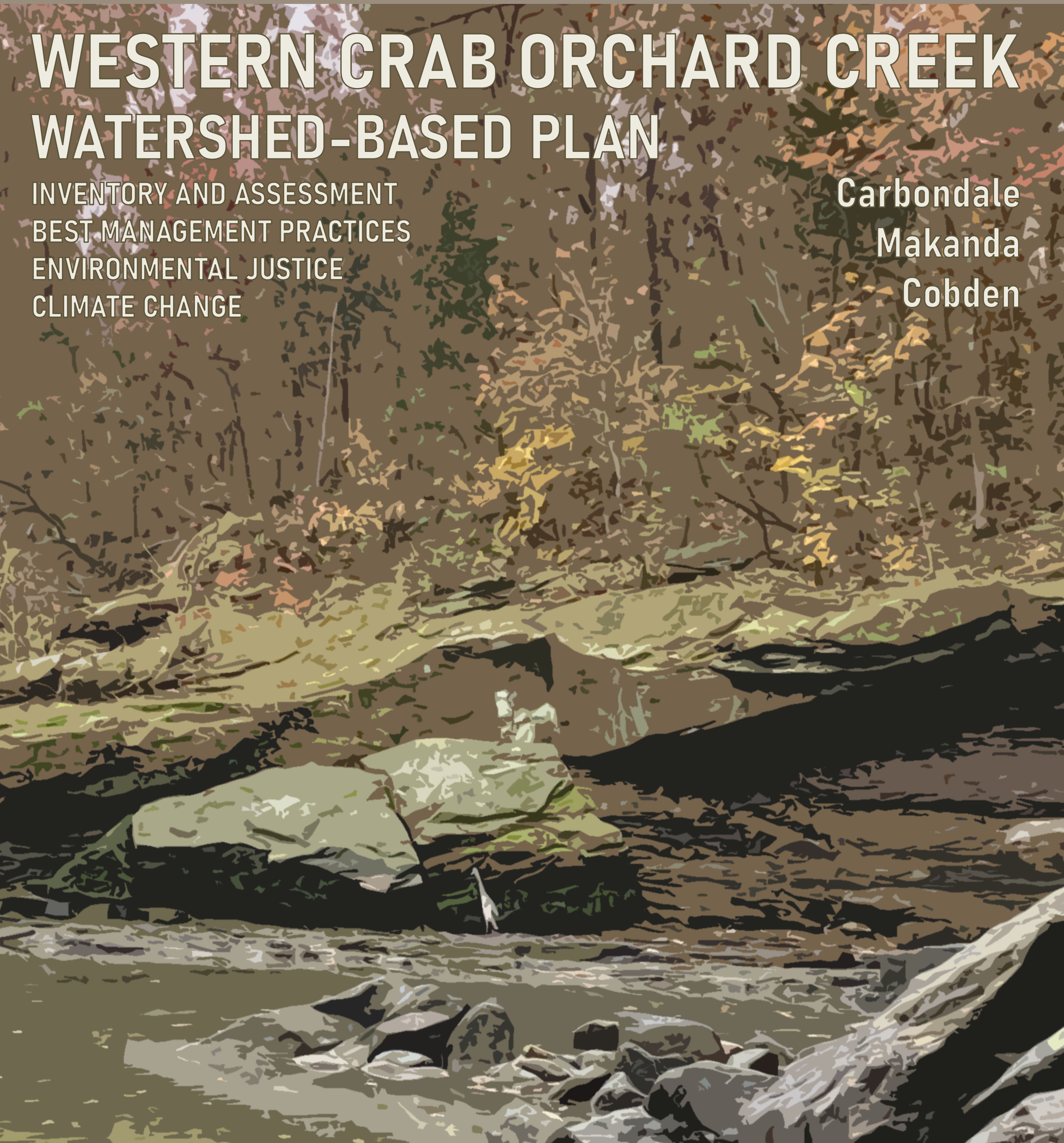
WESTERN CRAB ORCHARD CREEK WATERSHED-BASED PLAN

INVENTORY AND ASSESSMENT
BEST MANAGEMENT PRACTICES
ENVIRONMENTAL JUSTICE
CLIMATE CHANGE

Carbondale
Makanda
Cobden



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Acronyms and Abbreviations

ACS	American Community Survey
AISWCD	Association of Illinois Soil and Water Conservation Districts
AMA	Agricultural Management Assistance Program
BOD	Biochemical Oxygen Demand
CSP	Conservation Stewardship Program
CTA	Conservation Technical Assistance Program
CWA	Clean Water Act
DOI	Department of the Interior
EPA	Environmental Protection Agency
EMA	Emergency Management Agency
EQIP	Environmental Quality Incentives program
HAB	Harmful Algal Bloom
HUC	Hydrologic Unit Code
ICN	Illinois Climate Network
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILNLRS	Illinois Nutrient Loss Reduction Strategy
ISGS	Illinois State Geological Survey
JCHD	Jackson County Health Department
LRR	Lateral Recession Rate
MCL	Maximum Contaminant Level
MLCG	Maximum Contaminant Level Goal
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer Systems
NFIP	National Flood Insurance Program
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Agency
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
PCB	Polychlorinated Biphenyl
RMMS	Resource Management Mapping Service
RUSLE	Revised Universal Soil Loss Equation
SMU	Subwatershed Management Unit
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWCD	Soil and Water Conservation Districts
SWPPP	Stormwater Pollution Prevention Plan
TSS	Total Suspended Solids
UAS	Unmanned Aircraft System
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
VLMP	Volunteer Lake Monitoring Program

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Executive Summary

Beginning in the latter part 2018, the Greater Egypt Regional Planning and Development Commission (Greater Egypt) was contracted by the Illinois Environmental Protection Agency (IEPA) to develop a watershed-based plan for the Western Crab Orchard Creek watershed using EPA Section 604(b) funding.

The Western Crab Orchard Creek watershed is a collective group of three smaller watersheds comprised of: Drury Creek, Indian Creek – Drury Creek, and Little Crab Orchard Creek – Crab Orchard Creek. The study area is part of the larger Big Muddy River basin.

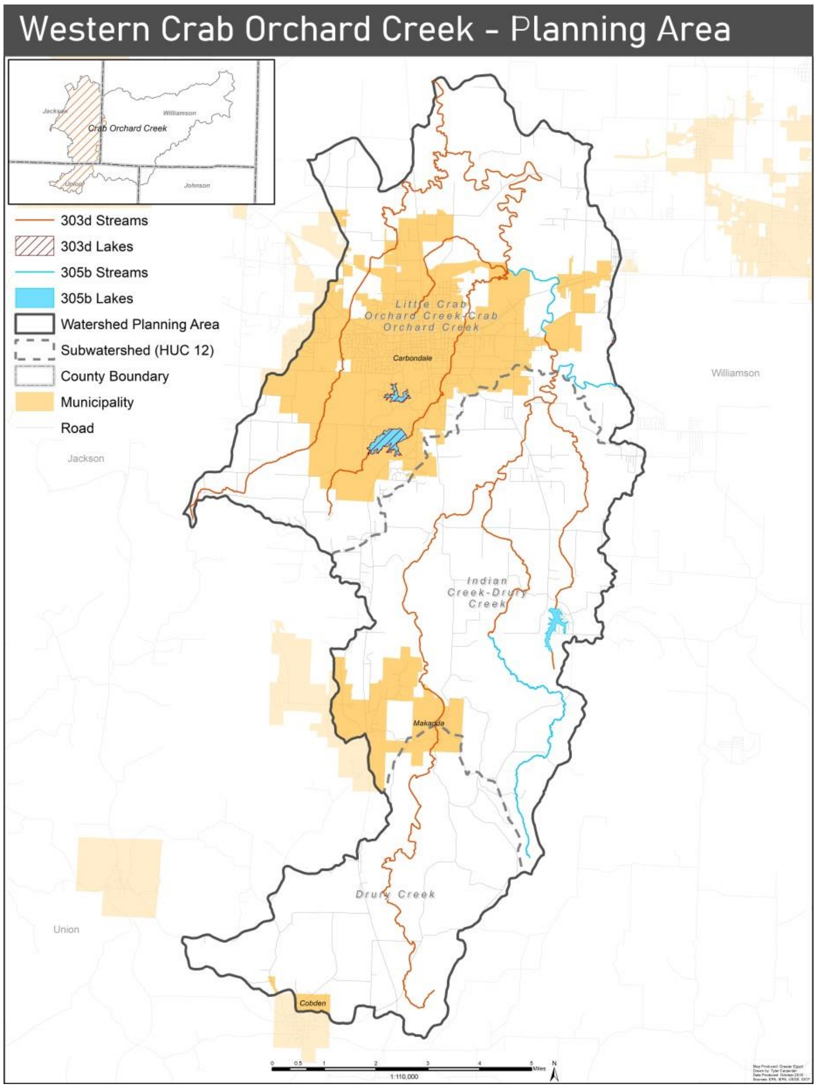
The planning area encompasses 56,533 acres, or around 88 square miles. Most of the watershed lies within Jackson County (78%), with the other portions being located in Union (19%) and Williamson County (3%). While the City of Carbondale represents the largest built environment in the study area, the Villages of Cobden and Makanda are also represented.

Nine waterbodies in the watershed have been placed on the Illinois Environmental Protection Agency's 303(d) List of Impaired Waters. This list is comprised of waterbodies that do not meet water quality standards. Causes of these impairments in the watershed include: dissolved oxygen, mercury, methoxychlor, PCBs, pH, sedimentation/siltation, total suspended solids (TSS), and water temperature.

Following the submission of the *Western Crab Orchard Creek Watershed Resource Inventory and Assessment*, an initial stakeholder meeting was held in 2020 to gain awareness of planning efforts, and to garner membership for the Western Crab Orchard Creek Watershed Planning Committee. The group convened on a quarterly basis and provided guidance throughout the plan. This included discussing existing knowledge of the watershed and suggesting best management practices (BMP) for the plan. The success of the plan relies heavily on the continuation of public involvement. This includes overseeing implementation of the plan and monitoring progress.

Land use in the watershed is represented by large areas of agriculture, forest, and urban environment. Agriculture in the watershed is composed of 18.7 percent of pasture and hay and 6.7 percent of cultivated crops. Forested areas represent the largest land use at 51 percent of the watershed. Developed land constitutes 21 percent. Remaining land uses in the watershed include open water (1.1%) and wetlands (1.2%). With around 25 percent of the watershed being classified as agriculture, there is a high potential for nutrient runoff. This is exemplified by areas of cropland that are located in the Little Crab Orchard Creek subwatershed.

Figure I



While impervious surfaces in the planning area are generally low, the City of Carbondale constitutes the largest portion of the watershed's impervious network. This is made up of roads, buildings, and other components of the built environment. Areas with high levels of impervious features and inadequate stormwater management can lead to localized flooding.

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) was utilized to generate existing pollutant loads for the Western Crab Orchard Creek watershed and its subwatershed management units. While the program produces general estimates, the data was generated from multiple factors including: land use, climatic indicators, agriculture, septic rates, urban runoff, and streambank erosion using lateral recession rates. In the Western Crab Orchard Creek watershed, estimated pollutant loads are mostly influenced by areas of agricultural and urban environment.

Table I – Estimated Pollutant Loads

Source	N Load (lb/yr)	Percent of Total Load	P Load (lb/yr)	Percent of Total Load	Sediment Load (tons/yr)	Percent of Total Load
Urban	81390.36	24.88%	12527.90	20.79%	1870.49	3.91%
Cropland	31256.72	9.56%	9009.52	14.95%	5606.23	11.71%
Pastureland	70201.03	21.46%	8968.51	14.88%	3733.30	7.80%
Forest and Grassland	8619.41	2.64%	3998.50	6.63%	845.65	1.77%
Groundwater	78323.21	23.94%	3696.34	6.13%	0.00	0.00%
Streambank	57308.84	17.52%	22063.91	36.61%	35818.03	74.82%
Total	**327,099.55**		**60,264.68**		**47,873.69**	

Pollutant load reduction targets were also generated for major pollutants. A reduction of nitrogen at 15 percent, phosphorus at 25 percent, and sediment reduction of 25 percent were calculated for the plan. Target goals are consistent with the Illinois Nutrient Loss Reduction Strategy (ILNLRS).

To achieve the target goals, Best Management Practices (BMPs) were suggested in regards to the major nutrient contributors in the watershed, agricultural and urban practices. While the plan addresses watershed-wide practices, site-specific BMPs have also been established to manage agricultural and urban pollutants and other impairments on a localized level.

These management efforts confront the impairments of the various waterbodies in the Western Crab Orchard Creek watershed. Some of the measures include gully, shoreline, and streambank stabilization methods. They have also been categorized by priority based on cost and pollutant load reductions.

The plan incorporates the *Nine Minimum Elements* required of a watershed-based plan. These elements include: a characterization of the watershed through a resource inventory and assessment to identify nonpoint source pollution, identification of management measures to address those pollutants, identifying funding and technical assistance, an educational component, and a monitoring and evaluation component to track progress and monitor accomplishments.

Funding will mainly be applied through EPA Clean Water Act Section 319 grants. Most of the BMPs in the plan are eligible to receive funding through these grants since their focus is reducing nonpoint source pollution.

Outreach and education of watershed-related activities are important in promoting awareness of the plan and progression of plan implementation. Some of the outreach components include: holding public meetings, distributing flyers about the plan and agricultural activities, educational programs, and recruiting volunteers for litter cleanups.

Implementation of the plan is divided into three phases. Phase I represents the first two years of the plan where most educational and outreach components are implemented; along with selecting site-specific BMPs for grant funding. Phase II will require the watershed action committee to continue submitting grants and begin implementation of BMPs. Phase III represents the last four years of the planning period in which BMP implementation will continue and evaluating the plan will begin.

Interim measurable milestones, water quality benchmarks, and a monitoring component have also been established to track progress and evaluate the success of the plan. Table 2 represents the ten-year water quality benchmarks in the plan with focus on nitrogen, phosphorus, and sediment.

Table II – Benchmark Reduction Targets

	Benchmark Reduction Targets					
Benchmark Period	**Nitrogen (percent)**	**Nitrogen (lbs)**	**Phosphorus (percent)**	**Phosphorus (lbs)**	**Sediment (percent)**	**Sediment (tons)**
2 Year (Phase I)	-	-	-	-	-	-
6 Year (Phase II)	7	228,970	10	60,265	10	47,880
10 Year (Phase III)	15	490,649	25	150,662	25	119,699

The monitoring component of the plan features programs offered by IEPA and the Illinois Department of Natural Resources (IDNR). The Ambient Water Quality Monitoring Network (AWQMN) and the Intensive River Basin Surveys are both ways in which water quality can be tested. Results will be analyzed by the watershed action committee to determine success of BMP implementation and the plan itself.

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1. Introduction

A watershed is a drainage basin where all water flows into from surrounding elevated lands. Precipitation and runoff drain to a waterbody, usually a lake or stream that centralizes all flow of the watershed. Watersheds can range from regional land areas that span states to smaller basins that are encompassed within counties. Watershed size is classified by Hydrologic Unit Codes (HUC) which range from 2 (regional) to 12 (sub-watershed).

Watershed-based plans provide a framework for improving water quality in a specific watershed. They are often designed to reduce pollutants from nonpoint sources and identify other components that impair water quality. These plans include a characterization of the watershed through a resource inventory and assessment to identify nonpoint source pollution, identification of best management practices (BMP) to address those sources, and a monitoring and evaluation component to track progress and monitor accomplishments.

The Western Crab Orchard Creek Watershed is comprised of three HUC-12 subwatersheds. This includes the subwatersheds of: Drury Creek, Indian Creek- Drury Creek, and Little Crab Orchard Creek– Crab Orchard Creek. In the planning area, nine waterbodies have been placed on IEPA's 303(d) List of Impaired Waters. This list is comprised of waterbodies that do not meet water quality standards. Causes of these impairments in the watershed include: dissolved oxygen, mercury, methoxychlor, PCBs, pH, sedimentation/siltation, total suspended solids (TSS), and water temperature.

Watershed-based planning focuses on collaboration among stakeholders and local decision makers. Early in the planning process, an initial stakeholders meeting took place to explain the process of watershed-based planning and gather members for the Western Crab Orchard Creek Watershed Planning Committee. This group met on a quarterly basis to oversee the planning process. Refer to appendix A for meeting materials.

Watershed-based plans must follow guidelines set forth by the Environmental Protection Agency. To be successful, watershed-based plans need to include the Nine

Minimum Elements of a Watershed-based Plan. [1] The components, information and location within this plan are as follows:

- *Element A*- Identify causes and sources of pollution.
    - This was completed through an inventory and assessment of the Western Crab Orchard Creek Watershed. The inventory includes a characterization of the watershed including details on: boundaries, geology and climate, soils, jurisdictions, demographics, and land use. It also includes an assessment of waterbodies and water quality which identifies sources of pollution in the watershed. (Chapter 2)

- *Element B*- Estimate load reductions expected from best management practices.
    - Pollutant load reduction targets were created to meet water quality goals. The load reduction goals for the Western Crab Orchard Creek Watershed-based Plan follow the statewide goals established in the Illinois Nutrient Loss Reduction Strategy. A goal of 15% reduction in Nitrogen and 25% reductions in Phosphorus and sediments have been set for the planning area. (Chapter 2)

- *Element C*- Describe the nonpoint source best management practices that are needed meet pollutant load reductions.
    - A description of each best management practice (BMP) type has been provided in the plan. Information for watershed-wide and site-specific BMP has also been provided. This includes: location, load reductions, amount, unit, and priority. (Chapter 4)

- *Element D*- Identify the technical and financial assistance needed to implement the plan.
    - Costs and work associated with the technical and financial assistance have been calculated for each management measure in the plan. Grant funding opportunities and cost match notes for each BMP have also been identified. (Chapter 5)

1Environmental Protection Agency, "Appendix C- Minimum Elements of a Watershed-based Plan," in *Nonpoint Source Program and Grants Guidelines for States and Territories* (Washington D.C., 2013.), 63-68.

- *Element E*- Develop an information and education component.
    - An outreach and educational component were created to gain public involvement which can promote the strategies and implementation measures in the plan. Various activities have been included to inform the public on watershed planning, BMP, and nonpoint source pollution. (Chapter 6)

- Element F- Develop a schedule for implementing the nonpoint source best management practices in the plan.
    - A schedule was developed that outlines the best management practices, educational components, and other strategies in the plan. (Chapter 7)

- Element G- Describe interim measurable milestones to monitor management measures in the plan.
    - Milestones are to be addressed for each BMP in the plan. These milestones are also developed for the outreach components and other strategies. Milestones were separated by phases throughout the planning period. (Chapter 7)

- Element H- Develop criteria to measure progress of loading reductions through management measures.
    - These benchmarks signify whether BMPs and other management measures are successful in reducing pollutant loads and are leading to water quality standards. (Chapter 8)

- Element I- Develop a monitoring component that evaluates the efficacy of management measures.
    - Elements in the monitoring component determine whether loading reductions are being met and water quality standards are being achieved. (Chapter 8)

The Western Crab Orchard Creek Watershed-based Plan incorporates all of these elements in an effort to reduce nonpoint source pollutant loads and improve water quality within the watershed. The success of the plan largely depends on the collaboration of stakeholders and local officials to implement and oversee the plan.

Figure 1.1- Indian Creek

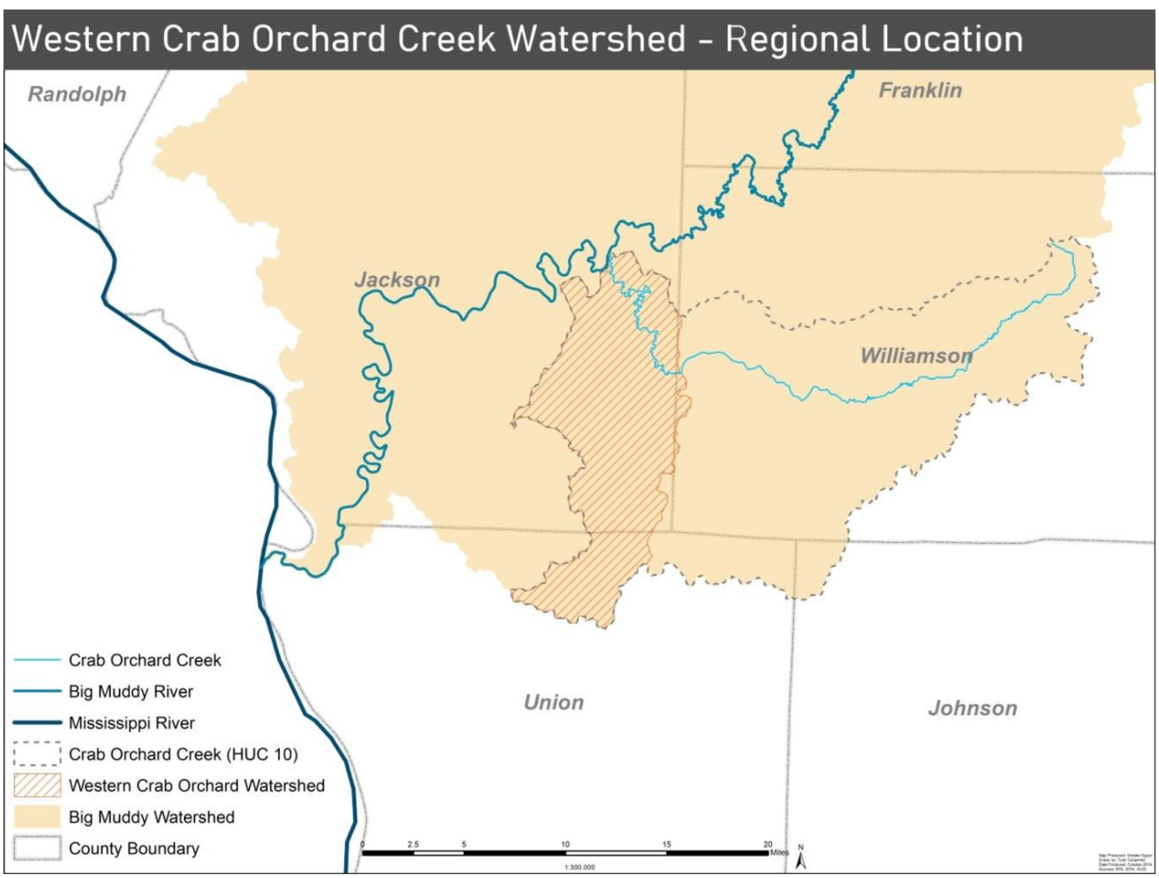
2. Watershed Inventory and Assessment

2.1. Watershed Geography & Climate

2.1.1. Geography

The Western Crab Orchard Creek watershed is a collective area encompassing three individual Hydrologic Unit Code (HUC) 12 subwatersheds. This includes: Drury Creek (071401060807), Indian Creek- Drury Creek (071401060808), and Little Crab Orchard Creek- Crab Orchard Creek (071401060809). This report will reference the Western Crab Orchard Creek watershed as the planning, or study area. This group of subwatersheds represents the western-most portion of the larger Crab Orchard Creek watershed (0714010608). The Western Crab Orchard Creek planning area encompasses 56,533 acres, or around eighty-eight square miles. *Figure 2.1* displays the study area and regional major waterbodies.

Figure 2.1



The planning area is located in Jackson, Union, and Williamson County in Illinois. The headwaters of Western Crab Orchard Creek watershed, which is represented by Drury Creek to the south, originates roughly two miles east of the Village of Cobden in Union County, Illinois. Crab Orchard Creek, flowing in from the east, converges with Drury Creek; eventually meeting at the confluence of the Big Muddy River to the north.

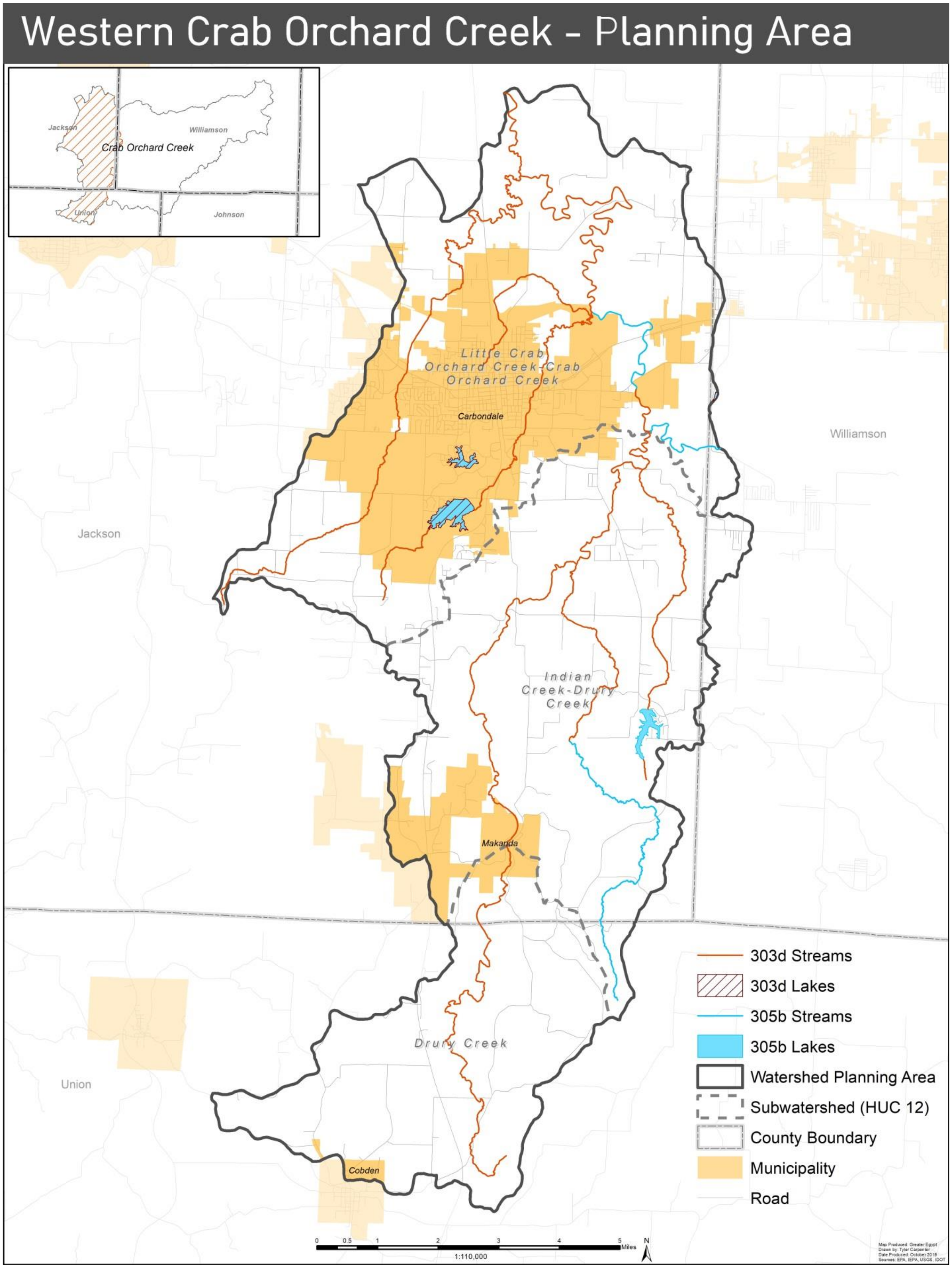
All waterbodies in the planning area eventually flow to the Big Muddy River. This river makes a winding course through Jackson County in a southwest direction eventually discharging into the Mississippi River.

The Western Crab Orchard Creek watershed is generally bound to the north by the Big Muddy River, to the east by Crab Orchard Lake, to the south by the Village of Cobden, and to the west by the western boundary of the City of Carbondale.

Three municipalities are located in the watershed planning area. These include the City of Carbondale, the Village of Makanda, and the Village of Cobden. With a population of nearly 22,000, Carbondale is the largest municipality in the planning area. The city is home to Southern Illinois University - Carbondale.

Figure 2.2- Indian Creek

Figure 2.3



Western Crab Orchard Creek - Planning Area
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
303d Streams
303d Lakes
305b Streams
305b Lakes
Watershed Planning Area
Subwatershed (HUC 12)
County Boundary
Municipality
Road
0
0.5
1
2
3
4
5
Miles
1:110,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: October 2019
Sources: EPA, IEPA, USGS, IDOT

2.1.2. Location of Water Bodies

The Western Crab Orchard Creek watershed lies on the divide between the Ohio and Mississippi River basins. There are nearly 91 miles of named streams in the watershed, as identified in the National Hydrography Dataset (NHD). Seven streams and two lakes are listed on the Illinois Environmental Protection Agency's (IEPA) 303(d) List of Impaired Waters. These waterbodies are displayed in *Figure 2.3 and 2.4.*

Drury Creek (IL_NDC) meanders 21 miles in a northerly direction through the center of the southern two subwatersheds converging with Crab Orchard Creek. Indian Creek (IL_NDCB) runs 11 miles in a similar direction before meeting Drury Creek. Sycamore Creek (IL_NDCA) also runs north, sourced from Spring Arbor Lake, and convenes with Drury Creek.

Crab Orchard Creek (IL_ND) flows from the Crab Orchard Lake spillway in the easternmost portion of the planning area, eventually ending at the confluence with the Big Muddy River. Larger tributaries that feed into Crab Orchard Creek include: Piles Fork Creek (IL_NDB), Eek Creek (IL_NDBA), and Little Crab Orchard Creek-West (IL_NDA); all of which are reported on the IEPA 303(d) List of Impaired Waters. Other smaller, unnamed tributaries run throughout the planning area in various directions, all flowing directly or indirectly into the main waterbodies.

Three lakes are also represented in the planning area. These include Carbondale City Lake, Campus Lake, and Spring Arbor Lake. The Carbondale City Lake (IL_RNI), or the Carbondale Reservoir; serves as a backup water source to Cedar Lake and remains an active recreational location. Campus Lake (IL_RNZH) is located on the southwestern part of campus at Southern Illinois University- Carbondale. While these two lakes are listed on the IEPA 303(d) Report, Spring Arbor Lake (IL_RNZG) is not impaired and remains a private waterbody. However, it is listed as an IEPA 305(b) assessed waterbody.

Wetlands are also a prominent feature throughout the study area. According to the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI), there are five classifications of wetlands identified in the Western Crab Orchard Creek watershed: freshwater emergent, freshwater forested/ shrub, freshwater pond, lake, and riverine. *Table 2.1* contains information on the distribution of wetlands. Freshwater forested and shrub wetland is the most prominent wetland classification in the watershed consisting of 2,186 acres, or accounting for nearly four percent of the watershed. The wetlands of the area have been spatially displayed in *Figure 2.5.*

Table 2.1- Distribution of Wetlands

Western Crab Orchard Creek Watershed			
Wetland Type	**Acres**	**Percent of Wetland Total**	**Percent of Total Watershed**
Freshwater Emergent	128.14	3.54%	0.23%
Freshwater Forested/ Shrub	2,186.06	60.36%	3.87%
Freshwater Pond	513.55	14.18%	0.91%
Lake	227.13	6.27%	0.40%
Riverine	566.76	15.65%	1.00%
Drury Creek Subwatershed			
Freshwater Emergent	13.41	3.22%	0.02%
Freshwater Forested/ Shrub	205.22	49.29%	0.36%
Freshwater Pond	97.61	23.45%	0.17%
Lake	0	0.00%	0.00%
Riverine	100.07	24.04%	0.18%
Indian Creek- Drury Creek Subwatershed			
Freshwater Emergent	47.47	4.82%	0.08%
Freshwater Forested/ Shrub	491.62	49.91%	0.87%
Freshwater Pond	177.86	18.06%	0.31%
Lake	67.43	6.85%	0.12%
Riverine	200.67	20.37%	0.35%
Little Crab Orchard Creek- Crab Orchard Creek Subwatershed			
Freshwater Emergent	67.25	3.03%	0.12%
Freshwater Forested/ Shrub	1,489.21	67.08%	2.63%
Freshwater Pond	238.07	10.72%	0.42%
Lake	159.7	7.19%	0.28%
Riverine	266	11.98%	0.47%

Source: US Fish and Wildlife Service National Wetlands Inventory

Figure 2.4

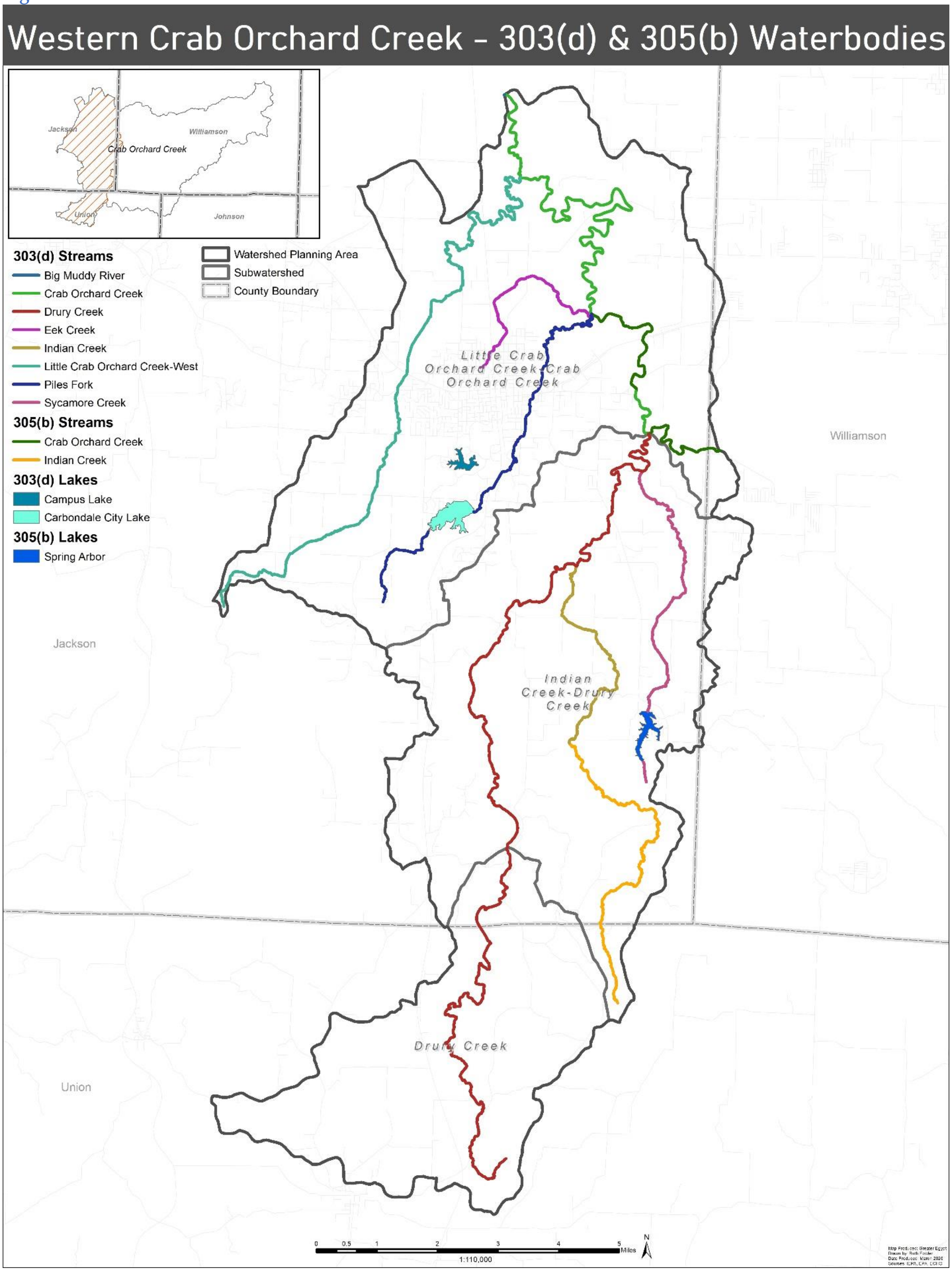
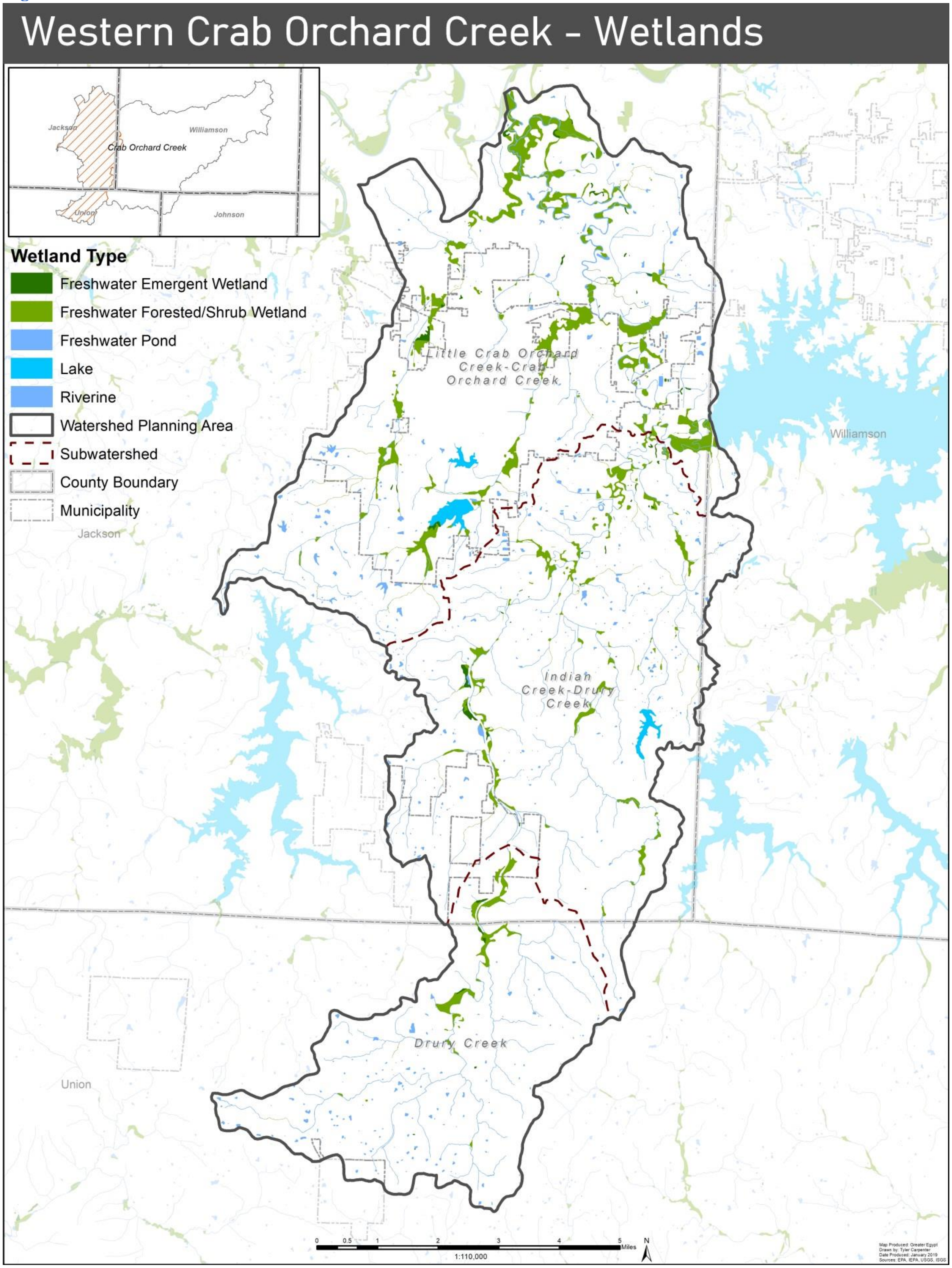

Western Crab Orchard Creek - 303(d) & 305(b) Waterbodies
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
303(d) Streams
Big Muddy River
Crab Orchard Creek
Drury Creek
Eek Creek
Indian Creek
Little Crab Orchard Creek-West
Piles Fork
Sycamore Creek
305(b) Streams
Crab Orchard Creek
Indian Creek
303(d) Lakes
Campus Lake
Carbondale City Lake
305(b) Lakes
Spring Arbor
Watershed Planning Area
Subwatershed
County Boundary
Little Crab Orchard Creek-Crab Orchard Creek
Indian Creek-Drury Creek
Drury Creek
Williamson
Jackson
Union
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Figure 2.5



Western Crab Orchard Creek - Wetlands
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Wetland Type
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Little Crab Orchard Creek-Crab Orchard Creek
Indian Creek-Drury Creek
Drury Creek
Williamson
Jackson
Union
1:110,000
Miles

2.1.3. Topography

The Western Crab Orchard Creek watershed is positioned on the southern limit of the glacial till from the Illinoisan age. A portion of the watershed is relatively flat, with gentle slopes near the headwaters and the southern border. This is most evident in the Little Crab Orchard Creek subwatershed. Indian Creek subwatershed represents the transition to higher elevation; this is more apparent at its southern border.
Drury Creek subwatershed exhibits the most elevated terrain at 890 feet. Its highest elevation occurs at the eastern border of the watershed at the foothills of the Shawnee National Forest. The general topography of the planning area is consistent with the surrounding watersheds of southern Illinois. The display in *Figure 2.6* shows the elevation and floodplain of the watershed. The lowest elevations are found in the northern section of Little Crab Orchard subwatershed at the confluence of the Big Muddy River; at approximately 353 feet. The watershed features an elongated shape with a mainly dendritic drainage pattern; while other areas in the watershed feature a contorted drainage pattern.

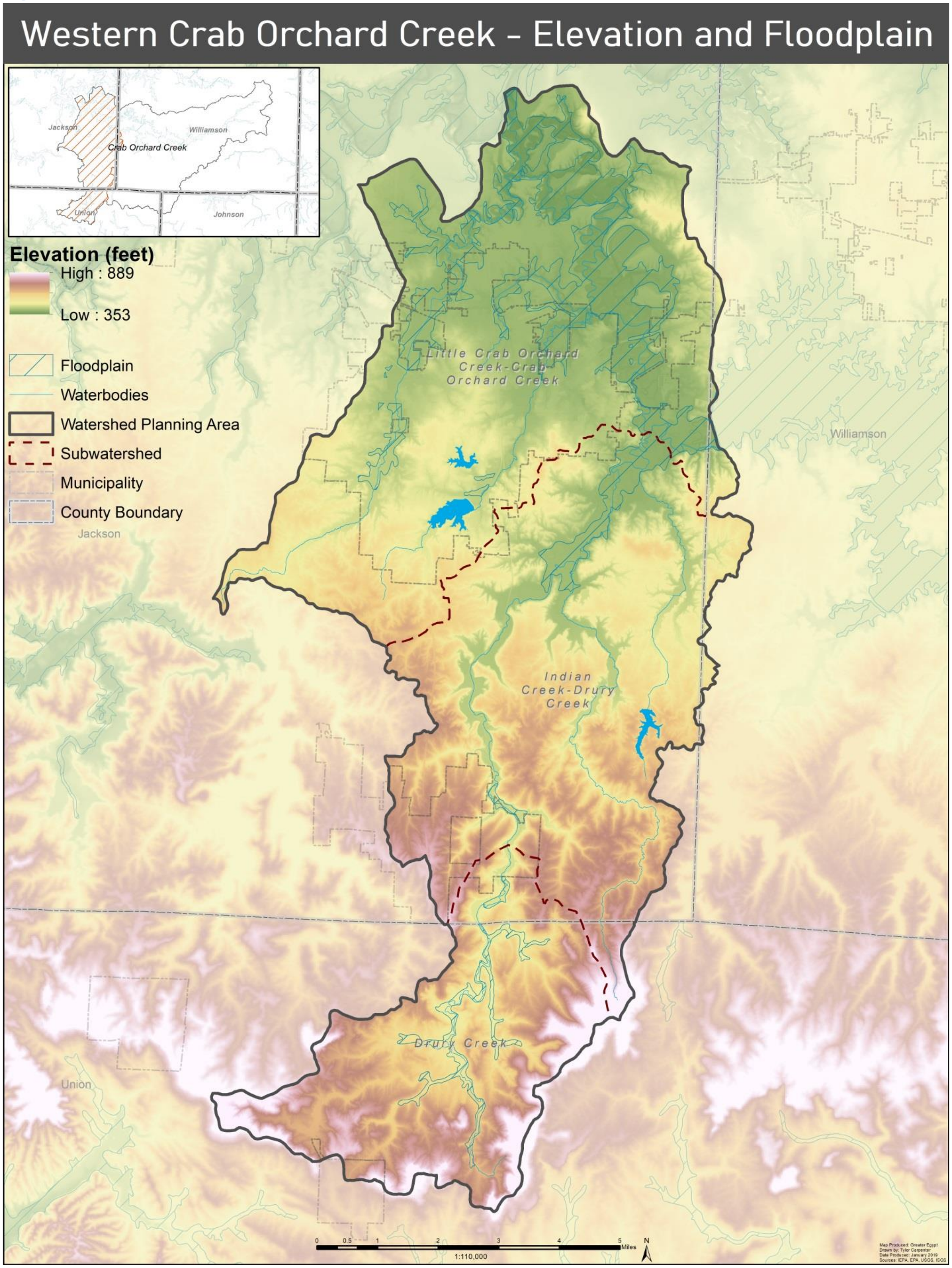
Around 11.84 percent (6,691 acres) of the watershed is in the floodplain. The floodplain information can be found in *Table 2.2*. A substantial portion of the floodplain is located in the northern basin of the Little Crab Orchard subwatershed. Even though most of this area is agricultural and forested land, there are areas in Carbondale within the floodplain. Flooding in these areas tends to be localized rather than cover a vast area.

Table 2.2- Floodplain Distribution by Subwatershed

Floodplain Distribution				
Watershed	Acres	Percent of Total Floodplain	Percent of Total Watershed	Percent of Sub Watershed
Western Crab Orchard Creek	6691.36	100.00%	11.84%	-
Little Crab Orchard	5262.93	78.65%	9.31%	21.45%
Indian Creek	828.77	12.39%	1.47%	4.03%
Drury Creek	599.64	8.96%	1.06%	5.24%

Source: ISWS, ISGS

Figure 2.6


Western Crab Orchard Creek - Elevation and Floodplain
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Elevation (feet)
High : 889
Low : 353
Floodplain
Waterbodies
Watershed Planning Area
Subwatershed
Municipality
County Boundary
Jackson
Williamson
Little Crab Orchard Creek-Crab Orchard Creek
Indian Creek-Drury Creek
Drury Creek
Union
0 0.5 1 2 3 4 5 Miles
1:110,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: January 2019
Sources: IEPA, EPA, USGS, ISGS

2.1.4. Subwatersheds and Subwatershed Management Units (SMU)

The Western Crab Orchard Creek watershed, specifically the HUC 12 subwatersheds, has been delineated further into 32 smaller subwatershed management units (SMU). Along with the HUC 12 subwatersheds, each SMU will be examined individually in this inventory and assessment. Each subbasin was delineated based on the drainage patterns and the direction of flow of tributaries in the watershed.
A unique identifier (HUC 14 code) was assigned to each subwatershed management unit for classification, and each SMU was given a name. This information can be found in *Table 2.3*, and illustrated in *Figure 2.7*. This table also provides acreage and the major tributary found within each unit. Detailed information for the subwatersheds can be found in later chapters.

Drury Creek Subwatershed (071401060807)

The Drury Creek subwatershed is the smallest of the three watersheds in the planning area with 11,452 acres. Seven SMUs are located within the Drury Creek subwatershed boundary. At 3,344 acres, the Cobden- North SMU is the largest in area. Drury Creek (IL_NDC) runs in a northerly direction through three of the SMUs; Upper Drury Creek, Shawnee- Drury Creek, and Makanda- South: Drury Creek. A small portion of the Village of Cobden is represented by SMU 2, Cobden – North. The majority of the Drury Creek watershed is situated in Union County, Illinois.

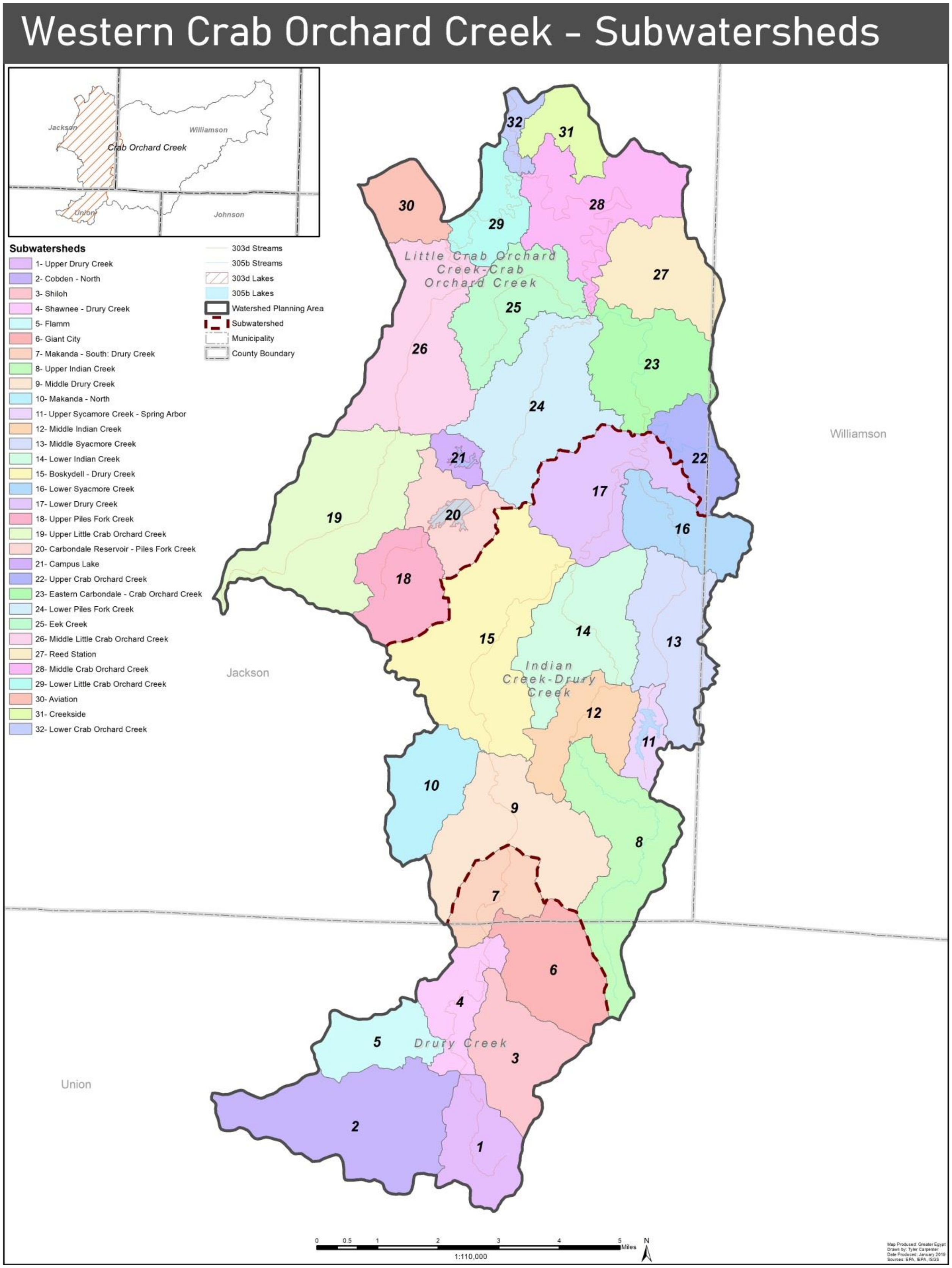
The subwatershed mainly consists of deciduous forest (67%) and pasture/hay (21%) land use classifications. Developed areas only account for ten percent of the subwatershed total. Since development in the Drury Creek subwatershed is limited, the number of impervious surfaces is also lower than other HUC 12 subwatersheds in the planning area. Ninety percent of the Drury Creek subwatershed exhibits no impervious features.

The sole water quality impairment in the subwatershed is dissolved oxygen (O_2). This mainly affects the subwatershed management units in which Drury Creek is located.

Table 2.3- Subwatershed Management Unit Information

MAP ID	SUBWATERSHED MANAGEMENT UNIT NAME	ACRES	HUC 14 CODE	MAJOR TRIBUTARY
Drury Creek Subwatershed				
1	Upper Drury Creek	1,348.55	07140106080701	Drury Creek
2	Cobden - North	3,344.13	07140106080702	-
3	Shiloh	1,646.71	07140106080703	-
4	Shawnee - Drury Creek	1,117.47	07140106080704	Drury Creek
5	Flamm	1,133.12	07140106080705	-
6	Giant City	1,834.83	07140106080706	-
7	Makanda - South: Drury Creek	1,029.51	07140106080707	Drury Creek
Indian Creek Subwatershed				
8	Upper Indian Creek	2,563.94	07140106080801	Indian Creek
9	Middle Drury Creek	2,759.19	07140106080802	Drury Creek
10	Makanda - North	1,482.13	07140106080803	-
11	Upper Sycamore Creek- Spring Arbor	5,21.372	07140106080804	Sycamore Creek
12	Middle Indian Creek	1,343.18	07140106080806	Indian Creek
13	Middle Sycamore Creek	2,034.89	07140106080805	Sycamore Creek
14	Lower Indian Creek	2,353.19	07140106080807	Indian Creek
15	Boskydell - Drury Creek	3,986.28	07140106080808	Drury Creek
16	Lower Sycamore Creek	1,363.05	07140106080809	Sycamore Creek
17	Lower Drury Creek	2,132.47	07140106080810	Drury Creek
Little Crab Orchard Creek Subwatershed				
18	Upper Piles Fork Creek	1,415.24	07140106080901	Piles Fork Creek
19	Upper Little Crab Orchard Creek	3,661.83	07140106080902	Little Crab Orchard Creek-West
20	Carbondale Reservoir- Piles Fork Creek	1,232.67	07140106080903	Piles Fork Creek
21	Campus Lake	346.65	07140106080904	-
22	Upper Crab Orchard Creek	939.718	07140106080905	Crab Orchard Creek
23	Eastern Carbondale - Crab Orchard Creek	2,024.58	07140106080906	Crab Orchard Creek
24	Lower Piles Fork Creek	2,951.01	07140106080907	Piles Fork Creek
25	Eek Creek	1,820.70	07140106080908	Eek Creek
26	Middle Little Crab Orchard Creek	2,903.56	07140106080909	Little Crab Orchard Creek-West
27	Reed Station	1,755.61	07140106080910	-
28	Middle Crab Orchard Creek	2,443.75	07140106080911	Crab Orchard Creek
29	Lower Little Crab Orchard Creek	1,017.33	07140106080912	Little Crab Orchard Creek-West
30	Aviation	895.507	07140106080913	-
31	Creekside	810.324	07140106080914	-
32	Lower Crab Orchard Creek	320.312	07140106080915	Crab Orchard Creek

Figure 2.7 - Subwatersheds and Subwatershed Management Units (SMU)



Indian Creek- Drury Creek Subwatershed (071401060808)

At 20,537 acres, the Indian Creek- Drury Creek subwatershed is represented by ten subwatershed management units. The watershed features three streams located on the IEPA 303(d) List of Impaired Waters. These include Indian Creek, Sycamore Creek, and the remaining segment of Drury Creek. These waterbodies generally run in a parallel, northerly direction. Spring Arbor Lake also represents the largest lake in the subwatershed; located in the Upper Sycamore Creek- Spring Arbor SMU.

The Indian Creek- Drury Creek subwatershed features a similar land use composition to Drury Creek subwatershed. Deciduous forest accounts for sixty-five percent of the total land use acreage, or 13,398 acres. Pasture/hay constitutes nearly sixteen percent of the total land use. Development in the subwatershed consists of 2,900 acres, or around fourteen percent of the subwatershed.

Impaired waterbodies are common in the subwatershed. Drury Creek ends at the confluence of Crab Orchard Creek in the Lower Drury Creek SMU. One reach of Indian Creek (IL_NDCB-01) is impaired by dissolved oxygen (O^2). Sycamore Creek (IL_NDCA), the source being Spring Arbor Lake, is also impaired by dissolved oxygen. The waterbody also exhibits impairments by pH levels on its acidity or its alkaline quality.

Little Crab Orchard Creek- Crab Orchard Creek Subwatershed (071401060809)

The Little Crab Orchard Creek- Crab Orchard Creek subwatershed represents the largest HUC 12 watershed in the planning area; with 24,536 acres of mixed land use classes. The watershed exhibits different characteristics than the other HUC 12 watershed, which features many more waterbodies; most of them being on the IEPA 303(d) List of Impaired Waters.

Land use in the subwatershed is mainly characterized by deciduous forest, development, and pasture/hay. While deciduous forest accounts for nearly thirty-one percent, or 7,539 acres, of the subwatershed, development is also a major feature in the subwatershed. Due to a large percentage of the City of Carbondale that is within the subwatershed boundary, nearly thirty percent of the area is considered developed. Since 7,265 acres of urban development is present, the number of impervious surfaces also rises significantly.

There are six waterbodies in the Little Crab Orchard Creek- Crab Orchard Creek subwatershed which are impaired. Two sections of Crab Orchard Creek are impaired by mercury (IL_ND-01) and other unknown causes (IL_ND-11). This main channel through the subwatershed is where all other tributaries flow. Piles Fork Creek (IL_NDB-03) runs through three separate SMUs and is impaired by methoxychlor. The creek also runs through the Carbondale City Lake (IL_RNI), which is impaired by mercury and total suspended solids (TSS). Eek Creek (IL_NDBA-01) to the north is impaired by dissolved oxygen and water temperature. Similar to Piles Fork Creek, Little Crab Orchard Creek- West (IL_NDA-01) is impaired by methoxychlor. IEPA lists mercury, polychlorinated biphenyls (PCBs), and TSS as impairments to Campus Lake (IL_RNZH).

2.1.5. Climate

The climate in the Western Crab Orchard Creek watershed borders the Humid Subtropical and Humid Continental climates. Weather in the region is influenced by warm air from the gulf, cold air from Canada, and eastward air from the southwest. The terrain has no impact on the climate. [2]

Temperatures in the region can vary significantly due to the effects of warm gulf air from the south and cold Canadian air from the north. Local temperature data was taken from the NOAA weather observation station located at the Carbondale Sewage Plant. The average temperature between 2000 and 2018 was 56.3 degrees Fahrenheit.[3] The average daily high and low were 58.6- and 52.7-degrees Fahrenheit. Data features in *Table 2.4* summarize the temperature information during the time between 2000 and 2018.

Table 2.4- 2000-2018 Monthly Average Temperatures

2000-2018 MONTHLY AVERAGE TEMPERATURES (degrees Farenheit)													
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Average High	42.7	44.4	58.8	62.3	72.3	79.1	84.3	83.1	73.4	62.1	50.6	45.8	58.6
Average	32.6	35.7	46.1	56.9	66.5	75.1	77.8	76.5	69.1	57.5	46.1	36	56.3
Average Low	25.1	24	38.1	48.8	63	69.6	70.7	71.7	65.4	53.7	37.6	23.4	52.7

Source: NOAA- National Climatic Data Search

The Western Crab Orchard Creek watershed is subject to considerable rainfall throughout the year. Local precipitation data was taken from the NOAA weather station located at the Carbondale Sewage Plant. The average annual precipitation was 49.29 inches between 2000 and 2018. The wettest months are typically from March to June. Average snowfall amounts in the region are around 11 inches annually. Information in *Table 2.5* displays the monthly average precipitation between 2000 and 2018.

2 David Muir, et al., "Upper Crab Orchard Creek: A Watershed Inventory," Greater Egypt Regional Planning and Development Commission, 1988, 6.
3 NOAA. "Monthly Mean Avg Temperature for Carbondale Sewage Plant, IL" https://w2.weather.gov /Climate/xmacis.php?wfo=pah. Accessed 25 March 2019.

Table 2.5- 2000-2018 Monthly Average Precipitation

2000-2018 MONTHLY AVERAGE PRECIPITATION (in inches)													
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Total	2.72	3.24	4.54	5	5.44	4.35	4.76	3.5	3.06	3.65	4.29	4.14	49.29

Source: NOAA- National Climatic Data Search

During the spring and summer months, damaging storms and heavy rainfall can be expected. Heavy rainfall usually leads to regional and localized flooding, and even flash flooding at times. More severe events of flooding take place along the Big Muddy River and the larger tributaries that flow into the Mississippi River. Like most areas in the Midwest, the watershed is susceptible to tornadoes. Winters can occasionally bring accumulations of snow and ice.

Wind data was obtained from the Illinois Climate Network (ICN) Carbondale Station, located on the SIU farm[4]. Wind speed generally ranges from 3 to 8 miles per hour throughout the year with an average of 6.0 miles per hour in 2018. However, gusts can be 29 to 47 miles per hour in any certain month. There is a prevalent pattern of wind from the south/ southwest. Considering the region is fairly flat, wind direction is caused by incoming weather patterns. *Table 2.6* displays the average wind data from the ICN.

Table 2.6- 2018 Wind Data

Month	Average Wind Speed (mph)	Max Speed (mph)	Average Direction (degrees)
Jan	8.0	38.8	225.8
Feb	7.8	42.1	206.8
Mar	7.3	39.2	196.1
Apr	8.3	47.4	184.6
May	5.2	40.2	194.9
Jun	4.6	43.7	202.0
Jul	3.9	29.5	198.5
Aug	4.3	29.3	197.0
Sep	3.8	34.0	169.1
Oct	5.1	30.0	206.3
Nov	6.3	38.5	205.0
Dec	6.8	43.7	202.1
AVG	6.0	38.0	199.0

4 ICN, "Water and Atmospheric Resources Monitoring Program," http://www.isws.illinois.edu/warm/datatype.asp. Accessed 25 March 2019.

2.2. Geology

The Western Crab Orchard Creek watershed is located between the Shawnee Hills Section of the Interior Low Plateaus Province and the Central Lowland Province, Tills Plains Section. It is also within close proximity of the Ozark Plateaus to the west. The physiographic provinces are further partitioned into divisions. The northern portion of the watershed rests on the southern border of the Mt. Vernon Hill Country Division.

The Pennsylvania System includes the uppermost bedrock in the planning area. It is overlain by relatively thin layers of glacial drift, loess, and alluvial deposits in river valleys. The Pennsylvanian surface is eroded by action of pre-glacial streams. There are system series, groups, and underlying geologic formations of the area that can be seen in *Figure 2.9*.

The Western Crab Orchard Creek watershed encompasses four types of underlying geologic formations. These formations include: Carbondale (10%), Caseyville (8%), Tradewater (72%), and the Upper Pope Group (10%). Accounting for the majority of the underlying formations, Tradewater mainly consists of shale and siltstone. Other depositional materials within the watershed include sandstone, coal, and limestone. The general thickness of the Tradewater formation is around 100 to 300 feet in Southern Illinois.[5] The Tradewater formation composes the majority of the Little Crab Orchard subwatershed, and nearly the entire area of the Indian Creek- Drury Creek subwatershed. In *Figure 2.8* there are displays of the geologic units in the Western Crab Orchard Creek watershed and the surrounding area.

Figure 2.8- Generalized Stratigraphic Column of the Pennsylvanian in Illinois

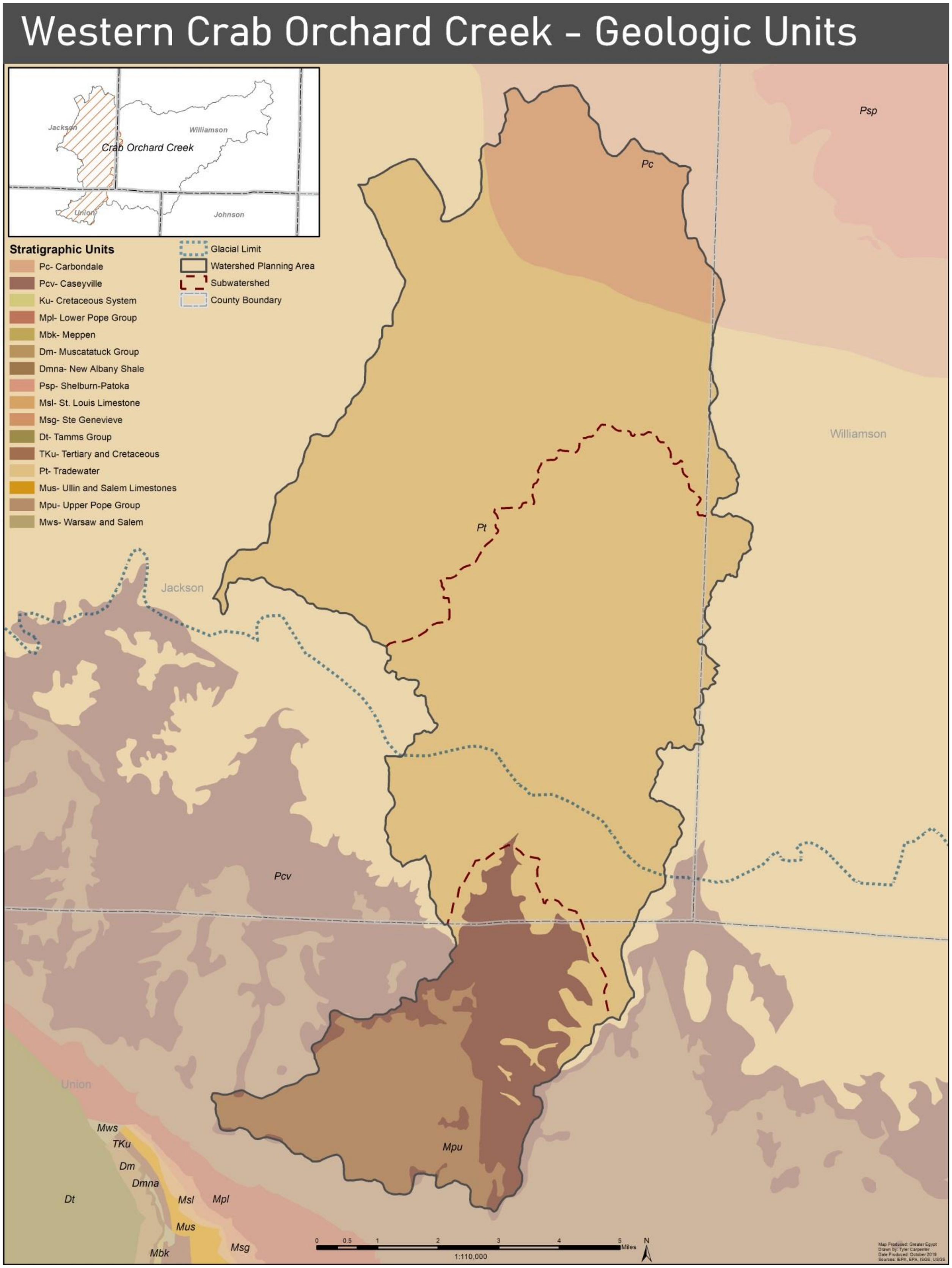
PENNSYLVANIAN							SYSTEM
MORROWAN	ATOKAN	DESMOINESIAN	MISSOURIAN			VIRGILIAN	SERIES
Racoon Creek Group			McLeansboro				Group
Caseyville	Tradewater	Carbondale	Shelburn	Patoka	Bond	Mattoon	Formation

Source: ISGS

The Carbondale formation reaches a thickness of around 500 feet. Gray shales and sandstone compose most of the Carbondale formation.[6] These types of rock occur within the northern portion of the watershed in the Little Crab Orchard subwatershed. The Caseyville and Upper Pope Group complete the remaining formations. These are present in the Drury Creek subwatershed to the south.

5 Tri-State Committee on Correlation of the Pennsylvanian System in the Illinois Basin, Toward a More Uniform Stratigraphic Nomenclature for Rock Units of the Pennsylvanian System in the Illinois Basin. (Bloomington: Illinois Basin Consortium, 2001), 16.
6 Ibid.

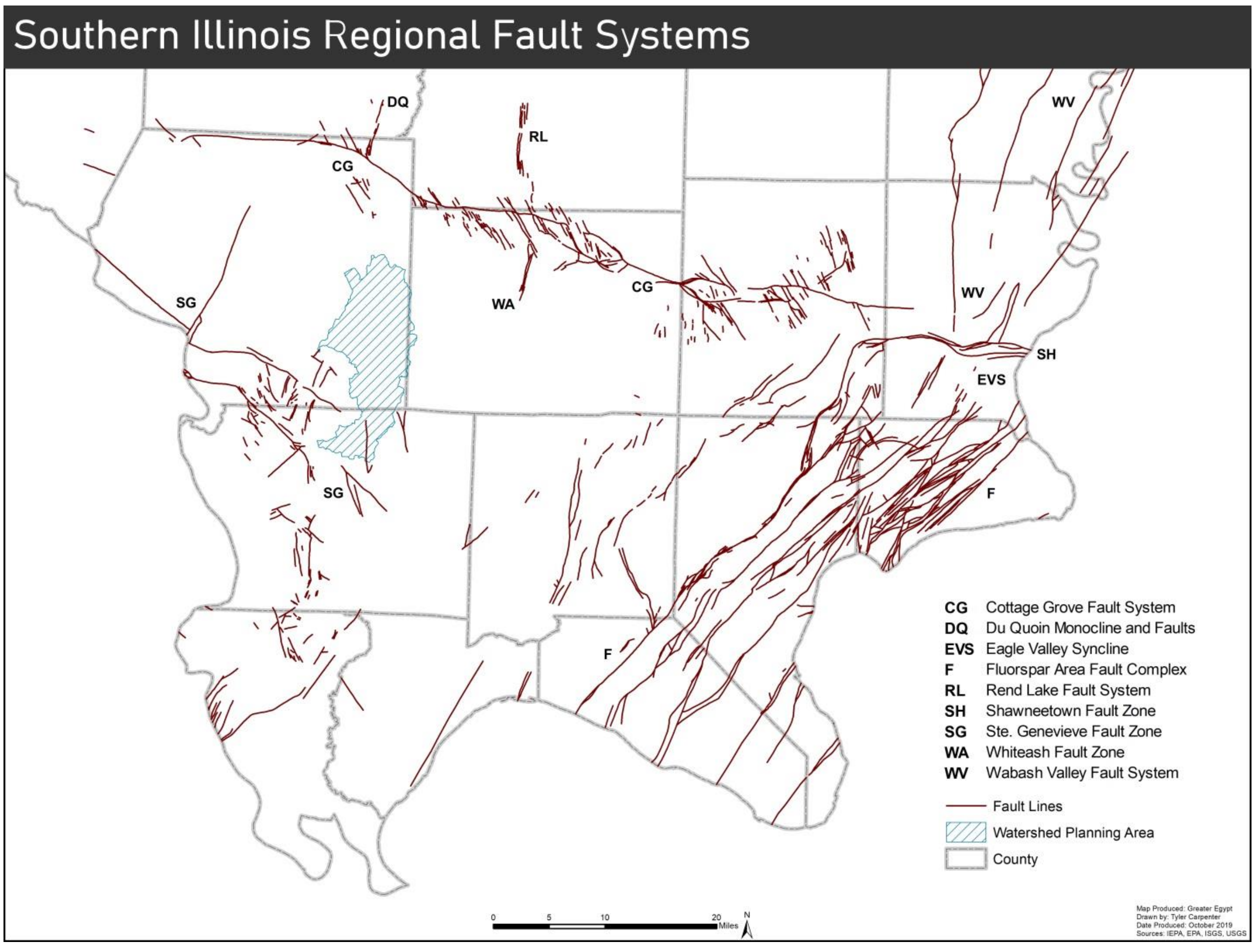
Figure 2.9


Western Crab Orchard Creek - Geologic Units
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Stratigraphic Units
Pc- Carbondale
Pcv- Caseyville
Ku- Cretaceous System
Mpl- Lower Pope Group
Mbk- Meppen
Dm- Muscatatuck Group
Dmna- New Albany Shale
Psp- Shelburn-Patoka
Msl- St. Louis Limestone
Msg- Ste Genevieve
Dt- Tamms Group
TKu- Tertiary and Cretaceous
Pt- Tradewater
Mus- Ullin and Salem Limestones
Mpu- Upper Pope Group
Mws- Warsaw and Salem
Glacial Limit
Watershed Planning Area
Subwatershed
County Boundary
Psp
Pc
Williamson
Pt
Jackson
Pcv
Union
Mws
TKu
Dm
Dmna
Dt
Msl
Mpl
Mus
Mbk
Msg
Mpu
0 0.5 1 2 3 4 5 Miles
1:110,000
N

2.2.1. Geologic Faults

Regionally, the study area exhibits a complex network of fault systems uncommon to most of the Midwestern United States. These different fault zones are displayed in *Figure 2.10.* Southern Illinois lies just north of the most seismically active area of the Midwest, that area being the New Madrid Seismic Zone, which lies along the border of Missouri, Arkansas, Kentucky, and Tennessee. It encompasses much of the Wabash Valley Fault Zone as well.

Figure 2.10



The Western Crab Orchard Creek watershed lies on the eastern edge of the Ste. Genevieve fault zone, as seen in *Figure 2.10*. The fault system runs in a northerly direction extending from Alexander to Randolph County on the Illinois side of the Mississippi River. The planning area is roughly five miles south of the Cottage Grove system.

2.2.2. *Mining*

Currently, the watershed does not exhibit any active mining. Mining in the watershed ceased operations in 1977 with the closure of Southern Illinois Minerals, Carbondale No. 1 Mine. *Table 2.7* displays of mine information for these coal companies. The majority of mining operations occurred during the 1920 to 1930s.[7]

Mining that took place in the area was a combination of surface and underground operations. Two main sites are apparent in *Figure 2.11*. These occurred southwest of Crab Orchard Lake, and in eastern Carbondale. There are 430 acres represented in the total surface mining in the planning area. Underground mining accounted for 415 acres. The main location of mining activity was divided by Sycamore Creek in the Indian Creek- Drury Creek subwatershed.

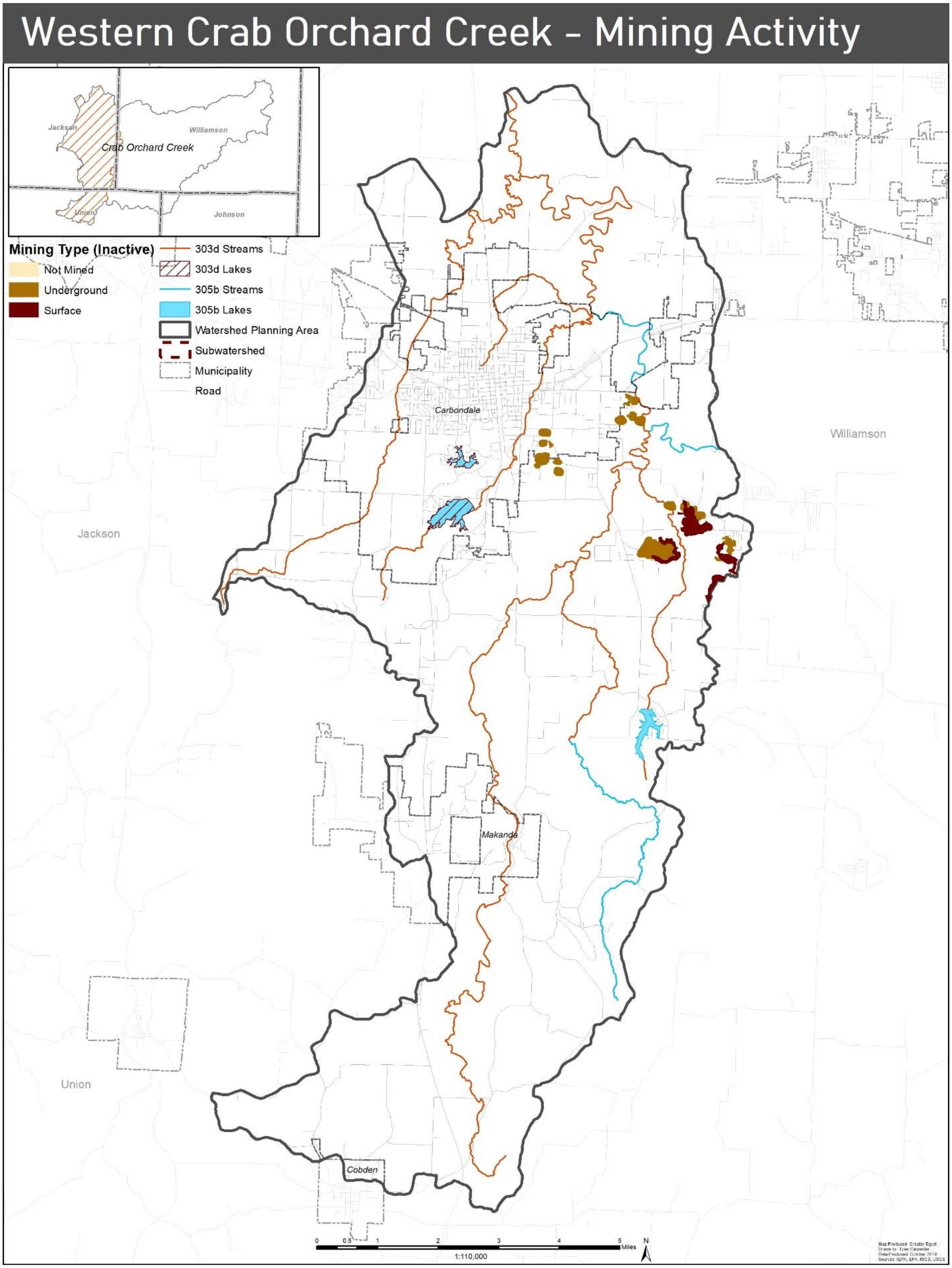
Table 2.7 - Mine Company Information

MINING COMPANY	MINE NAME	YEARS ACTIVE	ISGS INDEX NO.
Carbondale Coal Company	Carbondale No.2 Mine	1919-1937	104
Crab Orchard Coal Company	Crab Orchard Mine	1922-1927	2498
Hall & Blake Mine	-	1922-1924	2611
Independent Coal Company	Independent Mine	1927-1935	4233
Jackson County Coal Company	Jackson Mine	1934-1937	2495
John C. Swofford Coal Company	Swofford No.1 Mine	1922-1937	2502
Louis L. McDonald	McDonald Mines	1928-1939	2496
Nu Way Coal Company	Nu Way Mine	1932-1933	7165
Southern Illinois Minerals	Carbondale No.1 Mine	1973-1977	4155
Tab Mining Company	Tab Mine	1967-1972	891
Tregoning Coal Company	Tregoning No.1 Mine	1947-1965	821

Source: Illinois State Geological Survey

7 Shilts, William, Directory of Coal Mines in Illinois, 7.5 Quadrangle Series, Carbondale Quadrangle, Jackson County. Illinois State Geoligical Survey. (Champaign, Illinois, 2008).

