries and was dammed toward the base to form the 640-acre Lake Carroll. The 65.88 miles of intermittent stream and 6.88 miles of perennial stream drained the 14,426-acre watershed into the East Plum River and beyond to the Mississippi River, which carried water to the Gulf of Mexico.

Features within the watershed included steep hills and ravines that provided a beautiful setting for the 5,000-acre Lake Carroll residential community and golf course, surrounded by cropland with a few pastures and livestock operations in the headwaters. There was very little floodplain or hydric soils within the stark topography, and a large wetland sat at the base of Lake Carroll below the dam. Throughout the watershed, soils were silt loams with a few areas of silty clay loams. These well drained soils provided mostly farmland of statewide importance and not prime farmland. They tended to have moderately low to moderately high runoff potential and were also highly and moderately susceptible to detachment. These soils were not particularly susceptible to wind erosion. The headwaters of the watershed and some other areas had deep soils with high soil loss tolerance while ravines had soils with low soil loss tolerance. In between were soils with moderate tolerance.

East Fork Creek and Lake Carroll were not listed as impaired waters by the Illinois Environmental Protection Agency. However, the Plum River to which they both drained was impaired, as it did not support aquatic life of primary contact recreation due to alterations of stream and littoral vegetation, sediment and siltation, total suspended solids, and fecal coliform caused by channelization, irrigated crop production, and other unknown sources (2018). Along the streams, riparian conditions varied, with 37% rated as good, 40% fair, and 23% poor quality. About half of all streambanks were severely eroded (51%), while 23% were moderately eroded, and 26% were slightly eroded. Channelization was high in 22% of streams and moderate in 44% of streams, while 34% of streams had low to no channelization. The shorelines of Lake Carroll were completely protected by rip rap in various stages of repair and all with only slight erosion. Ponds and basins also had little to no erosion on their banks.

We estimated pollutant loading by land use to be 44,275 pounds per year of total nitrogen, 4,273 pounds per year of total phosphorous, and 1,203,281 pounds per year of total suspended solids. Generally speaking, the greatest amount of pollutant loading to streams and lakes per acre came from

residential land use surrounding Lake Carroll for total phosphorous, total suspended solids, and pathogens. Some of the agricultural lands in the headwaters of the watershed contributed the most total nitrogen per acre. The following inventory provided details for these findings.

Acknowledgements

The watershed inventory and planning process was initiated by efforts of the Lake Carroll Association and JadEco Natural Resource Consultation and Management. These entities had been working to maintain and improve the recreational water quality and fisheries of Lake Carroll for many years. In 2015, they added Olson Ecological Solutions to their team in order to enlarge their efforts to include the entire watershed in which they were a part. As a first step, these three partners jointly asked the Illinois Environmental Protection Agency for funding assistance, which was granted in 2017.

The following individuals were instrumental in compiling this inventory:

Edited by:	Rebecca Olson, Olson Ecological Solutions
Written by:	Rebecca Olson, Olson Ecological Solutions Kristin Adams, Tallgrass Restoration Steve Yost, Olson Ecological Solutions
Maps by:	Kristin Adams, Tallgrass Restoration
Modeling by:	Kristin Adams, Tallgrass Restoration
Stream survey by:	Joe Rush, JadEco Lakes and Natural Resources Consultation and Management
Stream survey data analysis by:	Steve Yost, Olson Ecological Solutions
Pond/basin survey by:	Kristin Adams, Tallgrass Restoration Rebecca Olson, Olson Ecological Solutions
Contributions by:	Doug Block, Landowner and Farmer Mike Schmeider, Lake Carroll Association

Table of Contents

Executive Summary 2
Acknowledgements 3
Part 1: East Fork Creek Watershed Boundaries 7
Location of Watershed 7
Watershed Size 7
Geographic Boundaries 7
Watershed Jurisdictions 7
Part 2: Watershed Drainage System and Waterbodies 14
Connectivity and Water Flow of Watersheds 14
Spatial Relationship and Connectivity through Pseudo-HUC System 14
Connectivity and Water Flow within East Fork Creek Watershed 14
Locations of Waterbodies 15
Wetlands 15
Floodzones and Flooding Frequency 16
Part 3: Land Uses and Land Cover 25
Historic Land Cover 25
Current Land Uses and Land Cover 25
Predicted Future Land Uses and Land Cover 25
Demographics 25
Part 4: Geology and Climate 34
Geology 34
Topography 35
Climate 35
Part 5: Soils 44
Soil Texture 44
Major Soil Types 44
Farmland Quality 44
Hydric Soils 45
Hydrological Soil Groups and Water Transmission 45
Soil Drainage Class 46
Soil Erodibility 46
Soil Erodibility by Water 46
Soil Erodibility by Wind 47
Soil Loss Tolerance 47
Highly Erodible Land (HEL) 48
Part 6: Water Quality Assessment 62
Illinois Integrated Water Quality and Section 303(d) List – Volume 1: Surface Water 62
Lake Carroll Water Quality Testing 63
Stream Survey 64
Shoreline Survey 64
Estimated Annual Pollutant Load 65
Works Cited 86

Geographic Information Systems (GIS) Works Cited 90

Figures

Figure 1 East Fork Creek Watershed, HUC-08, HUC-10, HUC-12 State Location 9
Figure 2 East Fork Creek Watershed, HUC-08, HUC-10, HUC-12 County Location 10
Figure 3 East Fork Creek Watershed, Nearby Municipalities 11
Figure 4 East Fork Creek Watershed, Watershed Boundaries 12
Figure 5 East Fork Creek Watershed, Political Township Boundaries 13
Figure 6 East Fork Creek Watershed, HUC-14 Watershed 18
Figure 7 East Fork Creek Watershed, Streams 19
Figure 8 East Fork Creek Watershed, Ravine and Stream Banks 20
Figure 9 East Fork Creek Watershed, National Wetlands Inventory (NWI) 21
Figure 10 East Fork Creek Watershed, Floodzones 22
Figure 11 East Fork Creek Watershed, Flooding Frequency Class 23
Figure 12 East Fork Creek Watershed, Ponds and Basins 24
Figure 13 East Fork Creek Watershed, Landcover in the Early 1800's 28
Figure 14 East Fork Creek Watershed, Land Cover 29
Figure 15 East Fork Watershed Census Blocks 33
Figure 16 East Fork Creek Watershed, Bedrock Geology 38
Figure 17 East Fork Creek Watershed, Quaternary Deposits 39
Figure 18 East Fork Creek Watershed, Erosion Hazard 40
Figure 19 East Fork Creek Watershed, Topographic Relief 41
Figure 20 East Fork Creek Watershed, Representative Slope (S) 42
Figure 21 East Fork Creek Watershed, Elevation 43
Figure 22 East Fork Creek Watershed, Soil Texture 52
Figure 23 East Fork Creek Watershed, Soil Map Unit 53
Figure 24 East Fork Creek Watershed, Prime Farmland 54
Figure 25 East Fork Creek Watershed, Hydric Soil Map Unit 55
Figure 26 East Fork Creek Watershed, Hydrologic Soil Groups 56
Figure 27 East Fork Creek Watershed, Soil Drainage Class 57
Figure 28 East Fork Creek Watershed, Soil Erodibility Factor (K) 58
Figure 29 East Fork Creek Watershed, Wind Erodibility Group (WEG) 59
Figure 30 East Fork Creek Watershed, Erosion Factor (T) 60
Figure 31 East Fork Creek Watershed, Land Use on Highly Erodible Land (HEL) 61
Figure 32 East Fork Creek Watershed, Stream and Tributary Survey Routes 67
Figure 33 Riparian Buffer Field Indicators 68
Figure 34 East Fork Creek Watershed, Channelization 69
Figure 35 East Fork Creek Watershed, Example Stream Tributaries and Ravines 70
Figure 36 East Fork Creek Watershed, Example Lake Carroll Shoreline 75
Figure 37 East Fork Creek Watershed, Example Ponds and Basins 76
Figure 38 East Fork Creek Watershed, Annual Nitrogen Load by Acreage 78
Figure 39 East Fork Creek Watershed, Annual Phosphorous Load by Acreage 79

Figure 40 East Fork Creek Watershed, Annual Sediment Load by Acreage 80
Figure 41 East Fork Creek Watershed, Annual Pathogen Load by Acreage 81
Figure 42 East Fork Creek Watershed, Annual Nitrogen Load Total 82
Figure 43 East Fork Creek Watershed, Annual Phosphorous Load Total 83
Figure 44 East Fork Creek Watershed, Annual Sediment Load Total 84
Figure 45 East Fork Creek Watershed, Annual Pathogen Load Total 85

Tables

Table 1 Political Townships 8
Table 2 HUC-14 Subwatershed Boundaries Acreage 17
Table 3 Stream and Shoreline Lengths 17
Table 4.1 Land Cover in the Early 1800's Acreage 28
Table 4.2 National Land Cover Database 2011 (NLCD2011) Legend 30
Table 4.3 Land Cover Acreage 32
Table 4.4 Land Cover Acreage by Subwatershed 32
Table 5 Representative Slope 36
Table 6 Precipitation and Temperature Monthly Averages for 2017 for East Fork Creek Watershed 37
Table 7 Soil Texture 48
Table 8 Highly Erodible Land by Land Use 48
Table 9 Soil Map Units Acreage 49
Table 10 Prime Farmland Acreage 50
Table 11.1 Hydric Soil Groups Acreage 51
Table 11.2 Hydrologic Soil Groups Acreage 51
Table 12 Soil Drainage Classes Acreage 51
Table 13 Erosion Factor (Kw) Acreage 51
Table 14 Erosion Hazard Acreage 51
Table 15 Wind Erodibility Groups Acreage 51
Table 16 Erosion Factor (T) Acreage 51
Table 17 Summary of Stream and Tributary Riparian Area Condition 66
Table 18 Summary of Stream and Tributary Bank Erosion 66
Table 19 Summary of Stream and Tributary Channelization 67
Table 20 Lake Carroll 2017 October Rip Rap/Shoreline Inspection 72
Table 21 Summary of Pond and Basin Erosion 74
Table 22 Summary of Pond and Basin Riparian Area Condition 74
Table 23 Estimated Existing Annual Pollutant Load by Source 77
Table 24 Total Pollution Loads by Subwatershed 77

Part 1: East Fork Creek Watershed Boundaries

Location of Watershed

The East Fork Creek Watershed was located in northwest Illinois along the border of Carroll and Stephenson Counties, Illinois. The nearest towns were Lanark to the south, Shannon to the east, and Mt. Carroll to the southeast, all in Carroll County, and Pearl City in Stephenson County to the north (see Figure 1, Figure 2, and Figure 3).

Watershed Size

The East Fork Creek Watershed was about 14,426 acres in size or 22.541 square miles, according to GIS analysis of the HUC12 boundary.

Geographic Boundaries

Watershed boundaries for the East Fork Creek encompassed Lake Carroll and its tributaries, culminating at the confluence of East Plum River (see Figure 4).

Watershed Jurisdictions

Jurisdiction of the watershed was split between Carroll and Stephenson Counties, and further split amongst several townships. Each of the two Counties governed portions of the watershed, separately responsible for zoning, planning, water quality protection, and nonpoint source pollution control.

Carroll County governed 83.6% of the land area in the watershed and Stephenson County represented the other 16.4%. Carroll County was split into Freedom Township to the west and Cherry Grove-Shannon Township to the east. Most of the Lake Carroll Development was within Freedom Township. Stephenson County mostly fell into Loran Township, with about 275 acres of land in Jefferson Township (see Table 1 and Figure 5).

On the State level, several entities helped monitor the natural resources within the East Fork Watershed. The Illinois EPA worked to reduce water pollution from non-point sources through providing grants. The US Army Corps of Engineers Rock Island District oversaw area permitting to maintain the integrity of the area's water features. Illinois Department of Natural Resources protected the environment in regards to the entire state. They had a branch within the Office of Water Resources that covered tasks such as water resource planning, navigation, floodplain management, and managing water supply and drought. Within this branch were two divisions: Capital Programs and Resource Management. The latter managed statewide dams and monitored flood conditions while the former regulated construction within waterways and floodplains. The Illinois Department of Transportation complied with maintaining the Clean Water Act by managing stormwater runoff and avoided wetland impacts caused by road development.

On the local level, the Lake Carroll Association organized a committee to work on their Lake Improvement Project. The goal of this project was to address current and future needs of Lake Carroll to improve the lake's condition. The Soil and Water Conservation District, which was part of the US

Department of Agriculture, had a district conservationist assigned to both counties within the watershed. The Lake Carroll Fishing Club also worked with the Lake Improvement Project to improve the Lake conditions by improving fish habitat.

Table 1 Political Townships

Political Townships			
Township Name	County Name	Acres	% Watershed
Jefferson	Stephenson	275.390	1.91%
Loran	Stephenson	2090.954	14.49%
Freedom	Carroll	3278.473	22.73%
Cherry Grove - Shannon	Carroll	8781.642	60.87%

Figure 1 East Fork Creek Watershed, HUC-08, HUC-10, HUC-12 State Location

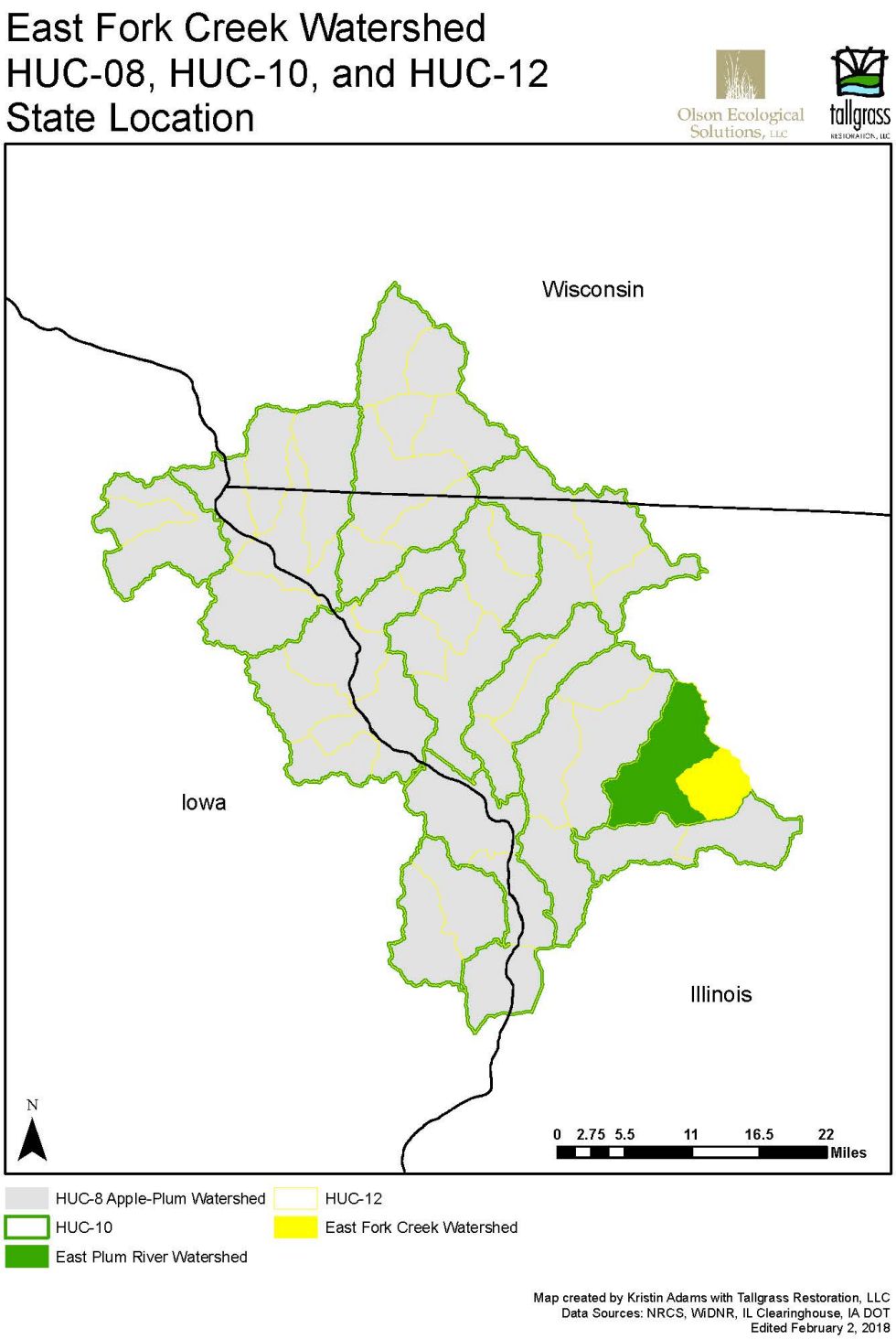


Figure 2 East Fork Creek Watershed, HUC-08, HUC-10, HUC-12 County Location

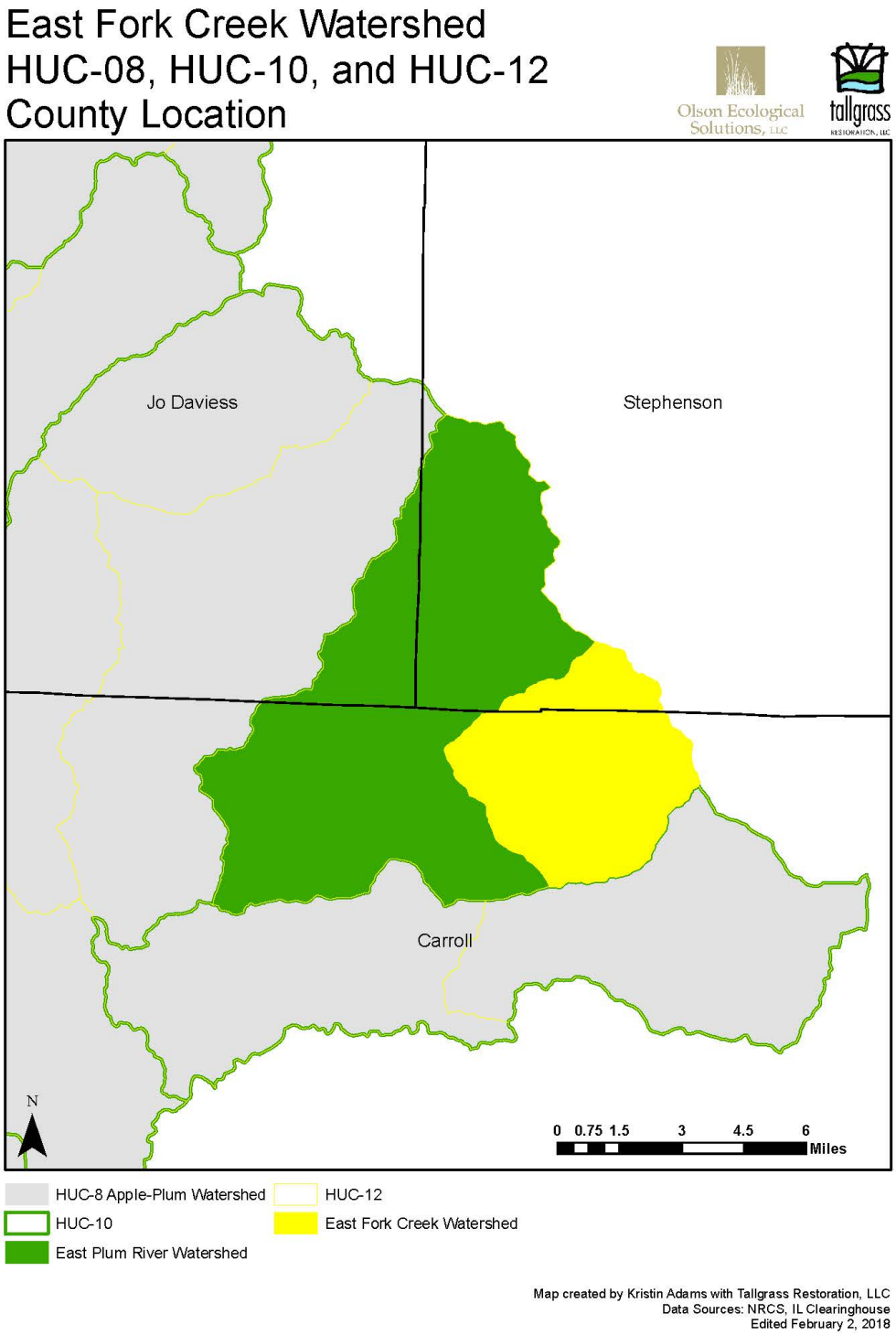
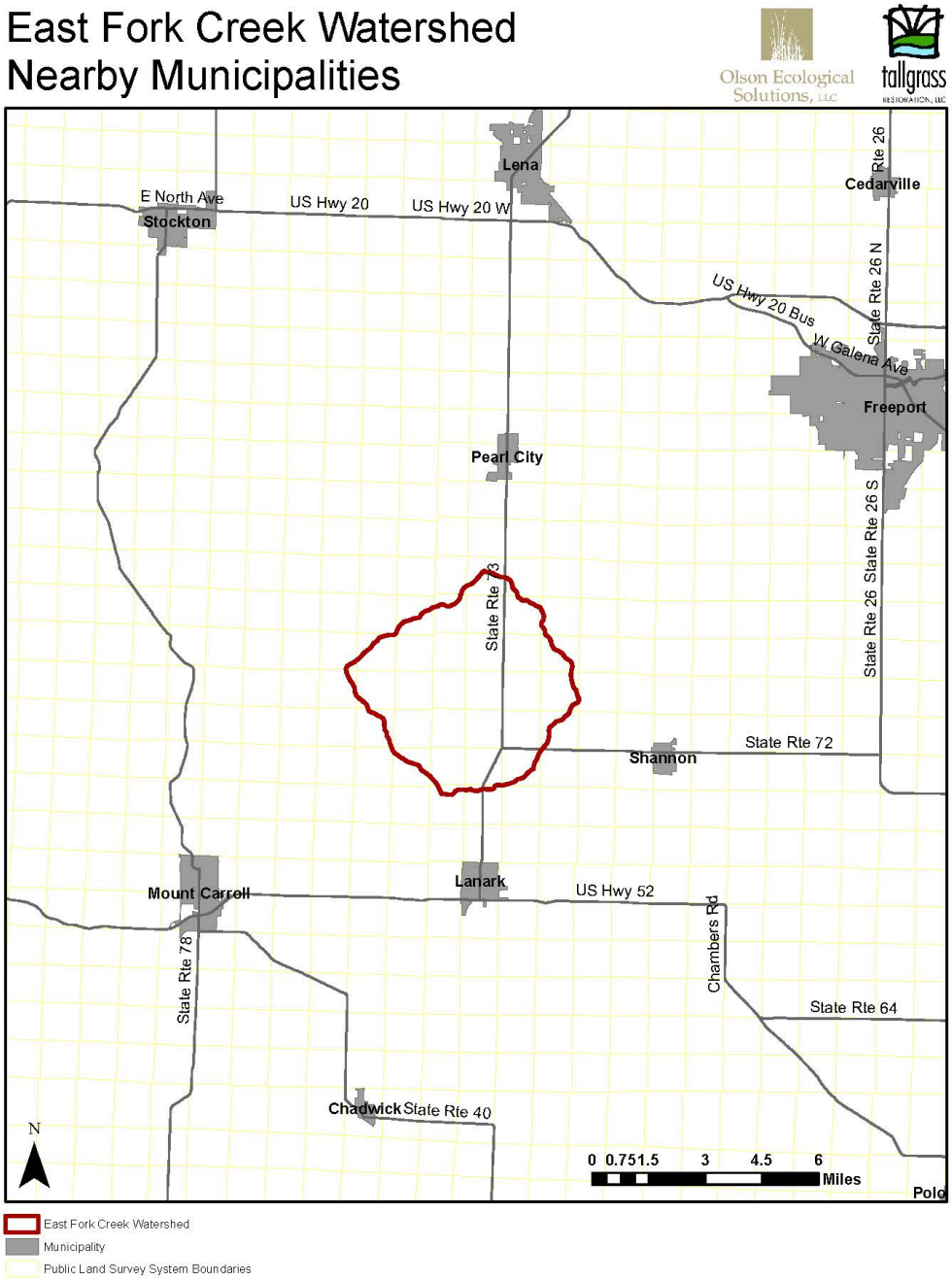


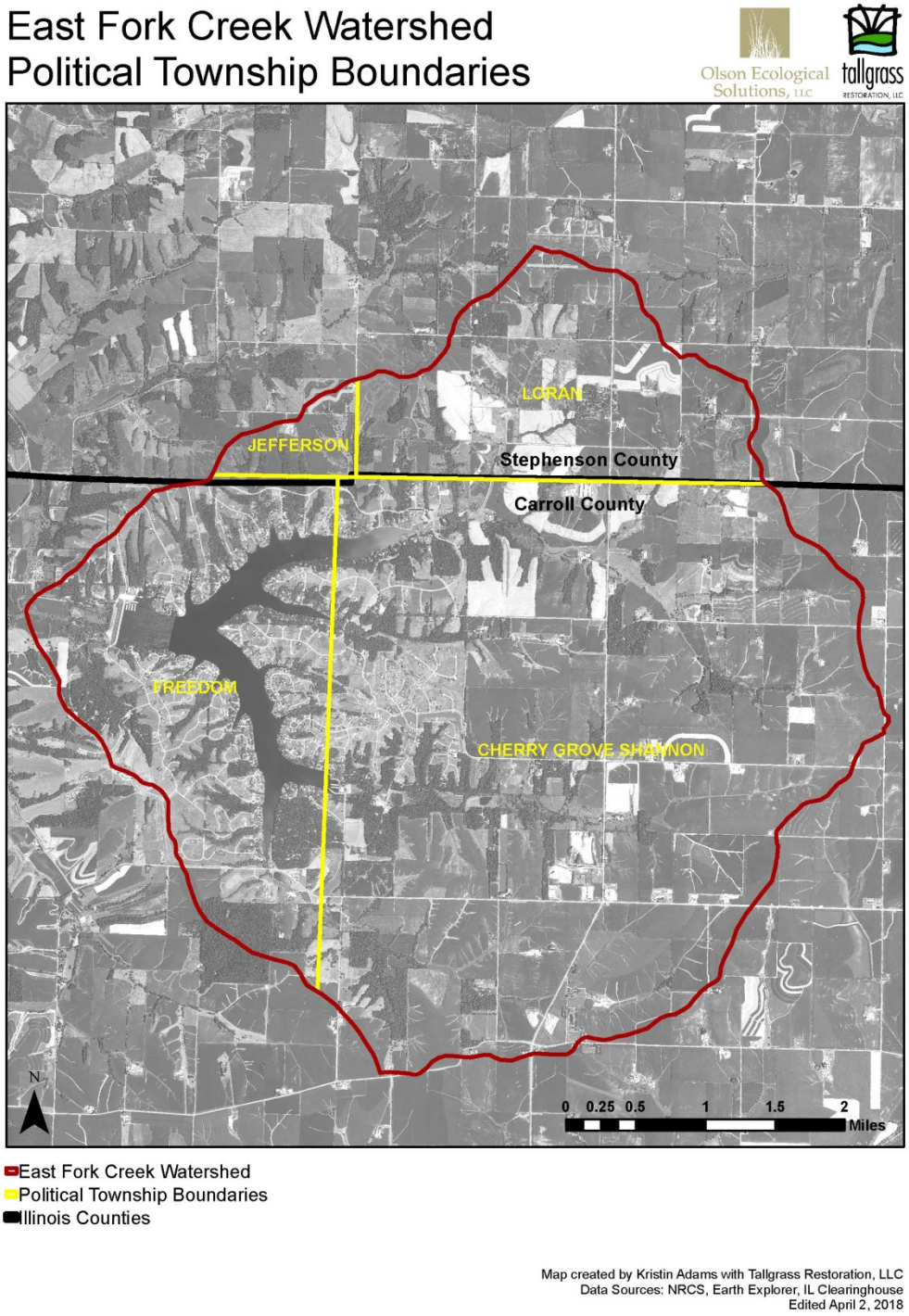
Figure 3 East Fork Creek Watershed, Nearby Municipalities



Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, TIGER Census, IL Clearinghouse
Edited February 8, 2018

Figure 4 East Fork Creek Watershed, Watershed Boundaries

Figure 5 East Fork Creek Watershed, Political Township Boundaries



Part 2: Watershed Drainage System and Waterbodies

The drainage system of East Fork Creek Watershed was understood by following the connectivity and water flow from one watershed to another, through further dividing the watershed into smaller subwatersheds, and by tracing the path from one stream to the next within the watershed. The relationship of these watersheds and streams with their lakes, ponds, detention basins, flood zones, and wetlands provided a full picture of water flow through the watershed and beyond.

Connectivity and Water Flow of Watersheds

The connectivity and water flow of the East Fork Creek Watershed was defined within the larger context of watersheds in which it lay. The East Fork Creek Watershed was a headwater of the East Plum River, which drained to the receiving Plum River and then joined the Mississippi River near Savanna, Illinois. According to the HUC (Hydrologic Unit Code) system, which organizationally divided larger drainage systems in the United States, the East Fork Creek Watershed was nested within the larger watersheds as follows (see Figure 1):

HUC for East Fork Creek and Associated Watersheds

	"0706"	Upper Mississippi-Maquoketa Plum River
HUC-08	"07060005"	Apple-Plum River
HUC-10	"0706000508"	East Plum River
HUC-12	"070600050801"	East Fork Creek/East Fork East Plum River

Spatial Relationship and Connectivity through Pseudo-HUC System

There was no assigned numbering system beyond the HUC-12 level, of which the East Fork Creek Watershed was the smallest division. In order to illustrate the spatial relationship and connectivity within the East Fork Creek, we applied a pseudo-HUC-14 level, giving seven subwatersheds a letter name of A through H and adding two digits to the HUC-12 code. We used drainage basins defined by elevation as the principal factor in the breakdown into smaller watersheds.

Subwatersheds A, B, C, D, and E represented headwaters to the East Fork Creek watershed. They flowed into F, and G, which housed Lake Carroll. In turn, these flowed into Subwatershed H below the dam of Lake Carroll. All of the subwatersheds terminated at the confluence of the next order stream except for one area; we brought the division to the confluence of the lake between Subwatersheds A, B and G. This kept land uses within the subwatersheds separated between agricultural and residential, in order to aid in interpreting models later in the watershed planning process (see Table 2 and Figure 6).

Connectivity and Water Flow within East Fork Creek Watershed

Water flow through the East Fork Creek Watershed was primarily through a network of intermittent and perennial streams. The connectivity and water flow of these streams was dictated by the steep topography and ravines of the area. Water drained from east to west via numerous intermittent streams, then flowed into a few long, perennial streams that were dammed, creating Lake Carroll in their lower reaches. One main stream led from the dam at Lake Carroll to the East Plum River. Total

stream length throughout the watershed, including steep ravines, was 72.76 miles (384,224 feet). Intermittent stream length outnumbered perennial stream length nine to one (90.4% intermittent streams and 9.4% perennial streams). There were about 65.88 miles of intermittent stream (347,936 feet) and 6.88 miles of perennial stream (36,287 feet) throughout the watershed (see Table 3). Steep ravines accounted for 20.29 miles (107,150 feet) of total stream length throughout the watershed, while flatter streams flowed for 52.47 miles (277,075 feet).

In order to communicate about the water flow, we named each of the main branches of the streams. East Fork Creek, the only stream within the watershed to have a published name, was the northernmost of four main tributaries to Lake Carroll. We split it into three tributaries: Upper East Fork Creek, North Lower East Fork Creek, and South Lower East Fork Creek. The three other streams, listed from north to south, we named: North Creek, Central Creek, and South Creek (see Figure 7).

Locations of Waterbodies

The main waterbody within the East Fork Creek Watershed was Lake Carroll, a 640-acre lake formed by the damming of East Fork Creek (Lake Carroll Assoc., 2018). In addition, we found 19 small ponds and seven detention basins visible on aerial imagery. The locations of the ponds were as follows: four ponds in Subwatershed B, three in C, two in D, two in E, one in F, two in G, and five ponds downstream of Lake Carroll in Subwatershed H. Detention ponds were located within the headwater reaches, with two detention ponds in Subwatershed A, four in B, and one in D. The total shoreline from the lakes, ponds, and detention basins was 104,312 feet (19.76 miles), most of which was at Lake Carroll (see Table 3, Figure 6, Figure 7, and Figure 11).

Wetlands

Several wetlands throughout the watershed were recognized by the National Wetlands Inventory (NWI), some of which were also discussed above as waterbodies. The wetlands were all associated with streams and lakes, and none were isolated. Lake Carroll itself was considered a deepwater lake wetland, as were the perennial streams. Upstream of Lake Carroll, a scrub/shrub wetland and two shallow marsh/wet meadow wetlands were clustered at the inlet of the lake in Subwatershed G. Two small open water wetlands were upstream from them in Subwatershed B along the north branch and main stem of Lower East Fork Creek. Along Central Creek in Subwatershed C, there was a small and large open water wetland next to a large bottomland forest. Two other small, open water wetlands occurred upstream of the lake in Subwatershed G and along South Creek in Subwatershed D. The largest wetland was a scrub-shrub wetland along the stream draining Lake Carroll, immediately downstream of the dam in Subwatershed H, with a second smaller shallow marsh/wet meadow wetland downstream near the confluence of the East Plum River. Two open water wetlands lined the tributary in Subwatershed H and one was tucked within the scrub-shrub wetland boundaries (see Figure 8).

This data was collected by remote sensing technology mounted on aircraft capable of detecting soil moisture and saturation. Wetland identification on NWI data was not conclusive identification of a wetland as defined by the US Army Corps of Engineers. Additional potential wetlands, including those isolated from the stream network, likely existed that were not mapped by the NWI.

Floodzones and Flooding Frequency

Floodzones and flooding frequency combined to explain the flooding patterns within the watershed. The floodzones within the watershed included a few areas having a greater than one percent chance of flooding in a year that was recorded as a Special Flood Hazard Area (A & AE) on the Flood Insurance Rate Map. There were no areas of 500-year floodzone. The 100-year floodzones included areas surrounding Lake Carroll and some of its inlets, upstream of inlets on perennial streams, and downstream of the dam. Surrounding the lake, areas in the 100-year floodzone were at lower elevations below the high bedrock escarpment. The inlets with 100-year floodzone included: East Fork Creek in Subwatershed G, Central Creek in Subwatershed C, and South Creek in Subwatershed D. Upstream of the inlets, this floodzone followed the perennial streams of the Upper and Lower East Fork Creek in Subwatersheds A and B for a short distance. Downstream of the dam, 100-year floodzone encompassed the large wetland and perennial stream until its confluence with East Plum River. The remainder of the watershed was considered Minimal Flood Hazard (X) (see Figure 9).

We used "Web Soil Survey" to assess the flooding frequency of the watershed (NRCS, 2017), which sometimes overlapped floodzones but more often offered independent information. Web Soil Survey expressed flood frequency as one of the following classes: none, very rare, occasional, frequent, or very frequent. The watershed had areas of frequent and occasional flooding, with the majority of the watershed having a flooding class of "none." Portions of frequent and occasional flooding classes existing outside of the 100-year floodzone boundary indicated that there was flood risk along streams outside of the floodzone. Frequent flooding was "flooding is likely to occur often under normal weather conditions" and was more than "50 percent likely in any year but less than 50% in all months of any year." Areas of frequent flooding overlapped a few of the 100 year flood zone but also were found on much of the intermittent stream segment of North Creek above the lake inlet in Subwatershed E, perennial and intermittent segments of Upper East Fork Creek in Subwatershed A, and certain upper intermittent parts of the watershed: North and South Lower East Fork Creeks in Subwatershed B, Central Creek in Subwatershed C, South Creek in Subwatershed D, and one inlet in Subwatershed G. Occasional flooding, or that which "occurs infrequently under normal weather conditions the chance of flooding is 5 to 50 percent in any year," was recorded on more of the watershed, including most of the perennial streams, significant parts of the intermittent streams, and an area below the Lake Carroll dam including the probable wetland. Besides those areas in frequent or occasional flood frequency, the rest of the watershed was recorded as no frequency ("none"), where flooding was "not probable" and the "flood frequency is zero percent in any year and flooding occurs less than once in 500 years" (see Figure 10).

Table 2 HUC-14 Subwatershed Boundaries Acreage

HUC 14 Subwatershed Boundaries Acreage			
HUC 14 Code	Name	Acres	% Watershed
07060005080101	A	1413.069	9.79%
07060005080102	B	3117.880	21.61%
07060005080103	C	2796.357	19.38%
07060005080104	D	2875.023	19.93%
07060005080105	E	985.200	6.83%
07060005080106	F	1003.585	6.96%
07060005080107	G	1692.623	11.73%
07060005080108	H	541.213	3.75%

Table 3 Stream and Shoreline Lengths

Stream Length (Feet)		
Subwatershed	Intermittent	Perennial
A *Note: Stream length between A and B is recorded in A	45,116.66	3,248.74
B	98,159.47	3,956.10
C	74,787.27	13,765.51
D	56,282.27	11,184.65
E	23,290.61	0.00
F	9,000.58	0.00
G	33,857.82	0.00
H	7,441.61	4,132.12

Stream Length (Miles)		
Subwatershed	Intermittent	Perennial
A *Note: Stream length between A and B is recorded in A	8.54	0.62
B	18.59	0.75
C	14.16	2.61
D	10.66	2.12
E	4.41	0.00
F	1.70	0.00
G	6.41	0.00
H	1.41	0.78

Shoreline Length		
	Feet	Miles
Lakes, Ponds, & Detention Basins	104,311.70	19.76

Figure 6 East Fork Creek Watershed, HUC-14 Watershed

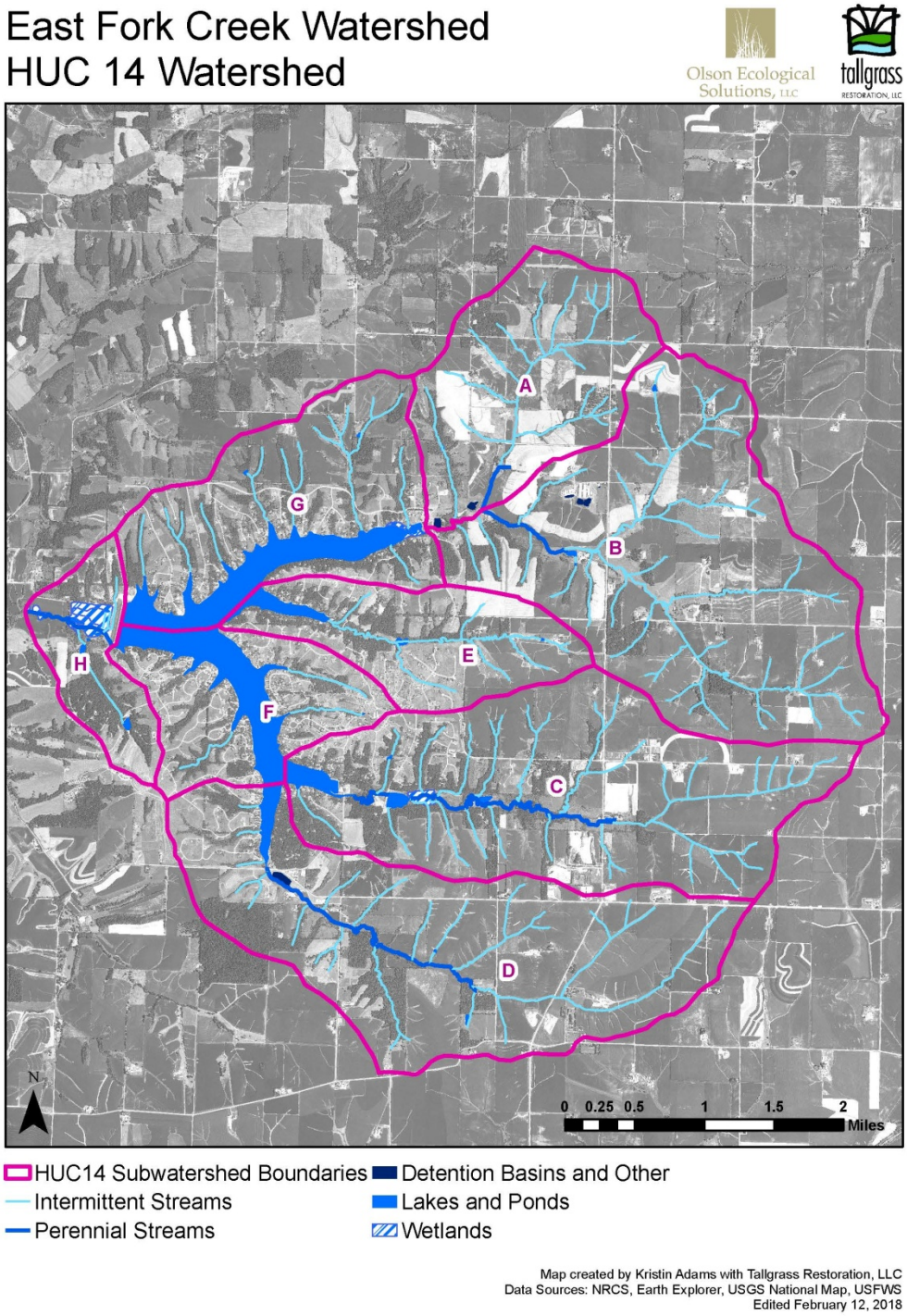


Figure 7 East Fork Creek Watershed, Streams

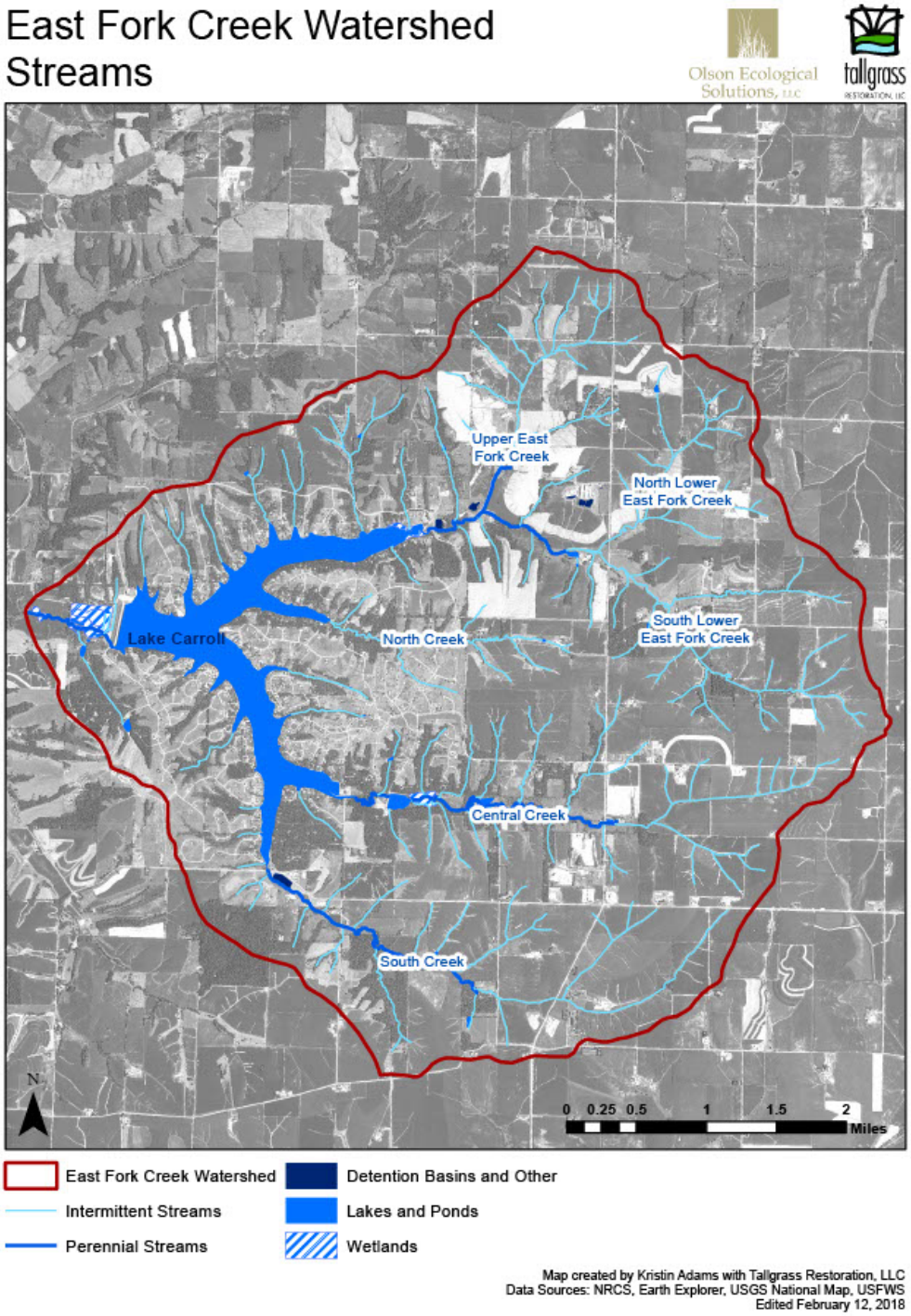


Figure 8 East Fork Creek Watershed, Ravine and Stream Banks

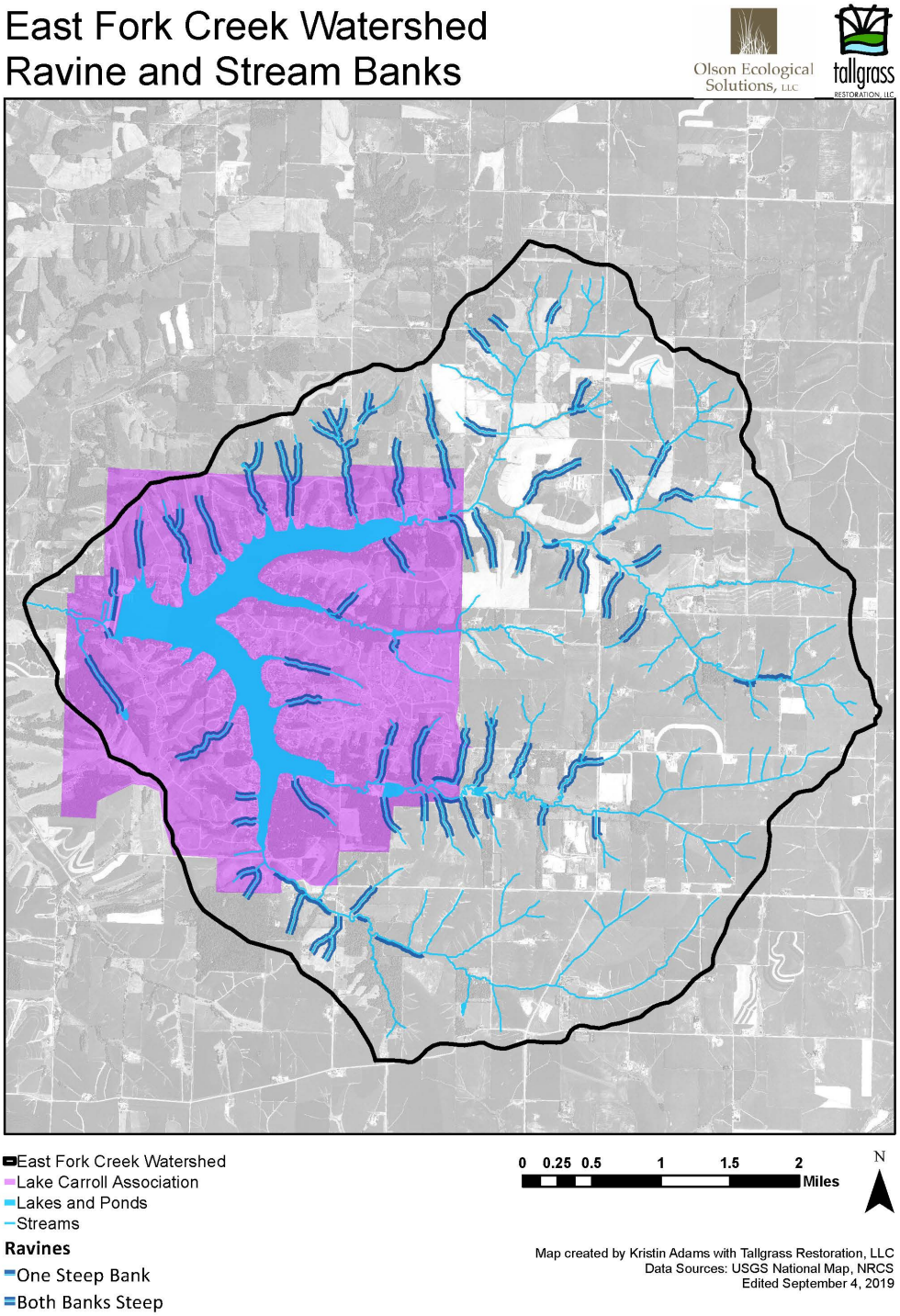


Figure 9 East Fork Creek Watershed, National Wetlands Inventory (NWI)

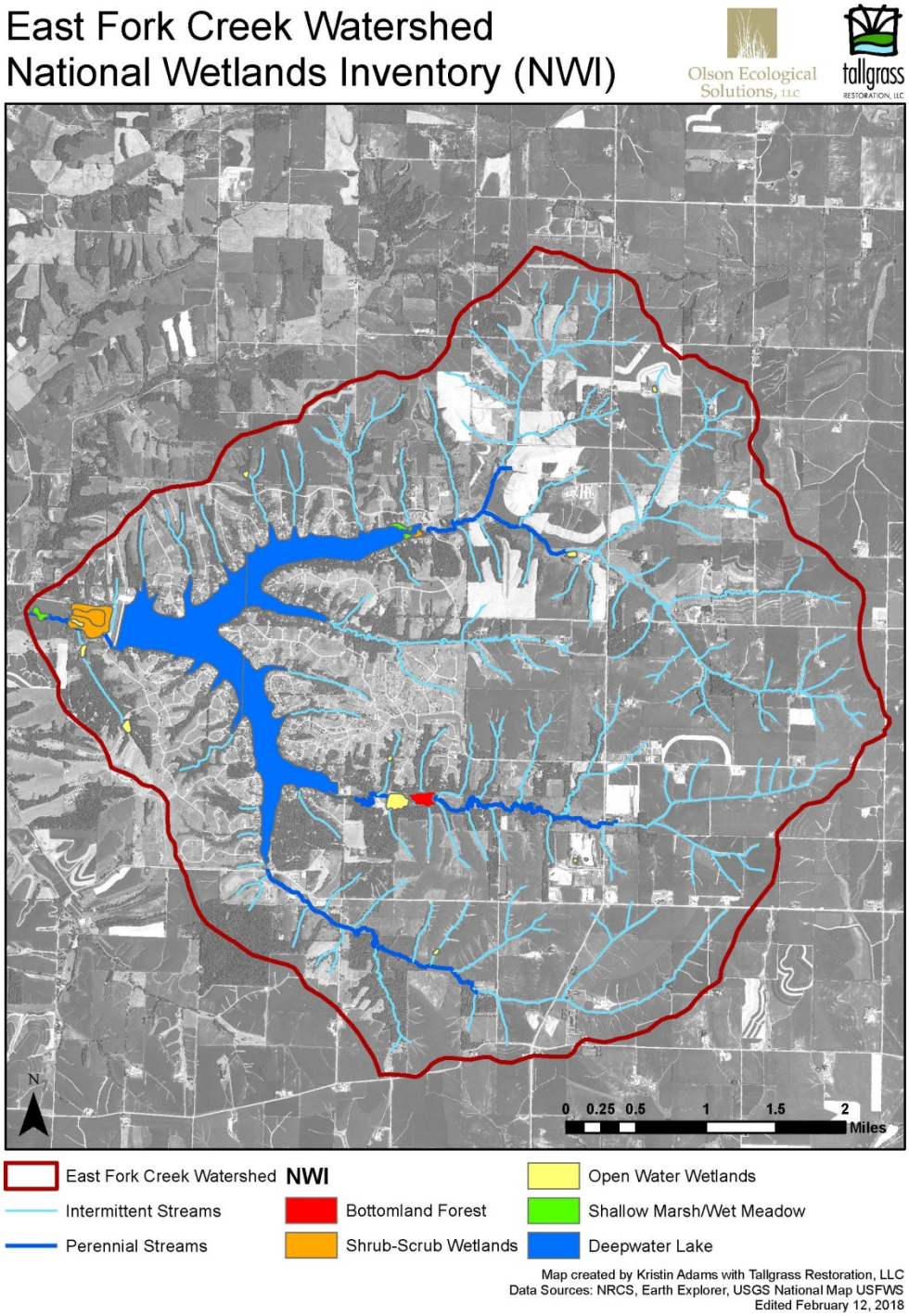


Figure 10 East Fork Creek Watershed, Floodzones

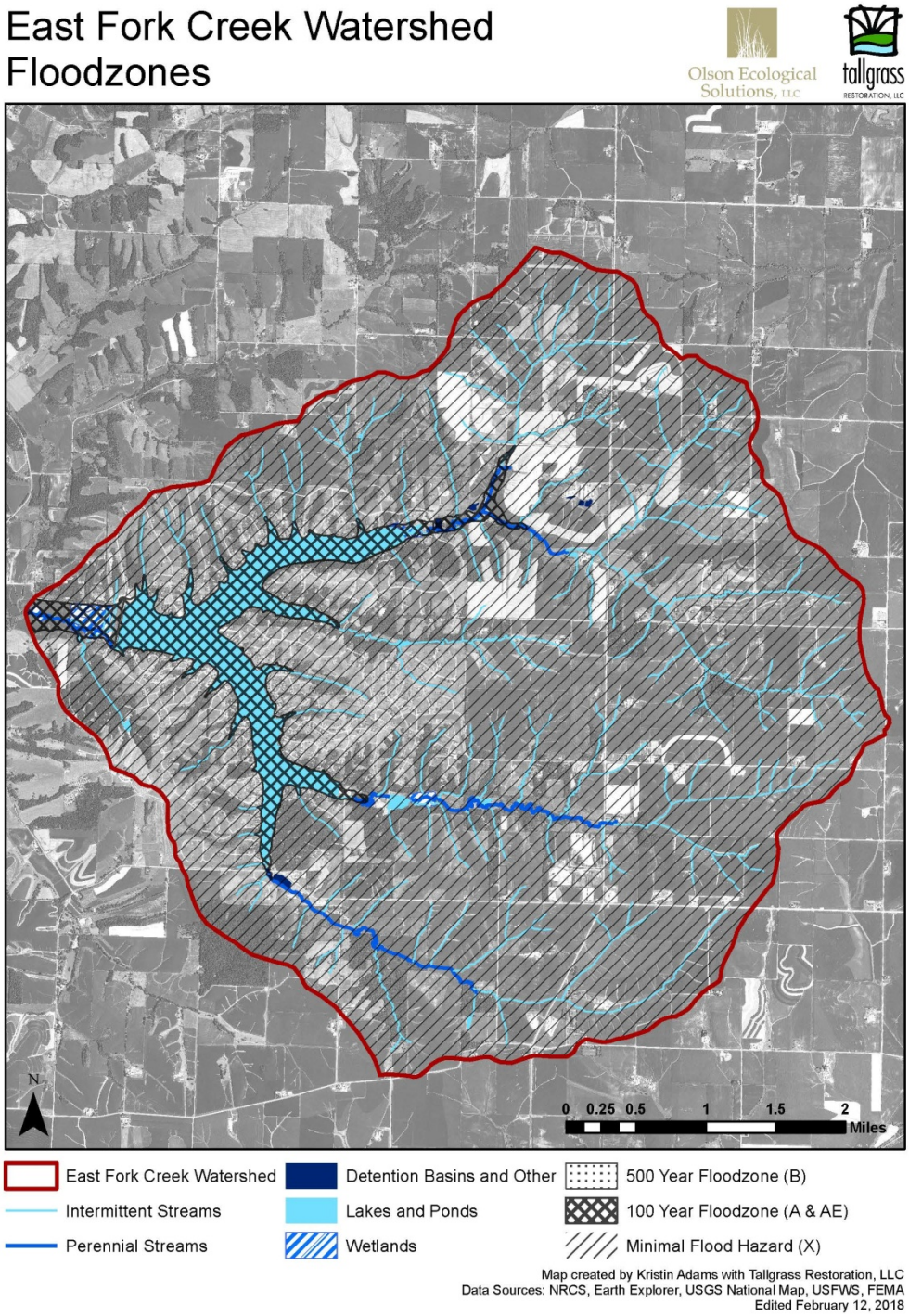


Figure 11 East Fork Creek Watershed, Flooding Frequency Class

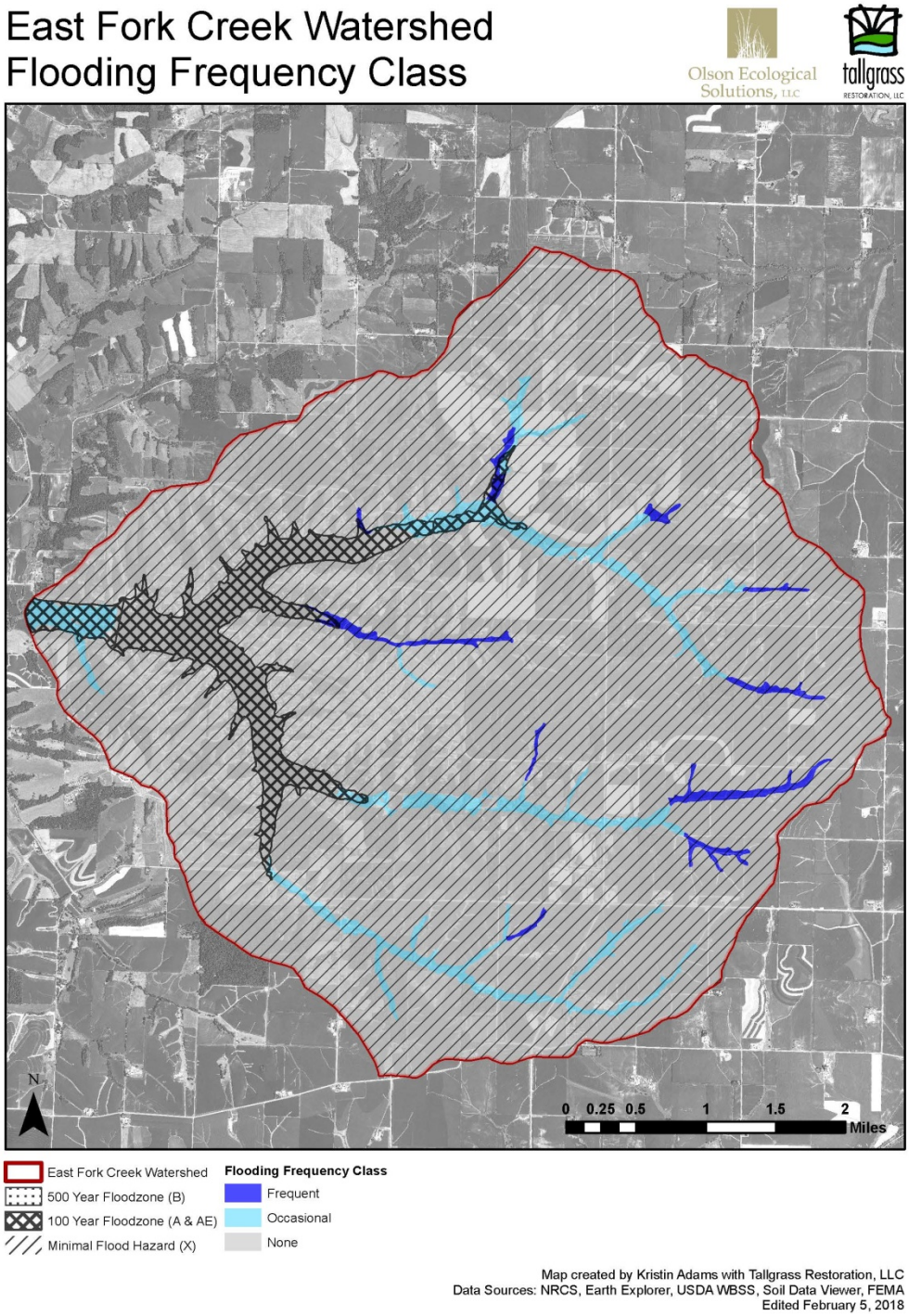
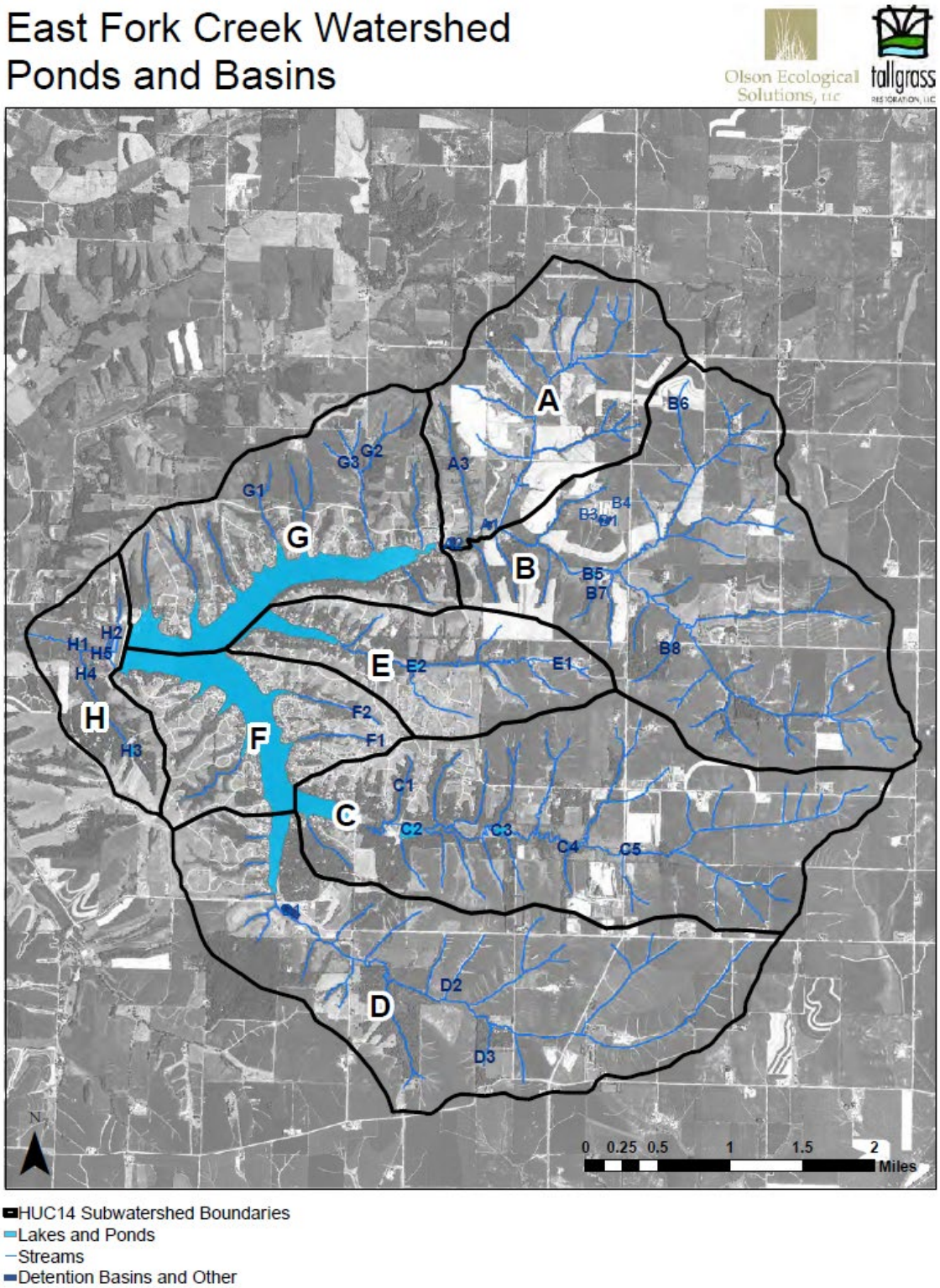


Figure 12 East Fork Creek Ponds and Basins



Part 3: Land Uses and Land Cover

Historic Land Cover

Prairies and forests historically covered the watershed. Prairie made up much of what is now Lake Carroll and the watershed's upper reaches to the east (4,606 acres). Forest covered two-thirds of the watershed (9,512 acres). A few cultural sites, most likely homesteads, dotted the prairies (115 acres). The stream running through the watershed (193 acres) was in its current location, prior to being dammed to form Lake Carroll (see Table 4.1 and Figure 12). The forests and prairies of the past gave way to today's farmland and a residential community with a golf course surrounding Lake Carroll.