Figure 2.11


Western Crab Orchard Creek - Mining Activity
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Mining Type (Inactive)
Not Mined
Underground
Surface
303d Streams
303d Lakes
305b Streams
305b Lakes
Watershed Planning Area
Subwatershed
Municipality
Road
Carbondale
Williamson
Jackson
Makanda
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

2.3. Soil Conditions

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soils mapping data (Web Soil Survey) and the Soil Surveys of Jackson, Union, and Williamson Counties (USDA, NRCS) were utilized for the examination of soils within the Western Crab Orchard Creek watershed. The data was utilized to summarize the soil types, hydrologic soil groups, hydric status, soil erodibility, and soil drainage.

2.3.1. Hydrologic Soil Groups

There are 34 dominant soil types within the Crab Orchard Creek watershed. In *Figure 2.12* there are displays over the generalized soil series, categorized by name and percent of cover in the watershed. Each soil is placed in a specific hydrologic group depending on the rate of water infiltration. These factors include whether the soil is protected by vegetation, consistently wet, or receives precipitation from storms. [8] The USDA defines the hydrologic soil groups by the following:

> **Group A**: Soils having a high infiltration rate (low runoff potential) when totally saturated. These consist mainly of deep, well drained to excessively drained sands or gravel-like sand grain sizes. These soils have a high rate of water transmission or high permeability.
>
> **Group B**: Soils having a moderate infiltration rate when totally saturated. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine grain sizes to moderately coarse grain sizes. These soils have a moderate rate of water transmission or moderate permeability.
>
> **Group C:** Soils having a slow infiltration rate when totally saturated. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine grain size or fine grains. These soils have a slow rate of water transmission or low permeability.
>
> **Group D:** Soils having a very slow infiltration rate (high runoff potential) when totally saturated. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high-water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious

8 USDA, NRCS. "Web Soil Survey." http://websoilsurvey.sc.egov.usda.gov/. Accessed: January-December 2019.

material. These soils have a very slow rate of water transmission or low permeability.[9]

Soils can also be assigned to a dual hydrologic group (A/D, B/D, or C/D). The first letter represents drained areas while the latter represents undrained areas. Information on the hydrologic soil groups and related information can be seen in *Table 2.8*. These groupings are also spatially depicted in *Figure 2.12*.

Table 2.8 - Hydrologic Soil Groups

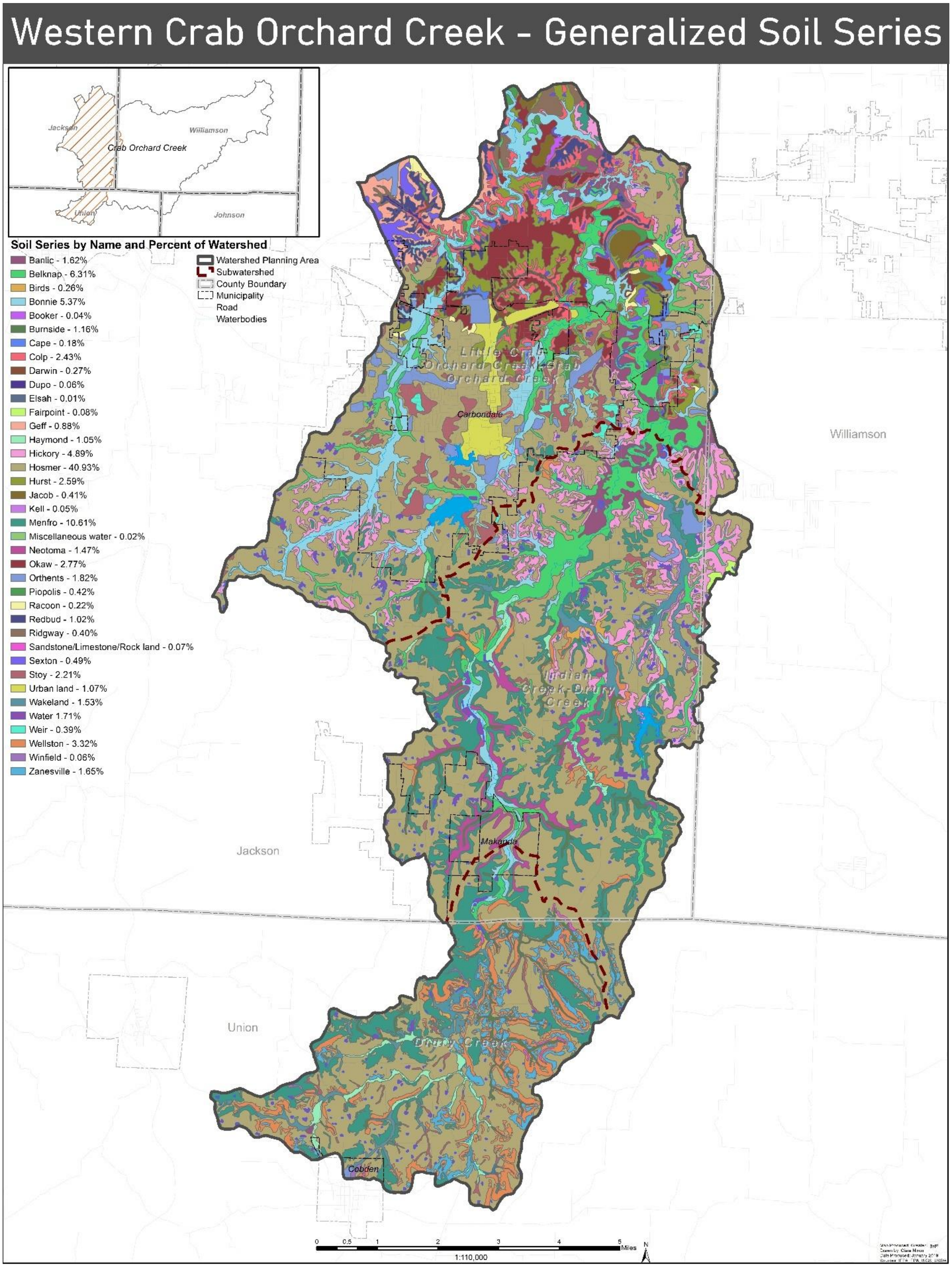
Hydrologic Group	Soil Texture	Drainage	Infiltration	Transmission Rate
A	Sand or Gravel	Deep, Well Drained to Excessively Drained	High	High
B	Moderately Fine to Moderately Coarse	Moderately Deep or Deep, Moderately Well Drained or Well Drained	Moderate	Moderate
C	Moderately Fine to Fine	Layer that Impedes the Downward Movement of Water	Slow	Slow
D	Clays	High Shrink-Swell Potential, High Water Table, Claypan Layer Near Surface, Shallow Over Nearly Impervious Surfaces	Very Slow (High Runoff)	Very Slow

Source: USDA

Covering approximately 23,142 acres in the Western Crab Orchard Creek watershed, Hosmer is the predominant soil series among the 45 soil types. This also accounts for 41 percent of the watershed. The Menfro soil types are the second most dominant soil type encompassing around 6,001 acres, or around ten percent of the watershed. Menfro soils have three categories in this watershed and consist of Menfro, Menfro-Hickory, and Menfro-Wellston. The Belknap soil type is slightly over half the acreage of Menfro soil, with 3,568 acres, and accounting for six percent of the watershed.

9 Ibid.

Figure 2.12

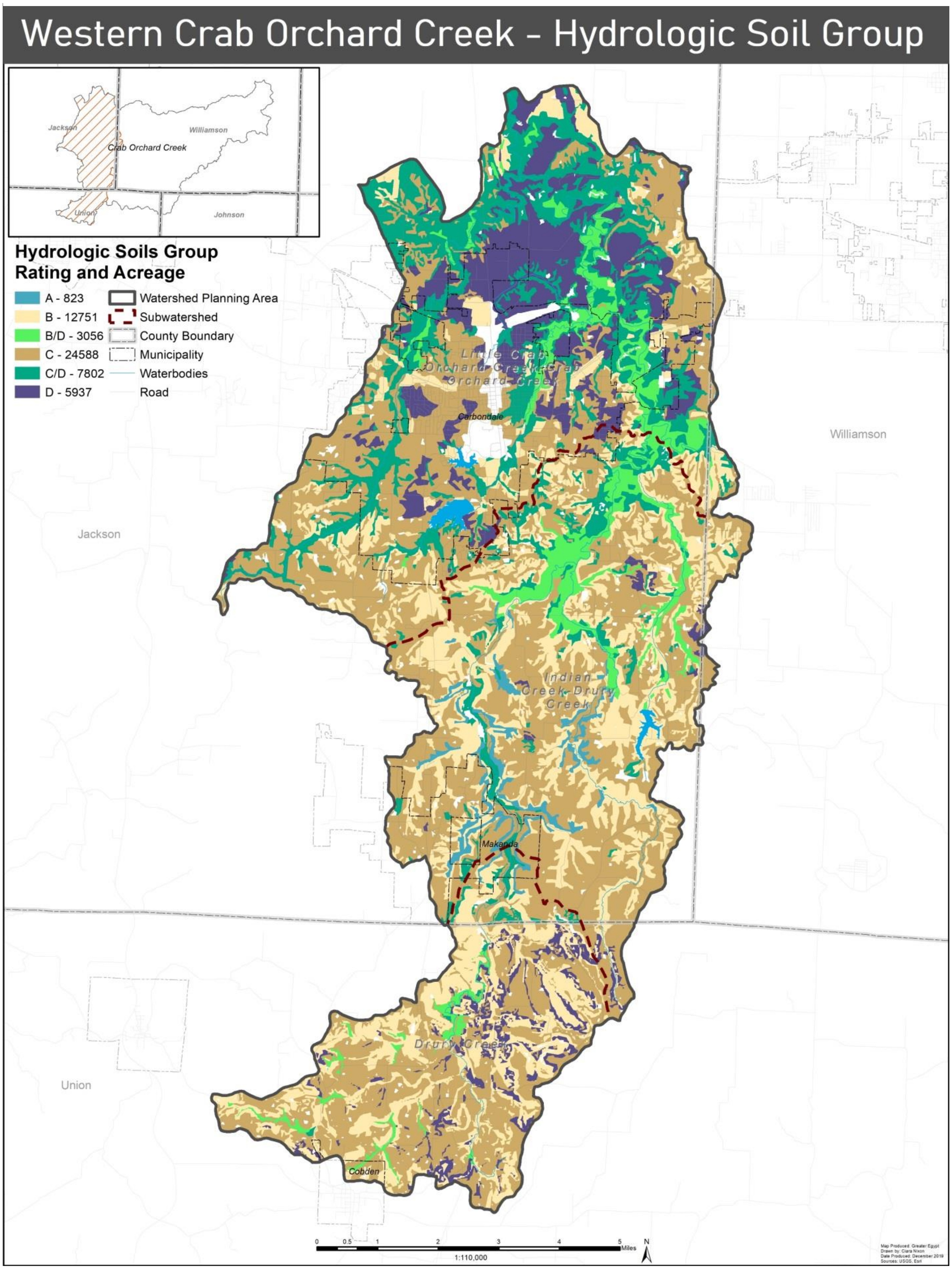


Western Crab Orchard Creek - Generalized Soil Series
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Soil Series by Name and Percent of Watershed
Banlic - 1.62%
Belknap - 6.31%
Birds - 0.26%
Bonnie 5.37%
Booker - 0.04%
Burnside - 1.16%
Cape - 0.18%
Colp - 2.43%
Darwin - 0.27%
Dupo - 0.06%
Elsah - 0.01%
Fairpoint - 0.08%
Geff - 0.88%
Haymond - 1.05%
Hickory - 4.89%
Hosmer - 40.93%
Hurst - 2.59%
Jacob - 0.41%
Kell - 0.05%
Menfro - 10.61%
Miscellaneous water - 0.02%
Neotoma - 1.47%
Okaw - 2.77%
Orthents - 1.82%
Piopolis - 0.42%
Racoon - 0.22%
Redbud - 1.02%
Ridgway - 0.40%
Sandstone/Limestone/Rock land - 0.07%
Sexton - 0.49%
Stoy - 2.21%
Urban land - 1.07%
Wakeland - 1.53%
Water 1.71%
Weir - 0.39%
Wellston - 3.32%
Winfield - 0.06%
Zanesville - 1.65%
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Road
Waterbodies
Little Crab Orchard Creek
Crab Orchard Creek
Carbondale
Williamson
Indian Creek-Drury Creek
Jackson
Makanda
Union
Drury Creek
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Soils in the watershed vary within the hydrologic group classification. Only about one percent, or 823 acres, of soils fall under group A. Group B consists of 15,806 acres, or twenty-eight percent and is the second largest of the groupings. Group C makes up the largest proportion of the watershed soils with 32,389 acres, or fifty-eight percent. Group D hydrologic classification constitutes about ten percent, or 5,936 acres of the watershed.

Dual hydrologic soil groups account for one third of the watershed. The soil group B/D is comprised of both Belknap and Wakeland soils, and makes up five percent of the watershed. The remaining ten soils are associated with soil group C/D. These include: Banlic, Birds, Bonnie, Colp, Dupo, Geff, Hosmer, Piopolis, Racoon, and Sexton. Information on the hydrologic soil groups and other related information is available in *Table 2.9*.

Figure 2.13



Western Crab Orchard Creek - Hydrologic Soil Group
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Hydrologic Soils Group
Rating and Acreage
A - 823
B - 12751
B/D - 3056
C - 24588
C/D - 7802
D - 5937
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Table 2.9 - Generalized Soils and Classifications

Soil Series	Hydric Y/N	Erodibility K factor	Hydrologic Soil Group	Drainage	Acres	Percent of Watershed
Banlic	N	0.64	C/D	WD	921.2	1.62%
Belknap	N	0.64	B/D	SPD	3,568.1	6.31%
Birds	Y	.49-.55	C/D	PD	147.9	0.26%
Bonnie	Y	0.55	C/D	PD	3,037.7	5.37%
Booker	Y	0.24	D	PD	27.3	0.04%
Burnside	N	0.43	B	WD	659.1	1.16%
Cape	Y	0.43	D	PD	102.6	0.18%
Colp	N	.43-.55	C/D	MWD	1,377.2	2.43%
Darwin	Y	0.37	D	VPD	157.4	0.27%
Dupo	N	0.64	C/D	SPD	35.9	0.06%
Elsah	N	0.49	B	WD	9.8	0.01%
Fairpoint	N	0.28	C	WD	45.7	0.08%
Geff	N	0.55	C/D	SPD	501.4	0.88%
Haymond	N	0.55	B	WD	594.5	1.05%
Hickory	N	.37-.43	B	WD	2,765.4	4.89%
Hosmer	N	0.64	C, C/D	MWD	23,142.2	40.93%
Hurst	N	0.55	D	SPD	1,464.9	2.59%
Jacob	Y	0.24	D	PD	236.4	0.41%
Kell	N	0.43	C	WD	29.8	0.05%
Menfro	N	.43-.64	B, C	WD	6,001.3	10.61%
Miscellaneous water	-	-	-	-	15.6	0.02%
Neotoma	N	0.15	A	WD	835.2	1.47%
Okaw	Y	0.55	D	PD	1,567.2	2.77%
Orthents	N	0.49	B, C	WD	1,029.0	1.82%
Piopolis	Y	0.43	C/D	PD	242.3	0.42%
Racoon	Y	0.49	C/D	PD	125.5	0.22%
Redbud	N	0.55	C	MWD	578.2	1.02%
Ridgway	N	0.43	B	WD	230.0	0.40%
Rock Land	-	-	-	-	41.3	0.07%
Sexton	Y	0.55	C/D	PD	280.3	0.49%
Stoy	N	0.55	D	SPD	1,251.7	2.21%
Urban land	-	-	-	-	609.2	1.07%
Wakeland	N	0.55	B/D	SPD	867.1	1.53%
Water	-	-	-	-	967.8	1.71%
Weir	Y	0.64	D	PD	222.3	0.39%
Wellston	N	0.43	B	WD	1,877.2	3.32%
Winfield	N	.43-.55	C	MWD	32.9	0.06%
Zanesville	N	0.43	C, D	WD	934.0	1.65%

Source: USDA

2.3.2. Hydric Soils

The USDA NRCS defines hydric soils as a, "soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part".[10] Of the thirty-four general soils that comprise the Crab Orchard Creek watershed, eleven are defined as hydric soils. *Table 2.10* contains the hydric soils with acreage amounts and percent of watershed. These soils account for 6040.5 acres (10.7%) of the watershed.

At 3,037.7 acres, the Bonnie soil series accounts for the most hydric soil in the watershed. This covers just five percent of the entire watershed. The Okaw soil series is the next largest, covering almost three percent of the watershed, or 1,567.2 acres. The other nine soils cover less than one percent of the watershed. Hydric soils in the watershed are depicted in *Figure 2.14.*

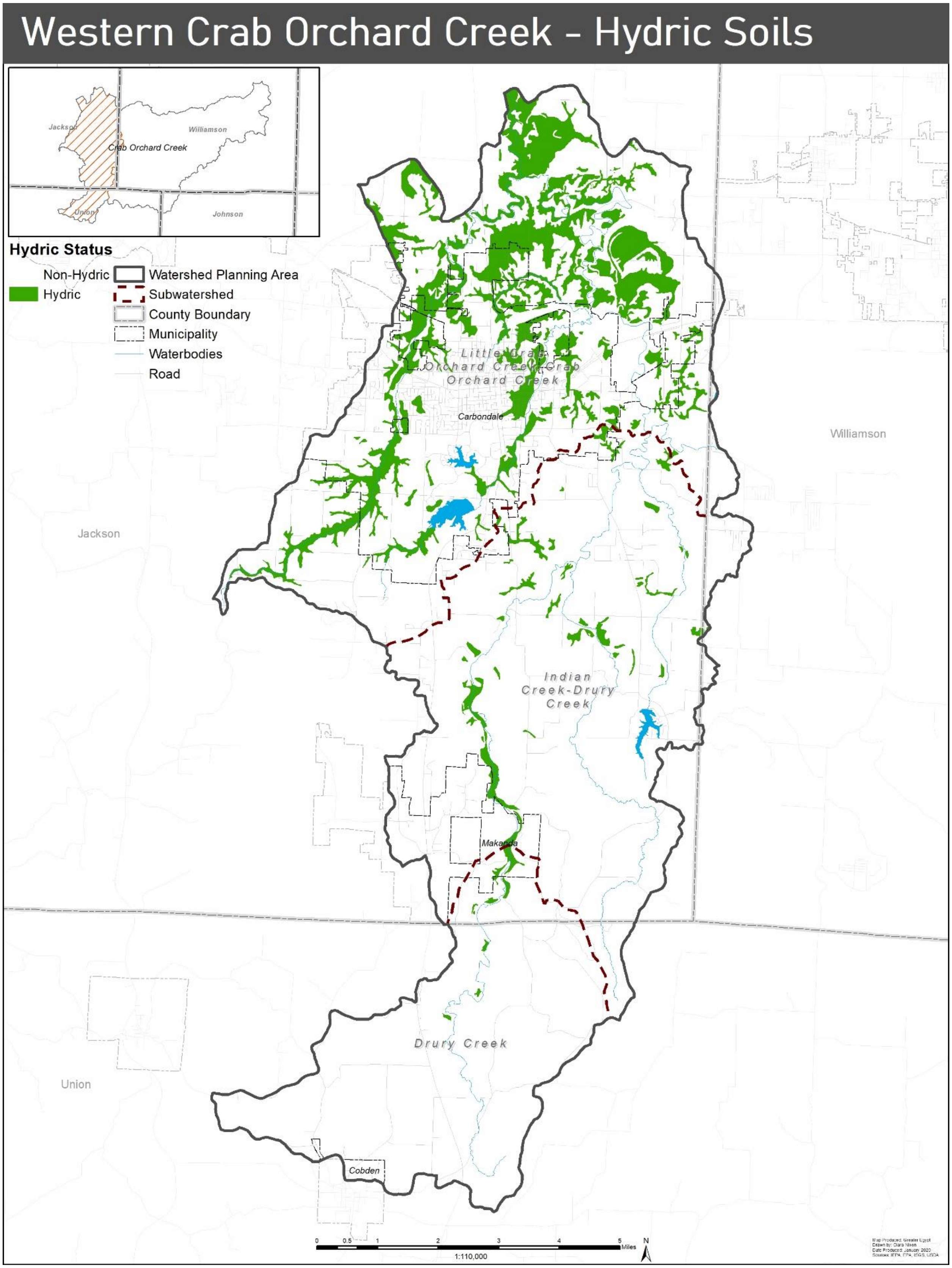
Table 2.10 - Hydric Soils

Hydric Soils	Acres	Percent of Watershed
Birds	147.9	0.26%
Bonnie	3037.7	5.37%
Booker	27.3	0.05%
Cape	102.6	0.18%
Darwin	157.4	0.28%
Jacob	236.4	0.42%
Okaw	1567.2	2.77%
Piopolis	242.3	0.43%
Racoon	125.5	0.22%
Sexton	173.8	0.31%
Weir	222.3	0.39%
Totals	**6040.5**	**10.69%**

Source: USDA

10 Ibid.

Figure 2.14



Western Crab Orchard Creek - Hydric Soils
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Hydric Status
Non-Hydric
Hydric
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek
Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

2.3.3. Soil Erodibility

Soil erodibility in the Western Crab Orchard Creek watershed varies by location. The soil erodibility factor (K-factor) was utilized to delineate erodibility. The USDA NRCS defines K-factor as the following:

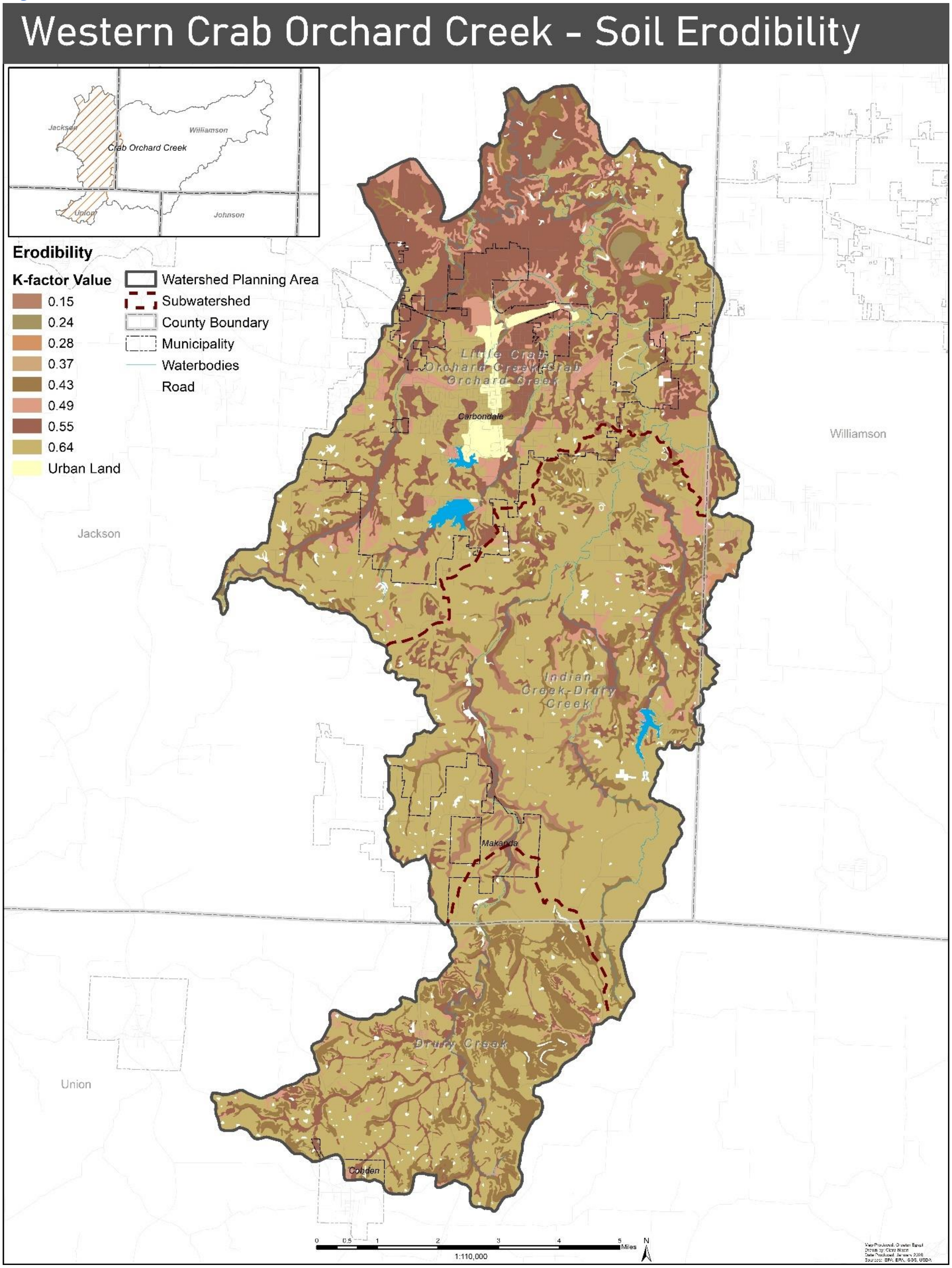
> Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.[11]

Erodibility correlates with the gradual increase in the K-factor value. The K-factor for soils in the Crab Orchard Creek watershed has eight ranges between .15 to .64. These values usually correlate with other features of the soils including hydric status and drainage classification.

The Neotoma series has the lowest K-factor value at .15 while the majority of soils have a K-factor value of .64. Six soil series consist of a K-factor value of .64: Banlic, Belknap, Depo, Hosmer, Menfro, and Weir soil series. These represent the highest erodible soils in the Western Crab Orchard Creek watershed. Soils and their K-factor values are represented in *Figure 2.15 and Table 2.9.*

11 Ibid.

Figure 2.15


Western Crab Orchard Creek - Soil Erodibility
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Erodibility
K-factor Value
0.15
0.24
0.28
0.37
0.43
0.49
0.55
0.64
Urban Land
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

2.3.4. Soil Drainage

The USDA also provides information regarding the drainage classifications of each soil type. In this case, these classifications are meant to describe the natural drainage characteristics. There are seven classifications ranging from “Excessively drained,” to “Very poorly drained.” Of the seven, there are five classes that represent the soil drainage classifications located within the Western Crab Orchard Creek watershed. The USDA defines the classes by the following:

> **Well drained:** Water is removed from the soil readily, but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions. Saturation does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the deep to redoximorphic features that are related to soil saturation.
>
> **Moderately well drained:** Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are saturated for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1 m, periodically receive high rainfall, or both.
>
> **Somewhat poorly drained:** Water is removed slowly so that the soil is moist at a shallow depth for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Saturation level markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high-water table, additional water from seepage, or nearly continuous rainfall.
>
> **Poorly drained:** Water is removed so slowly that the soil is moist at shallow depths periodically during the growing season or remains saturated for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously damp directly below plow-depth. Free water at shallow depth is

usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.[12]

These five classifications constitute all of the watershed total acreage, excluding the 1.8 percent of water and 609 acres of urban land. The *Table 2.11* summarizes these classification values. Most of the soils are moderately well drained at 25,130.5 acres (about forty-five percent of the watershed), or well drained at 15,011.1 acres (26%). The rest of the watershed is mostly made up of somewhat poorly drained soils at 8,610.3 acres, or (15.4%) and poorly drained soils at 6,089.6 acres (10.8%). The group with the least representation is very poorly drained soils at 57.4 acres (0.1%) of the watershed. These results are also displayed in *Figure 2.16.*

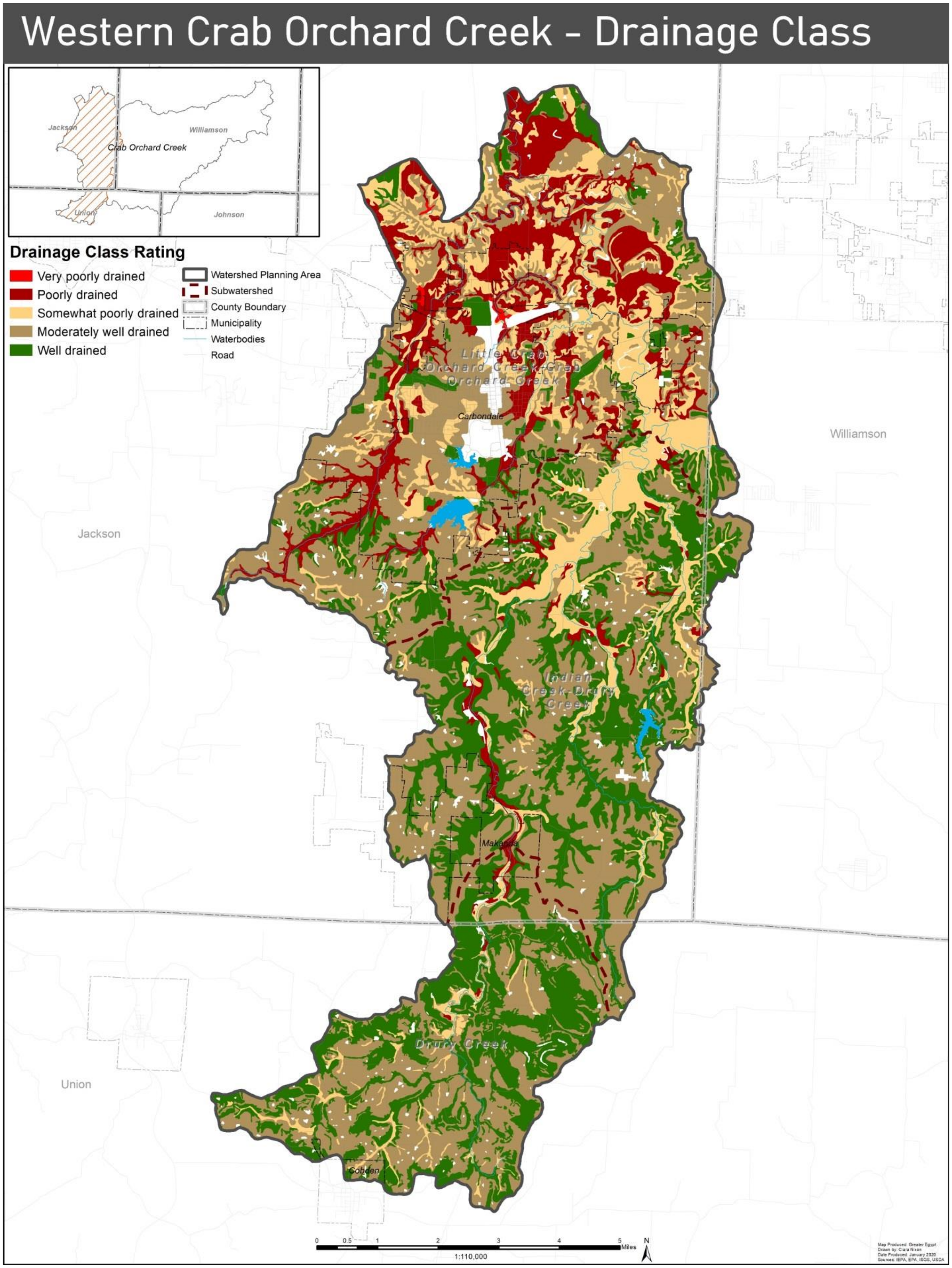
Table 2.11 - Drainage Classifications

Drainage Class	Acres	Percent of Watershed
Very Poorly Drained	57.4	0.1%
Poorly Drained	6,089.6	10.8%
Somewhat Poorly Drained	8,610.3	15.4%
Moderately Well Drained	25,130.5	44.9%
Well Drained	15,011.1	26.9%

Source: USDA

12 USDA. "Soil Survey Manual."

Figure 2.16


Western Crab Orchard Creek - Drainage Class
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Drainage Class Rating
Very poorly drained
Poorly drained
Somewhat poorly drained
Moderately well drained
Well drained
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N
Map Produced: Greater Egypt
Drawn by: Ciara Nixon
Date Produced: January 2020
Sources: IEPA, EPA, ISGS, USDA

2.4. Watershed Jurisdictions

The Western Crab Orchard Creek watershed lies mainly within Jackson County, with small portions in Williamson and Union Counties. The planning area encompasses the municipalities of Carbondale, Cobden, and Makanda. Only about twenty-two percent of the watershed is considered municipal.

Civil townships are present in Jackson County while survey townships make up Union and Williamson Counties. Jackson County townships that lie within the watershed include Carbondale, De Soto, Murphysboro, Makanda and Pomona; Cobden precincts One and Two are in Union County; Carterville and Grassy townships are in Williamson County. *Table 2.12* displays the townships and their size relative to the watershed while *Figure 2.17* spatially depicts the townships. Municipalities of the area are also depicted.

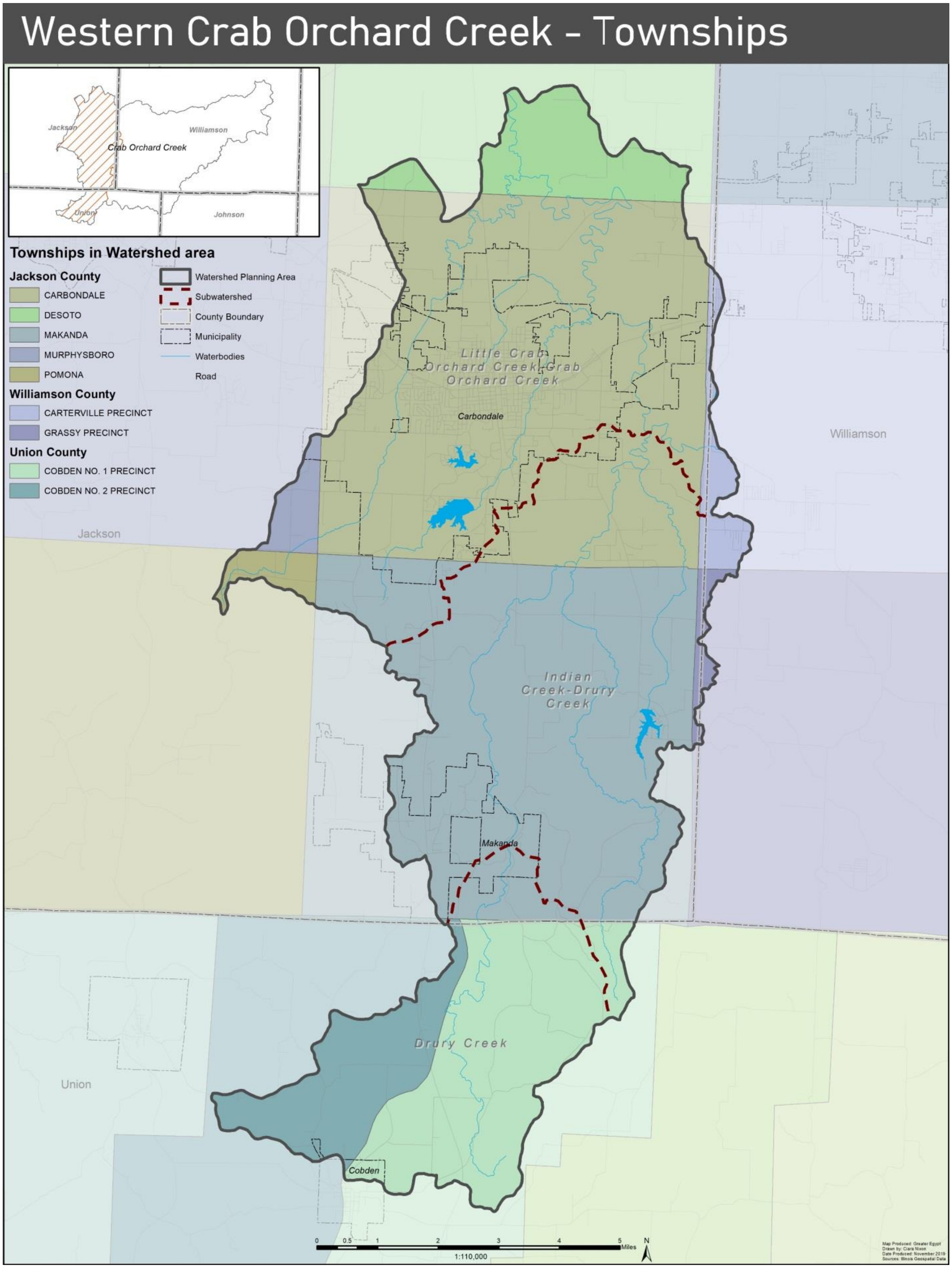
There are two wastewater treatment plants in the watershed, both of which are in Carbondale and are operated by the Carbondale Public Works Department.

Table 2.12 - Jurisdictional Areas

Jurisdiction	Total Acres	Acres in Watershed	Percent of Watershed
County	**940,293**	**56,533**	**100%**
Jackson	385,280	44,136	78%
Union	270,080	10,944	19%
Williamson	284,213	1,451	3%
Municipality	**15,414**	**12,569**	**22%**
Carbondale City	11,211	10,395	18%
Cobden Village	785	166	1%
Makanda Village	3,416	2,007	3%
Township	**196,178**	**56,533**	**100%**
Carbondale	24,481	21,983	40%
Carterville	24,258	1,042	2%
Cobden (No. 1 & 2)	30,137	10,945	19%
DeSoto	15,618	2,867	5%
Grassy	24,200	409	1%
Makanda	23,881	17,976	31%
Murphysboro	23,767	713	1%
Pomona	29,835	597	1%

Source: US Census Bureau

Figure 2.17



Western Crab Orchard Creek - Townships
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Townships in Watershed area
Jackson County
CARBONDALE
DESOTO
MAKANDA
MURPHYSBORO
POMONA
Williamson County
CARTERVILLE PRECINCT
GRASSY PRECINCT
Union County
COBDEN NO. 1 PRECINCT
COBDEN NO. 2 PRECINCT
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Indian Creek-Drury Creek
Makanda
Drury Creek
Cobden
Williamson
Jackson
Union
0 0.5 1 2 3 4 5 Miles
1:110,000
N

2.4.1. Municipal Ordinances

Municipalities in the Western Crab Orchard Creek watershed have adopted ordinances in regards to flooding events. These ordinances include elements of stormwater and erosion control, and often meet the requirements for participation in the National Flood Insurance Plan (NFIP). This program allows homeowners and businesses to purchase flood insurance, as long as the community has adopted and enforced ordinances that reduce the potential for flooding. Since the planning area falls into three different counties and multiple municipalities, each jurisdiction's ordinances will be briefly discussed in this section.

Jackson County jurisdictions in the Western Crab Orchard Creek watershed participate in the NFIP.[13] The Jackson County Flood Damage Prevention Ordinance outlines the requirements to be followed regarding all new and existing developments in the county in order to mitigate and prevent future flood hazards.[14] Jackson County ranks 7th out of 102 counties statewide on a Flood Vulnerability Index (FVI), making its flood risk amongst the highest in the state.[15] The City of Carbondale and Village of Makanda participate in the NFIP.

Ordinance No. 08-70-31-05 is the Flood Damage Prevention Ordinance for Williamson County. In addition to many other purposes, these ordinances serve to preserve the natural characteristics and functions of watercourses and floodplains in order to moderate flood and stormwater impacts, improve water quality, reduce soil erosion, protect aquatic and riparian habitat, provide recreational opportunities, provide aesthetic benefits and enhance community and economic development.[16]

Union County is also a participant in the NFIP. However, Cobden precincts one and two are not identified in the flood hazard boundary, and therefore do not participate in the program.[17] Cobden's precincts are required to abide by Ordinance No. 08-03-Flood Damage Prevention Ordinance. Municipalities in Union County that do not choose to participate in the NFIP are required by the state to submit a Stormwater Pollution Prevention Plan (SWPPP), under the Illinois Administrative Code Title 35 (Illinois Environmental Protection Act).

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13 FEMA, "Federal Emergency Agency Community Status Book Report-Illinois: Communities Participating in the Nation Flood Insurance Program," https://www.fema.gov/cis/IL.html Accessed January, 2020

14 Jackson County, IL "Flood Damage Prevention Ordinance" Accessed November, 2019

15 Greater Egypt Regional Planning and Development Commission, et al. "Jackson County Multi-Hazard Mitigation Plan," Greater Egypt, 2009, 53

16 Greater Egypt Regional Planning and Development Commission, et al. "Williamson County Multi-Hazard Mitigation Plan," Greater Egypt, 2009, 101-104

17 Union County, IL "Multi-Hazard Mitigation Plan," Accessed November, 2019

2.4.2. Local, State and Federal Responsibilities

In the Western Crab Orchard Creek watershed, there are a few local, state and federal agencies that implement programs related to watershed planning, water quality, and nonpoint source pollution. While some of these agencies have applied programs that target water related resources specifically for the Western Crab Orchard Creek watershed, other agencies have programs designated for these purposes, but have not been established for the planning area.

The following agencies have been described by their roles related to watershed planning, water quality, and nonpoint source pollution within and outside the planning area.

City of Carbondale

The City of Carbondale's Public Works department maintains a variety of public spaces within the city. The department is responsible for keeping the streets, sidewalks, and storm sewers in good repair. They operate and maintain the city's wastewater and water plants, are in charge of picking up refuse and recycling, and provide water and wastewater testing. The Public Works Department offers waste collection programs throughout the year such as the Christmas Tree Recycling Program, Extra Solid Waste Collection, Seasonal Leaf Collection, and the Residential Spring Clean-up program. On the City of Carbondale website, you can find the Public Works information and where to take and dispose of different items such as electronics and chemicals.[18]

Tree City USA status

Carbondale is one of only seven cities in Illinois that have held the Tree City USA award for more than 39 years. The Tree City USA program was established in 1976 by the National Arbor Day Foundation in collaboration with the National Association of State Foresters and the United States Forest Service Urban and Community Forestry Program. To reach this status, a city must meet the four standards of the program:

- Maintain a tree board or department
- Have a community tree care ordinance
- Spend at least $2 per capita on urban forestry
- Celebrate Arbor Day

18 Public Works-Responsibilities," https://www.ci.carbondale.il.us/165/Public-Works. Accessed September 2019

Carbondale has also received the Tree City Growth Award for 6 consecutive years (2016-2021), which recognizes Tree City USA communities for environmental improvements and achieving a higher level of tree care for the community.

Carbondale's Forestry Services, a division of the Public Works Department, oversees the care and maintenance of the city's trees and shrubs. They also provide a list for citizens of recommended trees to be planted to increase tree diversity in southern Illinois. The city maintains an ordinance concerning trees, bushes, and shrubs; some notable components are the required replacement planting in the case of Heritage Tree removal and the shade tree incentive program.

Southern Illinois University – Carbondale is also a recognized Tree Campus USA, one of twenty in the state of Illinois.

Greater Egypt Regional Planning and Development Commission

Since the 1960s, the Greater Egypt Regional Planning and Development Commission (Greater Egypt) has played an important role in regional water-related issues such as: watershed planning, water quality, and nonpoint source pollution. Greater Egypt has produced watershed inventories and plans for: Rend Lake, Cedar Lake, Atchison Creek, Pinckneyville Reservoir, Upper Crab Orchard, and the Upper Big Muddy watershed. These reports involved describing watershed characteristics and water quality in the particular watershed.

Most recently, the Pond Creek Watershed-based Plan was approved by the IEPA in September, 2019. Pond Creek watershed also lies in the larger Big Muddy River watershed. The plan consists of an inventory and assessment and identifies best management practices to control impairments in the watershed. The plan follows the *Nine Minimum Elements of a Watershed Plan* outlined by the EPA.

In 1981, the Illinois Environmental Protection Agency established the Volunteer Lake Monitoring Program. This program was established to gather fundamental information on Illinois inland lakes. Greater Egypt coordinates the program for Southern Illinois for the ten-county region. Volunteers gather the data on water transparency and water quality.

Illinois Department of Natural Resources (IDNR)

The Illinois Department of Natural Resources is responsible for many programs related to water related activities. The IDNR Division of Resource Management is responsible for various activities such as: regulating public waters, regulating construction and maintenance of dams, National Flood Insurance Program coordination, and Flood Mitigation Program (nonstructural) administration.

The Division also has an extensive permitting program in which they are responsible for permits for work along Illinois waterbodies. The four main components of the permitting program are: Floodway/Floodplain Management, Public Water Management, Dam Safety, and Lake Michigan Management.

Illinois Environmental Protection Agency (IEPA)

The IEPA oversees and implements many programs that target watershed planning, water quality, and nonpoint source pollution. Through the National Pollutant Discharge Elimination System (NPDES), the IEPA handles stormwater and wastewater discharges to waterbodies. NPDES permits are required for discharges of: treated municipal effluents, treated industrial effluents, and stormwater discharged through separate municipal storm sewer systems (MS4s) and construction sites. The IEPA Bureau of Water characterizes NPDES and other stormwater regulations by the following:

> Under Phase I of the NPDES Storm Water program, operators were required to obtain permit coverage for construction activity that resulted in a total land disturbance of 5 acres or more or less than 5 acres if they were part of a "larger common plan of development or sale" with a planned land disturbance of 5 acres or greater. Phase II reduced that project size to 1 acre or more.
>
> Phase I of the NPDES Storm Water program began in 1990 and required medium and large municipal separate storm sewer systems (MS4s) to obtain NPDES coverage. The expanded Phase II program began in March 2003 and required small MS4s in urbanized areas to obtain NPDES permits and implement six (6) minimum control measures. An urbanized area as delineated by the Bureau of Census is defined as a central place or places and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 people and an overall population density of at least 500 people per square miles.

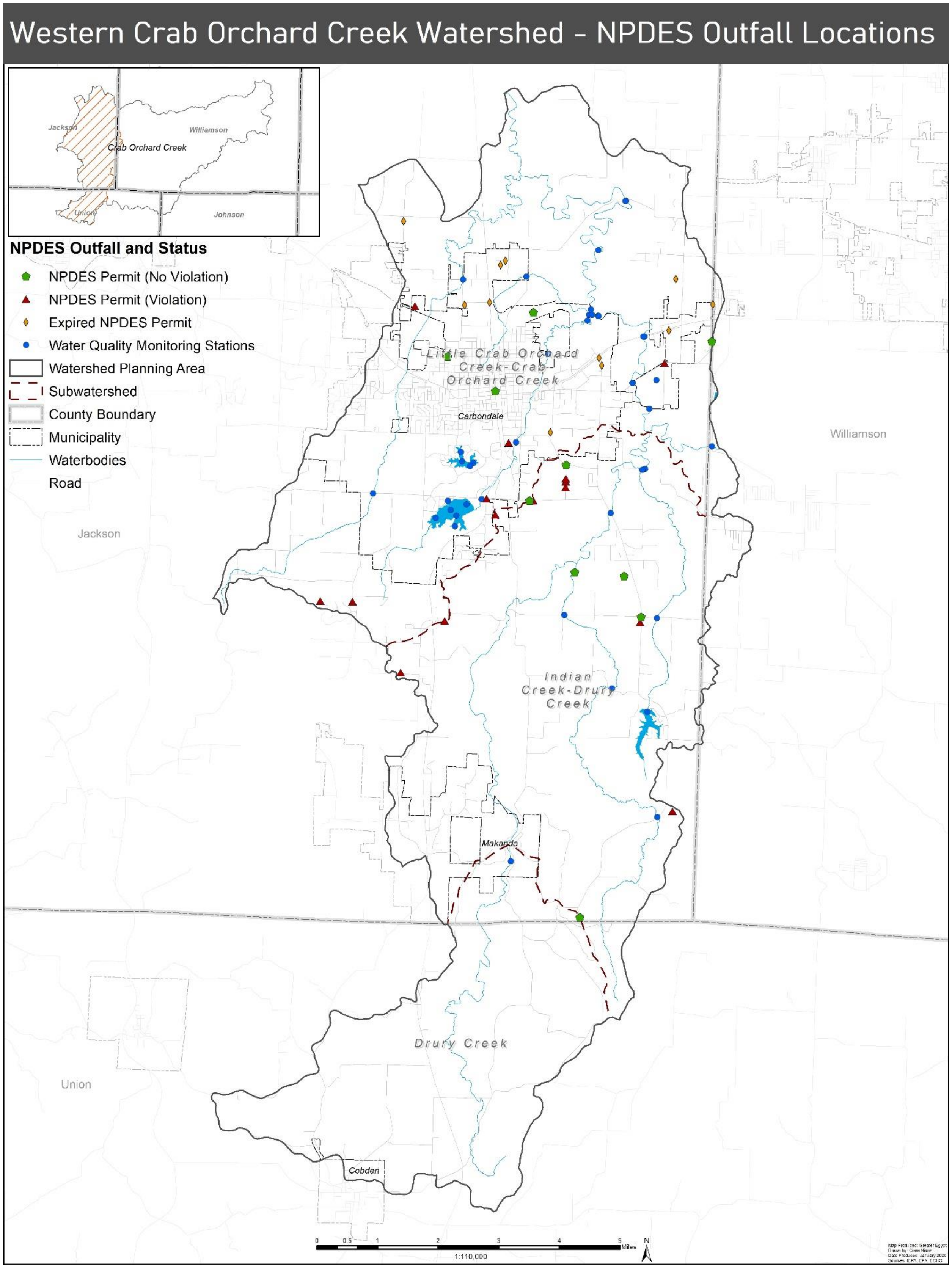
Western Crab Orchard Creek watershed has a total of thirty-six outfall locations. These are displayed in *Table 2.13*. The NPDES Facility locations are also spatially depicted in *Figure 2.18.* More information on existing and discontinued NPDES facilities can be found in the Water Quality section of this report (*Section 2.8*).

Table 2.13 – NPDES Outfall Locations

NPDES Facility Name	NPDES ID	NPDES Facility Name	NPDES ID
BEAZER EAST INC	IL0000400	JACKSON COUNTY - REED STATION MHP	ILG55100 8
BECK BUS TRANSPORTATION CORP	ILR006746	KOHLS CARBONDALE	ILR10B215
BUSH MHP STP #1	IL0046078	LAKE INDIAN HILLS SUBDIVISION STP	ILG55107 5
CARBONDALE BRICK&BLOCK	ILR000263	LENORE BASIN CORP-UNION HILLS	ILG55103 7
CARBONDALE NORTHWEST WWTP	IL0027871	LILAC BASIN CORP - UNION HILL STP	IL0046221
CARBONDALE, CITY OF	ILR400697	M&M RENTALS MHP	ILG55101 7
CEDAR LANE MHP #2 STP	ILG55104 5	PLEASANT HILL MOBILE HOME PARK STP	ILG55105 9
CHATEAU APARTMENTS	ILG55105 8	PLEASANT VALLEY MHP - STP	IL0047601
CIMCO RECYCLING CARBONDALE	ILR007139	RACCOON VALLEY MHP	IL0063843
CITY OF CARBONDALE SOUTHEAST STP	IL0027898	S.I. PROPERTIES, LLC	ILG55106 6
CORNER ONE STOP STP	ILG55101 6	SALUKI HOMES, LLC STP	IL0038415
CRAB ORCHARD LAKE MHP STP	ILG55101 9	SIUC PHYSICAL PLANT	IL0072320
FIRST BAPTIST CHURCH	ILR10J477	SIUC-TOUCH OF NATURE ENVIRONMENTAL CENTER	IL0047899
FROST MOBILE HOME PARK STP	IL0047635	SOUTHERN ILL REG SOCIAL SERV	ILR10J647
GIANT CITY SCHOOL DIST 130 STP	IL0025844	SOUTHERN MOBILE HOME PARK STP	ILG55107 7
GIANT CITY STATE PARK LODGE	IL0049794	TESA TAPE INCORPORATED	ILR001590
HEARTLAND LAKE AND LAND MANAGEMENT	ILG87088 8	UNITY POINT SCHOOL DIST. 140 STP	IL0045748
ILLINI READY MIX	ILR006463	WILDWOOD MOBILE HOME PARK - STP	IL0037125

Sources: US EPA

Figure 2.18


Western Crab Orchard Creek Watershed - NPDES Outfall Locations
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
NPDES Outfall and Status
NPDES Permit (No Violation)
NPDES Permit (Violation)
Expired NPDES Permit
Water Quality Monitoring Stations
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Jackson County Emergency Management Agency (JCEMA)

The Jackson County Emergency Management Agency was established to implement programs that work to reduce community vulnerability to natural hazards. The JCEMA is in charge of creating and implementing mitigation and informational frameworks to prevent or lower the impact of natural hazards, such as flooding. Actions carried out by the agency have made federal flood insurance available for the public while outlining important building codes to reduce building in areas at high risk of floods. The agency also works to improve the water quality in Jackson County by reducing soil erosion and protecting aquatic and riparian habitat. Other goals of the agency are to provide recreational opportunities and aesthetic benefits to enhance the community and economic development.[19]

Jackson County Health Department (JCHD)

The Jackson County Health Department has been providing a variety of public health services its residents since 1950. One of their main focuses is to protect the environment. The health department has held recycling drop-off services and collaborated with other agencies to form a Climate and Health Plan to help the Jackson County community prepare for the health effects of climate change.[20]

Jackson, Williamson and Union County Soil and Water Conservation Districts (SWCD)

The Soil and Water Conservation Districts within each county implement several programs in relation to conserving natural resources. Some of their programs include implementing conservation practices for farming that reduce soil loss, and increase environmental sustainability. [21] Duties related to water resources include the conservation and restoration of wetlands, the protection of groundwater resources, and the prevention of soil erosion.

19 "Flood Damage Prevention Ordinance," http://www.jacksoncounty-il.gov/home/showdocument?id=474 Accessed September 2019
20 "Jackson County Health Department," http://www.jchdonline.org/ Accessed September 2019
21 AISWCD. "Association of Illinois Soil and Water Conservation Districts AISWCD," http://www.aiswcd.org/. Accessed September 2019.

United States Fish and Wildlife Service (USFWS)

The USFWS works with many facets of government to oversee projects in water resource development, conservation planning, and natural resource damage assessment. In coordination with the United States Army Corps of Engineers (USACE) and other state agencies, the USFWS assists in developing resource projects for federal waters. These projects consist of dams, harbor development, flood control, and water storage. Under a collection of policies, the USFWS and the USACE collaborate to conserve the habitats of fish and wildlife during resource development. [22]

Along with water resource development, the agency also collaborates with multiple agencies by providing conservation planning assistance. USFWS staff assists organizations with developing plans of conservation and restoration that accompany their specific objectives of development. [23]

United States Army Corps of Engineers (USACE)

The United States Army Corps of Engineers St. Louis District is responsible for the preservation and maintenance of waterways within its jurisdiction. Their jurisdiction includes an area which covers eastern Missouri and southwestern Illinois. The Corps is responsible for maintaining the data associated with the waterbodies within its district. Stations in closest proximity to the Western Crab Orchard Creek watershed include Murphysboro and Plumfield, which are located along the Big Muddy River.[24]

The Corps is also responsible for water control operations. These operations consist of four Mississippi River navigation structures and five multi-purpose reservoirs within the district. The district also includes Rend Lake, located northeast of the Western Crab Orchard Creek watershed.[25]

22 USFWS. "Water Resource Development- Ecological Services," https://www.fws.gov/ecological-services/energy-development/water.html. Accessed Various Dates 2019.
23 USFWS. "Ecological Services- Conservation Planning," https://www.fws.gov/ecological-services/about/what-we-do.html. Accessed Various Dates 2019.
24 USACE. "St. Louis District- Water Management USACE," http://mvs-wc.mvs.usace.army.mil/. Accessed July 2019.
25 Ibid.

United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS)

The NRCS is a branch of the USDA that provides assistance to landowners by financial and technical means. Financial assistance programs provided by the agency include: Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP) and Agricultural Management Assistance Program (AMA). These programs assist landowners with agricultural and environmental improvements on their land.[26]

Technical assistance through the department is provided through the Conservation Technical Assistance Program (CTA). The CTA covers a variety of components and includes utilizing land management technology and improving and protecting water quality and fish habitat.[27]

26 USDA Natural Resources Conservation Service. "2014 Farm Bill- Financial Assistance Programs-NRCS," https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/?cid=stelprdb1237774. Accessed 20 July 2019.

27 USDA Natural Resources Conservation Service. "Technical Assistance," https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/. Accessed May 2019.

2.5. Watershed Demographics

To assess the population of the Western Crab Orchard Creek watershed, each entity was individually examined. The planning area lies within three different counties- Williamson, Jackson, and Union. Although the watershed consists of ten different townships, there are only three municipalities within the watershed's borders. Carbondale is the largest city, while Cobden and Makanda are smaller villages in the southern part of the watershed.

2.5.1. Population

According to the 2020 Census, Carbondale has a total population of 21,857. Almost all of the municipality is within the watershed. Near the central part of Western Crab Orchard Creek Watershed lies over half of the Village of Makanda. A small portion of Cobden touches the southern-most part of the watershed as well. The population counts and change from 2010-2020 for jurisdictions within the Planning Area are depicted in *Table 2.14.*

Table 2.14 - Population Change (2010-2020)

County/Municipality	Population 2010	Population 2020	Population Change	Population Change as %
Jackson	60,218	52,974	-7,244	-12.0%
Union	17,808	17,244	-564	-3.2%
Williamson	66,357	67,153	+796	1.2%
Carbondale	25,902	21,857	-4,045	-15.6%
Cobden	1,151	1,074	-77	-6.7%
Makanda	562	547	-15	-2.7%

Source: US Census Bureau

2.5.2. Median Age and Income

According to the American Community Survey, Carbondale has the lowest median age of the other two towns. Jackson County has a median age of 31. Union and Williamson counties have higher, similar median ages of 43 and 41, respectively. Makanda has the highest median age of 41, while Cobden has a median age of 39. The median age and the median household income are displayed in *Table 2.15.*

Table 2.15- Median Age and Median Household Income

Municipality/ County	Median Age	Median Household Income
Jackson County	31.9	$37,241.00
Union County	43.7	$50,625.00
Williamson Co.	41	$58,097.00
Carbondale City	24.4	$22,152.00
Cobden Village	39.3	$41,607.00
Makanda Village	41.1	$68,750.00

Source: US Census Bureau

Median Household income in the Western Crab Orchard Creek watershed varies. Corresponding to the numbers provided by the US Census Bureau, Carbondale has the lowest median income at $22,152, while Makanda has the highest median income at $68,750. Median Age and Median Household Income have been depicted by block group in *Figure 2.19* and *Figure 2.20*, respectively. Please note the maps are displaying data from the 2010 decennial census, as updated GIS files are not yet available for download from the Census Bureau.

Figure 2.19

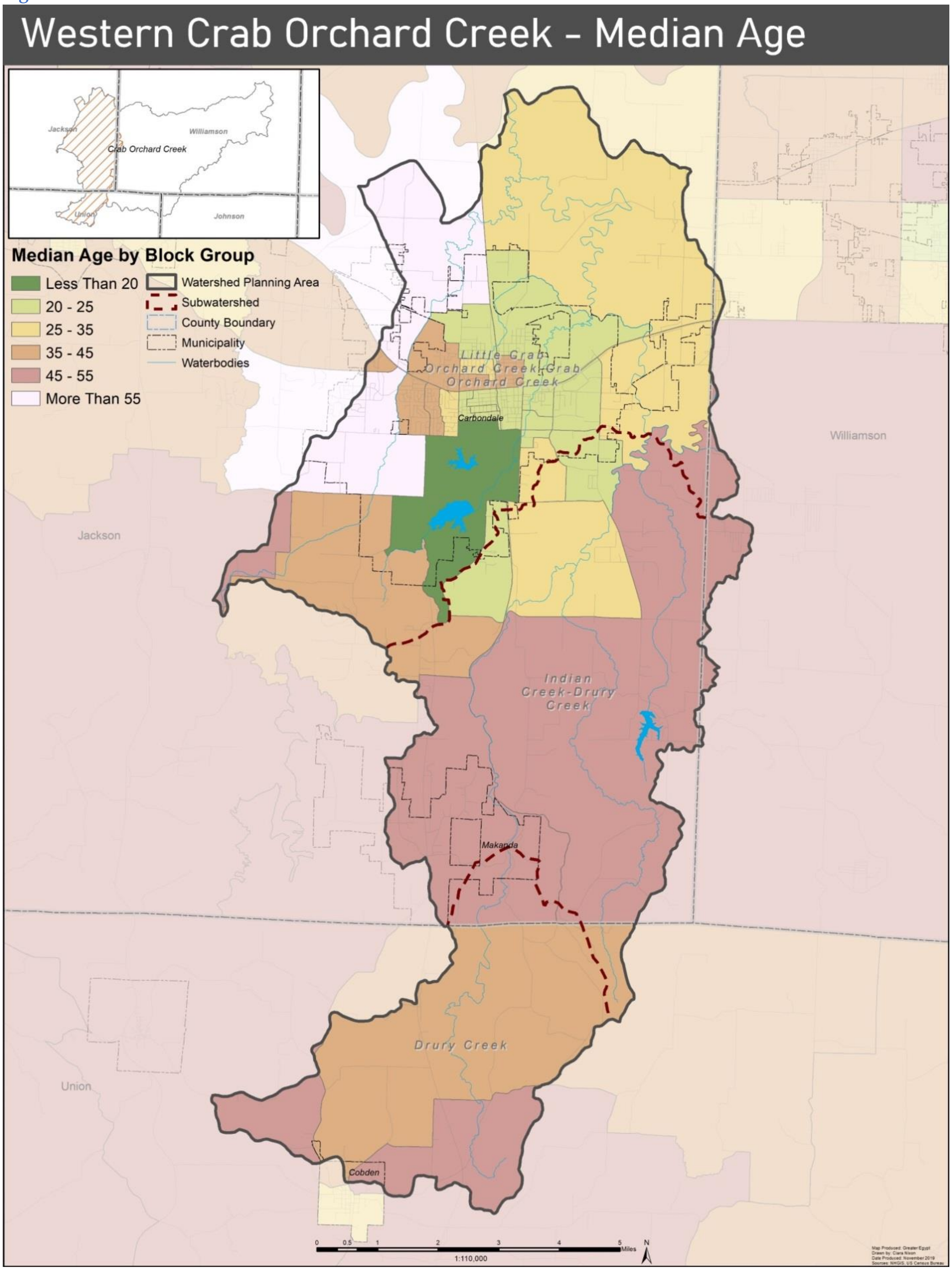
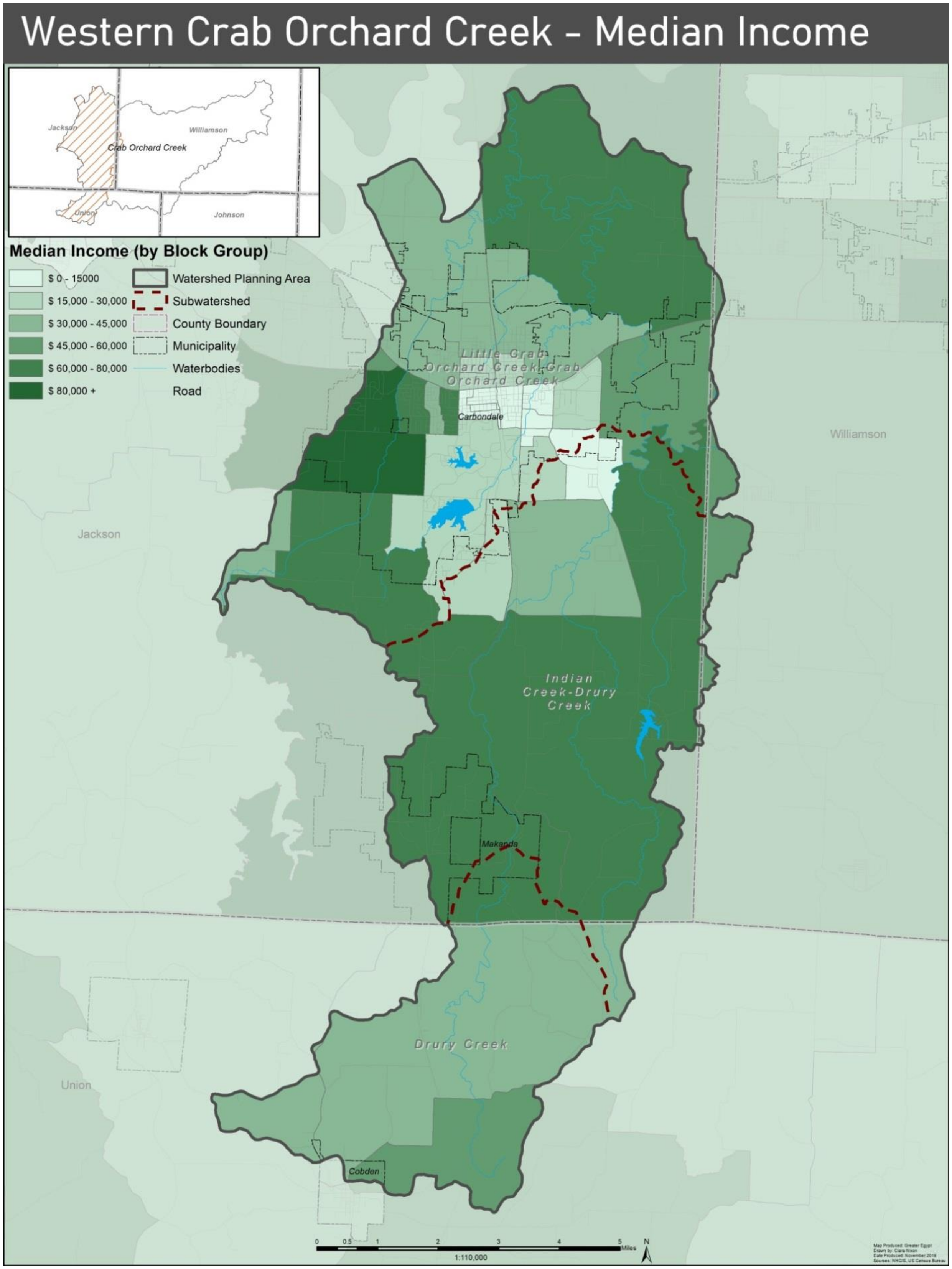

Western Crab Orchard Creek - Median Age
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Median Age by Block Group
Less Than 20
20 - 25
25 - 35
35 - 45
45 - 55
More Than 55
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Figure 2.20



Western Crab Orchard Creek - Median Income
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Median Income (by Block Group)
$ 0 - 15000
$ 15,000 - 30,000
$ 30,000 - 45,000
$ 45,000 - 60,000
$ 60,000 - 80,000
$ 80,000 +
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N
Map Produced: Greater Egypt
Drawn by: Ciara Nixon
Date Produced: November 2019
Sources: NHGIS, US Census Bureau

2.5.3. Employment

The 2021 Illinois Department of Employment Security's Unemployment Rate was at 4.8 percent for Jackson County, 4.7 percent in Union County, and at 4.9 percent for Williamson County. This is compared to 5.5 percent for the State of Illinois as a whole, and 4.6 percent for the United States as a whole.

With the Western Crab Orchard Creek watershed featuring higher education and healthcare, most of the population works in office, administration, and educational fields. Data was retrieved through the JobsEQ software developed by Chmura Economics and Analytics. *Table 2.16* displays the current employment breakdown of occupations for Carbondale, Illinois. The top three job classifications by employment for the City of Carbondale are: Office and Administration Support (2,758); Education, Training, and Library (2,185); Food Preparation and Serving Related Occupations (1,934).

Table 2.16- Carbondale Employment Information

Title	Number of Employees	Average Annual Salary	Location Quotient	Unemployment Numbers	Unemployment Rate
Management	862	$75,200	0.85	17	2.00%
Business and Financial Operations	591	$56,800	0.68	20	4.30%
Computer and Mathematical	367	$66,900	0.74	11	3.30%
Architecture and Engineering	125	$69,200	0.43	1	1.60%
Life, Physical, and Social Science	253	$51,300	1.82	4	2.60%
Community and Social Service	307	$40,300	1.14	12	2.60%
Legal	102	$66,900	0.74	1	1.20%
Education, Training, and Library	2,185	$59,600	2.3	114	5.30%
Arts, Design, Entertainment, Sports, and Media	263	$49,600	0.86	4	2.70%
Healthcare Practitioners and Technical	1,608	$80,100	1.67	23	2.10%
Healthcare Support	549	$30,800	1.15	14	4.70%
Protective Service	273	$41,300	0.75	5	2.30%
Food Preparation and Serving Related	1,934	$22,700	1.33	85	8.30%
Building and Grounds Cleaning and Maintenance	450	$29,200	0.75	15	6.40%
Personal Care and Service	430	$27,500	0.65	12	5.90%
Sales and Related	1,921	$29,500	1.12	57	5.60%
Office and Administrative Support	2,758	$32,700	1.1	93	5.60%
Farming, Fishing, and Forestry	11	$27,800	0.1	1	7.70%
Construction and Extraction	441	$59,200	0.56	11	5.60%
Installation, Maintenance, and Repair	485	$40,800	0.75	5	3.00%
Production	495	$32,700	0.48	7	5.90%
Transportation and Material Moving	565	$35,700	0.49	17	6.80%
Total - All Occupations	16,973	$44,900	1	n/a	n/a

Source: JobsEQ

Cobden and Makanda are much smaller towns compared to Carbondale. Cobden has a total of 639 employees, while Makanda only has 188. The top three job classifications by employment for Cobden are Management (104), Education, Training, and Library (64), and Production (59). Makanda Township has 58 employees working in Food Preparation and Serving-related jobs. This is followed by 22 employees in Installation, Maintenance, and Repair, and 20 employees in Office Administrive Support. Cobden and Makanda's occupations are broken down in *Table 2.17* and *Table 2.18*.

Table 2.17 - Cobden Employment Information

Title	Number of Employees	Average Annual Salary	Location Quotient	Unemployment Numbers	Unemployent Rate
Management	104	$69,600	2.71	3	1.70%
Business and Financial Operations	11	$64,900	0.33	3	4.10%
Computer and Mathematical	4	$72,600	0.21	1	3.30%
Architecture and Engineering	4	$72,500	0.34	0	n/a
Life, Physical, and Social Science	3	$64,400	0.52	0	n/a
Community and Social Service	14	$40,200	1.4	2	2.80%
Legal	1	$67,400	0.21	0	n/a
Education, Training, and Library	64	$41,300	1.78	11	6.20%
Arts, Design, Entertainment, Sports, and Media	6	$30,600	0.53	1	2.90%
Healthcare Practitioners and Technical	39	$58,900	1.09	3	2.20%
Healthcare Support	31	$29,500	1.71	3	5.50%
Protective Service	11	$57,500	0.79	1	3.00%
Food Preparation and Serving Related	25	$22,100	0.45	10	8.80%
Building and Grounds Cleaning and Maintenance	35	$26,800	1.55	4	6.40%
Personal Care and Service	16	$23,600	0.63	3	5.60%
Sales and Related	26	$31,800	0.41	6	5.30%
Office and Administrative Support	57	$32,600	0.6	7	5.60%
Farming, Fishing, and Forestry	49	$23,400	11.52	3	7.90%
Construction and Extraction	27	$50,500	0.91	4	6.10%
Installation, Maintenance, and Repair	17	$45,200	0.7	1	3.50%
Production	59	$36,700	1.51	6	5.80%
Transportation and Material Moving	38	$31,900	0.87	6	7.10%
Total - All Occupations	639	$40,300	1	n/a	n/a

Source: JobsEQ

Table 2.18 - Makanda Employment Information

Title	Number of Employees	Average Annual Salary	Location Quotient	Unemployment Numbers	Unemployment Rate
Management	11	$76,900	1.01	1	1.90%
Business and Financial Operations	4	$56,700	0.44	2	3.90%
Computer and Mathematical	2	$67,000	0.37	1	3.60%
Architecture and Engineering	1	$69,000	0.45	0	n/a
Community and Social Service	1	$41,600	0.19	1	3.00%
Legal	1	$64,900	0.43	0	n/a
Education, Training, and Library	1	$56,600	0.06	5	5.80%
Arts, Design, Entertainment, Sports, and Media	3	$49,500	0.78	2	3.30%
Healthcare Practitioners and Technical	6	$77,400	0.54	1	1.90%
Healthcare Support	4	$30,100	0.76	1	4.80%
Protective Service	2	$42,600	0.47	0	n/a
Food Preparation and Serving Related	58	$22,900	3.6	4	8.30%
Building and Grounds Cleaning and Maintenance	5	$29,200	0.81	1	6.60%
Personal Care and Service	7	$27,300	0.96	1	6.00%
Sales and Related	16	$29,300	0.86	4	5.00%
Office and Administrative Support	20	$33,000	0.71	5	5.80%
Farming, Fishing, and Forestry	0	n/a	0	0	n/a
Construction and Extraction	6	$59,900	0.72	1	5.50%
Installation, Maintenance, and Repair	22	$41,800	2.99	0	n/a
Production	7	$33,300	0.63	1	5.60%
Transportation and Material Moving	11	$37,300	0.82	1	6.70%
Total - All Occupations	188	$44,100	1	n/a	n/a

Source: JobsEQ

Jackson County has a total of 25,585 employed persons between 23 occupations. The top three highest paying jobs in the county are: Healthcare Practitioners (2,013), Management (1,505) and, Architecture and Engineering (216). Employment information for Jackson County, IL has also been provided in *Table 2.19*.

Table 2.19- Jackson County Employment Information

Title	Number of Employees	Average Annual Salary	Location Quotient	Unemployment Number	Unemployment Rate
Management	1,505	$76,900	0.98	34	2.00%
Business and Financial Operations	842	$56,700	0.64	42	4.10%
Computer and Mathematical	488	$67,000	0.65	20	3.40%
Architecture and Engineering	216	$69,000	0.5	5	1.80%
Life, Physical, and Social Science	308	$51,300	1.47	8	2.70%
Community and Social Service	465	$41,600	1.14	19	2.60%
Legal	155	$64,900	0.74	2	1.50%
Education, Training, and Library	3,077	$56,600	2.15	197	5.70%
Arts, Design, Entertainment, Sports, and Media	387	$49,500	0.84	13	3.00%
Healthcare Practitioners and Technical	2,013	$77,400	1.39	44	2.10%
Healthcare Support	819	$30,100	1.14	36	4.90%
Protective Service	476	$42,600	0.87	12	2.60%
Food Preparation and Serving Related	2,641	$22,900	1.2	199	8.30%
Building and Grounds Cleaning and Maintenance	751	$29,200	0.83	43	6.30%
Personal Care and Service	677	$27,300	0.68	39	6.00%
Sales and Related	2,567	$29,300	0.99	136	5.60%
Office and Administrative Support	3,879	$33,000	1.03	209	5.70%
Farming, Fishing, and Forestry	150	$25,200	0.89	8	7.40%
Construction and Extraction	1,140	$59,900	0.96	53	5.60%
Installation, Maintenance, and Repair	906	$41,800	0.93	23	3.10%
Production	979	$33,300	0.63	49	5.30%
Transportation and Material Moving	1,144	$37,300	0.65	73	6.60%
Total - All Occupations	25,585	$44,100	1	n/a	n/a

Source: JobsEQ

2.6. Land Use

For the land use portion of this inventory, the USGS Multi-Resolution Land Characteristics Consortium (MRLC) land cover and impervious datasets were used to complete the analyses, as well as the USDA's 2017 National Agricultural Statistics Service CropScape for the agricultural portion of the review. The MRLC land cover data differs from the USDA's CropScape data in regard to agricultural values. Any utilization of land use data in this plan will reference the MRLC; except the specific discussion on agriculture.

2.6.1. Existing Land Use

The largest land use category in the Western Crab Orchard Creek planning area is forest coverage. This category consists of three distinct classifications including deciduous, evergreen, and mixed forest, which in total span 28,957.3 acres, or 51.3 percent of the watershed. Deciduous forest has the largest land area of 28,661.7 acres (50.7%) of the watershed. The breakdown of classifications is available in *Table 2.20.*

The remaining land uses in the watershed are: developed areas (20%), open water (1.1%), barren land (0.02%), grassland/herbaceous (0.9%), pasture/hay (18.7%), cultivated crops (6.7%), and wetlands (1.3%).