Current Land Uses and Land Cover

During this inventory, the major land uses and land cover were agricultural, residential, and forest and open space. Most of the watershed was made up of cropland (56%, 8100 acres), and about 1% was in pasture (182 acres). Within the Lake Carroll Association community, 18% of the watershed (2547 acres) was used for residential, 7% in turf grass and open space (954 acres), and 3% (388 acres) for a golf course. Natural areas covered the remaining 15% as forest, water, and wetlands. Approximately 11% of the watershed was covered with forest (1525 acres). Water, mostly Lake Caroll, accounted for about 4% (590 acres) of the watershed, and a sparse scattering of wetlands added less than 0.5% (78 acres). Another small portion (<0.5%) of the watershed was barren (see Tables 4.2 and 4.3 and Figure 13).

In the upper reaches of the watershed, areas that were once prairie were converted to row crop agriculture. Low density residential homes dotted the agricultural portions of the watershed, and three pastures were located in Subwatersheds A and D. Area covered by water increased due to the construction of Lake Carroll. Roughly half of the remaining land that used to be forested was converted to row crop farming, while the other half housed the community with residences and open spaces (turf grass), a golf course, and Lake Carroll. Remaining forest was found in the steep ravines throughout the watershed, and a few large patches were in Subwatersheds C, D, and H.

Row crop farming, one of the major land uses within the watershed, was conducted by a combination of no-till, conservation till, and conventional till methods. JadEco Natural Resource Consultation and Management conducted a windshield survey of farming methods in order to determine the ratio of each. This provided a snapshot view of farming practices. In 2018, 58% of farmland was farmed using no-till and another 41% used conservation till practices. Less than 1% of all farming in the surveyed year used conventional tillage. Conversations with local farmers confirmed that no-till and conservation till were used when converting fields to beans (including consecutive years of bean production); however, conventional till was sometimes used when converting fields to corn, resulting in substantially higher yields. It was likely that the conventionally tilled field was subject to no till or conservation till in other years.

Predicted Future Land Uses and Land Cover

Impervious surfaces covered about 442.6 acres of the watershed, including homes, roads, paved trails, and paved lots. Anticipated changes to impervious surface were minimal, as gleaned from future land use studies including:

- Northwest Illinois Trails Study (Blackhawk Hills Regional Council, 2018)
- Eight-County Freight Study Summary Report (CPCS Transcom, 2018)
- Lake Carroll Real Estate Guide (Lake Carroll Assoc., December 2018)
- 2014-2019 Comprehensive Economic Development Strategy (Blackhawk Hills Regional Council, 2014)
- Carroll Co., IL 2008 Comprehensive Plan (Carroll Co. Economic Development Corp., 2008)
- Greenways and Trails Plan, Carroll Co., IL (Carroll Co. Economic Development Corp., no date)
- UTV-ATV Trail Proposal Update (Carroll Co., no date)

The population in Carroll County, and specifically in the Census Blocks that encompassed most of the watershed (see Figure 14), had been following a downward trend and was predicted to decrease. Section 8.4 of the Carroll County Comprehensive Plan stated, "Since Carroll County has experienced a decrease in population… it is not necessary to calculate projected residential land use demands." This comprehensive plan set a goal to improve current housing by rehabilitating existing houses (Carroll Co. Economic Development Corp., 2008). With 48 homes and 17 vacant lots for sale within the Lake Carroll Association community (Lake Carroll Real Estate Guide, 2018), we predicted no notable spike in the housing development. Furthermore, most of the watershed's land was in agriculture, which was not anticipated to change in the near future by any of the planning documents.

There were some road and trail projects planned within the watershed. However, road projects planned by the Illinois Department of Transportation included mostly replacements or resurfacing of existing infrastructure, not construction of new roads, and the Greenways and Trails Plan showed a trail system following Zier Road and connecting to Lake Carroll Boulevard. We speculated that this trail will be incorporated into existing roads and will not add to in future construction. Furthermore, the Carroll County Comprehensive Plan stated that expansion of rail and water transportation was needed, but we did not anticipate related changes having any effect on the watershed.

Demographics

There were different demographics within and outside of the Lake Carroll Association complex. We looked at the demographics in terms of numbers of homes, lots, and parcels; well data; and township and county-wide census information, and census block data. Within the Association, there were 933 homes and 2,550 lots as of April 2010 ("Mission and Vision," 2018), supporting primary and secondary residences (M. Schmeider, personal communication, May 24, 2018). Outside of the Association, there were approximately 175 parcels in different land ownership. These parcels ranged in size from 1/10th of an acre to 1,144 acres, with some landowners owning multiple parcels. About two-thirds (64%) of these parcels were less than 40 acres in size. Of those over 40 acres in size, about 14% were between 40 and 100 acres, 19% were between 100 and 300 acres, and 3% were over 300 acres (Carroll Co. GIS, 2018 and Stephenson Co. GIS, 2018). The majority of the homes on these parcels were single family, mixed with some condominiums.

The number of homes, lots, and parcels did not correlate with the number of wells in the watershed. There were about 800 recorded wells within the watershed, mostly congregated within the Lake Carroll Association. Some wells within the Association may have served more than one residence, while some

outside of the Association may have been used for agricultural purposes only, such as irrigation and livestock watering. Therefore, we dismissed well data.

To glean more information about the watershed demographics outside of the Association, we looked at 2016 census data for the four townships and two counties of the watershed. We assessed township data for population distribution and county data for industry. The townships of the watershed were Cherry Grove-Shannon and Freedom Townships in Carroll County and Loran and Jefferson Townships in Stephenson County. We determined how much of each township was comprised of the watershed in order to relate the census information per township to the watershed. Most of East Fork Creek Watershed's acreage was in Cherry Grove-Shannon Township (61%, 8,782 acres) followed by Freedom Township (23%, 3,278 acres), Loran Township (14%, 2,091 acres), and finally Jefferson Township (2%, 275 acres) (see Table 1). Looking at how much of the area of each township was comprised of the watershed, the order was the same: The watershed made up about 26% of Cherry Grove-Shannon Township's area (8,782 of 34,176 acres), 14% of Freedom Township's area (3,278 of 22,912 acres), 9% of Loran Township's area (2,091 of 22,400 acres), and 2% of Jefferson Township's area (275 of 11,712 acres). Therefore, Cherry Grove-Shannon Township census data was most relatable to the watershed. This township had a population of 1,407 in 2016, with about 26.4 people per square mile (per 640 acres), which included the towns of Shannon and Georgetown and rural farmland. This was moderately populated compared to all the townships. By comparison, there were 420 people and 11.7 people per square mile in Freedom Township (including Lake Carroll Association), 1,510 people and 43.1 people per square mile in Loran Township (including Pearl City), and 209 people and 11.4 people per square mile in Jefferson Township, which was entirely rural (U.S. Census Bureau, 2016a, 2016b, 2016c, and 2016d). Industry within Carroll and Stephenson Counties was similar, led by manufacturing; educational services, health care, and social assistance; and retail trade. Agriculture, a strong component of the East Fork Creek Watershed, comprised 8.7% of the industry in Carroll County and 5.1% in Stephenson County (U.S. Census Bureau, 2016e and 2016f). There were no known, predicted population changes or growth forecasts within the watershed or surrounding communities.

Census data also was also grouped by numbered blocks. There were three census block groups that encompassed the East Fork Watershed (See Figure 14). In Illinois Block Group 17177004003, located in the Northwest corner of the watershed and part of Stephenson County, the population was 1,048 in 2018 with an expected -0.6 growth rate, predicting 1,017 people by 2023. There were 36 persons per square mile with a median age of 41, median income of $60,575, 602 people in the workforce, and an unemployment rate of 3%. The Illinois Block Group 17177004001, in the northeast corner of the watershed and also within Stephenson County, had an estimated population of 1,000 people in 2018. By 2023, their population was predicted to dip to 976, a -0.5 growth rate. There were 23 persons per square mile with a median age of 46, median income of $53,136, 559 people in the workforce, and an unemployment rate of4%. The last block group, Illinois Block group 170159601001, covered the southern section of the watershed and was within Carroll County. Their population of 1,449 in 2018 was predicted to dip by -0.2% by 2023, resulting in 1,436 residents. The census data estimated 21 persons per square mile with a median age of 60, median income of $68,328, 666 people in the workforce, and an unemployment rate of 1%.

Table 4.1 Land Cover in the Early 1800's Acreage

Land Cover in the Early 1800's Acreage		
Land Use Type	Acres	% Watershed
Cultural	114.792	0.80%
Forest	9512.372	65.94%
Prairie	4606.374	31.93%
Water	192.921	1.34%

Figure 13 East Fork Creek Watershed, Landcover in the Early 1800's

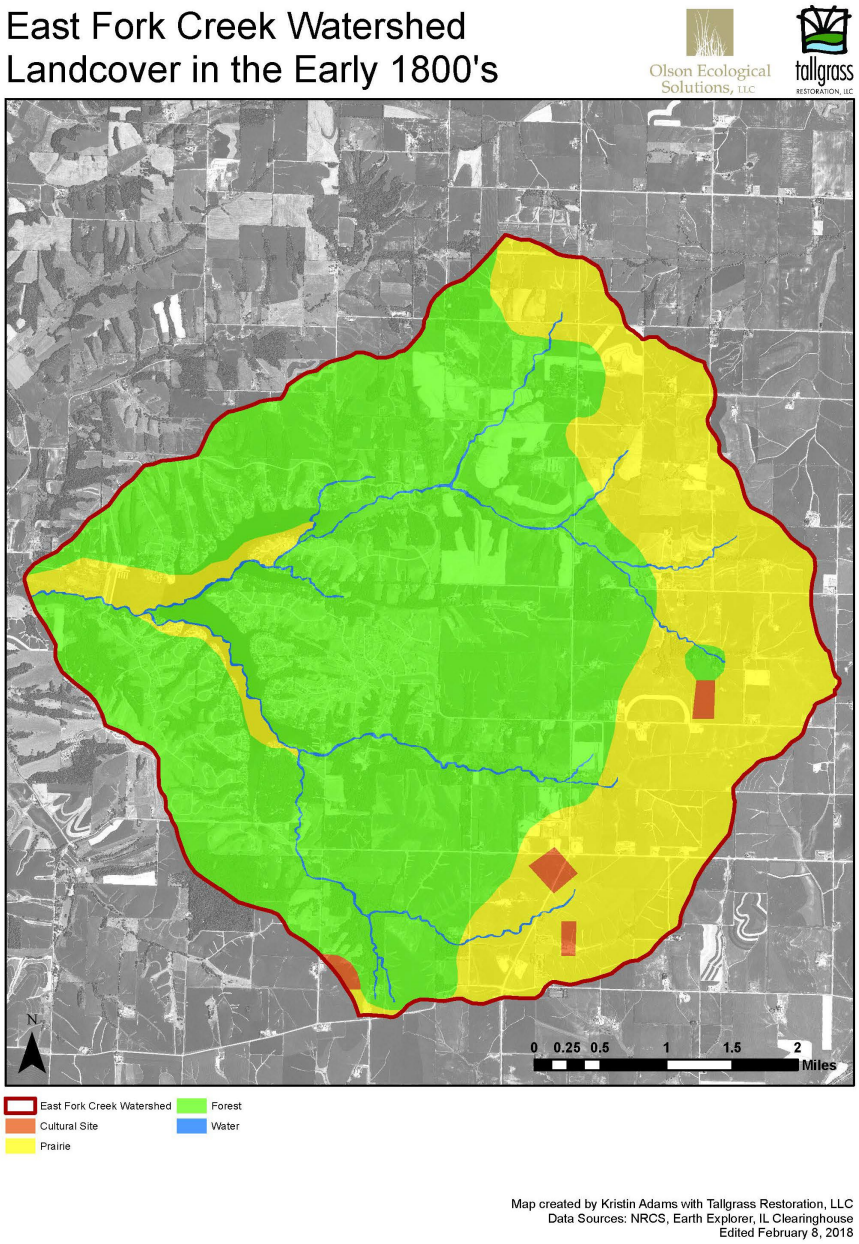


Figure 14 East Fork Creek Watershed, Land Cover

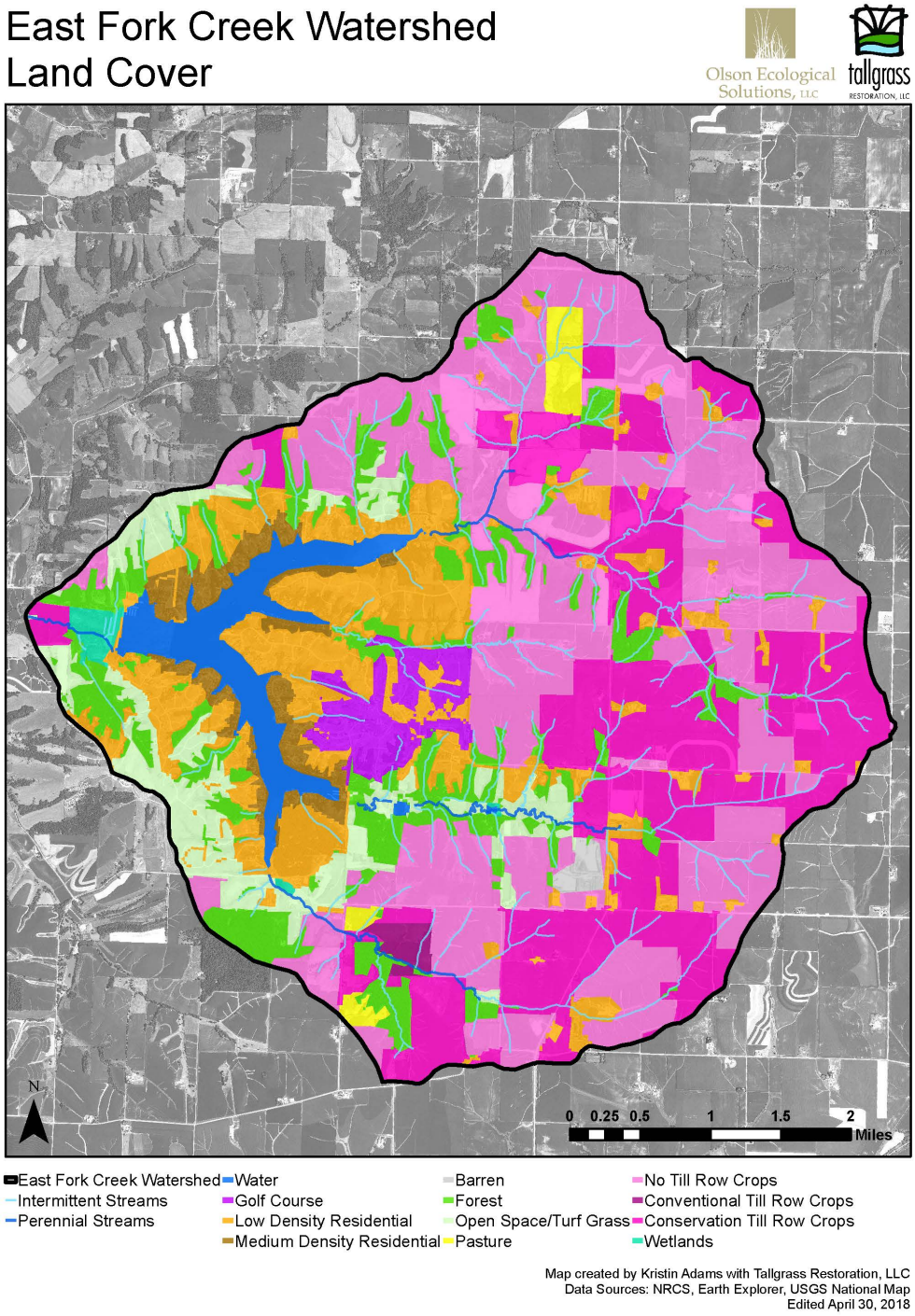


Table 4.2 National Land Cover Database 2011 (NLCD2011) Legend

Class\ Value	Classification Description
Water	
11	**Open Water (Intermittent Streams, Perennial Stream, and Water)**- areas of open water, generally with less than 25% cover of vegetation or soil.
Developed	
21	**Developed, Open Space (Open Space/Turf Grass)**- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	**Developed, Low Intensity (Low Density Residential)**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	**Developed, Medium Intensity (Medium Density Residential)** -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
Barren	
31	**Barren Land-Rock/Sand/Clay (Barren)**- areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
41	**Deciduous Forest (Forest)**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
Planted/Cultivated	
81	**Pasture/Hay (Pasture)**-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

82	**Cultivated Crops (No Till, Conservation Till, and Conventional Till Row Crops)** - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
90	**Woody Wetlands (Wetlands)**- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	**Emergent Herbaceous Wetlands (Wetalands)**- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

(Multi-Resolution Land Characteristics Consortium)

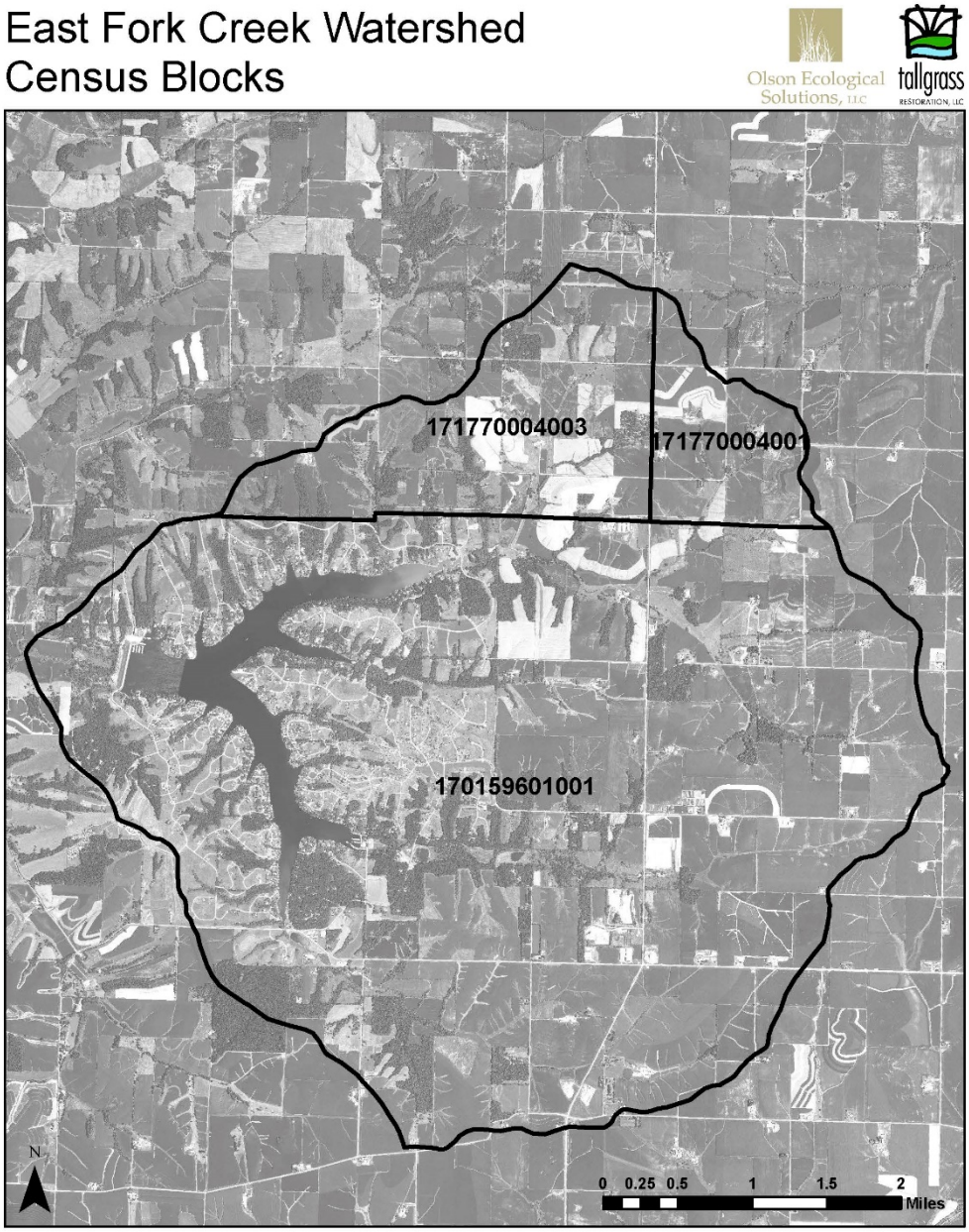
Table 4.3 Land Cover Acreage

Land Cover Acreage	
Land Cover Type	Acreage
Water	590.06
Golf Course	388.38
Low Density Residential	2,124.16
Medium Density Residential	423.24
Barren	60.54
Forest	1,525.13
Open Space/Turf Grass	953.55
Pasture	182.01
No Till Row Crops	4,718.41
Conventional Till Row Crops	77.83
Conservation Till Row Crops	3,304.54
Wetlands	78.37
Total acres:	**14,426**

Table 4.4 Land Cover Acreage by Subwatershed

Land Cover Acreage by Subwatershed								
Land Cover Type	A (Acres)	B (Acres)	C (Acres)	D (Acres)	E (Acres)	F (Acres)	G (Acres)	H (Acres)
Water	0.00	0.00	38.92	29.28	38.47	230.80	251.00	1.58
Golf Course	0.00	0.00	132.18	0.17	143.73	112.24	0.00	0.06
Low Density Residential	79.94	227.58	325.54	252.34	290.28	377.65	416.66	54.17
Medium Density Residential	0.00	0.00	59.42	19.22	23.79	135.56	185.25	0.00
Barren	0.00	0.00	59.63	0.91	0.00	0.00	0.00	0.00
Forest	115.56	227.97	333.90	306.93	64.51	67.81	228.67	179.78
Open Space/Turf Grass	0.00	0.00	216.42	305.85	0.00	79.41	196.46	155.41
Pasture	126.11	0.05	0.01	55.74	0.00	0.00	0.10	0.00
No Till Row Crops	847.88	1,477.69	749.49	929.40	310.99	0.00	371.97	30.70
Conventional Till Row Crops	0.00	0.00	0.00	77.83	0.00	0.00	0.00	0.00
Conservation Till Row Crops	243.70	1,184.60	877.74	891.45	13.46	0.00	42.59	51.00
Wetlands	0.00	0.00	3.11	5.90	0.00	0.00	0.00	69.36
Total	1,413.19	3,117.89	2,796.36	2,875.02	885.23	1,003.47	1,692.70	542.06

Figure 15 East Fork Watershed Census Blocks



Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: U.S. Census Bureau, Earth Explorer
Aerial Imagery Date: July 2015
Edited October 19, 2018

Part 4: Geology and Climate

Geology

The geologic features of the East Fork Creek Watershed were governed by steep, rolling topography influenced by lack of glacial activity, bedrock geology, and forces of wind and water combined with silty soils. The footprint of the Wisconsin Driftless System remained unglaciated during the major glacial periods, causing an unusual lack of glacial till and a steep and varied bedrock formation. This was represented by a large escarpment of brownish-gray dolomite bedrock, formed during the Silurian Period from the carbonic mineral dolomite, weathered only by wind and water. Silurian System made up most of the watershed, with Marquoketa Shale Group in its streambed.

Before Lake Carroll was formed in the early 1970s, exposed bluffs extended far above the perennial streams. The bedrock geology of the perennial stream basins included exposed Maquoketa shale and dense clay in areas where dolomite had long been weathered away (NRCS, 2008; Elmer and Higgins, 2006; and McGarry, 1997). Maquoketa shale, predominantly a clay-associate shale within beds of soft limestone and dolostone (non-bedrock), was formed from clay washed into the shallow inland sea that covered the central North American continent during the late Ordovician Tippicanoe Transgression. The dense clay that made up the bulk of the Maquoketa shale, often called “blue clay” in well logs, was nearly impermeable to groundwater. Due to the contrast in permeability between the shale and the overlying dolostone, springs and seeps were common along the contact (Kolata, 2010). In the eastern parts of Carroll County, including the upper reaches of this watershed, silt deposits on dolomitic bedrock with a slope of up to 60% were often only five inches thick, increasing to 10 feet thick on ridge tops. This depth and elevation influenced the development and diversity of soil types (Elmer and Higgins, 2006).

Wind-blown sediments from the Quaternary Period overlaid dolomite from the Silurian System throughout the entire watershed outside of the streambed. Silty sediments known as loess allowed the development of mineral soils at the soil’s surface (see comparison of Figure 1512 and Figure 1613). In the eastern part of the watershed, deposits of wind-blown Loess were deeper, and several of the streams and tributaries developed with less of a tree pattern because they were more influenced by thick silty-loam soils, shallower slopes, and remarkably less bedrock near the surface. Moving generally from east to west, the depth of these windblown sediments decreased (Elmer and Higgins 2006). From east to west and in shallower gradients, land cover changed in response the depth of wind-blown sediment. In general, there was a transition from farms in the east to woodlots and residential development on the more exposed rocky escarpment to the west. To the north of East Fork Creek and its watershed, the geologic features allowed for up to five feet of glacial till in the southwest Yellow River Watershed, compared to hundreds of feet in most of the East Fork Creek Watershed and none in the escarpment.

The forces of water cut streams through the changing elevations that varied by each subwatershed and stream valley combined with the ancient, slowly weathering dolomite rock and temperate climate that promoted abundant rainfall. Within the streams, the forces of water over a very long period of time weathered the dolomite rocky escarpment, bringing it to the shale and clay below in some places and allowing sedimentation of silty sediment. This sediment formed in the creek bed over deposits of ancient Maquoketa shale and other rocks older than the dolomite bedrock that loomed over them (McGarry, 1997). Streams naturally meandered through silt loam soils over dolomite bedrock, sometimes reaching the impervious clays below the bedrock. The watershed’s consistent, moderately-soft, ancient Silurian dolomite overlaid by relatively shallow, silty soils allowed for an even erosion pattern (see Figure 15). The streams formed with a great distance in between tributaries and in a

westerly path. Water cut a system of steeply sloped ravines resembling a tree when viewed on a map, which drained the basins via intermittent streams. In some of the watershed, intermittent streams drained directly into inlets to the lake (See Figure 17). Other intermittent streams became perennial streams, forming the four main tributaries to Lake Carroll and East Fork Creek.

Topography

The upper reaches of the East Fork Creek Watershed had steep and rolling topography with knobby hills, while the lower portion of the watershed was flatter (See Figure 18). Deep-cut ravines lined the streams in areas of distinct topographic relief, especially near Lake Carroll. The slopes and elevations of these areas varied throughout the watershed. According to the National Resource Conservation Service "Web Soil Survey," the majority of the watershed had greater than 5% but less than 30% slopes. Relatively few areas had slopes of greater than 30%, and the areas that were this steep were below the dam on the drainage of Lake Carroll and on some of the bluffs over the lake or streams. The eastern portion was more shallowly sloped and supported somewhat deeper silty-loam sediments. Expectedly, a slope of less than 5% was found across the lake bed, throughout most of the weathered network of perennial streams, and in some of the intermittent streams. The land area sloped greater than 5% was spread over most of the stream network (see Table 5 and Figure 19). The highest elevation was usually 980 feet above mean sea level but reached 990 feet in spots in both the northern and western corners of the watershed, and the lowest elevation was 680 feet above mean sea level at the confluence of the East Fork Creek and East Plum River. The impoundment at Lake Carroll was at 720 feet above mean sea level (see Figure 20).

Climate

Climate, as described in the Carroll County Soil Survey, was a major factor in the formation of soils, influencing plant and animal life. As reported in the survey, climate affected weathering of minerals and transportation of sediments in our watershed. The climate of this region had four distinct seasons and was an especially important factor to the crop producers in the area. Climactic factors included in this analysis were temperature and precipitation.

In Carroll and Stephenson Counties, the climate was temperate and humid. Climate had an overall significant difference with soil formation, but it was not likely to vary within a watershed (Elmer and Higgins, 2006). Average winters saw highs in the 30s and lows in the teens, with an average of 142 days at or below 32°F and 16 days at or below 0°F. Average summers had highs in the 80s and lows in the 60s with 24 days at or above 90°F and one day over 100°F occurring about every other year. Spring and fall had moderate temperatures, with spring highs around 57°F and lows of 36°F and fall highs of 60°F and lows of 40°F. The average length of the frost-free growing season was 165 days. The last occurrence of 32°F each year in the spring was on average April 28, and the first occurrence of this temperature in the fall was on average October 7 (ISWS, 2013).

Average precipitation in the East Fork Creek Watershed and the rest of the Plum River region varied greatly from year to year and between decades. Trends over the past 60 years showed significant increases, while the same data only amounted to slight increases when considering the past 100 years (IDNR, 2001). On average, the watershed and the rest of northern Illinois received from 32 (ISWS, 2005 to 2013) to 40 inches of precipitation annually and was subject to droughts, major prolonged wet periods, and flash floods that dropped four to eight inches of rainfall in a few hours in localized areas.

There were on average 117 days of measurable precipitation, including eight days with one inch or more of rainfall and 12 days with one inch or more of snowfall. Once per year on average, the area experienced a snowfall of six inches or more. The average annual snowfall was 35 inches (ISWS, 2005 to 2013). April, May, and June were typically the wettest months and January and February were the driest. Of the annual average rainfall, 65% usually fell during April through September (ISWS, 2013). Thunderstorms accounted for about 50 - 60% of the precipitation, half of which occurred between June and August. Typically, snow storms that released one inch or greater of snowfall per storm occurred between November 20 and March 26 (ISWS, 2013). Table 6 provided a snapshot of precipitation and temperature monthly averages for the most recent full year, 2017 (Wunderground, 2018).

Table 5 Representative Slope

Representative Slope		
Slope (% Rating)	Acreage	% Watershed
0	626.15	4.340
0.5	23.40	0.162
0.9	143.88	0.997
1	678.25	4.701
3	2.87	0.020
3.5	229.92	1.594
4	1801.82	12.490
6	370.88	2.571
7.5	2734.92	18.958
8	3348.20	23.209
9	306.86	2.127
10	19.47	0.135
14	2477.18	17.171
15	11.38	0.079
16	439.73	3.048
23.5	86.59	0.600
26.5	70.29	0.487
27	964.24	6.684
48	90.42	0.627

Table 6 Precipitation and Temperature Monthly Averages for 2017 for East Fork Creek Watershed

Precipitation and temperature monthly averages for 2017 for East Fork Creek Watershed							
Year	**Month**	**Total Precipitation**	**Temperature Average (F)**			**Degree Days**	
		(inches)	**Max.**	**Min.**	**Average**	**Heat Base 65**	**Cool Base 65**
2017	**Jan.**	0.53	30	19	25	40	0
	Feb.	0.24	44	24	34	31	0
	Mar.	0.82	45	27	36	29	0
	Apr.	0.67	61	39	50	15	0
	May	0.94	66	46	56	10	0
	Jun.	2.21	80	58	69	1	5
	Jul.	1.54	78	60	69	1	5
	Aug.	0.81	76	54	65	1	1
	Sep.	0.16	77	50	64	4	3
	Oct.	1.14	63	44	53	12	0
	Nov.	0.22	44	27	36	30	0
	Dec.	0.19	30	15	23	42	0
2017	**Total**	**9.47**	**58**	**39**	**48**	**18**	**1**
2017	**Winter**	0.53	40	23	32	33	0
2017	**Spring**	1.27	69	48	58	9	2
2017	**Summer**	0.84	77	55	66	2	3
2017	**Fall**	0.52	46	29	37	28	0
Station: Freeport, IL. Weather Underground. www.wunderground.com. February 2, 2018.							

Figure 16 East Fork Creek Watershed, Bedrock Geology

Figure 17 East Fork Creek Watershed, Quaternary Deposits

Figure 18 East Fork Creek Watershed, Erosion Hazard

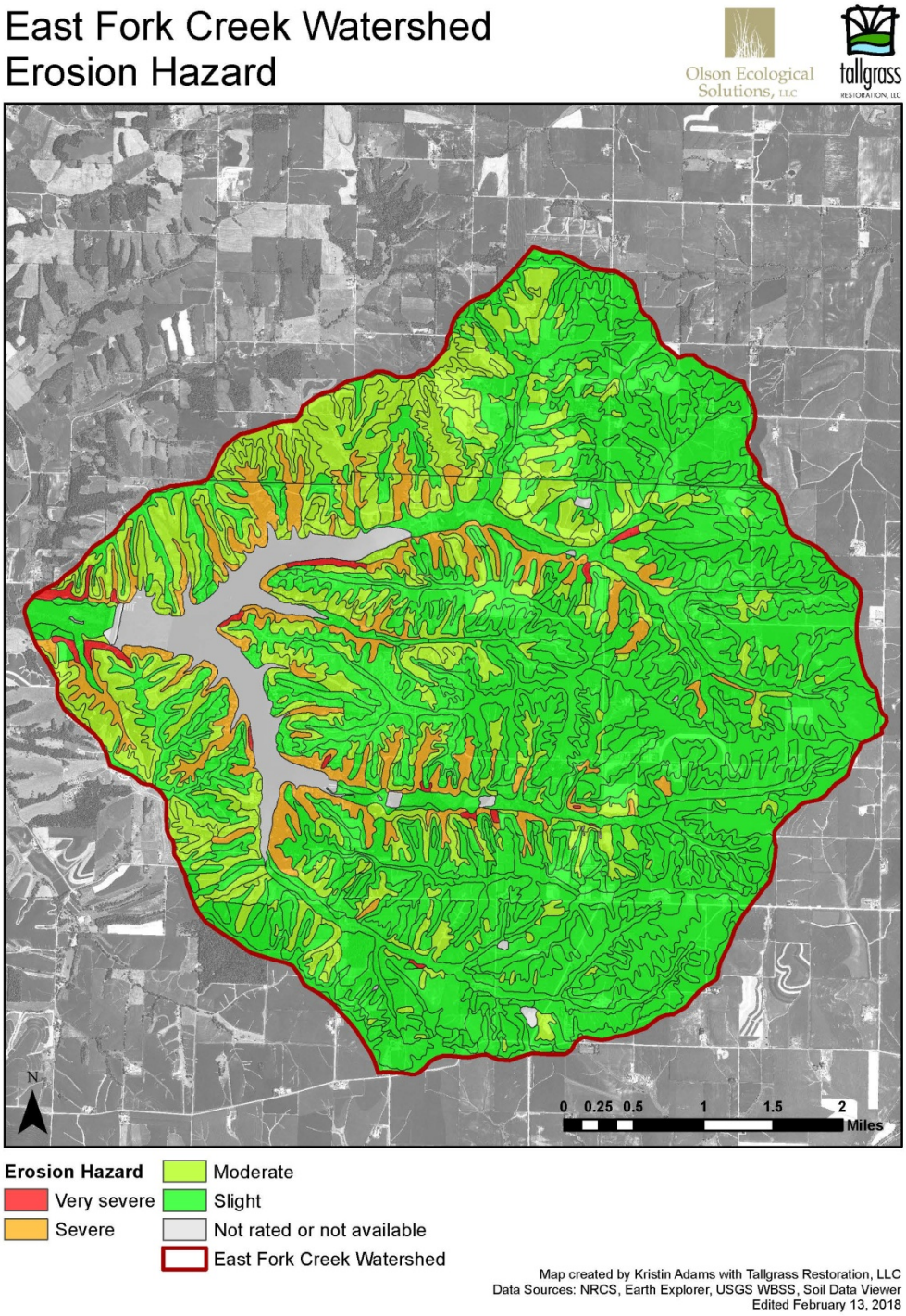


Figure 19 East Fork Creek Watershed, Topographic Relief

Map created by Kristin Adams with Tallgrass Restoration, LLC
Data Sources: NRCS, ESRI
Edited February 2, 2018

Figure 20 East Fork Creek Watershed, Representative Slope (S)

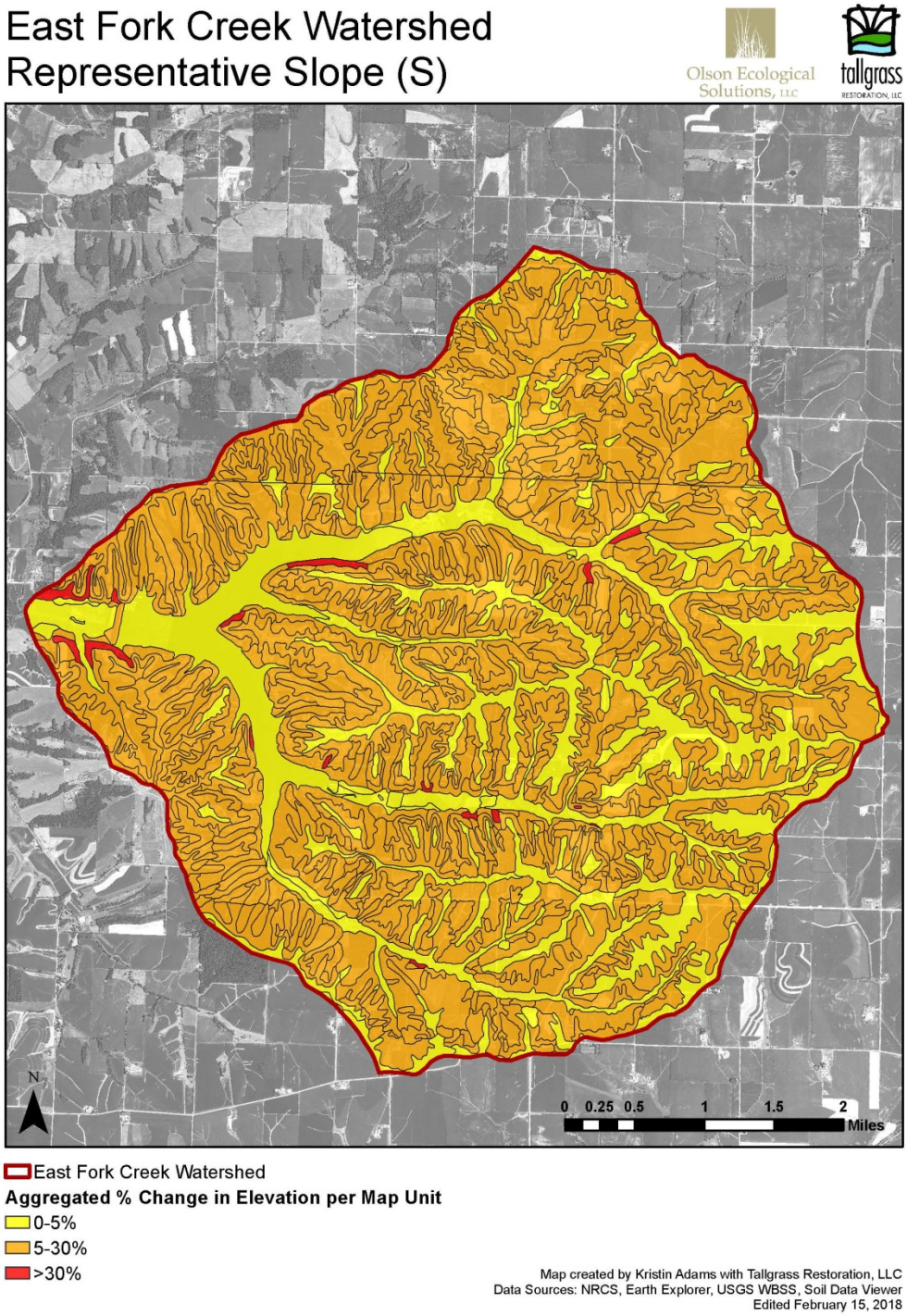
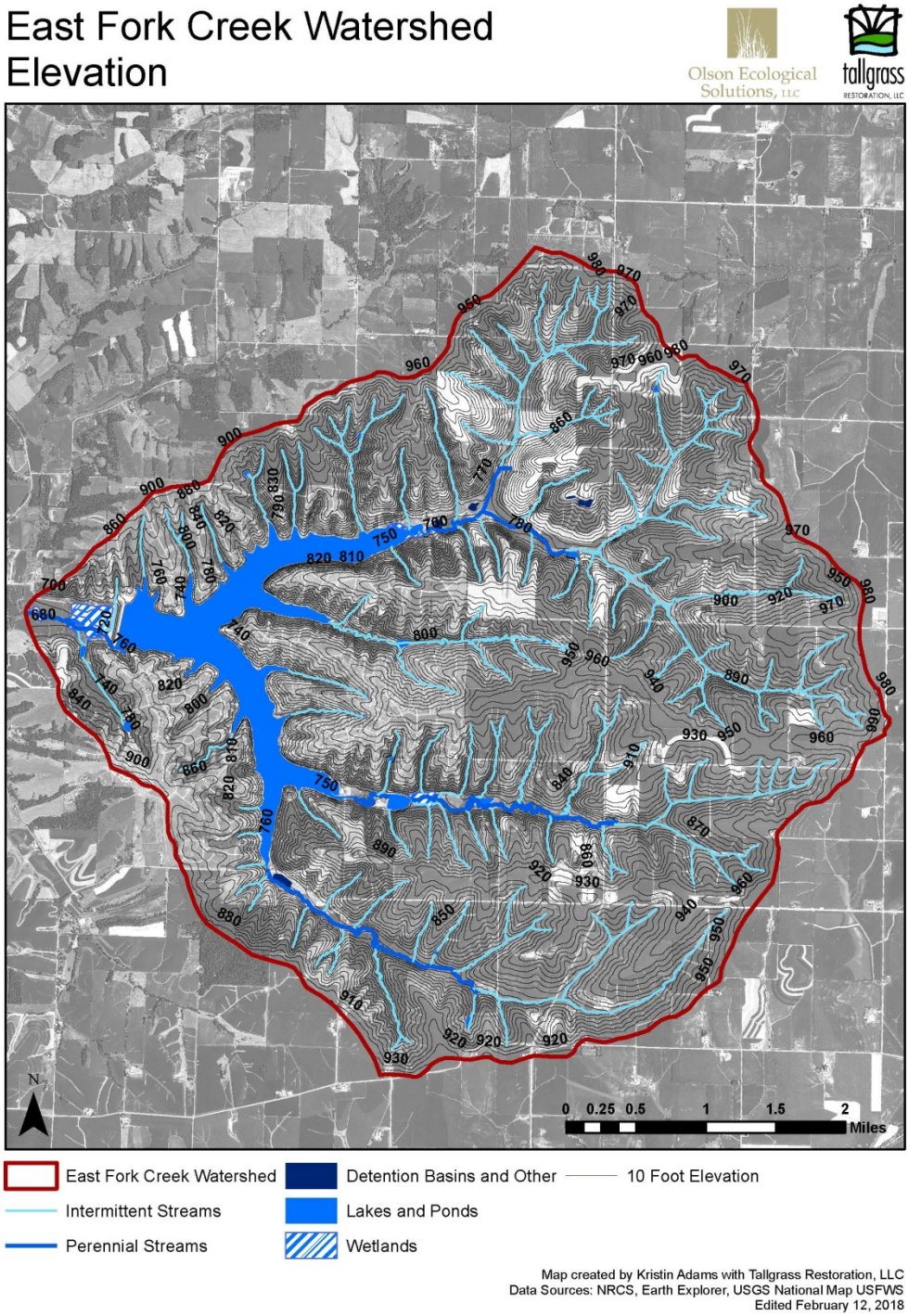


Figure 21 East Fork Creek Watershed, Elevation



Part 5: Soils

Soil development progressed intricately in the East Fork Creek Watershed's shallow bedrock valleys and silty loess plains. As described above, soils were influenced by topography changes and a long, unglaciated history favoring extensive weathering and soil development. This weathering caused the development of an extensive diversity of silt loams across the landscape. To understand soils in the watershed and their role in water quality, we looked at soil texture, types, farmland quality, hydric developments, hydrological groups and water transmission, drainage class, erodibility by water and wind, soil loss tolerance, and highly erodible lands (HELs).

Soil Texture

The soils of the East Fork Creek Watershed developed a silty texture, vastly present as silt loams (88%) with some areas of silty clay loams (7%). The remaining area was classified as water, earthen dam, and quarry (see Table 7 and Figure 21). The silt was provided by the windblown deposits that occurred over geologic time (Elmer and Higgins, 2006). Some exception to silt loam texture occurred along the major streams or washed-out bluffs. In the larger Plum River Watershed of which East Fork Creek Watershed is a part, lacustrine deposits of silty clay to clay developed in the upper few feet of terraces north and east of Savanna. In most stream basins, the wind first deposited silty loess-formed silt loams, which eroded and then sedimentary forces developed either silty clay loams or sandy loams (Ray and Fehrenbacher 1975).

Major Soil Types

Due to the complex topography over the dolomite bedrock and shale and clay beds, combined with the lack of glaciation, there were 87 different soil mapped units in the watershed (NRCS, 2018). None of the soil units represented more than 11% of the watershed area (see Table 9 and Figure 22). Each separate unit was a different soil type with associated percent slope. When we combined soil mapped units of the same soil type with different slopes, we found 49 soil types. The five soil types making up the majority of the watershed were Fayette silt loam (13.48% of the watershed), Palsgrove silt loam (12.27%), Newglarus-Palsgrove silt loams (8.95%), Osco silt loam (8.65%), and Newglarus –Lamoille silt loams (7.31%).

Farmland Quality

Soils are evaluated for their ability to produce food, feed, forage, fiber, and oilseed crops. Illinois soils fall into prime farmland, important farmland (farmland of statewide importance), or other land (not prime farmland). Prime farmland produced the highest yields with the lowest expenditure of energy and economic resources and was the least damaging to the environment. Important farmland was generally less productive than prime farmland and possessed greater restrictions that negatively affected its use for agricultural purposes. Other land may have possessed the potential for use as farmland, but some restriction(s) prevented its use for agriculture (Illinois Dept. of Agriculture, 2001).

There was a minority of prime farmland in the watershed (18.56%, 2,677 acres), with a small amount of prime farmland if protected from flooding (0.85%, 122 acres) or drained and protected from flooding

(0.30%, 44 acres). Most of the land of the watershed was ranked as either farmland of statewide importance (46.17%, 6,661 acres) or not prime farmland (34.12%, 4,923 acres). The prime farmland was mostly located at the highest elevations on the ridgetops between ravines, with a small amount located within flat valleys. This arrangement created long, skinny veins of prime farmland, usually correlating with representative slopes of 5% or less. Surrounding these veins were farmlands of statewide importance and not prime farmland, correlating with slopes greater than 5% (see Table 10 and Figure 23).

Hydric Soils

Few places existed along streams where water flow was slow enough to allow for flooding frequent enough to promote hydric soil development. Hydric soils were poorly drained soils, prone to flooding or wet conditions if not drained, which were sufficiently wet enough to develop anaerobic conditions in the upper part of the soil. They were naturally associated with wet prairies, forest floodplains, and wetlands, as they were either saturated or inundated long enough to support the growth of hydrophytic vegetation (USDA NRCS, n.d.).

Each soil map unit was rated based on its percentage of nonhydric and hydric components. Most of the watershed (89%) supported soils rated non-hydric. Only 0.16% of the watershed had dominantly hydric soils, rated as 90% hydric. Another 11% of the watershed had soils dominated by nonhydric soils but with 1% to 7% of its area with minor hydric components in the lower positions of the landscape (USDA NRCS, n.d.) (see Table 11.1 and Figure 24).

Hydrological Soil Groups and Water Transmission

Hydrological Soil Groups (HSG) explained the runoff response potential of soils based on transmission rate of water; depth to water table or restrictive layer; and soil texture, structure, and degree of swelling when saturated. Soils were assigned into four groups: A, B, C, or D. HSG A included soils with low runoff potential when thoroughly wet, so that water transferred freely through the soil. HSG B included soils with moderately low runoff potential. HSG C included soils with moderately high runoff potential, and HSG D included soils with high runoff potential. Furthermore, if a soil in HSG D was drained, it was assigned a dual class of either A/D, B/D, or C/D, with the first letter indicating the characteristic of the drained soil (NRCS, 2007).

A little more than half of the soils in the watershed (55.93%, 8,068 acres) fell in HSG B with moderately low runoff potential. Soils in this group tended to be sandy loam or loamy sand textures with 50% to 90% sand and 10% to 20% clay, but the silt loams of this watershed were included if they were well aggregated, had low bulk density, or contained more than 35% rock fragments. Another 1/3rd of the watershed (30.5%, 4,399 acres) had soils in HSG C with moderately high runoff potential, as water transmission through the soil was somewhat restricted. Typically, soils in this group were like those found in the watershed, silt loam and silty clay loam, but they could also have been loam, sandy clay loam, and clay loam textures with 20% to 40% clay and less than 50% sand. Soils in HSG D made up another 7% of the watershed (1,016 acres). These soils, typically clay textures with more than 40% clay and less than 50% sand, had high runoff potential and restricted or very restricted water movement through the soil. Usually the depth to a water impermeable layer was less than 20 inches and depth to

water table was less than 24 inches (NRCS, 2007). Some soils in the watershed that were naturally in HSG D were drained and therefore assigned a dual classification of B/D or C/D. These soils made up less than 2% of the watershed. HSG A was scarce, covering only 37 acres (0.26%) of the watershed. HSG C and D soils were recorded along around the lower portion of intermittent streams and around inlets to Lake Carroll while soils in HSG B were not as directly related to water paths (see Table 11.2 and Figure 25).

Soil Drainage Class

Soil drainage class referred to the frequency and duration of wet periods for soils in their natural condition, without artificial drainage and under conditions similar to those under which the soil formed. Within the watershed, five of the seven soil drainage classes were represented. The vast majority of soils were well drained, covering 88% of the watershed. In well drained soils, water was removed from the soil readily but not rapidly. Water was available to plants throughout most of the growing season, yet wetness did not inhibit growth of roots for significant periods of time during most growing seasons (Soil Survey Division Staff, 2017). There were also moderately well drained soils covering 4.5% of the watershed in Subwatersheds A and B, and another 3% of land coverage scattered throughout the watershed was made up of poorly drained, somewhat poorly drained, and somewhat excessively drained soils. These soil drainage classes had some correlation to hydrologic soil groups, as soils in classes other than well drained occurred on some of the B/D, C, and D HSGs. The soil drainage classes were not correlated to hydric soils or soil texture, and they had little to no correlation to prime farmland classifications (see Table 12 and Figure 26).

Soil Erodibility

Soil erosion, defined as the breakdown, detachment, transport, and redistribution of soil particles caused by water and wind combined with gravity, was of particular interest for the watershed due to its off-site impacts to water quality. Throughout the nation, soil erosion on cropland had been on a downward trend, decreasing by 43% between 1982 and 2007. Geographically, 54% of soil erosion from water had occurred in two of ten farm production regions in the United States, including Illinois, which emphasized the national importance of reducing erosion in northwest Illinois and this watershed. Expected erosion rates of soil were a factor of long-term climate data, inherent soil and site characteristics, and cropping and management practices (USDA NRCS, 2010). Understanding the first two factors will aid in recommending best management practices involving the third. In order to understand the characteristics of the soil, we looked at soil erodibility according to erosion by water, wind, or tolerance of soil loss on cropland. We determined soil erodibility by water using soil erosivity factor (K factor). We determined Wind Erodibility Group (WEG) to assess soil erodibility via wind, and we used the soil loss tolerance factor (T factor) to determine the tolerance of soil loss on cropland.

Soil Erodibility by Water

Soil eroded by water was assigned a soil erosivity (K) factor based on how easily soil detached and was transported by rainfall and runoff (NRCS, 2015). Soil with a higher K factor, on a scale of 0.02 to 0.64, was more susceptible to sheet and rill erosion by water. These estimates were based primarily on percentage of silt, sand, and organic matter; soil structure; and saturated hydraulic conductivity (Ksat).

Soils having a medium texture, like the silt loams and silty clay loams of the watershed, had moderate K values, generally about 0.25 to 0.4, because they were moderately susceptible to detachment and they produced moderate runoff. Soils with higher silt content most easily detached and tended to produce high rates of runoff, and these soils tended to have a K value higher than 0.4 (Institute of Water Research, 2002).

Soils generally were highly susceptible to detachment and produced high rates of runoff, with 47.84% of the soils throughout the watershed having an erosivity (K) factor of 0.43. Roughly the same amount of soils throughout the watershed were moderately susceptible to detachment and produced moderate rates of runoff, as 37.39% of soils in the watershed had a K factor of 0.37 and another 9.59% had a K factor of 0.32. With 4.42% of the soils not rated or unavailable, there were just 0.38% of the soils falling below 0.32 and 0.37% ranking above 0.43. Higher soil erosivity (K) factors in the watershed were seen in areas with hill and bluff topography elevated above the streams. In this area, wind-deposited soil became relatively thin. The lowest K factors were seen on the less eroded, undulating plains between the headwater streams where bedrock was significantly deeper (McGarry, 1997) (see Table 13 and Figure 27).

Soil Erodibility by Wind

Wind Erodibility Groups (WEG) consisted of soils that had similar properties affecting their susceptibility to wind erosion in cultivated areas: Group 1 soils were the most susceptible and Group 8 were the least susceptible. Most of the soils in the watershed (86.15%) were in WEG 6, with a small representation of Groups 5 (5.19%) and 4L (4.24%). There was 4.42% of the watershed that was not assessed (see Table 10 and Figure). WEG 6 could be silt loam with greater than 20% clay content and 45% nonerodible surface soil aggregates larger than 0.84 mm in diameter. WEG 5 could also be silt loam, but with less than 20% clay content and 40% nonerodible surface soil aggregates. WEG 4L, the soil most susceptible to wind erosion found in the watershed, could be silt loam or silty clay loam with 25% nonerodible surface soil aggregates (Wind Erodibility Groups, 2002). These more susceptible soils were associated with streambeds (see Table 14 and Figure 28).

Soil Loss Tolerance

Soil loss tolerance (T factor) was the estimated maximum rate of annual soil erosion that would allow crop productivity to be sustained economically and indefinitely. The five classes of soil loss tolerance ranged from one ton per acre per year for very shallow soils to five tons per acre per year for very deep soils (USDA NRCS, 2015). Much of the headwaters and higher elevations (41.63% of the watershed) had deeper soils and a T factor of 5, suggesting that these areas could erode 5 tons per acre per year and still sustain crop productivity. Another 19.87% of the watershed had soils with a T factor of 3. These areas correlated strongly with HSG B (and T factor 5 was also correlated with HSG B/D) but did not follow their boundaries exactly. Soils with a T factor of 2 made up another 23.19% of the watershed and seemed greatly associated with ravines and HSG C. The remaining soils had a T factor 1 pertaining to 6.24% of the watershed and associated with HSG C/D, or they had a T factor of 4 in 4.65% of the watershed on HSG C soils. The remaining 4.42% of the watershed was not rated or not applicable (see Table 15 and Figure 29).

Highly Erodible Land (HEL)

Highly erodible lands (HEL) were a big part of this hilly watershed. Cropland, residential, forest and open space, and a golf course all have highly erodible lands to consider with acreages of about 3000, 1200, 1000, and 200 respectively (See Table 8 and Figure 30).

When enrolling farmland into a program considering highly erodible land, it is possible to enroll whole agricultural fields that either had over 33.33% or more than 50 acres of highly erodible soils could be included (Justia US Law, *7 C.F.R. Subpart B – Highly Erodible Land Conservation)*. These highly erodible soils were characterized by soil map units with an erodibility index (EI) of 8 or greater.

HEL status was recorded by Farm Service Agency in 1990 in their Common Land Unit database (CLU). It was called for in the 1985 Food Security Act Farm Bill as a compliance requirement for farmers who used the benefits offered by US Department of Agriculture. The purpose was to minimize soil erosion, preserve land fertility of farmland, and protect water quality along with the nation's wetlands (NRCS, *Background on Highly Erodible Land Compliance*). This database used by the Natural Resources Conservation Service (NRCS) and Farm Services Agency (FSA) for HEL status determination had not been updated since 1990 to include the current erodibility indexes. It was also not available for public use. Despite this, the erodibility index could still be calculated by soil map unit to determine if there was a value over 8 although it wouldn't necessarily be classified as HEL by FSA standards.