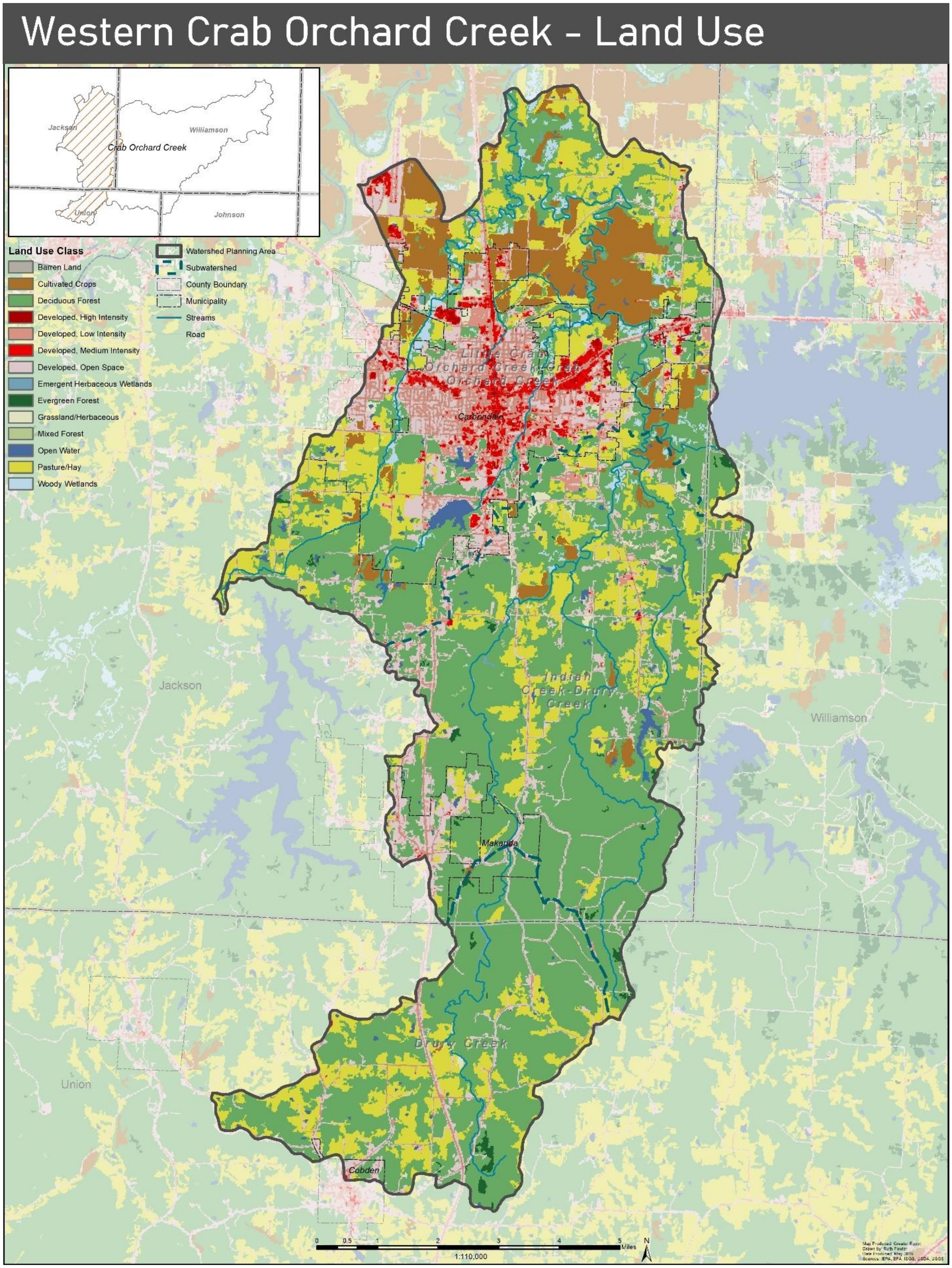
With twenty-five percent of the watershed being agricultural, there is a high potential for erosion. This is especially true for areas of cropland in the northern portion of the watershed that run alongside multiple waterbodies and creeks.

Table 2.20 - Land Use Classification for the Watershed Planning Area

Classification	Acreage	Percent of Watershed
Open Water	622.3	1.1%
Developed, Open Space	6,141.8	10.9%
Developed, Low Intensity	3,852.4	6.8%
Developed, Medium Intensity	1,056.2	1.9%
Developed, High Intensity	257.8	<1%
Barren Land	12.2	<1%
Deciduous Forest	28,661.7	50.7%
Evergreen Forest	274.5	<1%
Mixed Forest	21.1	<1%
Grassland/ Herbaceous	524.4	<1%
Pasture/ Hay	10,552.5	18.7%
Cultivated Crops	3,812.3	6.7%
Woody Wetlands	675.5	1.2%
Emergent Herbaceous Wetlands	68.1	<1%

Source: USGS Multi-Resolution Land Characteristics Consortium (MRLC)

Figure 2.21


Western Crab Orchard Creek - Land Use
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Land Use Class
Barren Land
Cultivated Crops
Deciduous Forest
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Developed, Open Space
Emergent Herbaceous Wetlands
Evergreen Forest
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
Woody Wetlands
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Streams
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Indian Creek-Drury Creek
Makanda
Drury Creek
Cobden
Jackson
Williamson
Union
0 0.5 1 2 3 4 5 Miles
1:110,000
N

According to the NRCS Soil Survey of Jackson County, "the main concerns affecting the management of cropland in Jackson County include crusting, flooding, ponding, poor tilth, water erosion, and saturation. Equipment limitations, high pH levels, limited available water capacity, limited rooting depth, low pH levels, and restricted permeability are additional concerns."[28]

Along with problems affecting cropland, there are also concerns regarding pastureland. These concerns are, "low fertility, low pH levels, water erosion, and saturation of soil.' Additional management concerns include equipment limitations, excessive permeability, flooding, frost heave, high pH levels, limited available water capacity, ponding, poor tilth, root-restrictive layers, and wind erosion."[29]

According to the 2012 Census of Agriculture (USDA), farming in Jackson and Union County consists mainly of soybeans, corn, wheat, and forage-land used for all haylage, grass silage, and green chop. Farmers in both Jackson and Union Counties have an average age of sixty years and are predominately white males. [30] It is important to note that although a small area of the watershed includes Williamson County, it does not constitute enough land to be deemed necessary for analysis.

Cultivation within the Western Crab Orchard Creek planning area follows a very similar pattern. Based on the USDA's National Agriculture Statistics Service CropScape[31], the planning area contains approximately 5,552.7 acres of agricultural land. *Table 2.21* displays the types of cultivation found within the planning area. *Figure 2.22* shows the location of the various crops. Accounting for about 4,334 acres, soybeans are the largest form of cultivation. Corn is also heavily cultivated at about 1,019 acres.

28 USDA NRCS. "Soil Survey of Jackson County, Illinois," Published Soil Surveys for Illinois, 2009, 146
29 Ibid., 149.
30 Census of Agriculture. "2012 Census Publications," USDA, 2012, 1-2.
31 *CropScape* (2018). USDA. National Agricultural Statistics Service, 2018.

Table 2.21 - Agricultural Diversity in the Watershed Planning Area

Agricultural Classification	Acreage	Percent of Agriculture	Percent of Watershed
Corn	1,019.31	18.36%	1.80%
Sorghum	6.89	<1%	0.01%
Soybeans	4,333.89	78.05%	7.67%
Winter Wheat	0.67	<1%	0.00%
Double Crop Winter Wheat/Soybeans	97.42	1.75%	0.17%
Oats	6.67	<1%	0.01%
Alfalfa	1.11	<1%	0.00%
Other Hay/Non-Alfalfa	46.26	<1%	0.08%
Clover/Wildflowers	0.44	<1%	0.00%
Fallow/Idle Cropland	16.46	<1%	0.03%
Apples	4.23	<1%	0.01%
Pecans	0.44	<1%	0.00%
Barren	18.90	<1%	0.03%

Source: USDA CropScape

2.6.2. Projected Future Land Use

To estimate the future land cover for the Western Crab Orchard Creek planning area, land cover from past datasets have been analyzed. Land cover from 2001 and 2011 datasets were used to compare past changes in land use.

The USGS Multi-Resolution Land Characteristics Consortium (MRLC) has land use data for the year 2006, but for the purpose of this analysis, the period from 2001 to 2011 is the best and most accurate representation of current land use change within the watershed. *Table 2.22* displays the acreage and percent of watershed of each land use classification for 2001 and 2011.

The percent of change from those years, projected acreage, and percent change of each classification are also displayed.

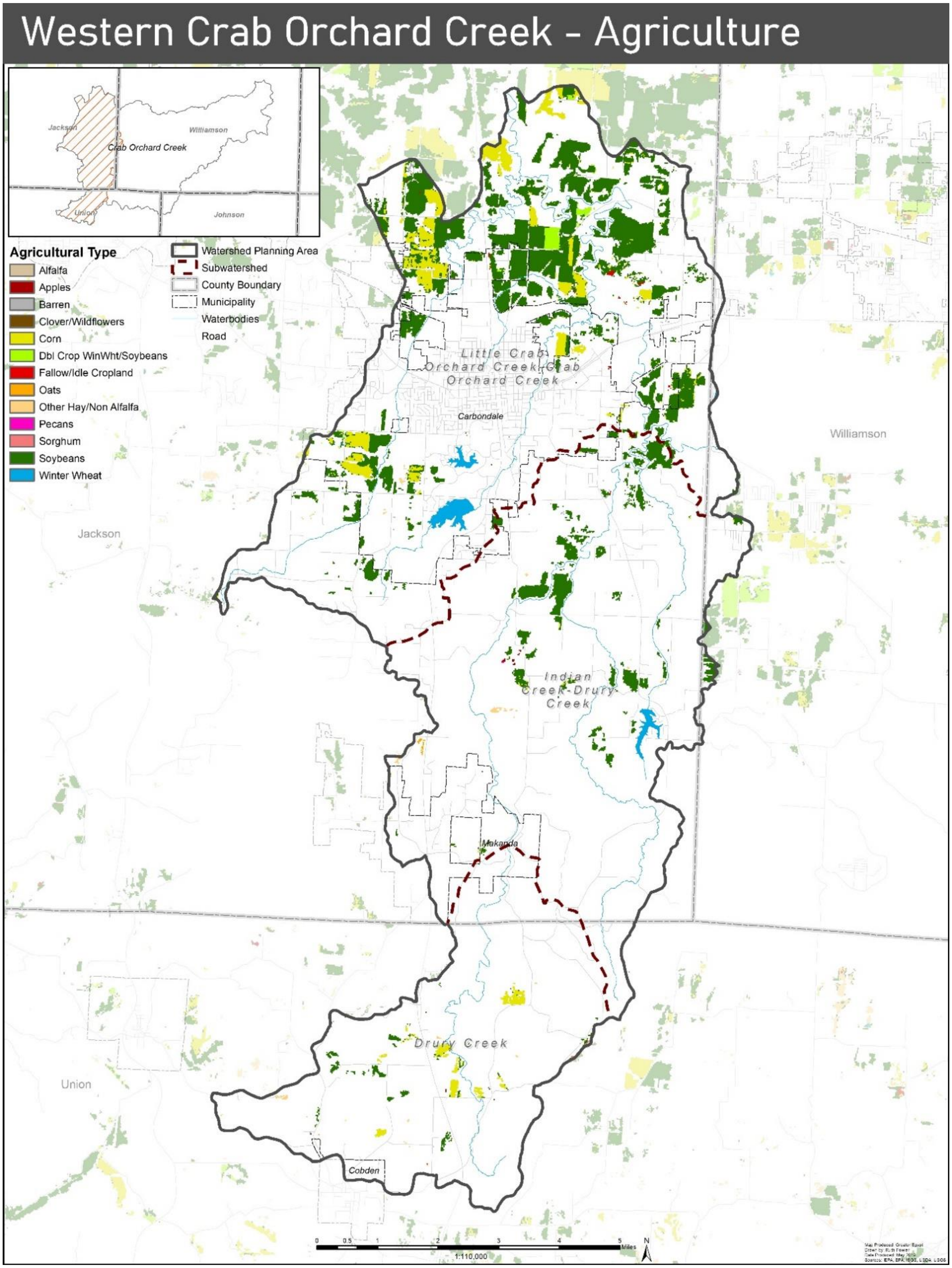
Assuming development in the area will remain constant, the raw change from 2001 to 2011 was used to calculate the 2021 projected acreage and projected percent change of each classification. The most notable change in the watershed involves the significant increase in both medium and high intensity developed land cover. Medium intensity developed land cover is projected to increase by 13.4 percent, which accounts for 141 acres, while high intensity developed land is projected to increase by 32.1 percent, which accounts for eighty-three acres.

Appendix D contains descriptions of the land use categories in the MRLC. It defines medium intensity developed land cover as, "areas with a mixture of constructed materials and vegetation. Impervious surfaces account for fifty to seventy-nine percent of the total cover. These areas most commonly include single-family housing units."[32] High intensity developed land cover is defined as, "highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80-100 percent of total cover."[33] Although there is a positive trend with medium and high intensity land cover, these classifications together only account for 2.3 percent of the total Western Crab Orchard Creek planning area.

An outlier to the analysis is the barren land classification, which portrayed a sharp increase of 1,000 percent between 2001-2011 and a projected increase of ninety-one percent by 2021. This seemingly large change only amounts to a projected 23.4 acres by 2021.

32 Department of Interior (DOI) and USGS. "National Land Cover Database 2011 Product Legend,"https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend. Accessed: February 19, 2019.
33 Ibid.

Figure 2.22



Western Crab Orchard Creek - Agriculture
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Agricultural Type
Alfalfa
Apples
Barren
Clover/Wildflowers
Corn
Dbl Crop WinWht/Soybeans
Fallow/Idle Cropland
Oats
Other Hay/Non Alfalfa
Pecans
Sorghum
Soybeans
Winter Wheat
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Table 2.22 - Existing and Projected Land Cover for the Planning Area

Land Cover Classification	Western Crab Orchard Creek Watershed							
	2001		2011		2001-2011		2011-2021	
	Acreage	Percent of Watershed	Acreage	Percent of Watershed	Change in Acreage	Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	610.7	1.1%	622.3	1.1%	11.6	1.9%	633.9	1.9%
Developed, Open Space	6,186.6	10.9%	6,141.8	10.9%	-44.7	-0.7%	6,097.1	-0.7%
Developed, Low Intensity	3,905.3	6.9%	3,852.4	6.8%	-52.9	-1.4%	3,799.4	-1.4%
Developed, Medium Intensity	915.0	1.6%	1,056.2	1.9%	141.2	15.4%	1197.5	13.4%
Developed, High Intensity	175.0	<1%	257.8	<1%	82.7	47.3%	340.5	32.1%
Barren Land	1.1	0.0%	12.2	<1%	11.1	+100%	23.4	90.9%
Deciduous Forest	28,922.9	51.2%	28,661.7	50.7%	-261.2	-0.9%	28,400.5	-0.9%
Evergreen Forest	274.5	<1%	274.5	<1%	0.0	0.0%	274.5	0.0%
Mixed Forest	21.1	<1%	21.1	<1%	0.0	0.0%	21.1	0.0%
Grassland/ Herbaceous	504.7	<1%	524.4	<1%	19.8	3.9%	544.2	3.8%
Pasture/ Hay	10,532.9	18.6%	10,552.5	18.7%	19.6	0.2%	10,572.1	0.2%
Cultivated Crops	3,781.4	6.7%	3,812.3	6.7%	30.9	0.8%	3,843.3	0.8%
Woody Wetlands	633.7	1.1%	675.5	1.2%	41.8	6.6%	717.3	6.2%
Emergent Herbaceous Wetlands	68.1	<1%	68.1	<1%	0.0	0.0%	68.1	0.0%

Source: USGS MRLC

2.6.3. Existing and Projected Imperviousness

As a whole, the Western Crab Orchard Creek planning area has a rather low level of imperviousness with eighty percent of the total land area being categorized as zero percent impervious. Imperviousness has been characterized by acreage and percent of the planning area by intervals of ten percent (*See Table 2.23*). These intervals have also been illustrated in *Figure 2.23*. As stated previously, 45,219 acres, or eighty percent, consists of non-existing impervious cover. This is a major contrast to the amount of land characterized as 90-100 percent impervious, which accounts for less than one tenth percent (0.07%) and only 37.6 acres. The more impervious locations in the Western Crab Orchard Creek watershed occur in Carbondale, specifically the Lower Piles Fork Creek, Campus Lake, and Middle Little Crab Orchard Creek SMUs.

Other areas that exhibit imperviousness are the road networks throughout the planning area. This is particularly evident near Hwy 51 that runs north/south and Hwy 13 that runs east/west. There are quite a lot of business and residential buildings on or near this road network, including Southern Illinois University- Carbondale. Another area with a high level of imperviousness is the Southern Illinois Airport in the north-western section of the watershed.

Following the same method to project future land use, impervious land cover from past and existing datasets were analyzed. Impervious land cover from the 2001 and 2011 datasets were utilized to compare past and present variations in imperviousness. *Table 2.23* also displays the projected percent of change and acreage to the year 2021. According to the analysis, levels of impervious will continue to rise above forty percent and become more noticeable over fifty percent imperviousness. The largest increase by percentage is the 90-100 level at 67.5 percent. Although it is expected to have the largest percent change, it constitutes the least amount of acreage at sixty-three acres, respectively. Levels of impervious ranging from zero to forty percent will see a steady decline from zero to two percent by 2021. Despite the fact the zero percent imperviousness level will only decrease by less than half of a percent by 2021, it is projected to decline by a noticeable 127.5 acres.

Figure 2.23

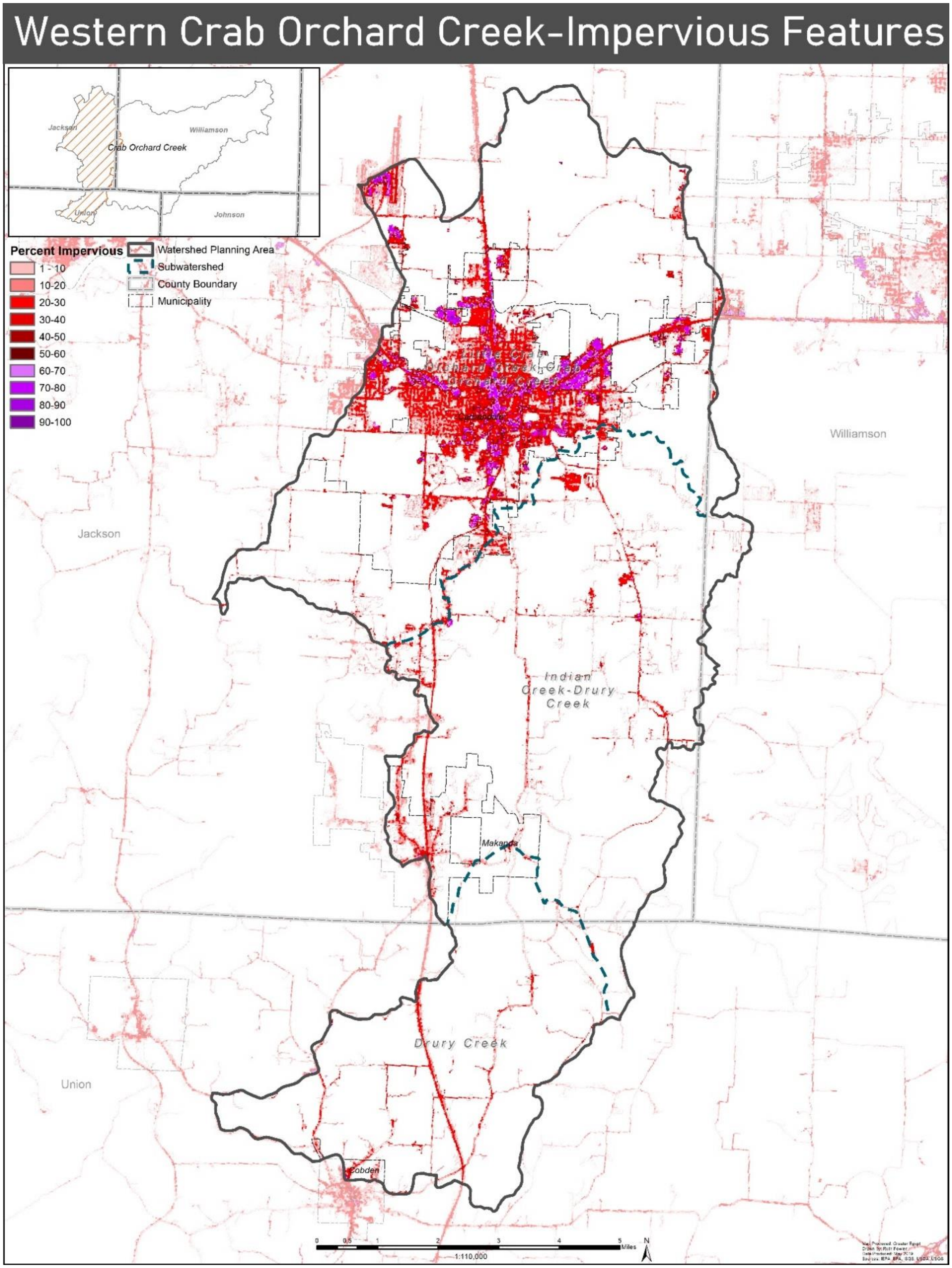

Western Crab Orchard Creek-Impervious Features
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Percent Impervious
1 - 10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
Miles
1:110,000

Table 2.23 - Existing and Projected Imperviousness of the Watershed Planning Area

Percent Imperviousness	2001		2011		2001-2011		2011-2021	
	Acreage	Percent of Watershed	Acreage	Percent of Watershed	Change (Acres)	Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	45,346.3	80.2%	45,218.8	80.0%	-127.5	-0.3%	45,091.3	-0.3%
0-10%	3,908.4	6.9%	3,899.5	6.9%	-8.9	-0.2%	3,890.6	-0.2%
10-20%	2,500.6	4.4%	2,463.6	4.4%	-36.9	-1.5%	2,426.7	-1.5%
20-30%	1,838.2	3.3%	1,809.3	3.2%	-28.9	-1.6%	1,780.4	-1.6%
30-40%	1,308.4	2.3%	1,286.9	2.9%	-21.6	-1.7%	1,265.3	-1.7%
40-50%	582.1	1.0%	582.3	1.0%	0.2	0.0%	582.5	0.0%
50-60%	381.0	<1%	412.8	<1%	31.8	8.4%	444.6	7.7%
60-70%	290.0	<1%	342.3	<1%	52.3	18.0%	394.6	15.3%
70-80%	222.6	<1%	287.6	<1%	64.9	29.2%	352.5	22.6%
80-90%	143.0	<1%	192.2	<1%	49.2	34.4%	241.3	25.6%
90-100%	12.2	<1%	37.6	<1%	25.4	207.3%	62.9	67.5%

Source: USGS MRLC

2.6.4. Existing Land Cover and Imperviousness of the Subwatersheds (HUC 12)

Each HUC 12 subwatershed has been delineated by land cover and imperviousness. *Table 2.24* displays both the acreage and percentage of each subwatershed by the land use classification. *Table 2.25* displays the 2021 projected values and percent change in land use of each subwatershed.

The Little Crab Orchard Creek and Indian Creek subwatersheds have the highest percentage of open water at 373.8 and 206.6 acres, respectively. This is largely due to the presence of Campus Lake, Carbondale Reservoir, and Spring Arbor Lake in these subwatersheds.

Because of the location of Carbondale, the Little Crab Orchard Creek and Indian Creek-Drury Creek subwatersheds exhibit the highest percentage of all developed land classifications. The Little Crab Orchard Creek subwatershed exhibits the highest concentrations of all developed land use including open space, low, medium, and high intensity. Together, this makes up around 7,265 acres, or about thirty percent of the subwatershed.

The only barren land within the Western Crab Orchard Creek planning area takes place in the Little Crab Orchard Creek watershed with only 12.2 acres of land cover. The forest cover, by and large, is concentrated in the south with Indian Creek- Drury Creek subwatershed having 13,532.4 acres of forest cover and Drury Creek subwatershed having 7,823 acres. The predominant forest type across all three of the subwatersheds is deciduous. Within the confines of these subwatersheds is the Shawnee National Forest and Giant City State Park.

Table 2.24 - Existing Subwatershed Land Use

Land Cover Classification	Little Crab Orchard Creek		Indian Creek -Drury Creek		Drury Creek	
	Acreage	Percent of Watershed	Acreage	Percent of Watershed	Acreage	Percent of Watershed
Open Water	373.8	1.5%	206.6	1.0%	41.8	<1%
Developed, Open Space	2,981.0	12.2%	2,276.6	11.1%	883.4	7.7%
Developed, Low Intensity	3,003.7	12.2%	604.6	2.9%	243.5	2.1%
Developed, Medium Intensity	1,024.5	4.2%	24.5	<1%	7.1	<1%
Developed, High Intensity	255.7	1.0%	1.3	<1%	0.7	<1%
Barren Land	12.2	<1%	0.0	0.0%	0.0	0.00%
Deciduous Forest	7,539.2	30.7%	13,398.4	65.2%	7,720.2	67.4%
Evergreen Forest	57.2	<1%	116.1	<1%	101.2	<1%
Mixed Forest	1.1	0.0%	18.5	<1%	1.6	<1%
Grassland/ Herbaceous	301.8	1.2%	205.5	1.0%	17.1	<1%
Pasture/ Hay	4,944.0	20.2%	3,204.3	15.6%	2,402.8	2 %
Cultivated Crops	3,430.9	14%	366.9	1.8%	14.0	<1%
Woody Wetlands	568.6	2.3%	106.8	<1%	0.0	0.0%
Emergent Herbaceous Wetlands	41.6	<1%	7.3	<1%	19.1	<1%

Source: USGS MRLC

Cultivated crops are largely grown in the Little Crab Orchard Creek watershed and specifically concentrated in the northern region. With Little Crab Orchard Creek subwatershed having both the highest values in both developed land cover as well as highest cultivated crop cover, it can be expected that the surrounding waterways will experience a higher level of impairment.

Pasture/hay land cover roughly covers fifteen to twenty percent of each subwatershed. The acreage is the highest in the Little Crab Orchard Creek subwatershed at 4,944 acres. This land classification is defined by the MRLC as, "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 twenty percent of total vegetation."[34] Pasture/hay land cover may seem like a less likely candidate for erosion, but can be just as damaging to both land and water resources. According to the Illinois USDA, "Erosion is not just a cropland problem, but can also occur in hay and pasture systems. Poor grazing management is a major cause of

34 Department of Interior (DOI) and USGS. "National Land Cover Database 2011 Product Legend," https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend. Accessed: February 21, 2019.

erosion. Trails rutted into the sod, poor control of water drainage from roads, disturbance of natural drainage, livestock trailing, and other land disturbances are also responsible for increasing grassland erosion."[35]

According to the estimations (*see Table 2.25*), the projected changes to land use in the watersheds are relatively low by in large. Barren land, which projects a 90.91 percent increase within Little Crab Orchard Creek, only accounts for 23.35 acres in total. The only considerable projected increase is within medium and high intensity developed land. Medium intensity land cover is projected to increase 32.35 percent within the Little Crab Orchard Creek subwatershed, which should total 338.47 acres by 2021. Deciduous forested land is projected to decrease across all three subwatersheds. The percent change is relatively small, ranging from 0.52-1.94 percent decrease, but accounts for a total loss of 261 acres by 2021.

Table 2.25 - Projected Subwatershed Land Use

Projected Watershed Land Use	Little Crab Orchard Creek		Indian Creek-Drury Creek		Drury Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	372.7	-0.3%	219.3	6.1%	41.8	0.0%
Developed, Open Space	2,941.2	-1.3%	2,271.9	-0.2%	883.2	-0.03%
Developed, Low Intensity	2,947.9	-1.9%	607.7	0.5%	243.3	-0.1%
Developed, Medium Intensity	1,158.8	13.1%	30.9	26.4%	7.6	6.3%
Developed, High Intensity	338.5	32.4%	1.3	0.0%	0.7	0.0%
Barren Land	23.4	90.9%	0.0	0.0%	0.0	0.0%
Deciduous Forest	7,393.1	-1.9%	13,328.4	-0.5%	7,675.3	-0.6%
Evergreen Forest	57.2	0.0%	116.1	0.0%	101.2	0.0%
Mixed Forest	1.1	0.0%	18.5	0.0%	1.6	0.0%
Grassland/ Herbaceous	315.3	4.5%	205.5	0.0%	23.4	36.4%
Pasture/ Hay	4,900.6	-0.9%	3,237.2	1.0%	2,432.9	1.3%
Cultivated Crops	3,433.6	0.1%	386.5	5.3%	22.7	61.9%
Woody Wetlands	610.4	7.4%	106.7	0.0%	0.0	0.0%
Emergent Herbaceous Wetlands	41.6	0.0%	7.3	0.0%	19.1	0.0%

Source: USGS MRLC

35 United States Department of Agriculture. "Grazing Factsheets-General," April 2003. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/technical/landuse/ Pasture/?cid=nrcs141p2 030611. Accessed: February 21, 2019.

2.6.5. Drury Creek Subwatershed (071401060807)

Existing Land Use

The most prevalent land use classifications are forest, agriculture, and developed land, which accounts for 99.3 percent of the land use. *Table 2.26* displays the acreage and percent of SMU. *Figure 2.24* displays the name and location of the SMUs geographically.

Drury Creek subwatershed is heavily forested, covering roughly 7,823 acres of forest land or 68.3 percent of the subwatershed. Every SMU contains over fifty percent of forest land. The Drury Creek subwatershed includes parts of Giant City State Park and the Shawnee National Forest. Cobden-North SMU has the most forest acreage, at 1,734.8 acres. Makanda- South Drury Creek is a smaller SMU but has 87.8 percent of forest coverage.

Agriculture is another large part of Drury Creek subwatershed and gets more expansive in the southernmost part. Pasture/hay and cultivated crops cover roughly 2,416.8 acres, 21.1 percent of the subwatershed. Less than one percent of agriculture is cultivated crops, with the majority being pasture/hay. Agriculture is more concentrated in Cobden North and Flamm SMU. Cobden has 1,177.2 acres of agriculture, covering 35.2 percent of the SMU. Flamm has 357.4 acres, covering 31.5 percent of the SMU.

Developed land use within Drury Creek is concentrated to the roadways and a small section of northern Cobden. Together, there is roughly 1,134.7 acres of developed land use, or 9.9 percent of the subwatershed. 77.9 percent of the developed land is considered open space- developed land cover and 21.5 percent is low intensity land cover. Drury Creek subwatershed has a relatively low level of development.

Projected Land Use

Drury Creek subwatershed is projected to experience very low levels of change throughout the subwatershed. The largest land use changes will occur among deciduous forest and pasture/hay. Deciduous forested land is projected to decrease 44.9 acres by 2021 while pasture/hay is projected to increase by roughly thirty acres.

Three out of seven SMUs are projected to experience no change in acreage. The only SMUs that are projected to experience change are: Cobden- North, Shawnee Drury Creek, Flamm, and Makanda-South. The SMU projected to experience the most change is Flamm. Deciduous forest land is projected to decrease by roughly 18.9 acres and increase in pasture/hay by around 10.2 acres.

Figure 2.24

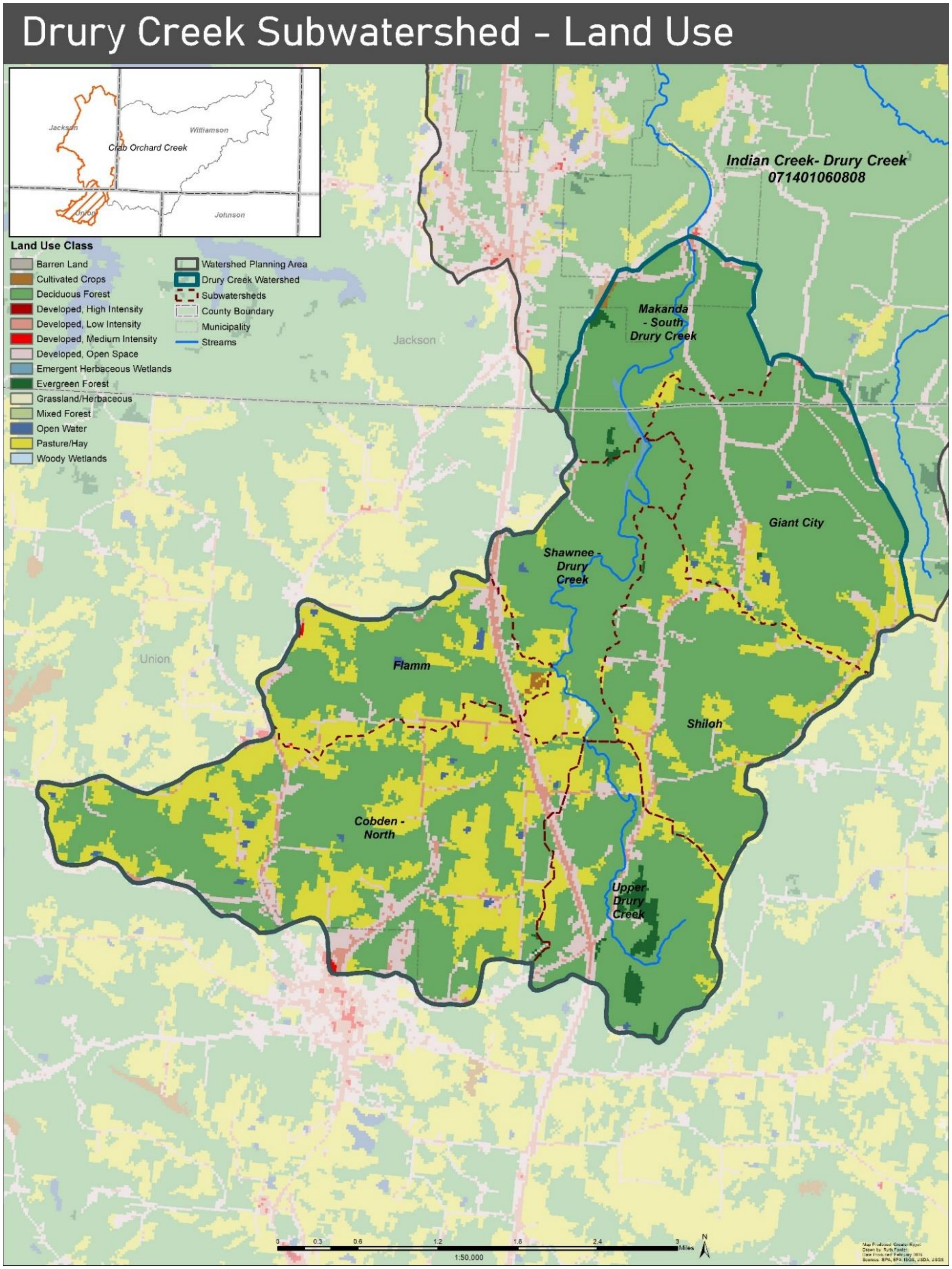

Drury Creek Subwatershed - Land Use
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Land Use Class
Barren Land
Cultivated Crops
Deciduous Forest
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Developed, Open Space
Emergent Herbaceous Wetlands
Evergreen Forest
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
Woody Wetlands
Watershed Planning Area
Drury Creek Watershed
Subwatersheds
County Boundary
Municipality
Streams
Indian Creek- Drury Creek
071401060808
Makanda - South Drury Creek
Jackson
Giant City
Shawnee - Drury Creek
Flamm
Union
Shiloh
Cobden - North
Upper Drury Creek
0 0.3 0.6 1.2 1.8 2.4 3 Miles
1:50,000
N

Table 2.26 - Existing Drury Creek Subwatershed Land Use

Subwatershed Land Use Classification	Upper Drury Creek		Cobden-North		Shiloh		Shawnee Drury Creek		Flamm		Giant City		Makanda South	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
Open Water	1.33	<1%	20.47	<1%	103.20	6.27%	2.22	<1%	10.43	<1%	7.34	<1%	0.00	0.00%
Developed, Open Space	118.79	8.81%	294.81	8.82%	20.68	1.26%	33.37	2.99%	88.53	7.81%	154.44	8.42%	90.39	8.78%
Developed, Low Intensity	39.60	2.94%	105.24	3.15%	0.22	<1%	13.57	1.21%	38.83	3.43%	19.14	1.04%	6.46	<1%
Developed, Medium Intensity	0.00	0.00%	3.56	<1%	0.00	0.00%	0.00	0.00%	2.22	<1%	0.45	<1%	0.67	<1%
Developed, High Intensity	0.00	0.00%	0.22	<1%	0.00	0.00%	0.00	0.00%	0.44	<1%	0.00	0.00%	0.00	0.00%
Deciduous Forest	947.23	70.24%	1732.36	51.80%	1203.23	73.07%	898.34	80.39%	635.23	56.06%	1418.46	77.31%	887.02	86.16%
Evergreen Forest	76.75	5.69%	2.45	<1%	1.11	<1%	1.78	<1%	0.00	0.00%	2.23	<1%	16.92	1.64%
Mixed Forest	0.00	0.00%	1.56	<1%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	0.00	0.00%	6.23	<1%	0.00	0.00%	10.90	<1%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Pasture/Hay	164.84	12.22%	1177.23	35.20%	318.27	19.33%	149.50	13.38%	348.79	30.78%	232.78	12.69%	11.35	1.10%
Cultivated Crops	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	8.65	<1%	0.00	0.00%	5.34	<1%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	0.00	0.00%	7.79	<1%	0.00	0.00%	0.00	0.00%	11.35	1.10%

Table 2.27 - Projected Drury Creek Subwatershed Land Use

Subwatershed Land Use Classification	Upper Drury Creek		Cobden-North		Shiloh		Shawnee Drury Creek		Flamm		Giant City		Makanda South	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	1.33	0.00%	20.47	0.00%	103.20	0.00%	2.22	0.00%	10.43	0.00%	7.34	0.00%	0.00	0.00
Developed, Open Space	118.79	0.00%	294.81	0.00%	20.68	0.00%	33.37	0.00%	88.53	0.00%	154.44	0.00%	90.17	0.00
Developed, Low Intensity	39.60	0.00%	105.24	0.00%	0.22	0.00%	13.57	0.00%	38.83	0.00%	19.14	0.00%	6.23	-0.03
Developed, Medium Intensity	0.00	0.00%	3.56	0.00%	0.00	0.00%	0.00	0.00%	2.22	0.00%	0.45	0.00%	1.11	0.67
Developed, High Intensity	0.00	0.00%	0.22	0.00%	0.00	0.00%	0.00	0.00%	0.44	0.00%	0.00	0.00%	0.00	0.00
Deciduous Forest	947.23	0.00%	1717.23	-0.87%	1203.23	0.00%	887.44	-1.21%	616.37	-2.97%	1418.46	0.00%	887.02	0.00
Evergreen Forest	76.75	0.00%	2.45	0.00%	1.11	0.00%	1.78	0.00%	0.00	0.00%	2.23	0.00%	16.92	0.00
Mixed Forest	0.00	0.00%	1.56	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00
Grassland/Herbaceous	0.00	0.00%	12.46	100.00%	0.00	0.00%	10.90	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00
Pasture/Hay	164.84	0.00%	1186.13	0.76%	318.27	0.00%	160.40	7.29%	359.00	2.93%	232.78	0.00%	11.35	0.00
Cultivated Crops	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	17.31	100.00%	0.00	0.00%	5.34	0.00
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	0.00	0.00%	7.79	0.00%	0.00	0.00%	0.00	0.00%	11.35	0.00

Source: USGS MRLC

2.6.6. Indian Creek-Drury Creek Subwatershed (071401060808)

Existing Land Use

Indian Creek subwatershed is 65.8 percent forested land, accounting for 13,514.5 acres. *Figure 2.25* displays the name and location of the SMUs geographically. Based on acreage values, Upper Indian, Boskydell, and Middle Drury Creek SMUs have the most forest land cover. *Table 6.9* displays the acreage and percent of SMU.

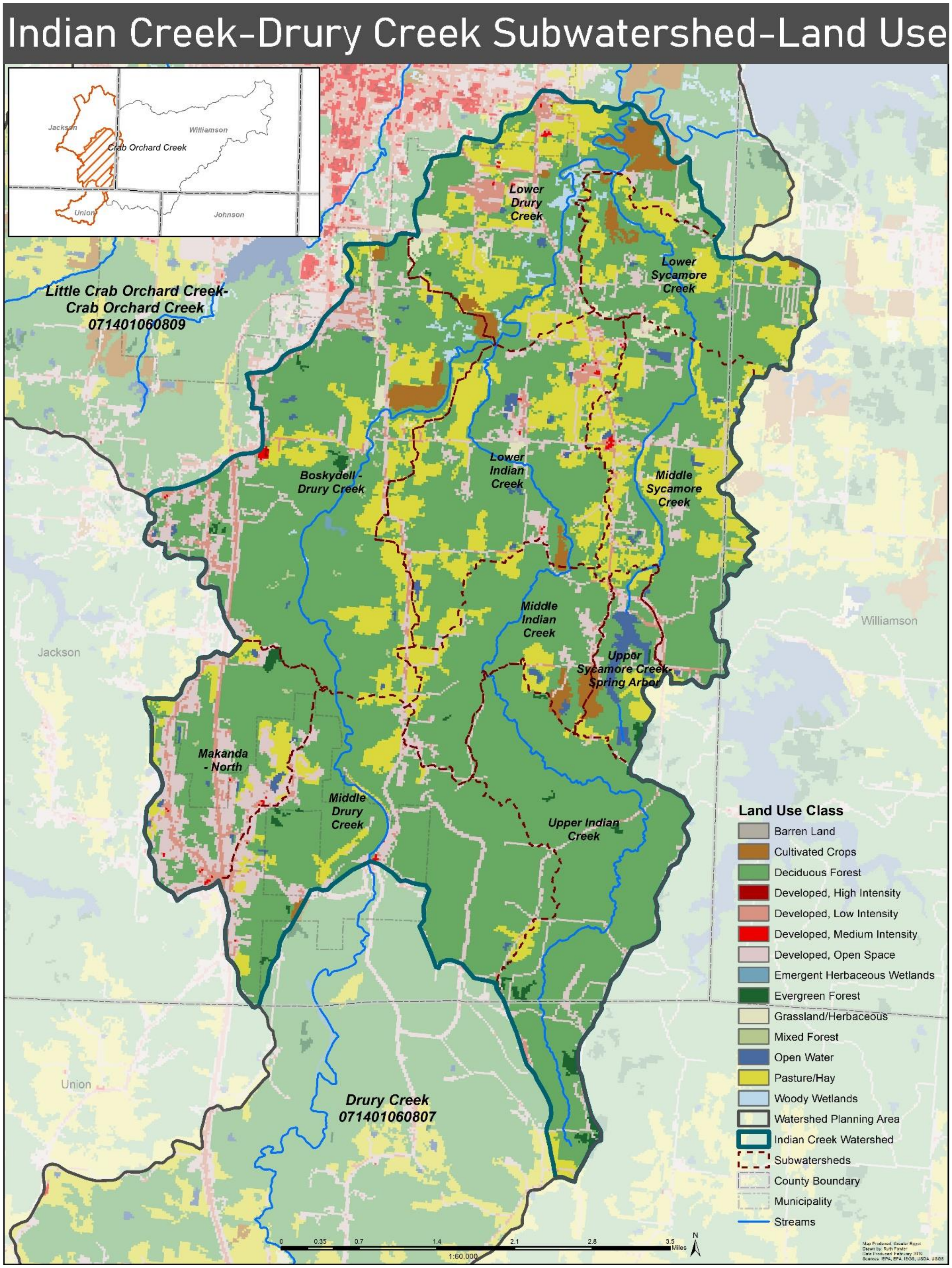
Upper Indian SMU is 91.5 percent forest land, or 2,435.4 acres. The southern half is within the boundaries of Giant City State Park, which explains the large percentage of forested land. Giant City State Park is nestled into the Shawnee National Forest, which has its boundaries in Indian Creek-Drury Creek as well as parts of the Drury Creek subwatershed.

The second largest land cover category is agriculture, which includes pasture/hay and cultivated crops. This accounts for 3,571.2 acres, or 17.4 percent of the subwatershed. Lower Indian Creek, Lower Drury Creek, and Boskydell SMUs have the largest amount of agriculture land use, totaling 1,976.2 acres. Pasture/hay land use is much more prevalent compared to cultivated crops across all three SMUs.

Developed land use is the third largest land use within Indian Creek-Drury Creek subwatershed, but only covers a relatively small amount of land. Approximately eleven percent of the watershed is developed land, but 78.3 percent of this developed land is considered “developed-open space”. The MRLC defines it as, “areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than twenty percent of total cover.” [36] Makanda-North and Boskydell SMU hold the most acreage of developed land, totaling 1,196.8 acres. This is largely consisting of open space and low intensity development. Due to their relative locations between Carbondale and Makanda, this contributes to the higher levels of developed land cover.

36 Department of Interior (DOI) and USGS. “National Land Cover Database 2011 Product Legend,” https://www.mrlc.gov/data/legends/national-land-cover-database-2011-nlcd2011-legend. Accessed: March 3, 2019.

Figure 2.25


Indian Creek-Drury Creek Subwatershed-Land Use
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Lower Drury Creek
Lower Sycamore Creek
Little Crab Orchard Creek-Crab Orchard Creek 071401060809
Boskydell - Drury Creek
Lower Indian Creek
Middle Sycamore Creek
Middle Indian Creek
Upper Sycamore Creek-Spring Arbor
Williamson
Jackson
Makanda - North
Middle Drury Creek
Upper Indian Creek
Union
Drury Creek 071401060807
Land Use Class
Barren Land
Cultivated Crops
Deciduous Forest
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Developed, Open Space
Emergent Herbaceous Wetlands
Evergreen Forest
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
Woody Wetlands
Watershed Planning Area
Indian Creek Watershed
Subwatersheds
County Boundary
Municipality
Streams
0 0.35 0.7 1.4 2.1 2.8 3.5 Miles
1:60,000
N

Projected Land Use

Indian Creek- Drury Creek subwatershed is projected to experience low levels of change by 2021. *Table 2.29* displays the 2021 projected values and percent change of land use of each SMU. The only notable changes will be occurring within forest land and pasture. The projected percent change can be deceiving, as deciduous forest is projected to decrease by seventy acres, but only equates to a -0.52 percent change since the land is vastly forested. Pasture is projected to increase by roughly thirty-three acres sub-watershed wide by 2021.

The only SMU that is projected to have noticeable change is within Lower Indian Creek. Deciduous forest land cover is projected to decrease by 40.23 acres, while agriculture is projected to increase approximately thirty-six acres.

Table 2.28 - Existing Indian Creek-Drury Creek Subwatershed Land Use

Subwatershed Land Use Classification	Upper Indian Creek		Middle Drury Creek		Makanda-North		Upper Sycamore Creek		Middle Indian Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
Open Water	0.00	0.00%	3.11	<1%	20.02	1.35%	82.33	15.79%	10.26	<1%
Developed, Open Space	137.59	5.37%	361.29	13.09%	448.22	30.24%	40.50	7.77%	107.04	7.97%
Developed, Low Intensity	12.89	<1%	41.55	1.51%	133.24	8.99%	15.13	2.90%	12.49	<1%
Developed, Medium Intensity	0.22	<1%	2.44	<1%	4.67	<1%	0.00	0.00%	0.00	0.00%
Developed, High Intensity	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Deciduous Forest	2290.32	89.33%	2142.16	77.64%	712.70	48.09%	250.12	47.97%	1010.90	75.26%
Evergreen Forest	55.12	2.15%	12.00	<1%	13.57	<1%	12.46	2.39%	2.23	<1%
Mixed Forest	0.00	0.00%	0.00	0.00%	4.00	<1%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Pasture/Hay	66.68	2.60%	189.53	6.87%	145.70	9.83%	93.46	17.93%	149.42	11.12%
Cultivated Crops	1.11	<1%	7.11	<1%	0.00	0.00%	27.37	5.25%	50.85	3.79%
Woody Wetlands	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

Subwatershed Land Use Classification	Middle Sycamore		Lower Indian Creek		Boskydell		Lower Sycamore Creek		Lower Drury Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
Open Water	29.38	1.44%	26.89	1.14%	20.89	<1%	4.45	<1%	9.35	<1%
Developed, Open Space	192.09	9.44%	213.60	9.08%	444.18	11.14%	108.31	7.95%	223.98	10.50%
Developed, Low Intensity	44.52	2.19%	62.90	2.67%	160.65	4.03%	5.34	<1%	116.00	5.44%
Developed, Medium Intensity	3.78	<1%	4.22	<1%	4.44	<1%	0.00	0.00%	4.68	<1%
Developed, High Intensity	0.00	0.00%	0.00	0.00%	1.33	<1%	0.00	0.00%	0.00	0.00%
Deciduous Forest	1209.09	59.42%	1347.41	57.26%	2606.19	65.38%	875.56	64.24%	954.69	44.77%
Evergreen Forest	0.00	0.00%	0.00	0.00%	18.89	<1%	0.00	0.00%	1.78	<1%
Mixed Forest	0.00	0.00%	0.00	0.00%	14.44	<1%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	28.71	1.41%	18.89	<1%	38.89	<1%	22.02	1.62%	97.07	4.55%
Pasture/Hay	526.64	25.88%	657.92	27.96%	552.17	13.85%	299.56	21.98%	524.10	24.58%
Cultivated Crops	0.67	<1%	17.56	<1%	91.55	2.30%	38.03	2.79%	132.92	6.23%
Woody Wetlands	0.00	0.00%	3.78	<1%	25.33	<1%	9.79	<1%	67.91	3.18%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	7.33	<1%	0.00	0.00%	0.00	0.00%

Table 2.29 - Projected Indian Creek- Drury Creek Subwatershed Land Use

Subwatershed Land Use Classification	Upper Indian Creek		Middle Drury Creek		Makanda-North		Upper Sycamore Creek		Middle Indian Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	0.00	0.00	3.11	0.00%	20.02	0.00%	82.33	0.00%	15.16	47.83%
Developed, Open Space	137.59	0.00	360.84	-0.12%	446.00	-0.50%	40.50	0.00%	107.04	0.00%
Developed, Low Intensity	12.89	0.00	41.77	0.53%	133.24	0.00%	15.13	0.00%	12.49	0.00%
Developed, Medium Intensity	0.22	0.00	2.67	9.09%	6.90	47.62%	0.00	0.00%	0.00	0.00%
Developed, High Intensity	0.00	0.00	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Deciduous Forest	2290.32	0.00	2142.16	0.00%	712.70	0.00%	250.12	0.00%	1003.99	-0.68%
Evergreen Forest	55.12	0.00	12.00	0.00%	13.57	0.00%	12.46	0.00%	2.23	0.00%
Mixed Forest	0.00	0.00	0.00	0.00%	4.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	0.00	0.00	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Pasture/Hay	66.68	0.00	189.53	0.00%	145.70	0.00%	93.46	0.00%	149.42	0.00%
Cultivated Crops	1.11	0.00	7.11	0.00%	0.00	0.00%	27.37	0.00%	52.85	3.95%
Woody Wetlands	0.00	0.00	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Emergent Herbaceous Wetlands	0.00	0.00	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

Subwatershed Land Use Classification	Middle Sycamore		Lower Indian Creek		Boskydell		Lower Sycamore Creek		Lower Drury Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	29.38	0.00%	31.12	15.70%	24.44	17.02%	4.45	0.00%	9.35	0.00%
Developed, Open Space	191.65	-0.23%	211.38	-1.04%	444.18	0.00%	108.31	0.00%	224.65	0.30%
Developed, Low Intensity	44.74	0.50%	63.57	1.06%	160.65	0.00%	5.34	0.00%	118.00	1.73%
Developed, Medium Intensity	4.01	5.88%	5.78	36.84%	4.44	0.00%	0.00	0.00%	6.90	47.62%
Developed, High Intensity	0.00	0.00%	0.00	0.00%	1.33	0.00%	0.00	0.00%	0.00	0.00%
Deciduous Forest	1209.09	0.00%	1307.18	-2.99%	2602.63	-0.14%	864.67	-1.24%	946.23	-0.89%
Evergreen Forest	0.00	0.00%	0.00	0.00%	18.89	0.00%	0.00	0.00%	1.78	0.00%
Mixed Forest	0.00	0.00%	0.00	0.00%	14.44	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	28.71	0.00%	18.89	0.00%	38.89	0.00%	22.02	0.00%	97.07	0.00%
Pasture/Hay	526.64	0.00%	676.37	2.80%	552.17	0.00%	310.46	3.64%	527.66	0.68%
Cultivated Crops	0.67	0.00%	35.12	100.00%	91.55	0.00%	38.03	0.00%	132.92	0.00%
Woody Wetlands	0.00	0.00%	3.78	0.00%	25.33	0.00%	9.79	0.00%	67.91	0.00%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	7.33	0.00%	0.00	0.00%	0.00	0.00%

2.6.7. Little Crab Orchard Creek - Crab Orchard Creek Subwatershed (071401060809)

Existing Land Use

The Little Crab Orchard Creek subwatershed has the most diverse landscape compared to the other two subwatersheds. The top three classifications of land cover are agriculture, forest, and developed land cover. These three classifications share relatively equal coverage across the watershed and total approximately 94.7 percent of land use. Agriculture, which includes pasture/hay and cultivated crops, constitutes 8,374.9 acres, or 31.1 percent of the Little Crab Orchard Creek subwatershed. Most of the agriculture is concentrated to the northern region, with the exception of Upper Little Crab SMU. This subwatershed management unit includes 1,605.2 acres of agriculture; accounting for 43.8 percent of its land use. Middle Crab Orchard Creek and Reed Station SMUs together, each have over fifty percent of their SMU used for agriculture, equating to 2,458.6 acres collectively.

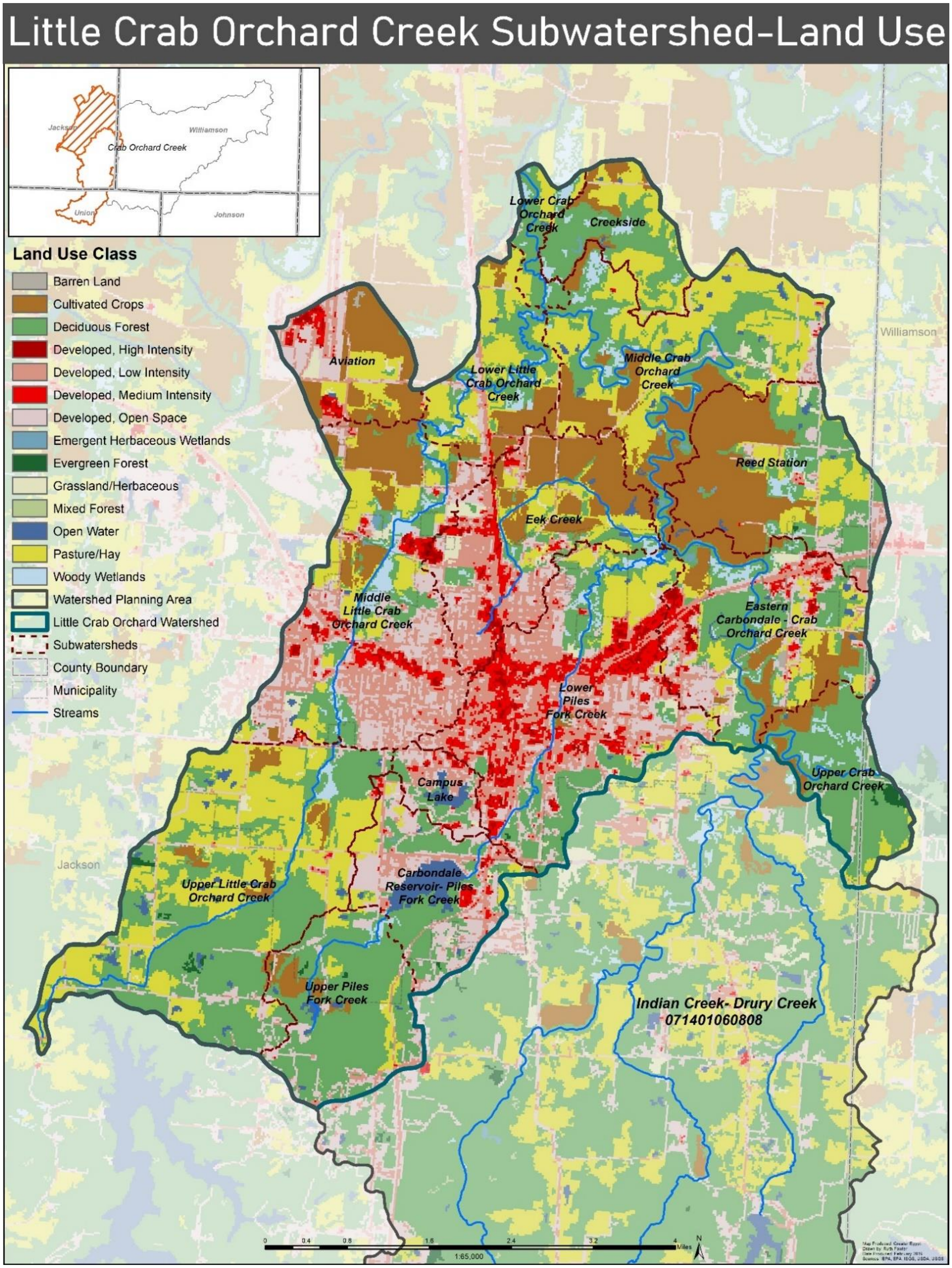
Because of the location of Carbondale, Little Crab Orchard Creek subwatershed exhibits the highest percentage of all developed land classifications. Together, this makes up around 7,265 acres, or roughly thirty percent of the subwatershed. The high concentrations of developed land are located primarily in Lower Piles Fork Creek and Middle Little Crab Orchard Creek SMUs, accounting for 3,605.2 acres collectively. Lower Piles Fork has 110.5 acres of high intensity developed land cover, accounting for 3.8 percent of its total land use. This is primarily because it encircles Carbondale and includes a large part of the Southern Illinois University campus.

Forest land is also largely mixed into Little Crab Orchard Creek watershed, accounting for 7,596.3 acres, or approximately 31 percent of land use. The highest concentration of forest land is located in the southern regions, specifically the Upper Piles Fork Creek and Upper Little Crab SMUs. Together, these two subwatersheds total 2,638.3 acres of forest land. Upper Crab Orchard Creek has the largest percent of land area covered in forest, at 73.1 percent, but the third highest in acreage amount at 686.9 acres.

Projected Land Use

Little Crab Orchard Creek subwatershed is projected to experience a relatively moderate percent change by 2021. *Table 2.31* displays the 2021 projected values and percent change in land use of each SMU. The overall trend across these SMUs is a decrease in forest land cover with an increase in developed land, specifically of medium and high intensity. Subwatershed wide, medium intensity land cover is projected to increase 32.4 percent, or 338.4 acres. Most of this change will occur in Upper Little Crab Orchard Creek, Carbondale Reservoir, and Eastern Carbondale SMUs. Eastern Carbondale SMU has a misleading value of 100 percent change due to barren land doubling in size. Even though it values a 100 percent change, total projected acreage only accounts for 14.2 acres. This relatively small acreage amount skews the projected percent change value.

Figure 2.26



Little Crab Orchard Creek Subwatershed-Land Use
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Land Use Class
Barren Land
Cultivated Crops
Deciduous Forest
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Developed, Open Space
Emergent Herbaceous Wetlands
Evergreen Forest
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
Woody Wetlands
Watershed Planning Area
Little Crab Orchard Watershed
Subwatersheds
County Boundary
Municipality
Streams
Lower Crab Orchard Creek
Creekside
Aviation
Lower Little Crab Orchard Creek
Middle Crab Orchard Creek
Williamson
Reed Station
Eek Creek
Middle Little Crab Orchard Creek
Eastern Carbondale - Crab Orchard Creek
Lower Piles Fork Creek
Campus Lake
Upper Crab Orchard Creek
Jackson
Upper Little Crab Orchard Creek
Carbondale Reservoir- Piles Fork Creek
Upper Piles Fork Creek
Indian Creek- Drury Creek
071401060808
0
0.4
0.8
1.6
2.4
3.2
4
Miles
1:65,000
N

Table 2.30 - Existing Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Land Use

Subwatershed Land Use Classification	Upper Piles Fork		Upper Little Crab		Carbondale Reservoir		Campus Lake		Upper Crab Orchard		Eastern Carbondale		Lower Piles Fork		Eek Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
Open Water	25.55	1.81%	62.28	1.70%	139.07	11.28%	39.75	11.47%	1.11	<1%	23.35	1.15%	4.89	<1%	10.90	<1%
Developed, Open Space	167.10	11.81%	222.19	6.07%	380.21	30.84%	108.59	31.33%	33.16	3.53%	280.87	13.87%	477.93	16.20%	201.93	11.09%
Developed, Low Intensity	59.33	4.19%	63.83	1.74%	183.42	14.88%	91.71	26.46%	4.01	<1%	207.71	10.26%	942.08	31.92%	441.89	24.27%
Developed, Medium Intensity	1.11	<1%	7.78	<1%	37.89	3.07%	19.76	5.70%	0.00	0.00%	94.96	4.69%	518.86	17.58%	133.88	7.35%
Developed, High Intensity	0.00	0.00%	0.44	<1%	3.34	<1%	3.78	1.09%	0.00	0.00%	34.25	1.69%	110.53	3.75%	41.81	2.30%
Barren Land	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	7.12	<1%	0.00	0.00%	0.00	0.00%
Deciduous Forest	972.83	68.74%	1637.64	44.72%	371.07	30.10%	78.17	22.55%	662.83	70.54%	641.58	31.69%	531.09	18.00%	165.24	9.08%
Evergreen Forest	5.78	<1%	22.02	<1%	1.34	<1%	0.00	0.00%	24.04	2.56%	0.00	0.00%	2.45	<1%	0.00	0.00%
Mixed Forest	1.11	<1%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	1.56	<1%	15.79	<1%	9.58	<1%	4.89	1.41%	14.24	1.52%	36.47	1.80%	37.59	1.27%	54.26	2.98%
Pasture/Hay	80.88	5.72%	1482.17	40.48%	99.18	8.05%	0.00	0.00%	49.41	5.26%	291.10	14.38%	255.76	8.67%	234.40	12.87%
Cultivated Crops	86.22	6.09%	123.00	3.36%	4.01	<1%	0.00	0.00%	108.17	11.51%	336.02	16.60%	10.23	<1%	512.61	28.15%
Woody Wetlands	13.78	<1%	24.69	<1%	2.45	<1%	0.00	0.00%	42.73	4.55%	65.16	3.22%	59.60	2.02%	21.13	1.16%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	1.11	<1%	0.00	0.00%	0.00	0.00%	6.00	<1%	0.00	0.00%	2.67	<1%

Subwatershed Land Use Classification	Middle Little Crab		Reed Station		Middle Crab Orchard		Lower Little Crab		Aviation		Creekside		Lower Crab	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
Open Water	8.46	<1%	11.77	<1%	35.83	1.47%	2.22	<1%	2.00	<1%	4.44	<1%	2.45	<1%
Developed, Open Space	655.21	22.57%	151.73	8.64%	90.35	3.70%	53.05	5.21%	144.39	16.12%	10.22	1.26%	5.34	1.67%
Developed, Low Intensity	718.65	24.75%	78.86	4.49%	28.71	1.17%	59.71	5.87%	122.15	13.64%	2.44	<1%	0.22	<1%
Developed, Medium Intensity	144.49	4.98%	4.22	<1%	3.34	<1%	9.55	<1%	48.95	5.47%	0.00	0.00%	0.00	0.00%
Developed, High Intensity	37.40	1.29%	2.44	<1%	0.67	<1%	1.11	<1%	20.02	2.24%	0.00	0.00%	0.00	0.00%
Barren Land	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	5.12	<1%	0.00	0.00%	0.00	0.00%
Deciduous Forest	410.98	14.15%	430.74	24.54%	726.61	29.73%	305.00	29.98%	11.57	1.29%	390.62	48.20%	203.53	63.54%
Evergreen Forest	0.00	0.00%	1.56	<1%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Mixed Forest	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	45.86	1.58%	19.77	1.13%	25.37	1.04%	9.77	<1%	23.14	2.58%	3.55	<1%	0.00	0.00%
Pasture/Hay	387.82	13.36%	269.46	15.35%	933.57	38.20%	367.38	36.11%	141.06	15.75%	276.47	34.12%	75.63	23.61%
Cultivated Crops	364.67	12.56%	745.74	42.48%	509.85	20.86%	168.48	16.56%	377.11	42.11%	83.05	10.25%	1.56	<1%
Woody Wetlands	118.44	4.08%	36.43	2.08%	78.34	3.21%	38.62	3.80%	0.00	0.00%	35.75	4.41%	31.59	9.86%
Emergent Herbaceous Wetlands	11.58	<1%	2.89	<1%	11.13	<1%	2.44	<1%	0.00	0.00%	3.78	<1%	0.00	0.00%

Table 2.31 - Projected Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Land Use

Subwatershed Land Use Classification	Middle Little Crab		Reed Station		Middle Crab Orchard		Lower Little Crab		Aviation		Creekside		Lower Crab	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	8.46	0.00%	14.66	24.53%	35.83	0.00%	2.22	0.00%	2.00	0.00%	4.44	0.00%	2.45	0.00%
Developed, Open Space	653.20	-0.31%	148.84	-1.90%	98.59	9.11%	52.61	-0.84%	141.06	-2.31%	10.22	0.00%	5.34	0.00%
Developed, Low Intensity	718.65	0.00%	77.75	-1.41%	30.71	6.98%	59.27	-0.74%	116.58	-4.55%	2.44	0.00%	0.22	0.00%
Developed, Medium Intensity	163.41	13.10%	5.78	36.84%	4.90	46.67%	10.43	9.30%	53.84	10.00%	0.00	0.00%	0.00	0.00%
Developed, High Intensity	52.10	39.29%	4.89	100.00%	1.11	66.67%	1.11	0.00%	24.03	20.00%	0.00	0.00%	0.00	0.00%
Barren Land	0.00	*	0.00	0.00%	0.00	0.00%	0.00	0.00%	10.23	100.00%	0.00	0.00%	0.00	0.00%
Deciduous Forest	393.84	-4.17%	430.74	0.00%	718.37	-1.13%	305.00	0.00%	11.57	0.00%	390.62	0.00%	203.53	0.00%
Evergreen Forest	0.00	0.00%	1.56	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Mixed Forest	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	45.86	0.00%	19.77	0.00%	26.93	6.14%	9.77	0.00%	23.14	0.00%	3.55	0.00%	0.00	0.00%
Pasture/Hay	378.92	-2.30%	269.46	0.00%	919.77	-1.48%	367.38	0.00%	141.06	0.00%	276.47	0.00%	75.63	0.00%
Cultivated Crops	361.11	-0.98%	742.85	-0.39%	518.08	1.61%	168.48	0.00%	372.00	-1.36%	83.05	0.00%	1.56	0.00%
Woody Wetlands	117.55	-0.75%	36.43	0.00%	78.34	0.00%	38.62	0.00%	0.00	0.00%	35.75	0.00%	31.59	0.00%
Emergent Herbaceous Wetlands	11.58	0.00%	2.89	0.00%	11.13	0.00%	2.44	0.00%	0.00	0.00%	3.78	0.00%	0.00	0.00%

Subwatershed Land Use Classification	Upper Piles Fork		Upper Little Crab		Carbondale Reservoir		Campus Lake		Upper Crab Orchard		Eastern Carbondale		Lower Piles Fork		Eek Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
Open Water	25.55	0.00%	62.28	0.00%	139.07	0.00%	39.75	0.00%	1.11	0.00%	19.35	-17.14%	4.89	0.00%	10.90	0.00%
Developed, Open Space	166.66	-0.27%	219.75	-1.10%	381.32	0.29%	108.15	-0.41%	33.16	0.00%	269.08	-4.20%	456.81	-4.42%	197.71	-2.09%
Developed, Low Intensity	59.55	0.37%	63.17	-1.05%	185.65	1.22%	89.94	-1.94%	4.01	0.00%	201.92	-2.78%	904.49	-3.99%	434.55	-1.66%
Developed, Medium Intensity	1.33	20.00%	10.45	34.29%	57.95	52.94%	20.65	4.49%	0.00	0.00%	117.42	23.65%	572.90	10.42%	140.11	4.65%
Developed, High Intensity	0.00	0.00%	0.89	100.00%	6.24	86.67%	5.33	41.18%	0.00	0.00%	48.70	42.21%	145.45	31.59%	48.70	16.49%
Barren Land	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	14.23	100.00%	0.00	0.00%	0.00	0.00%
Deciduous Forest	949.72	-2.38%	1612.96	-1.51%	344.77	-7.09%	78.17	0.00%	662.83	0.00%	616.00	-3.99%	509.07	-4.15%	166.12	0.54%
Evergreen Forest	5.78	0.00%	22.02	0.00%	1.34	0.00%	0.00	0.00%	24.04	0.00%	0.00	0.00%	2.45	0.00%	0.00	0.00%
Mixed Forest	1.11	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
Grassland/Herbaceous	1.56	0.00%	15.79	0.00%	9.58	0.00%	4.89	0.00%	14.24	0.00%	52.71	44.51%	33.36	-11.24%	54.26	0.00%
Pasture/Hay	90.22	11.54%	1482.17	0.00%	96.72	-2.47%	-0.22	*	49.41	0.00%	278.87	-4.20%	243.08	-4.96%	231.95	-1.04%
Cultivated Crops	86.22	0.00%	123.00	0.00%	4.01	0.00%	0.00	0.00%	108.17	0.00%	333.35	-0.79%	18.90	84.78%	512.61	0.00%
Woody Wetlands	27.55	100.00%	49.38	100.00%	4.90	100.00%	0.00	0.00%	42.73	0.00%	66.94	2.73%	59.60	0.00%	21.13	0.00%
Emergent Herbaceous Wetlands	0.00	0.00%	0.00	0.00%	1.11	0.00%	0.00	0.00%	0.00	0.00%	6.00	0.00%	0.00	0.00%	2.67	0.00%

" * " denotes a growth but Percent Change formula cannot be calculated due to starting value being 0.

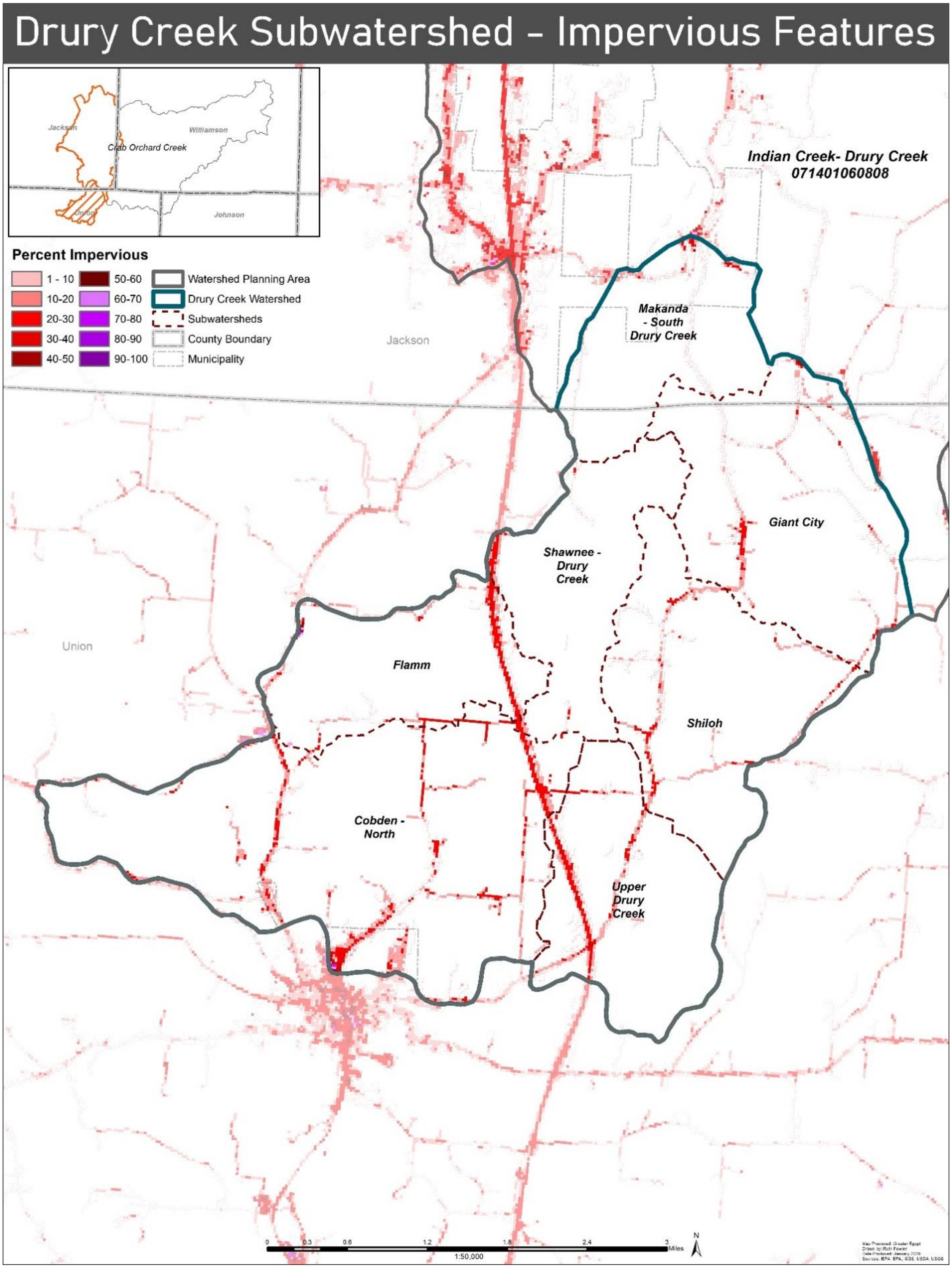
2.6.8. Existing and Projected Imperviousness of the Subwatersheds

Drury Creek Subwatershed (071401060807)

Drury Creek subwatershed has very low levels of imperviousness. This is in large part due to the presence of Giant City State Park and the Shawnee National Forest. A total of 88.3 percent of land cover is deemed permeable, or zero percent impervious. The remaining 11.8 percent ranges from one to fifty percent imperviousness. High levels of impervious surface are completely absent from this subwatershed. *Figure 2.27* displays the imperviousness of the subwatershed. *Table 2.32* presents both the acreage and percentage of each SMU by percent imperviousness.

The SMU with the highest amount of imperviousness is Cobden-North, which totals 12.1 percent of the land area. This is partly because of its close proximity to the village of Cobden. The SMU with the lowest amount of imperviousness is Shawnee-Drury Creek, which totals 4.2 percent of the SMU. Projections have also been made for future imperviousness in the SMUs. These estimates are displayed in *Table 2.33.*

Figure 2.27



Drury Creek Subwatershed - Impervious Features
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Percent Impervious
1 - 10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
Watershed Planning Area
Drury Creek Watershed
Subwatersheds
County Boundary
Municipality
Indian Creek- Drury Creek
071401060808
Makanda - South Drury Creek
Jackson
Giant City
Shawnee - Drury Creek
Union
Flamm
Shiloh
Cobden - North
Upper Drury Creek
0 0.3 0.6 1.2 1.8 2.4 3 Miles
1:50,000
N

Table 2.32 - Existing Drury Creek Subwatershed Imperviousness

2011 Percent Impervious	Upper Drury Creek		Cobden-North		Shiloh		Shawnee Drury Creek		Flamm		Giant City		Makanda South Drury	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
0%	1190.16	88.25%	2940.30	87.92%	1522.61	92.46%	1070.31	95.78%	1003.10	88.53%	1660.81	90.52%	931.99	90.53%
0-10%	80.53	5.97%	167.54	5.01%	58.49	3.55%	20.69	1.85%	52.36	4.62%	105.26	5.74%	77.04	7.48%
10-20%	42.93	3.18%	140.40	4.20%	47.15	2.86%	13.79	1.23%	38.83	3.43%	52.74	2.87%	14.47	1.41%
20-30%	24.25	1.80%	67.42	2.02%	16.24	0.99%	9.34	0.84%	20.86	1.84%	12.68	0.69%	3.56	0.35%
30-40%	7.12	0.53%	19.13	0.57%	1.78	0.11%	2.89	0.26%	12.43	1.10%	1.78	0.10%	0.67	0.06%
40-50%	3.56	0.26%	5.78	0.17%	0.44	0.03%	0.44	0.04%	2.88	0.25%	1.11	0.06%	1.11	0.11%
50-60%	0.00	0.00%	1.11	0.03%	0.00	0.00%	0.00	0.00%	1.11	0.10%	0.45	0.02%	0.45	0.04%
60-70%	0.00	0.00%	1.56	0.05%	0.00	0.00%	0.00	0.00%	1.11	0.10%	0.00	0.00%	0.22	0.02%
70-80%	0.00	0.00%	0.67	0.02%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
80-90%	0.00	0.00%	0.22	0.01%	0.00	0.00%	0.00	0.00%	0.44	0.04%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

Table 2.33 - Projected Drury Creek Subwatershed Imperviousness

Percent Impervious	Upper Drury Creek		Cobden-North		Shiloh		Shawnee Drury Creek		Flamm		Giant City		Makanda South Drury	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	1190.16	0.00%	2940.30	0.00%	1522.61	0.00%	1070.31	0.00%	1003.10	0.00%	1660.81	0.00%	931.99	0.00%
0-10%	80.53	0.00%	167.54	0.00%	58.49	0.00%	20.69	0.00%	52.36	0.00%	105.26	0.00%	76.81	-0.29%
10-20%	42.93	0.00%	140.40	0.00%	47.15	0.00%	13.79	0.00%	38.83	0.00%	52.74	0.00%	14.47	0.00%
20-30%	24.25	0.00%	67.42	0.00%	16.24	0.00%	9.34	0.00%	20.86	0.00%	12.68	0.00%	3.34	-6.25%
30-40%	7.12	0.00%	19.13	0.00%	1.78	0.00%	2.89	0.00%	12.43	0.00%	1.78	0.00%	0.67	0.00%
40-50%	3.56	0.00%	5.78	0.00%	0.44	0.00%	0.44	0.00%	2.88	0.00%	1.11	0.00%	1.11	0.00%
50-60%	0.00	0.00%	1.11	0.00%	0.00	0.00%	0.00	0.00%	1.11	0.00%	0.45	0.00%	0.67	50.00%
60-70%	0.00	0.00%	1.56	0.00%	0.00	0.00%	0.00	0.00%	1.11	0.00%	0.00	0.00%	0.45	100.00%
70-80%	0.00	0.00%	0.67	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
80-90%	0.00	0.00%	0.22	0.00%	0.00	0.00%	0.00	0.00%	0.44	0.00%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

Indian Creek-Drury Creek Subwatershed (071401060808)

Indian Creek-Drury Creek subwatershed has a fairly low level of imperviousness. Only 14.2 percent of land cover is impervious, which equates to 2,909 acres. Of this impervious land cover, most of it is falls within the realm of low-level imperviousness. Concentrations of impervious land cover are found in pockets of residential housing and the road network. *Figure 2.28* displays the imperviousness of the subwatershed. *Table 2.34* presents both the acreage and percentage of each SMU by percent imperviousness.

Makanda-North SMU has the highest level of imperviousness, equaling 586.1 acres, or 39.6 percent of total land use. Roughly 92.5 percent of the impervious land cover ranges from one to thirty percent imperviousness, which is common with residential housing.

Projections have also been made for future imperviousness in the SMUs. These estimates are displayed in *Table 2.35*. Overall changes within the subwatershed are projected to be very minimal. Total change in acres equals only 9.3 acres with a trend towards an increase in imperviousness.

Figure 2.28

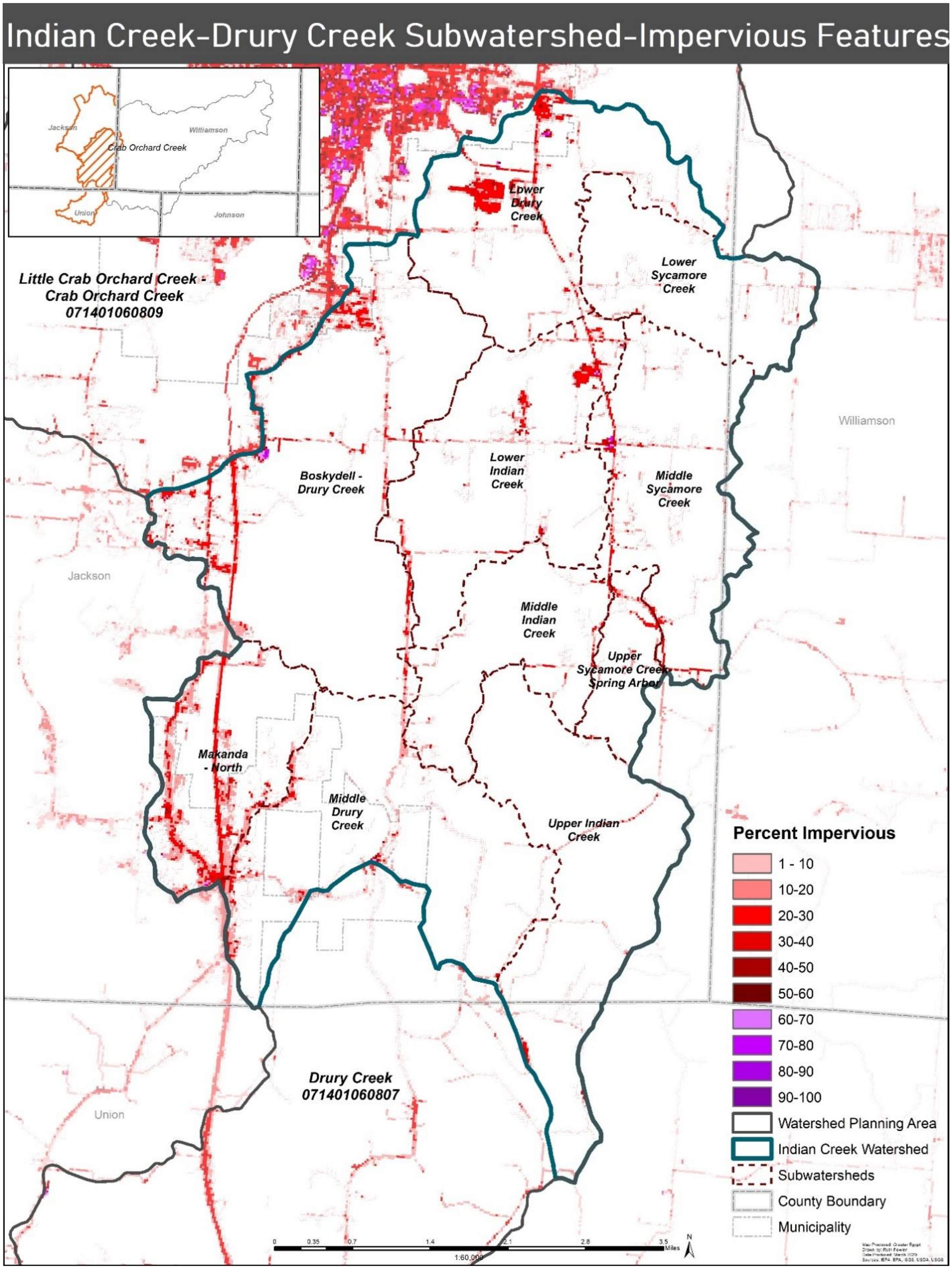

Indian Creek-Drury Creek Subwatershed-Impervious Features
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Little Crab Orchard Creek - Crab Orchard Creek 071401060809
Lower Drury Creek
Lower Sycamore Creek
Williamson
Boskydell - Drury Creek
Lower Indian Creek
Middle Sycamore Creek
Jackson
Middle Indian Creek
Upper Sycamore Creek Spring Arbor
Makanda - North
Middle Drury Creek
Upper Indian Creek
Drury Creek 071401060807
Union
Percent Impervious
1 - 10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
Watershed Planning Area
Indian Creek Watershed
Subwatersheds
County Boundary
Municipality
0
0.35
0.7
1.4
2.1
2.8
3.5
Miles
1:60,000
N

Table 2.34 - Existing Indian Creek- Drury Creek Subwatershed Imperviousness

2011 Percent Impervious	Upper Indian Creek		Middle Drury Creek		Makanda North		Upper Sycamore Creek		Middle Indian Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
0%	2413.24	94.12%	2353.91	85.31%	896.00	60.45%	465.74	89.33%	1223.65	91.10%
0-10%	110.69	4.32%	264.63	9.59%	270.71	18.27%	26.26	5.04%	87.87	6.54%
10-20%	30.67	1.20%	102.65	3.72%	193.08	13.03%	15.13	2.90%	20.07	1.49%
20-30%	5.78	0.23%	27.11	0.98%	78.52	5.30%	9.35	1.79%	10.26	0.76%
30-40%	2.22	0.09%	5.55	0.20%	28.25	1.91%	4.90	0.94%	1.12	0.08%
40-50%	1.11	0.04%	2.89	0.10%	11.12	0.75%	0.00	0.00%	0.22	0.02%
50-60%	0.22	0.01%	1.56	0.06%	2.45	0.17%	0.00	0.00%	0.00	0.00%
60-70%	0.00	0.00%	0.44	0.02%	1.78	0.12%	0.00	0.00%	0.00	0.00%
70-80%	0.00	0.00%	0.44	0.02%	0.22	0.02%	0.00	0.00%	0.00	0.00%
80-90%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

2011 Percent Impervious	Middle Sycamore Creek		Lower Indian Creek		Boskydell		Lower Sycamore Creek		Lower Drury Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
0%	1794.27	88.18%	2071.57	88.03%	3375.67	84.68%	1248.52	91.60%	1787.82	83.84%
0-10%	152.03	7.47%	162.04	6.89%	297.75	7.47%	92.96	6.82%	152.29	7.14%
10-20%	43.63	2.14%	57.35	2.44%	162.65	4.08%	17.35	1.27%	76.81	3.60%
20-30%	29.16	1.43%	36.01	1.53%	103.99	2.61%	3.56	0.26%	62.34	2.92%
30-40%	9.13	0.45%	16.67	0.71%	34.22	0.86%	0.67	0.05%	41.63	1.95%
40-50%	3.12	0.15%	5.56	0.24%	6.22	0.16%	0.00	0.00%	6.90	0.32%
50-60%	1.11	0.05%	2.67	0.11%	0.67	0.02%	0.00	0.00%	2.89	0.14%
60-70%	1.11	0.05%	1.11	0.05%	2.67	0.07%	0.00	0.00%	0.67	0.03%
70-80%	1.34	0.07%	0.22	0.01%	1.33	0.03%	0.00	0.00%	1.11	0.05%
80-90%	0.00	0.00%	0.00	0.00%	0.67	0.02%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.44	0.01%	0.00	0.00%	0.00	0.00%

Table 2.35 - Projected Indian Creek- Drury Creek Subwatershed Imperviousness

Percent Impervious	Upper Indian Creek		Middle Drury Creek		Makanda North		Upper Sycamore Creek		Middle Indian Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	2413.24	0.00%	2353.91	0.00%	896.00	0.00%	465.74	0.00%	1223.65	0.00%
0-10%	110.69	0.00%	264.19	-0.17%	268.93	-0.66%	26.26	0.00%	87.87	0.00%
10-20%	30.67	0.00%	102.65	0.00%	192.64	-0.23%	15.13	0.00%	20.07	0.00%
20-30%	5.78	0.00%	27.11	0.00%	78.08	-0.57%	9.35	0.00%	10.26	0.00%
30-40%	2.22	0.00%	5.55	0.00%	28.25	0.00%	4.90	0.00%	1.12	0.00%
40-50%	1.11	0.00%	3.11	7.69%	11.79	6.00%	0.00	0.00%	0.22	0.00%
50-60%	0.22	0.00%	1.78	14.29%	2.89	18.18%	0.00	0.00%	0.00	0.00%
60-70%	0.00	0.00%	0.44	0.00%	3.11	75.00%	0.00	0.00%	0.00	0.00%
70-80%	0.00	0.00%	0.44	0.00%	0.44	100.00%	0.00	0.00%	0.00	0.00%
80-90%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%

Percent Impervious	Middle Sycamore Creek		Lower Indian Creek		Boskydell		Lower Sycamore Creek		Lower Drury Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	1794.27	0.00%	2071.57	0.00%	3375.67	0.00%	1248.52	0.00%	1782.92	-0.27%
0-10%	151.58	-0.29%	160.48	-0.96%	297.75	0.00%	92.96	0.00%	152.73	0.29%
10-20%	43.63	0.00%	56.68	-1.16%	162.65	0.00%	17.35	0.00%	77.26	0.58%
20-30%	29.16	0.00%	36.01	0.00%	103.99	0.00%	3.56	0.00%	62.79	0.71%
30-40%	9.13	0.00%	16.67	0.00%	34.22	0.00%	0.67	0.00%	41.86	0.53%
40-50%	3.34	7.14%	6.22	12.00%	6.22	0.00%	0.00	0.00%	8.02	16.13%
50-60%	1.11	0.00%	4.00	50.00%	0.67	0.00%	0.00	0.00%	3.78	30.77%
60-70%	1.34	20.00%	1.33	20.00%	2.67	0.00%	0.00	0.00%	1.34	100.00%
70-80%	1.34	0.00%	0.22	0.00%	1.33	0.00%	0.00	0.00%	1.78	60.00%
80-90%	0.00	0.00%	0.00	0.00%	0.67	0.00%	0.00	0.00%	0.00	0.00%
90-100%	0.00	0.00%	0.00	0.00%	0.44	0.00%	0.00	0.00%	0.00	0.00%

Little Crab Orchard Creek- Crab Orchard Creek Subwatershed (071401060809)

Little Crab Orchard Creek- Crab Orchard Creek subwatershed has a relatively high level of imperviousness compared to the other two HUC 12 subwatersheds. This is in large part due to the presence of Carbondale within its boundaries, which includes multiple businesses and Southern Illinois University. *Figure 2.29* displays the imperviousness of the subwatershed. *Table 2.36* presents both the acreage and percentage of each SMU by percent imperviousness.

Based on most recent data, Little Crab Orchard Creek- Crab Orchard Creek subwatershed is 29.6 percent impervious. 17.1 percent of the land cover is classified above fifty percent impervious. These high levels of imperviousness are concentrated within Lower Piles Fork, Middle Little Crab Orchard Creek, and Eek Creek SMUs. As previously stated, Little Crab Orchard Creek subwatershed encompasses Southern Illinois University and parts of Southern Illinois Airport. The presence of these facilities, as well as accompanying housing, business, and roadways, contributes largely to the higher levels of imperviousness.

Lower Piles Fork Creek SMU is 69.5 percent impervious, covering roughly 2,049.4 acres of land. This SMU includes the intersection of Highway 13 and Highway 51, which makes it a hub for businesses and residential housing. Projections have also been made for future imperviousness in the SMUs. These estimates are displayed in *Table 2.37.*

Figure 2.29

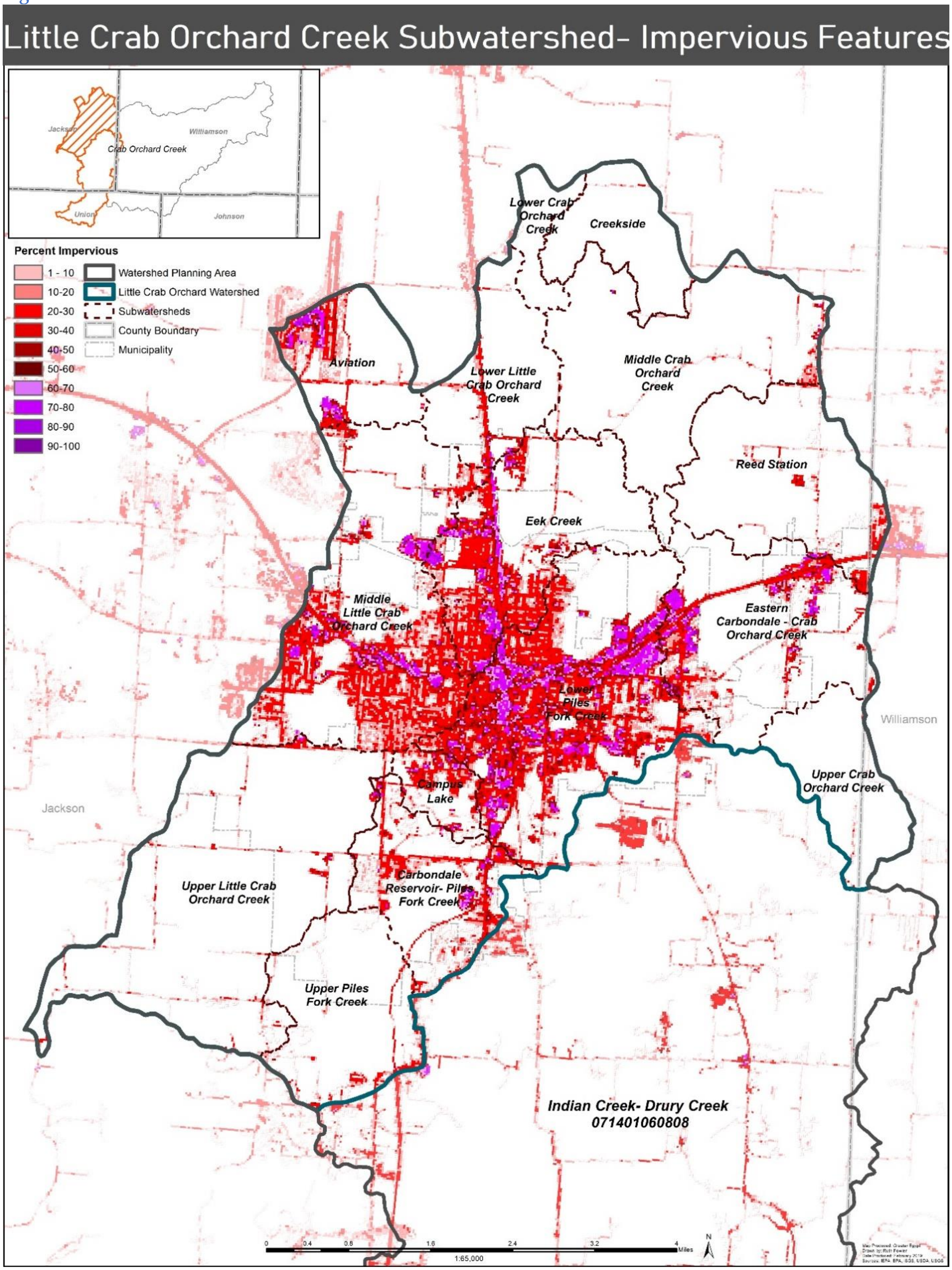

Little Crab Orchard Creek Subwatershed- Impervious Features
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Percent Impervious
1 - 10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
Watershed Planning Area
Little Crab Orchard Watershed
Subwatersheds
County Boundary
Municipality
Lower Crab Orchard Creek
Creekside
Aviation
Lower Little Crab Orchard Creek
Middle Crab Orchard Creek
Reed Station
Eek Creek
Middle Little Crab Orchard Creek
Eastern Carbondale - Crab Orchard Creek
Lower Piles Fork Creek
Williamson
Upper Crab Orchard Creek
Campus Lake
Jackson
Upper Little Crab Orchard Creek
Carbondale Reservoir- Piles Fork Creek
Upper Piles Fork Creek
Indian Creek- Drury Creek
071401060808
0
0.4
0.8
1.6
2.4
3.2
4
Miles
1:65,000
N

Table 2.36 - Existing Little Crab Orchard Creek Subwatershed Imperviousness

2011 Percent Impervious	Upper Piles Fork Creek		Upper Little Crab		Carbondale Reservoir		Campus Lake		Upper Crab Orchard		Eastern Carbondale		Lower Piles Fork Creek		Eek Creek	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
0%	1187.70	83.92%	3367.13	91.95%	626.92	50.86%	122.80	35.43%	902.55	96.04%	1405.91	69.44%	901.60	30.55%	1001.20	54.99%
0-10%	131.32	9.28%	149.46	4.08%	270.11	21.91%	69.29	19.99%	27.82	2.96%	177.91	8.79%	250.42	8.49%	78.06	4.29%
10-20%	40.22	2.84%	76.51	2.09%	122.13	9.91%	43.97	12.68%	6.23	0.66%	113.64	5.61%	254.87	8.64%	140.99	7.74%
20-30%	34.89	2.47%	41.15	1.12%	89.81	7.29%	41.75	12.04%	2.67	0.28%	82.06	4.05%	305.80	10.36%	189.03	10.38%
30-40%	16.89	1.19%	16.90	0.46%	61.29	4.97%	31.53	9.10%	0.45	0.05%	70.94	3.50%	376.30	12.75%	173.91	9.55%
40-50%	3.33	0.24%	2.67	0.07%	23.40	1.90%	14.88	4.29%	0.00	0.00%	48.48	2.39%	250.42	8.49%	66.49	3.65%
50-60%	0.67	0.05%	3.34	0.09%	16.71	1.36%	8.88	2.56%	0.00	0.00%	36.25	1.79%	205.50	6.96%	48.48	2.66%
60-70%	0.22	0.02%	2.00	0.05%	11.37	0.92%	7.33	2.11%	0.00	0.00%	28.69	1.42%	162.80	5.52%	50.48	2.77%
70-80%	0.00	0.00%	2.22	0.06%	8.02	0.65%	2.89	0.83%	0.00	0.00%	30.24	1.49%	146.56	4.97%	34.03	1.87%
80-90%	0.00	0.00%	0.00	0.00%	2.90	0.24%	3.11	0.90%	0.00	0.00%	25.35	1.25%	84.07	2.85%	30.91	1.70%
90-100%	0.00	0.00%	0.44	0.01%	0.00	0.00%	0.22	0.06%	0.00	0.00%	5.11	0.25%	12.68	0.43%	7.12	0.39%

2011 Percent Impervious	Middle Little Crab		Reed Station		Middle Crab		Lower Little Crab		Aviation		Creekside		Lower Crab Orchard	
	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU	Acreage	% of SMU
0%	1346.48	46.37%	1518.36	86.49%	2320.68	94.96%	893.91	87.87%	560.00	62.53%	797.67	98.44%	314.75	98.26%
0-10%	312.13	10.75%	108.18	6.16%	50.07	2.05%	26.86	2.64%	59.40	6.63%	5.33	0.66%	4.45	1.39%
10-20%	378.70	13.04%	47.32	2.70%	42.28	1.73%	27.97	2.75%	93.44	10.43%	5.11	0.63%	0.89	0.28%
20-30%	349.31	12.03%	38.43	2.19%	21.14	0.87%	27.53	2.71%	63.63	7.11%	1.78	0.22%	0.22	0.07%
30-40%	263.37	9.07%	28.43	1.62%	3.78	0.15%	21.98	2.16%	30.93	3.45%	0.22	0.03%	0.00	0.00%
40-50%	79.70	2.74%	8.89	0.51%	2.00	0.08%	9.10	0.89%	20.25	2.26%	0.22	0.03%	0.00	0.00%
50-60%	53.65	1.85%	1.56	0.09%	1.78	0.07%	4.66	0.46%	16.69	1.86%	0.00	0.00%	0.00	0.00%
60-70%	46.53	1.60%	1.56	0.09%	0.89	0.04%	2.22	0.22%	17.58	1.96%	0.00	0.00%	0.00	0.00%
70-80%	39.85	1.37%	1.11	0.06%	0.67	0.03%	2.00	0.20%	14.68	1.64%	0.00	0.00%	0.00	0.00%
80-90%	26.05	0.90%	1.33	0.08%	0.22	0.01%	0.89	0.09%	16.02	1.79%	0.00	0.00%	0.00	0.00%
90-100%	7.79	0.27%	0.44	0.03%	0.22	0.01%	0.22	0.02%	2.89	0.32%	0.00	0.00%	0.00	0.00%

Table 2.37 - Projected Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Imperviousness

Percent Impervious	Upper Piles Fork Creek		Upper Little Crab		Carbondale Reservoir		Campus Lake		Upper Crab Orchard		Eastern Carbondale		Lower Piles Fork Creek		Eek Creek	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	1187.70	0.00%	3367.13	0.00%	600.62	-4.19%	122.58	-0.18%	902.55	0.00%	1386.79	-1.36%	871.36	-3.35%	999.65	-0.15%
0-10%	130.88	-0.34%	149.46	0.00%	272.34	0.83%	68.84	-0.64%	27.82	0.00%	173.90	-2.25%	245.53	-1.95%	76.72	-1.71%
10-20%	40.22	0.00%	74.06	-3.20%	120.79	-1.09%	43.97	0.00%	6.23	0.00%	105.85	-6.85%	236.63	-7.16%	137.88	-2.21%
20-30%	34.89	0.00%	40.48	-1.62%	90.48	0.74%	40.42	-3.19%	2.67	0.00%	77.39	-5.69%	287.34	-6.04%	186.58	-1.29%
30-40%	16.89	0.00%	16.90	0.00%	62.18	1.45%	31.53	0.00%	0.45	0.00%	68.27	-3.76%	360.73	-4.14%	171.46	-1.41%
40-50%	3.56	6.67%	2.67	0.00%	25.18	7.62%	14.43	-2.99%	0.00	0.00%	49.81	2.75%	248.20	-0.89%	64.05	-3.68%
50-60%	0.89	33.33%	4.00	20.00%	22.29	33.33%	9.10	2.50%	0.00	0.00%	41.81	15.34%	214.17	4.22%	50.70	4.59%
60-70%	0.22	0.00%	3.11	55.56%	18.94	66.67%	7.77	6.06%	0.00	0.00%	37.14	29.46%	181.03	11.20%	53.37	5.73%
70-80%	0.00	0.00%	3.11	40.00%	14.49	80.56%	3.33	15.38%	0.00	0.00%	40.25	33.09%	177.47	21.09%	35.58	4.58%
80-90%	0.00	0.00%	0.00	0.00%	5.35	84.62%	4.22	35.71%	0.00	0.00%	34.47	35.96%	104.53	24.34%	35.58	15.11%
90-100%	0.00	0.00%	0.89	100.00%	0.00	0.00%	0.44	100.00%	0.00	0.00%	8.90	73.91%	24.02	89.47%	9.12	28.12%

Percent Impervious	Middle Little Crab		Reed Station		Middle Crab		Lower Little Crab		Aviation		Creekside		Lower Crab Orchard	
	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change	Projected Acreage (2021)	Projected Percent Change
0%	1313.53	-2.45%	1518.36	0.00%	2308.44	-0.53%	893.91	0.00%	560.00	0.00%	797.67	0.00%	314.75	0.00%
0-10%	312.80	0.21%	105.52	-2.46%	57.64	15.11%	26.42	-1.65%	58.29	-1.87%	5.33	0.00%	4.45	0.00%
10-20%	377.36	-0.35%	46.87	-0.94%	42.95	1.58%	27.97	0.00%	91.22	-2.38%	5.11	0.00%	0.89	0.00%
20-30%	349.98	0.19%	37.32	-2.89%	22.25	5.26%	27.30	-0.81%	61.41	-3.50%	1.78	0.00%	0.22	0.00%
30-40%	263.60	0.08%	28.21	-0.78%	4.23	11.76%	21.75	-1.01%	28.70	-7.19%	0.22	0.00%	0.00	0.00%
40-50%	79.26	-0.56%	9.33	5.00%	2.45	22.22%	9.10	0.00%	18.91	-6.59%	0.22	0.00%	0.00	0.00%
50-60%	57.44	7.05%	1.78	14.29%	2.67	50.00%	4.88	4.76%	17.13	2.67%	0.00	0.00%	0.00	0.00%
60-70%	54.10	16.27%	2.44	57.14%	1.56	75.00%	2.44	10.00%	19.13	8.86%	0.00	0.00%	0.00	0.00%
70-80%	48.31	21.23%	2.22	100.00%	0.89	33.33%	2.44	22.22%	18.24	24.24%	0.00	0.00%	0.00	0.00%
80-90%	33.62	29.06%	2.67	100.00%	0.45	100.00%	0.89	0.00%	18.24	13.89%	0.00	0.00%	0.00	0.00%
90-100%	13.58	74.29%	0.89	100.00%	0.22	0.00%	0.22	0.00%	4.23	46.15%	0.00	0.00%	0.00	0.00%

2.7. Watershed Drainage and Assessment

To further characterize the waterbodies in the Western Crab Orchard Creek watershed, an assessment was conducted to identify certain impairments of waterbodies. Components assessed are: extent of channelization, condition of riparian area, and extent of streambank and shoreline erosion.

Assessment methods include physical field evaluations, analyses of aerial photography from 1938 to 2019, and remote analysis utilizing an unmanned aircraft system (UAS). *Figure 2.30* displays the assessed waterbodies, as well as the location of assessment points. Less accessible reaches were assessed with UAS (remote assessment). Appendix C includes the field form that was used for assessments.

For each assessment component, the waterbodies were delineated by their individual reach code. These reach codes identify certain portions of the stream and represent varying degrees of stream length. Each assessment point was assigned an Assessment ID. Appendix B displays the stream name with its corresponding Assessment ID, reach code and length. Streams and tributaries were then categorized by their subwatershed. The assessed lakes in the planning area were also assigned a shoreline code. These waterbodies include Campus Lake, Carbondale Reservoir, and Spring Arbor Lake. If a watershed contained retention or detention basins, these structures were also reported. Each HUC 12 watershed in the overall study area will be examined individually.

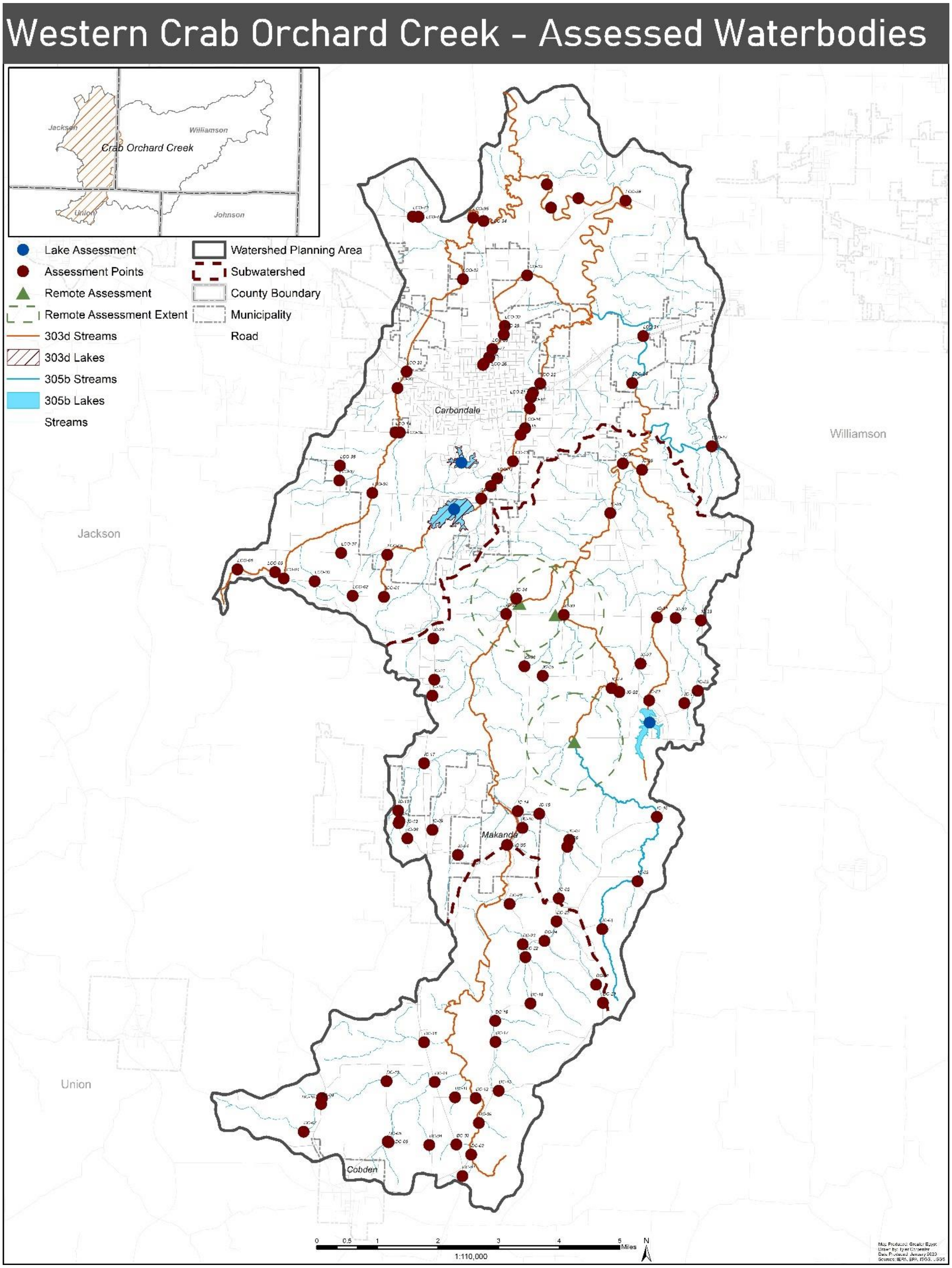
2.7.1. Assessment Components

Extent of Erosion

Erosion is the degradation of a streambank or shoreline by natural and non-natural processes. While natural activity can erode a streambank over time, changes to hydrology and land use can escalate this process. Factors such as channelization and loss of riparian habitat can also lead to eroded banks.

Erosion was assessed as none, low, moderate, or high. In some cases, erosion may also be described as severe if the extent of erosion is extreme. These designations

Figure 2.30


Western Crab Orchard Creek - Assessed Waterbodies
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Lake Assessment
Assessment Points
Remote Assessment
Remote Assessment Extent
303d Streams
303d Lakes
305b Streams
305b Lakes
Streams
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Road
Carbondale
Makanda
Cobden
Williamson
Jackson
Union
0 0.5 1 2 3 4 5 Miles
1:110,000

correspond to the lateral recession rate (LRR) category. LRR also correlate to the pollutant load reduction section of this report (*Section 8.8*). This characterizes erosion classes as: slight (none or low), moderate (moderate), severe (high), and very severe (high). *Figure 2.31* displays examples of the various levels of erosion at different assessment points throughout the watershed. Physical assessments included an environmental evaluation for each of the assessment points. Sample evaluation forms can be viewed in Appendix C.

Figure 2.31 - Levels of Eroded Streambanks

Levels of Eroded Streambanks: A-None or Low (slight); B- Moderate (moderate); C- Severe (high); D-Very Severe (high)

If a particular stream reach showed a large variance in streambank erosion, a new reach identification was created. This includes a unique ID and Reach Code. Results for the streambank and shoreline erosion assessment are summarized in the following section. These results have been delineated by subwatershed (HUC 12).

Condition of Riparian Area and Littoral Zone

Riparian areas and littoral zones provide a buffer for streams and other waterbodies by filtering pollutants from runoff. These buffers also provide beneficial wildlife habitat. This assessment classifies these features as the area up to 150 feet from the stream on either bank or shoreline.

Stream reaches that have thirty-three percent, or less areas with degraded riparian areas have been classified as good, thirty-three to sixty-six percent as fair, and sixty-six percent or more as poor. Lake shores have also been classified with these percentages for the condition of littoral areas.

Generally, the amount of natural habitat is the most critical component in assessing riparian areas and littoral zones. Consideration is also given to development, debris (synthetic), and other environmental factors. Debris, blockages, and other obstructions have also been assessed.

Field assessments, UAS photography, and other aerial imagery were used in determining the condition of riparian areas. The figure below represents the various conditions of riparian areas and littoral zones.

Figure 2.32 - Condition of Riparian Areas and Littoral Zones

Condition: A- Good; B- Fair; C- Poor

Degree of Channelization

Channelization refers to the reduction of a natural meandering stream channel. While this straightening can sometimes limit the impact of flooding, it can also have impacts on erosion and loss of habitat.

Since channelization encourages a non-sinuous course, water flows much faster; resulting in an increase of sediment transport and decrease of riffles and pools that can hold off heavy flow. Streams where one to thirty-three percent of banks are channelized are considered low, thirty-three to sixty-six percent of reach channelized is moderate, and a high degree of channelization is expressed as exhibiting sixty-six percent or more channelized features.

Physical assessments, historical photography and GIS were utilized for the degree of channelization assessment. Comparitive aerial images to highlight channelization are displayed in the figure below.

Figure 2.33- Historical and Current Aerial of Channelized Stream

Source: City of Carbondale, Jackson County

2.7.2. Drury Creek Subwatershed Assessment (071401060807)

As with most watersheds, the Drury Creek subwatershed experiences varying levels of erosion. Levels of increased erosive activity are not confined to one specific subwatershed. Riparian areas in the watershed are generally in good condition with no reaches exhibitng poor conditions. Since the watershed is fairly rural, with an abundance of forested land, channelization has a minimal impact.

Extent of Erosion

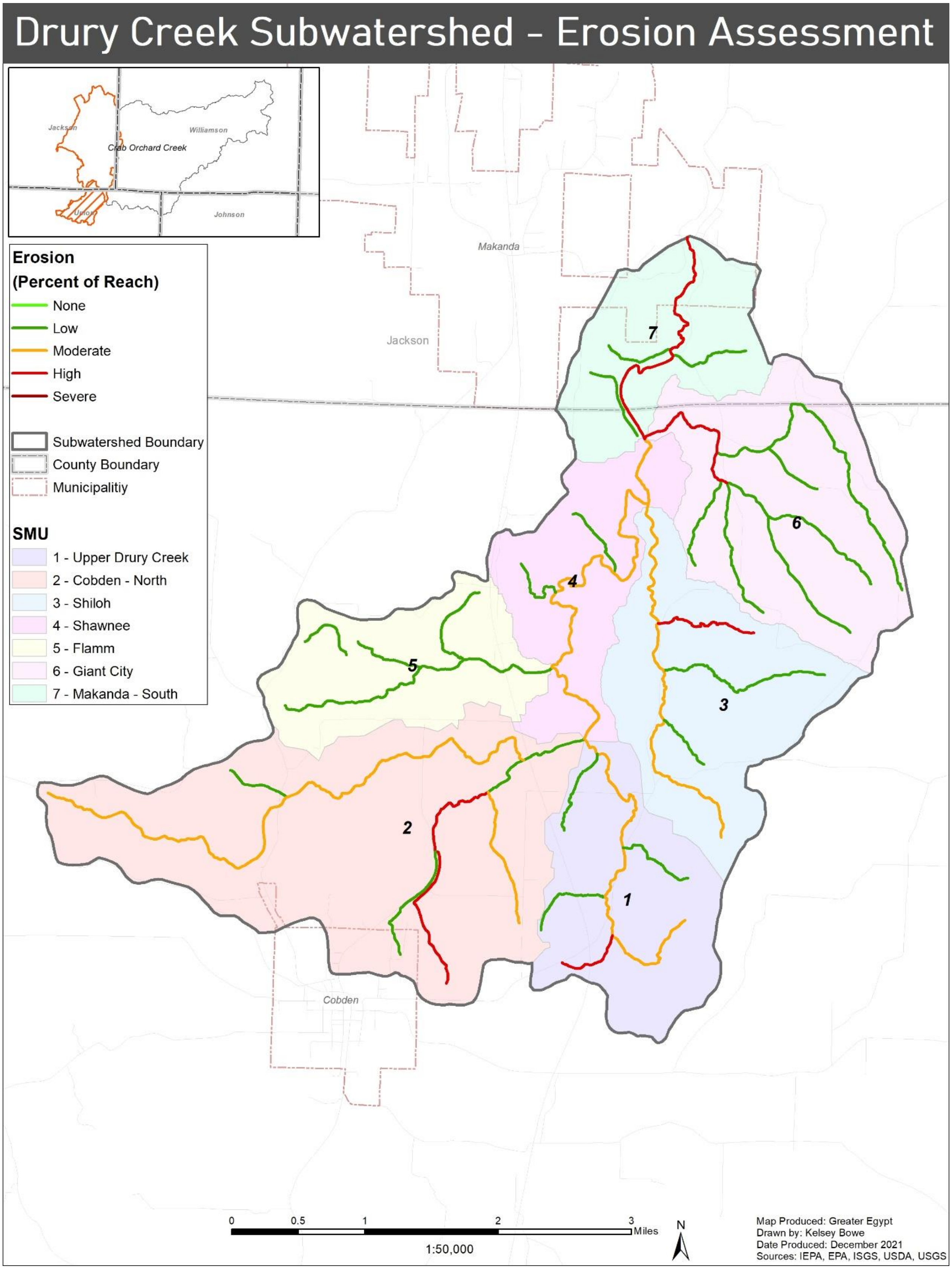
Table 2.38 summarizes the extent of erosion for the Drury Creek watershed. The majority of streams and tributaties in the Drury Creek subwatershed exhibit some degree of streambank erosion. While there are several areas of high erosion, the reach may be classified as moderate because other parts of that particular reach exhibit less erosion.

Areas of increased erosion occur in every subwatershed to some degree, except for in the Flamm SMU. *Figure 2.34* depicts the extent of erosion for the Druy Creek subwatershed.

Table 2.38 - Drury Creek Subwatershed Extent of Erosion

Drury Creek Subwatershed						
Extent of Erosion	None or Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%
Upper Drury Creek	2	25.0%	5	62.5%	1	12.5%
Cobden-North	4	57.1%	2	28.6%	1	14.3%
Shiloh	0	0.0%	2	66.7%	1	33.3%
Shawnee-Drury Creek	0	0.0%	3	100.0%	0	0.0%
Flamm	0	0.0%	0	0.0%	0	0.0%
Giant City	4	80.0%	0	0.0%	1	20.0%
Makanda	1	50.0%	0	0.0%	1	50.0%

Figure 2.34


Drury Creek Subwatershed - Erosion Assessment
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Erosion
(Percent of Reach)
None
Low
Moderate
High
Severe
Subwatershed Boundary
County Boundary
Municipalitiy
SMU
1 - Upper Drury Creek
2 - Cobden - North
3 - Shiloh
4 - Shawnee
5 - Flamm
6 - Giant City
7 - Makanda - South
Makanda
Jackson
Cobden
1
2
3
4
5
6
7
0
0.5
1
2
3
Miles
1:50,000
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

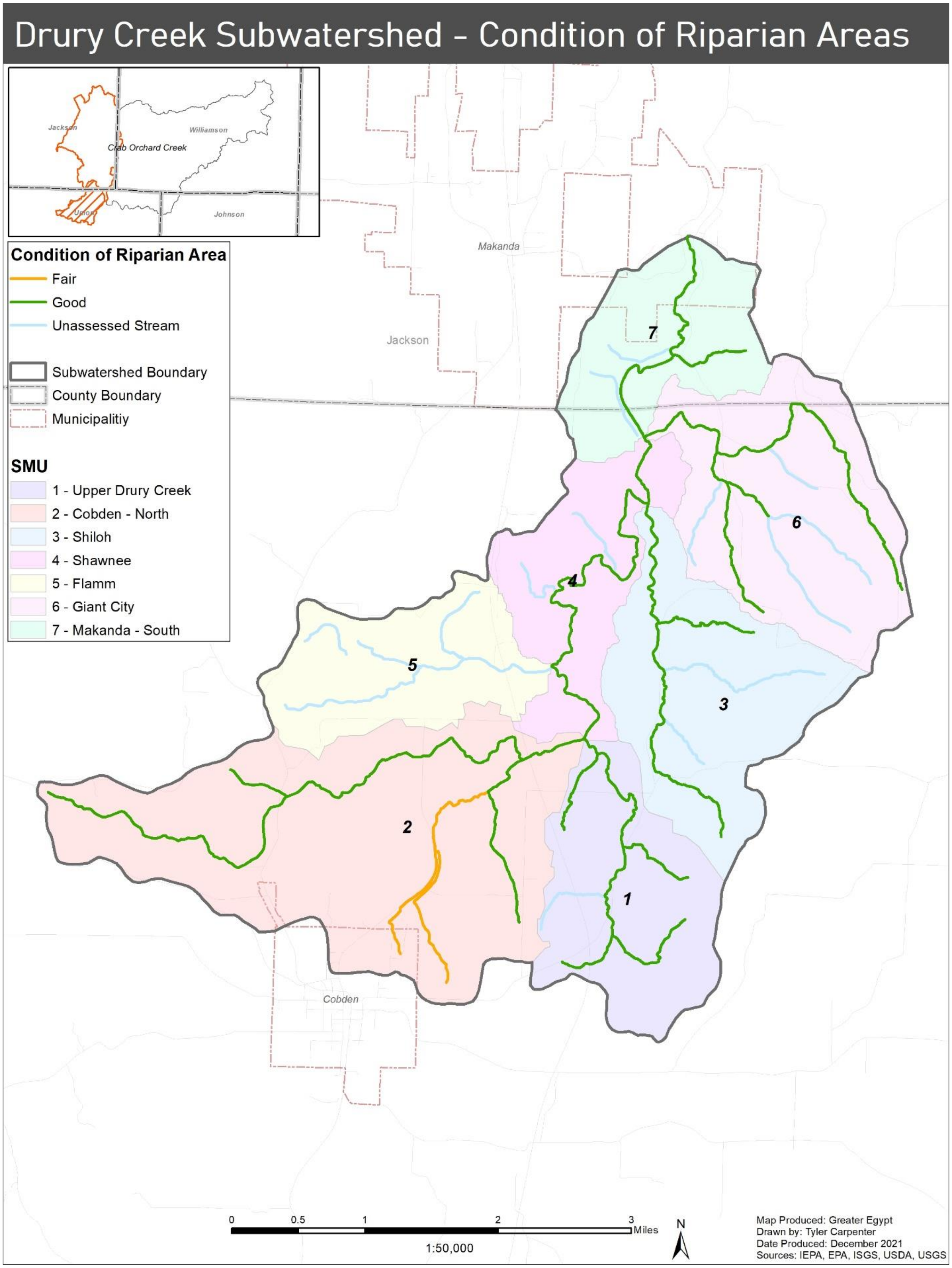
Condition of Riparian Areas

In general, riparian areas in the Drury Creek watershed exhibit good conditions. Since forested areas in the subwatershed account for 67.4 percent, and development and agricultural areas account for thirty percent of land use, riparian areas have generally been preserved. Twenty-five of the twenty-eight reaches examined in the subwatershed have been assessed as good. The remaining reaches are categorized as fair. No reaches were considered to be in poor condition. The condition of riparian areas are summarized in the table below. Riparian conditions of Drury Creek subwatershed can be viewed in *Figure 2.35*.

Table 2.39 - Drury Creek Subwatershed Condition of Riparian Area

Drury Creek Subwatershed						
Condition of Riparian Area	Good		Fair		Poor	
	Reaches	%	Reaches	%	Reaches	%
Upper Drury Creek	7	87.5%	1	16.7%	0	0.0%
Cobden-North	5	71.4%	2	25.0%	0	0.0%
Shiloh	3	100.0%	0	0.0%	0	0.0%
Shawnee-Drury Creek	3	100.0%	0	0.0%	0	0.0%
Flamm	0	0.0%	0	0.0%	0	0.0%
Giant City	5	100.0%	0	0.0%	0	0.0%
Makanda	2	100.0%	0	0.0%	0	0.0%

Figure 2.35


Drury Creek Subwatershed - Condition of Riparian Areas
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Condition of Riparian Area
Fair
Good
Unassessed Stream
Subwatershed Boundary
County Boundary
Municipalitiy
SMU
1 - Upper Drury Creek
2 - Cobden - North
3 - Shiloh
4 - Shawnee
5 - Flamm
6 - Giant City
7 - Makanda - South
Makanda
Jackson
Cobden
1
2
3
4
5
6
7
0
0.5
1
2
3
Miles
1:50,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

Degree of Channelization

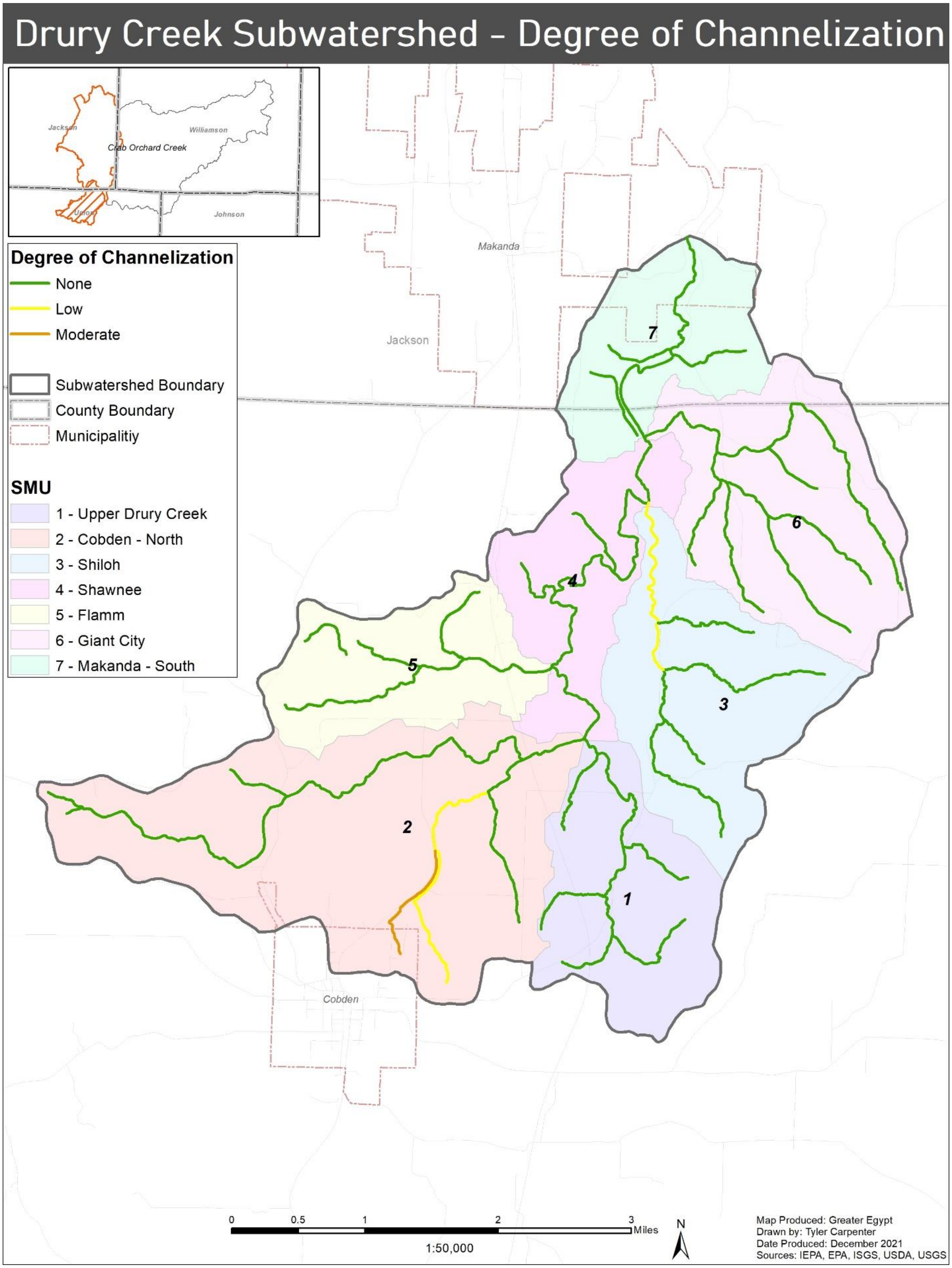
The Drury Creek subwatershed is mostly rural and forested land, leaving little channelized features in the area. Forty-two out of the forty-five reaches assessed exhibit no channelization. Two reaches have a low degree, while only one reach is characterized as exhibiting a moderate degree of channelization. Channelization is typically more prevalent in cropland areas or urban areas. Since Drury Creek is fairly undeveloped and has a considerable amout of forested land, channelization of streams is uncommon.

Table 2.40 summarizes the degree of channelization, categorized by SMUs in Drury Creek subwatershed. The degree of channelization is also displayed in *Figure 2.36.*

Table 2.40 - Drury Creek Subwatershed Degree of Channelization

Drury Creek Subwatershed								
Degree of Channelization	None		Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
Upper Drury Creek	9	100.0%	0	0.0%	0	0.0%	0	0.0%
Cobden-North	6	75.0%	1	12.5%	1	12.5%	0	0.0%
Shiloh	4	80.0%	1	20.0%	0	0.0%	0	0.0%
Shawnee-Drury Creek	5	100.0%	0	0.0%	0	0.0%	0	0.0%
Flamm	4	100.0%	0	0.0%	0	0.0%	0	0.0%
Giant City	10	100.0%	0	0.0%	0	0.0%	0	0.0%
Makanda	4	100.0%	0	0.0%	0	0.0%	0	0.0%

Figure 2.36



Drury Creek Subwatershed - Degree of Channelization
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Degree of Channelization
None
Low
Moderate
Subwatershed Boundary
County Boundary
Municipalitiy
SMU
1 - Upper Drury Creek
2 - Cobden - North
3 - Shiloh
4 - Shawnee
5 - Flamm
6 - Giant City
7 - Makanda - South
Makanda
Jackson
Cobden
1
2
3
4
5
6
7
0
0.5
1
2
3
Miles
1:50,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

2.7.3. Indian Creek- Drury Creek Subwatershed Assessment (071401060808)

The Indian Creek-Drury Creek subwatershed is the second largest watershed that was assessed. The watershed has varying categories of erosion; however, the most erosive areas are found within its three main streams: Indian Creek, Drury Creek, and Sycamore Creek. The majority of riparian areas in the watershed are considered in good condition. Alike Drury Creek watershed, the Indian Creek-Drury Creek subwatershed has little channelization of its streams.

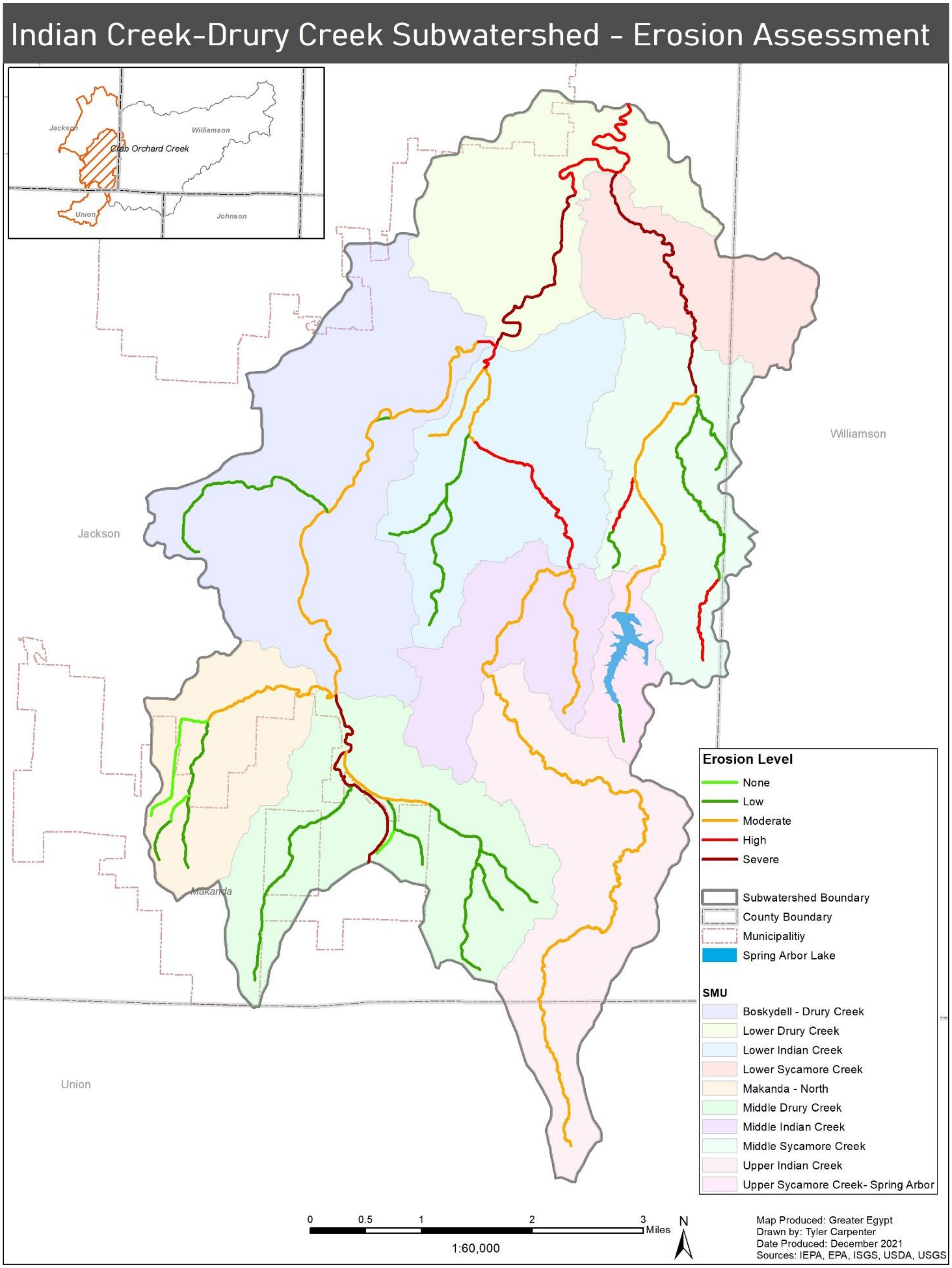
Extent of Erosion

Table 2.41 displays the extent of erosion for the Indian Creek-Drury Creek subwatershed. The majority of streams and tributaties in the Indian-Drury Creek subwatershed exhibit some degree of streambank erosion. There was an added classification of "severe", as there were assessed portions of certain reaches that exhibited extremely high levels of erosion. No subwatered is completely exempt from erosion. Areas of increased erosion occur in every SMU to some degree. *Figure 2.37* displays the erosion assessment.

Table 2.41 - Indian Creek- Drury Creek Subwatershed Extent of Erosion

Indian Creek- Drury Creek Subwatershed						
Extent of Erosion	None or Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%
Upper Indian Creek	0	0%	4	100%	0	0%
Middle Drury Creek	8	57%	2	14%	4	29%
Makanda-North	4	67%	2	33%	0	0%
Upper Sycamore Creek	1	50%	1	50%	0	0%
Middle Indian Creek	0	0%	2	100%	0	0%
Middle Sycamore Creek	4	50%	2	25%	0	0%
Lower Indian Creek	2	25%	3	38%	0	0%
Boskydell-Drury Creek	2	50%	1	25%	0	0%
Lower Sycamore Creek	0	0%	0	0%	1	100%
Lower Drury Creek	0	0%	0	75%	1	25%

Figure 2.37



Indian Creek-Drury Creek Subwatershed - Erosion Assessment
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Williamson
Jackson
Union
Makanda
Erosion Level
None
Low
Moderate
High
Severe
Subwatershed Boundary
County Boundary
Municipalitiy
Spring Arbor Lake
SMU
Boskydell - Drury Creek
Lower Drury Creek
Lower Indian Creek
Lower Sycamore Creek
Makanda - North
Middle Drury Creek
Middle Indian Creek
Middle Sycamore Creek
Upper Indian Creek
Upper Sycamore Creek- Spring Arbor
0 0.5 1 2 3 Miles
1:60,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

Condition of Riparian Areas

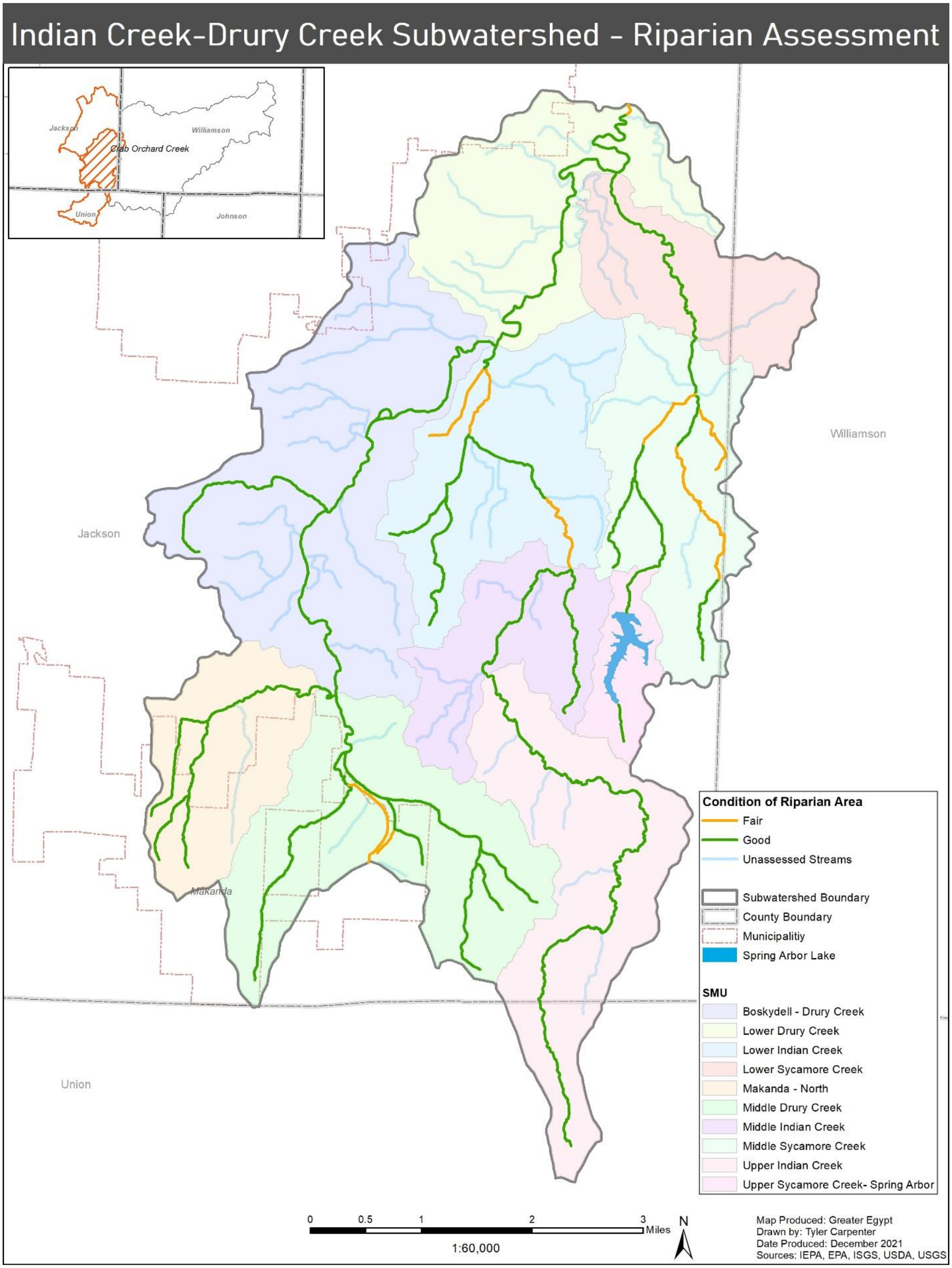
In general, riparian areas in the Indian Creek-Drury Creek subwatershed exhibit good conditions. Indian Creek-Drury Creek is also heavily forested, covering 65.8 percent of the watershed.

A total of 117 reaches were examined in the subwatershed. Ninety-one percent of those are categorized as being in good condition. The remaining ten reaches are categorized as fair. Nine of these ten reaches flow through agricultural fields and have little to no buffer. One area considered as having a fair riparian area is located in the southern most part of the watershed and flows near Makanda boardwalk area. No reaches were considered to be in poor condition. The condition of riparian areas are summarized in the table below. Results are also shown in *Figure 2.38*

Table 2.42 - Indian Creek- Drury Creek Subwatershed Condition of Riparian Areas

Indian Creek- Drury Creek Subwatershed						
Condition of Riparian Area	Good		Fair		Poor	
	Reaches	%	Reaches	%	Reaches	%
Upper Indian Creek	4	100%	0	0%	0	0%
Middle Drury Creek	11	79%	3	21%	0	0%
Makanda-North	6	100%	0	0%	0	0%
Upper Sycamore Creek	2	100%	0	0%	0	0%
Middle Indian Creek	2	100%	0	0%	0	0%
Middle Sycamore Creek	5	63%	3	38%	0	0%
Lower Indian Creek	5	63%	3	39%	0	0%
Boskydell-Drury Creek	4	100%	0	0%	0	0%
Lower Sycamore Creek	1	100%	0	0%	0	0%
Lower Drury Creek	3	75%	1	25%	0	0%

Figure 2.38



Indian Creek-Drury Creek Subwatershed - Riparian Assessment
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Jackson
Williamson
Union
Makanda
Condition of Riparian Area
Fair
Good
Unassessed Streams
Subwatershed Boundary
County Boundary
Municipalitiy
Spring Arbor Lake
SMU
Boskydell - Drury Creek
Lower Drury Creek
Lower Indian Creek
Lower Sycamore Creek
Makanda - North
Middle Drury Creek
Middle Indian Creek
Middle Sycamore Creek
Upper Indian Creek
Upper Sycamore Creek- Spring Arbor
0 0.5 1 2 3 Miles
1:60,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

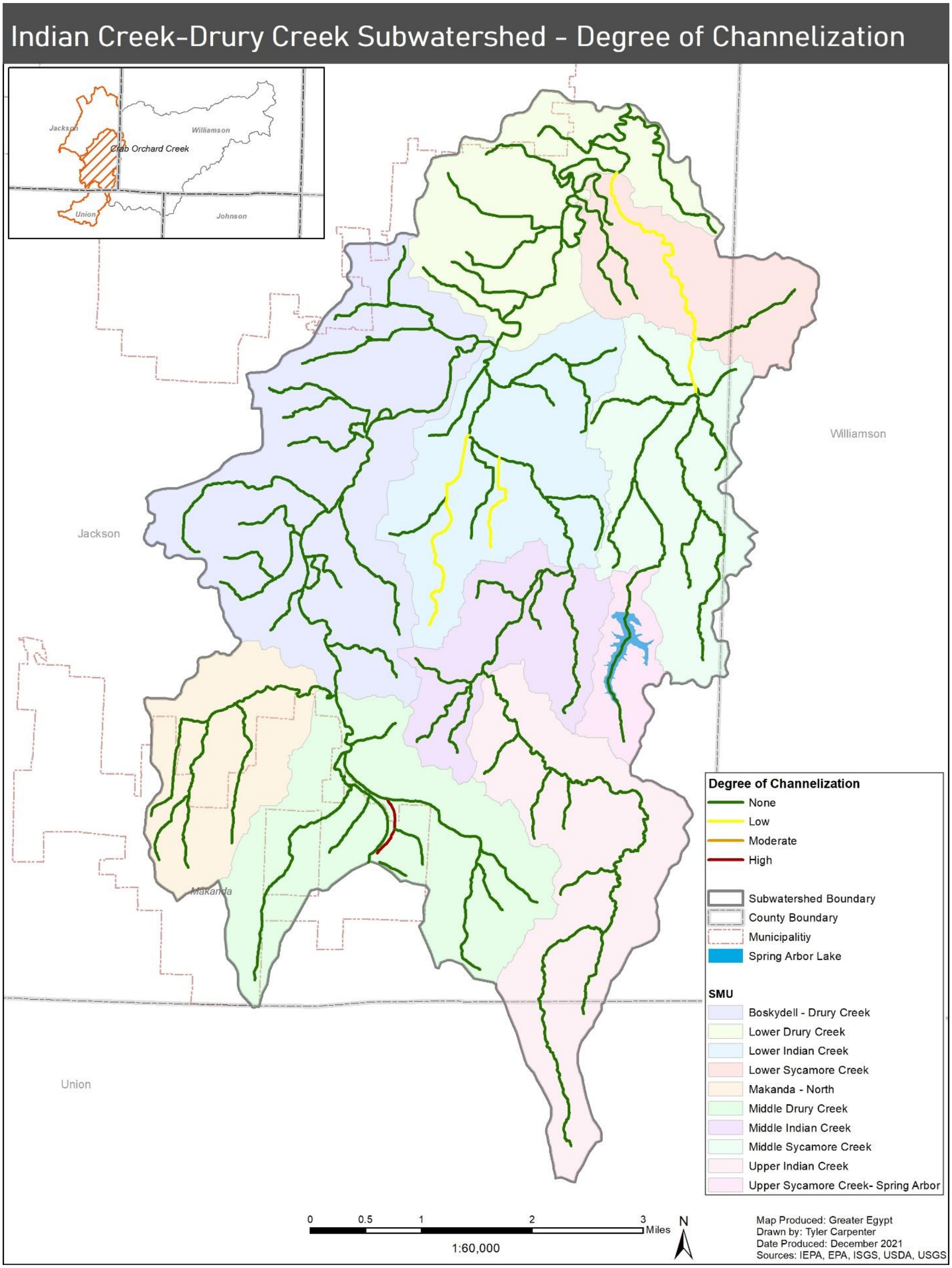
Degree of Channelization

The majority of reaches in the Indian Creek-Drury Creek subwatershed have no degree of channelization. Ninety-six percent of the reaches assessed exhibit no channelization. Three reaches are categorized as having a low degree. These three reaches flow through agricultural fields. The remaining two reaches have high degrees of channelization. Channelization is typically more prevalent in cropland or developed areas of the watershed. The condition of riparian areas are summarized in *Table 2.43* and illustrated in *Figure 2.39*.

Table 2.43 - Indian Creek- Drury Creek Subwatershed Degree of Channelization

Indian Creek- Drury Creek Subwatershed								
Degree of Channelization	None		Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
Upper Indian Creek	9	100%	0	0%	0	0%	0	0%
Middle Drury Creek	15	88%	0	0%	0	0%	2	12%
Makanda-North	7	100%	0	0%	0	0%	0	0%
Upper Sycamore Creek	3	100%	0	0%	0	0%	0	0%
Middle Indian Creek	7	100%	0	0%	0	0%	0	0%
Middle Sycamore Creek	12	100%	0	0%	0	0%	0	0%
Lower Indian Creek	14	88%	2	12%	0	0%	0	0%
Boskydell-Drury Creek	27	100%	0	0%	0	0%	0	0%
Lower Sycamore Creek	4	80%	1	20%	0	0%	0	0%
Lower Drury Creek	14	100%	0	0%	0	0%	0	0%

Figure 2.39


Indian Creek-Drury Creek Subwatershed - Degree of Channelization
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Williamson
Jackson
Makanda
Union
Degree of Channelization
None
Low
Moderate
High
Subwatershed Boundary
County Boundary
Municipalitiy
Spring Arbor Lake
SMU
Boskydell - Drury Creek
Lower Drury Creek
Lower Indian Creek
Lower Sycamore Creek
Makanda - North
Middle Drury Creek
Middle Indian Creek
Middle Sycamore Creek
Upper Indian Creek
Upper Sycamore Creek- Spring Arbor
0 0.5 1 2 3 Miles
1:60,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

2.7.4. Indian Creek- Drury Creek Subwatershed Lake Assessment

Spring Arbor Lake (IL_RNZG)

Indian Creek- Drury Creek subwatershed contains one lake listed on the IEPA 305(b) List which is assessed as part of Illinois and Federal EPA standards. A motorized pontoon boat was used to assess the lake shoreline.

Erosion Assessment

Nearly the entire east side of the lake is developed for residential housing. The west side of the lake is mostly forested; however, the majority of this side of the lake is categorized as having moderate or high erosion. This may be due to the lack of developed land on the west side, making the area unmanaged compared to the residential side.

There are forty shore codes that make up the shoreline. Half of the shorelines, or twenty shore codes, are categorized as none, or low. The majority of shores that exibited low erosion are on the residential side of the lake, where properties owners are more likely to use some form of erosion mitigation, such as riprap. Two of the twenty shorelines are categorized as no erosion. These two shore codes make up the spillway and beachfront that are located at the northern most part of the lake.

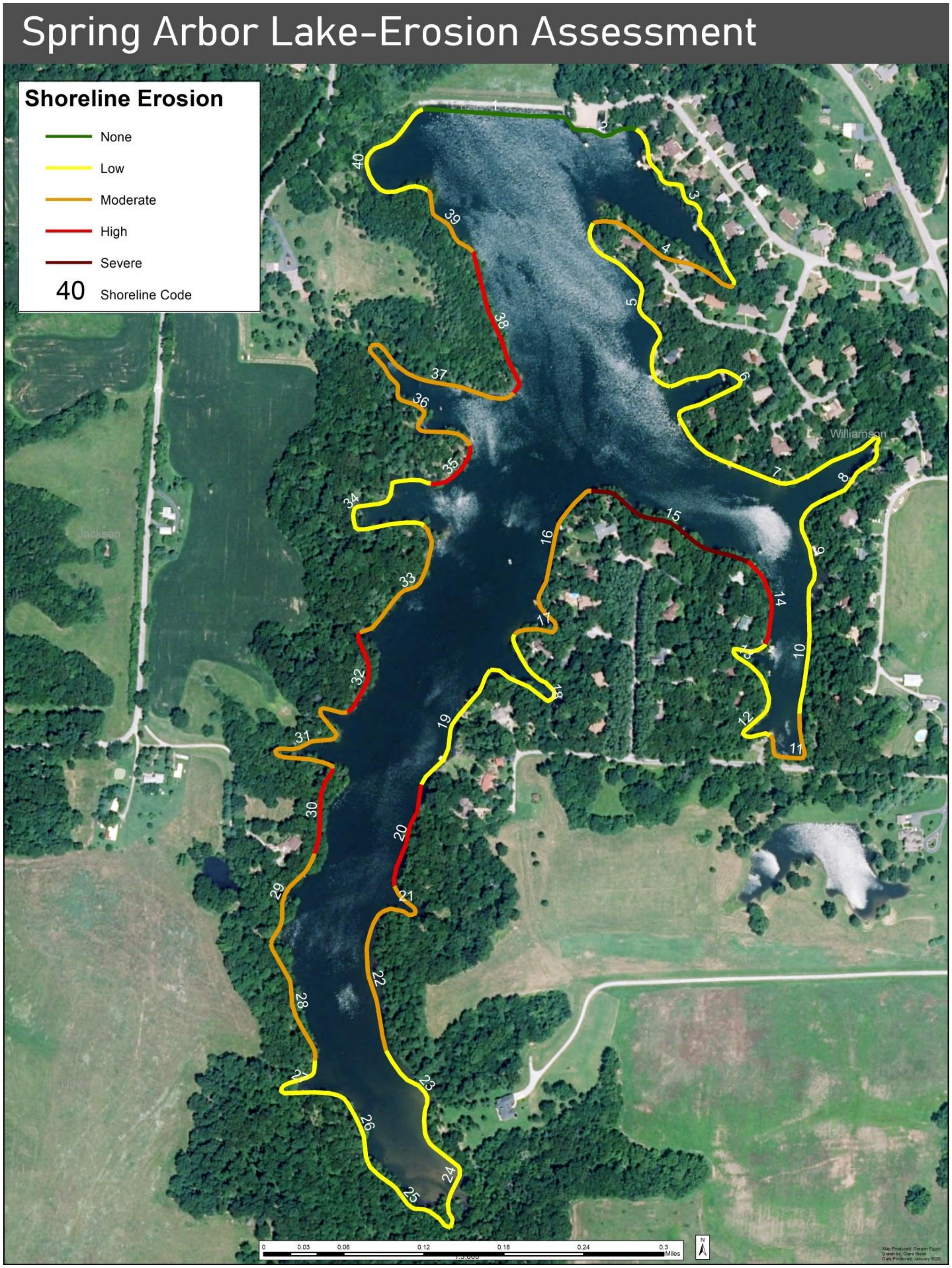
Thirteen shores are considered moderate, while six have a high rating. The last remaining shore has a severe rating. The location of this particular area makes it more prone to erosive conditions as it is along a north/northeast facing bank that is located in a wide corridor, where the typical southeast/south air flow can tunnel through. Flowing air is typically dry, causing drier soil conditions that are more prone to erosion.