Table 7 Soil Texture

Soil Texture			
Surface Texture		Acres	% Watershed
Earthen Dam		11.38	0.08
Pits, Quarries		13.04	0.09
Silt loam		12753.93	88.41
Silty clay loam		1034.99	7.17
Water		613.10	4.25

Table 8 Highly Erodible Land (HEL) by Land Use

Landuse of Highly Erodible Lands	
Land Use Type	Acreage
Water	1.878221
Golf Course	209.0312
Low Density Residential	982.3342
Medium Density Residential	165.5502
Barren	43.8434
Forest	474.1086
Open Space/Turf Grass	480.5054
Pasture	59.55811
No Till Row Crops	1915.378
Conventional Till Row Crops	51.46825
Conservation Till Row Crops	963.0193
Wetlands	4.096468

Table 9 Soil Map Units Acreage

Soil Map Units Acreage

Map Unit	Name	Acres	% Watershed
429C2	Palsgrove silt loam, 5 to 10 percent slopes, moderately eroded	1583.519	10.98%
905F	Newglarus-Lamoille silt loams, silurian landscape, 18 to 35 percent	964.242	6.68%
86B	Osco silt loam, 2 to 5 percent slopes	898.583	6.23%
928D2	Newglarus-Palsgrove silt loams, silurian landscape, 10 to 18 percent	765.312	5.30%
280B2	Fayette silt loam, 2 to 6 percent slopes, moderately eroded	701.922	4.87%
W	Water	613.105	4.25%
8239A	Dorchester silt loam, 0 to 2 percent slopes, occasionally flooded	611.498	4.24%
280C	Fayette silt loam, glaciated, 5 to 10 percent slopes	605.388	4.20%
29D2	Dubuque silt loam, 10 to 18 percent slopes, moderately eroded	546.198	3.79%
280C2	Fayette silt loam, 5 to 10 percent slopes, eroded	530.897	3.68%
928C2	Newglarus-Palsgrove silt loams, silurian landscape, 5 to 10 percent	525.613	3.64%
419C2	Flagg silt loam, 5 to 10 percent slopes, eroded	507.173	3.52%
410D3	Woodbine silty clay loam, 10 to 18 percent slopes, severely eroded	374.001	2.59%
410D2	Woodbine silt loam, 10 to 18 percent slopes, eroded	294.652	2.04%
505E3	Dunbarton silty clay loam, 12 to 20 percent slopes, severely eroded	280.143	1.94%
412C2	Ogle silt loam, 5 to 10 percent slopes, eroded	275.134	1.91%
411C2	Ashdale silt loam, 5 to 10 percent slopes, eroded	237.197	1.64%
547C2	Eleroy silt loam, 5 to 10 percent slopes, eroded	217.989	1.51%
753C2	Massbach silt loam, 5 to 10 percent slopes, eroded	193.526	1.34%
86C2	Osco silt loam, 5 to 10 percent slopes, eroded	181.607	1.26%
506C2	Hitt silt loam, 5 to 10 percent slopes, eroded	177.171	1.23%
731C2	Nasset silt loam, 5 to 10 percent slopes, eroded	170.733	1.18%
21C2	Pecatonica silt loam, 5 to 10 percent slopes, eroded	170.060	1.18%
86C	Osco silt loam, 5 to 10 percent	168.220	1.17%

Table 9 (continued)

Map Unit	Name	Acres	% Watershed
675B	Greenbush silt loam, 2 to 5 percent slopes	162.498	1.13%
429D2	Palsgrove silt loam, 10 to 18 percent slopes, moderately eroded	161.264	1.12%
414C2	Myrtle silt loam, 5 to 10 percent slopes, eroded	160.540	1.11%
505D2	Dunbarton silt loam, 6 to 12 percent slopes, eroded	159.710	1.11%
505E2	Dunbarton silt loam, 12 to 20 percent slopes, eroded	159.586	1.11%
686C2	Parkway silt loam, 5 to 10 percent slopes, eroded	148.518	1.03%
505D3	Dunbarton silty clay loam, 6 to 12 percent slopes, severely eroded	147.152	1.02%
675C	Greenbush silt loam, 5 to 10 percent slopes	130.008	0.90%
3451A	Lawson silt loam, 0 to 2 percent slopes, frequently flooded	113.953	0.79%
675C2	Greenbush silt loam, 5 to 10 percent slopes, eroded	98.017	0.68%
905G	Newglarus-Lamoille silt loams, silurian landscape, 35 to 60 percent	90.422	0.63%
403E2	Elizabeth silt loam, 12 to 35 percent slopes, eroded	86.585	0.60%
419B	Flagg silt loam, 2 to 5 percent slopes	84.484	0.59%
227C2	Argyle silt loam, 5 to 10 percent slopes, eroded	76.052	0.53%
411B	Ashdale silt loam, 2 to 5 percent slopes	62.950	0.44%
417D2	Derinda silt loam, 10 to 18 percent slopes, eroded	60.706	0.42%
403F2	Elizabeth silt loam, 18 to 35 percent slopes, eroded	60.593	0.42%
546C2	Keltner silt loam, 5 to 10 percent slopes, eroded	59.489	0.41%
280D3	Fayette silty clay loam, glaciated, 10 to 18 percent slopes, severely	58.139	0.40%
418C2	Schapville silt loam, 5 to 10 percent slopes, eroded	53.929	0.37%
572C2	Loran silt loam, 5 to 10 percent slopes, eroded	52.440	0.36%
21D2	Pecatonica silt loam, 10 to 18 percent slopes, eroded	50.582	0.35%
417D3	Derinda silty clay loam, 10 to 18 percent slopes, severely eroded	45.526	0.32%
506C3	Hitt silty clay loam, 5 to 10 percent slopes, severely eroded	32.945	0.23%
21C3	Pecatonica silty clay loam, 5 to 10 percent slopes, severely eroded	32.326	0.22%
280D2	Fayette silt loam, 10 to 18 percent slopes, eroded	29.322	0.20%

Table 9 (continued)

Map Unit	Name	Acres	% Watershed
8451A	Lawson silt loam, cool mesic, 0 to 2 percent slopes, occasionally flooded	28.211	0.20%
21D3	Pecatonica silty clay loam, 10 to 18 percent slopes, severely eroded	28.182	0.20%
547D2	Eleroy silt loam, 10 to 18 percent slopes, eroded	27.205	0.19%
3579A	Beavercreek silt loam, 0 to 2 percent slopes, frequently flooded	27.058	0.19%
429B2	Palsgrove silt loam, 2 to 6 percent slopes, moderately eroded	25.622	0.18%
274B	Seaton silt loam, 2 to 5 percent slopes	25.198	0.17%
3107A+	Sawmill silt loam, 0 to 2 percent slopes, frequently flooded,	23.405	0.16%
233C2	Birkbeck silt loam, 5 to 10 percent slopes, eroded	21.814	0.15%
3333A	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	20.351	0.14%
40C2	Dodgeville silt loam, 5 to 10 percent slopes, eroded	19.474	0.13%
280C3	Fayette silty clay loam, 5 to 10 percent slopes, severely eroded	18.634	0.13%
547B	Eleroy silt loam, 2 to 5 percent slopes	15.252	0.11%
419D2	Flagg silt loam, 10 to 18 percent slopes, eroded	14.219	0.10%
864	Pits, Quarries	13.042	0.09%
835G	Earthen Dam	11.382	0.08%
686B	Parkway silt loam, 2 to 5 percent slopes	10.304	0.07%
8579A	Beavercreek silt loam, 0 to 2 percent slopes, occasionally flooded	10.152	0.07%
61B	Atterberry silt loam, 2 to 5 percent slopes	9.839	0.07%
21F2	Pecatonica silt loam, 18 to 35 percent slopes, eroded	9.694	0.07%
419D3	Flagg silty clay loam, 10 to 18 percent slopes, severely eroded	9.604	0.07%
414B	Myrtle silt loam, 2 to 5 percent slopes	8.888	0.06%
279B	Rozetta silt loam, 2 to 5 percent slopes	8.666	0.06%
416C3	Durand silty clay loam, 5 to 10 percent slopes, severely eroded	8.343	0.06%
8415A	Orion silt loam, 0 to 3 percent slopes, occasionally flooded	8.038	0.06%
37B	Worthen silt loam, 2 to 5 percent slopes	7.097	0.05%
745C2	Shullsburg silt loam, 5 to 10 percent	6.624	0.05%

Table 9 (continued)

Map Unit	Name	Acres	% Watershed
403D2	Elizabeth silt loam, 10 to 18 percent slopes, eroded	6.345	0.04%
40D2	Dodgeville silt loam, 10 to 18 percent slopes, eroded	5.918	0.04%
51B	Muscatune silt loam, 2 to 5 percent slopes	4.527	0.03%
105C	Batavia silt loam, 5 to 10 percent slopes	4.379	0.03%
81B	Littleton silt loam, 2 to 5 percent slopes	3.297	0.02%
731B	Nasset silt loam, 2 to 5 percent slopes	2.873	0.02%
732C	Appleriver silt loam, 5 to 10 percent slopes	1.982	0.01%
29C2	Dubuque silt loam, 5 to 10 percent slopes, moderately eroded	1.897	0.01%
417C2	Derinda silt loam, 5 to 10 percent slopes, eroded	1.835	0.01%
8074A	Radford silt loam, 0 to 2 percent slopes, occasionally flooded	1.715	0.01%
745B	Shullsburg silt loam, 2 to 5 percent slopes	1.598	0.01%
279A	Rozetta silt loam, 0 to 2 percent slopes	1.157	0.01%
198B	Elburn silt loam, 2 to 5 percent slopes	1.014	0.01%

Table 10 Prime Farmland Acreage

Prime Farmland Acreage		
Farmland Classification	Acres	% Watershed
All areas are prime farmland	2677.195	18.56%
Farmland of statewide importance	6660.741	46.17%
Not prime farmland	4922.776	34.12%
Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	43.755	0.30%
Prime farmland if protected from flooding or not frequently flooded during the growing season	121.992	0.85%

Table 11.1 Hydric Soil Groups Acreage

Hydric Soil Groups Acreage		
Hydric Rating (1-100)	Acres	% Watershed
0 (Non-Hydric)	12780.328	88.59%
1 (Low)	1.157	0.01%
2 (Low)	525.518	3.64%
3 (Low)	8.038	0.06%
4 (Low)	898.584	6.23%
5 (Low)	47.264	0.33%
6 (Low)	40.824	0.28%
7 (Low)	101.340	0.70%
90 (High)	23.405	0.16%

Table 11.2 Hydrologic Soil Groups Acreage

Hydrologic Soil Groups Acreage		
Hydrologic Soil Group	Acres	% Watershed
A	37.210	0.26%
B	8068.037	55.93%
B/D	266.791	1.85%
C	4398.503	30.49%
C/D	1.982	0.01%
D	1016.403	7.05%
Not Available	637.529	4.42%

Table 12 Soil Drainage Classes Acreage

Soil Drainage Classes Acreage		
Soil Drainage Class	Acres	% Watershed
Not rated or not available	637.529	4.42%
Moderately well drained	645.887	4.48%
Poorly drained	23.405	0.16%
Somewhat excessively drained	153.523	1.06%
Somewhat poorly drained	253.589	1.76%
Well drained	12712.521	88.12%

Table 13 Erosion Factor (Kw) Acreage

Erosion Factor (Kw) Acreage		
K Factor	Acres	% Watershed
Not rated or not available	637.530	4.42%
0.28	54.943	0.38%
0.32	1383.494	9.59%
0.37	5394.686	37.39%
0.43	6902.242	47.84%
0.49	53.564	0.37%

Table 14 Erosion Hazard Acreage

Erosion Hazard Acreage		
Erosion Hazard	Acres	% Watershed
Not rated or not available	637.529	4.42%
Slight	9672.747	67.05%
Moderate	3051.820	21.15%
Severe	973.936	6.75%
Very severe	90.422	0.63%

Table 15 Wind Erodibility Groups Acreage

Wind Erodibility Groups Acreage		
Wind Erodibility Group	Acres	% Watershed
Not rated or not available	637.530	4.42%
4L	611.499	4.24%
5	749.123	5.19%
6	12428.307	86.15%

Table 16 Erosion Factor (T) Acreage

Erosion Factor (T) Acreage		
T Factor	Acres	% Watershed
0	637.529	4.42%
1	900.114	6.24%
2	3346.155	23.19%
3	2866.064	19.87%
4	670.673	4.65%
5	6005.920	41.63%

Figure 22 East Fork Creek Watershed, Soil Texture

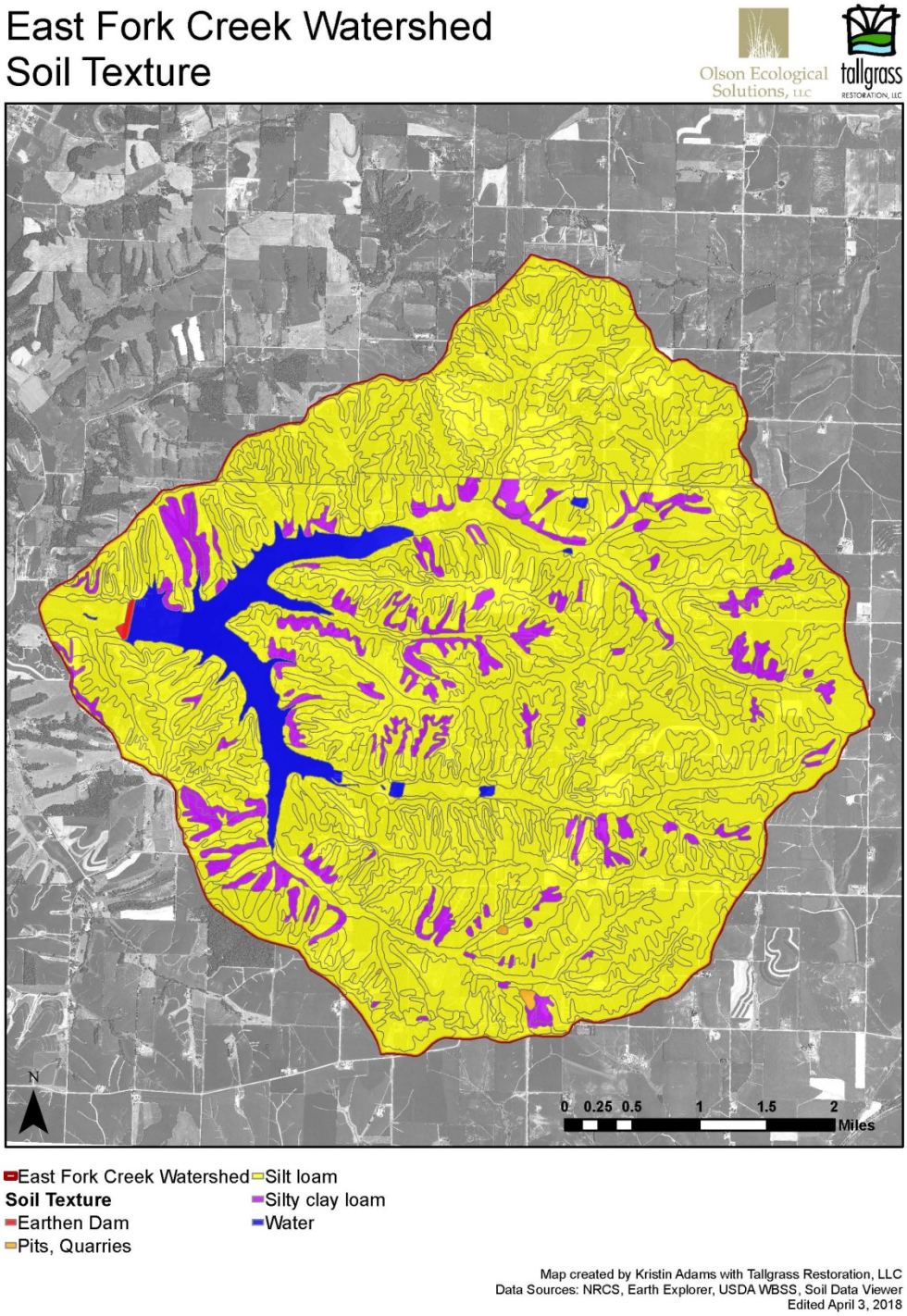


Figure 23 East Fork Creek Watershed, Soil Map Unit

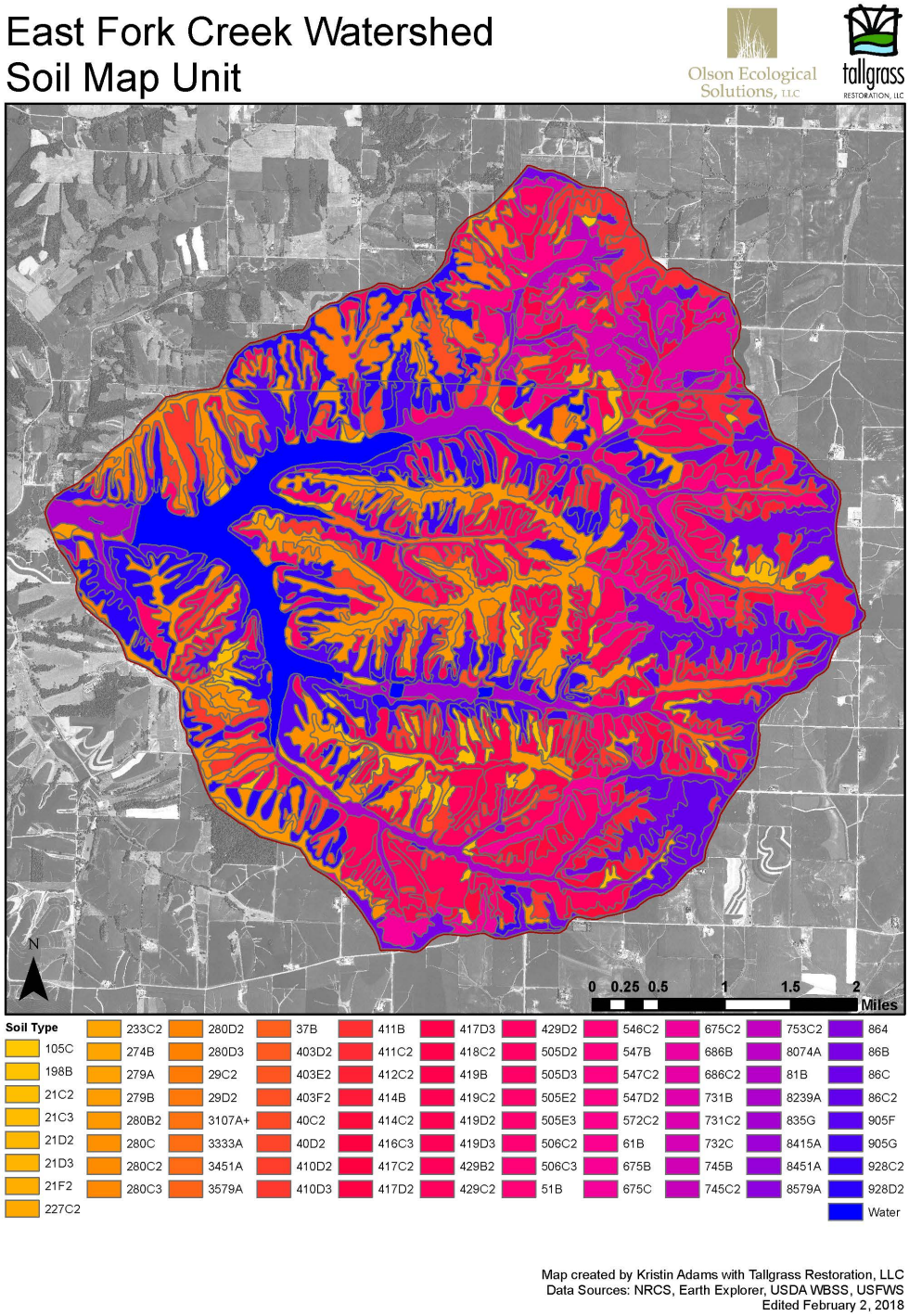


Figure 24 East Fork Creek Watershed, Prime Farmland

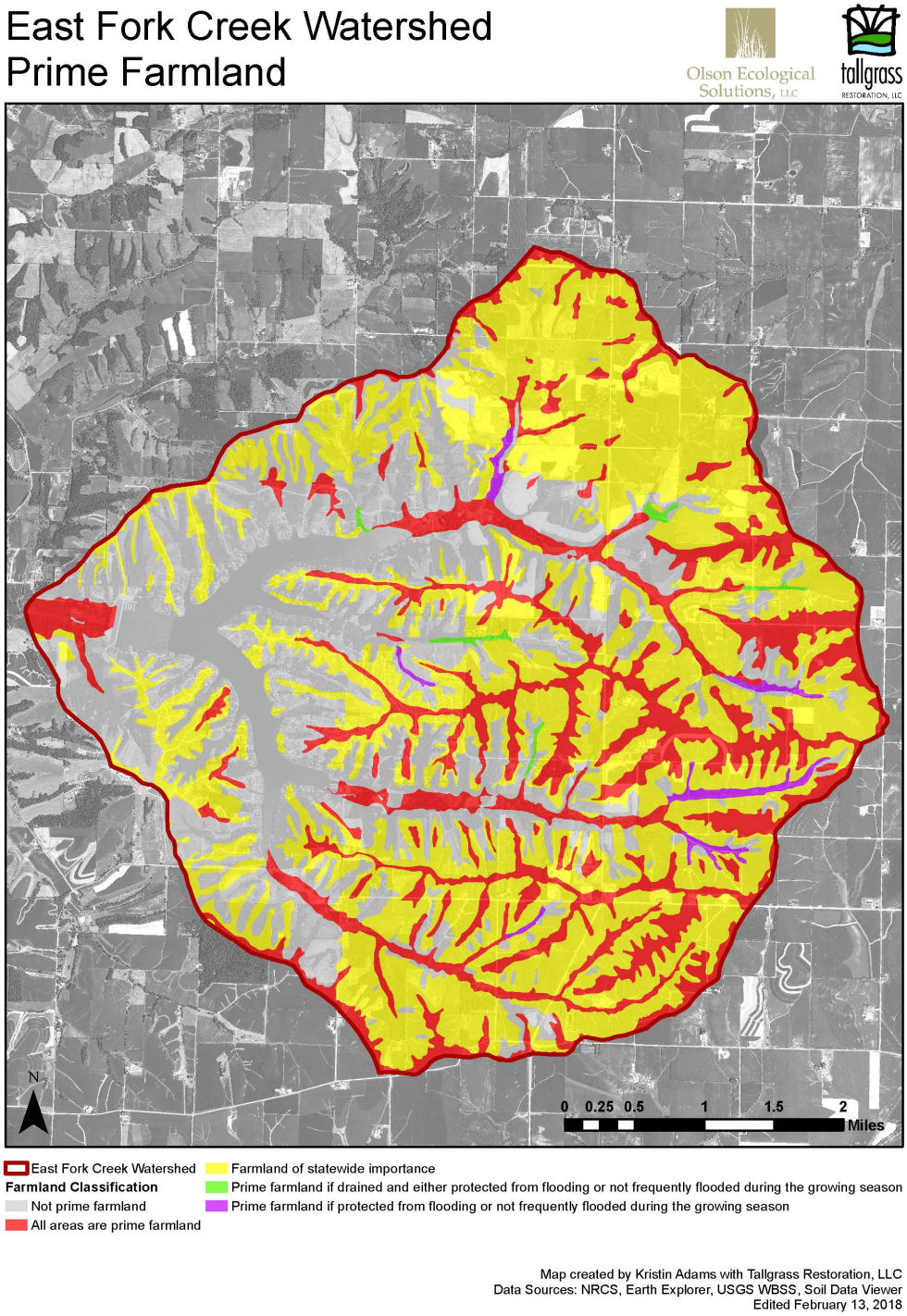


Figure 25 East Fork Creek Watershed, Hydric Soil Map Unit

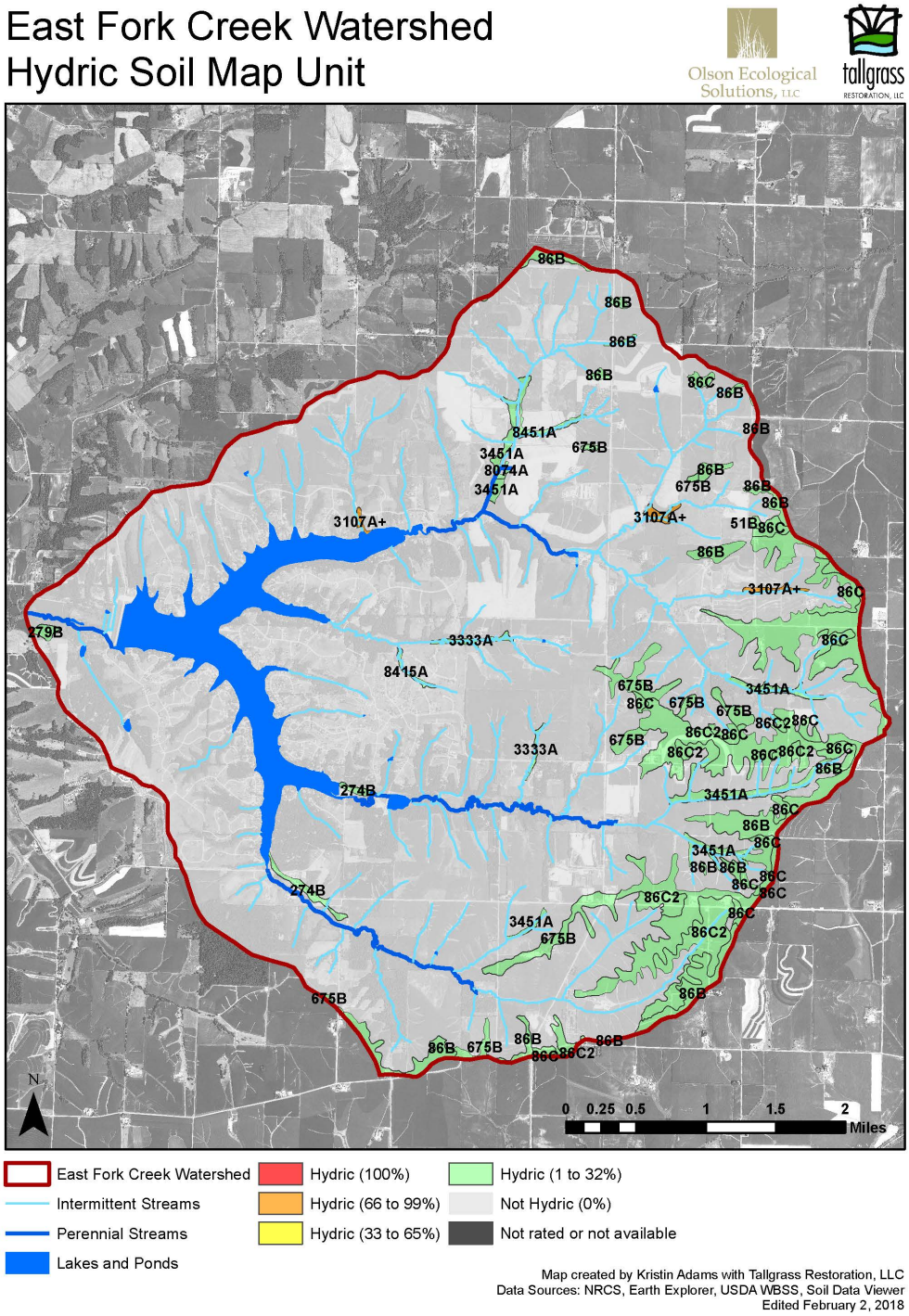


Figure 26 East Fork Creek Watershed, Hydrologic Soil Groups

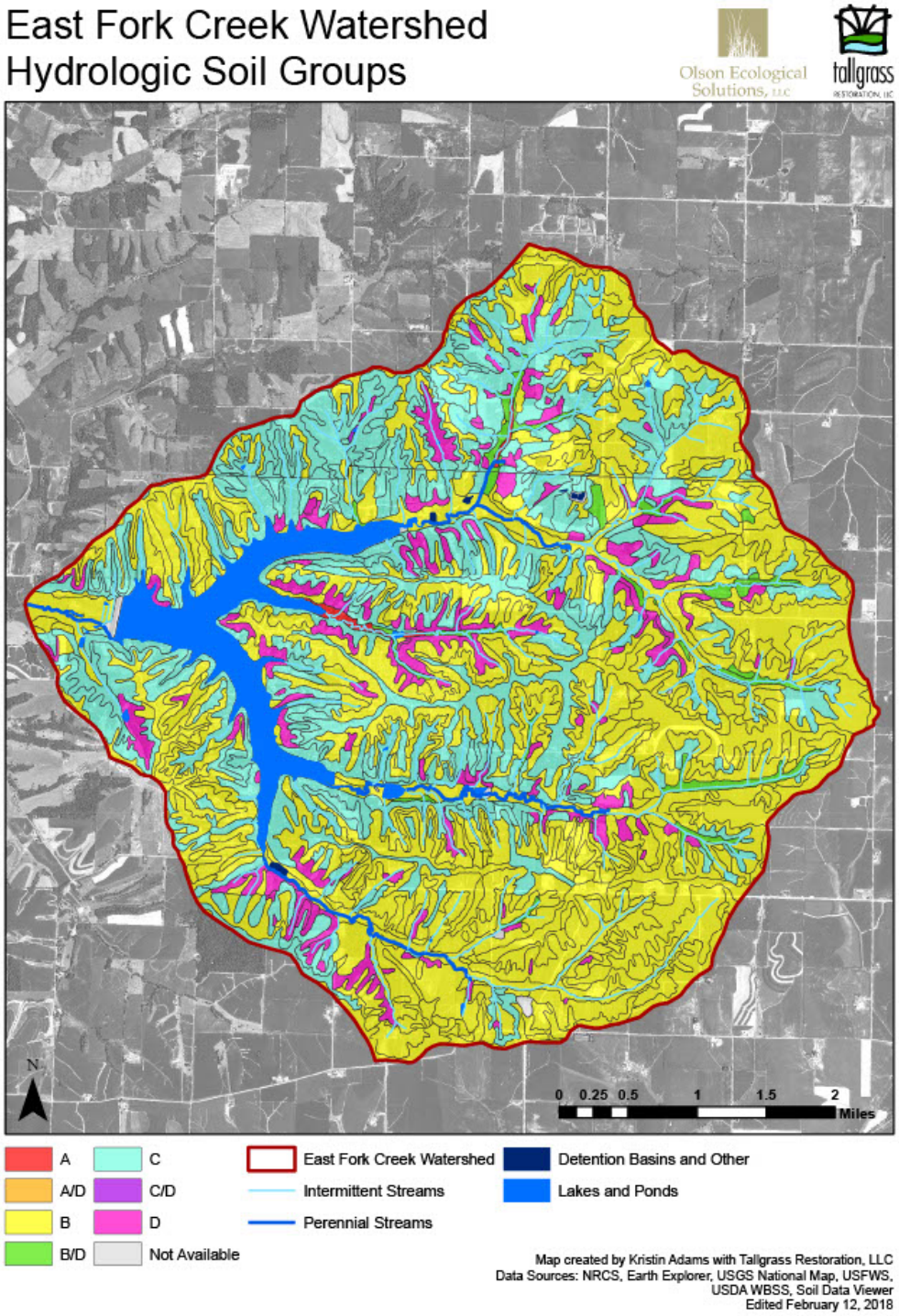


Figure 27 East Fork Creek Watershed, Soil Drainage Class

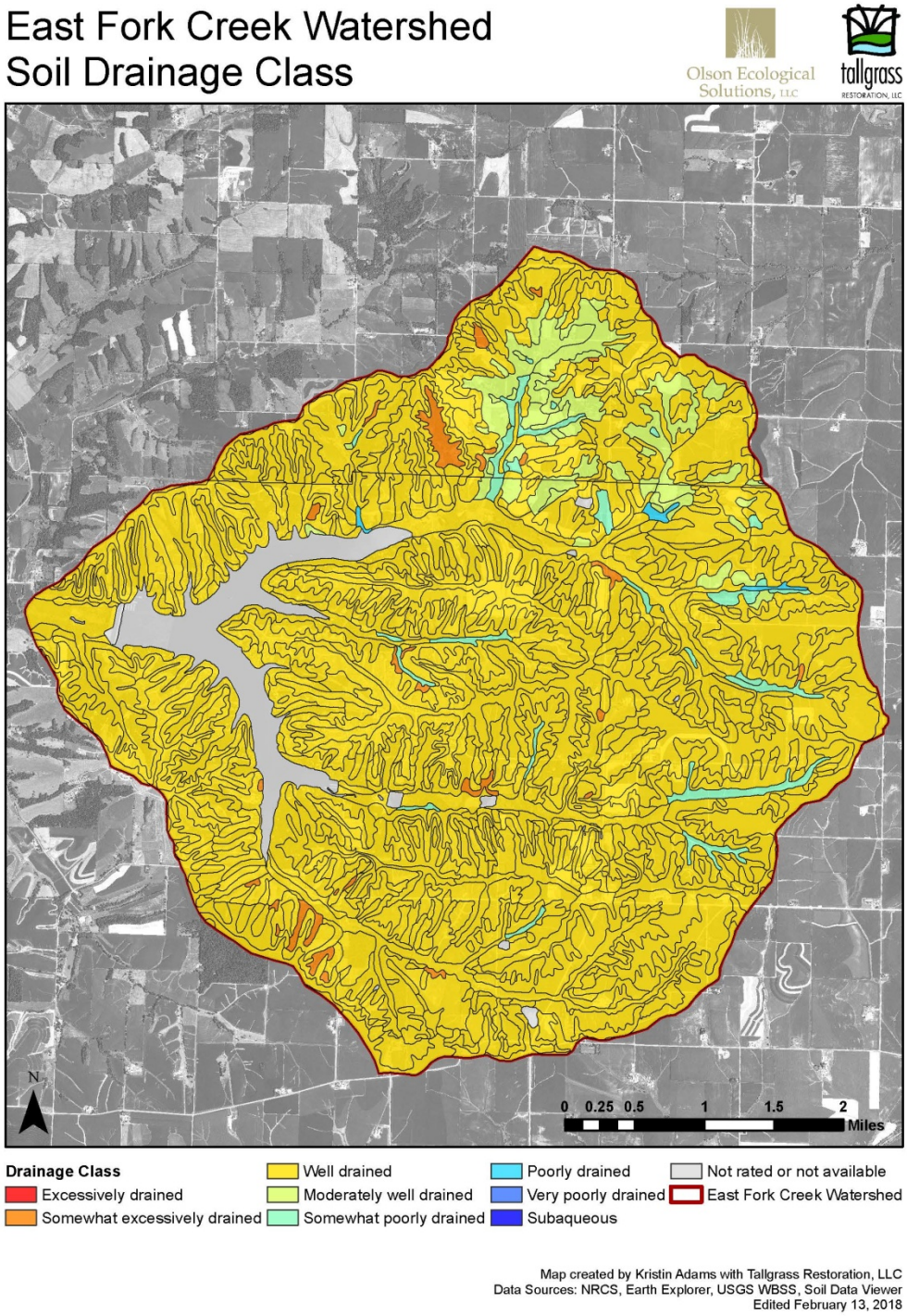


Figure 28 East Fork Creek Watershed, Soil Erodibility Factor (K)