The Spring Arbor Lake assessment is summarized in *Table 2.44.* The erosion assessment is displayed in *Figure 2.40.*

Table 2.44 - Spring Arbor Lake Erosion and Littoral Assessment

Spring Arbor Lake Shore Code	Shoreline Length Assessed (ft)	Degree of Erosion	Condition of Riparian Area
IL_RNZG-01	567	None	Good
IL_RNZG-02	314	None	Fair
IL_RNZG-03	786	Low	Fair
IL_RNZG-04	634	Moderate	Fair
IL_RNZG-05	823	Low	Fair
IL_RNZG-06	602	Low	Fair
IL_RNZG-07	930	Low	Fair
IL_RNZG-08	461	Moderate	Good
IL_RNZG-09	316	Low	Good
IL_RNZG-10	491	Low	Good
IL_RNZG-11	375	Moderate	Good
IL_RNZG-12	315	Low	Good
IL_RNZG-13	368	High	Good
IL_RNZG-14	361	High	Good
IL_RNZG-15	708	Severe	Good
IL_RNZG-16	504	Moderate	Good
IL_RNZG-17	315	Moderate	Good
IL_RNZG-18	604	Moderate	Good
IL_RNZG-19	543	Low	Good
IL_RNZG-20	420	High	Good
IL_RNZG-21	286	Moderate	Good
IL_RNZG-22	571	Moderate	Good
IL_RNZG-23	421	Low	Good
IL_RNZG-24	426	Low	Good
IL_RNZG-25	433	Low	Good
IL_RNZG-26	299	Low	Good
IL_RNZG-27	436	Low	Good
IL_RNZG-28	505	Moderate	Good
IL_RNZG-29	409	Moderate	Good
IL_RNZG-30	351	High	Good
IL_RNZG-31	744	Moderate	Good
IL_RNZG-32	349	Moderate	Good
IL_RNZG-33	562	Moderate	Good
IL_RNZG-34	719	Low	Good
IL_RNZG-35	243	Low	Good
IL_RNZG-36	665	Moderate	Good
IL_RNZG-37	639	Low	Good
IL_RNZG-38	600	Moderate	Good
IL_RNZG-39	324	Moderate	Good
IL_RNZG-40	638	Low	Good
Total	**20,057**		

Figure 2.40

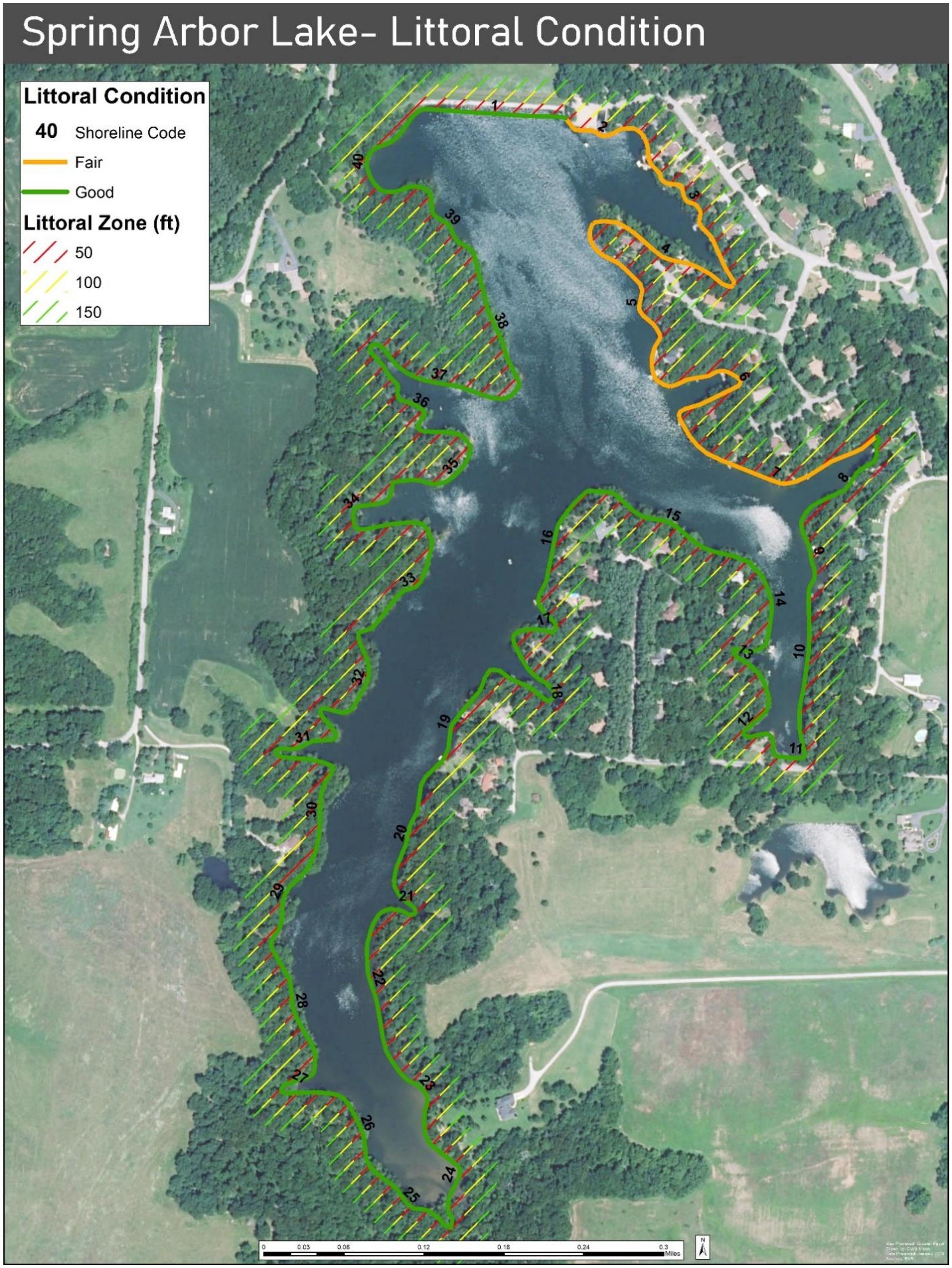

Spring Arbor Lake-Erosion Assessment
Shoreline Erosion
None
Low
Moderate
High
Severe
40 Shoreline Code
Williamson
Jackson
Miles

Condition of Littoral Zone

Table 2.44 also summarizes the littoral condition along Spring Arbor Lake. Since the area surrounding the lake is heavily forested, the Spring Arbor features a generally good littoral zone. Out of the forty reaches, thirty-four reaches are considered to have a good littoral area. That accounts for seventy-eight percent of the total shoreline as having being in good condition.

The remaining six shorelines are categorized as having a fair littoral area. These six shorelines are located along the northeast side of the lake. In this area, there is a cluster of residential homes that are both closer together, and closer to the shoreline, than elsewhere on the lake. In other areas of residental homes, the properties are more spread out from each other and are farther back from the lake shore, giving these areas better conditions.

Figure 2.41



Spring Arbor Lake- Littoral Condition
Littoral Condition
40 Shoreline Code
Fair
Good
Littoral Zone (ft)
50
100
150

2.7.5. Little Crab Orchard Creek-Crab Orchard Creek Stream Assessment (071401060809)

Little Crab Orchard Creek-Crab Orchard Creek subatershed is the largest of the three subwatersheds assessed. This subwatershed contains two lakes. The erosion levels in the subwatershed vary from none to severe. The riparian areas, like the other subwatersheds, vary between good and fair, with no areas displaying poor conditions. Channelization in the watershed varies between none to high, and has the highest amount of channelized streams compared to the other subwatersheds.

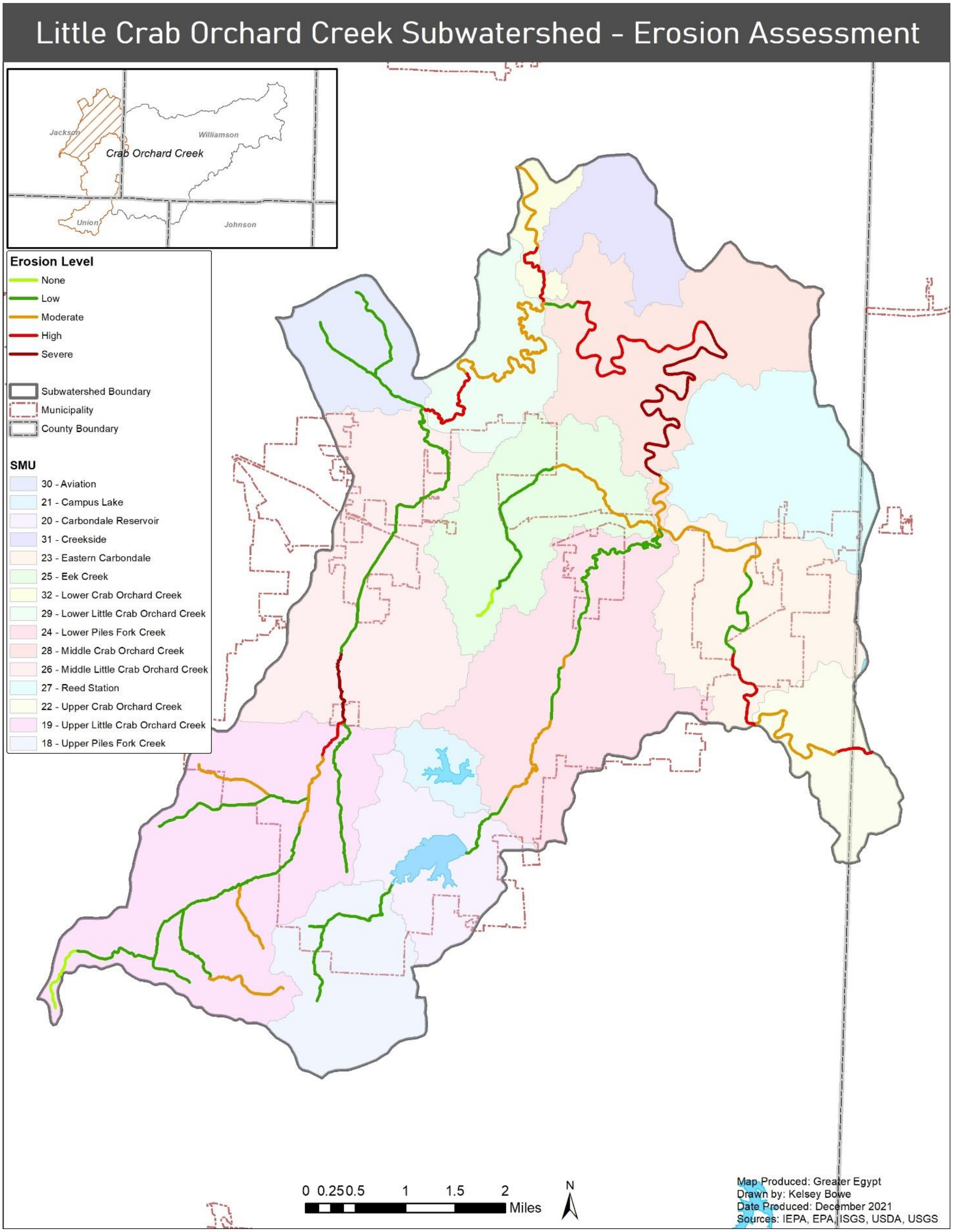
Extent of Erosion

Table 2.45 summarizes the extent of erosion in the Little Crab Orachard Creek-Crab Orchard Creek subwatershed. The majority of the reaches exhibit none or low erosion. Seventeen reaches exhibit moderate erosion. Reaches that exhibit high erosion are in undeveloped areas where streambank management is minimal. *Figure 2.42* displays the extent of erosion.

Table 2.45 - Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Extent of Erosion

Little Crab Orchard Creek- Crab Orchard Creek Subwatershed						
Extent of Erosion	None or Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%
Upper Piles Fork Creek	4	100%	0	0%	0	0%
Upper Little Crab Orchard Creek	7	54%	5	38%	0	0%
Carbondale Reservoir	6	100%	0	0%	0	0%
Campus Lake	0	0%	0	0%	0	0%
Upper Crab Orchard Creek	0	0%	1	20%	0	0%
Eastern Carbondale-Crab Orchard Creek	1	33%	1	33%	0	0%
Lower Piles Fork	8	62%	5	38%	0	0%
Eek Creek	5	83%	1	17%	0	0%
Middle Little Crab Orchard Creek	3	75%	0	0%	1	25%
Reed Station	0	0%	0	0%	0	0%
Middle Crab Orchard Creek	1	25%	1	25%	1	25%
Lower Little Crab Orchard Creek	0	0%	2	67%	0	0%
Aviation	2	100%	0	0%	0	0%
Creekside	0	0%	0	0%	0	0%
Lower Crab Orchard Creek	0	0%	1	50%	0	0%

Figure 2.42



Little Crab Orchard Creek Subwatershed - Erosion Assessment
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Erosion Level
None
Low
Moderate
High
Severe
Subwatershed Boundary
Municipality
County Boundary
SMU
30 - Aviation
21 - Campus Lake
20 - Carbondale Reservoir
31 - Creekside
23 - Eastern Carbondale
25 - Eek Creek
32 - Lower Crab Orchard Creek
29 - Lower Little Crab Orchard Creek
24 - Lower Piles Fork Creek
28 - Middle Crab Orchard Creek
26 - Middle Little Crab Orchard Creek
27 - Reed Station
22 - Upper Crab Orchard Creek
19 - Upper Little Crab Orchard Creek
18 - Upper Piles Fork Creek
0 0.25 0.5 1 1.5 2
Miles
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

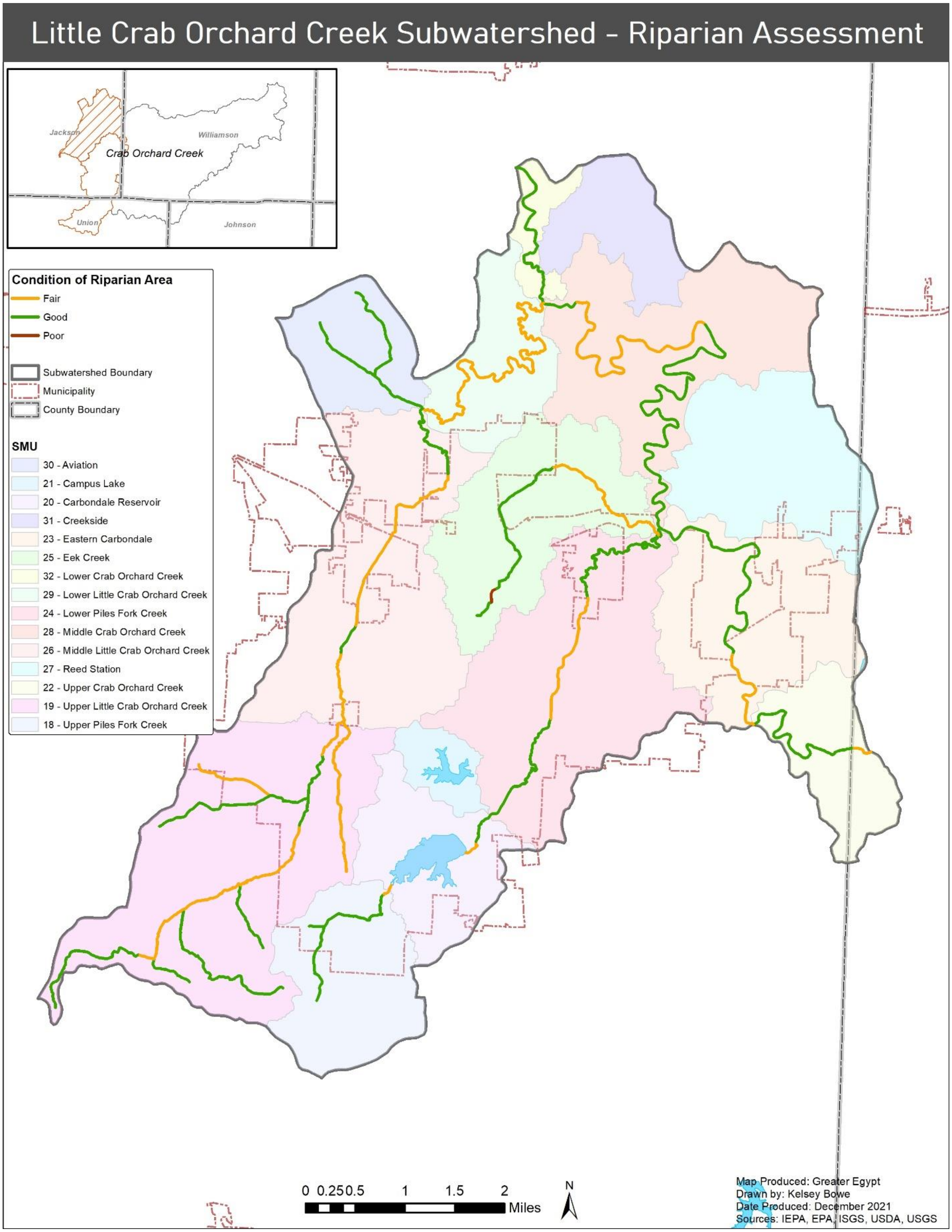
Condition of Riparian Areas

The riparian areas in the Little Crab Orchard Creek-Crab Orchard Creek subwatershed range between good and fair, with no areas exibiting poor conditions. The watershed consists of the largest urbanized area between the three subwatersheds; however, the majority of riparian areas are in good condition, with thirty-nine reaches in that category. Twenty-five reaches exhibit fair riparian condition because the reach either flows through an agricultural field, or is surrounded mostly by developed land.*Table 2.46* summarizes the condition of riparian areas in the subwatershed.

Table 2.46 - Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Condition of Riparian Areas

Little Crab Orchard Creek- Crab Orchard Creek Subwatershed						
Condition of Riparian Area	Good		Fair		Poor	
	Reaches	%	Reaches	%	Reaches	%
Upper Piles Fork Creek	4	100%	0	0%	0	0%
Upper Little Crab Orchard Creek	9	69%	4	31%	0	0%
Carbondale Reservoir	3	50%	3	50%	0	0%
Campus Lake	0	0%	0	0%	0	0%
Upper Crab Orchard Creek	2	40%	3	60%	0	0%
Eastern Carbondale-Crab Orchard Creek	2	67%	1	33%	0	0%
Lower Piles Fork	6	46%	7	54%	0	0%
Eek Creek	4	67%	1	17%	1	17%
Middle Little Crab Orchard Creek	2	50%	2	50%	0	0%
Reed Station	0	0%	0	0%	0	0%
Middle Crab Orchard Creek	3	75%	1	25%	0	0%
Lower Little Crab Orchard Creek	0	0%	3	100%	0	0%
Aviation	2	100%	0	0%	0	0%
Creekside	0	0%	0	0%	0	0%
Lower Crab Orchard Creek	2	0%	0	0%	0	0%

Figure 2.43



Little Crab Orchard Creek Subwatershed - Riparian Assessment
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Condition of Riparian Area
Fair
Good
Poor
Subwatershed Boundary
Municipality
County Boundary
SMU
30 - Aviation
21 - Campus Lake
20 - Carbondale Reservoir
31 - Creekside
23 - Eastern Carbondale
25 - Eek Creek
32 - Lower Crab Orchard Creek
29 - Lower Little Crab Orchard Creek
24 - Lower Piles Fork Creek
28 - Middle Crab Orchard Creek
26 - Middle Little Crab Orchard Creek
27 - Reed Station
22 - Upper Crab Orchard Creek
19 - Upper Little Crab Orchard Creek
18 - Upper Piles Fork Creek
0 0.250.5 1 1.5 2
Miles
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

Degree of Channelization

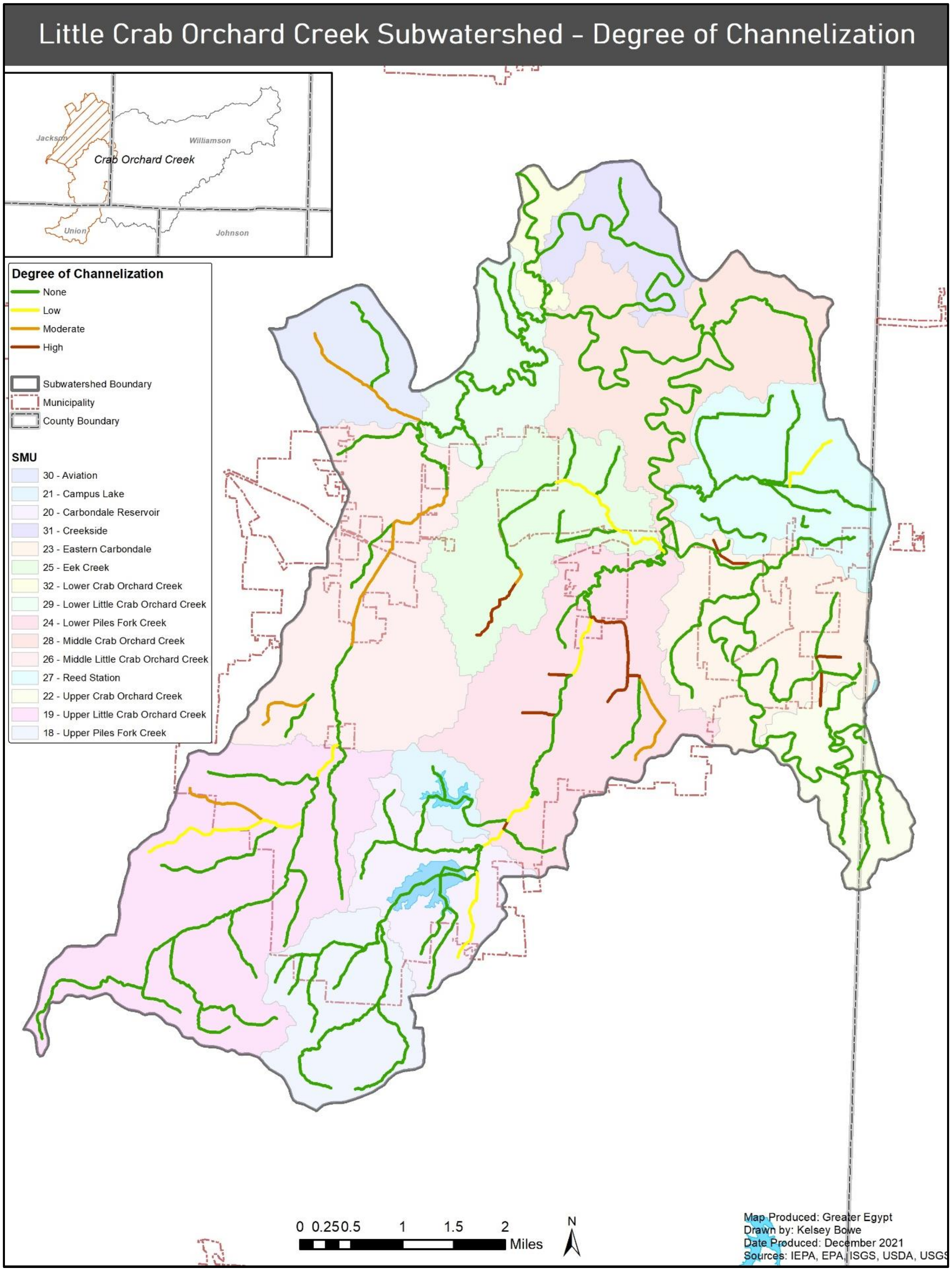
With six of reaches characterized as moderate and twelve characterized as high, the Little Crab Orchard Creek-Crab Orchard Creek subwatershed exibits the most reaches with those ratings. However, the majority of the reaches in the watershed are rated none, or low. Eighty-two percent of the reaches have no channelized features.

The degree of channelization in the subwatershed is summarized in *Table 2.47*. *Figure 2.44* displays the degree of channelization in the Little Crab Orchard Creek-Crab Orchard Creek subwatershed.

Table 2.47 - Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Degree of Channelization

Little Crab Orchard Creek- Crab Orchard Creek Subwatershed								
Degree of Channelization	None		Low		Moderate		High	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
Upper Piles Fork Creek	10	100%	0	0%	0	0%	0	0%
Upper Little Crab Orchard Creek	14	82%	2	12%	1	6%	0	0%
Carbondale Resovoir	17	94%	1	6%	0	0%	0	0%
Campus Lake	5	100%	0	0%	0	0%	0	0%
Upper Crab Orchard Creek	11	100%	0	0%	0	0%	0	0%
Eastern Carbondale-Crab Orchard Creek	11	73%	0	0%	0	0%	4	27%
Lower Piles Fork	13	59%	3	14%	1	4%	5	23%
Eek Creek	4	45%	1	11%	1	11%	3	33%
Middle Little Crab Orchard Creek	7	78%	0	0%	2	22%	0	0%
Reed Station	10	91%	1	9%	0	0%	0	0%
Middle Crab Orchard Creek	6	100%	0	0%	0	0%	0	0%
Lower Little Crab Orchard Creek	6	100%	0	0%	0	0%	0	0%
Aviation	1	50%	0	0%	1	50%	0	0%
Creekside	2	100%	0	0%	0	0%	0	0%
Lower Crab Orchard Creek	4	0%	0	0%	0	0%	0	0%

Figure 2.44


Little Crab Orchard Creek Subwatershed - Degree of Channelization
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Degree of Channelization
None
Low
Moderate
High
Subwatershed Boundary
Municipality
County Boundary
SMU
30 - Aviation
21 - Campus Lake
20 - Carbondale Reservoir
31 - Creekside
23 - Eastern Carbondale
25 - Eek Creek
32 - Lower Crab Orchard Creek
29 - Lower Little Crab Orchard Creek
24 - Lower Piles Fork Creek
28 - Middle Crab Orchard Creek
26 - Middle Little Crab Orchard Creek
27 - Reed Station
22 - Upper Crab Orchard Creek
19 - Upper Little Crab Orchard Creek
18 - Upper Piles Fork Creek
0 0.250.5 1 1.5 2
Miles
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

2.7.6. *Little Crab Orchard Creek- Crab Orchard Creek Subwatershed Lake Assessment*

Little Crab Orchard Creek watershed contains two lakes listed on the IEPA 303(d) List of Impaired Waters. These include Campus Lake and Carbondale Reservoir; both located in the City of Carbondale. The waterbodies differ in size, but experience similar issues regarding erosion, littoral conditions, and other environmental risks.

Campus Lake (IL_RNZH)

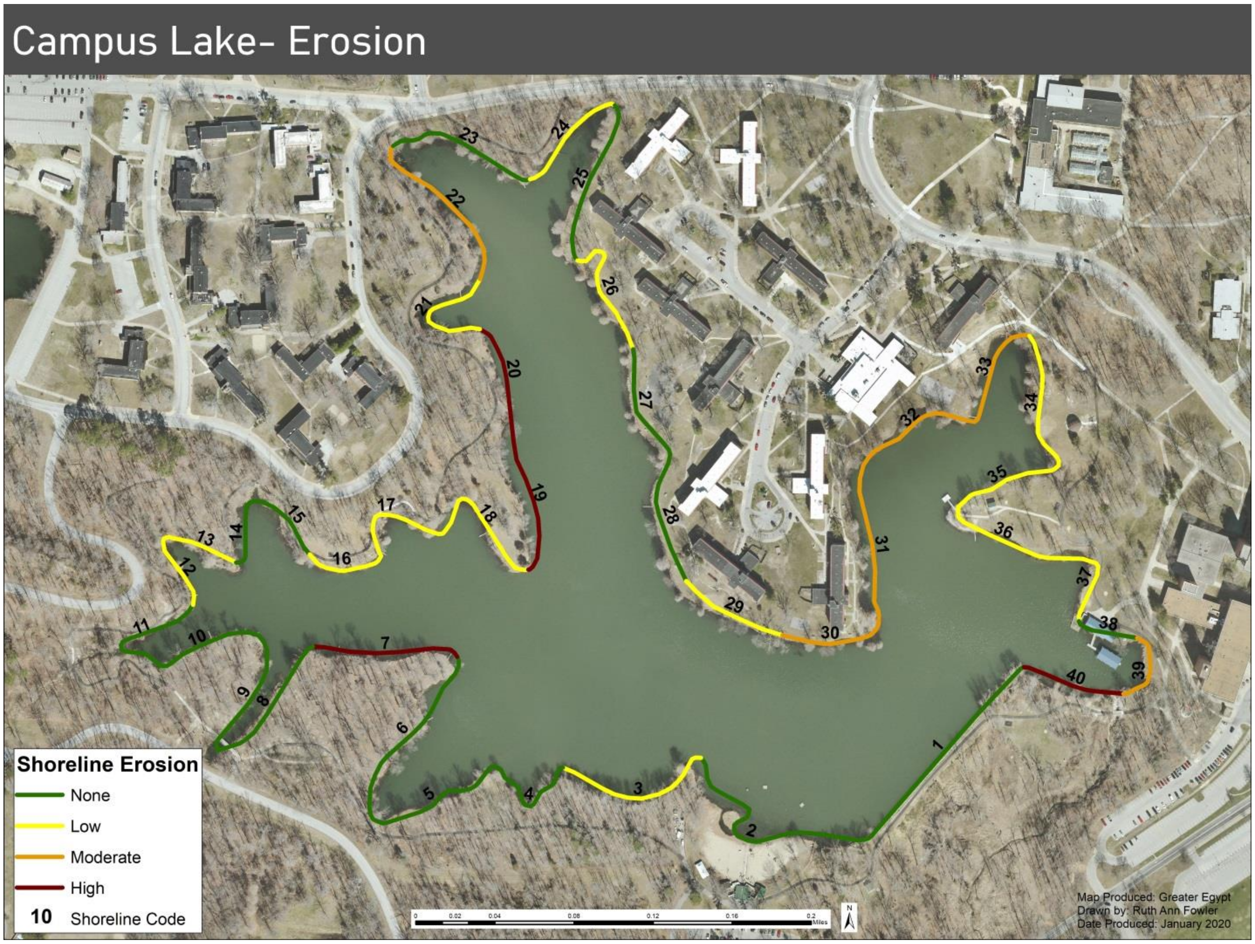
Campus Lake is located on the grounds of Southern Illinois University of Carbondale. The lake is primarily used for recreation. While the waterbody is onlyfourty acres, it does exhibit varying levels of erosion and conditions to its riparian areas. Harmful algal blooms (HAB) are also an environmental issue for the lake. When a HAB is suspected, the lake is tested, and is typically shut down for use until the event is resolved.

Table 2.48 contains information regarding the extent of erosion for Campus Lake. While much of the lake was observed as having low to no erosion, there are a few areas where higher levels of erosion are evident. These typically occur around the prominent points of the lake. Results are also displayed in *Figure 2.45.*

Table 2.48 Campus Lake Erosion and Littoral Assessment

Shore Code	Shoreline Length Assessed (ft)	Degree of Erosion	Condition of Littoral Zone
IL_RNZH-01	621	None	Good
IL_RNZH-02	652	None	Good
IL_RNZH-03	435	Low	Good
IL_RNZH-04	300	None	Good
IL_RNZH-05	385	None	Good
IL_RNZH-06	507	None	Good
IL_RNZH-07	396	High	Good
IL_RNZH-08	390	None	Good
IL_RNZH-09	358	None	Good
IL_RNZH-10	325	None	Good
IL_RNZH-11	316	None	Good
IL_RNZH-12	203	Low	Good
IL_RNZH-13	207	Low	Good
IL_RNZH-14	191	None	Good
IL_RNZH-15	218	None	Good
IL_RNZH-16	203	Low	Good
IL_RNZH-17	300	Low	Good
IL_RNZH-18	399	Low	Good
IL_RNZH-19	424	High	Good
IL_RNZH-20	265	High	Good
IL_RNZH-21	338	Low	Good
IL_RNZH-22	471	Moderate	Good
IL_RNZH-23	408	None	Good
IL_RNZH-24	316	Low	Good
IL_RNZH-25	445	None	Fair
IL_RNZH-40	278	High	Good
IL_RNZH-26	372	Low	Fair
IL_RNZH-27	314	None	Fair
IL_RNZH-28	361	None	Fair
IL_RNZH-29	300	Low	Fair
IL_RNZH-30	256	Moderate	Fair
IL_RNZH-31	467	Moderate	Fair
IL_RNZH-32	338	Moderate	Poor
IL_RNZH-33	301	Moderate	Fair
IL_RNZH-34	374	Low	Fair
IL_RNZH-35	322	Low	Good
IL_RNZH-36	256	Low	Good
IL_RNZH-37	308	Low	Good
IL_RNZH-38	167	None	Poor
IL_RNZH-39	208	Moderate	Fair
Total	**13,695**		

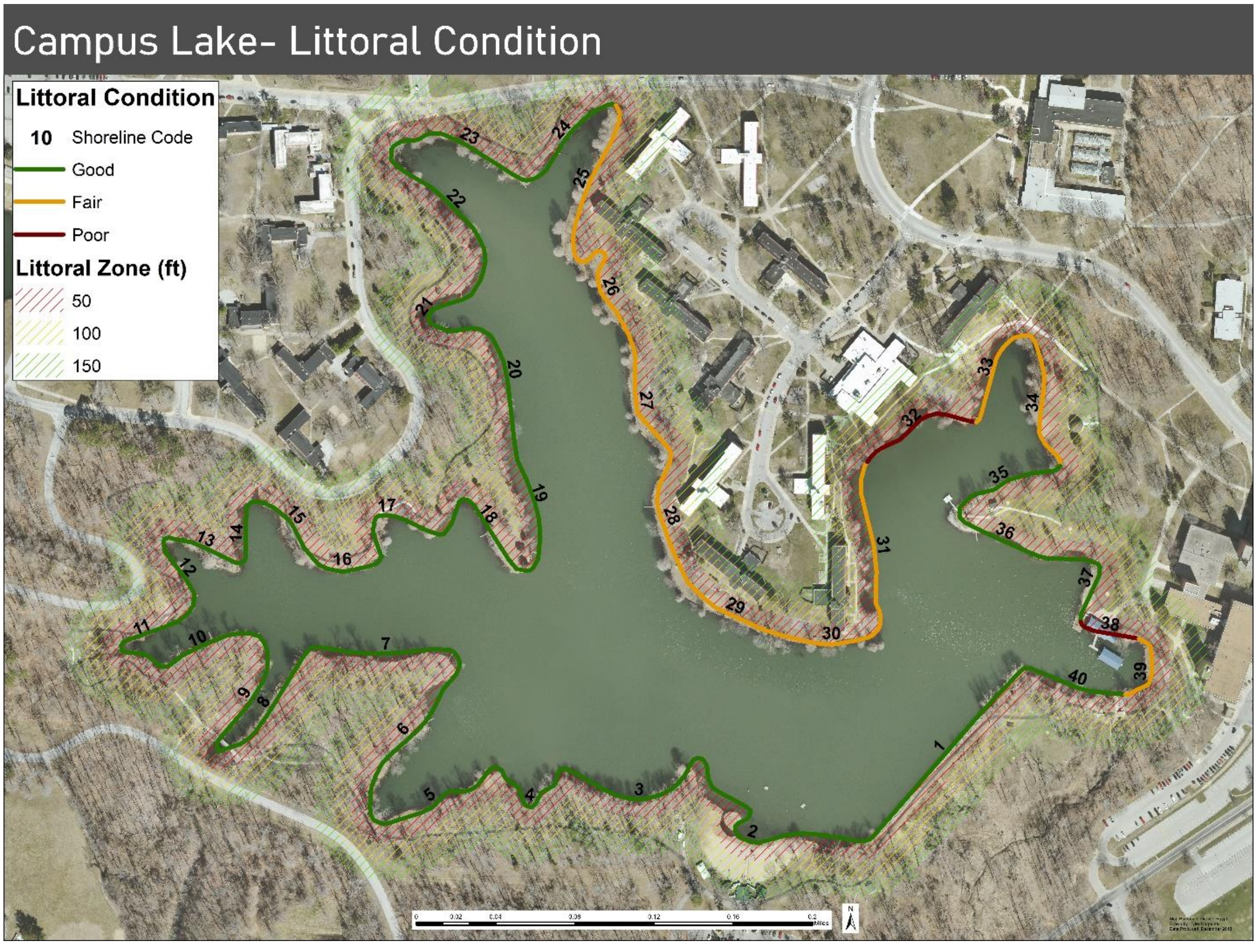
Figure 2.45



The littoral buffer around Campus Lake tends to be in good condition. Areas that exhibit fair or poor conditions are generally located near development on the campus. This includes Thompson Point, which separates the east part of the lake. This area of development includes university housing, where littoral areas have been reduced that contribute to the impervious surfaces around the lake.

Figure 2.46 displays the condition of the littoral zone for Campus Lake. The map also displays the critical littoral zone in fifty foot increments.

Figure 2.46


Campus Lake- Littoral Condition
Littoral Condition
10 Shoreline Code
Good
Fair
Poor
Littoral Zone (ft)
50
100
150

Carbondale Reservoir (IL_RNI)

Also located within the City of Carbondale is the Carbondale Reservoir, or City Lake. While the waterbody once served as a source of public water, it is now used for recreation. The city owns the lake, and the municipalitie's water quality laboratory is located on the southwest portion of the lake.

The waterbody is 137 acres and it displays many areas of erosion. Most notably, shoreline sections in the southern portion of the lake have been classified as high and severe. An example of one of these severe areas is pictured below.

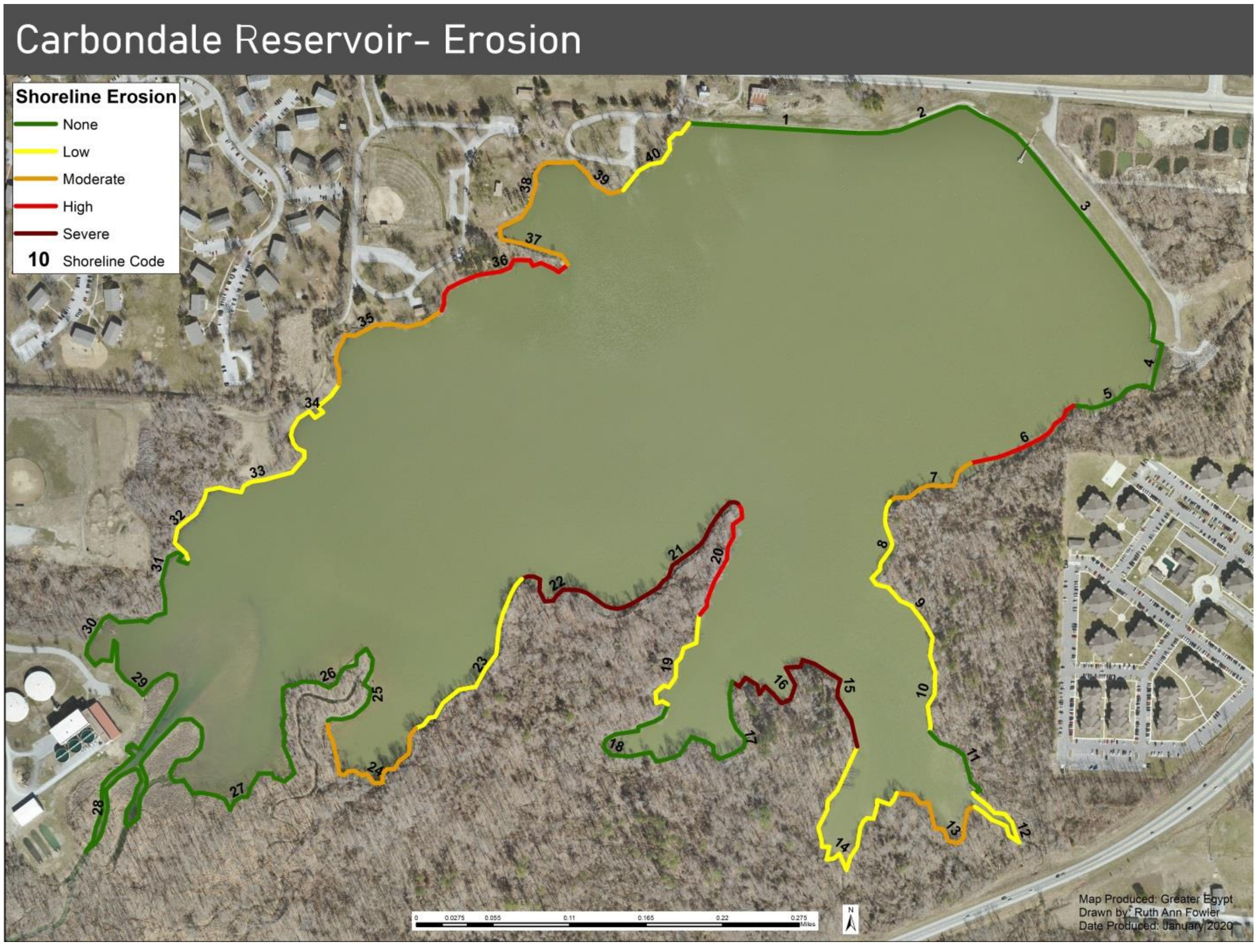
Figure 2.47 - Carbondale Reservoir Severe Erosion

Table 2.49 contains the extent of erosion for Carbondale Reservoir. Other areas with increased levels of erosion occur along the northwestern portion. This area includes development comprised of an apartment complex, roads, and the lake boat ramp. Results are also displayed in *Figure 2.48*.

Table 2.49 - Carbondale Reservoir Erosion and Littoral Assessment

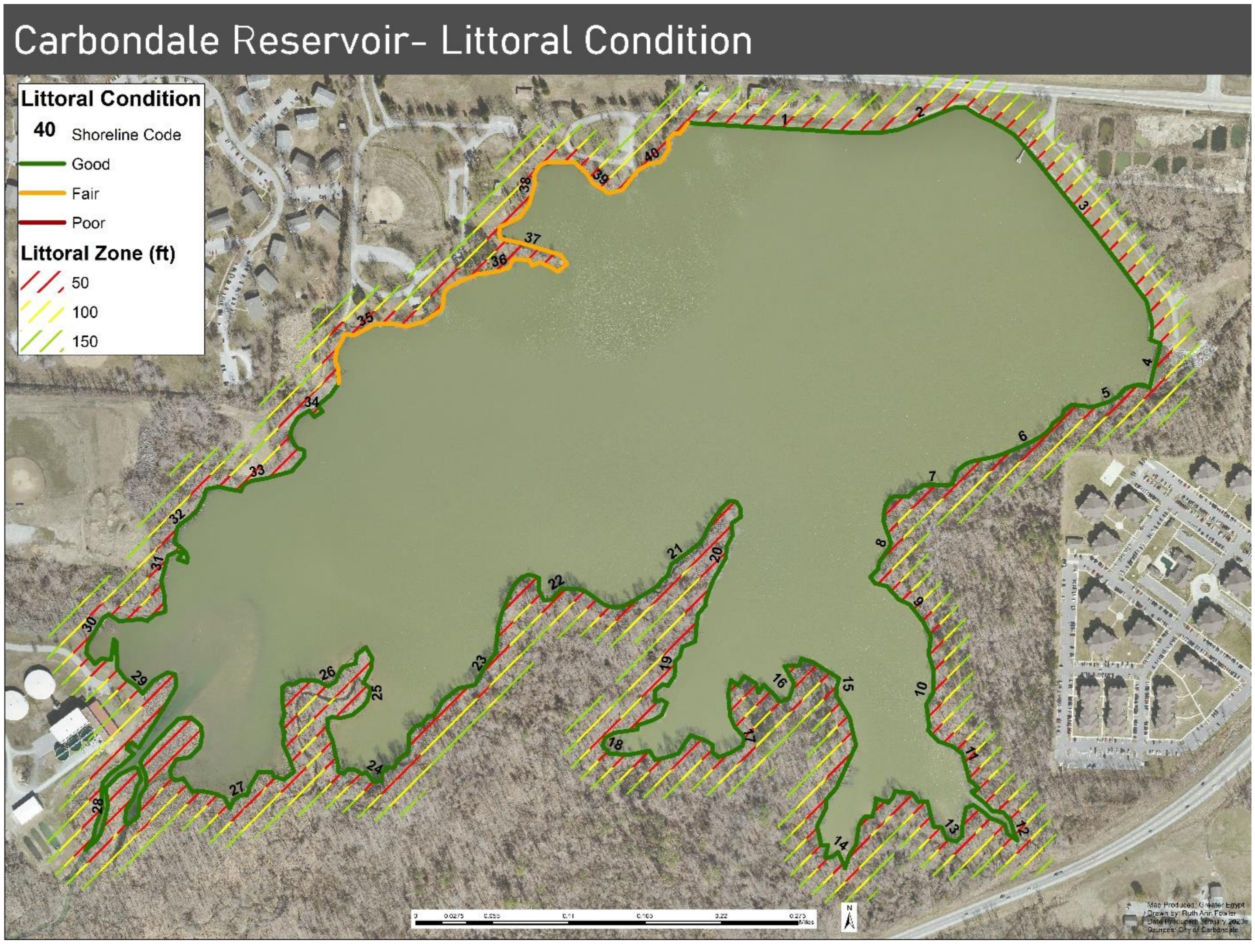
Shore Code	Shoreline Length Assessed (ft)	Degree of Erosion	Condition of Riparian Area
IL_RNI-01	730	None	Good
IL_RNI-02	346	None	Good
IL_RNI-03	1,169	None	Good
IL_RNI-04	243	None	Good
IL_RNI-05	292	None	Good
IL_RNI-06	466	High	Good
IL_RNI-07	373	Moderate	Good
IL_RNI-08	325	Low	Good
IL_RNI-09	406	Low	Good
IL_RNI-10	301	Low	Good
IL_RNI-11	343	None	Good
IL_RNI-12	498	Low	Good
IL_RNI-13	524	Moderate	Good
IL_RNI-14	1,038	Low	Good
IL_RNI-15	513	Severe	Good
IL_RNI-16	466	Severe	Good
IL_RNI-17	521	None	Good
IL_RNI-18	736	None	Good
IL_RNI-19	476	Low	Good
IL_RNI-20	477	High	Good
IL_RNI-21	635	Severe	Good
IL_RNI-22	479	Severe	Good
IL_RNI-23	747	Low	Good
IL_RNI-24	677	Moderate	Good
IL_RNI-25	411	None	Good
IL_RNI-26	413	None	Good
IL_RNI-27	1,229	None	Good
IL_RNI-28	2,092	None	Good
IL_RNI-29	408	None	Good
IL_RNI-30	610	None	Good
IL_RNI-31	361	None	Good
IL_RNI-32	325	Low	Good
IL_RNI-33	449	Low	Good
IL_RNI-34	425	Low	Good
IL_RNI-35	591	Moderate	Fair
IL_RNI-36	610	High	Fair
IL_RNI-37	325	Moderate	Fair
IL_RNI-38	436	Moderate	Fair
IL_RNI-39	234	Moderate	Fair
IL_RNI-40	386	Low	Fair
Total	**22,085**		

Figure 2.48



The only areas around Carbondale Reservoir in which littoral conditions are not considered to be in good conition occur along the stretch of shoreline previously mentioned. Reduced littoral vegetation coincides with the impervious surfaces in the area. The remaining areas were assessed as being in good condition. *Figure 2.49* displays the condition of littoral areas for Carbondale Reservoir.

Figure 2.49



Like nearby Campus Lake, Carbondale Reservoir experiences harmful algal blooms. These typically occur during summer months, when the temperatures are conducive for a bloom to occur. Increased runoff and the presence of nutrients may also contribute to the development of these environmental hazards.

Figure 2.50 - Lake Closure Signs

2.7.7. Basins and Blockages

Basins have also been assessed as part of this report. These include detention and retention basins. Detention basins are usually dry structures that temporarily store water during a heavy period of stormwater runoff. These types of basins can also release the detained water at a controlled rate. Although their primary purpose is to store water, they can also be constructed in a manner that provides benefits to habitats and water quality.

Retention basins, also known as wet basins, also serve to manage stormwater runoff, but store water on a permanent basis. Like detention basins, retention areas can also reduce, or prevent flooding, and improve water quality.

Both types of structures are prevalent in the planning area, with specific focus around the City of Carbondale. Basins in the Western Crab Orchard Creek watershed are displayed in *Figure 2.51*

The following tables summarize the basins by type, jurisdiction, and location (latitude/longitude). Basins were assigned an identification number. There are seventy-three basins in the watershed. The majority of these features occur in the Little Crab Orchard Creek- Crab Orchard Creek watershed. One of the largest detention areas is located at the Carbondale Superblock Sports Complex. Basins are also displayed in *Table 2.50* with Basin IDs.

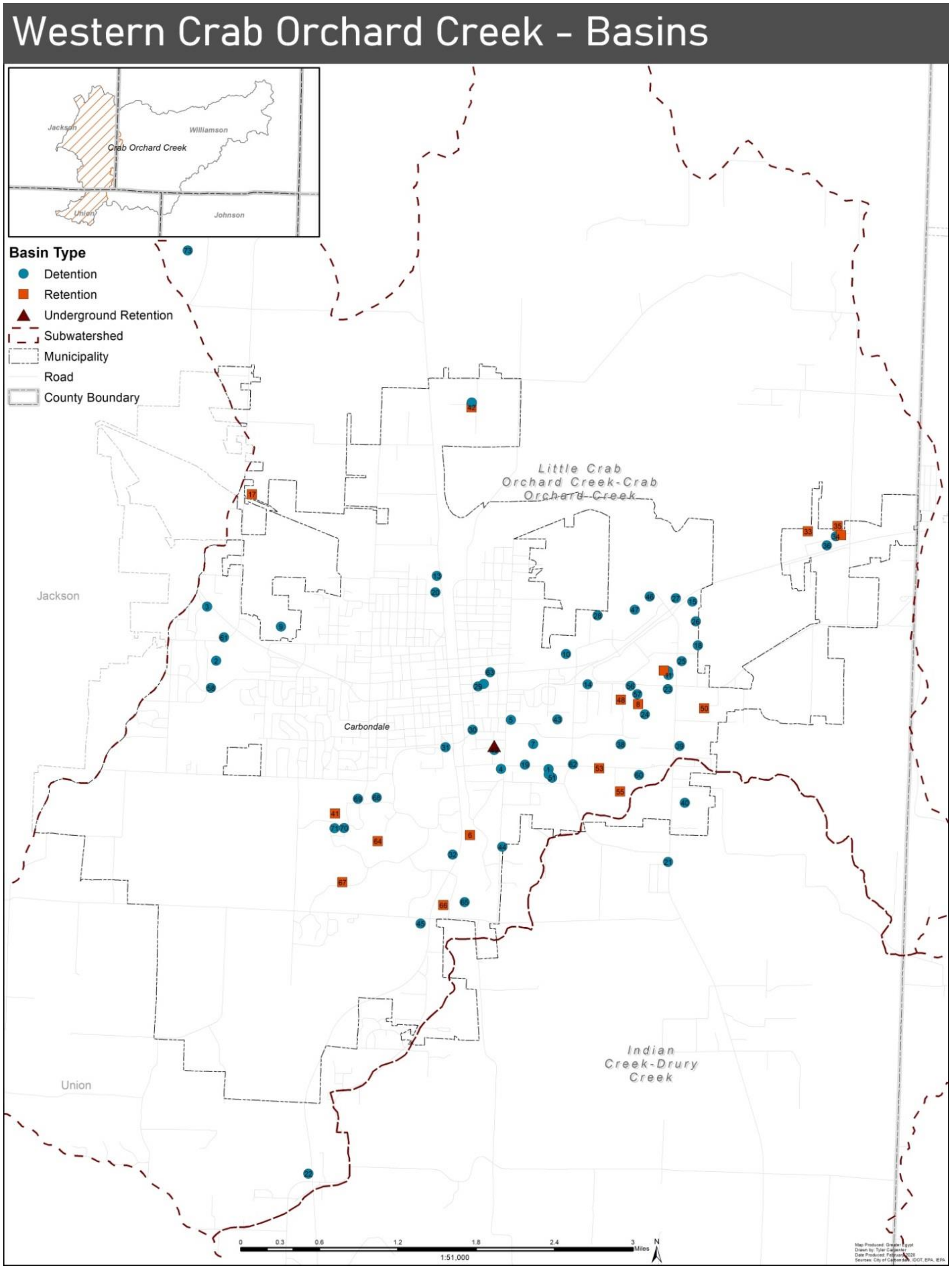
Table 2.50 - Basin Identification

Basin Type	Basin ID	Jurisdiction	Latitude	Longitude
Detention	1	Carbondale	-89.202631	37.717245
Detention	2	Carbondale	-89.249421	37.728381
Detention	3	Carbondale	-89.250847	37.734358
Detention	4	Carbondale	-89.209267	37.717137
Detention	5	Carbondale	-89.208043	37.722619
Retention	6	Carbondale	-89.213375	37.709739
Detention	7	Carbondale	-89.204869	37.719986
Retention	8	Carbondale	-89.190329	37.724703
Detention	9	Jackson County	-89.240473	37.732343
Detention	10	Carbondale	-89.200575	37.730051
Detention	11	Carbondale	-89.186202	37.727979
Detention	12	Carbondale	-89.186276	37.728411
Detention	13	Carbondale	-89.218872	37.738383
Detention	14	Carbondale	-89.197449	37.72675
Detention	15	Carbondale	-89.183103	37.736198
Retention	16	Carbondale	-89.186851	37.728469
Retention	17	Jackson County	-89.244986	37.74694
Detention	18	Carbondale	-89.182193	37.731364
Detention	19	Carbondale	-89.20593	37.717682
Detention	20	Carbondale	-89.219032	37.736563
Detention	21	Jackson County	-89.185651	37.707266
Detention	22	Jackson County	-89.23482	37.671777
Detention	23	Carbondale	-89.186233	37.726435
Detention	24	Carbondale	-89.189373	37.723564
Detention	25	Carbondale	-89.1844	37.729574
Detention	26	Carbondale	-89.182543	37.734006
Detention	27	Carbondale	-89.185425	37.736515
Detention	28	Carbondale	-89.196284	37.7344
Detention	29	Carbondale	-89.21274	37.726238
Detention	30	Carbondale	-89.213369	37.721417
Detention	31	Carbondale	-89.217109	37.719398
Detention	32	Carbondale	-89.215745	37.707527
Retention	33	Carbondale	-89.167188	37.744282
Detention	34	Carbondale	-89.163272	37.74379
Retention	35	Jackson County	-89.163061	37.744947
Detention	36	Carbondale	-89.164507	37.742768
Retention	37	Carbondale	-89.162524	37.743945

Table 2.50 (Cont'd) - Basin Identification

Basin Type	Basin ID	Jurisdiction	Latitude	Longitude
Detention	38	Carbondale	-89.192634	37.720183
Detention	39	Carbondale	-89.184426	37.720152
Detention	40	Carbondale	-89.18348	37.713866
Retention	41	Carbondale	-89.232295	37.711766
Retention	42	Carbondale	-89.214598	37.757168
Detention	43	Carbondale	-89.20157	37.722787
Detention	44	Carbondale	-89.208845	37.708513
Detention	45	Carbondale	-89.219991	37.699789
Detention	46	Carbondale	-89.189062	37.736638
Detention	47	Carbondale	-89.191108	37.735136
Retention	48	Carbondale	-89.192773	37.725127
Detention	49	Carbondale	-89.210276	37.719235
Retention	50	Carbondale	-89.181102	37.724403
Detention	51	Carbondale	-89.202109	37.716302
Detention	52	Carbondale	-89.202577	37.716673
Retention	53	Carbondale	-89.195564	37.717479
Detention	54	Carbondale	-89.211965	37.726527
Retention	55	Carbondale	-89.19259	37.714951
Detention	56	Carbondale	-89.191463	37.726695
Detention	57	Carbondale	-89.190474	37.725787
Detention	58	Carbondale	-89.250047	37.725359
Detention	59	Carbondale	-89.214574	37.757684
Detention	60	Carbondale	-89.18999	37.716841
Detention	61	Carbondale	-89.248392	37.73099
Detention	62	Carbondale	-89.199241	37.71786
Detention	63	Carbondale	-89.21112	37.727826
Retention	64	Carbondale	-89.226258	37.708817
Detention	65	Carbondale	-89.213909	37.702292
Retention	66	Carbondale	-89.216874	37.701893
Retention	67	Carbondale	-89.231049	37.704171
Detention	68	Carbondale	-89.22653	37.713644
Detention	69	Carbondale	-89.229159	37.713458
Detention	70	Carbondale	-89.230983	37.710186
Detention	71	Carbondale	-89.23232	37.710133
Underground Retention	72	Carbondale	-89.210289	37.719696
Detention	73	Jackson County	-89.254763	37.773787

Figure 2.51



Western Crab Orchard Creek - Basins
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Basin Type
Detention
Retention
Underground Retention
Subwatershed
Municipality
Road
County Boundary
Little Crab Orchard Creek-Crab Orchard Creek
Jackson
Carbondale
Indian Creek-Drury Creek
Union
0
0.3
0.6
1.2
1.8
2.4
3
Miles
1:51,000
N

Debris Blockages

Many areas in the Western Crab Orchard Creek watershed exhibit different types of debris blockages. These impediments are both natural and synthetic. Downed vegetation represents the majority of the blockages. *Figure 2.52* displays some of the obstructions in Little Crab Orchard Creek and Piles Fork Creek. Residents near the area have expressed concerns over flooding and other impairments related to the occurrences.

Figure 2.52 - Watershed Waterbody Obstructions

Figure 2.53 - Watershed Dumping Site

Dumping and litter is also prevalent in many portions of the watershed. This is typically evident around stream crossings and rural areas. *Figure 2.53* reveals an area where dumping has occurred at crossing along Indian Creek.

2.8. Water Quality Assessment

For this assessment, water quality of Western Crab Orchard Creek waterbodies with available data has been analyzed. A water quality assessment has also been completed for local municipalities within the Western Crab Orchard Creek planning area.

In conforming to the regulations of the Federal Clean Water Act (CWA) sections 303(d) and 305(b), the Illinois Environmental Protection Agency (IEPA) is required to inform the U.S. Environmental Protection Agency on water quality of Illinois waterbodies. While Section 303(d) require the IEPA to provide a list of waterbodies whose designated uses are considered impaired, Section 305(b) entails an inventory of water quality of Illinois waterbodies and groundwater sources.

There are seven designated uses in Illinois, and six apply within the Crab Orchard Creek planning area. These are: Aquatic Life, Fish Consumption, Primary Contact, Secondary Contact, Public and Food Processing Water Supplies, and Aesthetic Quality. Indigenous Aquatic Life is not a designated use for the planning area.

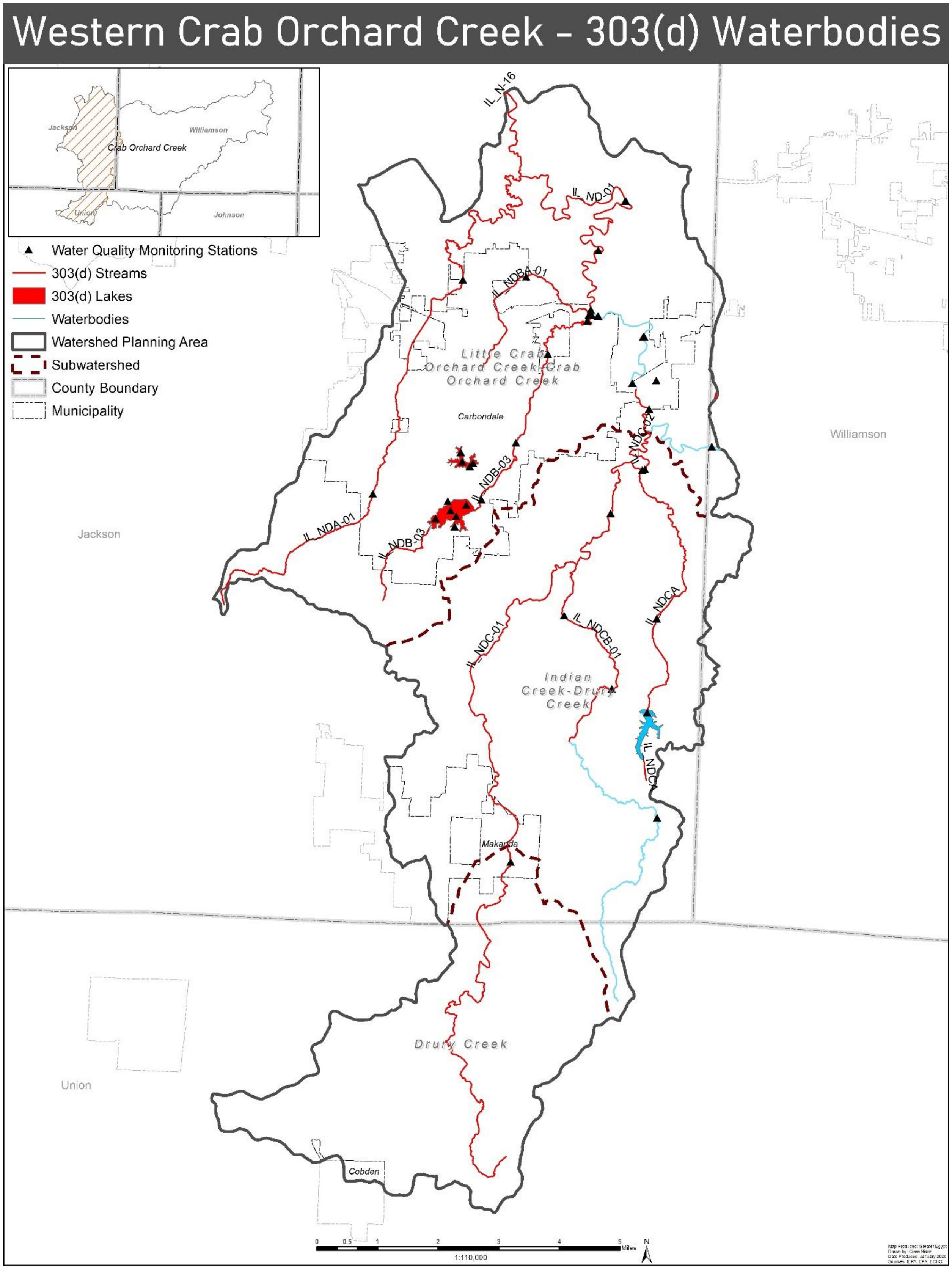
2.8.1. Water Quality Impairments and Monitoring

303(d) and 305(b) Streams

The streams assessed for water quality impairments under Section 303(d) include: Big Muddy River, Crab Orchard Creek, Drury Creek, Eek Creek, Indian Creek, Little Crab Orchard Creek-West, Piles Fork Creek, and Sycamore Creek. Lakes assessed for impairments include: Carbondale City Lake and Campus Lake. A depiction of 303(d) waterbodies and IEPA monitoring stations can be viewed in *Figure 2.54*.

Water quality assessments for these impaired waterbodies have been detailed for this report. Data provided from the IEPA, municipalities, and other sources have been utilized for this assessment. Waterbody information has been analyzed by Subwatershed (HUC 12).

Figure 2.54


Western Crab Orchard Creek - 303(d) Waterbodies
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Water Quality Monitoring Stations
303(d) Streams
303(d) Lakes
Waterbodies
Watershed Planning Area
Subwatershed
County Boundary
Municipality
IL_N-16
IL_ND-01
IL_NDBA-01
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
IL_NDC-02
IL_NDB-03
IL_NDA-01
IL_NDB-03
IL_NDCA
IL_NDCB-01
IL_NDC-01
Indian Creek-Drury Creek
IL_NDCA
Makanda
Drury Creek
Cobden
Williamson
Jackson
Union
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Drury Creek Subwatershed (071401060807)

Table 2.51 outlines the designated uses and assessment status of 305(b) waterbodies within Drury Creek subwatershed, as identified in the Illinois Integrated Water Quality Report and Section 303(d) List for 2016. Drury Creek (IL_NDC-01) was the only assessed waterbody in the report. It was assessed solely for aquatic life, which is not supported. Drury Creek continues into Indian Creek-Drury Creek subwatershed.

Table 2.51 - Drury Creek Subwatershed 305(b) Streams

Drury Creek- 071401060807				
Waterbody Name & Assessment ID	Designated Use	Use ID	Assessed in 2016 Integrated Report	Use Attainment
Drury Creek (IL_NDC-01)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A

Source: 2016 IEPA integrated Water Quality Report and 303(d) Lists

Drury Creek has been placed on the IEPA's 303(d) List of Impaired Waters. This is due to several impairments. Information from the 305(b) Assessment can be found in *Table 2.52*. Causes of impairment include: alteration in stream-side or littoral vegetation covers and dissolved oxygen. The sources for impairment are loss of riparian habitat and an unknown source.

Table 2.52 - 305(b) Assessment Information for Drury Creek Subwatershed

Waterbody	Assessment Unit ID	Size	Causes of Impairment(s)	Sources of Impairment(s)
Drury Creek	IL-NDC-01	19.39	Alteration in stream-side or littoral vegetative covers, Dissolved Oxygen	Loss of Riparian Habitat, Source Unknown

Source: 2016 IEPA integrated Water Quality Report and 303(d) Lists

The information contained in the 303 (d) section also lists the impaired designated use and cause of impairment. The following table summarizes the causes and sources of impairment for Drury Creek (NDC-01). The impaired designated use is aquatic life, which is caused by dissolved oxygen.

Table 2.53 - 303(d) Information for Drury Creek Subwatershed

Waterbody	Assessment Unit ID	Size	Impaired Designated Use (s)	Causes of Impairment(s)
Drury Creek	IL_NDC-01	19.39	Aquatic Life	Dissolved Oxygen

Indian Creek – Drury Creek Subwatershed (071401060808)

Table 2.54 outlines the designated uses and assessment status of 305(b) waterbodies within Indian Creek - Drury Creek subwatershed, as identified in the Illinois Integrated Water Quality Report and Section 303(d) List for 2016. This includes four stream reaches and one lake. There are a total of five designated uses, with only two designated uses being assessed. Aquatic life was evaluated for all waterbodies, and only fully supported for Indian Creek (NDBC-02). Aesthetic quality was assessed for Drury Creek and Sycamore Creek, but only fully supported for Drury Creek. Spring Arbor Lake was assessed for aquatic life and aesthetic quality but had insufficient information.

Drury Creek, Indian Creek, and Sycamore Creek have been placed on the IEPA's 303(d) list of impaired waters. This is due to several impairments. Information from the 305(b) list can be found in *Table 2.54*. Dissolved oxygen impairs all three streams. The sources of impairment vary by waterbody.

Table 2.54 - Indian Creek- Drury Creek Subwatershed 305(b) Waterbodies

Indian Creek- Drury Creek- 071401060809				
Waterbody Name & Assessment ID	Designated Use	Use ID	Assessed in 2016 Integrated Report	Use Attainment
Drury Creek (IL_NDC-02)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting
Indian Creek (IL_NDBC-01)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A
Indian Creek (IL_NDBC-02)	Aquatic Life	582	Yes	Fully Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A
Sycamore Creek (IL_NDCA)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting
Spring Arbor Lake (IL_RNZG)	Aquatic Life	582	Yes	Insufficient Information
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Insufficient Information

Table 2.55 - Indian Creek- Drury Creek Subwatershed 303(d) Waterbodies

Waterbody	Assessment Unit ID	Size	Causes of Impairment(s)	Sources of Impairment(s)
Drury Creek	IL_NDC-02	1.43	Dissolved Oxygen	Acid Mine Drainage, Highway/Road/Bridge Runoff(Non-construction Related), Impacts from Abandoned Mine Lands (Inactive), Streambank Modifications/destabilization, Crop Production (Crop Land or Dry Land), Agriculture
Indian Creek	IL_NDCB-01	4.37	Alteration in stream-side or littoral vegetative covers, Low flow alterations, Dissolved Oxygen, Changes in Stream Depth and Velocity Patterns	Streambank Modifications/destabilization, Habitat Modicication-other than Hydromodification, Loss of Riparian Habitat, Crop Production (Crop Land or Dry Land), Agriculture
Sycamore Creek	IL_NDCA	5.66	Dissolved Oxygen, pH	Acid Mine Drainage, Impacts from Abandoned Mine Lands (Inactive), Loss of Riparian Habitat, Crop Production (Crop Land or Dry Land), Agriculture

Source: 2016 IEPA integrated Water Quality Report and 303(d) Lists

The information contained in the 303 (d) section also lists the impaired designated use and causes of impairment. The following table summarizes the causes and sources of impairment for Drury Creek, Indian Creek, and Sycamore Creek. Aquatic Life is the only impaired designated use for all three 303(d) waterbodies. Dissolved oxygen is the cause of impairment for all three waterbodies, while Sycamore Creek is also impaired due to pH levels.

Table 2.56- 303(d) Information for Indian Creek- Drury Creek Subwatershed

Waterbody	Assessment Unit ID	Size	Impaired Designated Use (s)	Causes of Impairment(s)
Drury Creek	IL_NDC-01	19.39	Aquatic Life	Dissolved Oxygen
Indian Creek	IL_NDCB-01	4.37	Aquatic Life	Dissolved Oxygen
Sycamore Creek	IL_NDCA	5.66	Aquatic Life	Dissolved Oxygen, pH

Source: 2016 IEPA integrated Water Quality Report and 303(d) Lists

Little Crab Orchard Creek Subwatershed (071401060809)

Table 2.57 outlines the designated uses and assessment status of 305(b) waterbodies within Little Crab Orchard Creek subwatershed, as identified in the Illinois Integrated Water Quality Report and Section 303(d) List for 2016.

There are five streams and two lakes that were assessed in the report. They are Big Muddy River, Eek Creek, Little Crab Orchard Creek- West, Piles Fork Creek, Crab Orchard Creek; which had five assessed reaches, Campus Lake, and Carbondale City Lake. Aquatic Life was assessed for all nine stream reaches and both lakes; and was only fully supported in Crab Orchard Creek (Reach IL_ND-01, 12, & 13), Campus Lake, and Carbondale City Lake. Fish Consumption was assessed in 2016 for Big Muddy River, Crab Orchard Creek (ND-01, ND-02, ND-12, ND-13), Campus Lake, and Carbondale City Lake. Fish Consumption was only Fully Supported in Crab Orchard Creek, Reach ND-12 and ND-13. Aesthetic Quality was only fully supported for Crab Orchard Creek (ND-01), Eek Creek, and Piles Fork Creek.

Information from the 303(b) Assessment regarding the cause and source for waterbody impairments can be found in *Tables 2.58 and 2.59*. The common causes of impairment are dissolved oxygen, mercury, methoxychlor, and alterations in streamside or littoral vegetation cover. The common source of impairment is caused by agriculture.

Table 2.57 – Little Crab Orchard Creek- Crab Orchard Creel 305(b) Waterbodies

Little Crab Orchard Creek- Crab Orchard Creek				
Stream Name & Assessment ID	**Designated Use**	**Use ID**	**Assessed in 2016 Integrated Report**	**Use Attainment**
Piles Fork Creek (IL_NDB-03)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting
Campus Lake (IL_RNZH)	Aquatic Life	582	Yes	Fully Supporting
	Fish Consumption	583	Yes	Not Supporting
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Not Supporting
Carbondale City Lake (IL_RNI)	Aquatic Life	582	Yes	Fully Supporting
	Fish Consumption	583	Yes	Not Supporting
	Public and Food Processing Water Supplies	584	Yes	Fully Supporting
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Not Supporting

Table 2.57 (cont'd) - Little Crab Orchard Creek- Crab Orchard Creek Watershed 305(b) Waterbodies

Little Crab Orchard Creek- Crab Orchard Creek				
Stream Name & Assessment ID	**Designated Use**	**Use ID**	**Assessed in 2016 Integrated Report**	**Use Attainment**
Big Muddy River (IL_N-16)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	Yes	Not Supporting
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A
Crab Orchard Creek (IL_ND-01)	Aquatic Life	582	Yes	Fully Supporting
	Fish Consumption	583	Yes	Not Supporting
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting
Crab Orchard Creek (IL_ND-02)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	Yes	Not Supporting
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A
Crab Orchard Creek (IL_ND-11)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	No	N/A
Crab Orchard Creek (IL_ND-12) (IL_ND-13)	Aquatic Life	582	Yes	Fully Supporting
	Fish Consumption	583	Yes	Fully Supporting
	Aesthetic Quality	590	No	N/A
Eek Creek (IL_NDBA-01)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting
Little Crab Orchard Creek-West (IL_NDA-01)	Aquatic Life	582	Yes	Not Supporting
	Fish Consumption	583	No	N/A
	Primary Contact Recreation	585	No	N/A
	Secondary Contact	586	No	N/A
	Aesthetic Quality	590	Yes	Fully Supporting

Table 2.58 - 303(d) Information for Little Crab Orchard Creek- Crab Orchard Creek Subwatershed

Waterbody	Assessment Unit ID	Size (miles)	Impaired Designated Use (s)	Causes of Impairment(s)
Big Muddy River	IL_N-16	11.79	Aquatic Life	Sedimentation/Siltation, Dissolved Oxygen
Big Muddy River	IL_N-16	11.79	Fish Consumption	Mercury
Crab Orchard Creek	IL_ND-01	10.41	Fish Consumption	Mercury
Crab Orchard Creek	IL_ND-11	1.01	Aquatic Life	Cause Unknown
Eek Creek	IL_NDBA-01	3.61	Aquatic Life	Dissolved Oxygen, Water Temperature
Little Crab Orchard Creek-West	IL_NDA-01	13.92	Aquatic Life	Methoxychlor
Piles Fork Creek	IL_NDB-03	7.2	Aquatic Life	Methoxychlor
Carbondale City Lake	IL_RNI	135.6	Aesthetic Quality	Total Suspended Solids (TSS)
Carbondale City Lake	IL_RNI	135.6	Fish Consumption	Mercury
Campus	IL_RNZH	40.0	Aesthetic Quality	Total Suspended Solids (TSS)
Campus	IL_RNZH	40.0	Fish Consumption	Mercury, Polychlorinated biphenyls

Table 2.59 - Little Crab Orchard Creek- Crab Orchard Creek Watershed 303(d) Waterbodies

Waterbody	Assessment Unit ID	Size	Causes of Impairment(s)	Sources of Impairment(s)
Big Muddy River	IL_N-16	11.79	Dissolved Oxygen, Sedimentation/Siltation, Mercury	Non-irrigated Crop Production, Natural Sources, Atmospheric Deposition- Toxics, Source Unknown
Crab Orchard Creek	IL-ND-01	10.4	Mercury	Atmospheric Deposition-Toxics, Source Unknown
Crab Orchard Creek	IL-ND-02	2.1	Manganese, Other flow regime alterations, Dissolved Oxygen	Source Unknown, Impacts from Hydrostructure Flow Regulations/modification, Upstream Impoundments
Crab Orchard Creek	IL-ND-11	1	Dissolved Oxygen, Cause Unknown	Source Unknown
Eek Creek	IL_NDBA-01	3.6	Alteration in stream-side or littoral vegetative covers, Dissolved Oxygen, Water Temperature, Loss of Instream Cover	Channelization, Industrial Land Treatment, Loss of Riparian Habitat, Rcra Hazardous Waste Sites, Crop Production (Crop Land or Dry Land), Agriculture, Habitat Modification- other than Hydromodification
Little Crab Orchard Creek-West	IL_NDA-01	13.9	Alteration in stream-side or littoral vegetative covers, Methoxychlor, Dissolved Oxygen	Loss of Riparian Habitat, Streambank Modifications/destabilization, Crop Production (Crop Land or Dry Land), Urban Runoff/Storm Sewers, Livestock (Grazing or Feeding Operations)
Piles Fork	IL_NDB-03	7.2	Alteration in stream-side or littoral vegetative covers, Methoxychlor, Other flow regime alterations, Dissolved Oxygen	Highway/Road/Bridge Runoff (Non-construction related), Impacts from Hydrostructure Flow Regulations/modification, Streambank Modifications/destabilization, Urban Runoff/Storm Sewers, Upstream Impoundments
Campus Lake	IL_RNZH	41.2 ac	Mercury, Polychlorinated biphenyls, Total Suspended Solids(TSS), Phosphorus(Total)	Atmospheric Deposition-Toxics, Source Unknown, Other Spill Related Impacts, Waterfowl, Urban Runoff/Storm Sewers, Runoff from Forest/Grassland/Parkland
Carbondale City Lake	IL_RNI	132.9 ac	Mercury, Total Suspended Solids(TSS), Phosphorus (Total)	Atmospheric deposition-Toxics, Source Unknown, Littoral/shore Area Modifications (Non-riverine), Municipal Point Source Discharges, Urban Runoff/Storm Sewers, Runoff from Forest/Grassland/Parkland

2.8.2. Supplementary Monitoring and Strategies

In accordance with the Clean Water Act, impaired waterbodies are required to have a Total Maximum Daily Load (TMDL) be developed for each pollutant. CDM Smith, an engineering and construction firm, developed a TMDL for Crab Orchard Watershed in 2008. The Crab Orchard watershed is a 185,000-acre watershed that encompasses all three HUC 12 watersheds in our planning area. *The Crab Orchard Watershed TMDL Report* [37] was designed to provide detailed information for HUC 12 watersheds within the planning area.

The *Illinois Nutrient Loss Reduction Strategy* (ILNLRS) is a collaborative effort between the Illinois Water Resources Center, IEPA, and the Illinois Department of Agriculture. The strategy prioritizes watersheds that are expected to have the greatest capacity to reduce high volumes of nutrient loss annually. All three HUC 12 watersheds in our planning area are located in the Big Muddy River Watershed (HUC 07140106), which is an IEPA priority watershed for addressing total phosphorus losses from nonpoint sources. Further information about the ILNLRS can be found in *Section 8.8.*

Volunteer Lake Monitoring Program

Since 1984, Greater Egypt has coordinated the VLMP for southern Illinois' ten-county region. This volunteer-based program is maintained by the IEPA. The monitoring season begins May 1st and concludes October 31st with volunteers monitoring their lakes twice a month. Program participants are required to have access to a boat and anchor. Training is provided by the Regional Coordinator for southern Illinois.

Volunteers are divided into three tiers. Tier I is the most basic, while Tier II and III require previous participation in the program. Participation is dependent on funding and supplies from IEPA. The level of monitoring is dependent on the tier level of the volunteer.

Tier I:
Basic lake monitoring. Volunteers measure lake water clarity with a Secchi Disk and make other basic lake observations. Volunteers record the level of aquatic plant growth, record the siting of any invasive species, the lake water level, weather, and watershed conditions at the time of monitoring.

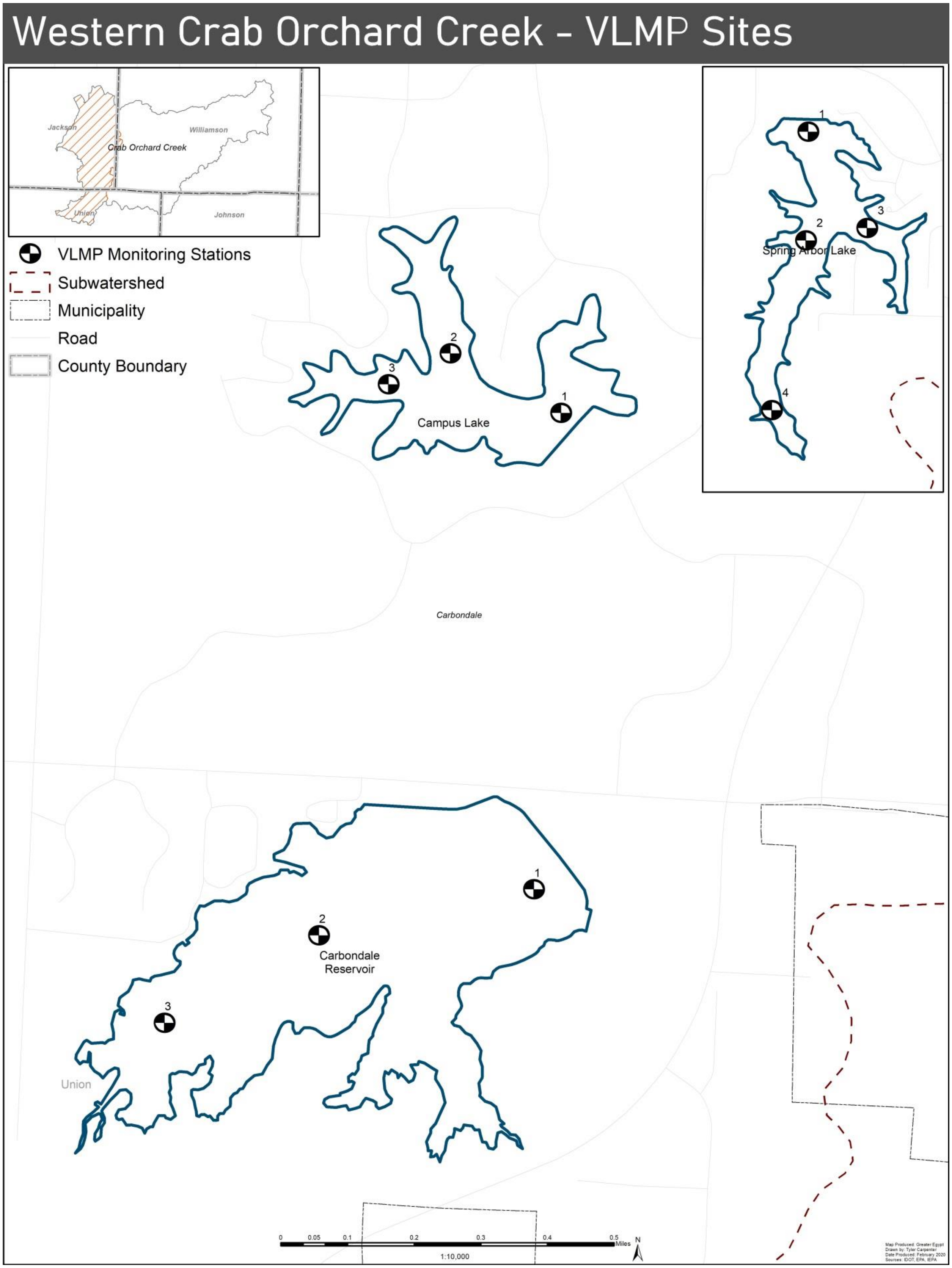
37 CDM. Crab Orchard Watershed TMDL Report.

Tier II:
After actively participating in Tier I, volunteers are eligible for Tier II monitoring. Tier II volunteers complete Tier I monitoring while also taking lake water samples.

Tier III:
In addition to collecting water samples, volunteers also collect chlorophyll samples as well as measure oxygen levels and water temperatures.

Three lakes in the Western Crab Orchard Creek watershed have been participants in the program with Tier II status. These include Campus Lake, Carbondale Reservoir, and Spring Arbor Lake. Nearby Cedar Lake, the water supply for Carbondale and Makanda, is also monitored through the program. A site map for the lake locations can be viewed in *Figure 2.55*.

Figure 2.55


Western Crab Orchard Creek - VLMP Sites
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
VLMP Monitoring Stations
Subwatershed
Municipality
Road
County Boundary
Campus Lake
1
2
3
Spring Arbor Lake
4
Carbondale
Carbondale Reservoir
Union
0
0.05
0.1
0.2
0.3
0.4
0.5
Miles
1:10,000
N
Map Produced: Greater Egypt
Drawn by: Tyler Carpenter
Date Produced: February 2020
Sources: IDOT, EPA, IEPA

Reports and Projects from Campus Lake (SIUC)

Because Campus Lake sits within, and is owned by Southern Illinois University Carbondale it acts as a study site for a multitude of research projects by faculty and students at the university. Two past projects are summarized below:

Diagnostic/Feasibility Study of Campus Lake, Southern Illinois University Carbondale, Jackson County, Illinois, 2004.

Prepared by Southern Illinois University Carbondale: C. Muchmore, J. Stahl, E. Talley, and F.M. Wilhelm
In Cooperation with Illinois Environmental Protection Agency

This report was funded by the Illinois Clean Lakes program and included collaboration between the SIU College of Engineering, College of Science, and Center for Environmental Health and Safety. It includes extremely detailed summaries of limnological and geological data, population and economic statistics, pollution loadings, and trophic interactions. The report also lays out proposed strategies for improving the water quality, erosion, and recreation opportunities. BMPs proposed in this plan are summarized below.

> To reduce pollutant and sediment loads in Campus Lake, it was suggested to install stepped sediment basins from horticulture pond to the lake, construct a stormwater wetland, and increase the size and efficiency of storm-drain catchments.
>
> Proposed in-lake methods included aeration devices and manipulation of fish populations.
>
> To reduce shoreline erosion, installment of rip-rap and new asphalt footpaths were proposed.
>
> To improve recreation access, it was proposed to update existing facilities to comply with ADA standards and create a new accessible fishing pier.
>
> Other recommendations were to monitor zooplankton and fish populations, continued water quality monitoring, and enhance public education.

Campus Lake Sustainable Eco-Recreation Projects: 2017- ongoing

Led by Dr. Marjorie Brooks, SIU Dept of Zoology in collaboration with the Department of Engineering, Physical Plant, Student Recreation, and Campus Sustainability personnel.

Campus Lake has had a recurring issue of Harmful Algal Blooms (HABs). Not only do these events lower water quality and pose a threat to aquatic life, they are dangerous to people and pets. When HABs occur, the lake closes to all recreation activities. Considered "one of the jewels of SIU campus", it is unfortunate that students, staff, and the public lose access to the lake, sometimes for weeks to months at a time. It can also be an eyesore when warning signs and visible sheens of algae are visible.

In order to mitigate the effects of HABs, the Sustainable Eco-Recreation Project was started in fall of 2017. This included a multitude of projects with collaboration of many professors and students[38]:

- Design and prototype inventions for aeration and cooling of the lake to prevent algal blooms
    - solar powered fountains
    - stationary bicycle powered aerators
    - obstacle courses for paddleboats and canoes
- Public surveys to get a baseline of opinions on Campus Lake
- Wetland restoration
- Water quality testing
- Informational presentations and brochures

These projects provide hands-on experience for students and aim to make the lake a better place for the whole community to enjoy. Details and updates on the projects can be found at news.siu.edu

38 Brooks, Marjorie, "Sustainable Eco-Recreation Report", Green Fund Project, Final Report, December 2018.

2.8.3. Water Quality of Impaired Lakes and Streams

Campus Lake (IL_RNZH)

The 2016 Illinois Integrated Water Quality Report states the designated uses of Campus Lake to be aquatic life, fish consumption, primary contact recreation, secondary contact, and aesthetic quality. Designated uses not being fully supported are fish consumption and aesthetic quality. The causes of impairment include: total suspended solids (TSS), mercury, and polychlorinated biphenyls. Potential sources of these impairments include: atmospheric deposition-toxics, source unknown, other spill related impacts, waterfowl, urban runoff/ storm sewers, and runoff from forest/grassland/parkland. The IEPA has established four monitoring stations within Campus Lake, which are displayed in *Table 8.11*. Locations of these sites are detailed in the following table.

Table 2.60 - Campus Lake IEPA Monitoring Stations

Station Code	County	Station Location
RNZH-1	Jackson	Site 1 Near Dam
RNZH-2	Jackson	Site 2 Mid Lake Confl with W Arm
RNZH-3	Jackson	Site 3 Middle N Arm
RNZH-4	Jackson	Site 4 Near Dam

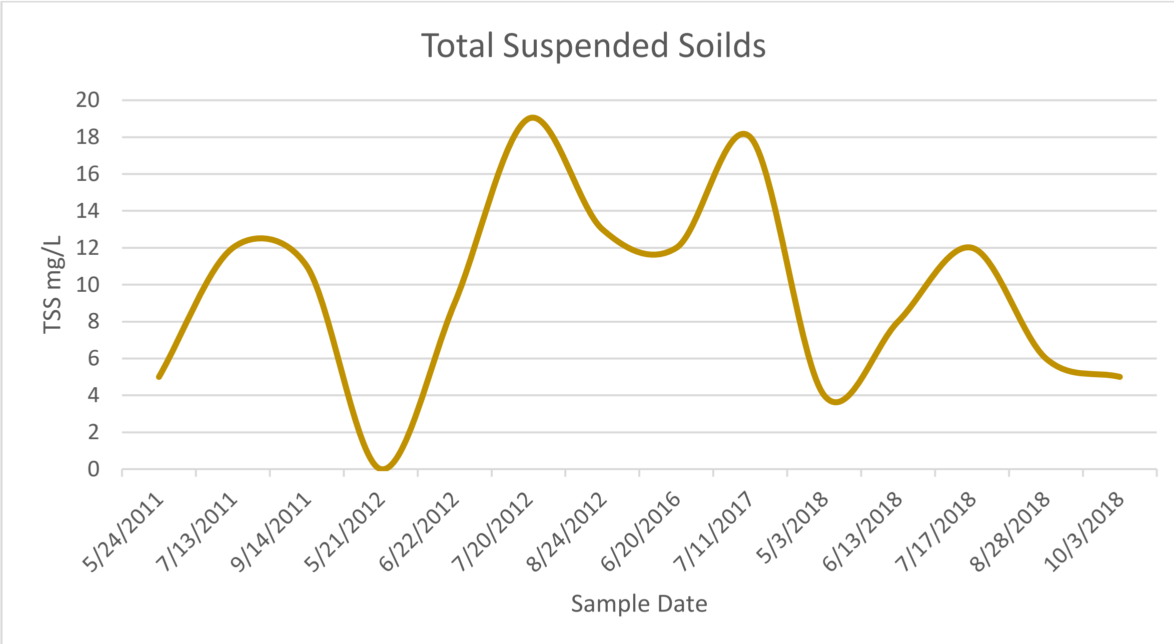
Source: RMMS (IEPA)

Water Quality data for Campus Lake was provided by IEPA and includes years 2011, 2012, 2016, 2017, 2018, and 2019. While a variety of analytes were tested, focus will be directed towards nutrients causing the impairments. It is important to note that data for Campus Lake has a qualifier of "W", which is defined as "Quality assurances/quality control of sample collection, handling, or processing is not sufficient to justify Illinois EPA use of this result for Clean Water Act sections 305(b)/303(d) reporting and related purposes". Since it is the only data available to us, we decided it was still useful to include in this report.

Total Suspended Solids

Total suspended solids are the cause of impairment for aesthetic quality. Currently there is no numeric standard for total suspended solids. TSS values in the graph are recorded at varying intervals and some years are missing from available data. Samples were taken at Station Code: RNZH-1.

Figure 2.56 - RNZH-1 Total Suspended Solids



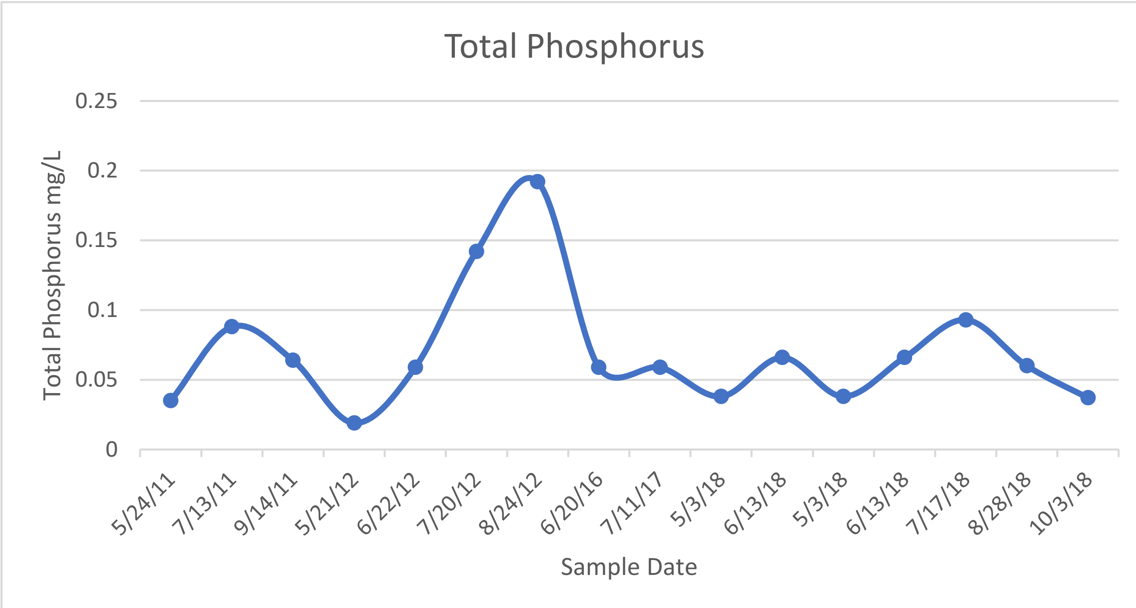
Source: IEPA

Total Phosphorus

The Illinois Water Quality Standard for phosphorus is not to exceed 0.05 mg/L for any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more.[39] Several readings for Campus Lake exceed the water quality standard for phosphorus. Total phosphorus values in the graph are recorded at varying intervals based on available data. Some years are missing from the data. Samples were taken at Station Code: RNZH-1.

39 Illinois Pollution Control Board. Title 35: Environmental Protection-Subtitle C: Water Pollution-part 302 Water Quality Standards, Subpart A: General Water Quality Provisions. PDF. Accessed March 2020.

Figure 2.57 - RNZH-1 Total Phosphorus

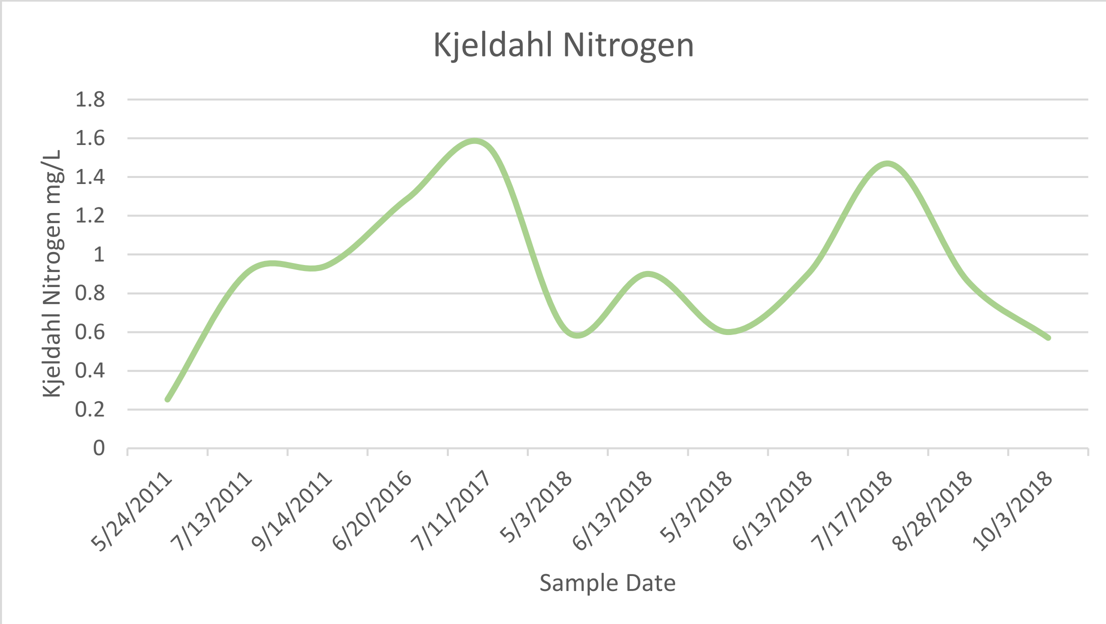


Source: IEPA

Total Kjeldahl Nitrogen

Illinois currently has no water quality standard for total Kjeldahl nitrogen related to aquatic life use. TKN values in the graph are recorded at varying intervals based on available data. Some years are missing from the data. Samples were taken at Station Code: RNZH-1.

Figure 2.58 - RNZH-1 Kjeldahl Nitrogen



Source: IEPA

Mercury

Mercury is the cause of impairment for fish consumption within Campus Lake. The only available data for mercury in Campus Lake comes from year 2007. The results are from three different stations around the lake. Results are displayed in *Table 2.61*. A technical support document published by the EPA in 2006 describes mercury as, "a toxic metal that is of significant concern as an environmental pollutant. It exists in the environment naturally and as a product of man-made processes, including waste incineration and fossil fuel combustion. Mercury is a persistent environmental contaminant, which cannot be degraded or destroyed".[40]

40 EPA. Technical Support Document for Reducing Mercury Emissions from Coal-Fired Electric Generating Units. Springfield, IL: EPA, March 14,2006. PDF.

Table 2.61 - 2007 Mercury Sample Results

Station Code	Sample Depth (ft)	Collection Date	Result (mg/kg)	Weight Basis	Result Particle Size Basis
RNZH-2	11	9/21/2007	0.11	dry	Unsieved
RNZH-3	5	9/21/2007	0.04	dry	Unsieved
RNZH-4	16	9/21/2007	0.1	dry	Unsieved

Source: IEPA

Carbondale Reservoir (IL_RNI)

The 2016 Illinois Integrated Water Quality Report states the designated use of Carbondale Reservoir to be aquatic life, fish consumption, public and food processing water supplies, primary contact recreation, secondary contact, and aesthetic quality. Designated uses not being fully supported are fish consumption and aesthetic quality. The causes of impairment include: mercury, total suspended solids (TSS), and total phosphorus. Potential sources of these impairments include: atmospheric deposition-toxics, source unknown, littoral/shore area modifications (non-riverine), municipal point source discharges, urban runoff/storm sewers, and runoff from forest/grassland/parkland.

The IEPA has established six monitoring stations within Carbondale Reservoir, which are displayed in *Table 2.62*. Locations of these sites are detailed in the following table.

Table 2.62 - Carbondale Reservoir IEPA Monitoring Stations

Station Code	County	Station Location
RNI-1	Jackson	Site 1 near dam
RNI-2	Jackson	Site 2 mid lake
RNI-3	Jackson	Site 3 SW end of lake
RNI-4	Jackson	Site 4- 1978
RNI-101	Jackson	-
RNI-102	Jackson	-

Source: IEPA

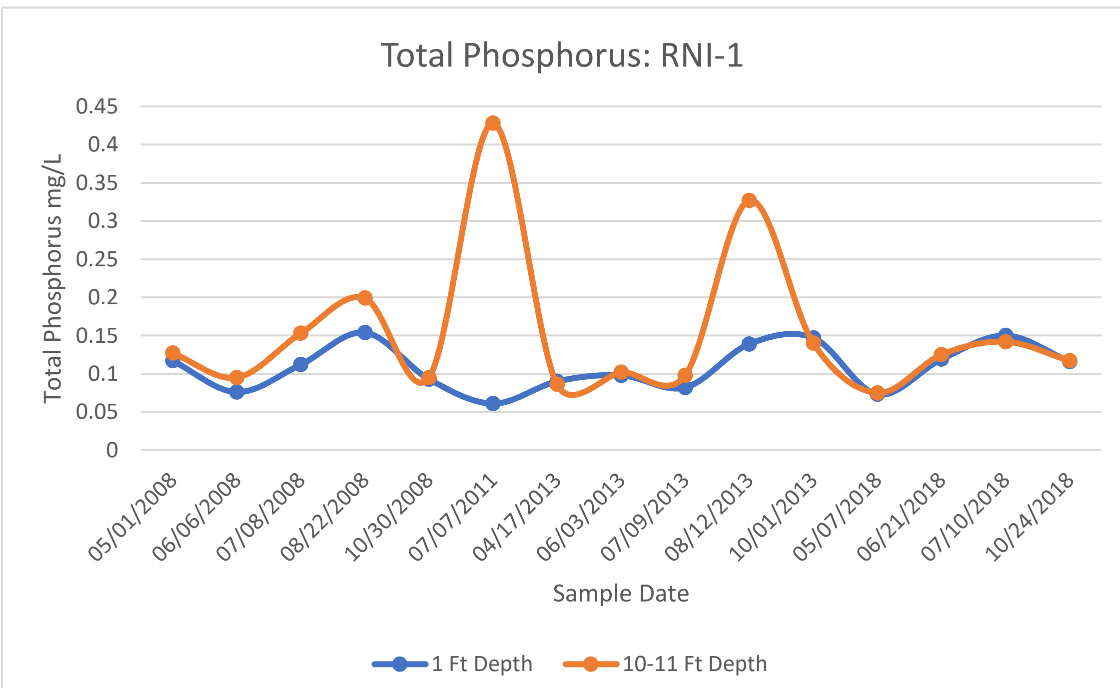
Water quality data for Carbondale Reservoir was provided by IEPA and includes years 2008, 2011, 2013, and 2018. While a variety of analytes were tested, focus will be directed towards nutrients causing the impairments.

Total Phosphorus

The Illinois Water Quality Standard for phosphorus is not to exceed 0.05 mg/L for any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more.[41] Several readings for Carbondale Reservoir exceed the water quality standard for Phosphorus. Total phosphorus values in the graph are recorded at varying intervals based on available data. Some years are missing from the data. Samples were taken at Station Code: RNI-1, RNI-2, and RNI-3. Separate graphs were created for the 3 different locations.

Station code RNI-1 has readings from sample depth of 1 ft, 10 ft, and 11ft. Depths of 10ft and 11ft were combined for this graph.

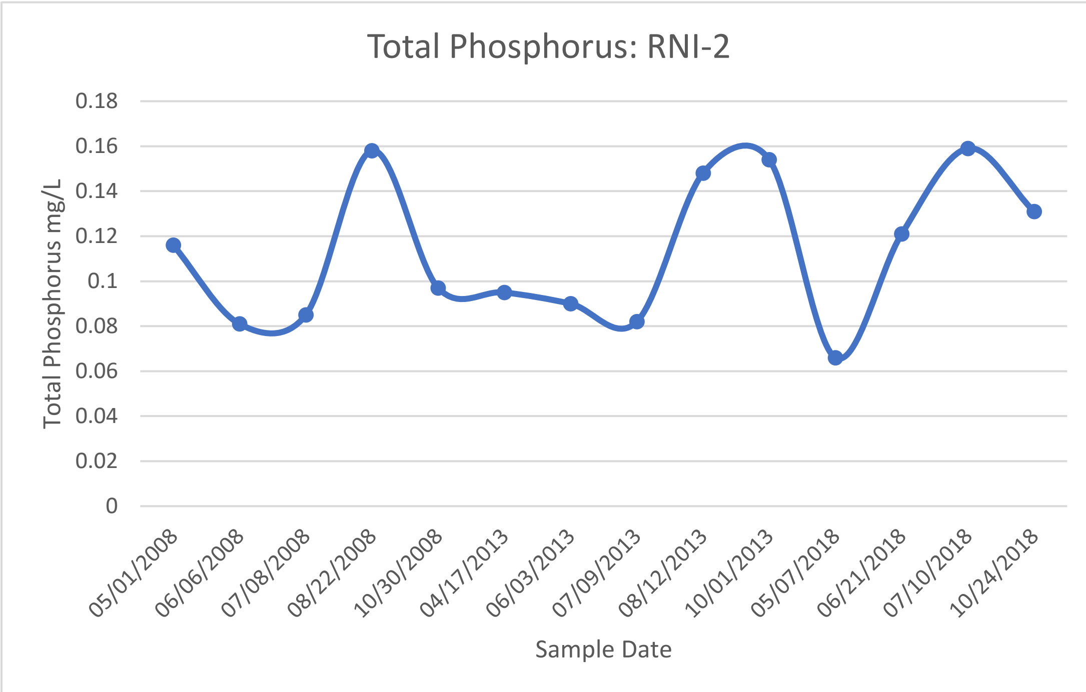
Figure 2.59 - RNI-1 Total Phosphorus



Source: IEPA

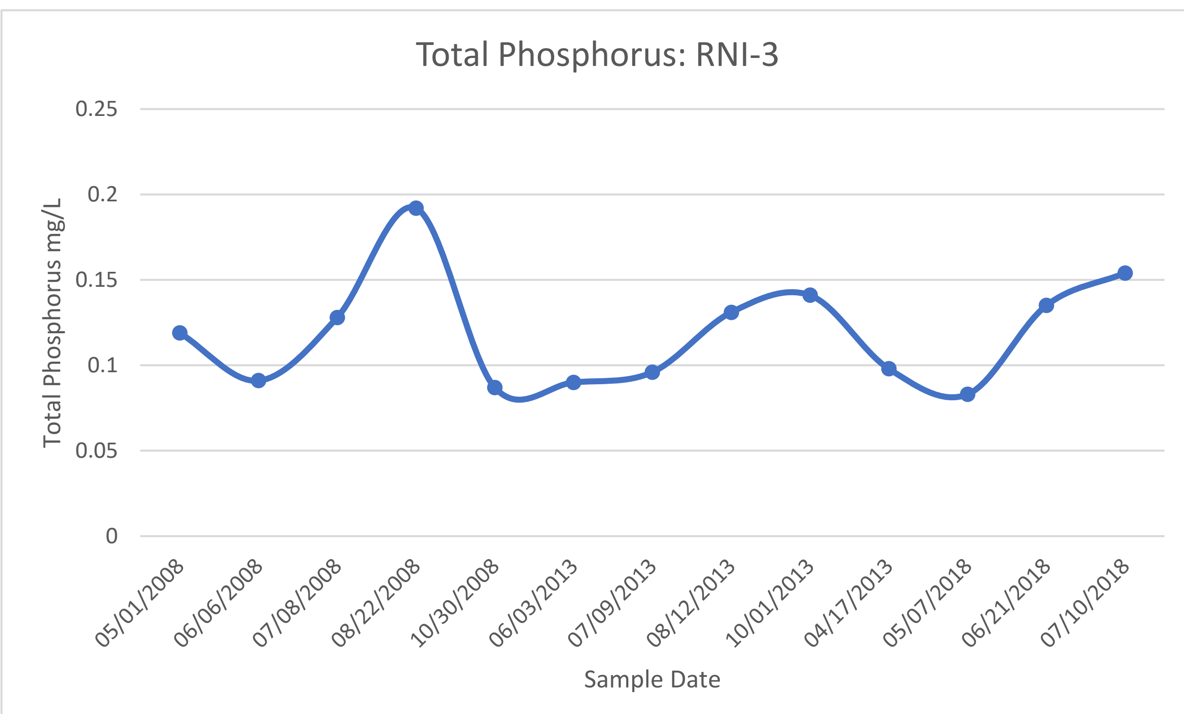
41 Illinois Pollution Control Board. Title 35: Environmental Protection-Subtitle C: Water Pollution-part 302 Water Quality Standards, Subpart A: General Water Quality Provisions. PDF. Accessed March 2020.

Figure 2.60 - RNI-2 Total Phosphorus



Source: IEPA

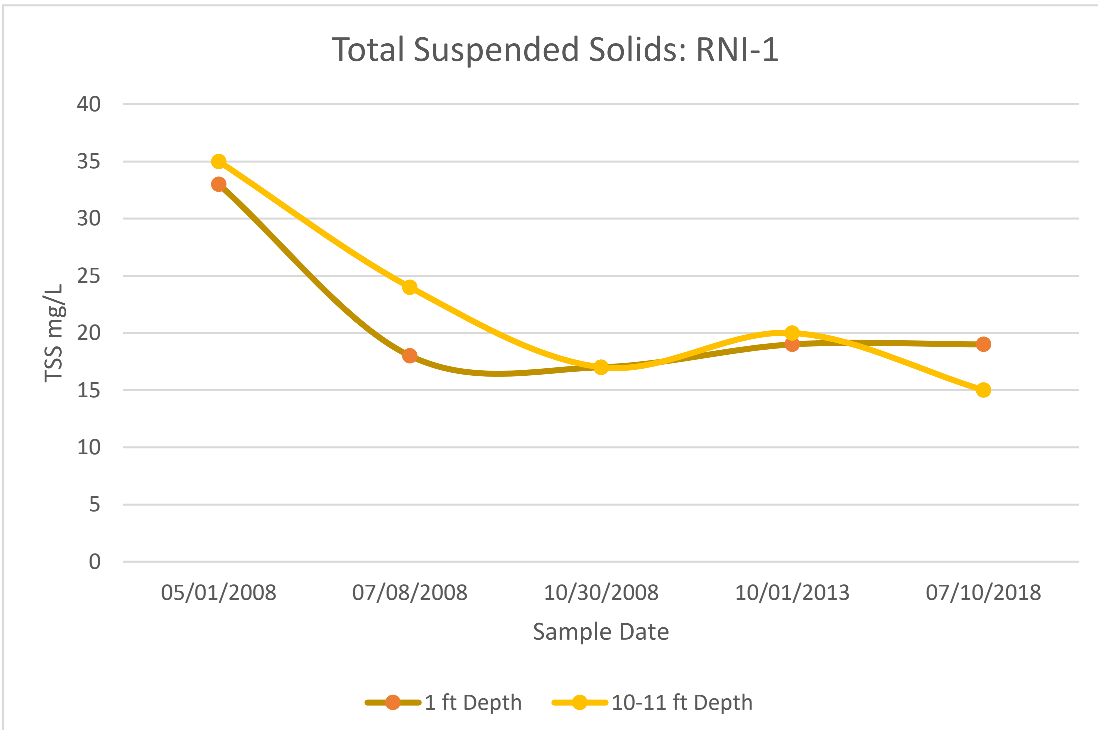
Figure 2.61 - RNI-3 Total Phosphorus



Total Suspended Solids

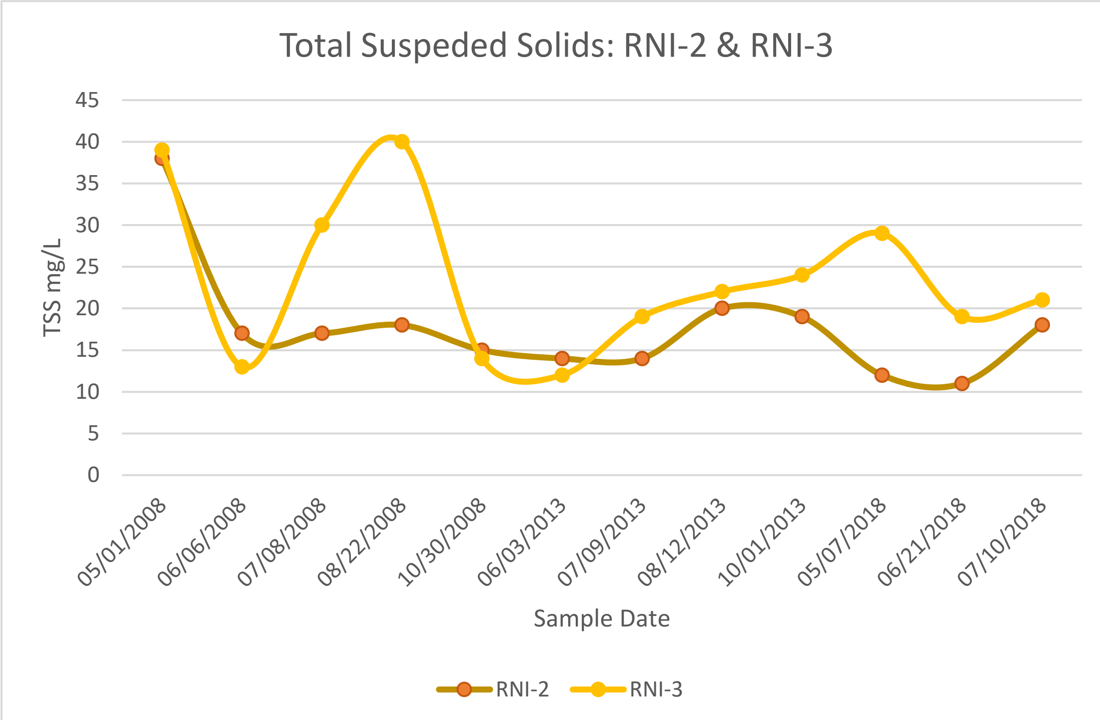
Total suspended solids are the cause of impairment for aesthetic quality. Currently there is no numeric standard for total suspended solids. TSS values in the graph are recorded at varying intervals and some years are missing from available data. Samples were taken at Station Code: RNI-1, RNI-2, and RNI-3. Station RNI-1 had more limited sample dates and could not be combined with the other stations in the graph. RNI-1 also had water samples taken at different depths, whereas RNI-2 and RNI-3 solely had water samples taken at 1ft depth.

Figure 2.62 - RNI-1 Total Suspended Solids



Source: IEPA

Figure 2.63 - RNI-2 & 3 Total Suspended Solids



Source: IEPA

Mercury

Mercury is the cause of impairment for fish consumption within Carbondale Reservoir. Data is limited for mercury and has not been tested since 2011.

Table 2.63 - Carbondale Reservoir Mercury Sample Results

Station Code	Sample Depth (ft)	Collection Date	Result (mg/kg)	Weight Basis	Result Particle Size Basis
RNI-1	13	08/22/2008	0.07	dry	Unsieved
RNI-3	3	08/22/2008	0.05	dry	Unsieved
RNI-1	13	07/07/2011	0.08	dry	

Crab Orchard Creek (IL_ND-01)

The only stream segment with sufficient data from multiple years is for Crab Orchard Creek. The 2016 Illinois Integrated Water Quality Report states the designated uses of Crab Orchard Creek to be aquatic life, fish consumption, secondary contact, and aesthetic quality. The designated use not being fully supported is fish consumption. The cause of impairment is mercury and potential sources of impairment are atmospheric deposition-toxics and an unknown source.

The IEPA has established two monitoring stations for Crab Orchard Creek. Locations of these sites are detailed in the following table.

Table 2.64 - NDA-01 IEPA Water Monitoring Stations

Station Code	County	Station Location
ND-01	Jackson	Dillinger Rd, 1.1 mi W of reed station Rd and 3 mi NE of Carbondale
ND-99	Williamson	Below Crab Orchard LK Dam NR Carterville

Source: IEPA

Mercury

Data for mercury testing in Crab Orchard Creek is sparse. The last available reading is from 2008. The results are displayed in the table below.

Table 2.65 - Crab Orchard Creek Mercury Sample Results

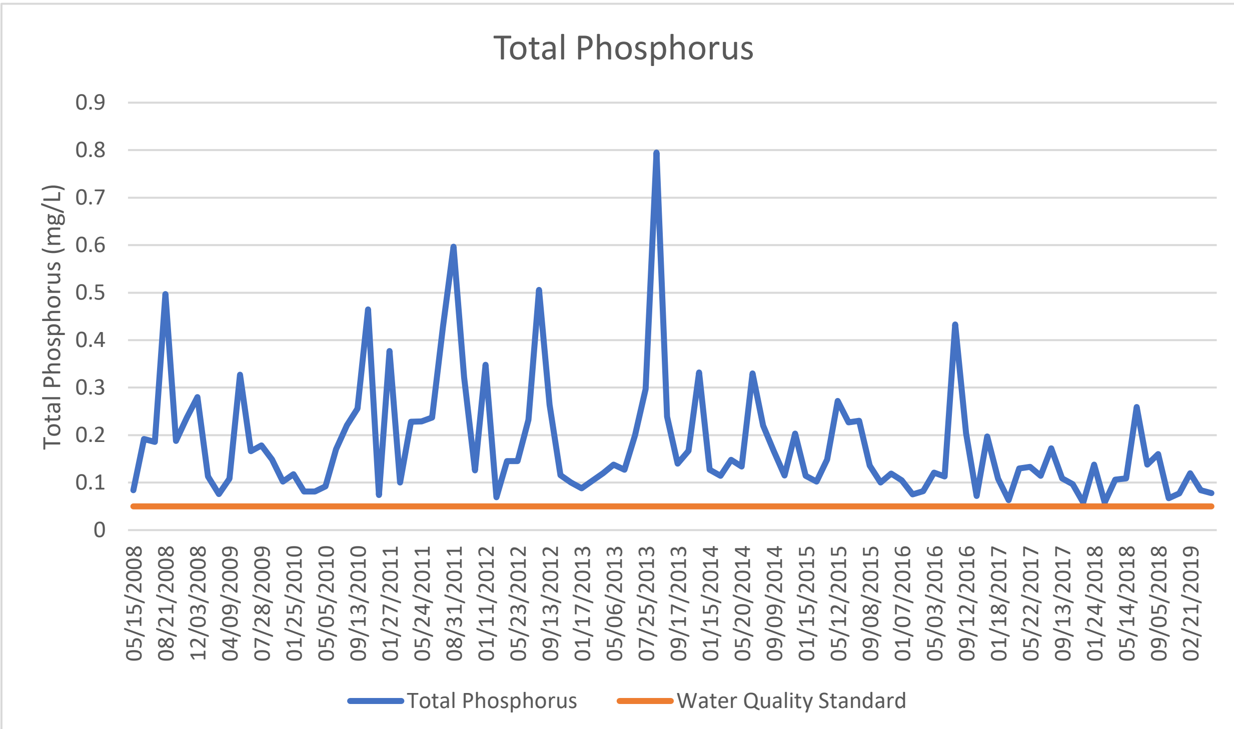
Station Code	Collection Date	Result (mg/kg)	Weight Basis	Result Particle Size Basis
ND-01	8/21/2008	0.04	dry	Wet sieve (<63u)

Source: IEPA

Total Phosphorus

Total phosphorus values in the graph are recorded at varying intervals based on available data. All water samples tested are above the water quality standard set at 0.05mg/L.

Figure 2.64 - IL_ND-01 Total Phosphorus

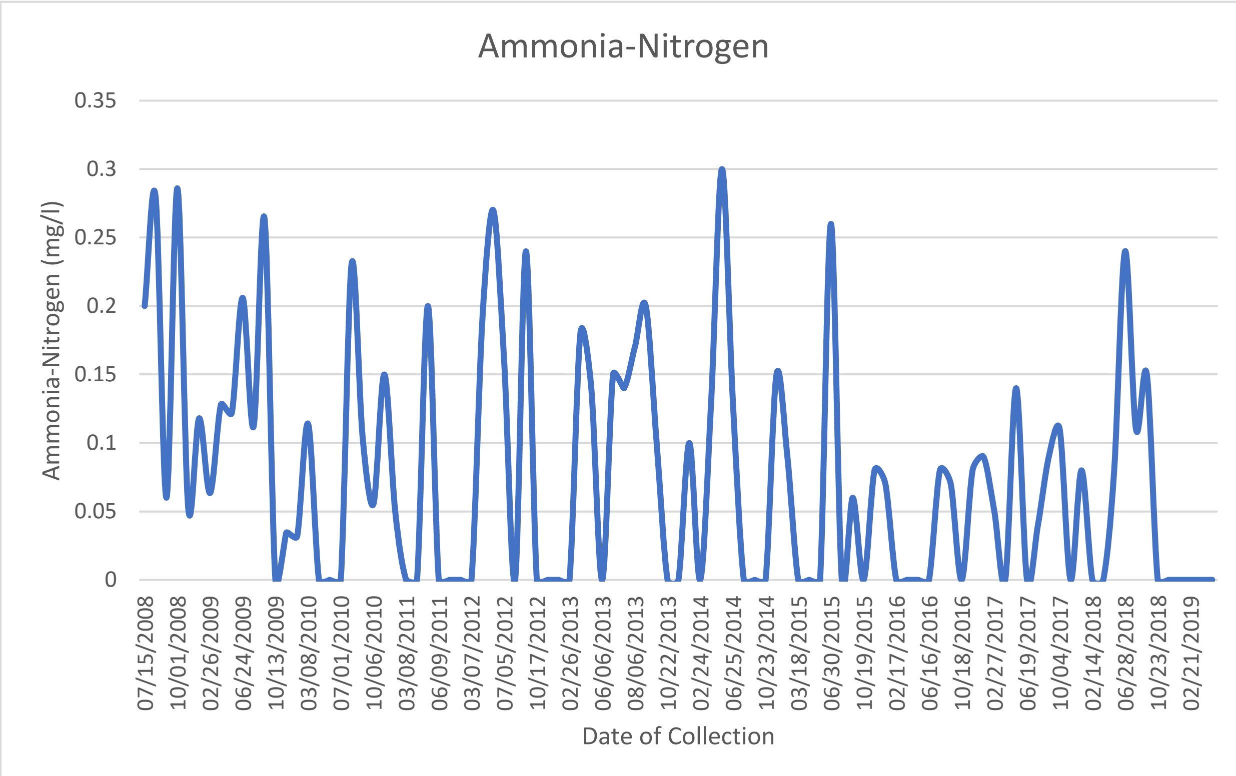


Ammonia-Nitrogen

Total ammonia-nitrogen was measured from year 2008 to 2019. The Illinois Water Quality Standard for Total ammonia nitrogen is 15 mg/L.[42] All readings are well below the EPA recommended level. Ammonia is a form of nitrogen that exists in aquatic environments and is toxic to aquatic life. [43]

42 Illinois Pollution Control Board. Title 35: Environmental Protection-Subtitle C: Water Pollution-part 302 Water Quality Standards, Subpart A: General Water Quality Provisions. PDF. Accessed March 2020.
43 United States Environmental Protection Agency. Aquatic Life Ambient Water Quality Criteria for Ammonia- Freshwater. Washington D.C: August 2013. PDF.

Figure 2.65 - IL_ND-01 Ammonia Nitrogen



2.8.4. Local Water Quality Assessment

To address water quality at the local level, an assessment has been completed for the municipalities within the Western Crab Orchard Creek planning area. This assessment was designed to review the latest water quality reports submitted by those municipalities. Carbondale City obtains water from two source lakes. Their main and primary source of water is Cedar Lake, with a backup source being the City Reservoir. Makanda Village includes the South Highway Water District and Buncombe Water District, which both purchase their water from the City of Carbondale. Cobden Village sources their drinking water from three ground water wells. The City of Carbondale report and the Cobden Village report have been utilized for this assessment.

Each municipality is required to test certain organic and inorganic contaminants. Regulated contaminants consist of: Lead, Copper, Chloramines, Haloacetic Acids, and Total Trihalomethanes. The following key represents the factors used in each water quality report.

> **Action Level (AL):** The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.
>
> **Maximum Contaminant Level Goal (MCLG):** The level of a contaminant in drinking water below which there is no known or known or expected risk to health. MCLGs allow for a margin of safety.
>
> **Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
>
> **ppb:** Micrograms per liter or parts per billion.
>
> **ppm:** Milligrams per liter or parts per million.
>
> **NTU:** Nephelometric Turbidity Unit, used to measure cloudiness in drinking water.

Table 2.66 displays the water quality reports for lead and copper. Both Carbondale and Cobden have a MCLG value of 1.3 ppm for copper and a MCLG value of 0 ppb for lead. Action Levels are set at 1.3 ppm for copper and 15 ppb for lead within each municipality and jurisdiction. While the reports for Carbondale and Cobden are for 2018, Carbondale sampled for both Copper and Lead in 2017. Cobden sampled for copper and lead on July 15th, 2016. Both Carbondale and Cobden are under triennial monitoring due to favorable monitoring history, specific high-tech treatment processes, regular sampling and quality laboratory testing. According to the water quality reports, no jurisdiction was in violation of lead or copper levels. Likely sources of lead consist of corrosion of household plumbing systems, and erosion of natural deposits. Sources of copper include erosion of natural deposits, leaching from wood preservatives, and corrosion of household plumbing materials.[44][45]

Table 2.66 – Lead and Copper Information

Municipality	Contaminants	MCLG	Action Level (AL)	90th Percentile	Sites Over Lead AL	Units	Violation	Likely Source of Contaminaion
Carbondale	Copper	1.3	1.3	0.0365	0	ppm	No	Erosion of natural deposits; leaching from wood preservatives; corrosion of household plumbing systems
	Lead	0	15	1.22	0	ppb	No	Corrosion of household plumbing systems; Erosion of natural deposits
Cobden	Copper	1.3	1.3	0.21	0	ppm	No	Erosion of natural deposits; leaching from wood preservatives; corrosion of household plumbing systems
	Lead	0	15	2.1	0	ppb	No	Corrosion of household plumbing systems; Erosion of natural deposits

Source: Carbondale and Cobden

Along with lead and copper, other regulated contaminants that are reported are chloramines, haloacetic acids and total trihalomethanes. The source of chloramines is likely a water additive used to control microbes. Haloacetic acids and trihalomethanes are by-products of drinking water disinfection. Information of these contaminants can be found in *Table 2.67*. Both Carbondale and Cobden are within the limits for each contaminant, and no violations have occurred.

Table 2.67- Municipal Water Quality: Regulated Contaminants

Municipality	Contaminant	Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Carbondale	Total Trihalomethanes	25.0	18.9-31.7	N/A	80	ppb	No	By-product of drinking water chlorination
	Haloacetic Acids	34.0	20.9-36.9	N/A	60	ppb	No	By-product of drinking water chlorination
	Chloramines	3.0	2.0-3.0	4.0	4.0	ppm	No	Water additive used to control microbes
Cobden	Total Trihalomethanes	5.0	5.0-5.0	N/A	80	ppb	No	By-product of drinking water chlorination
	Haloacetic Acids	1.0	1.07-1.07	N/A	60	ppb	No	By-product of drinking water chlorination
	Chlorine	1.4	0.55-1.73	MRDLG - 4	MRDL - 4	ppm	No	Water additive used to control microbes

Source: Carbondale and Cobden Water Quality Reports

44 Public Works Department, City of Carbondale. 2019. "Water Quality Report." Accessed September 9. https://explorecarbondale.com/Archive/ViewFile/Item/397
45 Village of Cobden. 2019. "Annual Drinking Water Quality Report." Accessed September 9. http://cobdenil.com/pdfs/information/CCR%202018%20to%20mail%202019.pdf

City of Carbondale Water Quality Report

Carbondale obtains drinking water from two source lakes. Their main and primary source being Cedar Lake, while the City Reservoir serves as a backup water supply. Buncombe Public Water District and South Highway Water District both serve Makanda's drinking water supply. They both purchase drinking water from the city of Carbondale.

The water report includes the parameters from the previous municipal water quality reports identified as regulated contaminants. In addition, inorganic contaminants were also reported. This category includes substances such as: Fluoride, Nitrate (As N), and Barium. Secondary/ State Regulated Contaminants included in the report are: Manganese, Chloride, Sodium, and Sulfate. The contaminants in all categories are within the regulated range designated by the EPA; therefore, no violations have occurred.

Turbidity, which is a measure of the cloudiness of the water caused by suspended particles, did get a single measurement exceeding the standard. It is noted in the water quality report that levels returned to normal within 24 hours and the water was safe to drink at all times.

Table 2.68 - 2019 Carbondale Water Quality Report

Contaminant		Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Disinfectants & Disinfection By-Products	Total Trihalomethanes	25.0	18.9-31.7	N/A	80	ppb	No	By-product of drinking water chlorination
	Haloacetic Acids	34.0	20.9-36.9	N/A	60	ppb	No	By-product of drinking water chlorination
	Chloramines	3.0	2.0-3.0	4.0	4.0	ppm	No	Water additive used to control microbes
Inorganic	Fluoride	0.70	0.65 - 0.70	4.0	4.0	ppm	No	Erosion of natural deposits; Water additive which promotes strong teeth; Fertilizer discharge and aluminum factories
	Nitrate	0.23	0.23 - 0.23	10.0	10.0	ppm	No	Runoff from fertilizer use; Leaching from septic tanks; sewage; Erosion of natural deposits
	Barium	0.022	0.022 - 0.022	2.0	2.0	ppm	No	Discharge of drilling wasters; Discharge from metal refineries; Erosion of natural deposits
Synthetic Organic	Simazine	0.38	0 - 0.38	4.0	4.0	ppb	No	Herbicide runoff
Secondary/ State Regulated	Manganese	2.4	2.4-2.4	150.0	150.0	ppb	No	Erosion of naturally occuring deposits
	Chloride	8.4	8.0-8.0	250	250	ppm	No	Erosion of naturally occuring deposits; used in water softener regeneration
	Sodium	17	17-17	N/A	N/A	ppm	No	Erosion of naturally occuring deposits; used in water softener regeneration
	Sulfate	26	26-26	250	250	ppm	No	Erosion of naturally occuring deposits / Water treatment

Turbidity	Limit (Treatment Technique)	Level Detected	Violation	Typical Source
Highest Single Measurement	1.0 NTU	2.47 NTU	Yes	Soil Run-Off
Lowest monthly % meeting limit	0.3 NTU	98%	No	

Source: City of Carbondale

Village of Cobden Water Quality Report

The source of drinking water used by Cobden is ground water. In the Annual Drinking Water Quality Report, Cobden lists three wells as their ground water source. The water quality report includes the parameters from the previous municipal water quality reports identified as regulated contaminants. In addition, inorganic contaminants were also reported. This category includes substances such as: barium, fluoride, manganese, nitrate (measured as nitrogen), sodium, and zinc. Radioactive contaminants reported include combined radium and gross alpha (excluding radon and uranium). The contaminants in all categories are within the regulated range designated by the EPA; therefore, no violations have occurred. Results are displayed in *Table 2.69*.

Table 2.69 - Village of Cobden Water Quality Report

Contaminant		Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Disinfectants & Disinfection By-Products	Total Trihalomethanes	5.0	5.0-5.0	N/A	80	ppb	No	By-product of drinking water disinfection
	Haloacetic Acids	1.0	1.07-1.07	N/A	60	ppb	No	By-product of drinking water disinfection
	Chlorine	1.4	0.55-1.73	MRDLG - 4	MRDL - 4	ppm	No	Water additive used to control microbes
Inorganic	Barium	0.038	0.038-0.038	2	2	ppm	No	Discharges of drilling wastes; Discharges from metal refineries; Erosion of natural deposits
	Fluoride	0.937	0.937-0.937	4	4	ppm	No	Erosion of natural deposits; water additive which promotes strong teeth; Discharge from fertilizer and aluminum
	Manganese	1	1.0-1.0	150	150	ppb	No	This contaminant is not currently regulated by the USEPA. However, the state regulated. Erosion of natural deposits.
	Nitrate (measured as Nitrogen)	1	1.0-1.0	10	10	ppm	No	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits
	Sodium	17	17-17	-	-	ppm	No	Erosion from naturally occuring deposits. Used in water softener regeneration
	Zinc	0.018	0.018-0.018	5	5	ppm	No	This contaminant is not currently regulated by the USEPA. However, the state regulates. Naturally occurring; discharge from metal
Radioactive	Combined Radium	1.45	1.45-1.45	0	5	pCi/L	No	Erosion of natural deposits.
	Gross alpha excluding radon and uranium	1.27	1.27-1.27	0	15	pCi/L	No	Erosion of natural deposits.

Source: Village of Cobden

Cedar Lake Water Quality Report

Cedar Lake is the primary source of drinking water for the city of Carbondale. Water samples from Cedar Lake are collected and tested at three different locations every month. The most recent report at the time of this review was January 22, 2020. Water quality reports are posted on a monthly basis, with no annual water quality review. The most up to date water quality test results can be found at explorecarbondale.com. Results from January's water quality test can be found below.

Table 2.70 - Cedar Lake January 2020 Water Quality Report

Sample #	pH	Ammonia, mg/L	Turbidity, NTU	Alkalinity, mg/L	D.Oxygen	Nitrite (NO2-N) IC SM 4110B"m:LOQ 0.15 mg/L	Nitrite (NO3-N) IC SM 4110B"m:LOQ 0.11 mg/L	Total Kjeldahl Kjeldahl Nitrogen, mg/L	Total Nitrogen-N, mg/L	Total Phosphorus, mg/L	
122019005	7.74	<.1	5.7	42	10.4	<0.15	0.42	3.4	4.4	0.04	
122019006	7.69	<.1		40	10.6	<0.15	0.47	1.6	2.6	0.04	
122019007	7.63	<.1	10.4	40	10.8	<0.15	0.49	2.8	4	0.11	

Sample #	Total Suspended Solids mg/L	Volatile Total Suspended Solids, mg/L	Volatile Total suspended solids, %	E Coli*, col/100-mL	Fecal Colform*, col/100-mL	Sample Collector	Weather	Lake Elevation, ft	Rainfall within 48 hours, in.	Depth of sample	Field Temp, oF
12220026	5	3	60%	8	4	Eric Stead	Overcast, cloudy	433	0	1 foot	40.7
12220027	8	8	100%	10	10	Eric Stead	Overcast, cloudy		0	1 foot	
12220028	9	7	78%	10	10	Eric Stead	Overcast, cloudy		0	15 foot	

Sample #	Sample Description	Sample Location GPS Coordinates	Date/time collected	Date/time received	composite	Grab	Date/Time Processed	Sample condition
12220026	NW Cedar Lake	37 o40'31.31N by 89 o17'11.97W	1/22/2020 1127	1/22/2020 1250		X	1/22/2020 1300	ACCEPTABLE
12220027	NE Cedar Lake	37 o40'6.52N by 89 o16'15.94W	1/22/2020 1135	1/22/2020 1250		X	1/22/2020 1300	ACCEPTABLE
12220028	Intake	37 o39'43.43N by 89 o16'28.91W	1/22/2020 0802	1/22/2020 1250		X	1/22/2020 1300	ACCEPTABLE

Source: City of Carbondale

2.8.5. Harmful Algal Blooms

In the past year (2019), both the Carbondale Reservoir and Campus Lake experienced microcystin levels above the recommended value set by the EPA to protect public health. A news release from EPA on May 22nd, 2019 states, "Based on the latest scientific information, EPA has established recommended water concentrations, at or below which protects public health, for the cyanotoxins microcystin (8 micrograms per liter) and cylindrospermopsin (15 micrograms per liter). EPA's recommendations are protective of all age groups and are based on peer-reviewed and published science"[46].

The Illinois Department of Public Health describes microcystin as," the most well-known toxin produced during a harmful algal bloom, and it can cause a variety of symptoms by affecting the skin, liver, GI tract, and nervous system. Ingestion, inhalation, or direct contact with contaminated water may cause illness".[47]

Water quality data from Carbondale Reservoir and Campus Lake was provided by the Illinois EPA. The microcystin levels have been graphed for both lakes.

Campus Lake

Campus Lake has had a long history with the presence of blue-green algae in its waters. A Phase 1 Diagnostic/Feasibility Study of Campus Lake, Jackson County, Illinois; prepared by SIU-C in 2003, stated a seasonal trend of blue-green algal blooms in months July and August. [48]

Microcystin levels were measured in year 2015, 2018, and 2019. These values are recorded in *Table 2.71.* The highlighted columns in the table are values that are above the EPA recommended water concentration of 8 micrograms per liter. These values occurred on May 19, 2015 and September 16, 2019. *Figure 2.68* shows the location of the water sampling sites on Campus Lake.

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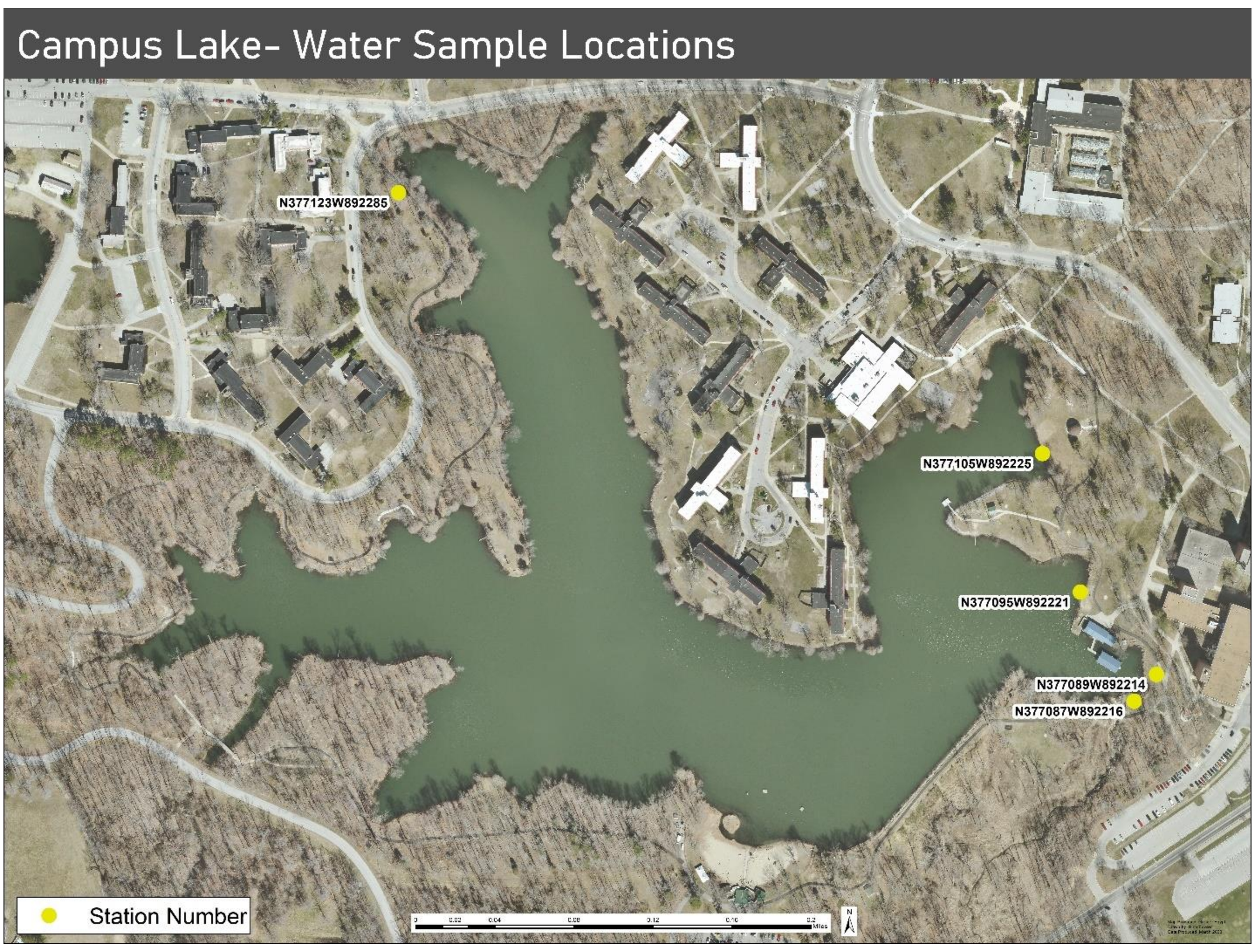
46 "EPA Issues Recommendations for Recreational Water Quality Criteria and Swimming Advisories for Cyanotoxins." *United States Environmental Protection Agency,* 22 May 2019, https://www.epa.gov/newsreleases/ epa-issues-recommendations-recreational-water-quality-criteria-and-swimming-advisories. News release.
47 "Harmful Algal Blooms (HABs)." Harmful Algal Blooms (HABs) | IDPH. Illinois Department of Public Health. Accessed March 11, 2020.http://www.dph.illinois.gov/topics-services/environmental-health-protection/toxicology/habs.
48 Charles Muchmore et al.," *Diagnostic/ feasibility Study of Campus Lake, Southern Illinois University Carbondale, Jackson County, Illinois,"United States Environmental Protection Agency. (March 2004). PDF.*

Table 2.71 - Campus Lake Microcystin Values

Campus Lake		
DATE	Microcystin (ug/l)	Station #
5/19/2015	9.93	N377089W892214
5/19/2015	0.65	N377123W892285
7/16/2018	2.83	N377087W892216
7/16/2018	ND	N377105W892225
9/16/2019	15.6	N377095W892221
10/3/2019	1.03	N377095W892221
11/14/2019	ND	N377087W892214

Figure 2.66 - Campus Lake Water Sample



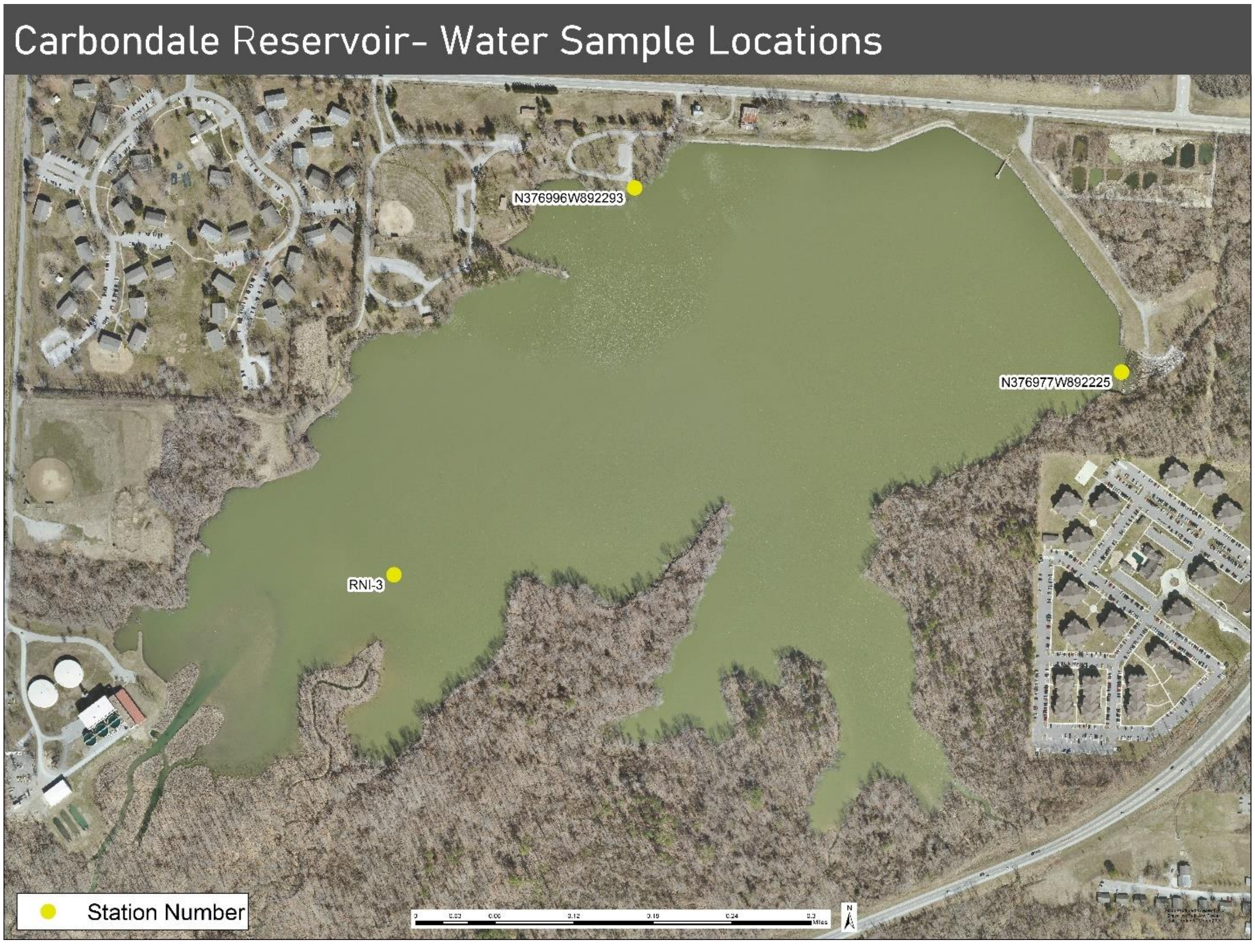
Carbondale Reservoir

Microcystin levels were measured in Carbondale Reservoir by IEPA during the year 2018 and 2019. These values are recorded in *Table 2.72.* The highlighted columns in the table below are values that are above the EPA recommended water concentration of 8 micrograms per liter. The highest reported value occurred on October 21, 2019, with a value of 7,760 ug/l.

Table 2.72 - Carbondale Reservoir Microcystin

Carbondale Reservoir		
DATE	Microcystin (ug/l)	Station #
6/21/2018	0	RNI-3
7/10/2018	0.88	N376977W892225
7/10/2018	0.64	RNI-3
8/1/2018	1.69	RNI-3
10/24/2018	2.65	RNI-3
9/17/2019	6.07	N376996W892293
10/3/2019	10.4	N376996W892293
10/21/2019	7,760	N376996W892293
10/31/2019	9.93	N376996W892293
11/14/2019	0	N376996W892293
12/3/2019	74.5	N376996W892293
12/12/2019	3.45	N376996W892293
12/18/2019	0.59	N376996W892293

Figure 2.67 - Carbondale Reservoir Water Sample Locations



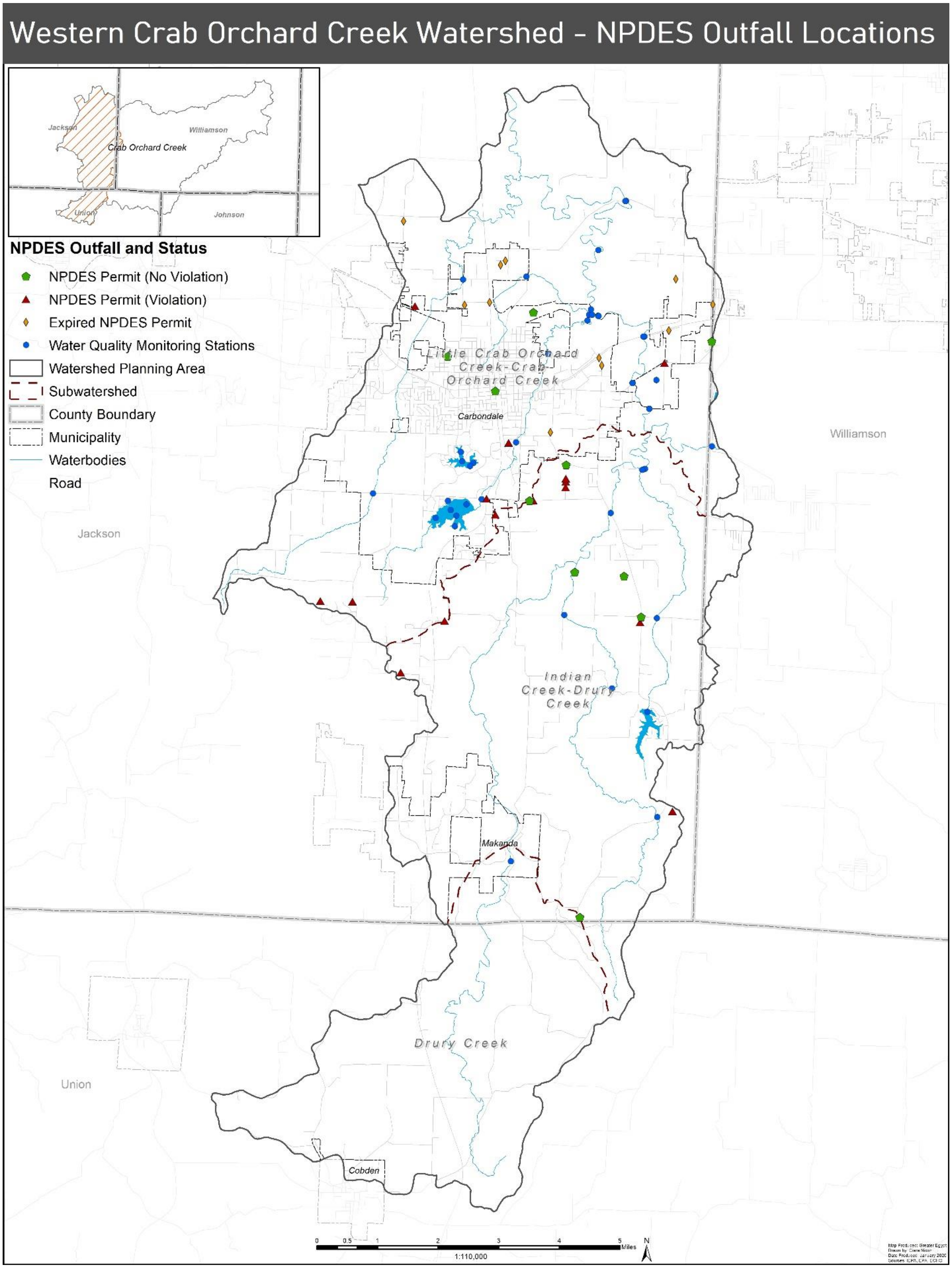
2.8.6. National Pollutant Discharge Elimination Systems (NPDES) Outfall Locations

The National Pollution Discharge Elimination Systems (NPDES) permit program is set in place to regulate point source pollutions that are being discharged into US waters. The Western Crab Orchard Creek watershed has a total of thirty-six NPDES outfall locations. Majority of these outfalls are located in Little Crab Orchard Creek subwatershed, while no outfalls are located in Drury Creek subwatershed. The NPDES outfall locations are displayed in *Figure 2.70* and categorized by permit and violation status. NPDES permits are active for five years from the effective date and facilities have the option to reapply for an extention. They must do so with 180 days of the expiration date. Some permits are listed as expired and may no longer discharge into a waterway; however, these sites are still monitored for water qualtiy purposes.

Thirteen of the thirty-six outfalls in the area are in current violation status for exceeding effluents. Outfall locations are tested and recorded quarterly throughout the year. The most recent twelve quarters with pollutant violations are displayed in *Table 2.73*. Saluki Homes, LLC STP has the most violations in the area, with sixty-one total violations since the permit was issued on April 4, 2015. During the last twelve quarters, Saluki Homes, LLC STP has had violations of nitrogen, total suspended solids, and dissolved oxygen. Pleasant Valley MHP-STP follows with the second highest number of total violations; twenty-eight since its effective date, and has recently been recorded for exceeding effluents of BOD, dissolved oxygen and total suspended solids. Southern Mobile Home Park STP has seventeen violations of total suspended solids and dissolved oxygen. Lilac Basin follows closely with sixteen violations of nitrogen and total suspended solids. SIUC-Touch of Nature Environmental Center has twelve violations of nitrogen and dissolved oxygen.

Racoon Valley MHP along with Lenore Basin Corp-Union Hills both have a total of eight violations. Racoon Valley MHP has had effluent violations of fecal coliform, while Lenore Basin has exceeded in dissolved oxygen. Both have met these exceedances during six of the recent twelve quarters. Pleasant Hill Mobile Home Park STP has had seven violations of dissolved oxygen and total suspended solids. City of Carbondale Southeast exceeded total suspended solids and Unity Point School Distict 140 STP exceeded nitrogen; both have six violations.

Figure 2.68



Western Crab Orchard Creek Watershed - NPDES Outfall Locations
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
NPDES Outfall and Status
NPDES Permit (No Violation)
NPDES Permit (Violation)
Expired NPDES Permit
Water Quality Monitoring Stations
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
0 0.5 1 2 3 4 5 Miles
1:110,000
N

Effluent Exceedance

Cedar Lane MHP #2 STP has a total of three violations since its permit issue date in 2014. Due to an exceedance of dissolved oxygen, one of those violations has been within the last twelve quarters. Giant City School District 130 STP has had the second lowest number of violations with three violations of total suspended solids since January of 2017. Carbondale Northwest WWTP has the lowest number of violations, with only one recorded violation due to nitrogen.

The NPDES outfalls in the watershed have effluent violations of BOD, nitrogen, total suspended solids, dissolved oxygen, and fecal coliform. A pollutant key is provided below to assist with understanding the effluent violations.

Table 2.73 – Outfall Effluent Violations

Facility Name	Outfall	QTR 1	QTR 2	QTR 3	QTR 4	QTR 5	QTR 6	QTR 7	QTR 8	QTR 9	QTR 10	QTR 11	QTR 12
		01/01-03/31/17	04/01-06/30/17	07/01-09/30/17	10/01-12/31/17	01/01-03/31/18	04/01-06/30/18	07/01-09/30/18	10/01-12/31/18	01/01-03/31/19	04/01-06/30/19	07/01-09/30/19	10/01-01/17/20
CARBONDALE NORTHWEST WWTP	001											N	
CEDAR LANE MHP #2 STP	001											DO	
CITY OF CARBONDALE SOUTHEAST STP	001		TSS			TSS				TSS			
GIANT CITY SCHOOL DIST 130 STP	001								N DO TSS				
LENORE BASIN CORP-UNION HILLS	001				DO	DO	DO	DO	DO				DO
LILAC BASIN CORP - UNION HILL STP	001		N TSS	N		N			N		N TSS	N TSS	N TSS
PLEASANT HILL MOBILE HOME PARK STP	001			DO				DO	DO	TSS		DO	
PLEASANT VALLEY MHP - STP	001	BOD	DO	DO BOD TSS	DO TSS	TSS	DO	DO	DO	BOD TSS	DO	DO	DO
RACCOON VALLEY MHP	001			FC			FC	FC		FC	FC	FC	
SAUKI HOMES LLC STP	001	N	N	N DO	N	N	N DO	N DO TSS	N DO TSS	N TSS	N	N	N TSS
SIUC-TOUCH OF NATURE ENVIRONMENTAL CENTER	001			DO N			N	N DO				N	N
SOUTHERN MOBILE HOME PARK STP	001	TSS	DO	DO TSS	TSS	DO		DO	DO			DO	
UNITY POINT SCHOOL DIST 140 STP	001					N			N				N

Source: EPA- ECHO

Pollutant KEY	
BOD, carbonaceous	BOD
Nitrogen	N
TSS	TSS
Dissolved Oxygen	DO
Fecal Coliform	FC

Two of the thirty-six outfalls are listed as being in current violation, but are not related to effluent pollutants. Bush MHP STP #1 is listed for Failure to Report DNR, while the SIUC Physical Plant is listed for Reportable Noncompliance. Violators of these permits may be held accountable by federal laws that provide various methods of taking enforcement actions. These actions may include monetary penalties, mandatory injunctions, and/or jail sentences. Lawful actions may be taken by the public if concerns of violations are not already being handled by the EPA or state regulatory agencies, as these documents are posted under the EPA website for public use.

2.8.7. Pollutant Load Analysis

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) modeling tool was used to estimate the existing nonpoint source nutrient loads (nitrogen & phosphorus) and sediment loads for the Western Crab Orchard Creek watershed. This includes an analysis of the watershed planning area, individual HUC 12 subwatersheds, and HUC fourteen subwatershed management units.

STEPL utilizes land cover category types, precipitation data, soil information, existing best management practices, stream and lake erosion, and other data input for calculating pollutant loads. The program does not incorporate land uses such as water (622 acres), barren land (12 acres), and wetlands (744 acres). These classes have been excluded from this analysis.

To calculate the sediment load, or degree of streambank erosion, the STEPL model utilizes: streambank length, height, soil type, and lateral recession rate (LRR). *Table 2.74* characterizes these classifications for the LRR. Four categories reflect the degree of streambank and shoreline erosion in the model: slight, moderate, severe, and very severe.

Table 2.74 -LRR Categories and Values

Category	Description	Lateral Recession Rate (ft/yr)	Medium Value
Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.	0.01-0.05	0.03
Moderate	Bank is predominantly bare with some rills and vegetative overhang.	0.06-0.2	0.13
Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.	0.3-0.5	0.4
Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and stream course or gully may be meandering.	0.5+	0.5

Source: EPA- STEPL

LRR categories have been applied to the assessed values from the erosion assessment in Chapter Seven. For the purpose of continuity between data, all streams have been assigned the medium value for LRR rates. *Table 2.75* represents the correlation between assessed streams and assigned LRR values.

Table 2.75 - LRR and Assessment Values

Assessment Criteria	LRR Category	LRR (ft/yr)	Medium Value
None or Low	Slight	0.01-0.05	0.03
Moderate	Moderate	0.06-0.2	0.13
High	Severe	0.3-0.5	0.4
Severe	Vere Severe	0.5+	0.5

Source: EPA- STEPL

Table 2.76 represents the STEPL model for the Western Crab Orchard Creek watershed-wide existing pollutant loads. The model estimations suggest urban land use accounts for nearly twenty-five percent of the nitrogen load for the entire planning area. Groundwater constitutes twenty-four percent of the nitrogen load, while pastureland makes up the remaining highest percentage at twenty-one percent.

The majority of the phosphorus load in the planning area originates from streambank erosion, at nearly thirty-seven percent. Urban land use contributes the second largest amount of the nutrient load at twenty-one percent. Cropland and pastureland are almost identical in representing the remaining sizeable phosphorus loads at 14.95 and 14.88 percent, respectively.

Because erosion from streambanks and shorelines is a prevalent issue in the planning area, the model suggests that seventy-five percent of the sediment load is due to these sources. Other source contributors include cropland (11.7%) and pastureland (7.8%).

Table 2.76 - Western Crab Orchard Creek Watershed-wide Existing Pollutant Loads

Source	N Load (lb/yr)	Percent of Total Load	P Load (lb/yr)	Percent of Total Load	Sediment Load (tons/yr)	Percent of Total Load
Urban	81,390.36	24.88%	12,527.90	20.79%	1,870.49	3.91%
Cropland	31,256.72	9.56%	9,009.52	14.95%	5,606.23	11.71%
Pastureland	70,201.03	21.46%	8,968.51	14.88%	3,733.30	7.80%
Forest	8,619.41	2.64%	3,998.50	6.63%	845.65	1.77%
Groundwater	78,323.21	23.94%	3,696.34	6.13%	0.00	0.00%
Streambank	57,308.84	17.52%	22,063.91	36.61%	35,818.03	74.82%
Total	**327,099.55**		**60,264.68**		**47,873.69**	

Source: EPA- STEPL

Table 2.77 breaks down the nutrient loads by HUC 12 subwatersheds. Because of its large size and various land uses, including urban development and cropland, Little Crab Orchard Creek subwatershed produces the majority of the nutrient loading in the planning area. This subwatershed accounts for nearly fifty-six percent of the total nitrogen load, fifty-two percent of the total phosphorus load, and forty-four percent of the sediment load in the Western Crab Orchard Creek watershed.

Table 2.77 - HUC 12 Existing Pollutant Loads

Subwatershed	SMU ID	Size (acres)	N Load (lb/yr)	Percent of Total N Load	P Load (lb/yr)	Percent of Total P Load	Sediment Load (t/yr)	Percent of Total Sediment Load
Drury Creek	1	11454.32	48033.13	14.68%	8857.94	14.70%	7066.57	14.76%
Indian-Drury Creek	2	20539.69	96639.38	29.54%	20245.48	33.59%	19511.20	40.76%
Little Crab Orchard Creek	3	24538.79	182427.04	55.77%	31161.25	51.71%	21295.92	44.48%
Total		**56,532.80**	**327,099.55**		**60,264.67**		**47,873.69**	

Source: EPA- STEPL

The model suggests that the Indian Creek- Drury Creek subwatershed exhibits the second highest level of nutrient loading in the planning area. This subwatershed accounts for thirty percent of the nitrogen load, thirty-four percent of the phosphorus load, and nearly forty-one percent of the overall sediment load in the planning area.