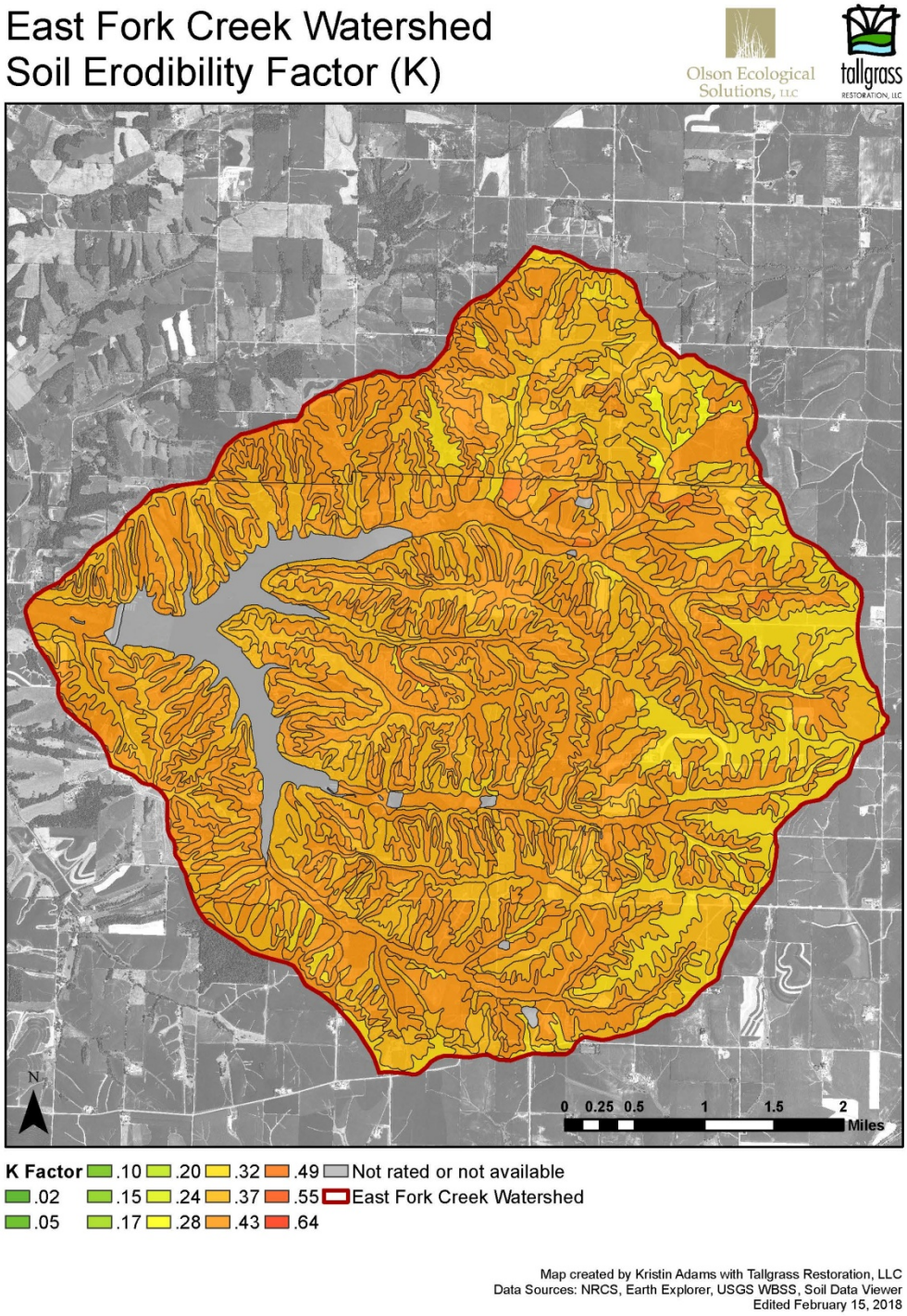


Figure 29 East Fork Creek Watershed, Wind Erodibility Group (WEG)

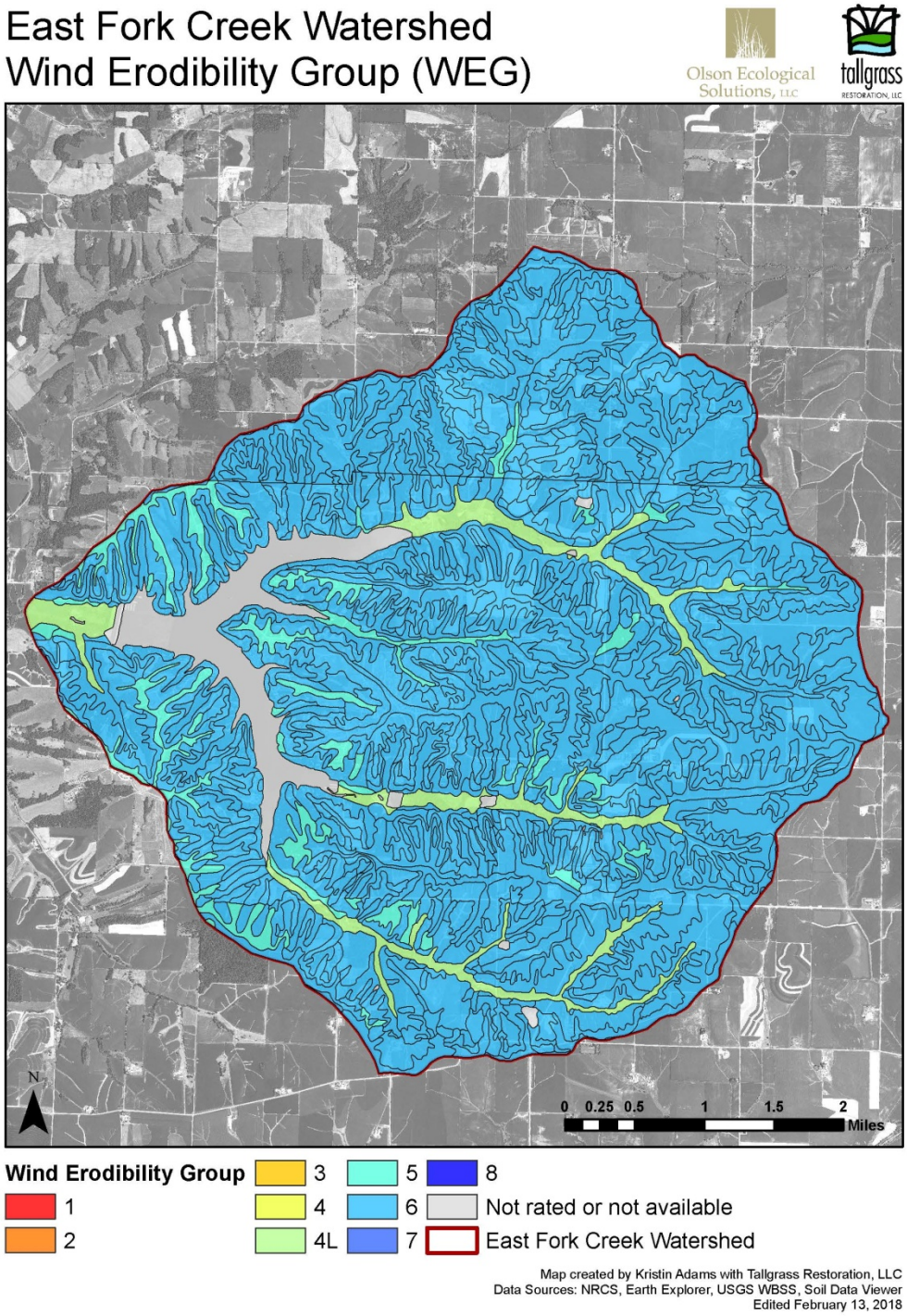


Figure 30 East Fork Creek Watershed, Erosion Factor (T)

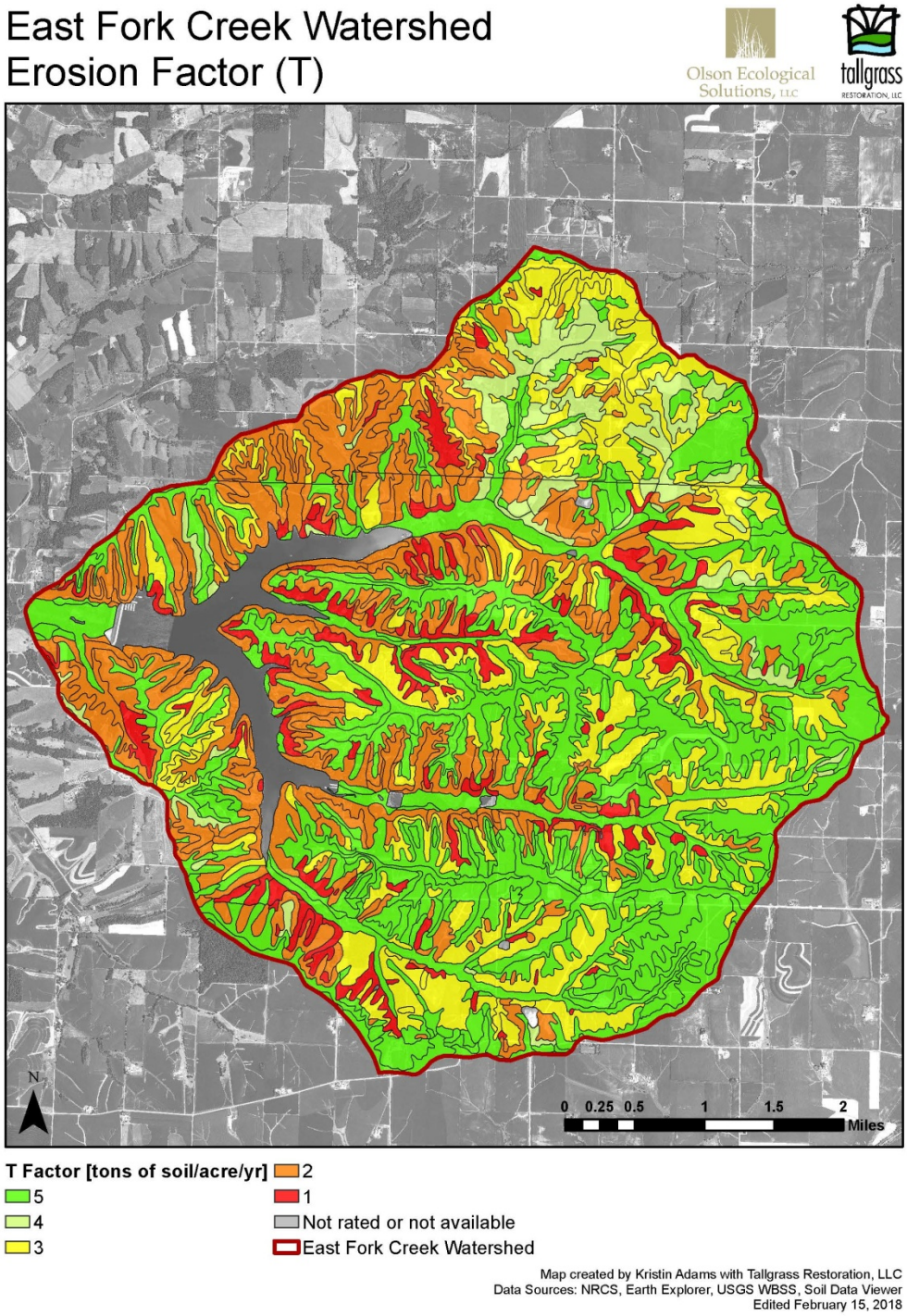
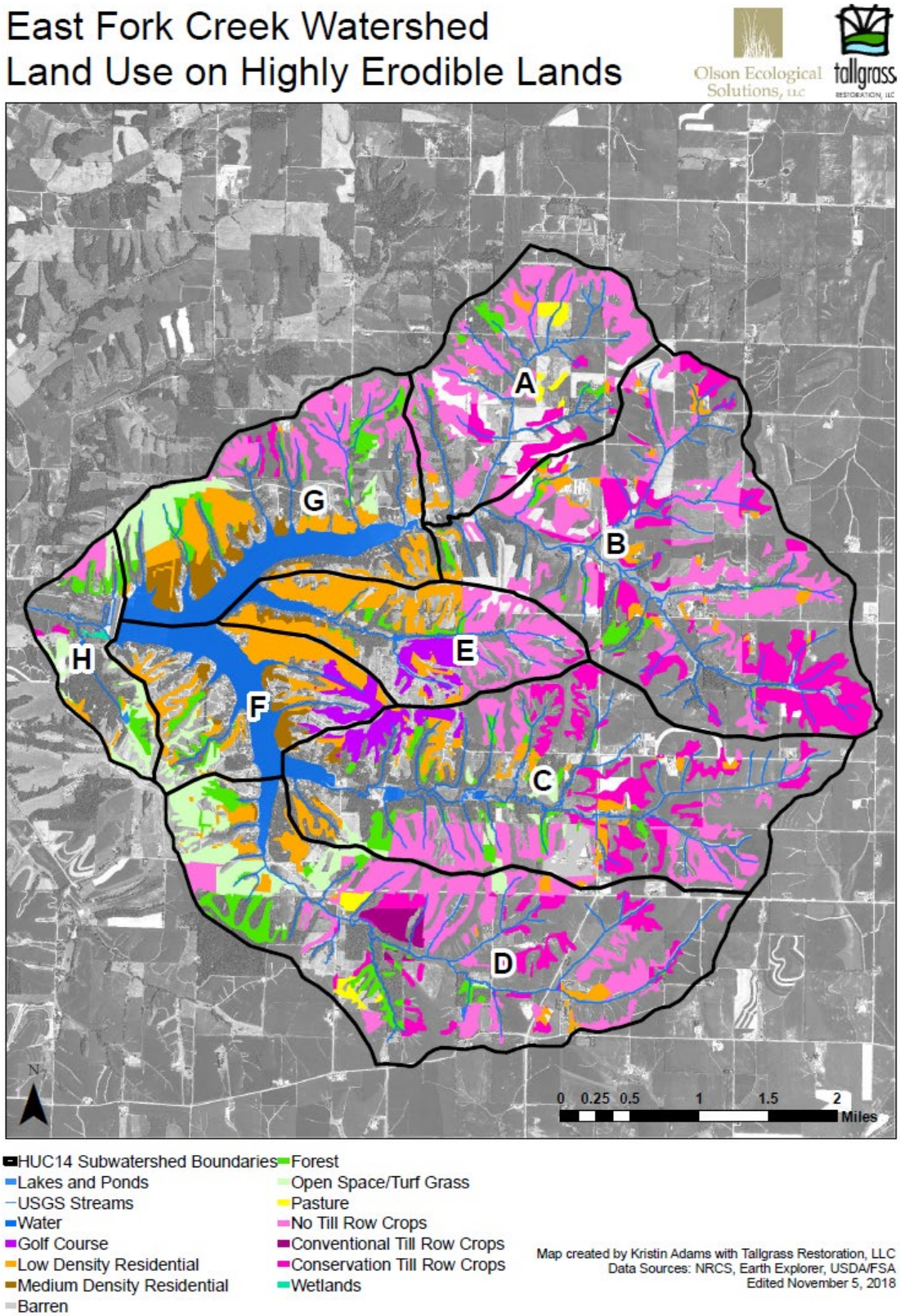


Figure 31 Highly Erodible Lands (HEL) by Land Use Type



Part 6: Water Quality Assessment

We assessed water Quality in the East Fork Creek Watershed from the Illinois Integrated Water Quality and Section 303(e) List; studies of Lake Carroll available from the Lake Carroll Association; a survey of the watershed's streams and streambanks; and a survey of the watershed's lake, pond, and basin shorelines.

Illinois Integrated Water Quality and Section 303(d) List – Volume 1: Surface Water

There was little known about the water quality of the East Fork Creek Watershed, also called the East Fork of the East Plum River. Prior to the publication of this inventory, no management plans or total maximum daily load (TMDL) statements had been issued for any of the watersheds associated with the East Plum River. We gleaned some limited information from the *Illinois Integrated Water Quality Report and Section 303(d) List* (ILEPA, 2018).

The *Illinois Integrated Water Quality Report and Section 303(d) List* identified surface waters that had uses such as aquatic life, fish consumption, primary contact recreation, and aesthetic quality that were impaired by various causes like sedimentation and fecal coliform from various sources. Lake Carroll (IL RMQ) was not listed as an impaired water. It had insufficient information to assess aquatic life and aesthetic quality, while fish consumption and primary contact recreation were not assessed, along with their associated causes and sources. East Fork Creek, also called East Fork East Plum River (IL_MJCB), was not assessed and therefore not listed as an impaired waterway, nor was the East Plum River (IL_MJC) into which it drained. The Plum River, to which both the East Fork Creek and East Plum River drained, had impaired uses of aquatic life and aesthetic quality causes by alterations of stream or littoral vegetation, sedimentation and siltation, total suspended solids, and fecal coliform. Known sources of these impairments included channelization and irrigated crop production. In addition, the Mississippi River was documented as impaired by accumulation mercury and polychlorinated biphenyls (PCBs). The Illinois Environmental Protection Agency provided the following information about the Plum River (ILEPA, 2018):

AUID:	IL_MJ-01 Plum River
Basin:	9, Mississippi North River
Category:	5
Stream Length:	31.39 miles
TMDL:	None
Status of Use Attainment:	Not supporting: aquatic life (N582) and primary contact recreation (N585) Not assessed: fish consumption (X583) and aesthetic quality (X590)
Causes of Impairment:	Alterations of stream or littoral vegetation (84), sedimentation and siltation (371), total suspended solids (403), and fecal coliform (400)
Sources of Impairment:	Channelization (20), irrigated crop production (66), and unknown sources (140)
Priority:	Medium: Ranked 2,192 the list of prioritized 303(d) streams for aquatic life by sedimentation/siltation Ranked 2,193 for aquatic life by fecal coliform Ranked 2,194 for primary contact recreation by fecal coliform

Lake Carroll Water Quality Testing

The water quality of Lake Carroll was monitored annually between 2007 to 2011 and again in 2016 by Integrated Lakes Management. In 2017, volunteers monitored phosphorous and had chlorophyll lab tested by Northern Lake Services. No monitoring data for East Fork Creek was available. Most monitoring events occurred in June of each year. Conditions usually worsen as the warm, summer months continue; therefore, we acknowledge that the results presented below most likely did not reflect the worst lake condition of each year. Lake Carroll Association plans to continue monitoring efforts, likely on an annual basis (Dick Schwalbenberg, pers. comm.).

Water quality monitoring results thus far showed Lake Carroll in good condition relative to most man-made lakes fed by surface water in Illinois. In 2016, the most recent, comprehensively monitored year, the lake was in a mesotrophic state, better than the common nutrient-rich eutrophic and hypereutrophic conditions of most Illinois man-made lakes. Individual water quality parameters monitored varied greatly depending on the sampling date. While water clarity was good and showed trends of improvement, the reason for the improvement was attributed to the invasion of zebra mussels (ILM, 2016), a non-native species that has negatively impacted lake ecology and native mussel populations in areas surrounding the Great Lakes (USGS, 2019). Three important parameters had slight opportunities for improvement, although they were also within a desirable range in most situations: nitrogen, phosphorous, and dissolved oxygen (ILM, 2016).

Nitrogen: Nitrogen in its inorganic form is used as food by plants and algae. Measuring 3.47 mg/l on June 21, 2016, it was present in much higher concentrations than that which can cause algae blooms, 0.3 mg/l (ILM, 2016).

Phosphorous: Phosphorous, the main element regulating plant and algae growth within Lake Carroll, had total phosphorous (TP) levels consistently below the state standard of 0.05 mg/l. However, orthophosphorous, the form of phosphorous most available to plants and algae, had levels that jumped above the recommended guideline of 0.01 mg/l during two of the seven monitored years (2009 and 2011). More than this recommended level is enough to allow nuisance algae blooms to form (ILM, 2016).

Dissolved Oxygen: Dissolved oxygen (DO), or oxygen within the water available to plants and animals, was found in Lake Carroll at quantities able to support life (> 5 mg/l) at all depths except near the lake bottom (ILM, 2016). Oxygen poor, anaerobic conditions near the bottom affect the digestion and sequestration rates of phosphorous and other excess nutrients and organic material in the sediment.

Chlorophyll: All of the factors above relate to algae growth, measured by the concentrations of clorophyll in the water. During most years, chlorophyll was below the 20 ug/l threshold indicating algae blooms, except for 2011, at which time chlorophyll measured about 25 ug/l (ILM, 2016).

Stream Survey

We assessed streams and ravines within the East Fork Creek Watershed for riparian condition, bank erosion, and channelization. In order to do so, JadEco Natural Resource Consulting and Management walked stream and ravine sections selected to represent the watershed by distribution throughout the eight subwatersheds (see Figure 31). We also analyzed channelization using aerial imagery. We appreciated the cooperation of many landowners throughout the watershed who offered permission to access their properties. Joe Rush of JadEco spent eight days surveying the streams and ravines. He recorded riparian condition as good, fair, and poor along both sides of each section; erosion of banks as slight, moderate, and severe; and channelization of streams as low (or none), medium, and high. Riparian condition was defined according to vegetative cover and soil permeability within 50-foot width from the banks. (see Figure 33).

We found that riparian condition varied throughout the watershed, as 37% was good, 40% was fair, and 23% was poor (see Table 16). Erosion was an issue, as 51% of the surveyed streambanks were severely eroded. Erosion was moderate on another 23% and slight on 26% of the banks (see Table 17). There was no significant difference in erosion severity between ravines and streams. Channelization was high on about 1/5th of the surveyed streams (22%). Another 44% of the streams had moderate channelization, and 34% were in a natural state with low to no channelization (see Table 18). Most areas of channelization were found in the headwaters on intermittent streams running through agricultural lands. These reaches were represented in the stream survey where we reported percent channelization (see Figure 32 and Figure 33).

Shoreline Survey

Surveys of shorelines occurred along Lake Carroll and the ponds and basins within the watershed. We assessed bank erosion and riparian condition of shorelines in all locations.

Lake Carroll: The entire shoreline of Lake Carroll was protected with rip rap, with all 11,196 feet qualifying as having slight erosion during an October 2017 survey (see Table 19 and Figure 34). The riparian zone, within the 50'-wide strip buffering the shoreline, was either managed with lawns, docks, and impervious surface or unmanaged, vacant lots. Of the total 81,282 feet of shoreline, 87% (70,690 ft) had managed riparian areas and 13% (10,592 ft) were vacant lots with naturalized riparian zones.

Watershed Ponds and Basins: Bank erosion was determined with a field survey on November 19, 2018. We found slight erosion on 85% (9,971 ft) of the 11,790 feet of shoreline along ponds and basins within the watershed. An additional 15% (1,735 ft) of the banks had moderate erosion, and less than 1% (84 ft) had severe erosion (see Table 20). Riparian condition for a majority of the ponds and basins was in a natural state and considered good (56%, 6,627 ft). Managed riparian areas were poor when mowed to the water's edge in 20% of the area (2,384 ft) and moderate when partially mowed within the 50' riparian zone in 24% of the area (2,779 ft) (see Table 21, Figure 11, and Figure 35).

Estimated Annual Pollutant Load

Pollutant modeling showed a breakdown by subwatersheds of the total pollutant load in a given area. In order to achieve this information, we used the EPA created a software called "Better Assessment Science Integrating Point and Non-point Sources," or BASINS. This software allowed us to analyze watershed and water quality using both user input data and data downloaded from the internet. Within this software was a model called PLOAD, which allowed us to calculate the pollutant load amounts in a watershed. This was useful in figuring out the baseline pollutant loads within the watershed so that we will be able to analyze effects of implementing Best Management Practices (BMP) within the watershed as proposed by future watershed planning.

In order to produce accurate pollutant load estimates, we compiled and created input data for the BASINS program including delineated subwatersheds, land use, precipitation, event mean concentrations. As described earlier in this inventory, we created eight subwatersheds within the HUC 12 East Fork Creek Watershed in ArcMap based on elevation and hydrography. We assigned each subwatershed a specific HUC 14 code and a name: A, B, C, D, E, F, G, and H. The model also required a current land use map, for which we used the National Land Cover Database from 2011 modified within ArcMap to accurately reflect current land uses gathered from knowledge of the area and aerial map imagery. We gathered annual precipitation data from NOAA using the Lanark Station at a value of 39.69 inches. We researched local values for the estimated event mean concentrations (EMC) and used the most current EMC data from February 2018 created for the Des Plaines River Watershed by Northwater Consulting. We also used default EMC values from the EPA's Region 5 Model for land use types that did not have an updated local value. We used the Simple (EMC) Method to generate the pollutant modeling, which determined pollutant loading annually, both in total and per acre for each subwatershed for total nitrogen (TN), total phosphorous (TP), total suspended solids (TSS), and pathogens.

Generally speaking, Subwatersheds E and F showed the greatest amount of annual pollutant loading per acre, with Subwatershed G trailing close behind. These areas were residential lands surrounding Lake Carroll. Of the outlying agricultural areas, Subwatersheds A, D, and H tended to have the least overall impact on pollutant loading, while Subwatersheds B and C led the annual nitrogen loading per acre (see Figure 36, Figure 37, Figure 38, and Figure 39).

To summarize the estimated existing annual pollutant load by land use source at the watershed scale (see Table 22), we used the Export Coefficient Formula below:

$$\text{Export Coefficient (lb/ac/yr)} = ((P \times CF \times Rv) / 12) \times C \times 2.72$$

In this equation, we used the following assumptions (US Congress, 2014):

- P = Annual Precipitation = 39.69 in/yr annual precipitation
- CF = Correction Factor = 0.90 for storms with no runoff
- Rv = Runoff Coefficient = 0.05 + (0.09 x I)
- I = Percent Impervious
- C = Event Mean Concentration (mg/l)

Looking at the total annual loads per subwatershed did not provide results that were as straightforward as the per-acre approach, as Subwatersheds B and C were not only highest overall pollutant contributors but also two of the largest subwatersheds. For the entire East Fork Creek Watershed, pollutant loads from land uses were as follows: 44,275 pounds per year of total nitrogen; 4,273 pounds per year of total phosphorous; and 1,203,281 pounds per ear of total suspended solids (see Table 23 and Figure 40, Figure 41, Figure 42, and Figure 43).

Table 17 Summary of Stream and Tributary Riparian Area Condition

Summary of stream and tributary riparian area condition				Riparian Condition (ft)		
Tributary Name	**Subwatershed**	**Reach Code**	**Total Buffer Length (ft)**	**Good**	**Fair**	**Poor**
Upper East Fork Creek	A	A1	5907	0	4145	1762
South Lower East Fork Creek	B	B1	41914	6759	18025	17129
Central Creek	C	C1	27520	14430	11565	1525
South Creek	D	D1	27486	7969	11236	8282
North Creek	E	E1	6344	4970	690	684
Unnamed Tributary	F	F1	4680	3276	1404	0
Unnamed Tributary	F	F2	6450	4515	1935	0
Unnamed Tributary	F	F3	5690	659	3666	1365
Unnamed Tributary	F	F4	5828	0	4484	1344
Unnamed Tributary	G	G1	6186	969	3859	1358
Unnamed Tributary	G	G2	6028	0	6028	0
Unnamed Tributary	G	G3	2864	2765	83	16
Unnamed Tributary	G	G4	3536	3125	250	161
Unnamed Tributary	G	G5	2908	1314	615	979
Unnamed Tributary	H	H1	8648	3457	750	4442
Unnamed Tributary	H	H2	8182	8182	0	0
Total length (ft)			**170171**	**62390**	**68736**	**39046**
% of Watershed			**100%**	**37%**	**40%**	**23%**

Table 18 Summary of Stream and Tributary Bank Erosion

Summary of stream and tributary bank erosion				Bank Erosion (ft)		
Tributary Name	**Sub-watershed**	**Reach Code**	**Total Stream Length**	**Slight**	**Moderate**	**Severe**
Upper East Fork Creek	A	A1	8863	2341	1846	4676
South Lower East Fork Creek	B	B1	43290	8018	15121	20151
Central Creek	C	C1	27980	3069	4913	19998
South Creek	D	D1	33302	5920	6503	20879
North Creek	E	E1	6704	1410	1254	4040
Unnamed Tributary	F	F1	4680	1945	2420	315
Unnamed Tributary	F	F2	6450	0	778	5672
Unnamed Tributary	F	F3	6764	6632	0	132
Unnamed Tributary	F	F4	5828	3642	848	1338
Unnamed Tributary	G	G1	6350	4112	539	1699
Unnamed Tributary	G	G2	6028	1073	2858	2097
Unnamed Tributary	G	G3	3583	1098	707	1778
Unnamed Tributary	G	G4	4060	994	535	2531
Unnamed Tributary	G	G5	4268	1785	1221	1262
Unnamed Tributary	H	H1	9052	1095	2916	5041
Unnamed Tributary	H	H2	8492	4663	356	3473
Total length (ft)			**185694**	**47797**	**42815**	**95082**
% of Watershed			**100%**	**26%**	**23%**	**51%**

Table 19 Summary of Stream and Tributary Channelization

Summary of stream and tributary channelization				Channelization (ft)		
Tributary Name	**Sub-watershed**	**Reach Code**	**Total Stream Length (ft)**	**None/ Low**	**Medium**	**High**
Upper East Fork Creek	A	A1	2817	123	1852	842
South Lower East Fork Creek	B	B1	20992	8058	10707	2228
Central Creek	C	C1	12820	5524	6021	1275
South Creek	D	D1	15558	4681	3277	7601
North Creek	E	E1	3030	1094	1454	483
Unnamed Tributary	F	F1	2340	138	1708	495
Unnamed Tributary	F	F2	3225	1533	1576	117
Unnamed Tributary	F	F3	2747	113	1142	1492
Unnamed Tributary	F	F4	2914	780	1654	480
Unnamed Tributary	G	G1	3093	389	1597	1107
Unnamed Tributary	G	G2	3014	101	1452	1462
Unnamed Tributary	G	G3	1638	481	989	168
Unnamed Tributary	G	G4	1768	1338	430	0
Unnamed Tributary	G	G5	1492	145	1288	59
Unnamed Tributary	H	H1	4404	1234	1908	1263
Unnamed Tributary	H	H2	4038	3613	425	0
Total length (ft)			**85890**	**29343**	**37478**	**19070**
% of Watershed			**100%**	**34%**	**44%**	**22%**

Figure 32 Stream and Tributary Survey Routes

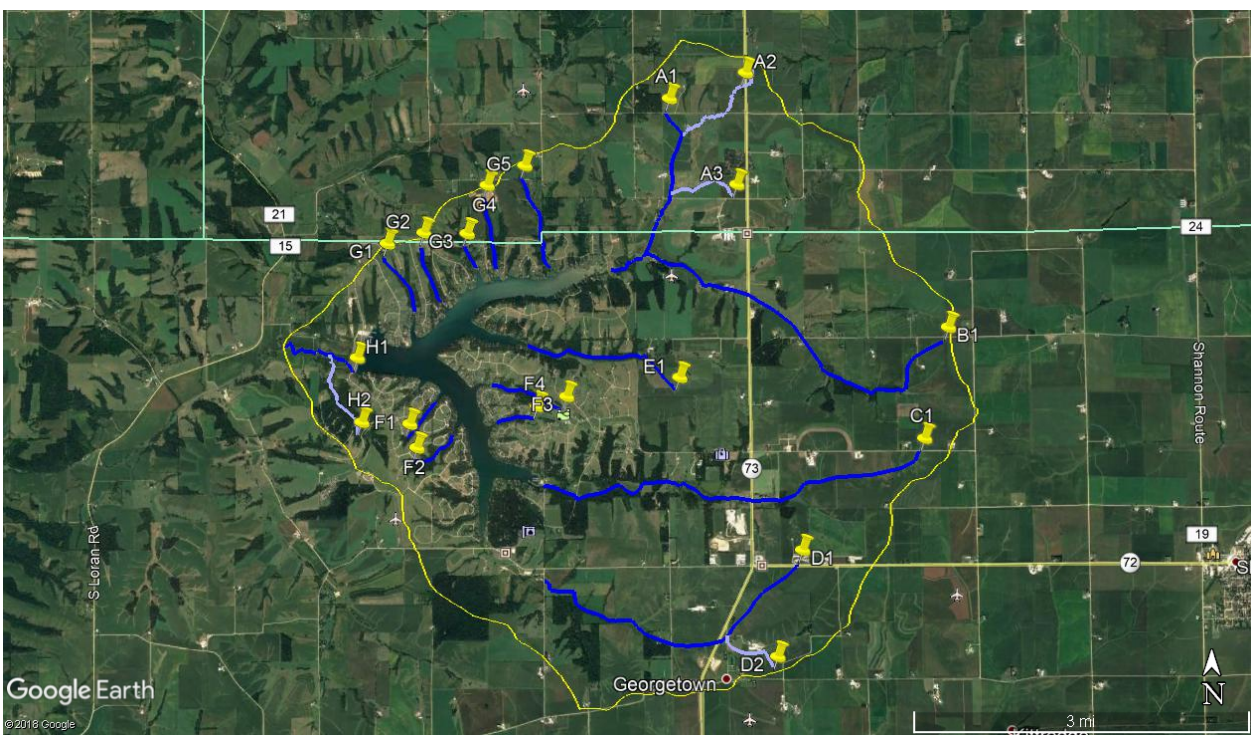


Figure 33 Riparian Buffer Field Indicators

Riparian Buffer Field Indicators

Riparian condition was rated by custom criteria addressing vegetation scarcity, total width of herbaceous or mixed vegetation, and soil permeability. Permeability was determined by presence of sand or sandy loams in buffer soils as measured by observation of surficial soils, bank cut surfaces, or probing with a piece of wood. The definitions below were used to rate each segment.