The remaining pollutant loads in the Western Crab Orchard Creek watershed occur in the Drury Creek subwatershed. Nitrogen, phosphorus, and sediment loads account for 14.7 percent of the overall total for the planning area.

Subwatershed Pollutant Load Analysis

Subwatersheds have also been individually modeled in STEPL. This includes the three HUC 12 subwatersheds and their corresponding subwatershed management units. The HUC 12 subwatersheds and SMUs will also be examined individually. Pollutant loads generally reflect the dominant land use categories and size of each subwatershed.

Drury Creek Subwatershed Existing Pollutant Loads

Table 2.78 displays the STEPL model for Drury Creek subwatershed. Pastureland represents the majority of the nitrogen load in the subwatershed at forty-one percent. Streambank erosion contributes nearly twenty percent of the total nitrogen load while urban and groundwater sources account for the remaining majority at 16.75 percent each.

Table 2.78 - Drury Creek Subwatershed Existing Pollutant Loads

Source	N Load (lb/yr)	Percent of Total Load	P Load (lb/yr)	Percent of Total Load	Sediment Load (tons/yr)	Percent of Total Load
Urban	8,046.82	16.75%	1,241.63	14.02%	184.80	2.62%
Cropland	130.08	0.27%	37.20	0.42%	22.92	0.32%
Pastureland	19,665.92	40.94%	2,257.60	25.49%	788.97	11.16%
Forest	2,735.93	5.70%	1,297.06	14.64%	192.69	2.73%
Groundwater	8,050.88	16.76%	404.12	4.56%	0.00	0.00%
Streambank	9,403.50	19.58%	3,620.35	40.87%	5,877.19	83.17%
Total	**48,033.13**		**8,857.95**		**7,066.57**	

Source: EPA- STEPL

Because erosion is a concern in the subwatershed, streambanks account for forty-one percent of the phosphorus load and eighty-three percent of the sediment load. Other major land use contributors to the phosphorus load include pasture (25%) and forest (15%).

The Drury Creek subwatershed has been delineated further by its subwatershed management units. *Table 2.79* represents the various SMUs and their corresponding pollutant loads.

Table 2.79 - Drury Creek Subwatershed Existing Pollutant Loads by SMU

Subwatershed Management Unit	SMU ID	Size (acres)	N Load (lb/yr)	P Load (lb/yr)	Sediment Load (t/yr)
Upper Drury Creek	1	1348.55	5543.41	1284.08	1264.86
Cobden North	2	3344.13	20244.36	3325.16	2493.92
Shiloh	3	1646.71	5325.85	1019.55	827.52
Shawnee-Drury Creek	4	1117.47	2397.05	331.35	94.13
Flamm	5	1133.12	5087.12	621.83	220.28
Giant City	6	1834.83	6000.16	1214.64	914.89
Makanda-South Drury Creek	7	1029.51	3435.18	1061.34	1250.95
Total		**11,454.32**	**48,033.13**	**8,857.94**	**7,066.57**

Indian Creek-Drury Creek Subwatershed Existing Pollutant Loads

While this subwatershed is heavily forested, urban spaces and pasture account for a majority of the remaining land use. This is evident in the pollutant loading model displayed in *Table 2.80.* Sources of nitrogen in the subwatershed include: urban (20%), pasture (22%), groundwater (23%), and the majority coming from streambank at nearly twenty-seven percent. Phosphorus sources in the watershed are primarily from streambank erosion (49%). However, thirty percent of the load originates from urban and pastureland uses.

Table 2.80 - Indian Creek-Drury Creek Subwatershed Existing Pollutant Loads

Source	N Load (lb/yr)	Percent of Total Load	P Load (lb/yr)	Percent of Total Load	Sediment Load (tons/yr)	Percent of Total Load
Urban	19,378.32	20.05%	2,981.98	14.73%	445.38	2.28%
Cropland	4,159.49	4.30%	1,310.57	6.47%	899.65	4.61%
Pastureland	20,912.93	21.64%	3,098.82	15.31%	1,542.70	7.91%
Forest	3914.26	4.05%	1,780.59	8.79%	479.72	2.46%
Groundwater	22,444.38	23.22%	1,128.97	5.58%	0.00	0.00%
Streambank	25,830.00	26.73%	9,944.55	49.12%	16,143.75	82.74%
Total	**96,639.38**		**20,245.48**		**19,511.20**	

Similar to Drury Creek subwatershed, Indian Creek- Drury Creek subwatershed's main source of sediment load is from streambanks at eighty-three percent. Pastureland also contributes a small portion at around eight percent. *Table 2.81* displays the SMU nutrient loading for the Indian Creek- Drury Creek subwatershed.

Table 2.81 -Indian Creek- Drury Creek Subwatershed Existing Pollutant Loads by SMU

Subwatershed Management Unit	SMU ID	Size (acres)	N Load (lb/yr)	P Load (lb/yr)	Sediment Load (t/yr)
Upper Indian Creek	8	2,563.94	5,116.37	1,298.72	1,262.04
Middle Drury Creek	9	2,759.19	9,391.82	2,069.16	1,960.40
Makanda-North	10	1,482.13	7,449.93	1,192.64	624.14
Upper Sycamore Creek-Spring Arbor	11	521.37	2,877.19	646.83	633.77
Middle Indian Creek	12	1,343.18	5,043.21	1,084.86	938.74
Middle Sycamore Creek	13	2,034.89	10,159.71	1,811.12	1,562.54
Lower Indian Creek	14	2,353.19	12,430.77	2,177.99	1,834.88
Boskydell-Drury Creek	15	3,986.28	15,638.47	2,791.57	1,960.88
Lower Sycamore Creek	16	1,363.05	10,277.58	2,715.98	3,463.07
Lower Drury Creek	17	2,132.47	18,254.33	4,456.62	5,270.73
Total		**20,539.69**	**96,639.38**	**20,245.48**	**19,511.20**

Source: EPA- STEPL

Little Crab Orchard Creek Subwatershed Existing Pollutant Loads

At 24,539 acres, the Little Crab Orchard Creek subwatershed is the largest subwatershed in the planning area and consists of multiple land uses. Because of these characteristics, pollutant load sources differ from the other two subwatersheds and exhibit the largest contribution of pollutant loads in the planning area. Existing pollutant loads are displayed in *Table 2.82.*

With a dense urban environment, largely attributed to the City of Carbondale, nearly thirty percent of the nitrogen load comes from this classification. Groundwater also accounts for a high proportion of nitrogen at twenty-six percent. The remaining sources include: pasture (16%), cropland (15%), and streambank (12%).

Table 2.82 - Little Crab Orchard Creek Subwatershed Existing Pollutant Loads

Source	N Load (lb/yr)	Percent of Total Load	P Load (lb/yr)	Percent of Total Load	Sediment Load (tons/yr)	Percent of Total Load
Urban	53,965.21	29.58%	8,304.29	26.65%	1,240.31	5.82%
Cropland	26,967.16	14.78%	7,661.75	24.59%	4,683.65	21.99%
Pastureland	29,622.18	16.24%	3,612.08	11.59%	1,401.63	6.58%
Forest	1,969.22	1.08%	920.86	2.96%	173.24	0.81%
Groundwater	47,827.94	26.22%	2,163.25	6.94%	0.00	0.00%
Streambank	22,075.34	12.10%	8,499.00	27.27%	13,797.09	64.79%
Total	**182,427.04**		**31,161.25**		**21,295.92**	

Source: EPA- STEPL

Phosphorus sources are evenly split between streambank (27%), urban development (27%), and cropland (25%). With many waterbodies in the subwatershed, streambank erosion accounts for nearly sixty-five percent of the total sediment load. Cropland constitutes the majority of the remaining load at twenty-two percent.

Pollutant loading for the subwatersheds and SMUs have also displayed in the following figures (*2.71-2.73*). These include nitrogen, phosphorus, and sediment loading.

Table 2.83 -Little Crab Orchard Creek Subwatershed Existing Pollutant Loads by SMU

Subwatershed Management Unit	SMU ID	Size (acres)	N Load (lb/yr)	P Load (lb/yr)	Sediment Load (t/yr)
Upper Piles Fork Creek	18	1,415.24	4,376.29	731.05	308.34
Upper Little Crab Orchard Creek	19	3,661.83	21,374.73	2968.01	1,976.92
Carbondale Reservoir-Piles Fork Creek	20	1,232.67	13,458.63	2055.56	946.47
Campus Lake	21	346.65	3,962.88	595.44	210.92
Upper Crab Orchard Creek	22	939.718	3,565.60	874.52	888.75
Eastern Carbondale-Crab Orchard Creek	23	2,024.58	13,678.88	2395.80	1,572.83
Lower Piles Fork Creek	24	2,951.01	20,444.83	2865.83	914.36
Eek Creek	25	1,820.7	15,790.70	2615.36	1,318.44
Middle Little Crab Orchard Creek	26	2,903.56	22,706.20	3621.60	1,911.17
Reed Station	27	1,755.61	13,756.73	2410.45	1,239.56
Middle Crab Orchard Creek	28	2,443.75	24,923.00	5509.67	6,223.68
Lower Little Crab Orchard Creek	29	1,017.33	8,920.32	1739.79	1,710.36
Aviation	30	895.507	8,647.01	1428.02	654.90
Creekside	31	810.324	4,103.71	551.31	264.30
Lower Crab Orchard Creek	32	320.312	2,717.54	798.85	1,154.93
Total		**24,538.79**	**182,427.04**	**31,161.25**	**21,295.92**

Source: EPA- STEPL

Figure 2.69

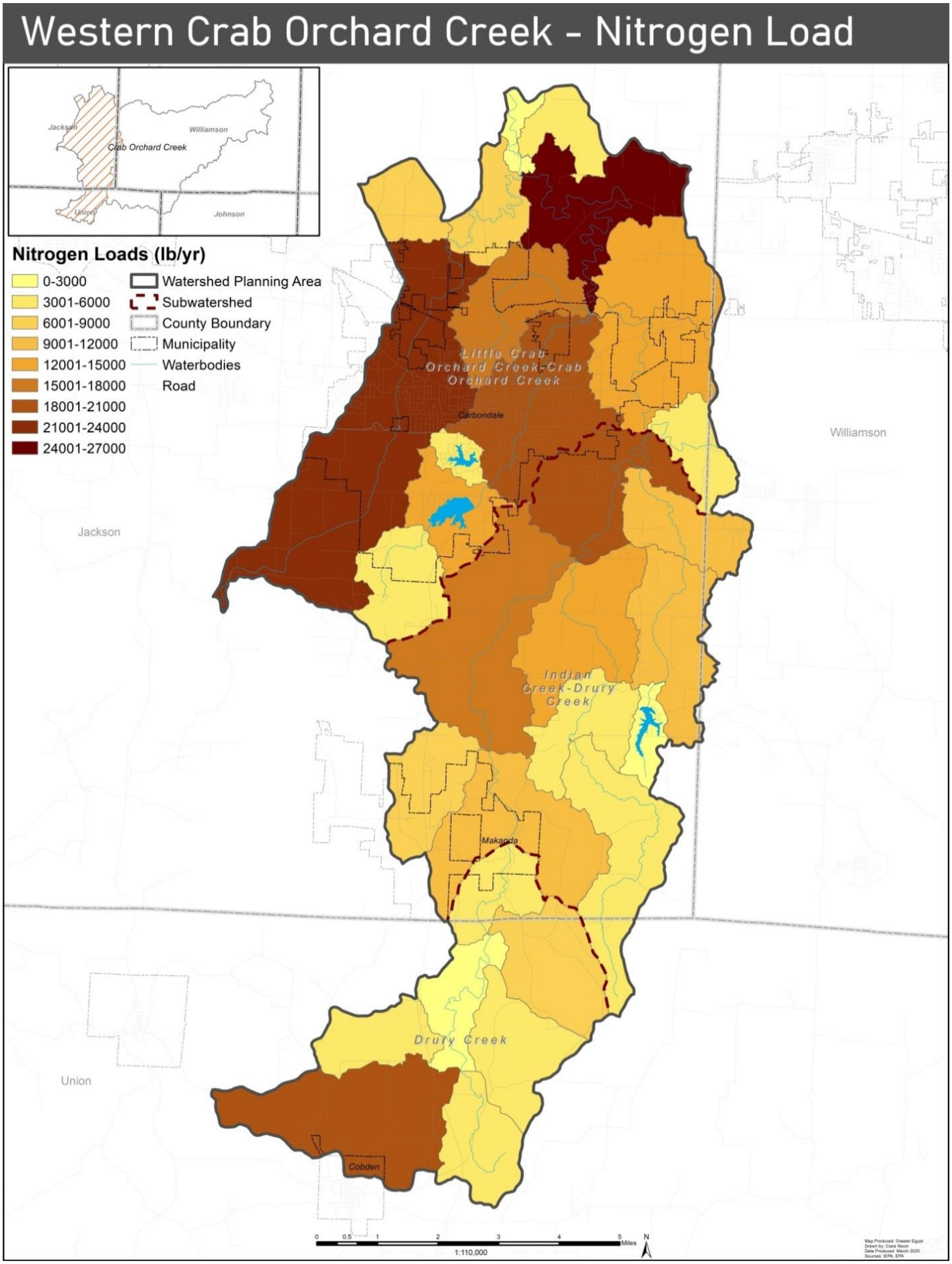
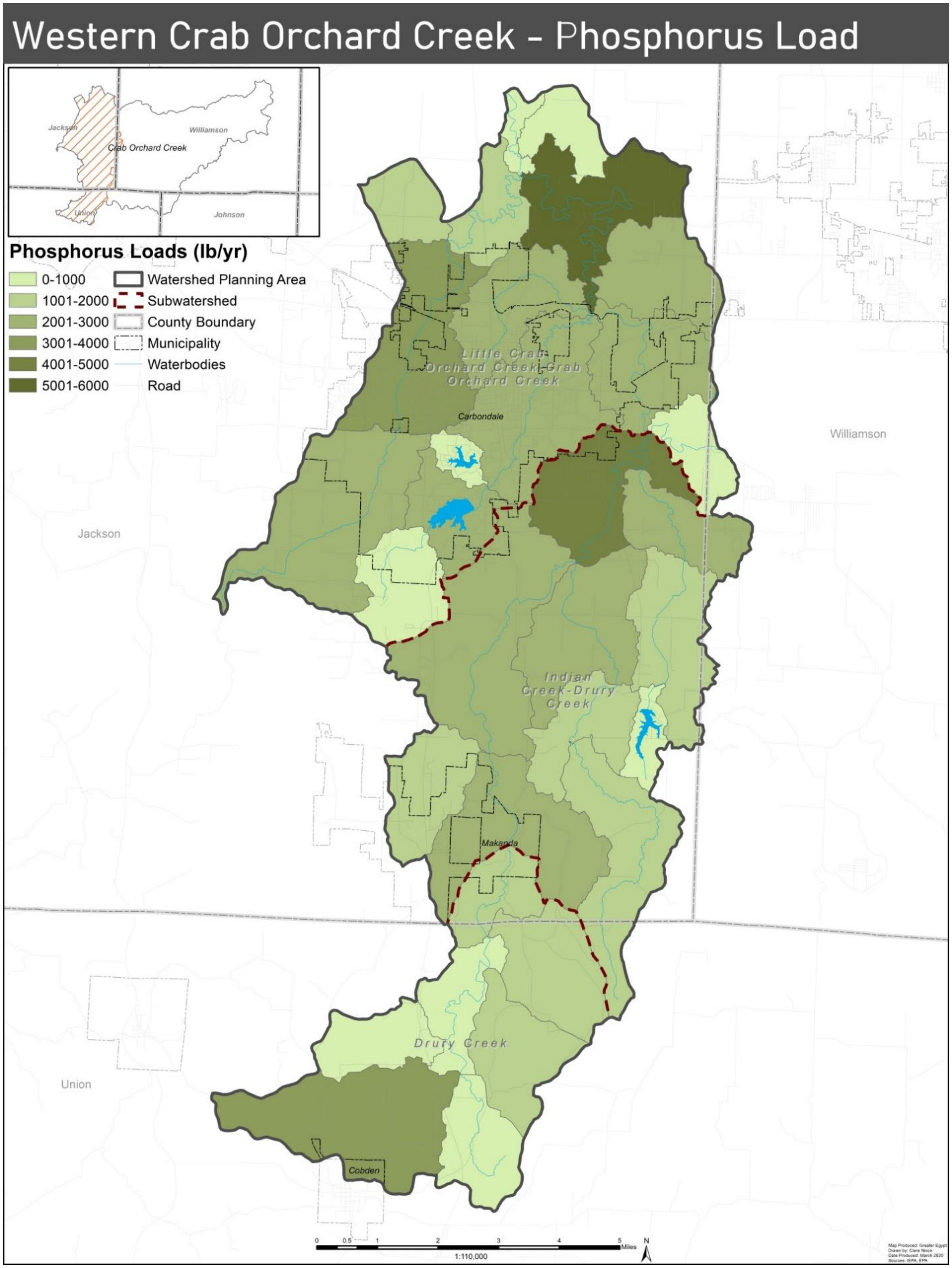
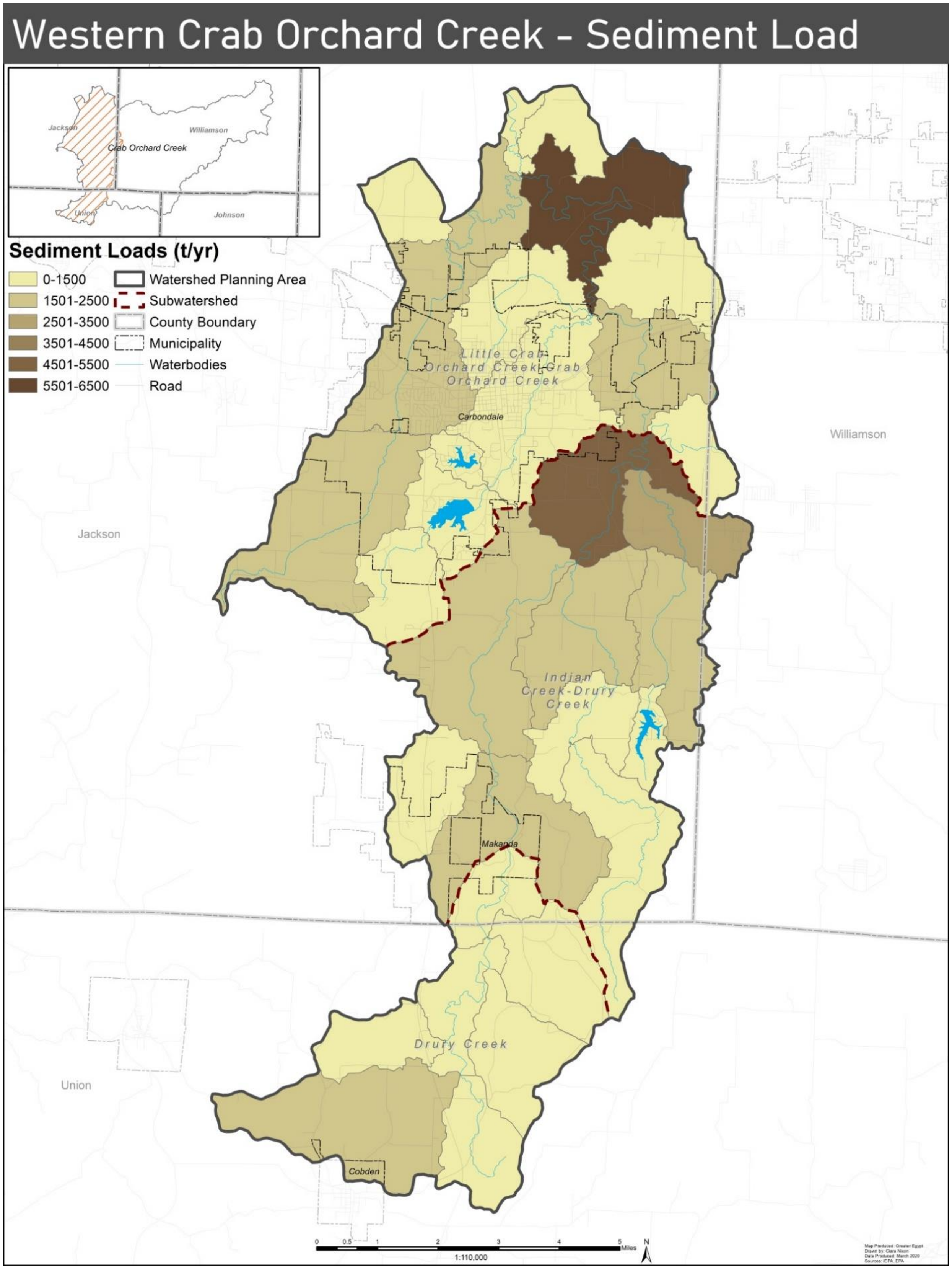

Western Crab Orchard Creek - Nitrogen Load
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Nitrogen Loads (lb/yr)
0-3000
3001-6000
6001-9000
9001-12000
12001-15000
15001-18000
18001-21000
21001-24000
24001-27000
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
1:110,000
Miles

Figure 2.70



Western Crab Orchard Creek - Phosphorus Load
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Phosphorus Loads (lb/yr)
0-1000
1001-2000
2001-3000
3001-4000
4001-5000
5001-6000
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
1:110,000
Miles
N

Figure 2.71


Western Crab Orchard Creek - Sediment Load
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Sediment Loads (t/yr)
0-1500
1501-2500
2501-3500
3501-4500
4501-5500
5501-6500
Watershed Planning Area
Subwatershed
County Boundary
Municipality
Waterbodies
Road
Little Crab Orchard Creek-Crab Orchard Creek
Carbondale
Williamson
Jackson
Indian Creek-Drury Creek
Makanda
Drury Creek
Union
Cobden
1:110,000
Miles

2.8.8. Pollutant Load Reduction Targets

The Western Crab Orchard Creek Watershed-based Plan will address the problematic areas in the watershed by proposing best management practices (BMP) to limit the nutrient runoff and other impairments. In order to better plan for these measures, pollutant load reduction targets are set to offer a benchmark for BMP effectiveness. While BMPs can be site-specific and cover a wide range of techniques, they should target the major impairments in the watershed.

According to the 2016 Illinois Integrated Water Quality Report, there are many known and potential causes and sources of water pollution in the planning area. The 303(d) and 305(b) information from *Section 2.8.1* summarizes the causes and sources based on the Illinois Integrated Water Quality Report and other factors identified in this inventory and assessment.

As described in *Section 2.8.1*, the Illinois Nutrient Loss Reduction Strategy (ILNLRS) was designed to provide a framework for BMP implementation and reduction of nitrogen and phosphorus in Illinois waterbodies. The plan sets a Phase I milestone of state-wide nutrient reduction of nitrate-nitrogen of fifteen percent. The reduction target for phosphorus is twenty-five percent. These targets are to be met by 2025, with an overall target of forty-five percent for both nutrients. [49]

Pollutant load reduction targets for the Western Crab Orchard Creek watershed will conform to the targets presented in the ILNLRS. *Table 2.84* provides a summary of the pollutant load reduction targets for the planning area and subwatersheds for a ten-year period. While the plan provides information on limiting sediment in waterbodies, it does not provide a reduction target. However, a target of twenty-five percent has been assigned for the Western Crab Orchard Creek watershed. These targets are also presented in the following tables.

The summary suggests that with a fifteen percent reduction in nitrogen, the planning area's total load would be reduced by 49,065 pounds annually. At a twenty-five percent reduction, phosphorus loads will be reduced by 15,066 pounds per year. The summary also includes an annual reduction of sediment of 11,968 tons (25%).

To meet these pollutant load reduction targets, best management practices will have to be suggested and implemented in the planning area. BMP considerations will be a component of the overall Western Crab Orchard Creek Watershed-based Plan.

49 IEPA. *NLRS- Executive Summary.* PDF. Accessed: May 2019.

Table 2.84 -Western Crab Orchard Creek Watershed-Wide Pollutant Load Reduction Targets

Watershed	SMU ID	Nitrogen (percent of total)	Nitrogen Load Reduction Target (lbs)	Phosphorus (percent of total)	Phosphorus Load Reduction Target (lbs)	Sediment (percent of total)	Sediment Load Reduction Target (tons)
Western Crab Orchard Creek	**-**	**15.00%**	**49064.93**	**25.00%**	**15066.17**	**25.00%**	**11968.42**
Subwatershed Load Reduction Targets							
Drury Creek	**1**	14.68%	7204.97	14.70%	2214.49	14.76%	1766.64
Indian Creek- Drury Creek	**2**	29.54%	14495.91	33.59%	5061.37	40.76%	4877.80
Little Crab Orchard Creek	**3**	55.77%	27364.06	51.71%	7790.31	44.48%	5323.98
TOTAL			**49064.93**		**15066.17**		**11968.42**

Subwatershed Pollutant Load Reduction Targets

Reduction targets have also been assessed for the subwatershed management units within each HUC 12 subwatershed in the planning area. The following graphs illustrate the SMU reduction targets for nitrogen, phosphorus, and sediment.

Table 2.85 -Drury Creek Subwatershed Pollutant Load Reduction Targets

Watershed	SMU ID	Nitrogen (percent of total)	Nitrogen Load Reduction Target (lbs)	Phosphorus (percent of total)	Phosphorus Load Reduction Target (lbs)	Sediment (percent of total)	Sediment Load Reduction Target (tons)
Drury Creek Subwatershed	**-**	**15.00%**	**7204.97**	**25.00%**	**2214.49**	**25.00%**	**1766.64**
Subwatershed Management Unit Load Reduction Targets							
Upper Drury Creek	**1**	11.54%	831.51	14.50%	321.02	17.90%	316.22
Cobden North	**2**	42.15%	3036.65	37.54%	831.29	35.29%	623.48
Shiloh	**3**	11.09%	798.88	11.51%	254.89	11.71%	206.88
Shawnee-Drury Creek	**4**	4.99%	359.56	3.74%	82.84	1.33%	23.53
Flamm	**5**	10.59%	763.07	7.02%	155.46	3.12%	55.07
Giant City	**6**	12.49%	900.02	13.71%	303.66	12.95%	228.72
Makanda-South Drury Creek	**7**	7.15%	515.28	11.98%	265.34	17.70%	312.74
TOTAL			**7204.97**		**2214.49**		**1766.64**

Table 2.86 -Indian Creek- Drury Creek Subwatershed Pollutant Load Reduction Targets

Watershed	SMU ID	Nitrogen (percent of total)	Nitrogen Load Reduction Target (lbs)	Phosphorus (percent of total)	Phosphorus Load Reduction Target (lbs)	Sediment (percent of total)	Sediment Load Reduction Target (tons)
Indian Creek- Drury Creek Subwatershed	**-**	**15.00%**	**14495.91**	**25.00%**	**5061.37**	**25.00%**	**4877.80**
Subwatershed Management Unit Load Reduction Targets							
Upper Indian Creek	**1**	5.29%	767.46	6.41%	324.68	6.47%	315.51
Middle Drury Creek	**2**	9.72%	1408.77	10.22%	517.29	10.05%	490.10
Makanda-North	**3**	7.71%	1117.49	5.89%	298.16	3.20%	156.04
Upper Sycamore Creek-Spring Arbor	**4**	2.98%	431.58	3.19%	161.71	3.25%	158.44
Middle Indian Creek	**5**	5.22%	756.48	5.36%	271.21	4.81%	234.68
Middle Sycamore Creek	**6**	10.51%	1523.96	8.95%	452.78	8.01%	390.64
Lower Indian Creek	**7**	12.86%	1864.62	10.76%	544.50	9.40%	458.72
Boskydell-Drury Creek	**8**	16.18%	2345.77	13.79%	697.89	10.05%	490.22
Lower Sycamore Creek	**9**	10.63%	1541.64	13.42%	678.99	17.75%	865.77
Lower Drury Creek	**10**	18.89%	2738.15	22.01%	1114.16	27.01%	1317.68
TOTAL			**14495.91**		**5061.37**		**4877.80**

Table 2.87 Little Crab Orchard Creek Subwatershed Pollutant Load Reduction Targets

Watershed	SMU ID	Nitrogen (percent of total)	Nitrogen Load Reduction Target (lbs)	Phosphorus (percent of total)	Phosphorus Load Reduction Target (lbs)	Sediment (percent of total)	Sediment Load Reduction Target (tons)
Little Crab Orchard Creek Subwatershed	**-**	**15.00%**	**27364.06**	**25.00%**	**7790.31**	**25.00%**	**5323.98**
Subwatershed Management Unit Load Reduction Targets							
Upper Piles Fork Creek	**1**	2.40%	656.44	2.35%	182.76	1.45%	77.09
Upper Little Crab Orchard Creek	**2**	11.72%	3206.21	9.52%	742.00	9.28%	494.23
Carbondale Reservoir-Piles Fork Creek	**3**	7.38%	2018.79	6.60%	513.89	4.44%	236.62
Campus Lake	**4**	2.17%	594.43	1.91%	148.86	0.99%	52.73
Upper Crab Orchard Creek	**5**	1.95%	534.84	2.81%	218.63	4.17%	222.19
Eastern Carbondale-Crab Orchard Creek	**6**	7.50%	2051.83	7.69%	598.95	7.39%	393.21
Lower Piles Fork Creek	**7**	11.21%	3066.72	9.20%	716.46	4.29%	228.59
Eek Creek	**8**	8.66%	2368.60	8.39%	653.84	6.19%	329.61
Middle Little Crab Orchard Creek	**9**	12.45%	3405.93	11.62%	905.40	8.97%	477.79
Reed Station	**10**	7.54%	2063.51	7.74%	602.61	5.82%	309.89
Middle Crab Orchard Creek	**11**	13.66%	3738.45	17.68%	1377.42	29.22%	1555.92
Lower Little Crab Orchard Creek	**12**	4.89%	1338.05	5.58%	434.95	8.03%	427.59
Aviation	**13**	4.74%	1297.05	4.58%	357.00	3.08%	163.72
Creekside	**14**	2.25%	615.56	1.77%	137.83	1.24%	66.07
Lower Crab Orchard Creek	**15**	1.49%	407.63	2.56%	199.71	5.42%	288.73
TOTAL			**27364.06**		**7790.31**		**5323.98**

3. Climate Change and Environmental Equity

Global average temperature has increased by 1.8^{0}F from 1901 to 2016, evidence consistently points to human related activities; which includes increased greenhouse gas emissions- as the cause for this rapid increase in global temperatures[50] . Climate change is no longer a future problem, effects are being felt in the present time around the world, and events and trends associated with climate change are only expected to continue to increase in number of events and in severity[51] .

In the Midwest, climate change is driving more dramatic shifts in seasonal wet/dry regimes. Areas are experiencing severe storms, floods, and extreme heat waves within generally short time periods. All of these factors can have an effect on water quality, infrastructure stability, agriculture productivity, and general community resiliency to natural hazards, as well as alter historic hydrologic regimes. Southern Illinois currently encompasses regions within Köppen-Geiger climate types Dfa (hot-summer humid continental) and Cfa (humid subtropical); but future models suggest most of the state will be classified as Cfa by 2071[52] *Figures 3.1 and 3.2* show the Köppen-Geiger climate classifications of Illinois and surrounding areas for present day (based on data from 1980-2016) and projected climate types for the future (based on 32 different climate models for years 2071-2100)[53].

The most significant effects from climate change on watersheds in the Western Crab Orchard Creek watershed will be more frequent and severe floods, lowered water quality in Urban Heat Islands, and more frequent Harmful Algal Blooms.

Climate change and other water quality issues disproportionally affect low-income populations and black, indigenous, and people of color (BIPOC) communities; this chapter will address some of the causes of this problem and propose strategies to mitigate the effects. Greater Egypt partnered with the Carbondale NAACP to include this section in the report and get input on what environmental problems communities in the Western Crab Orchard Creek Watershed want addressed.

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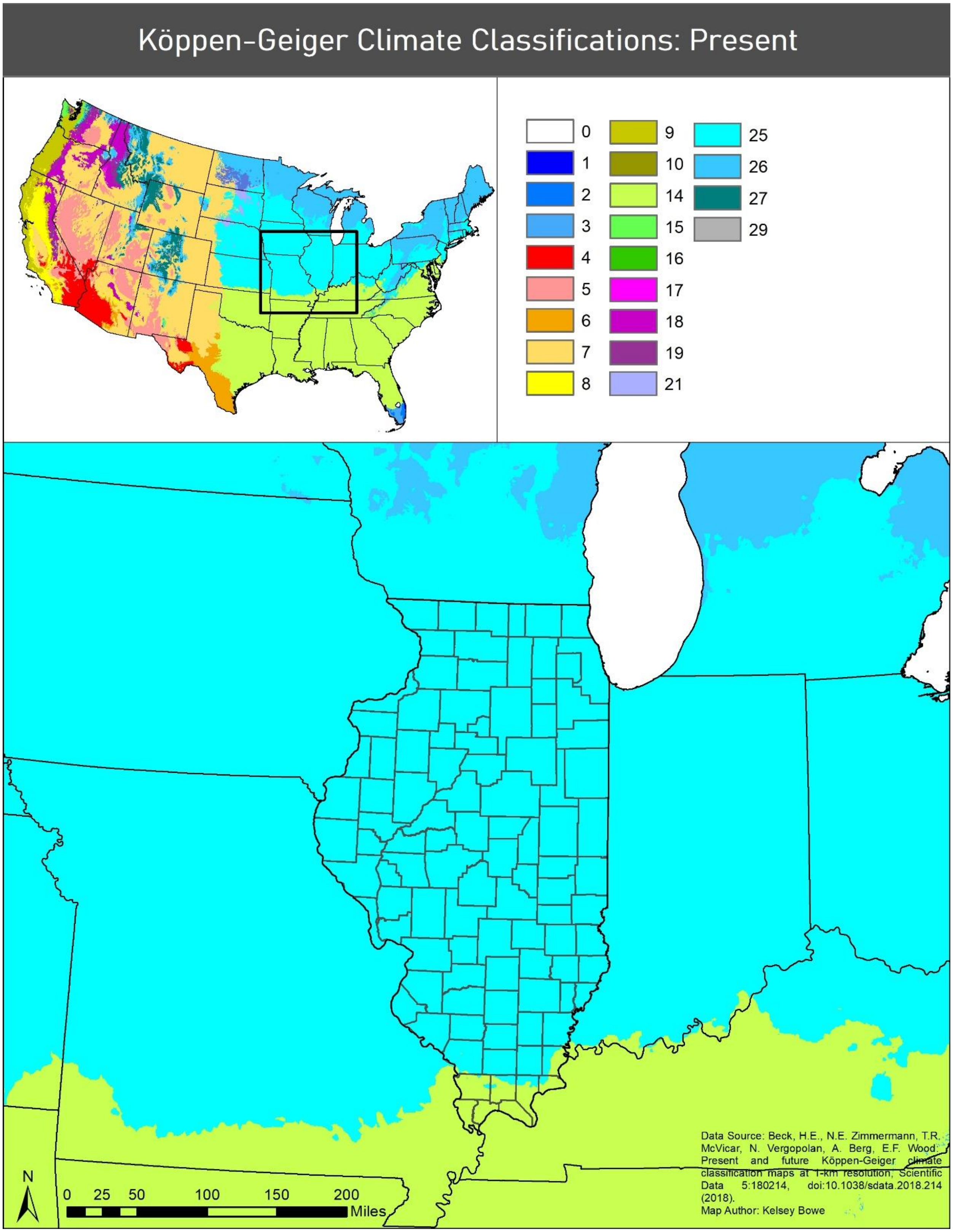
[50] Hayhoe, K. et al., 2018: Our Changing Climate. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144.
[51] Gray, E. and Merzdorf J. "Earth's Freshwater Future: Extreme Floods and Drought", NASA Global Climate Change, 2019.
[52] Beck, H.E., N.E. Zimmermann, T.R. McVicar, N. Vergopolan, A. Berg, E.F. Wood: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018).

Table 3.1 Legend for the numeric values in the maps to the Köppen-Geiger climate classes

1: Af Tropical, rainforest	16: Cfc Temperate, no dry season, cold summer
2: Am Tropical, monsoon	17: Dsa Cold, dry summer, hot summer
3: Aw Tropical, savannah	18: Dsb Cold, dry summer, warm summer
4: BWh Arid, desert, hot	19: Dsc Cold, dry summer, cold summer
5: BWk Arid, desert, cold	20: Dsd Cold, dry summer, very cold winter
6: BSh Arid, steppe, hot	21: Dwa Cold, dry winter, hot summer
7: BSk Arid, steppe, cold	22: Dwb Cold, dry winter, warm summer
8: Csa Temperate, dry summer, hot summer	23: Dwc Cold, dry winter, cold summer
9: Csb Temperate, dry summer, warm summer	24: Dwd Cold, dry winter, very cold winter
10: Csc Temperate, dry summer, cold summer	25: Dfa Cold, no dry season, hot summer
11: Cwa Temperate, dry winter, hot summer	26: Dfb Cold, no dry season, warm summer
12: Cwb Temperate, dry winter, warm summer	27: Dfc Cold, no dry season, cold summer
13: Cwc Temperate, dry winter, cold summer	28: Dfd Cold, no dry season, very cold winter
14: Cfa Temperate, no dry season, hot summer	29: ET Polar, tundra
15: Cfb Temperate, no dry season, warm summer	30: EF Polar, frost

Figure 3.1



Köppen-Geiger Climate Classifications: Present
0
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5
6
7
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16
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18
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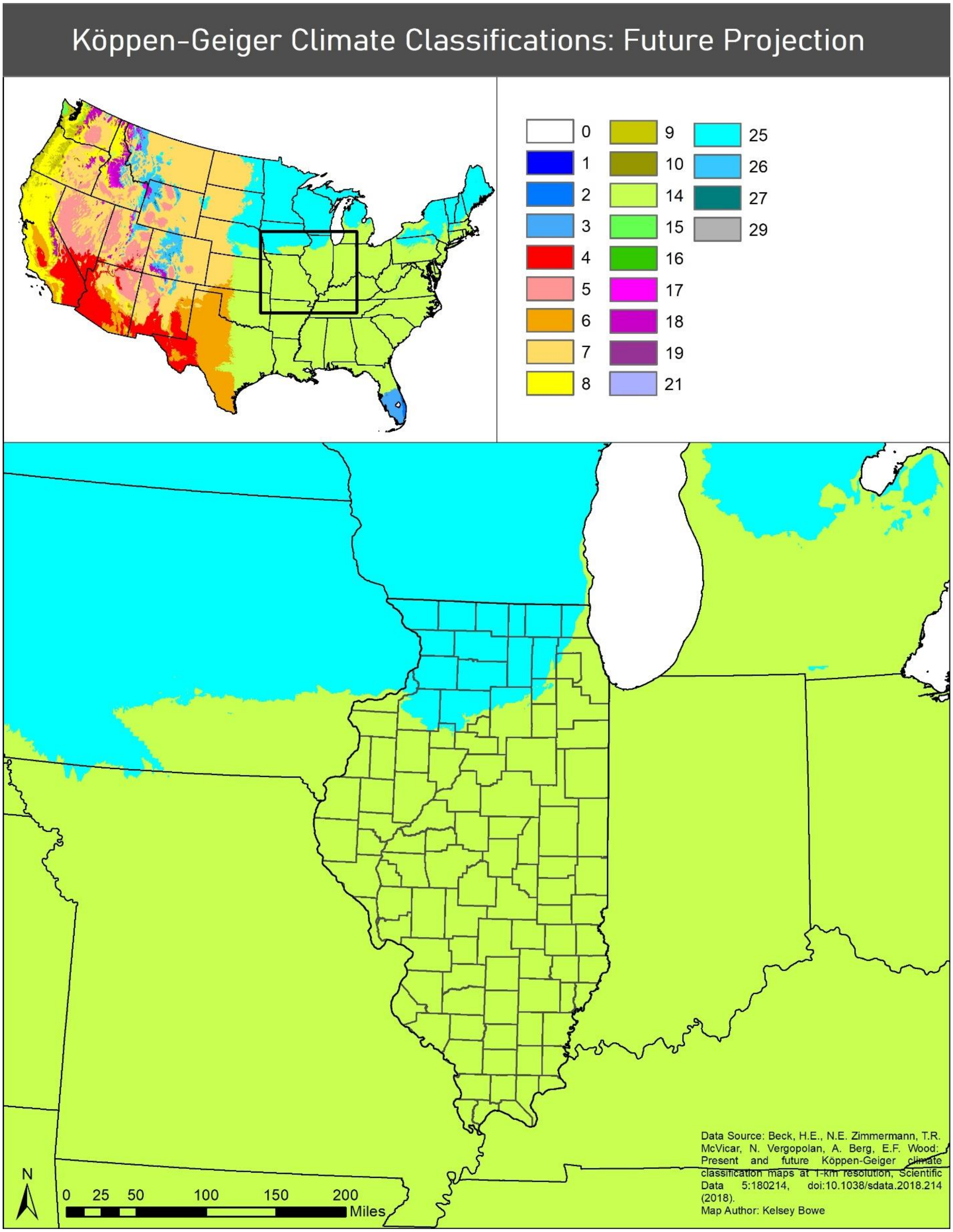
26
27
29
N
0 25 50 100 150 200
Miles
Data Source: Beck, H.E., N.E. Zimmermann, T.R. McVicar, N. Vergopolan, A. Berg, E.F. Wood: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018).
Map Author: Kelsey Bowe

Figure 3.2


Köppen-Geiger Climate Classifications: Future Projection
0
1
2
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0 25 50 100 150 200
Miles
Data Source: Beck, H.E., N.E. Zimmermann, T.R. McVicar, N. Vergopolan, A. Berg, E.F. Wood: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018).
Map Author: Kelsey Bowe

3.1. Flooding

Extreme precipitation is already increasing with the warming climate, which in turn increases the frequency and intensity of floods. Springtime precipitation is expected to increase in southern Illinois by ten to fifty percent by 2050, with Illinois already experiencing dramatic increases in extreme precipitation events over the past two decades[53]. 2019 was the second wettest year ever documented in the U.S., with extreme flooding events occurring along the Arkansas, Missouri, and Mississippi river basins. These floods affected fifteen states, and had an estimated combined cost of twenty billion dollars[54]. The Mississippi River experienced its longest lasting flood in 2019, with river gauges at or above flood stage for record breaking periods in Iowa, Illinois, Mississippi, and Louisiana[55]. Similarly, the Big Muddy River at Murphysboro (USGS Stream Gauge 05599490) was at or above flood stage (22ft) for a total of 143 days during 2019. Peak water height was recorded at 31ft on 6/11/2019[56].

In addition to riverine flooding, Illinois is experiencing and increase in urban or flash flooding, which the state defines as "The inundation of property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers. 'Urban flooding' does not include flooding in undeveloped or agricultural areas. 'Urban flooding' includes (i) situations in which stormwater enters buildings through windows, doors, or other openings, (ii) water backup through sewer pipes, showers, toilets, sinks, and floor drains, (iii) seepage through walls and floors, and (iv) the accumulation of water on property or public rights-of-way." (IL General Assembly Public Act 098-0858 "Urban Flooding Awareness Act")

A major concern with urban flooding is that it can be difficult to predict which areas have the highest risk, according to the summary report of the Urban Flooding Awareness Act, 90 percent of insurance payouts for urban flooding in Illinois occurred outside of FEMA's mapped 100-year floodplain. The report also states that mapping areas of urban flooding is not feasible on a statewide level and should be addressed by communities. Increased precipitation and urban flooding will also increase stormwater pollution, which can include a variety of chemicals and materials that get washed into waterbodies during storm events. Common stormwater pollution includes litter, motor oil, lawn fertilizers, and sediment. *Figure 3.3* shows the most recent 100-year floodplain

53 Frankson, R.K. et al., Illinois State Climate Summary, NOAA Technical Report, 2017.
54 National Oceanic and Atmospheric Administration, " 2019 was the 2nd wettest year on record for the U.S." January 8, 2020.
55 Donegan, Brian, The Weather Channel, "2019 Mississippi River Flood the Longest-Lasting Since the Great Flood of 1927 in Multiple Locations" May, 22, 2019.
56 USGS National Water Information System: Web Interface, USGS 05599490 Big Muddy River at RTE 127 at Murphysboro, IL

as determined by the FEMA National Flood Hazard Layer (NFHL) and the percentage of impervious surfaces from the 2017 landcover dataset for the planning area. Many areas of Carbondale are highly impervious, which has a higher risk of flash flood events, even though much of the city lies outside the flood zone boundary.

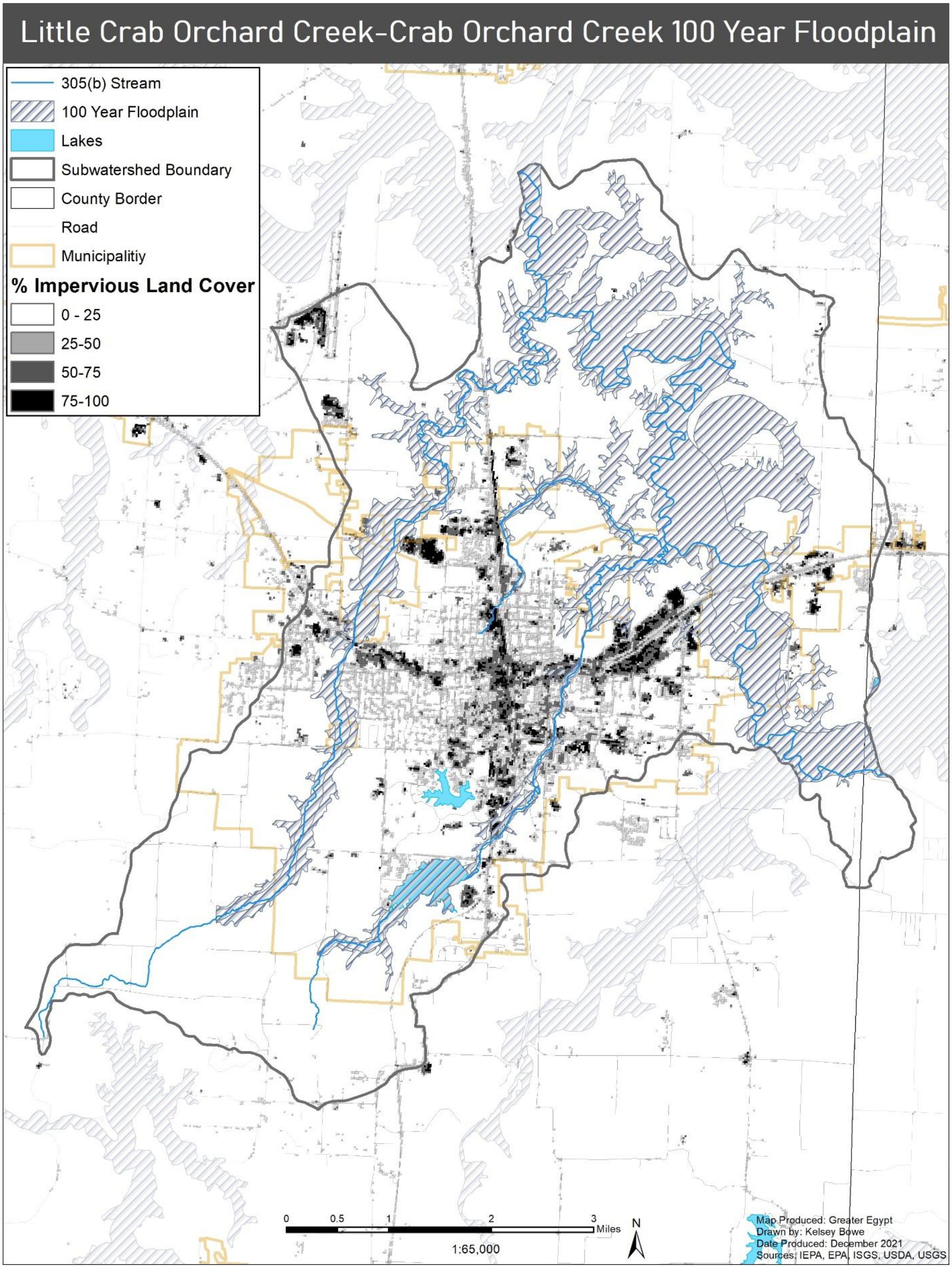
There is currently a lack of data for risk assessments related to infrastructure and climate change in the US[57]; however, these increases in floods will likely strain our already aging infrastructure. Dams, levees, stormwater drains, and sewage pipes can be worn out more quickly with frequent severe weather, and many municipal facilities were not built for levels of flash floods that are starting to become more common.

3.1.1. Impacts on Agriculture

Agriculture is a huge component of southern Illinois's economy, especially along the Mississippi, Big Muddy, and Ohio rivers. Both flash and riverine floods can have major impacts on farming and ranching. More intense and frequent spring rains can delay planting, overly saturated soil can harbor harmful fungi and other microbes, and stormwater flow can erode necessary top soils. Long-term riverine floods can destroy a harvest completely, damage buildings and equipment, flood out pasture fields, and drown livestock

57 Lall, U.T. et. Al. 2018: Water. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II U.S. Global Change Research Program, Washington, DC, USA, pp. 145–173.

Figure 3.3


Little Crab Orchard Creek-Crab Orchard Creek 100 Year Floodplain
305(b) Stream
100 Year Floodplain
Lakes
Subwatershed Boundary
County Border
Road
Municipalitiy
% Impervious Land Cover
0 - 25
25-50
50-75
75-100
0
0.5
1
2
3
Miles
1:65,000
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

3.2. Heat Waves

Evidence suggests that the frequency and severity of droughts in the US will increase with climate change; and in the Midwest specifically droughts are expected to occur in late summer months. In Illinois the seasonality and distribution of severe weather events is being altered by climate change, leading to increases in both intense floods and drought[58].

Historically, very hot days (highs at or above 95 degrees F) happened only one to two per year in Illinois, but climate models suggest this will increase to anywhere from ten to sixty very hot days per year by 2090, even under the lower greenhouse emission scenarios. Heat waves and drought negatively affect water quality, and can also dry up small streams and shallow wetlands; killing populations of freshwater organisms and altering community structure.

3.2.1. Urban Heat Islands

Heat waves are even further exacerbated in urban areas due to the Heat Island Effect, built structures including roads and buildings absorb and re-emit the sun's energy more than natural landscapes. Urban areas can be 1-7°F hotter in the day and 2-5°F hotter during the night than outlying areas[59]. Trees and other vegetation provide shade and moisture, which keep areas cooler; in comparison a parking lot absorbs heat and evaporates less water- leading to elevated temperatures.

Side effects of living in urban heat islands can include higher home energy bills, increased exposure to air pollution, and higher risk of heat-related illness. Urban heat islands tend to have higher greenhouse gas emissions and impaired water quality. Heat can also be a type of stormwater pollution- during summer storms, urban stormwater becomes warmer than normal from running over hot pavement[60]. This warm water runs directly from storm drains into local water bodies, raising the water temperature. Even small increases in the temperature of a stream can have dramatic effects on the life cycles of fish and aquatic invertebrates.

58 "Climate Change in Illinois" Illinois State Climatologist, University of Illinois Prairie Research Institute & State Water Survey
59 U.S. Environmental Protection Agency. 2008. Reducing urban heat islands: Compendium of strategies. Draft. https://www.epa.gov/heat-islands/heat-island-compendium.
60 "Heat Island Impacts" United States Environmental Protection Agency

3.2.2. Harmful Algal Blooms

Prolonged periods of drought and excessive heat raise water temperature, increasing the risk of Harmful Algal Blooms (HABs). HABs in freshwater systems are a result of cyanobacteria, a type of blue-green algae that can reproduce, or bloom, rapidly in nutrient-rich warm waters such as ponds and reservoirs. Cyanobacteria occur naturally across the US, but HABs only occur under certain conditions. The other major factor that increases risk of HABs is fertilizer runoff from agricultural and urban areas[61].

Some but not all cyanobacteria produce toxins that cause skin irritation and can be deadly if ingested, a significant risk for young children and pets. Swimming and even playing on beaches are not recommended during HABs. Additionally, the EPA recommends waiting two weeks after a HAB ends before eating fish from the waterbody. Other side effects from HABs include lowered dissolved oxygen and increased turbidity of water, which can lead to die-offs of fish, invertebrates, and submerged freshwater plants.

3.2.3. Impacts on Agriculture

Severe drought can stress plants and disrupt normal growing cycles, leading to less productive crops and grazing pasture. This can cause many issues for ranchers, during droughts feed prices go up and cattle prices can plummet[62].

Prolonged drought combined with areas of heavy agriculture can also exacerbate groundwater/aquifer depletion. When groundwater is pumped for crop irrigation (along with other uses) faster than precipitation can recharge the water storage, the water table will lower. If the water table drawdown is significant, wells can run dry in peoples' home, costs associated with pumping water increase, and in severe cases land subsidence may occur. This is an issue in the Southwest and Great Plains states[63] and some areas of the Chicago suburbs[64] but is less of a concern for southern Illinois.

61 "Harmful Algal Blooms" United States Environmental Protection Agency
63 Larson, Debra "Drought Impacts on the Cattle Industry" University of Illinois Animal Sciences
64 "Groundwater depletion across the nation" USGS factsheet, 2003.

64 Mannix et al., "Groundwater Depletion in Chicago's Southwestern Suburbs" Illinois State Water Survey

3.3. Vulnerable Communities and Environmental Equity

The effects of climate change are becoming more prevalent. Low-income and minority communities are disproportionately exposed to the consequences of climate change in addition to a long history of policies and industry that allowed for negative impacts to human health and the environment in low-income and minority communities. Carbondale, Illinois is not an exception to this trend: the city has a long history of environmental injustice, in particular the Koppers Tie Plant, discussed in the next sub-section.

3.3.1. Koppers Wood Treatment Site

In 1902, the Ayer and Lord Tie Company built a plant on the Northeast side of Carbondale to produce railroad ties and utility poles. The plant was intended to serve the Illinois Central Railroad and had a production capacity 25% larger than any other similar plant in the world. The plant originally employed mostly black workers at a greatly reduced wage. The plant was in operation until 1991[65].

Workers and their families were regularly exposed to exploitative environments and wood treatment chemicals, including creosote and dioxins. Coal-tar creosote includes chemicals that are known to burn or irritate the skin, chemically burn the eyes, cause convulsions and mental confusion, and lead to kidney and liver disorders according to the Agency of Toxic Substances and Disease Registry. Long and frequent exposure can lead to irritation of the respiratory tract and cancer. The air, water and soil in the neighborhoods surrounding the plant also became contaminated with the chemicals. In the early 2000s, a pattern of high cancer rates, predominantly multiple myeloma, was noticed among communities with ties to the Koppers Plant.

A 2000 report states that soils at the Koppers site were visibly contaminated with creosote and that the groundwater contamination at the site included phenols, metals, volatile organic chemicals, pentachlorophenol (PCP, and polycyclic aromatic hydrocarbons (PAHs). Past accidental releases of creosote products also contaminated Crab Orchard Creek. Exposure pathways included ingestion, inhalation, and dermal contact of polluted groundwater; inhalation of airborne emissions from plant operations; dermal contact, ingestion of contaminated soils and fugitive dust.

The Department of Public Health calculated that in 2000 the people of Northeastern Carbondale were safe from contamination because they had taken soil samples, air

65 "History", Carbondale Koppers Justice, Southern Illinois Community Foundation

samples, and tested four private wells north of the site and found the water safe; however, the public remained skeptical of these findings.

In August 2003 the U.S. EPA issued a cleanup proposal called a Statement of Basis for public review. The U.S. Environmental Protection Agency (EPA) issued a Final Decision and Response to Comments in 2004 for the Beazer East, Inc. former Koppers Wood-Treating Facility. The Final Decision required Beazer to excavate contaminated soils and Glade Creek sediments, reroute a segment of Glade Creek, construct soil covers, install trenches and a well to collect subsurface creosote and creosote chemicals, and construct an on-site containment cell for placement of consolidated remediation waste. In addition, the Final Decision required Beazer to place an institutional control on the property deed restricting the use of land and groundwater and monitor groundwater conditions and the natural recovery of creek sediments. This Explanation of Significant Difference (ESD) document describes and records the EPA's decision to modify the selected remedy to address additional contaminated soil on the Site[66].

In 2010, Beazer East completed a six-year cleanup at the site under EPA's supervision. The discovery of remaining contamination made additional cleanup necessary, which began in 2020 to address dioxin/furan-contaminated soil on 16 acres of the site. Crews cleared trees and brush to expand existing soil covers and excavated more than 34,000 tons of contaminated soil. Areas will be re-seeded with native vegetation following clean up procedures. Both cleanups were ordered under the authority of the federal Resource Conservation and Recovery Act. Based on a recent press release, it has been assessed that the former Koppers Ties plant has finished their clean-up remediation[67].

In 2021 a monument designed by Dan Johnson was erected in Attucks Park, Carbondale; the monument was built to "create dialogue, increase awareness, and promote healing for the people exposed to chemical toxins."[68] While questions and skepticism remain by many citizens in Carbondale, the monument and recent site remediation efforts are a step in the direction towards justice for the families affected by the plant. In an interview with The Southern, Melissa McCutchen of Carbondale Concerned Citizens said "Another thing is, we will not allow other people who have not been affected to dictate this narrative, "We matter, and that's why our fight continues."[69]

66 "Hazardous Waste Cleanup: Former Koppers Wood Treatment Facility - Carbondale, Illinois", US EPA
67 Blakely, Amelia. "A Tale of Two Brownfield Sites in the Midwest as They Look to the Future." WBEZ Chicago, WBEZ Chicago, 11 Feb. 2021.
68 Blakely, Amelia, "Koppers monument erected; environmental justice fight continues on Carbondale's Northeast Side", The Southern Illinoisian, 2021.

3.3.2. Community Partner Programs and Future Suggestions

Current work and suggestions for future projects from the Carbondale NAACP and A.C.E.S. 4 Youth Program are summarized below. A.C.E.S. 4 Youth is a nonprofit organization that focuses on environmental injustices and aims to address them through civic engagement, service learning, relational organizing, and power building for "An Equitable & Just Transition"[69].

Soon after schools closed due to the COVID-19 pandemic in 2020, an area Consortium of Education Services for Our Youth DBA: A.C.E.S. 4 Youth entered into a partnership with the Carbondale Branch NAACP and conducted civic engagement sessions with students from Carbondale Community High School, and Alton High School.

With the passing of the Illinois Climate Equitable Jobs Act (CEJA), signed by Governor Pritzker, September 14, 2021, A.C.E.S. 4 Youth proposes to implement a program that teaches participants how to; be energy efficient, reduce the waste of natural resources, collect and analyze data, and monitor the quality of water, air, and soil through service-learning activities. Program activities will include tours to waterways and community gardens.

The continued program will target southern Illinois neighborhoods identified in CEJA - areas that have been designated as Restore Reinvest Renew (R3) and Environmental Justice (EJ) neighborhoods which are predominantly American Descendants of Slavery (ADOS) and Black, Indigenous and People of Color (BIPOC) communities. Greater Egypt Regional Planning and Development Commission and two long-standing community organizations - Attucks Community Services, and Gift of Love Charities, with current community gardens, will be added as additional partners.

The proposed program will also educate youth teens and young adults in using many of the EPA tools and lessons online. Specifically, those that address testing and monitoring water, air, and soil. In addition, participants will be educated on the need to go through a transformation to be prepared for a Just Transition to clean renewable energy.

They will learn how to engage in data collection, conduct analysis to develop their media message, gain community resident support and work with decision-makers to endorse the environmental and social change that will occur from the implementation of the Climate and Equitable Jobs Act.

69 Aces4youth.com

Partners will encourage collaboration with educators in our schools, county health department and Federally Qualified Health Centers (FQHC), and social services agencies interested in making policy changes that address the social determinants of health of ADOS/BIPOC, to build a healthier community and establish safe places for residents in the midst of COVID-19 and beyond.

4. Best Management Practices and Pollutant Load Reductions

For the Western Crab Orchard Creek Watershed-based Plan, BMPs have been separated into watershed-wide and site-specific classes. There are a variety of practices in the plan that focus on issues regarding agricultural practices due to the watershed being primarily agriculturally based. Several other BMPs were recommended to address ongoing hydrological issues within the watershed. BMPs were suggested based on several factors including: reduction loads, need, feasibility, cost, and labor.

Pollutant load reductions have been calculated for each site-specific practice by implementing the Region 5 Model. Reductions were also estimated for watershed-wide BMPs. However, estimations for site-specific BMPs may be more accurate considering the variables used for those calculations pertain to a particular area.

BMPs have been arranged by general area in the following section. Along with the general location, they have also been classified by: subwatershed management unit, amount, unit, and priority ranking.

Each BMP suggested in the plan has been characterized and described further by methodology. As previously stated, management measures address the major pollutants in the watershed derived from the original pollutant loads outlined in the watershed resource inventory. Further information on the recommended BMPs can be found in the Illinois Urban Manual, as well as the NRCS Field Office Technical Guide. The Illinois Urban Manual outlines specifications about the purpose of the BMPs, as well as guidance for construction.[70] The NRCS Field Office Technical Guide is state specified guidance that covers general information on the area, natural resources, conservation management systems, practice standards and specifications, and conservation effects. [71]

70 *Illinois Urban Manual.* Association of Illinois Soil & Water Conservation, 2013. PDF File.
71 NRCS and USDA. "Field Office Technical Guide," https://efotg.sc.egov.usda.gov/#/. Accessed August 16, 2019.

4.1. Agricultural BMPs

According to the existing pollutant loads derived from the STEPL model, agricultural practices (cropland/pastureland) account for 21% of the nitrogen load, 29.8% of the total phosphorus load, and 19.5% of the total sediment load in the watershed. *Figure 4.1* displays various agricultural BMPs presented in this plan.

Figure 4.1- Examples of Agricultural BMPs

Source: USDA NRCS, Ohio

4.1.1. Agricultural Filter Strips

Agricultural filter strips protect water quality by naturally filtering nutrients and sediment. Since Western Crab Orchard Creek is impaired by sedimentation, this BMP is effective in reducing these pollutant loads into the waterbody. With the amount of agricultural runoff taking place within the watershed, agricultural filter strips are particularly effective in reducing pollutant loads. Pollutant load reductions were generated in the Region 5 Model assuming BMP efficiencies of: sixty-five percent sediment reduction; seventy-five percent phosphorus reduction; and seventy percent nitrogen reduction. The model also takes Universal Soil Loss Equation (USLE) or the Revised USLE (RUSLE) parameters into consideration. These are specific for the geographic area. Unless otherwise noted, all agricultural BMPs follow the same efficiency percentages.

Figure 4.2 - Agricultural Filter Strip

4.1.2. Conservation Tillage

Conversation tillage can include mulch-till, no-till, and strip-till practices. These forms of conservation tillage usually leave a residual of the previous layer of crops. Each method varies in practice, but the benefits are typically consistent with the others. Any form of conservation tillage paired with contour farming brings added benefit. Major benefits of implementing some form of conservation tillage include reduction in soil erosion and improved water quality. This management practice is a low to moderate cost to place within the area of interest.

4.1.3. Cover Crops

Cover crops provide benefits to agricultural land by improving water quality and reducing erosion. These are usually planted following seasonal harvests. Some landowners in the Western Crab Orchard Creek watershed already plant some form of cover crops, but this number is relatively small compared to the overall acreage of agricultural practices. Cover crops serve to protect soil surface from raindrop impact, improve infiltration relative to bare soil, and trap eroded particles. Cover crops are typically small grains, specifically planted to provide soil cover during the winter. This practice is tailored to the specific crop benefits and/or soil concerns of the farmer. Cover crops control erosion by protecting the soil from wind and water. They can also be used for excess nutrient uptake, increased soil nutrients and organic matter, and weed suppression.

4.1.4. Critical Area Planting

Critical Area Planting involves establishing permanent vegetation on land that is currently eroded or expected to erode in the near future. Usually these are places that are highly eroded and are unable to be farmed. This practice is most commonly used on steep slopes and areas of bare ground, especially along streams, channels, and shorelines. The benefit of this practice is to increase soil cover and reduce erosion from wind or rain. Areas where this BMP may apply include active or abandoned mined lands, areas needing stabilization before or after natural disasters such as floods, hurricanes, tornados, and wildfires, eroded banks of natural channels, banks of newly constructed channels, and lake shorelines. Establishing permanent cover helps to stabilize the soil structure, therefore reducing runoff and improving water quality.[72]

72 USDA-NRCS, "Critical Planting Area," *Conservation Practice Standard,* Code 342 (September, 2010)

Several areas of farm land in Western Crab Orchard Creek are highly eroded and could benefit from this practice.

4.1.5. Crop Rotation

Crop rotation involves cycling two or more crops on the same ground over a period of time. The changing sequence of crops between years allows for increased soil health, as well as reducing sheet, rill and wind erosion. Rotating another crop into the cycle with a larger rooting depth will support further intake of excess nutrients the previous crop could not reach. The outcome is enhanced water quality due to nutrients being used for their intended purpose of crop production instead of running off into nearby waterways. Using cover crops during fallow seasons provides additional nutrient retention. Crop rotation can be combined with many other conservation efforts for enhanced benefits to land and streams. [73]

4.1.6. Drainage Water Management

Drainage water management (DWM) is a practice used in conjunction with existing tile drained fields on flatter landscapes. A water control structure is installed which allows for control of water level by draining excess water or retaining it for future use. This allows for seasonal variation of the crops water needs. By retaining water for future use, crops are given the opportunity to capture water and nutrients for their benefit; thus, decreasing direct flow of nutrients into surrounding waterbodies. This aids in crop production, as well as improved water quality. [74]

4.1.7. Grassed Waterways

Figure 4.3 - Grassed Waterway in Planning Area

Grassed waterways prevent erosion in areas prone to consistent water flow. They can also serve as a filtering mechanism for nutrients. Compared to surrounding areas, the Western Crab Orchard Creek Watershed has very few landowners that implement this practice. The parameters used in the STEPL model for grassed waterways include: soil type, top and bottom width of

73 USDA-NRCS," Conservation Crop Rotation," *Conservation Practice Standard,* Code 328 (October, 2015)
74 USDA-NRCS, "Drainage Water Management Fact Sheet". (Accessed July, 2019).

existing gully, depth, length, and number of years to form.

Since grassed waterways are very effective in addressing erosion and nutrients, the BMP efficiency used in the pollutant load reduction models was set at 1 (100 percent efficiency). Implementation of grassed waterways is assuming at least a 60-foot width per gully.

4.1.8. Livestock Crossings

Livestock frequently crossing through a stream can cause erosion to the streambank and impair the water via increased sedimentation and nutrient loading. Livestock crossings can be constructed by varies means, but with the purpose in mind to stabilize the stream. In many cases, farmers will fence off a portion of the stream to help minimize disturbance. Several locations along Western Crab Orchard Creek are in need of livestock crossings.

Figure 4.4 - Livestock crossing

4.1.9. Pasture/ Hay Planting

A pasture is an area planted with grass or legumes to provide forage for livestock. As a best management practice, specific species are selected to improve forage production, enhance livestock nutrition, and protect the soil from erosion. Converting cropland into pasture or hay production not only benefits local wildlife, but improves water quality as well. The hay/pasture fields filter out nutrients and sediment before entering the stream.[75] Since Western Crab Orchard Creek is impaired by sedimentation, implementing pasture/hay fields would be a beneficial BMP.

4.1.10. Riparian Buffers

A riparian buffer is land following along streams, lakes, and wetlands that is managed for perennial vegetation (grass, shrubs, and/or trees) to improve and guard aquatic resources from the hostile impacts of agricultural practices. Riparian buffers are similar to filter strips, and have additional benefits. Like filter strips, buffers reduce sediment

75 USDA- NRCS, "Pasture and Hayland Planting," *NRCS Job Sheet*. (December, 2009).

and nutrients by filtering the water that flows through it. Since buffers are generally larger than agricultural filters, they can reduce the flow of water at a higher pace. This is beneficial for the riparian buffers along Western Crab Orchard Creek. Since implementation of buffers can be more expensive than normal filter strips, they were suggested sparingly for the Western Crab Orchard Creek Watershed-based Plan.

Figure 4.5 - Riparian Buffer

4.1.11. Terraces

Terraces are cross-slope channels that control erosion on cropland and are usually built so crops can be grown on the terrace. They handle areas of concentrated flow where short-lived gullies may form. There are two types of terraces. Storage terraces collect water and store it until it can be absorbed into the soil or released to stable outlet channels or through underground outlets. Gradient terraces are designed as cross-slope channels to collect runoff water and carry it to a stable outlet like a waterway. Terraces aid in erosion control along moderate to steep slopes by intercepting stormwater runoff and allowing sediment to remain on the cropland instead of washing into nearby streams or ponds. Terraces combined with other BMPs, such as conservation tillage, would increase their effectiveness.[76] Portions of cropland within Western Crab Orchard Creek are mildly sloped with evidence of sheet and rill erosion, therefore suggesting terrace implantation would be a suitable BMP.

4.1.12. Water & Sediment Control Basins

Water and Sediment Control Basins (WASCOB) function quite similar to terraces, but are more geared towards irregular topography where farmers cannot easily plow on the contours. An earth embankment is constructed perpendicular to a gently sloped

76 USDA- NRCS, "Terraces," *Iowa Job Sheet.* (May, 2001).

waterway in order to trap runoff. The sediment is allowed to settle within the basin, while the remaining runoff slowly releases into a stable outlet. The WASCOB prevents rill erosion and increased sedimentation in waterways by slowing down runoff, especially after a heavy rain. [77]

77 USDA-NRCS, "Water and Sediment Control Basin" *Conservation Practice Standard*, Code 638. (October, 2017)

4.2. Urban BMPs

4.2.1. Raingardens/Bioswales

Raingardens and Bioswales hold or slow down excess stormwater, relieving stress on sewer systems. They also act as a filter for stormwater pollutants. Swales are effective in trapping sediment and other nutrients before releasing the water flow into other areas. Depending on the contributing area for the practice, bioswales are generally a suitable structure to reduce total suspended solids.

4.2.2. Green roofs

Along with providing reduced energy costs, green roofs can also provide some environmental benefits including a reduction of stormwater runoff. While the construction of a green roof might immediately be costly, improved energy efficiency would negate the cost over a period of time. For the Western Crab Orchard Creek Watershed, green roofs could also be used as an educational tool, providing a possible environment for sustainability and natural-based solutions to infrastructure. This also helps to mitigate urban heat island effects.

4.2.3. Urban Trees

Suitably placed trees can decrease heating and cooling costs by 10-20% on average within 10-15 years after planting. Sales prices of homes with trees increased by 3.5% to 4.5% over similar properties without trees. Recovery rates were faster for patients whose windows offered views of a wooded landscape. Studies have shown that there is a correlation with less violence happening in public housing where there were trees planted. Trees reduce surface asphalt temperatures by up to 36° F and vehicle cabin temperatures by 47°F. Trees can reduce energy usage, and act as a windbreak, reduce noise, control erosion, clean the air, increase property values. Planting a tree is an investment in time, money, and the future. Planting quality trees begins by choosing vigorous, structurally sound trees from the nursery. Strong trees have straight roots, a thick trunk with taper, and a good branch structure appropriate for the species. Trees that become large at maturity are most durable when grown with one dominant trunk or leader to the top of the tree. The root collar or root flare (the point where the uppermost roots emerge from the trunk) should be in the top two inches of the root ball. A firm, flat-bottomed hole will prevent trees from sinking. Use a rototiller or shovel to loosen soil in an area three times the size of the root ball. This loose soil promotes rapid root growth and quick establishment. The root collar should be even with the landscape soil after planting.

Minimize air pockets by packing gently and applying water Staking holds trees erect and allows the root ball to anchor. A layer of organic mulch, such as leaf litter, shredded bark, or wood chips, helps protect tree roots from temperature extremes and conserves soil moisture. Mulch also helps prevent grass from competing with the tree for water and nutrients. The mulched area makes it easier to operate mowers and weed eaters without hitting the trunk and compacting soil. Apply about three gallons irrigation per inch of trunk diameter to the root ball two or three times a week for the first growing season. It would be wise to increase volume and decrease frequency as the tree becomes established. Weekly irrigation the second year and bimonthly irrigation the third year should be sufficient for establishment. Once established, irrigation requirements depend on species, climate and soil conditions. Irrigation devices should be regularly checked for breaks and leaks.

4.2.4. Permeable Pavement

Considering nearly thirty percent of the Western Crab Orchard Creek Watershed exhibits ten percent or more impervious surfaces, porous and permeable pavement has been suggested as an option to reduce nutrient loads from stormwater runoff. Unlike normal pavement, permeable surfaces act to reduce larger volumes of stormwater across a specific site, and subsequently, limit the advancement of nutrients. This is also helpful in limiting other contaminants from vehicles.

4.2.5. Rain Barrels

Rain barrels are containers which capture the rain flowing off your roof through a downspout. It is safe to use for watering gardens, lawns, and trees, and also for washing cars or outdoor areas. Rain barrels with a drainage valve can be used to store water for use between rain events. When the valve is opened, the water is able to empty from the barrel slowly, thus reducing the amount of runoff and increasing infiltration during storm events.

Rain barrels, and the supplies to make them, are available at most garden, hardware, and home improvement stores. Premade residential rain barrels are generally available in 55-gallon and 90-gallon sizes. Commercial and industrial properties may find cisterns more suitable than rain barrels. Cisterns hold more water and are more durable. Their holding capacity makes them better suited for buildings with large roof areas. Permitting may be required if you install a cistern underground.

Keep in mind that rain barrels are not a stand-alone stormwater management system. They typically fill up in the first rains of the season and will need to overflow to a safe disposal area throughout the rainy season. Garages and outbuildings that do not have basements are best for rain barrels. A patio cover or carport away from the building may also be suitable. Remember, a rain barrel may overflow nearly every time it rains. When the barrels are full, an overflow pipe can allow the extra water to be redirected into a rain garden, lawn, or other landscaped area, or into the sewer/stormwater system if there are no safe landscape alternative.

4.2.6. No Spray Zones (NSZ)

As its name implies, these areas would implement a no spray, or reduced spray, approach to fertilizer use and other chemical use for a particular space. Among other nutrients, this would reduce the amount of nitrogen and phosphorus in runoff. This approach can be useful in suburbs, commercial districts, universities and golf courses.

4.3. Hydrologic BMPs

4.3.1. Infiltration/Detention Basins

For the purpose of reducing flooding and other water quality issues, infiltration basins have been proposed for the plan. An Infiltration Basin is a shallow impoundment that stores and infiltrates runoff over a level, uncompacted, (preferably unobstructed zone) with comparatively permeable soils. Development of these basins will mitigate future flooding occurrences in areas prone to the back-up of water flow. Infiltration Basins use the existing soil mantle to decrease the volume of stormwater runoff through infiltration and evapotranspiration. The quality of the runoff is also improved by the natural cleansing processes of the existing soil mantle and by the vegetation planted in the basins. The key to promoting infiltration is to provide enough surface area for the volume of runoff to be absorbed.

4.3.2. Dikes

Dikes help to mitigate areas prone to flooding by controlling the water level of the area. They can also be included in cropland water management plans to retain water for agricultural purposes[78] Mention of floodproofing earthen dikes is included in the 1997 Preliminary Investigation Report for Western Crab Orchard Creek Watershed.

4.3.3. Wetland Conversion

Converting frequently flooded cropland into wetlands proves to be highly beneficial for improving water quality, as well as reducing soil erosion. Wetlands capture water and filter out excess nutrients before slowing releasing it back into the waterways. This action helps mitigate flooding downstream. Hydric soil near Western Crab Orchard Creek in the western half of the watershed indicates that wetlands existed in that area previously. Most of that land now is for agricultural usage. Not only do wetland conversions help to improve water quality, but it helps to bring more biodiversity into the environment. Converting the land back to wetlands would be extremely beneficial for improved water quality in Western Crab Orchard Creek, especially with reducing sedimentation.

78 USDA-NRCS, "Dike" *Practice Introduction*, Code 356 (December, 2008)

Figure 4.6 - Restored wetland at SIU's Campus Lake

Photo Source: rec.siu.edu

4.3.4. ***Gully Stabilization***

Gullies are a hydrological formation of water channels that occur over time through the force of water and erosion. It is a trench or ravine which has a deep channel, and can cause flooding events to happen much more frequently and severely depending on their location. They are usually found within higher elevation areas like hillsides or mountainsides, and are associated with waterfalls and excessive run-off and spring run-off.

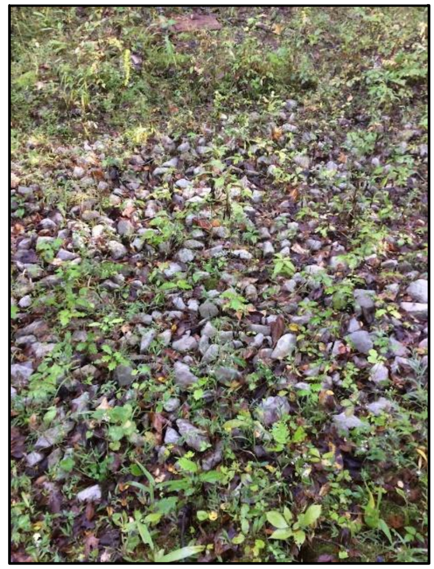
Brush Fills

Brush fill is a continuous filling mechanism on small gullies with brush debris. This includes materials like branches of trees or the stems of bushy vegetation. If brush is placed across the gully, it is called a "brush plug". Brush fill work starts at the head of the gully. The first step in constructing the brush plug is by lining the gully bed with small tree and shrub branches, in order to protect the soil. The next step is placing larger branches over the smaller tree and shrub branches.