Good Condition

Width ≥ 50'
And at least 55% vegetated*
And vegetation at least 12" in height

OR
Width ≥ 25'
And at least 70% vegetated* and vegetation at least 12" in height
Or
≥ 55% vegetated* and Sandy L. / Sand and vegetation at least 12" in height

Modifiers.

Grasses about 6 inches in height that had mowed to manage for weeds (noxious or otherwise) were accepted as meeting the 12" condition. We decided on this modifier after speaking with a local farmer who reported a standard practice of mowing grasses to about 6 inches only once per year.

The presence of only non-native shrubs such as honeysuckle without any other vegetation mixed in (such as herbaceous vegetation or native trees/shrubs), was not considered vegetation over 12 inches in height.

Fair Condition

Width
≥15' but ≤ 25'
And ≥55% vegetated *
And vegetation at least 12" in height

Poor Condition

Width
< 15'
Or does not meet the other two categories.

Figure 34 East Fork Creek Watershed, Channelization

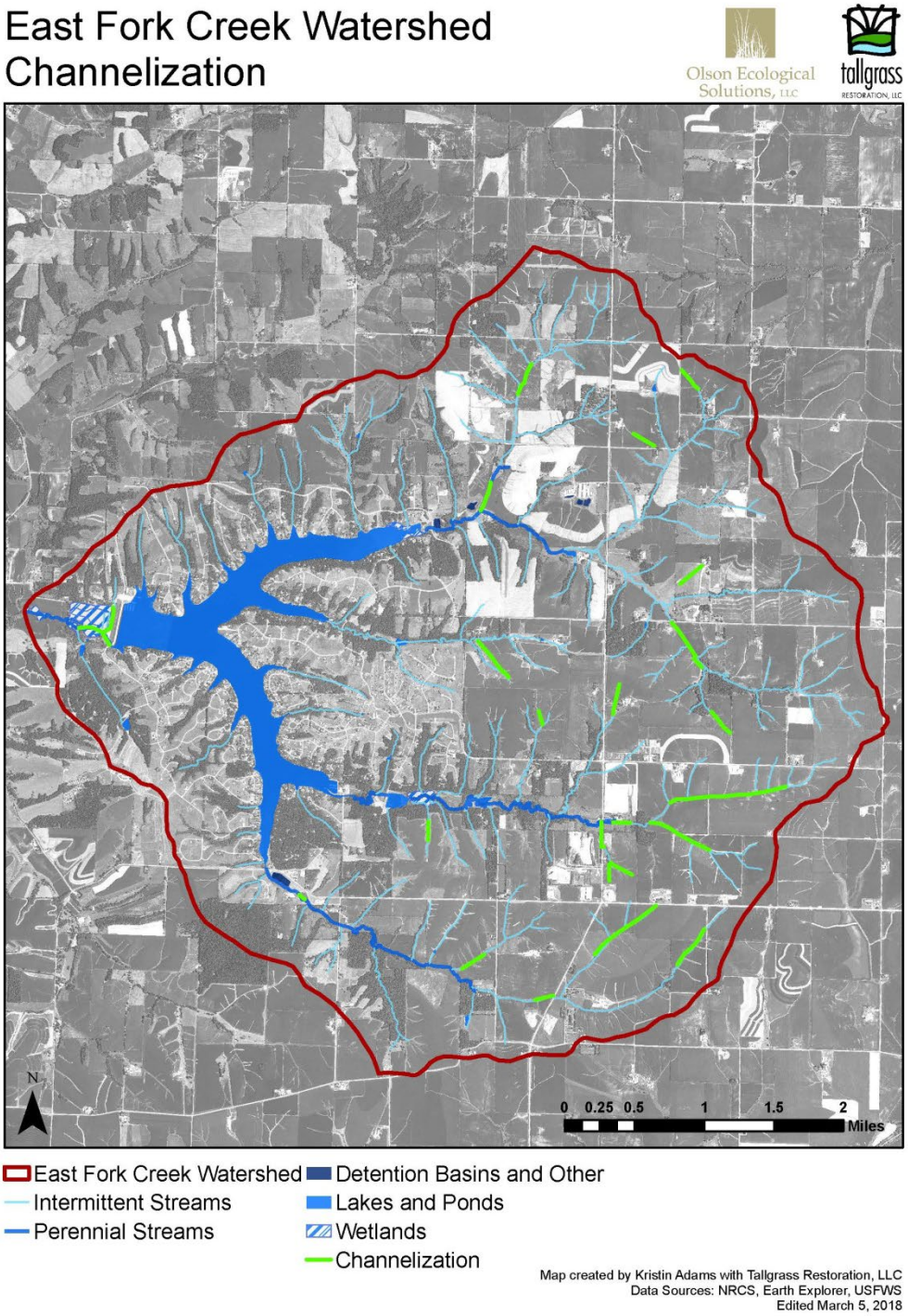


Figure 35 Example Stream Tributaries and Ravines

Table 20 Lake Carroll 2017 October Rip Rap/Shoreline Inspection

2017 OCT RIP RAP/SHORELINE INSPECTION				
	SEC	LOT	NEED TO CORRECT	Shoreline Linear Footage
1	17	181	Exposed Fabric	206
2	17	168	Recommendation - Exposed Fabric	77
3	17	145	Exposed Soil	133
4	17	54	Exposed Soil	138
5	17	45	Rock < 1ft above Pool	177
6	16	230	Exposed Soil	71
7	16	218	Falling Seawall Exposed	90
8	16	101	Exposed Soil	101
9	5	103	Rock < 1ft above Pool	145
10	5	108	Exposed Soil	100
11	5	121	Rock < 1ft above Pool	77
12	5	208	Exposed Fabric	160
13	5	222	Exposed Soil	71
14	12	115	Exposed Fabric	155
15	13	89	Exposed Soil	190
16	13	80R	Washed Out	201
17	22	4	Exposed Soil	208
18	21	19	Exposed Fabric	158
19	21	41	Exposed Fabric	112
20	21	42	Exposed Fabric	203
21	21	45	Exposed Fabric	149
22	21	48	Exposed Fabric	188
23	1	173	Exposed Fabric	191
24	1	145R	Exposed Soil	130
25	1	99	Exposed Fabric	100
26	1	92	Rock < 1ft above Pool	121
27	4	39	Exposed Fabric	130
28	4	40R/41	Exposed Fabric	101
29	4	78	Needs Rip Rap	54
30	4	103	Exposed Soil	76
31	4	105R	Exposed Fabric	62
32	23	31	Exposed Fabric	178
33	23	39	Exposed Fabric	53
34	23	47	Rock < 1ft above Pool	180
35	23	65	Rock < 1ft above Pool	247
36	23	76	Rock < 1ft above Pool & Exposed Soil	131
37	23	218	Exposed Fabric	247
38	23	100	Exposed Fabric	166
39	24	93	Exposed Fabric	214
40	24	92	Exposed Fabric	187
41	24	52	Exposed Soil	146
42	24	51	Exposed Soil	79

2017 OCT RIP RAP/SHORELINE INSPECTION				
	SEC	LOT	NEED TO CORRECT	Shoreline Linear Footage
43	24	30	Rock < 1ft above Pool & Exposed Soil	276
44	24	15	Exposed fabric	210
45	25	87	Exposed Fabric	185
46	25	86	Exposed Fabric	281
47	25	85	Exposed Fabric	114
48	25	75	Exposed Soil	93
49	25	67	Exposed Fabric under Oak Tree	86
50	25	66	Exposed Fabric	306
51	25	65	Exposed Fabric	189
52	25	62	Exposed Fabric	198
53	25	56	Exposed Fabric	149
54	25	54	Exposed Soil & Fabric	215
55	26	6	Exposed Fabric	37
56	26	7	Rock < 1ft above Pool	260
57	26	10	Exposed Fabric	87
58	26	22	Exposed Fabric	255
59	26	26	Exposed Soil	261
60	26	29	Exposed Fabric	62
61	27	12	Exposed Fabric	244
62	27	13	Exposed Soil	71
63	27	45	Rock < 1ft above Pool & Exposed Soil	182
64	27	54	Exposed Fabric & Soil	155
65	28	22	Exposed Fabric	119
66	28	23	Exposed Fabric	116
67	28	25	Exposed Fabric	184
68	28	26	Exposed Soil	182
69	28	37	Rock < 1ft above Pool	211
70	28	38	Rock < 1ft above Pool	215
71	28	43	Exposed Soil	72
72	28	49	Exposed Fabric	278
73				
74				
75				
76				
77			Total Linear Footage	11196
78				

Table 21 Summary of Pond and Basin Erosion

Summary of Pond and Bank Erosion Survey						Bank Erosion		
Reach Code	Subwatershed	Type	Total Shoreline (ft)	Bank Height (ft)	Lateral Recession Rate (ft/yr)	Slight (ft)	Moderate (ft)	Severe (ft)
A2	A	Basin	1888	3	0.01	1794		
				3	0.05		94	
B5	B	Pond	1075	2.5	0.01	860		
				2.5	0.05		215	
B7	B	Basin	349	10	0.01	349		
B8	B	Pond	616	0.5	0.01	308		
				3	0.06		308	
C2	C	Pond	2508	2	0.02	2508		
C4	C	Pond	399	3.5	0.01	339		
				4	0.06		52	
				4	0.03			8
C5	C	Pond	557	2	0.01	279		
				2	0.2		278	
D1	D	Basin	1196	3	0.01	1196		
E2	E	Pond	1466	1.5	0.01	880		
				3	0.06		513	
				8	0.3			73
F1	F	Pond	275	0.5	0.05		275	
F2	F	Basin	255	15	0.01	252		
				10	0.3			3
H3	H	Pond	1206	5	0.01	1206		
Total Length (ft)			**11790**			**9971**	**1735**	**84**
Percent of Watershed (%)			**100%**			**85%**	**15%**	**1%**

Table 22 Summary of Pond and Basin Riparian Area Condition

Summary of Pond and Bank Riparian Area Condition				Riparian Condition		
Reach Code	Subwatershed	Type	Total Shoreline (ft)	Good (ft)	Fair (ft)	Poor (ft)
A2	A	Basin	1888	1888		
B5	B	Pond	1075			1075
B7	B	Basin	349	209		140
B8	B	Pond	616			616
C2	C	Pond	2508	502	2006	
C4	C	Pond	399	359	40	
C5	C	Pond	557	279		278
D1	D	Basin	1196	1196		
E2	E	Pond	1466	733	733	
F1	F	Pond	275			275
F2	F	Basin	255	255		
H3	H	Pond	1206	1206		
Total Length (ft)			**11790**	**6627**	**2779**	**2384**
Percent of Watershed (%)			**100%**	**56%**	**24%**	**20%**

Figure 36 Example Lake Carroll Shoreline

Figure 37 Example Ponds and Basins: Pond B5, Pond E2, and Basin A2

Table 23 Estimated Existing Annual Pollutant Load by Source

Source	Sediment Load (tons/yr)	N Load (lb/yr)	P Load (lb/yr)
Water	0.18	0.09	5.97
Golf Course	66.04	4,956.15	943.40
Low Density Residential	172.63	1,158.14	1,418.90
Med Density Residential	90.97	3,864.76	356.74
Barren	0.37	6.39	3.68
Forest	9.26	6.88	92.61
Open Space/Turf Grass	5.79	6.88	57.90
Pasture	5.53	147.50	44.21
No Till Row Crops	146.14	150.45	955.14
Conventional Till Row Crops	2.41	178.04	18.91
Conservation Till Row Crop	102.35	112.84	367.92
Wetlands	0.16	1.17	6.03

Table 24 Total Pollution Loads by Subwatershed

Total Pollution Loads by Subwatershed				
HUC 14 Code	Name	N Load lbs/yr	P Load lbs/yr	TSS Load lbs/yr
07060005080101	A	3,444	290	89,660
07060005080102	B	7,498	599	204,667
07060005080103	C	8,549	877	231,628
07060005080104	D	6,567	544	177,810
07060005080105	E	5,912	699	143,446
07060005080106	F	5,664	651	159,754
07060005080107	G	5,895	543	178,357
07060005080108	H	745	69	17,959
	Totals:	**44,275**	**4,273**	**1,203,281**

Figure 38 East Fork Creek Watershed, Annual Nitrogen Load by Acreage

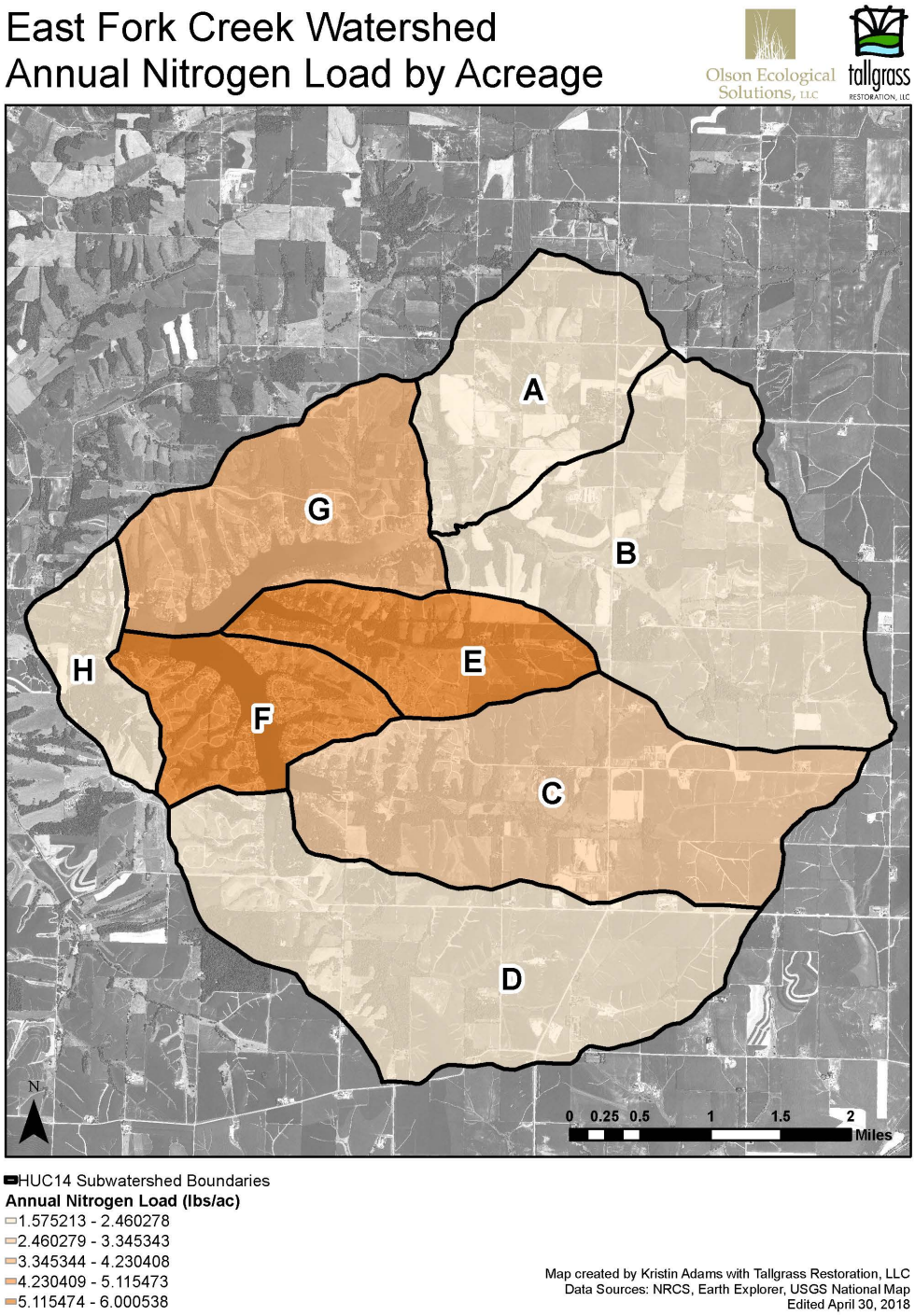


Figure 39 East Fork Creek Watershed, Annual Phosphorous Load by Acreage

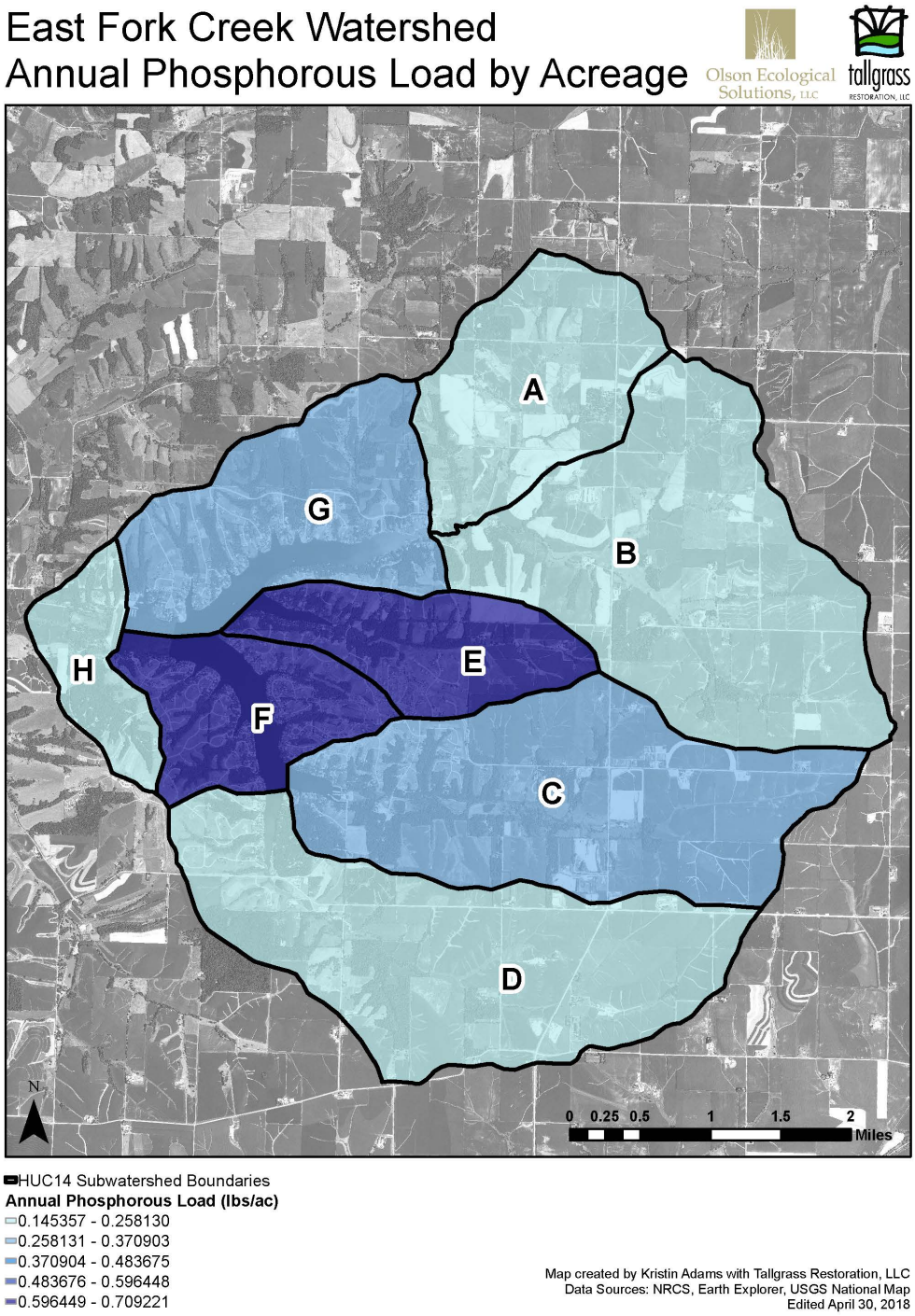


Figure 40 East Fork Creek Watershed, Annual Sediment Load by Acreage

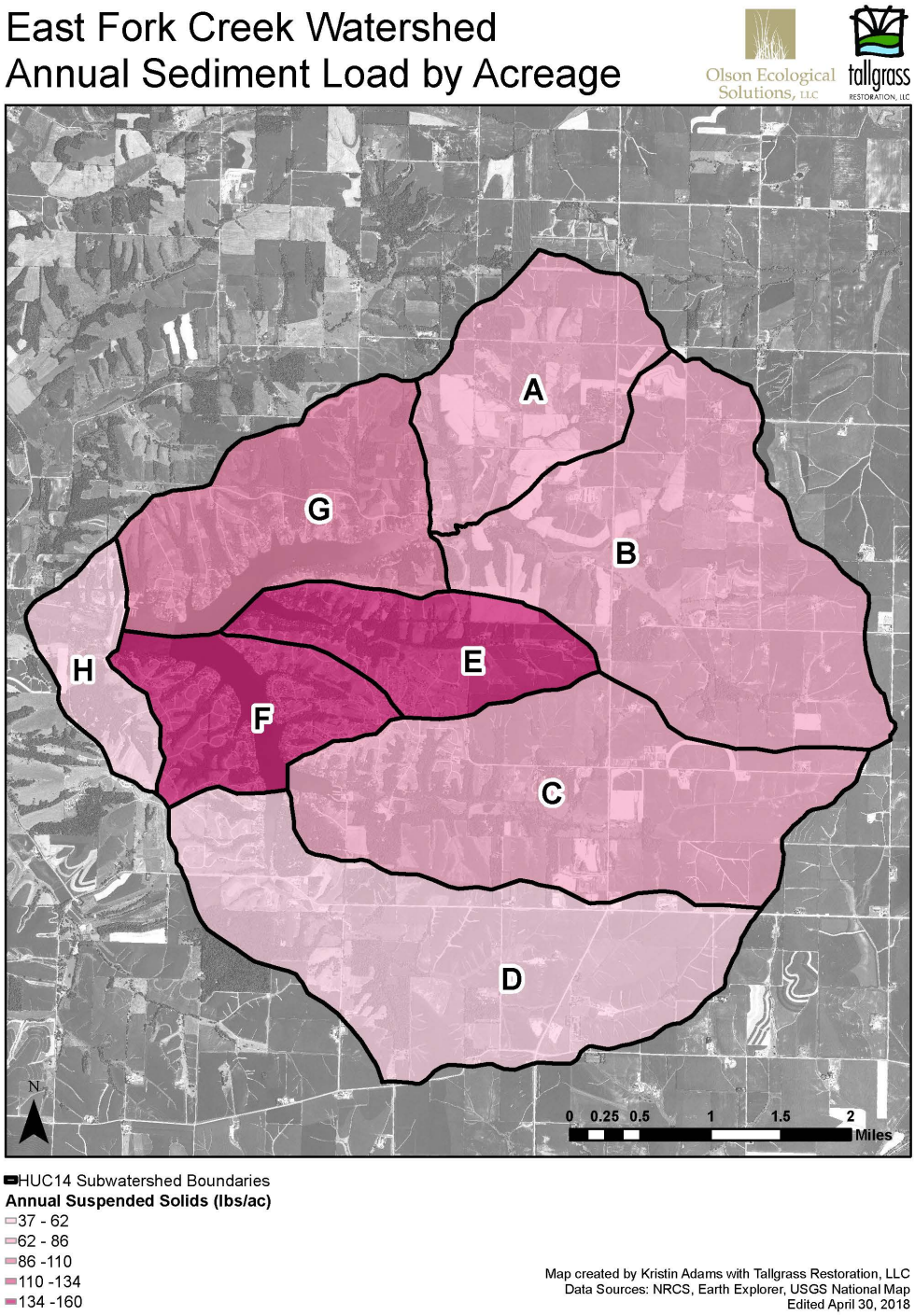


Figure 41 East Fork Creek Watershed, Annual Pathogen Load by Acreage

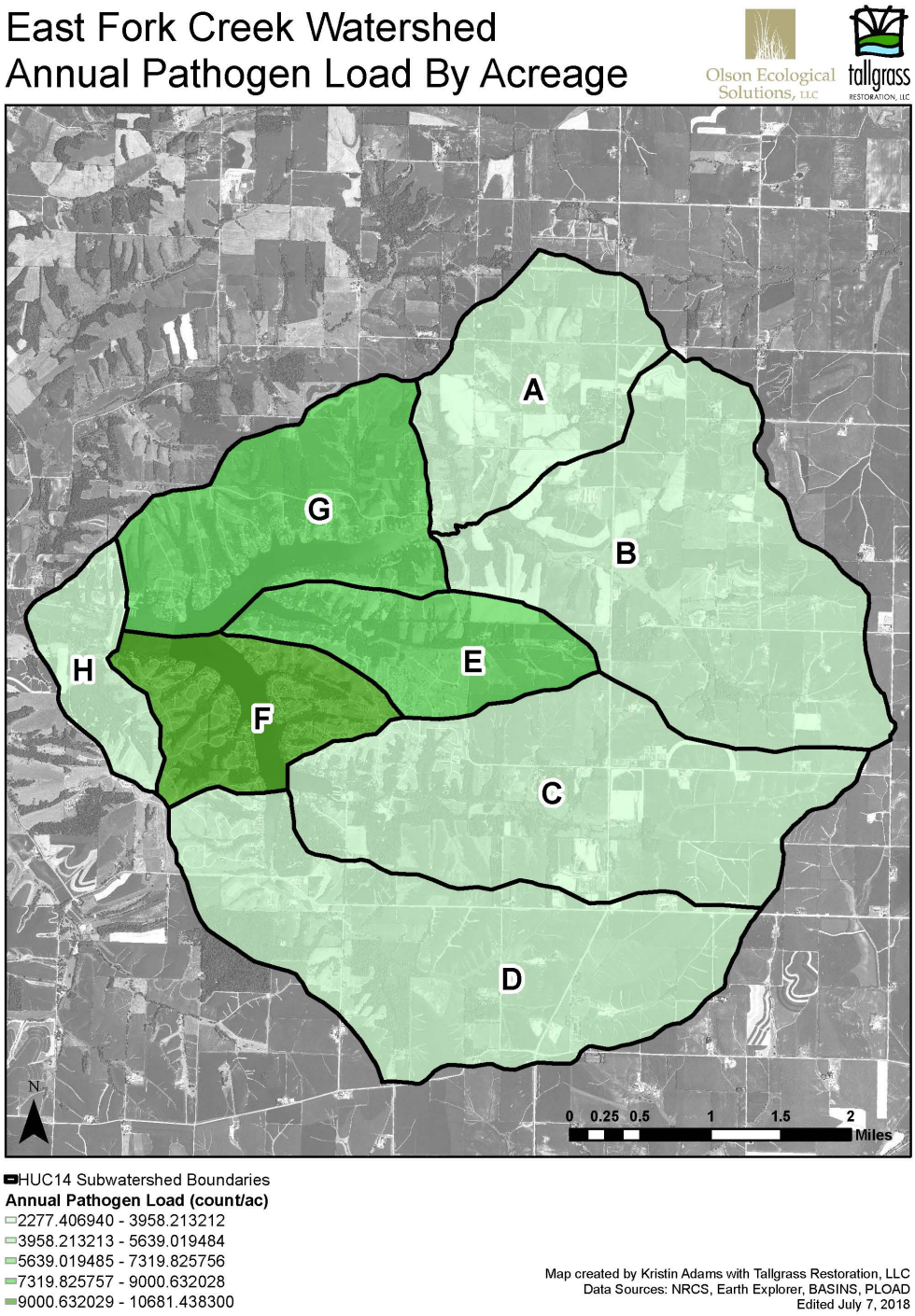


Figure 42 East Fork Creek Watershed, Annual Nitrogen Load Total

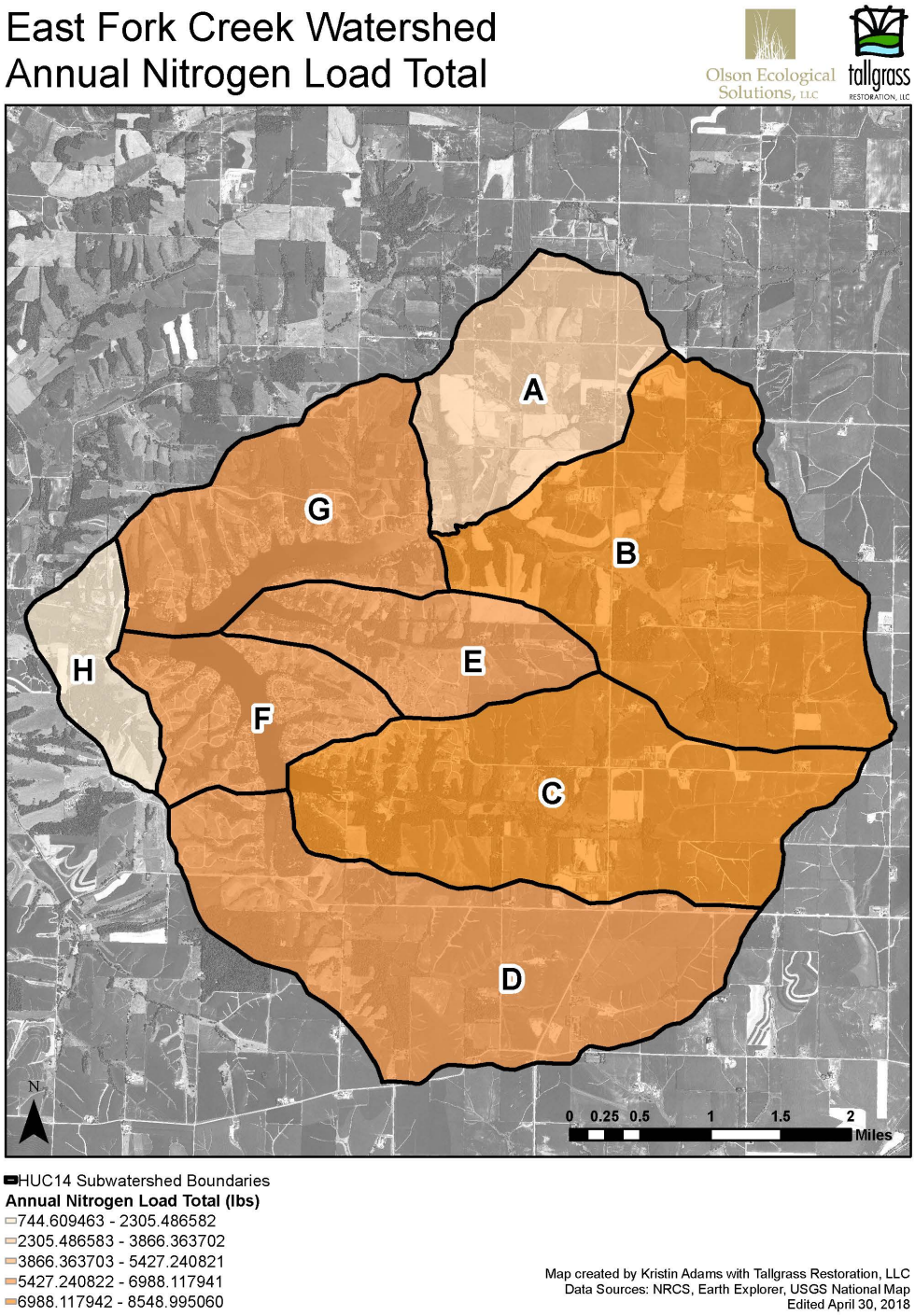


Figure 43 East Fork Creek Watershed, Annual Phosphorous Load Total

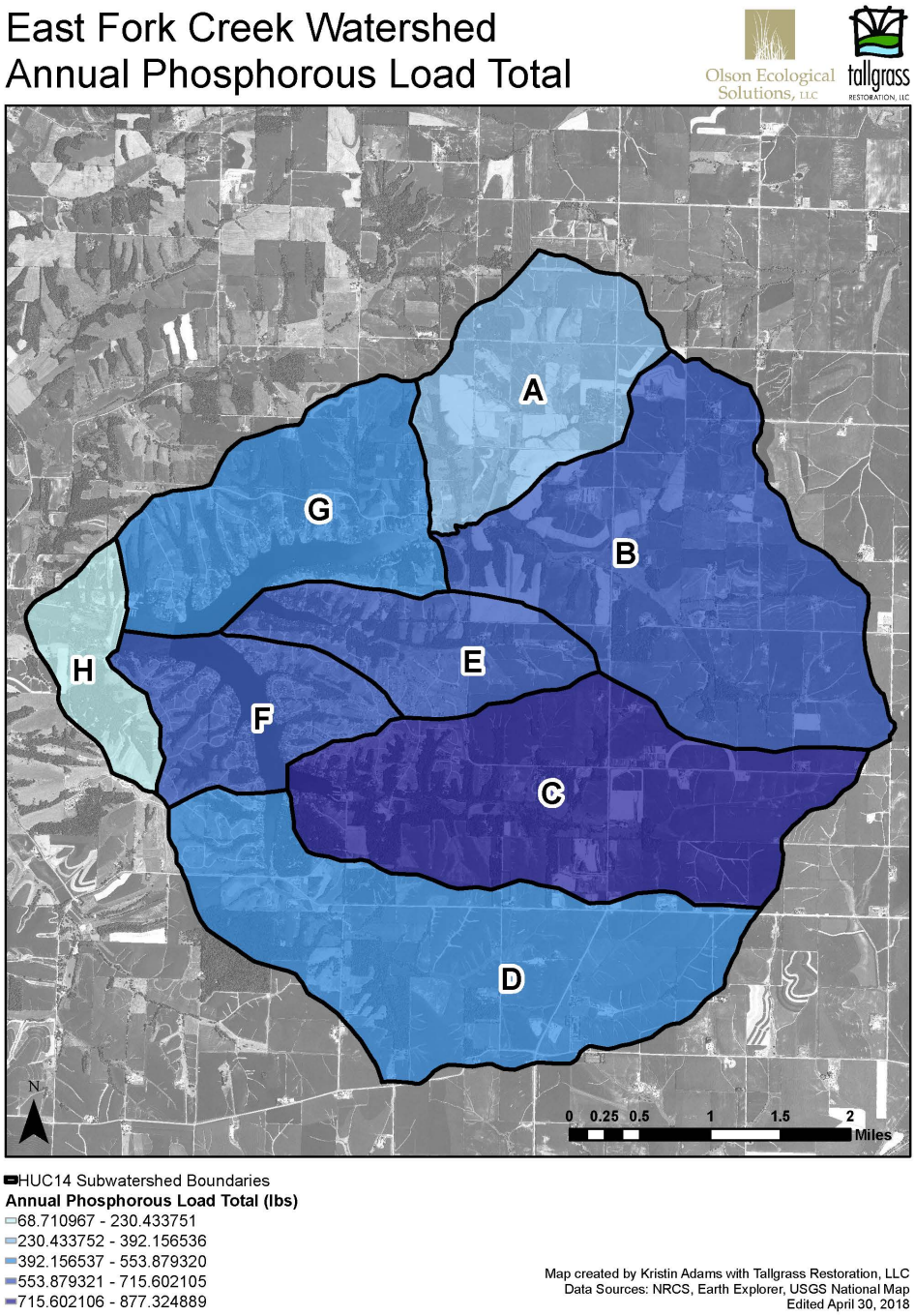


Figure 44 East Fork Creek Watershed, Annual Sediment Load Total

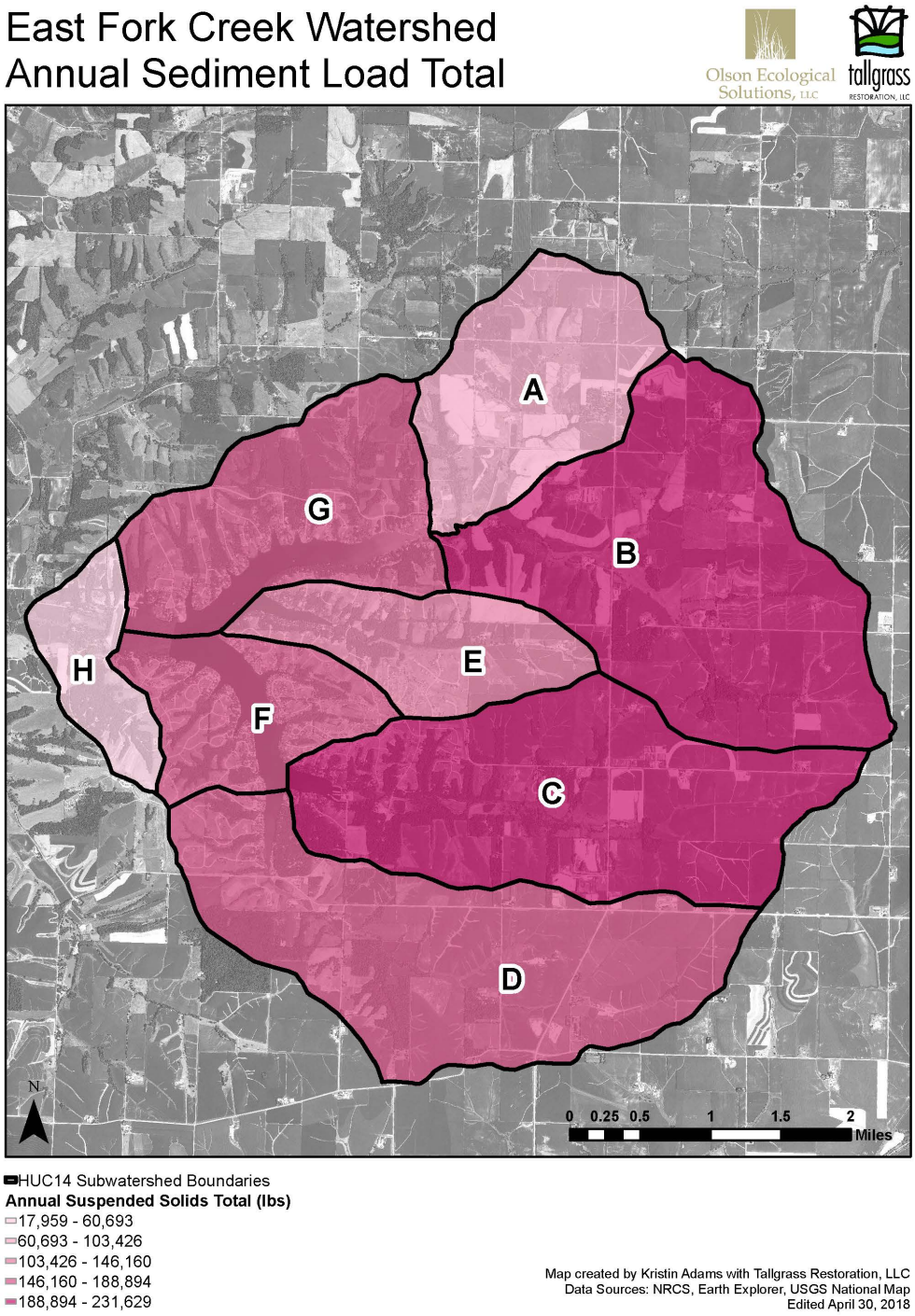
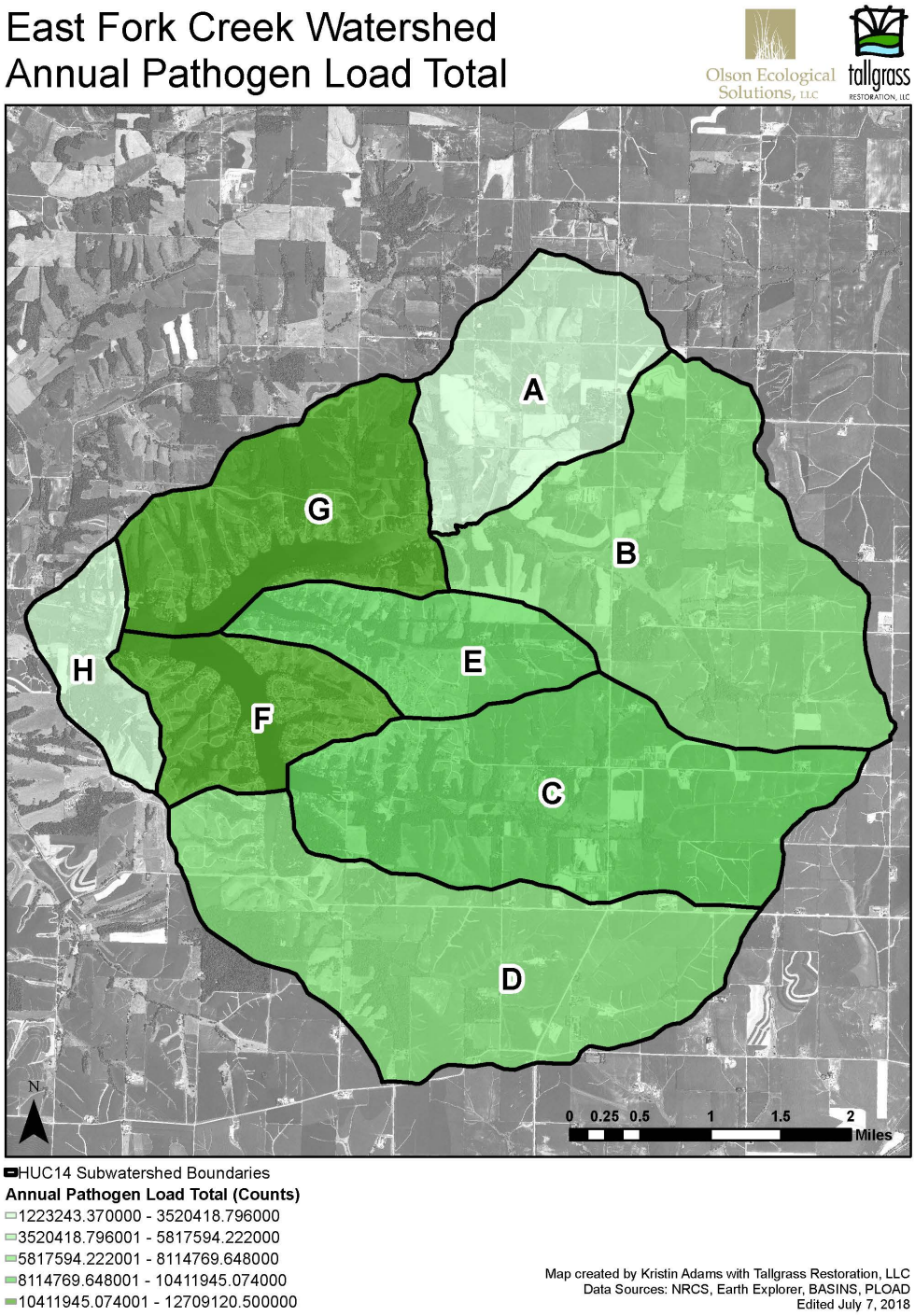


Figure 45 East Fork Creek Watershed, Annual Load Total



Works Cited

Blackhawk Hills Regional Council. 2018. Northwest Illinois Trails Study. Retrieved from http://www.blackhawkhills.com/wp-content/uploads/2018/06/2018-05-25-Trails-Study-Report.pdf

Blackhawk Hills Regional Council. 2014. 2014-2019 Comprehensive Economic Development Strategy. Retrieved from http://www.blackhawkhills.com/wp-content/uploads/2016/11/CEDS-2014-2019-Final-Web.pdf

Carroll County, Illinois 2008 Comprehensive Plan. 2008. Carroll County Economic Development Corporation. Retrieved from https://www.carroll-county.net/vertical/sites/%7B7FC08AB3-4BE5-4C4B-891B-83D2782F3DCA%7D/uploads/%7BFD72486E-6F7A-4D30-9F6B-0D8FC21979E5%7D.PDF

Carroll County Economic Development Corporation. (no date). Greenways and Trails Plan, Carroll County, Illinois. Retrieved from https://www.dnr.illinois.gov/recreation/greenwaysandtrails/ComprehensivePlans/Carroll.pdf

Carroll County. (no date). UTV-ATV Trail Proposal Update. Retrieved from https://www.carroll-county.net/vertical/sites/%7B7FC08AB3-4BE5-4C4B-891B-83D2782F3DCA%7D/uploads/UTV-ATV.TRAIL.PROPOSAL.UPDATE.pdf

CPCS Transcom. 2018. Eight-County Freight Study Summary Report. Retrieved from http://www.eciatrans.org/pdf/FINAL_Eight%20County%20Freight%20Summary%20Report.pdf

Elmer, Steven L. and Steven K. Higgins. (2006). *Soil Survey for Carroll County, Illinois.* Retrieved from USDA Natural Resources Conservation Service https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/illinois/IL015/0/Carrolll_IL.pdf

Environmental Protection Agency. 2013. Total Nitrogen. Retrieved from: https://www.epa.gov/sites/production/files/2015-09/documents/totalnitrogen.pdf

Illinois Department of Agriculture. (2001, August). *Illinois LESA System: Land Evaluation and Site Assessment.* Retrieved from https://www2.illinois.gov/sites/agr/Resources/LandWater/Documents/LESA.pdf

Illinois Environmental Protection Agency. (2008, June 15 draft). *Illinois Integrated Water Quality Report and 303(d) List.* Retrieved from http://www.epa.illinois.gov/topics/water-quality/watershed-management/tmdls/303d-list/index

Illinois State Water Survey (ISWS). (2013). *Water and Atmospheric Resources Monitoring Program (WARM).* Retrieved from http://www.isws.illinois.edu/warm/weather/

Integrated Lakes Management. 2016. *Lake Carroll Water Quality Testing, June 21, 2016.* Unpublished.

Institute of Water Research, Michigan State University. (2002). *RUSLE Online Erosion Assessment Tool.* Retrieved from www.iwr.msu.edu/rusle/kfactor.htm

Justia US Law. *7 C.F.R. Subpart B – Highly Erodible Land Conservation.* Retrieved from https://law.justia.com/cfr/title07/7-1.1.1.1.14.2.html

Kolata, D.R., and C.K. Nimz. (2010). *Geology of Illinois.* Champaign, IL: Illinois State Geologic Survey.

Lake Carroll Association. 2019. "About Lake Carroll." Retrieved from www.golakecarroll.com/WebPage.asp?PN=About

Lake Carroll Association. 2018. Lake Carroll Real Estate Guide. retrieved on 1/2/19 from http://www.golakecarroll.com/LCA/NewsDoc/NewsDoc40029.pdf

Lake Carroll Association. (n.d.) "Mission & Vision." Retrieved from www.golakecarroll.com/WebPage.asp?PN=Mission

McGarry, Christopher S. (1997). *Bedrock Geology of Carroll County, Illinois*. Retrieved from Illinois State Geological Survey https://www.isgs.illinois.edu/maps/county-maps/Carrolll-bedrock-geology

National Centers for Environmental Information, and NCEI. (2018, March). "Global Summary of the Month Station Details." Lanark, IL Station, April 2017-March 2018. Retrieved from National Climatic Data Center, www.ncdc.noaa.gov/cdo-web/datasets/GSOM/stations/GHCND:USC00114879/detail [Accessed May 1, 2018]

Natural Resources Conservation Service. 2018. Web Soil Survey. Retrieved from: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Northwater Consulting. (2018, February). "Appendix G: Pollutant Load Methodology and Flow and Load Duration Results." Retrieved from *Des Plaines River Watershed,* Lake County Stormwater Management Commission https://www.lakecountyil.gov/DocumentCenter/View/22789/Appendix-G-Pollutant-Load-Methodology-and-Flow-and-Load-Duration-Results

Ray, B.W. and J.B. Fehrenbacher. (1975). *Soil Survey Carroll County, Illinois.* Retrieved from https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/illinois/carrollIL1975/carroll.pdf

Soil Science Division Staff. (2017). *Soil survey manual.* Retrieved from USDA Handbook 18 https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/ref/?cid=nrcs142p2_054262

U.S. Census Bureau (n.d.) Selected Economic Characteristics for Carroll County, Illinois. 2012-2016

American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

U.S. Census Bureau (n.d.) Selected Economic Characteristics for Stephenson County, Illinois. 2012-2016 American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Census Bureau (2016a). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for Cherry Grove-Shannon township, Carroll County, IL* https://censusreporter.org/profiles/06000US1701512996-cherry-grove-shannon-township-carroll-county-il/

U.S. Census Bureau (2016b). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for Freedom township, Carroll County, IL* https://censusreporter.org/profiles/06000US1701527832-freedom-township-carroll-county-il/

U.S. Census Bureau (2016c). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for Jefferson township, Stephenson County, IL* https://censusreporter.org/profiles/06000US1717738284-jefferson-township-stephenson-county-il/

U.S. Census Bureau (2016d). *American Community Survey 5-year estimates.* Retrieved from *Census Reporter Profile page for Loran township, Stephenson County, IL* https://censusreporter.org/profiles/06000US1717744758-loran-township-stephenson-county-il/

U.S. Census Bureau (2016e) Demographic and Housing Estimates for Carroll County, Illinois. 2012-2016 American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Census Bureau (2016f) Demographic and Housing Estimates for Stephenson County, Illinois. 2012-2016 American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). (2017, Aug. 21.) *Web Soil Survey.* Retrieved from websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

_____. (2015b, August 26). Natural Resources Inventory Glossary. *NRCS Soil Survey.* Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs143_014127

_____. (2008). *Soil Survey for Stephenson County, IL.* Retrieved from https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/illinois/stephensonIL1976/stephenson.pdf

_____. (2010, April). *2007 National Resources Inventory Soil Erosion on Cropland.* Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf

_____. (2007). *Part 630 Hydrology National Engineering Handbook: Chapter 7 Hydrologic Soil Groups.* Retrieved from https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba

_____. (1997). *Prime farmland table of 1993: definitions from National Resource Inventory.* Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs143_014052October1993]fcategories

_____. (n.d.). *Hydric Rating.* Retrieved from https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1295760&ext=pdf

_____. (n.d.). *Highly Erodible Land Definitions.* Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/pr/soils/?cid=nrcs141p2_037282

_____. (n.d.). *Background on Highly Erodible Land (HEL).* Retrieved from https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid...ext=pdf
Special thanks to NRCS Soil Staff's GIS and Resource Inventory Specialist, Timothy Prescott.

_____. (n.d). *Web Soil Survey.* Retrieved from http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm (Accessed Feb 2, 2018)

United States Congress, Office of Water Regulations and Standards., et al. 2014. "Thorn Creek Watershed Based Plan Addendum." Thorn Creek Watershed Based Plan Addendum, Dec. 2014. www2.illinois.gov/epa/Documents/iepa/water-quality/watershed-management/watershed-based-planning/2016/thornwbp.pdf.

U.S. Geological Survey. 2019. What are zebra mussels and why should we care about them? Retrieved on 4/15/19 from: https://www.usgs.gov/faqs/what-are-zebra-mussels-and-why-should-we-care-about-them?qt-news_science_products=0#qt-news_science_products

Water Quality Association. 2019. Common Waterborne Contaminants. Retrieved from https://www.wqa.org/learn-about-water/common-contaminants

Wind Erodibility Groups (I). (2002, August). In *South Dakota Technical Guide Section II – Cropland Interpretations.* Retrieved from https://efotg.sc.egov.usda.gov/references/Agency/SD/Archived_winderos_100415.pdf

Wundergound. (2018). *2017 Monthly weather history reports for Freeport, IL. Freeport Illinois.* Retrieved from www.wunderground.com (Accessed February 2, 2018)

Geographic Information Systems (GIS) Works Cited

201706_ILLINOIS_NAIP_1X0000M_UTM_CNIR. 4 bands. 1 meter per pixel. IL: United States Department of Agriculture, Farm Service Agency, and Aerial Photography Field Office, August 23, 2017. Available online at https://earthexplorer.usgs.gov/. Accesssed [1/26/2018]. (Coordinate System: WGS 1984).

Federal Emergency Management Aqency (FEMA). *National Flood Hazard Layer.* Washington, D.C.: FEMA-NFHL, December 17, 2010. Available online at https://msc.fema.gov. [Accessed 02/01/2018]. (Coordinate System: GCS North American 1983).

Illinois Natural History Survey (INHS). *Illinois Department of Natural Resources, Illinois Natural History Survey, Land Cover of Illinois in the Early 1800s.* Champaign, IL: INHS, August 2003. Available online at https://clearinghouse.isgs.illinois.edu/data/landcover/illinois-landcover-early-1800s. [Accessed 02/08/2018]. (Coordinate System: NAD 1983 UTM Zone 16N).

Illinois State Geological Survey (ISGS). *Bedrock Geology of Illinois.* Champaign, IL: Dennis Kolata, ISGS, 2005. Available online at https://clearinghouse.isgs.illinois.edu/data/geology/bedrock-geology-2005. [Accessed 02/08/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Illinois County Boundary Lines.* Champaign, IL: ISGS, June 2003. Available online at http://clearinghouse.isgs.illinois.edu/data. [Accessed 01/30/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Illinois Public Land Survey System.* Champaign, IL: ISGS, June 2003. Available online at http://clearinghouse.isgs.illinois.edu/data. [Accessed 1/29/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Illinois State Boundary.* Champaign, IL: ISGS, June 2003. Available online at http://clearinghouse.isgs.illinois.edu/data. [Accessed 01/31/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Location Points from the ISGS Wells and Borings Database.* Champaign, IL: ISGS, February 21, 2008. Available online at https://clearinghouse.isgs.illinois.edu/data/geology/bedrock-geology-2005. [Accessed 02/14/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Potential of Agricultural Chemical Contamination of Aquifers.* Champaign, IL: ISGS, February 21, 2008. Available online at https://clearinghouse.isgs.illinois.edu/data/hydrology/potential-agricultural-chemical-contamination-aquifers. [Accessed 03/07/2018]. (Coordinate System: GCS North American 1983).

Illinois State Geological Survey (ISGS). *Quaternary Deposits of Illinois, 1996.* Champaign, IL: A.K. Hansel and Johnson, W.H., ISGS, 1996. Available online at https://clearinghouse.isgs.illinois.edu/data/geology/quaternary-deposits-1996. [Accessed 02/08/2018]. (Coordinate System: GCS North American 1983).

Iowa Department of Transportation (IDOT). *Iowa State Plane Boundary.* Iowa: IDOT, June 15, 2016. Available online at http://data.iowadot.gov/datasets/iowa-state-plane-boundary. [Accessed 01/31/2018]. (Coordinate System: WGS 1984).

Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA). *Watershed Boundary Dataset HUC10.* Fort Worth, TX: NRCS and USDA 2005. Available online at https://nrcs.app.box.com/v/huc/folder/18546994164. Accessed [1/26/2018]. (Coordinate System: WGS 1984).

Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA). *Watershed Boundary Dataset HUC12.* Fort Worth, TX: NRCS and USDA 2005. Available online at https://nrcs.app.box.com/v/huc/folder/18546994164. Accessed [1/26/2018]. (Coordinate System: WGS_1984).

Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA), National Geospatial Center of Excellence (NGCE). *USDA-NRCS Easement Areas.* Fort Worth, TX: NRCS, USDA, and NGCE, 2000-Present. Available online at https://gdg.sc.egov.usda.gov/GDGOrder.aspx. Accessed [02/13/2018]. (Coordinate System: NAD 1983 UTM Zone 16N).

Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA), National Geospatial Center of Excellence (NGCE). *Watershed Boundary Dataset (WBD) HUC8 modified.* Fort Worth, TX: NRCS, USDA, and NGCE, April 4, 2014. Available online at https://www.fws.gov/wetlands/Data/Mapper.html. Accessed [1/26/2018]. (Coordinate System: WGS 1984).

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. *Soil Survey Geographic (SSURGO) Database*. Available online at https://sdmdataaccess.sc.egov.usda.gov. Accessed [2/2/2018]. (Coordinate System: WGS_1984).

Stephenson County GIS. *Stephenson County Basemap, East Fork Parcel Selection.* Freeport, IL: Michael Munda, purchased February 2, 2017. (Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet).

U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). *USDA, National Agricultural Statistics Service, 2015 Illinois Cropland Data Layer.* Washington, D.C.: USDA, NASS Marketing and Information Services Office, February 2016. Available online at http://nassgeodata.gmu.edu/CropScape/IL. [Accessed 03/09/2018]. (Coordinate System: WGS 1984, UTM Zone 16N).

U.S. Department of Commerce, U.S. Census Bureau, Geography Division. *TIGER/Line Shapefile, 2013, state, Illinois, Current Place.* Washington, D.C.: U.S. Department of Commerce, U.S. Census Bureau, Geography Division, Geographic Products Branch, May 2013. Available online at https://catalog.data.gov/dataset/tiger-line-shapefile-2013-state-illinois-current-place. [Accessed 02/08/2018]. (Coordinate System: GCS North American 1983).

U.S. Fish and Wildlife Service (USFWS). *National Wetlands Inventory in Illinois.* Champaign, IL: IL Natural History Survey, April 1996. Available online at https://www.fws.gov/wetlands/data/mapper.html. Accessed [09/15/2015]. (Coordinate System: GCS North American 1983).

US Geological Survey Gap Analysis Program. *Protected Areas Database of the United States 1.4.* Fort Worth, TX: U.S. Geological Survey, May 5, 2016. Available online at https://gdg.sc.egov.usda.gov/GDGOrder.aspx. Accessed [02/13/2018]. (Coordinate System: NAD 1983 UTM Zone 16N).

U.S. Geological Survey (USGS). *Contours.* Denver, CO: USGS, 2010-2015. Available online at https://viewer.nationalmap.gov/. Accessed [01/26/2018]. (Coordinate System: GCS North American 1983).

U.S. Geological Survey (USGS), National Geospatial Program. *USGS National Hydrography Dataset (NHD).* Reston, VA: USGS, August 14, 2017. Available online at https://viewer.nationalmap.gov/launch/. Accessed [02/01/2018]. (Coordinate System: GCS North American 1983).

Wisconsin Department of Natural Resources (WDNR), Bureau of Technology Services. *State of Wisconsin Boundary.* WDNR: Wisconsin, June 26, 2007. Available online at https://data-wi-dnr.opendata.arcgis.com/. [Accessed 01/31/2018]. (Coordinate System: NAD83 HARN Wisconsin Transverse Mercator).

TIGER State and County Demographic Statistics by State, 1 map 0.816 MB - TIGER County Social, Econ, Housing Stats by State, 1 map 3.007 MB - Geographic Names - Populated Places, 2 maps 0.028 MB From USDA Geospatial Data Gateway (see above)

2012 Land Use: USGS GeoTIFF nwalt_landuse_2012 "U.S. Conterminous Wall-to-wall anthropogenic land use trends (NWALT) 1974-2012" Site Metadata for values https://water.usgs.gov/GIS/metadata/usgswrd/XML/ds948_NWALT.xml#Entity_and_Attribute_Information

2011 Land Cover: USGS National Map Metadata: https://www.sciencebase.gov/catalog/item/5a1c31aee4b09fc93dd6387c OR https://www.sciencebase.gov/catalog/file/get/5a1c31aee4b09fc93dd6387c?f=__disk__05%2Fbd%2Fa3%2F05bda3d6a41956e9414ab8ba8f2efb06bea70197&transform=1&allowOpen=true

1999-2000 IL Gap Analysis Land Classification – IL Clearinghouse, accessed 2/8/2018 https://clearinghouse.isgs.illinois.edu/data/land-cover/illinois-gap-analysis-program-land-cover-classification

This page was intentionally left blank.