A brush fill should rise above the gully banks so it can be weighted down with rocks or heavier limbs to condense the brush. It is helpful to use green limbs to permit the formation of the desired shape due to their malleability. The brush should be compacted in order to allow for compost placement. A tractor can be driven over the brush for this purpose. The main purpose of brush fills is to eradicate the gully with the soil that brush holds.

Earth Plugs

Figure 4.7 - A rip rap and earthen gully plug along the upper Cache River, Johnson County IL.



Earth plugs are small structures that are constructed across the width of gullies. Their main purpose is to hold water and allow for it to infiltrate into the ground. In humid regions, earth plugs must be combined with short diversions. The placement of earth plugs depends on the gully channel's gradient. To determine the earth plug's site, measurements are taken by running a level line from the water level of the upstream earth dam to the channel bottom, and fixing another plug in that spot. The last step is to decide on the number of earthen plugs necessary, while taking into account the compensation gradient. The maximum height for earth plugs is three meters.

The earth plugs are raised above the ground level. The short diversion ditches lead overflow away from the ends of the plugs to prevent erosion damage and to spread the water. Finally, the water is either held or infiltrated by the gully or by the soil on the spreading areas. For this BMP, sufficient plant cover must be maintained due to silt deposits gradually reducing the available storage capacity of the small ponds. The amount of diverted overflow increases and may erode the discharge areas if precautions are not taken.

Woven-Wire Check Dams

Woven-wire check dams are small barriers which are usually constructed to hold fine material in the gully. They are used in gullies with moderate slopes (not more than ten percent) and small drainage areas that do not have flood flows which carry rocks and boulders. The dam is either constructed straight across the gully or in a crescent shape with its open end upstream. The crescent shape check dam is commonly used to allow a longer spillway than is possible on a straight one. At the same time, it anchors and protects the ends of the dam. An offset equal to about one-sixth of the gully's width at the dam site will generally provide sufficient curvature.

For example, if the gully is 7.5 m wide, the spillway of the dam would be about 1.25 m downstream from the abutments. A row of posts is set 0.6 to 0.9 m deep along the curve of the dam at about one-meter intervals. Posts should be placed to form an interval near the center of the gully for the central portion of the spillway. A trench about 0.2 m deep and about 0.15 m wide is dug along the upstream side of the row of posts. Heavy gauge (four mm or more in diameter) woven wire is placed in the ditch against the posts so that 0.25 to 0.3 m of the wire projects above the ground surface along the spillway interval. The coarse mesh should be placed at the bottom of the ditch.

The wire should be stapled securely to the posts. Keep the top of the wire as level as possible along the central portion (the crest of the spillway) to obtain a much better spread of water over the structure. A layer of fine mulch is placed underneath the apron, which allows for a closer bond with the earth is secured. Rocks, brush or sod may be used for the apron. Anchor the brush by pulling the butt ends through the wire mesh, where both the fill and projecting branches will help hold it. Lay enough brush to make an apron at least 1.2 m long and which extends at least 0.6 m on each side of those posts that form the level portion of the spillway. A tie pole is placed across the center of the apron and anchored to stakes in order to compress the brush. The apron is countersunk by shorter brush used near the upper end, which produces a shingle effect. To promote rapid filling and to seal the structure, straw, fine brush or similar material should be packed against the wire on the upstream side to the spillway crest. This should be covered with a well-packed earth fill with a minimal 1:2 ratio or fifty percent slope. Sodding or placing of rocks along the spillway crest prevents future erosion

Brushwood Check Dams

Brushwood check dams are made of posts and brush which are placed across the gully. The main objective of brushwood check dams is to hold fine material carried by flowing water in the gully. Small gully heads, which are no deeper than one meter, can also be stabilized by brushwood check dams. Brushwood check dams are considered as temporary structures and should not be used to treat ongoing problems such as concentrated run-off from roads or cultivated fields. They can be employed in connection with land use changes such as reforestation or improved range management until vegetative and slope treatment measures become effective. If soil in the gully is deep enough, brushwood check dams can be used in all regions. The gradient of the gully channel may vary from five to twelve percent, but the length of the gully channel, beginning from the gully head, should not be more than 100 meters.

There are many types of brushwood check dams, but whichever one is chosen- the spillway crest of the dam must be kept lower than the ends. This allows water to flow over the dam rather than around it. The maximum height of the dam is one meter from the ground (effective height). Both the upstream and downstream face inclination is thirty percent backwards. The spillway form is either concave or rectangular.

Loose Stone Check

Figure 4.8 Stone Check Dam

Photo source: State of Minnesota Stormwater Manual

Loose stone check dams are made of relatively small rocks that are placed across the gully. The main objectives for these dams are to control channel erosion along the gully bed, and to stop waterfall erosion by stabilizing gully heads. Loose stone check dams are utilized in order to stabilize the incipient and small gullies and the branch gullies of a continuous gully or gully network. The length of the gully channel is not more than 100 m and the gully catchment area is two ha or less. These dams can be used in all regions. The maximum effective height of the dam is 1.0 m and its foundation depth is at least 0.5 m. The thickness of the dam at the spillway level is 0.5 to 0.7 m and the inclination of its downstream face is twenty percent (1•1/5 ratio); the thickness of the base is calculated accordingly. The upstream face of the dam is generally vertical.

The foundation of the dam is dug so that the length of the foundation will be more than the length of the spillway. The foundation of the wings should be dug in such a manner that the wings will enter at least fifty centimeters into each side of the gully. The crest of the dam and middle part must be constructed with bigger rocks than the rest of the dam. The wings of the dam should be protected against flash flooding water by wing walls. The angle between the wing wall and the wing needs to be thirty to forty-five degrees. The wing wall's height must be equal to the depth of the spillway. Fill the space behind the wing walls with soil. The space behind the dam should also be filled to spillway level with soil excavated for the foundation, and from the gully bed. The form of the spillway should be concave[79].

79 Organization, Food and Agriculture. "Principals of Gully Control." III. Specific Treatment Measures, 2000, www.fao.org/3/AD082E/AD082e03.htm.

4.4. Waterbody BMPs

While other BMP previously suggested have focused solely on agriculture and flood prone areas, it is important to recommend management measures that can immediately affect waterbodies. These management practices deal with both agriculture and urban environments.

4.4.1. Debris & Litter Removal

Many areas in the Western Crab Orchard Creek Watershed exhibit some form of blockages. This is certainly evident in some segments of Western Crab Orchard Creek watershed. While this is sometimes overlooked, it can be detrimental to the health of a stream or lake. Depending on the flow, a blockage can alter the stream channel and cause erosion on the streambank. Removing debris allows for reduced flooding, and increased streamflow. Areas with major blockages can also exhibit flooding. The natural materials that are taken from these blockages can be utilized in other management practices to benefit the watershed area and to reduce the cost of planning for managing the watershed. There are different methods of litter collection and removal BMPs, as well as methods for preventing litter from entering storm drains and waterbodies in the first place; these will be described in the following sections.

The following litter capture and removal strategies were adapted from the US EPA website[80]

Storm Drain Capture

There are a wide variety of designs that capture litter at the entrance of a storm drain. These can prevent the clogging of stormwater pipes and keep litter out of waterbodies.

Curb Inlet Covers: Screens or plastic covers that keep trash on the street to be picked up by street sweepers.

Catch Basin Outlet Screens or Fabric Inserts: Basket-like structures placed just inside the entrance of a storm drain to capture litter before it goes into the pipes. Must be emptied frequently to be effective and prevent overflows.

Figure 4.9 – Catch Basin with Hood

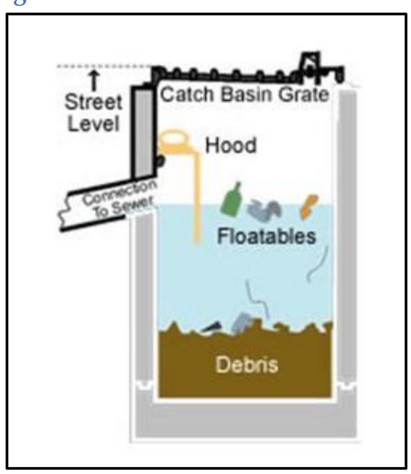


Photo source: U.S. EPA

80 U.S. EPA "Trash Capture Technologies" https://www.epa.gov/trash-free-waters/trash-capture-technologies#drain

Catch Basin Hoods: Hoods over the sewer connection within a storm drain to prevent floating litter from entering. This measure is only useful for storm drains that have catch basins.

In-Line Captures

In line litter captures are structures that trap litter and other debris within storm drain pipes. One such method is a linear radial device: a screen cage within the cement vault. This allows the flow of water to the outlet, while capturing the debris. Regular cleaning and maintenance of the unit is required.

Figure 4.10 – Hydrodynamic Separator

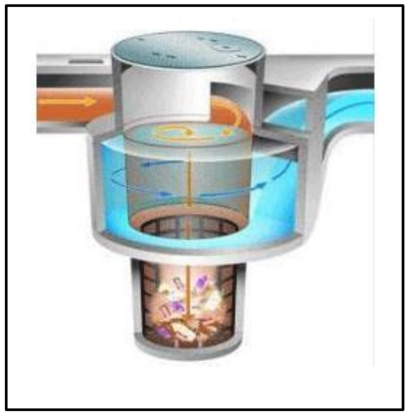


Photo source: U.S. EPA

Hydrodynamic separators are another in-line method, in which a flow through system has units to separate out sediments and floatables. Hydrodynamic separators can come in a variety of sizes, from single manhole designs to ones that capture litter from large areas. They can be expensive to install but tend to be long lasting with proper maintenance.

Netting Systems

Netting systems may be in-line or at the pipe outlet. Generally, these are large mesh nets or wire cages that trap all large debris from entering a waterbody. These structures require regular emptying and repairs to be effective, especially in urban stormwater systems.

Open Water Trash Capture

There are several open water methods that may be useful in the WCOC watershed.

Litter boons and bandalong traps are floating structures that guide litter into collection areas. Both of these structures can be customized to fit the needs of the site. They are typically anchored to the bottom and may have areas that allow for movement of fish and wildlife under the water.

Figure 4.11 – Litter Boon

Figure 4.12 - Bandalong Trap

Photo sources: U.S. EPA

Trash traps are cage-like structures built with metal poles. These are strategically placed in urban streams with high amounts of litter flow. The Anacostia Watershed Society has been designing and studying the effectiveness of this design in the Washington DC area since 2009[81].

Figure 4.13 – Nash Run Trash Trap

Photo source: U.S. EPA

81 Anacostia Watershed Society "Trash Traps, innovative solutions to clean downstream" https://www.anacostiaws.org/what-we-do/river-restoration-projects/pollution-reduction/trash-traps.html

4.4.2. Streambank and Shoreline Stabilization

Varying degrees of erosion occur on all waterbodies. This is particularly evident in Western Crab Orchard Creek. Stabilization of shorelines and streambanks is important to reduce the progress of erosion and mitigate any future occurrences. Stabilization measures can also reduce pollutant loads from runoff; streambank erosion accounts for 75% of the sediment loading and 37% of the phosphorus loading in the watershed.

While streambank stabilization measures are useful tools to protect and restore natural stream habitats, they only treat the symptoms of erosion, not the main cause. Watershed wide BMPs used to reduce storm runoff, gully formation, and surface erosion should be used in combination with the methods listed in this section.

The Region 5 Model uses various parameters to estimate load reductions for shoreline and streambank stabilization. Soil, length and height are components included in the model. Lateral recession rates (LRR) are also used in determining the effectiveness of stabilization. *Table 4.1* displays the modified LRR characterization used in the STEPL Region 5 Model.

Table 4.1 - Modified Lateral Recession Rate Diagram in STEPL Region 5 Model

LRR (ft/yr)	Category	Median Value	Description
0.01 - 0.05	Slight	0.03	Some bare bank but active erosion not readily apparent
0.06 - 0.2	Moderate	0.13	Bank is predominantly bare with some rills and vegetative overhang
0.3 - 0.5	Severe	0.4	Bank is bare with rills and severe vegetative overhang
0.5+	Very Severe	0.5	Bank is bare with gullies and severe vegetative overhang

Source: EPA, IEPA

For consistency, LRRs used for streambank and shoreline stabilization were set at median values: Slight (0.03), Moderate (0.13), Severe (0.4). Efficiency parameters were set at 1 (100 percent efficiency). In most cases, this strategy was used for both banks of a reach unless otherwise noted.

Rip Rap and Rock Weirs/Artificial Riffles

Rip rap is one of the most common methods of streambank and shoreline stabilization. Recycled concrete or large rocks are used to protect banks from erosion and are most useful for low to moderately eroded streams and shorelines. Rip Rap is already used in many areas of the WCOC watershed.

Figure 4.14 - Rip Rap along Indian Creek

In addition to stabilizing a single length of bank, rip rap can be used to restore riffle habitat and provide stabilization along both sides of a stream. This creates habitat heterogeneity; benefitting insects, fish, and some bird species[82]. This practice is common on the upper Cache River in southern Illinois.

Tree revetments

While riprap may be a suitable option for mitigation strategies for stabilization of a stream, there are more environmentally beneficial options to choose from that still provide the same streambank care as riprap. The strategy of using tree revetments in order to reduce the sediment load, erosion rates, and nutrient uptake is a good alternative to riprap. This material involves rows of cut trees anchored to the toe of a stream bank, and it can be installed using hand tools or light powered machinery.

Tree revetment materials can be scavenged within the watershed as a part of the debris removal; which cuts the cost of materials needed. It can also be harvested or purchased at a lower cost than riprap. The tree revetments allow for biodegradable materials to be put in place and serves as a way for vegetation to grow along the banks of streams. The revetments serve as a filtration system for pollutants, overabundance of nutrients, and filtering large sediment loads to reduce the erosion of the streambank.

82Henrich et. al, "Cascading ecological responses to an in-stream restoration project in a midwestern river", Restoration Ecology, 2014.

Coconut Fiber Roll

The use of the coconut fibers within a streambank helps to stabilize it by preventing erosive activity. The use of this material helps by improving on plant life root systems along the bank for a more stable stream. This material is used in a log form that is comprised of coconut hull fibers. These logs are staked at the toe of the stream bank and can be easily built using hand tools.

The cost of this mitigation strategy is moderate to low cost, and is cheaper than other methods of stabilization. The coconut fibers tend to have a high-water retention rate, and become heavier with the more water they uptake; which in turn acts as a means to anchor during a flooding event. The coconut also allows for vegetation growth, and provides a filtration system to take more nutrients/pollutants out of the water.

Figure 4.15 – Gabion Baskets along Crab Orchard Creek

Gabion Baskets

Gabion baskets consist of wire mesh cages filled with cobble. Typically, the baskets are cube shaped and stacked along stream banks to provide stabilization. To further strengthen gabion baskets, live branches are sometimes placed within the basket, over time the roots grow throughout the structures and into the bank. This BMP is useful where banks are steep and construction space is limited. Gabion baskets tend to cost more than rip rap and coconut fiber rolls, and are only recommended for extremely eroded areas.

Deflectors

This BMP is an instream structures used to deflect water away from the eroding bank. These structures can also increase stream habitats by creating meanders in channelized areas, and by creating deeper pools. This can be beneficial to many aquatic species[83]. Deflectors are commonly made from logs or rip rap. In large rivers, these structures may be used to deepen channels for navigation. Other names for this BMP are jetties, wing dams, and dikes. The use of deflectors is recommended in channelized streams with moderate to high bank erosion.

83 Ohio Stream Management Guide no 19

Regrade and Revegetate

Often the most effective BMP, this involves regrading a streambank with machinery, and replanting the new banks with native vegetation. There are different methods and types of plants that can be used for this activity. Revegetation practices can include seeding, live stakes, or planting whole shrubs and trees. Specific projects will require consultants. Since this is a multi-step process and requires significant manpower, it can be very expensive. This method is recommended for short sections of streams with extreme erosion and channelization problems.

Figure 4.16 - A regraded streambank that has been seeded

Photo source: Iowa DNR

4.5. BMP Recommendations

Best management practices for the Western crab Orchard Creek watershed have been proposed by agricultural and waterbody categories. BMPs previously described are further subdivided by watershed-wide and site-specific areas.

4.5.1. Watershed-wide BMPs

As previously stated, BMPs suggested in the plan are separated into watershed-wide and site-specific categories. Watershed-wide BMPs include agricultural BMPs and stabilization methods. Load reductions are symbolized by N (Nitrogen), P (Phosphorus), TSS (Total Suspended Solids), BOD (Biological Oxygen Demand), and COD (Chemical Oxygen Demand).

Much of the agriculture in the WCOC watershed is pasture/hay, which has lower pollutant inputs than cultivated cropland. The Little Crab Orchard Creek-Crab Orchard Creek subwatershed has the highest amount of cultivated crops at 3,430.9 acres. The remaining cropland rests in the Indian Creek – Drury Creek subwatershed. The following has been suggested for nutrient load reductions:

- Thirty (30) percent of cropland to take part in nutrient management planning
- Twenty (20) percent of cultivated cropland to implement conservation cover, cover crops, no-till, and strip-till farming
- Fifteen (15) percent to introduce critical planting
- Ten (10) percent to implement drainage water management and terrace farming practices (if applicable)
- Five (5) percent of cropland to convert to pasture or hayland

Watershed-wide streambank stabilization was based on the extent of erosion. Proposed total stabilized stream length by sub-watershed is displayed in the following figures. Load reductions are based on both sides of banks being stabilized for watershed-wide and site-specific categories. The method used for stabilization will depend on erosion severity, cost effectiveness, and the aesthetic desires of landowners or local officials.

Table 4.2 – Watershed-wide BMP and Load Reductions

BMP	Amount	Unit	Load Reductions- lbs/ yr (N, P) ton/yr-(Sediment)		
			N	P	Sediment
Conservation Cover	762	acre	4,661	2,490	2,131
Cover Crops	762	acre	4,661	2,490	2,131
Critical Planting	572	acre	3,600	1,924	1,658
Debris Removal	-				
Drainage Water Management	381	acre	2,498	1,335	1,162
Livestock Crossing	-				
No-Till	762	acre	4,661	2,490	2,131
Nutrient Management Plan	1,144	acre	6,719	3,589	3,041
Pasture/Hayland Planting	191	acre	1,341	717	635
Streambank Stabilization*	105,500	feet	4,430	2,215	2,215
Strip-Till	762	acre	4,661	2,490	2,131
Terrace	381	acre	2,498	1,335	1,162
		TOTALS:	**39,730**	**21,075**	**18,397**
			N	P	Sediment

Streambank is listed in this table as a watershed-wide practice. Load reductions for individual reaches have also been established as site-specific practices. These reduction numbers are based on both sides of the streambank.

4.5.2. Site Specific BMPs

Many of the watershed-wide BMP have also been suggested at site-specific areas. BMPs such as shoreline, streambank, and gully stabilization have been recommended. The figures below also illustrate the locations of site-specific BMP for the subwatershed by map code. Map codes are also available on the site-specific BMP load reductions in the following section.

4.5.3. Site-specific BMP and load reductions are displayed by SMU. Load reductions follow the same layout as the watershed-wide diagram. A priority ranking was also established for each site-specific practice. Rankings were based on load reductions. The following table summarizes the rankings and load reductions by category. Rankings are based on Nitrogen reduction targets.

Table 4.3 – BMP Priority Index

Priority	Description	Stabilization Criteria (N)	
		Streambank	Gully & Shoreline
L	Low	0-500	0-10
M	Medium	501-1,000	11-50
H	High	1,001+	51+

The following figures represent the site-specific BMP in the plan. Streambank stabilization is represented by reach, and gully stabilization by the Map IDs. For site-specific management measures for the subwatershed management units please see Appendix E. This also contains information for shoreline stabilization for the three lakes examined in this plan.

Figure 4.17

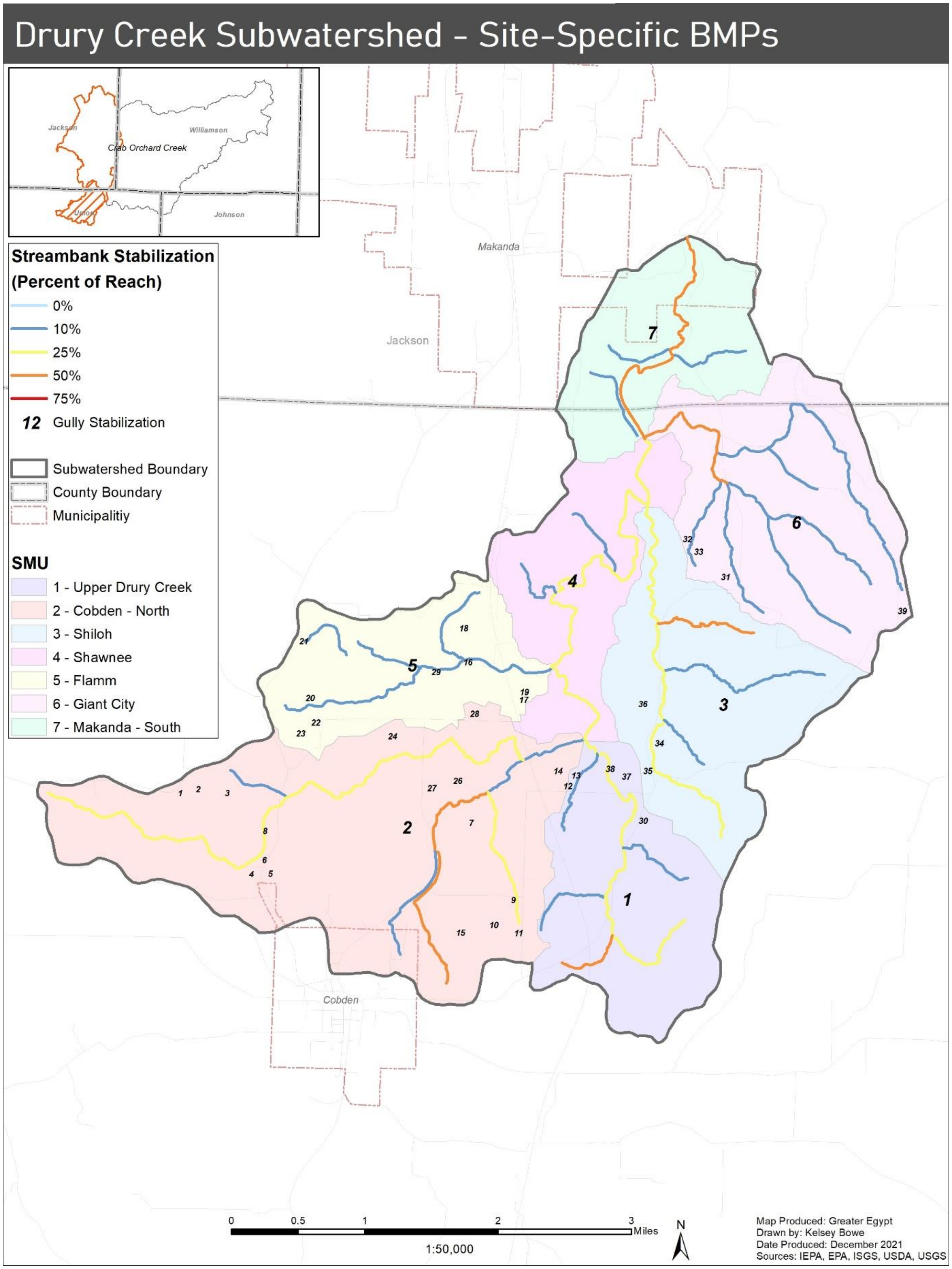
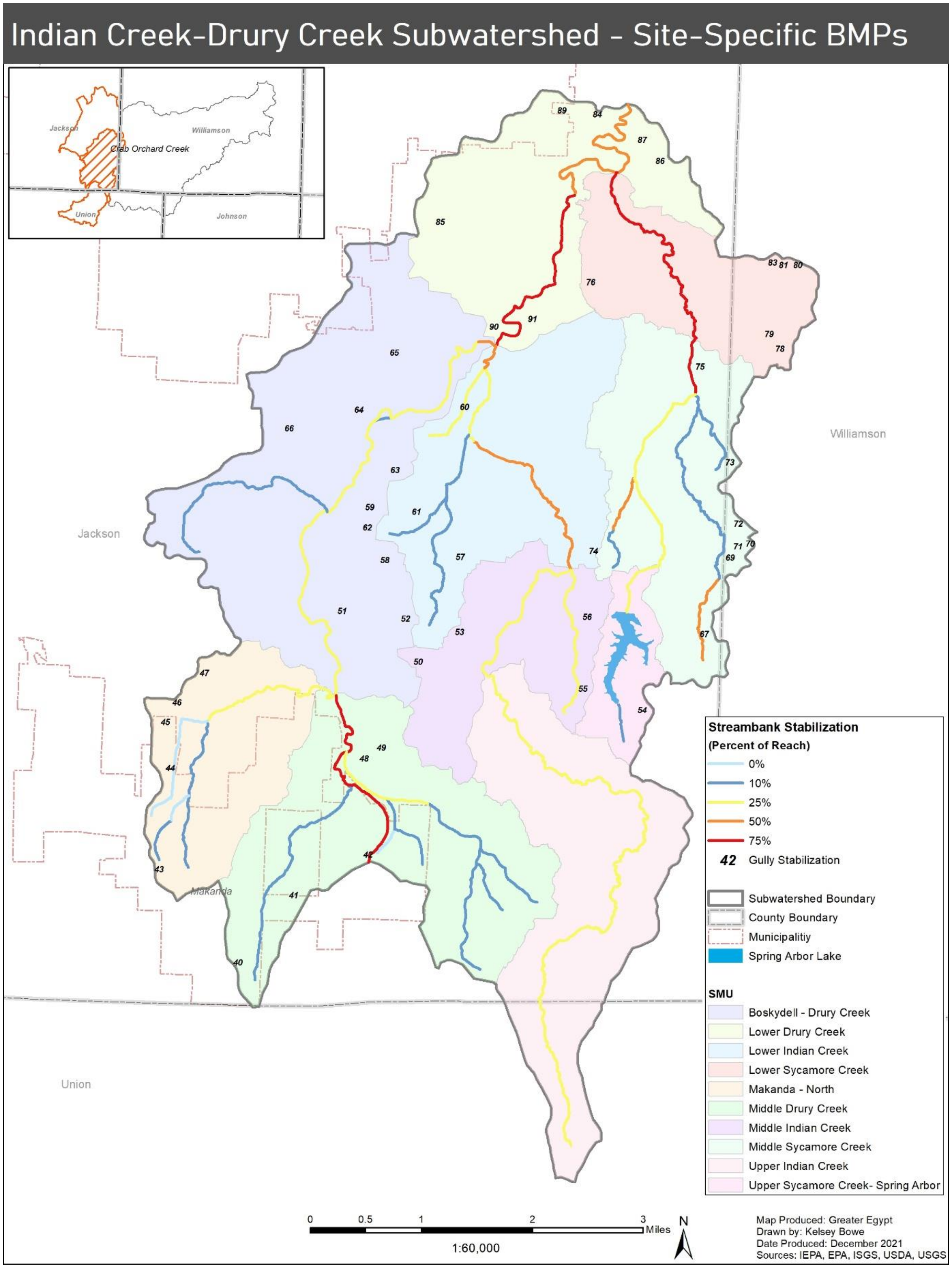
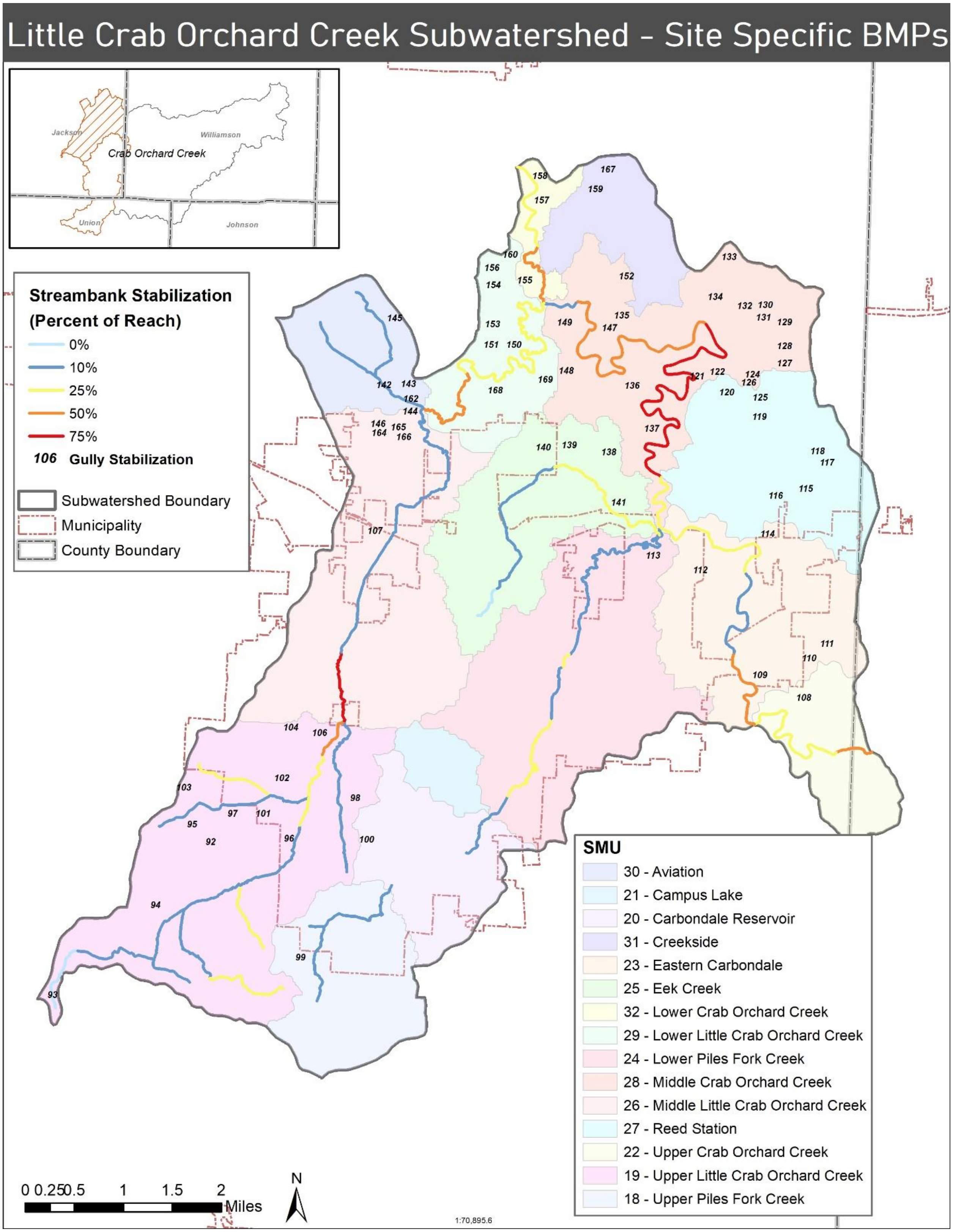

Drury Creek Subwatershed - Site-Specific BMPs
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Streambank Stabilization
(Percent of Reach)
0%
10%
25%
50%
75%
12 Gully Stabilization
Subwatershed Boundary
County Boundary
Municipalitiy
SMU
1 - Upper Drury Creek
2 - Cobden - North
3 - Shiloh
4 - Shawnee
5 - Flamm
6 - Giant City
7 - Makanda - South
Makanda
Jackson
Cobden
0 0.5 1 2 3 Miles
1:50,000
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

Figure 4.18



Indian Creek-Drury Creek Subwatershed - Site-Specific BMPs
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Jackson
Williamson
Union
Makanda
Streambank Stabilization
(Percent of Reach)
0%
10%
25%
50%
75%
42 Gully Stabilization
Subwatershed Boundary
County Boundary
Municipalitiy
Spring Arbor Lake
SMU
Boskydell - Drury Creek
Lower Drury Creek
Lower Indian Creek
Lower Sycamore Creek
Makanda - North
Middle Drury Creek
Middle Indian Creek
Middle Sycamore Creek
Upper Indian Creek
Upper Sycamore Creek- Spring Arbor
0 0.5 1 2 3 Miles
1:60,000
N
Map Produced: Greater Egypt
Drawn by: Kelsey Bowe
Date Produced: December 2021
Sources: IEPA, EPA, ISGS, USDA, USGS

Figure 4.19



Little Crab Orchard Creek Subwatershed - Site Specific BMPs
Jackson
Williamson
Crab Orchard Creek
Union
Johnson
Streambank Stabilization (Percent of Reach)
0%
10%
25%
50%
75%
106 Gully Stabilization
Subwatershed Boundary
Municipality
County Boundary
SMU
30 - Aviation
21 - Campus Lake
20 - Carbondale Reservoir
31 - Creekside
23 - Eastern Carbondale
25 - Eek Creek
32 - Lower Crab Orchard Creek
29 - Lower Little Crab Orchard Creek
24 - Lower Piles Fork Creek
28 - Middle Crab Orchard Creek
26 - Middle Little Crab Orchard Creek
27 - Reed Station
22 - Upper Crab Orchard Creek
19 - Upper Little Crab Orchard Creek
18 - Upper Piles Fork Creek
0 0.25 0.5 1 1.5 2 Miles
N
1:70,895.6

Total load reductions exceed the annual load reduction targets found in Section 2.8.8. Pollutant load reduction totals are displayed in the table below. Implementation of all management measures in the plan would result in a 36 percent reduction in nitrogen. Phosphorus and sediment loads would be reduced at levels beyond the existing pollutant loads.

Table 4.4 – Total BMP Load Reductions

Total Watershed Reductions	N	P	Sediment
	118,528	**60,669**	**57,991**
Percent of Total Pollutant Load	36.24%	100.67%	121.13%
Load Reduction Target	15%	25%	25%

5. Technical and Financial Assistance

Each BMP in the plan has also been described by the technical and financial assistance needed to implement each measure. While technical assistance comes from a few select groups, the financial assistance for management measures comes from a variety of different sources. It is important to note that most BMP projects will have to be customized to the specific location and needs of the agency overseeing the implementation; therefore, the costs outlined in the tables of this chapter should only be used as a general estimate. Detailed costs will have to be determined from stakeholders, contractors, engineers, and materials suppliers and are outside the scope of this Plan.

5.1. Technical Assistance

The labor to execute the BMPs will largely come from local municipalities, public works, landowners, and Greater Egypt Regional Planning and Development Commission (Greater Egypt). State and federal agencies such as the USDA/NRCS and the Jackson, Williamson and Union County Soil and Water Conservation Districts will also be utilized.

The type of technical assistance largely depends on which type of BMP is being implemented. For agricultural BMPs, the USDA and Soil and Conservation Districts will be able to provide their services. If the BMP is municipal, local public works can offer their support. However, for most management measures, drawings and surveys will likely be required by an engineer.

Greater Egypt could also provide technical assistance for some of the BMPs. This includes: GIS services, site plans and drawings, and grant writing and administration.

5.2. Funding Sources

A majority of the management measures described in Chapter 4 will require funding. The major source of funding will be through the Clean Water Act Section 319 Grant Program. This would be granted through the IEPA. Section 319 grants can cover up to sixty percent of the costs. The other forty percent would be met through a local match (municipal, landowner, etc.)

While 319 funding covers most BMPs in the plan, other funding sources have to be considered for the remaining measures. The USDA Natural Resource Conservation Service offers many funding and easement opportunities through programs such as: Agriculture Management Assistance (AMA), Conservation Stewardship Program (CSP), Environmental Quality Incentives Program (EQIP), and Agricultural Conservation Easement Program (ACEP). Through the USDA Farm Service Agency (FSA), funding is offered through programs such as: Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), and Farmable Wetlands Program (FWP). Emergency Conservation and Emergency Forest Restoration Programs offer funding and technical assistance, also through USDA FSA, to restore lands that have been damaged by natural disasters.

The Illinois Department of Agriculture offers funding such as: Conservation Practices Program (CPP), Well Decommissioning Program (WDP), Streambank Stabilization and Restoration (SSRP), Nutrient Management Program (NMP), Soil and Water Conservation District Grants Program, and Vegetative Filter Strip Assessment Law. Another funding source aimed particularly at reducing soil loss and protecting water quality is offered through the Bureau of Land and Water Resources through the Partners for Conservation Program.

Other grants offered through the Illinois Department of Natural Resources include: Open Space Lands Acquisition & Development and Land & Water Conservation Programs, Park and Recreational Facility Construction Grant Program, Federal Recreational Trails Program, Bike Path Grant Program, Schoolyard Wildlife Habitat Grant Program, and the Illinois Biodiversity Field Trip Grant Program.

Illinois EPA provides multiple funding opportunities to finance the design and construction of both, wastewater and nonpoint source pollution projects through grants and low-interest loan programs that include: Illinois Green Infrastructure Grant Program for Stormwater Management (IGIG), Nonpoint source Grants, Wastewater/Stormwater and Drinking Water Loans, Driving a Cleaner Illinois, and Illinois Clean Energy Community Foundation.

In most cases, these programs will not cover the entire cost of the selected BMPs. The remaining costs would have to be funded by landowners, municipalities, businesses, and other entities.

5.3. Implementation

The associated cost of each BMP is displayed in the following tables. Costs largely depend on which BMP is being implemented. To implement all BMPs suggested in the plan, the total would be $42,546,862.43. Costs generally take into account the technical and financial assistance needed along with the maintenance following implementation. Infiltration Basin and streambank stabilization are the top two most costly BMPs, with detention basin being the third, respectively. Conservation cover, grassed waterways, and pasture/hayland planting are the following largest costs.

The cost for filter strips (agricultural, urban vegetated) is dependent on whether the entity is using existing or natural vegetation compared to planting new vegetation.

Table 5.1 - Agricultural, watershed wide, and outreach BMP Costs

BMP	Cost	Unit	Technical Assistance	Funding Source(s)
Agricultural Filter Strip	$176.23	acre	Farm Bureau, Landowner, NRCS, SWCD	IEPA 319, NRCS, USDA
Agricultural Management Workshop	$1,950.00	workshop	Planning Commission, Farm Bureau, NRCS, USDA, SWCD	IEPA 319
Contour Farming	$7.44	acre	NRCS, USDA	IEPA 319, NRCS, USDA
Cover Crops	$85.24	acre	Farm Bureau, NRCS, USDA, SWCD	IEPA 319, NRCS, USDA
Critical Area Planting	$184.95	acre	NRCS, USDA	IEPA 319, NRCS, USDA
Crop Rotation	$14.90	acre	Farm Bureau, NRCS, USDA	NRCS, USDA
Debris Removal	$500.00	site	Volunteers, landowners, public works, contractor	Volunteers, landowners, public works, contractor
Detention Basin	$0.74	cubic foot	Landowner, IDOT, contractor, municipality, public works	Landowners, municipality
Drainage Water Management	$9.55	acre	Farm Bureau, NRCS, USDA	NRCS, USDA
Grassed Waterways	$3,252.00	acre	Farm Bureau, Landowner, NRCS, SWCD	IEPA 319, NRCS, USDA
Litter Cleanup	$0.00	acre	Volunteers	-
No-Till Farming	$20.81	acre	NRCS, USDA	IEPA 319, NRCS, USDA
Nutrient Management Planning	$4.00	acre	Farm Bureau, NRCS, USDA, SWCD	IEPA, NRCS, USDA
Pasture and Hayland Planting	$393.00	acre	Farm Bureau, NRCS, USDA	NRCS, USDA
Public Education on Water Quality	$0.50 each / $150.00 per 300	flyer/brochure	Planning Commission	IEPA 319 Grant, Planning Commission
Public Education on Stormwater/Agricultural Management	$0.50 each / $150.00 per 300	flyer/brochure	Planning Commission	IEPA 319 Grant, Planning Commission
Streambank Stabilization*	$75.30	linear feet	Landowner, volunteer, contractor	IEPA 319 Grant
Strip-Till Farming	$20.81	acre	NRCS, USDA	IEPA 319, NRCS, USDA
Terrace Farming	$3.89	linear feet	Farm Bureau, NRCS, USDA, SWCD	NRCS, USDA

Table 5.2 – Urban BMP Costs

BMP	Cost	Unit	Technical Assistance	Funding Source(s)	Notes	Source:
Bioswale/ Infiltration trench	$11.00	cubic ft	City planners	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	*unit price is is per cubic foot of water filtered by the BMP	Barr Eningeering, Minnesota Pollution Control Agency 2011
Detention basin	$58-145	cubic ft	City planners	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	*unit price is is per cubic foot of water filtered by the BMP	Barr Eningeering, Minnesota Pollution Control Agency 2011
Retention/Filtration basin	$15.00	cubic ft	City planners	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	*unit price is is per cubic foot of water filtered by the BMP	Barr Eningeering, Minnesota Pollution Control Agency 2011
Green Roof	$10-50 residental, up to $200	sq ft	City or University Sustainability Planners, private contractors	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs		https://www.homeadvisor.com/cost/roofing/green-roof/
Porous Pavement	$16.00	cubic ft	City or University Sustainability Planners, private contractors, IDOT, local road commissions	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs, landowners if driveway project	*unit price is is per cubic foot of water filtered by the BMP	Barr Eningeering, Minnesota Pollution Control Agency 2011
Permeable Pavers	$10-20	sq ft	City or University Sustainability Planners, private contractors, IDOT, local road commissions	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs, landowners if driveway project	Can vary depending on type of materials chosen, generally cheaper for small driveway projets and more expensive for streetscaping	homeadvisor.com
Rain Barrel	$15-40	barrel	Extension office, workshop events	landowers, 604b (workshops)		Barrel/hardware prices
Rain Garden	$3-40	sq ft	Extension office, workshop events	EPA 319, City Budget, landowner, 604b (workshops)	varies widely depending on use of contractors/landscapers, and variety of plants chosen	https://web.uri.edu/riss/files/Abridged_ServiceManual.pdf
No Spray Zone	$0.00		City parks depts, SIU facilities, golf course site managers, Homeowners Associations		Regular land maintence would still be needed, but removing the use of fertilzers and pesticides saves money	
Urban Trees	$8,000-10,000	tree pit	City or University Sustainability Planners, private contractors	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	includes tree, other matierals, and installation labor	Charles River Watershed Association Low Impact Best Management Practice (BMP)

Table 5.3 – Litter Removal BMP Costs

BMP	Cost	Unit	Technical Assistance	Funding Source(s)	Source:
Hydrodynamic separator	$16,650.00	unit + installation and maintenance	City planners, IDOT, road commissions, engineers	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	Urban drainage flood control district, urban watersheds research institute, Colorado Stormwater Council, Colorado State University (2017)
Linear Radial Device	$48,300.00	unit construction	City planners, IDOT, road commissions, engineers	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	California State University, Sacramento Office of Water Programs
Storm Drain Capture	design and size of storm drain effect which capture designs are feasbile, cost may vary		City planners, IDOT, road commissions, engineers	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	
Bandalong Trap	$50-100,000	unit installation	City or University Sustainability Planners, private contractors	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs	EPA Aquatic Trash Prevention Great Practices Compendium (2015)
Trash Trap	$6,000.00	Materials, installed by volunteers	City or University Sustainability Planners, private contractors, IDOT, local road commissions	EPA 319, City Budget, IDOT/US Infrastructure grants, State Community grant programs,	Friends of Anacostia Creek

6. Outreach and Education

The success of the Western Crab Orchard Creek Watershed-based Plan is largely dependent on public outreach and educational measures. During the planning phase, public and Watershed Planning meetings were held to provide guidance and raise awareness of the plan. Greater Egypt also hosted public events such as the Rain Garden Workshop and the Stormwater Management Survey to engage community members within the planning area. These activities will continue after the plan is approved and will support the success of the plan.

Early in the planning phase, an initial stakeholders meeting was held to gather local knowledge of the watershed and define preliminary goals including identifying key areas of watershed impairments. Another goal of the initial meeting was to gather members for the Western Carb Orchard Creek Watershed Planning Committee. Meetings were usually held quarterly, and were designed to provide guidance for the plan. Committee members provided local knowledge of water-related activities and identified BMPs that were suggested in the plan.

The Western Crab Orchard Creek Watershed-based Plan has several public awareness and educational components. The schedule for implementing the educational and informational components of the plan is further detailed in the following chapter.

6.1. Establish a Western Crab Orchard Creek Watershed Action Committee.

This assembly would serve much like the planning committee during the development of the plan. The goal of a steering committee would be to promote awareness of the watershed plan and monitor and oversee the progress of plan implementation. Committee members would also be in charge of making revisions to the plan if:

a) Implementation schedule is not meeting expectations;

b) Interim measurable milestones are not being met;

c) Benchmarks for load reduction targets are not satisfactory.

6.2. Gather Public Input

6.2.1. Hold Public Meetings

An initial public meeting would serve to inform the public on implementation of the plan and garner membership for the steering committee. Like the public meetings during the planning phase, flyers, newspaper ads, and PSAs could be used to inform the public of meeting dates.

6.2.2. Water Resources Survey

Greater Egypt conducted an online public survey with questions regarding general knowledge and concern of four main topics: general water quality, stormwater runoff & management, Best Management Practices, and watershed planning. The survey target area was the Carbondale Urbanized Area, which encompasses Carbondale, Cambria, Carterville, Crainville, Colp, Herrin, Energy, Spillertown, and Marion (Jackson and Williamson Counties).

Survey responses are currently being analyzed, results will be available on the Greater Egypt website and for all jurisdictions in the survey target area. Results will be used to guide future projects and grant applications.

6.3. Website

Greater Egypt maintains an updated webpage with information regarding all of our watershed-planning activities. Plan documents, meeting dates and minutes, and any other important information can be easily found at http://greateregypt.org/watershed-based-planning/.

6.4. Volunteer Litter Cleanup Days

Litter cleanup events are a great way for organizations to participate in team building and community service. We recommend the planning team coordinate with existing groups such as Green Earth Carbondale, Southern Illinois University-Carbondale, Keep Carbondale Beautiful, or clubs such as local scout groups, 4-H, and rotary club.

Figure 6.1 – Volunteer litter clean-up day in Piles Fork Creek

Photo source: Stephanie Eichholz

6.5. Education Programs

6.5.1. Rainscaping Program

In partnership with the University of Illinois Extension at Jackson County, Greater Egypt hosted a Rainscaping workshop which included four classes on rain gardens and stormwater landscaping and a fifth in person session to weed and add new plants to the demonstration rain garden at the Jackson County Extension grounds.

Figure 6.2 – Rainscaping Workshop- Jackson County Extension

Similar programs should continue to educate and provide resources for landowners to manage stormwater on their own properties. This will further benefit the WCOC Watershed as raingardens and other stormwater management measures will reduce pollution and sediment runoff.

6.5.2. Enviroscape Lessons

Figure 6.3 – Enviroscape Models presented at the 2021 Hunting & Fishing Days

Greater Egypt owns two Enviroscape models which can be used to teach lessons on a variety of topics including:

- Basic water cycle and watershed concepts
- Non-point source pollution (Urban and Agricultural)
- Point source pollution
- Stormwater runoff
- Best Management Practices

These models are useful for fairs/expos and classroom visits. Lessons can be tailored to a variety of age groups, but work best for elementary school groups. Greater Egypt presented the Enviroscape models at the 2021 Hunting & Fishing Days with positive reception from groups that stopped at our booth.

6.6. Volunteer Lake Monitoring Program

Since 1984, Greater Egypt has coordinated the VLMP for southern Illinois' ten-county region. This volunteer-based program is maintained by the IEPA. The monitoring season begins May 1st and concludes October 31st with volunteers monitoring their lakes twice a month. Program participants are required to have access to a boat and anchor. Training is provided by the Regional Coordinator for southern Illinois.

*This program has currently been suspended by the IEPA, but we expect it to make a comeback in the following years.

Volunteers are divided into three tiers. Tier I is the most basic, while Tier II and III require previous participation in the program. Participation is dependent on funding and supplies from IEPA. The level of monitoring is dependent on the tier level of the volunteer.

Tier I:

Basic lake monitoring. Volunteers measure lake water clarity with a Secchi Disk and make other basic lake observations. Volunteers record the level of aquatic plant growth, record the siting of any invasive species, the lake water level, weather, and watershed conditions at the time of monitoring.

Tier II:

After actively participating in Tier I, volunteers are eligible for Tier II monitoring. Tier II volunteers complete Tier I monitoring while also taking lake water samples.

Tier III:

In addition to collecting water samples, volunteers also collect chlorophyll samples as well as measure oxygen levels and water temperatures.

7. Implementation and Milestones

To be successful, watershed-based plans require designing a thorough monitoring and evaluation component. These elements include: an implementation schedule which identifies key intervals for management measures (Element F), a description of interim measurable milestones for nonpoint source management (Element G), benchmarks to monitor the effectiveness of BMP load reductions (Element H), and the overall monitoring component to evaluate the progress of implementation (Element I). Elements H and I will be discussed in Chapter 7 of this plan.

7.1. Implementation Schedule

The implementation schedule reflects the general goals in the Crab Orchard Creek Watershed-based plan. Components of the schedule have been classified into three separate phases as seen in *Table 7.1*.

Phase I signifies the short-term actions to be taken in the first two years of the plan. These goals include establishing a watershed action council which would serve to implement the plan and track progress. The other educational and informational components of the plan largely fall under this phase.

Phase II constitutes the mid-term implementation of the plan. Components in this phase should be completed within the sixth year of plan implementation. Key elements of this phase include the continuation of public involvement, and submitting grant applications for BMPs suggested in the plan. The implementation and execution of BMPs will also fall under this segment of the plan.

Phase III indicates the final stage of the plan. This is characterized by continuing efforts in BMP implementation and evaluating accomplishments throughout the plan.

Site-specific BMPs have been characterized by a priority ranking in Chapter 3. These priority rankings follow the phases of the implementation schedule. Generally, BMPs with a high priority ranking will be the first to have grant submissions written for them. Grant submissions, implementation, and execution of high priority BMPs will be considered mainly Phase II components. Subsequently, medium and low priority BMPs will be implemented in the latter part of Phase II and beginning of Phase III depending on available funding.

Table 7.1- Implementation Schedule

Implementation Schedule										
Target	Phase I		Phase II				Phase III			
	Short-term (2 yr)		Mid-term (3-6 yr)				Long-term (7-10 yr)			
	1	2	3	4	5	6	7	8	9	10
Establish watershed action committee	X									
Hold public meetings to gain input	X	X	X	X	X	X				
Post watershed signage for public awareness and BMP implementation	X	X	X	X	X	X	X	X	X	X
Create a website for watershed activities and key dates		X								
Enlist volunteers for litter cleanup days		X	X	X	X	X	X	X	X	X
Hold Electronic Recycling Drives			X			X			X	
Distribute educational brochures for stormwater and agricultural management	X		X		X		X		X	
Hold workshops to inform public on agricultural management		X		X		X		X		
Continue researching funding and technical assistance	X	X	X							
Select site-specific BMP for preliminary designs	X	X	X							
Submit grant applications based on BMP in plan		X	X	X	X	X	X	X		
Meet with landowners to review BMP in plan	X	X	X	X	X	X	X	X		
Implement and execute BMP			X	X	X	X	X	X	X	X
Monitor BMP implementation				X	X	X	X	X	X	X
Announce success of plan implementation					X	X	X	X	X	X

7.2. Interim Measurable Milestones

To determine whether nonpoint source best management practices are being implemented, interim measurable milestones have been designed to monitor success. The educational and outreach components have also utilized the milestone matrix. These milestones follow the same phases as the implementation schedule with three phases distinguishing varying degrees of BMP implementation. Interim measurable milestones are displayed in *Table 7.2*

Understanding that every BMP in the plan may not be implemented is important in identifying the measurable milestones. Feasibility of each BMP has to be considered when distinguishing milestones. If BMP implementation is progressive throughout the plan, the interim measurable milestones in this plan are attainable over a ten-year implementation period.

Progress in achieving the milestone goals will be evaluated periodically by the Crab Orchard Creek Watershed Action Committee. If milestones are not being met, there may be need for adjustments. Adjustments may come in the form of establishing new BMPs, or adjusting the interim measurable milestones to adhere to current progress. Since these milestones are originally established to document progress, any changes should not be significant.

Table 7.2- Interim Measurable Milestones

Interim Measurable Milestones				
Goal	**Indicator**	**Short (2-year)**	**Mid (6-yr)**	**Long (10-yr)**
Address Impairments from Urban & Agricultural Practices/ Improve Water Quality	Linear Feet of Streambank Stabilized	-	15,000	30,000
	Agricultural Strips Created	-	10	20
	Acres to Implement Critical Planting	-	150	300
	Acres Converting to Conservation Tillage	-	150	300
	Acres Converting to No-Till	-	200	400
	Pasture/Hayland Planting	-	100	200
	Acres Converting to Strip-Till	-	200	400
	Acres to Implement Cover Crops	-	150	300
	Acres to Implement Field Borders	-	100	200
	Nutrient Management Planning Partnerships	1	3	6
	Gullies Stabilized	-	20	60
	Drainage Water Management Partnerships	1	3	6
	Riparian Buffers Created	-	2	4

Table 7.2- Interim Measurable Milestones (cont'd)

Interim Measurable Milestones				
Goal	**Indicator**	**Short (2-year)**	**Mid (6-yr)**	**Long (10-yr)**
Outreach and Education	Educational Brochures for Stormwater Management	500	1000	1500
	Educational Brochures for Agricultural Management	500	1000	1500
	Festival/School Enviroscape Presentations	5	10	20
	Number of Litter Cleanup Days	5	10	20
	Public Meetings Held	5	10	15
	Stormwater Management Workshops Held	2	4	10
Reduce/Mitigate Flooding	Urban raingardens/bioswales	-	10	20
	Stormwater(Urban) Tree Planting	5	10	20
	Detention Basins	-	-	1
	Infiltration Basins	-	2	4

8. Evaluation and Monitoring

Along with the implementation schedule and interim measurable milestones, water quality benchmarks (Element H) and a monitoring component (Element I) are required to evaluate the implementation and the overall success of the plan.

8.1. Evaluation Criteria (Water Quality Benchmarks)

The benchmarks provided in *Table 8.1* are based on the implementation of all BMPs in the plan. Practices that were ranked as high priority, as seen in Chapter 3, will be completed by the sixth year; or Phase II of the planning period. Those with a medium or low priority ranking will be implemented by the tenth year. This characterizes Phase III. Determining success and achieving these benchmarks will be dependent on the number of BMP that are actually implemented in the planning period.

Benchmarks in this plan target nitrogen, phosphorus, and sediment. This is largely due to the availability of data from models and nutrient loading information, and the impairments from the 303(d) waterbody in the Western Crab Orchard Creek Watershed.

Since Phase I of the plan extends to the end of the second year, benchmarks have not been assigned. This is due partly to the activities in that phase not having an immediate impact on nutrient load reductions (workshops, flyers, etc.). Load reductions that do occur in this period will be minimal.

Table 8.1 Benchmarks for Determining Plan Progress

	Benchmark Reduction Targets					
Benchmark Period	Nitrogen (percent)	Nitrogen (lbs)	Phosphorus (percent)	Phosphorus (lbs)	Sediment (percent)	Sediment (tons)
2 Year (Phase I)	-	-	-	-	-	-
6 Year (Phase II)	7	228,970	10	60,265	10	47,880
10 Year (Phase III)	15	490,649	25	150,662	25	119,699

While many of the high-priority BMPs will be implemented in Phase II, benchmarks have been set to around half of the overall nutrient load reduction targets. Considering Phase II ends at the sixth year of the planning period, effects of some BMPs implementation may not be apparent until Phase III of the plan.

Phase III benchmarks account for the total reductions of nutrients in the plan. Phase III BMPs should be implemented by the tenth year of the plan. These include any remaining high-priority BMPs and the medium and low BMPs according to the priority index.

8.2. Monitoring Component

A monitoring component is essential to a watershed-based plan in order to determine progress in achieving water quality. Several elements represent the monitoring component for the plan. These items will provide water quality data that can be used to assess the efficacy of the Western Crab Orchard Creek Watershed-based Plan. The monitoring strategy components are as follows:

1. **Ambient Water Quality Monitoring Network (AWQMN) -** 146 fixed stations are set up along streams throughout Illinois to routinely collect water quality data.[84] Samples of water are collected in 6-week intervals and are analyzed for a variety of parameters, including temperature and dissolved oxygen. Since the planning area experiences various impairments including dissolved oxygen, the AWQMN would be an important component in monitoring the progress of water quality in the watershed.

2. **Dissolved Oxygen Monitoring -** Since some waterbodies in the planning area experience impairments by dissolved oxygen, measuring and monitoring the level of this feature is crucial in evaluating the effectiveness of the plan. Dissolved oxygen measurements would likely come from IEPA, Illinois State Water Survey, the Planning Commission, or a local consultant.

3. **Intensive River Basin Surveys -** Every five years IEPA and IDNR conduct intensive basin surveys of various watersheds in Illinois. IDNR completes testing of aquatic species while the IEPA monitors instream habitats and water quality. The TMDL for the Upper Big Muddy Watershed was completed in 2018.[85]

84IEPA. *River and Stream Monitoring:* Springfield, IL: IEPA. https://www2.illinois.gov/epa/topics/water-quality/monitoring/Pages/river-and-stream.aspx
Accessed: June, 2019
85Fertaly, Margaret. IEPA. Personal Correspondence to the Author (phone). June, 2019.

4. **National Pollutant Discharge Elimination Systems Permit Reviews -** Reviewing NPDES Permits from discharges in the watershed would assist in examining effluent limit exceedance of harmful pollutants. See Chapter 2.8.6 for more information regarding the NPDES facilities in the watershed.

5. **Sediment Monitoring –** In collaboration with the Illinois State Water Survey (ISWS), sediment monitoring stations would be installed to provide baseline data, and continued annual sediment reports. Since some waterbodies in the planning area, and the larger Big Muddy watershed, exhibit sedimentation and siltation, obtaining accurate sediment loading data would be crucial in analyzing the efficacy of management measures; specifically gully and streambank stabilization methods.

These monitoring components will be utilized throughout the ten-year planning period. While most of the monitoring components are provided through a state agency at no cost, sediment monitoring though the Illinois State Water Survey would require an investment for installation and continued maintenance.

Table 8.2 - Schedule for Monitoring Components

Monitoring Schedule										
Monitoring Component	Phase I		Phase II				Phase III			
	1	2	3	4	5	6	7	8	9	10
Ambient Water Quality Monitoring Network		X					X			
Dissolved Oxygen Monitoring			X	X	X	X	X	X	X	X
Intensive River Basin Surveys				X					X	
NPDES Permit Reviews	X	X	X	X	X	X	X	X	X	X
Sediment Monitoring (Big Muddy Stations)	X	X	X	X	X	X	X	X	X	X

APPENDIX A: Meeting Materials

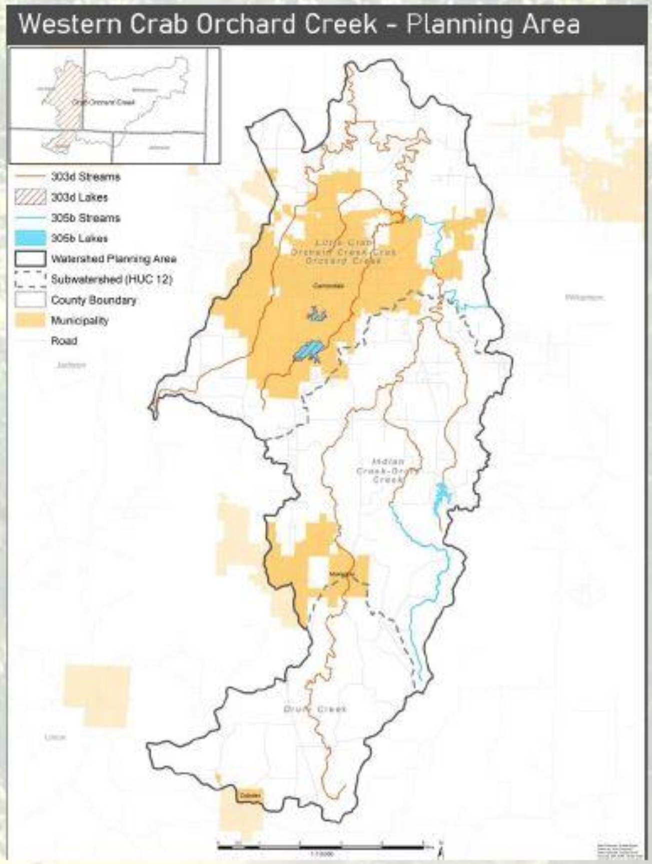
WESTERN CRAB ORCHARD CREEK WATERSHED PLANNING MEETING

Meeting Held through Zoom
August 27, 2020- 6:00PM
Link to Meeting Registration:
Registration (click)

The Greater Egypt Regional Planning and Development Commission will be holding a public information meeting for the Western Crab Orchard Creek Watershed-based Plan on **August 27, 2020 at 6:00 PM**. The meeting will be virtual (please see the meeting information below).

A watershed-based plan is stakeholder-driven approach to water quality. Plans generally include forming a planning committee and proposing best management practices to improve water quality for impaired waterbodies.

This online session will serve as the initial public meeting for the watershed-based plan. The purpose of the meeting is to introduce the components of a watershed-based plan which include: inventory and assessment, best management practices, public outreach and education, and the monitoring and implementation strategy.



Citizens, professionals, and businesses of the watershed are encouraged to attend the meeting and provide comments and suggestions about the planning area and the current plan. For more information about the meeting and the Western Crab Orchard Creek Watershed-based Plan, please visit:

http://greateregypt.org/crab-orchard-creek-west-watershed-based-plan/

Meeting Registration Link: Registration (click)

If you have questions or comments, please contact Tyler Carpenter at the Greater Egypt Office: **618-997-9351** or **tylercarpenter@greateregypt.org**.

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Western Crab Orchard Creek Watershed Planning Committee
AGENDA
August 27, 2020
6:00 PM
Zoom (Virtual Meeting)

1.) Welcome and Introductions

2.) Watershed Basic

3.) Overview of Planning Area

4.) Elements of a Successful Watershed-based Plan

5.) Future Plan Involvement

6.) Discussion/ Questions

Western Crab Orchard Creek Watershed-based Plan

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Initial Stakeholder Meeting Minutes

August 27th, 2020 6:00PM
Virtual Meeting (Zoom)

In attendance : Stephanie Eichholz; Brad Luebke; Gregory Norris; Jeff Hill; Kathryn Carpenter; Jenny Richardson; Lucia Amorelli; Jean Sellar; Nicole Young; Karen Schauwecker; Tina Shingleton; Molly Maxwell; JD Tanner; Sean Henry; Jennifer Paulson; Barbara McKasson; Richard Little; Orval Rowe;

Staff Present: Tyler Carpenter; Ciara Nixon

Greater Egypt Introduction

- Tyler Carpenter with Greater Egypt Regional Planning and Development Commission will discuss the planning components for the Western Crab Orchard Creek Watershed-based Plan. These plans require public assistance to be successful.

- Tyler Carpenter is the Director of Environmental Planning at Greater Egypt Regional Planning and Development Commission. Greater Egypt RP&DC serves five counties. The commission includes SIMPO, economic development, hazard mitigation work through FEMA, and environmental planning. The work at the commission is funded through grants.

Western Crab Orchard Creek Watershed Planning

- Planning area information.
    - 56,533 acres, or 88 square miles located mainly within Jackson and Union County, with small portions within Williamson Counties.
    - The watershed encompasses three separate HUC 12 subwatersheds that will be referred to as the Western Crab Orchard Creek Watershed:
        - Little Crab Orchard Creek – 24,539 acres
        - Indian Creek- Drury Creek – 20,018 acres
        - Drury Creek – 11,454 acres
    - Municipalities within the watershed include Carbondale, Makanda, and Cobden.
    - Land use within the watershed planning area is composed of a variety of land use classes, with majority being forest, agriculture, or urban land. About 95% of Carbondale is located within the Little Crab Orchard Creek watershed, making the majority of land use in this watershed urban land, with some pockets of agriculture. The southern two watersheds,

Indian Creek- Drury Creek and Drury Creek, are mostly forested with some agriculture present.

- ❖ More information regarding the watershed-based plan can be found in the Western Crab Orchard Creek Inventory and Assessment found here on our website: http://greateregypt.org/wp-content/uploads/2018/12/FINAL-Western-C.O.C.-Watershed-Inventory-and-Assessment-1-1.pdf

- What is a Watershed-based Plan?
    - A watershed-based plan summarizes the overall condition of the watershed to then provide a framework to restore water quality in impaired waters
    - The plan also protects water quality in other waters adversely affected or threatened by point source and non-point source pollution.
    - The program allows for funding of water quality projects through EPA 319 Program.

- Why develop a watershed-based plan?
    - A watershed-based plan is developed to create a framework to reduce pollution on surface and groundwater and to restore water bodies to a healthy state. The watershed-based plan may also conserve farmland.
    - Other benefits of developing a watershed-based plan include collaboration among stakeholders, prevention and reduction of flooding, and provides funding for various management measures.
    - A watershed-based plan also contributes to the Illinois Nutrient Loss Reduction Strategy

- What is the IL Nutrient Loss Reduction Strategy (ILNLRS)?
    - This strategy is a collaborative effort between IEPA, IL Dept. of Agriculture, and the IL NLRS Policy Working Group and subcommittees to strategize and promote best management practices (BMP) for nutrient runoff.

- What makes a watershed-based plan successful?
    - The success of a watershed-based plan is dependent on the involvement and collaboration of the stakeholders. Without public involvement, it can be difficult to discover problems within a watershed and to come up with solutions.
        - Stakeholders can include representatives from local government, conservation groups, businesses, landowners, etc.

- What are the elements of a successful watershed-based plan?
    - To be approved by the EPA, a watershed-based plan must include the Nine Minimum Elements of a Watershed-based Plan. These elements include:
        1. Identify causes and sources of water pollution and estimate existing pollutant loads
        2. Set water quality goals and load reduction targets to achieve those goals, and estimate load reductions expected from recommended management measures.
        3. Describe the management measures needed to achieve load reduction targets
        4. Describe the technical and financial assistance and relevant authorities needed to implement the plan
        5. Enhance public understanding though outreach measures

6. Provide a schedule for implementing the management measures identified in the plan
7. Identify interim, measurable milestones for determining whether management measures are being implemented on schedule
8. Identify interim benchmarks to measure progress in meeting water quality goals and load reduction targets
9. Describe a monitoring component

- Future plan involvements
    - The future plan involves developing a Planning Committee. This committee can include individuals who have authority to implement change and management components. Individuals should also have local knowledge of the watershed, such as landowners and local farmers. Committee members may also include individuals who are impacted by water-related issues.
        - Future Actions:
            - Watershed Planning Elements Meeting
            - Best Management Practice Meeting
            - Implementation and Monitoring Strategy Meeting
            - Final Meeting

❖ The final Western Crab Orchard Creek Watershed-based Plan is due June 30th, 2021.

Questions:

- Barbara McKasson: Why has the VLMP stopped?
    - The funding for the VLMP is in limbo. We are hoping funding for this program will be reinstated by 2021.
- Barbara McKasson: What would the source of methoxychlor be?
    - This chemical is now banned by EPA. It used to be used on crops as insecticide. What is left in water now is likely residual from past events.
- Barbara McKasson: How does this tie into NARP planning?
    - NARP and watershed planning have similar goals to reduce nutrients in watersheds and waterbodies. If you are part of a watershed planning group, you can also qualify for NPDES requirements for NARP planning.
- Gregory Norris: Will slide and record be accessible?
    - Slides will be made available on the watershed website.
- Jean Sellar: Most of the BMP's and other practices listed were for far down the gradient in the watershed, but water falls equally in the uplands. BMP's and sediment control practices need to start at the top of the watershed and encourage infiltration and sediment control where the water falls.
    - Everything flows downward in a watershed. Having BMPs higher in the watershed could certainly be a strategy and work to reduce nutrients from flowing downstream.
- Barbara McKasson: If we want to visit a location of concern on your maps. Would someone be available to help us find the area on the ground?
    - Let us know what site you would like to visit, and we can give you the information.

- Gregory Norris: Are you doing any work in the Metro East?
    - Greater Egypt's Water Quality Planning Area currently consists of ten counties in southern Illinois. This does not include the Metro East.

Western Crab Orchard Creek Watershed-based Plan

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Western Crab Orchard Creek Watershed Planning Committee
AGENDA

November 19, 2020

10:00 AM

Zoom - Registration (click)

Watershed-based Plan Information (click)

1.) Welcome and Introductions

2.) Review of Initial Stakeholders Meeting

3.) Nine Elements of a Watershed-based Plan
  a. Review
  b. Status

4.) Synopsis of the Western Crab Orchard Creek Watershed Inventory
  a. Boundaries
  b. Land Use
  c. Pollutant Loads/ Pollutant Loading
  d. Assessment

5.) Concerns within the Watershed
  a. EPA 303d List: Impairments
  b. EPA 305b List: Inventory (EPA)

6.) Preliminary Goals

7.) Planning Committee Participation

8.) Meeting Schedule

9.) Adjourn

Western Crab Orchard Creek Watershed-based Plan

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Watershed Planning Committee
Meeting One Minutes
November 19th, 2020 10:00AM
Virtual Meeting (Zoom)

In attendance:

Thomas Brummer, *Assistant Director- SIU-Touch of Nature*
Christina Crites, *VP and Wastewater Group Manager- CMT Engineering*
Stephanie Eichholz, *Director- Green Earth, Inc*
Beth Fisher, *Southern Illinois Healthcare*
Liz Gersbacher, *Jackson County IL League of Women Voters*
Jeff Hill, *Northwest Plant Superintendent, City of Carbondale*
Gayle Klam, *President- Jackson County IL League of Women Voters*
Brad Luebke, *Plant Superintendent- Northwest Water Plant*
Barbara McKasson, *Conservation Co-Chair- Sierra Club, Shawnee Chapter*
Gregory Norris, *Commission Member, IEPA- Advisory Commission for Environmental Justice*
Orval Rowe, *Deputy Coordinator- Jackson County EMA*
Karen Schauwecker, Sustainability Program Coordinator- Office of Sustainability, SIUC
Tina Shingleton, *Village President- Village of Makanda*
JD Tanner, *Director- SIU-Touch of Nature*

Staff Present: Tyler Carpenter, Raye Fields, Cody Lueker, Cary Minnis, Ciara Nixon, Noah Scalero.

Welcome and Introductions

- Tyler Carpenter with Greater Egypt reviewed information regarding the Western Crab Orchard Creek Watershed-based Plan with the Watershed Planning Committee.

Review of Initial Stakeholders Meeting

- Questions from Initial Stakeholders Meeting.
- Summary of Watershed-based Planning.
- Review of Nine Minimum Elements of a Watershed-based Plan.

Western Crab Orchard Creek Watershed Assessment
(Maps are shown within the PowerPoint Presentation)

- Review of planning area information.
    - Elevation and Floodplain; Wetlands; Land Use; Agriculture; Subwatersheds; Assessed Waterbodies.
- Review of Watershed Assessment Analyses.
    - Erosion analysis of streambanks and shorelines.
    - Riparian/Littoral analysis of streambanks/shorelines.
    - Channelization analysis of streams.
- Analysis of Estimated Pollutant Loads.
- Review of water quality goals and load reduction targets.
    - Using the IL Nutrient Loss Reduction Strategy (ILNLRS)
- Concerns within the watershed.
    - Crab Orchard Creek Subwatershed 303d Information.
    - Indian Creek- Drury Creek Subwatershed 303d Information.
    - Drury Creek Subwatershed 303d Information.
- Future involvement from Planning Committee.
- Meeting Schedule:
    - ✓ November 2020, Meeting 1- Introduction of Plan Elements and Watershed Inventory.
    - January 2021, Meeting 2- Best Management Practices and Remaining Plan Elements.
    - March 2021, Meeting 3- Prioritization of Best Management Practices.
    - May 1, 2021, Meeting 4- Draft Plan Review.

❖ The final Western Crab Orchard Creek Watershed-based Plan is due June 30th, 2021.

Meeting adjourned.

WESTERN CRAB ORCHARD CREEK WATERSHED PLANNING MEETING

Meeting Held through Zoom
February 23, 2021- 10:00A M
Link to Meeting Registration:
Registration (click)

The Greater Egypt Regional Planning and Development Commission will be holding the second Planning Committee meeting for the Western Crab Orchard Creek Watershed-based Plan on **February 23, 2021** at **10:00 AM.** The meeting will be virtual (please see the meeting information below).

Meeting Registration Link: Registration (click)

If you have questions or comments, please contact Tyler Carpenter at the Greater Egypt Office: **618-997-9351** or **tylercarpenter@greateregypt.org**.

Western Crab Orchard Creek Watershed-based Plan

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Western Crab Orchard Creek Watershed Planning Committee
AGENDA

February 23, 2021

10:00 AM

Zoom - Registration (click)

Watershed-based Plan Information (click)

1.) Welcome and Introductions

2.) Review of Previous Meetings

3.) Pollutant Load Reduction Target Summary

4.) Element C: Best Management Practices to Achieve Load Reduction Targets
- a. General BMP overview
- b. Watershed-wide Practices
- c. Site-specific Practices
- d. Load Reductions

5.) Element D: Technical and Financial Assistance
- a. Funding/Grants

6.) Element E: Education and Outreach

7.) Elements F-I: Implementation and Monitoring Strategy

8.) Meeting Schedule

9.) Adjourn

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959 (618) 997-9351

Planning Committee Meeting 2 – Minutes
February 23rd, 2021 10:00AM
Virtual Meeting (Zoom)

In Attendance

Tina Shingleton, President, *Village of Makanda*
Stephanie Eicholz, Director, *Green Earth Inc.*
Sean Henry, Director, *Public Works Carbondale*
Barbara McKasson, Conservation Chair, *Shawnee Group Sierra Club*

Staff Present

Tyler Carpenter, *GIS and Environmental Planning Director*
Noah Scalero, *Planner*

Greater Egypt Introduction

- Tyler Carpenter with Greater Egypt briefly reviewed topics covered in previous meetings for the Western Crab Orchard Creek Watershed – based plan.

✓ Detailed information regarding the watershed – based plan can be found in the Crab Orchard Creek Inventory and Assessment found on our website: http://greateregypt.org/wp-content/uploads/2018/12/FINAL-Western-C.O.C.-Watershed-Inventory-and-Assessment-1.pdf

Western Crab Orchard Creek Watershed Planning

- Review of previous meetings
- Completed Elements
  - Element A – Identification of causes of impairment and pollutant sources that need to be controlled to achieve load reductions identified in watershed plan
  - Element B– An estimate of the load reductions expected from management measures.
- Remaining Elements
  - Element C: Describe management measures that will achieve load reductions and targeted critical areas
    - The BMP process was explained to members
    - The plan will need to include watershed-wide and site-specific measures
  - Element D: Technical and Financial Assistance

- Members will have until the next meeting to submit BMP proposals
  - Element E: Education and Outreach
  - Element F – I: Implementation and Monitoring Strategy
- Needs from Committee / Meeting Schedule

Future Meetings

- ✓ Watershed Planning Elements – Meeting 1
- ✓ Best Management Practices – Meeting 2
- Implementation and Monitoring Strategy – Meeting 3
- Final Meeting 4

Meeting adjourned.

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
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Western Crab Orchard Creek Watershed Planning Committee 2.5
AGENDA

May 4, 2021

10:00 AM

Zoom Meeting Link (click)

Watershed-based Plan Information (click)

1.) Welcome and Introductions

2.) Review of Previous Meetings

3.) Pollutant Load Reduction Target Summary

4.) Element C: Best Management Practices to Achieve Load Reduction Targets
- a. General BMP overview
- b. Watershed-wide Practices
- c. Site-specific Practices
- d. Load Reductions

5.) Element D: Technical and Financial Assistance
- a. Funding/Grants

6.) Element E: Education and Outreach

7.) Elements F-I: Implementation and Monitoring Strategy

8.) Meeting Schedule

9.) Adjourn

Western Crab Orchard Creek Watershed-based Plan

Greater Egypt Regional Planning and Development Commission
3000 West DeYoung Street, Suite 800B-3
Marion, IL 62959   (618) 997-9351

Planning Committee Meeting 2.5 – Minutes
May 4th, 2021 10:00AM
Virtual Meeting (Zoom)

Staff Present

Tyler Carpenter, *GIS and Environmental Planning Director*
Ciara Nixon, *Planner*

Greater Egypt Introduction

- Ciara Nixon with Greater Egypt briefly reviewed topics covered in previous meetings for the Western Crab Orchard Creek Watershed – based plan.

✓ Detailed information regarding the watershed – based plan can be found in the Crab Orchard Creek Inventory and Assessment found on our website: http://greateregypt.org/wp-content/uploads/2018/12/FINAL-Western-C.O.C.-Watershed-Inventory-and-Assessment-1.pdf

Western Crab Orchard Creek Watershed Planning

- Review of previous meetings
- Completed Elements
  - Element's A and B
- Remaining Elements
  - Element's C, D, E and F remain
  - Ciara emphasized the importance of BMP proposals from committee members
  - Members will have until the next meeting to turn in BMP proposals

Future Meetings

✓ Watershed Planning Elements – Meeting 1
✓ Best Management Practices – Meeting 2
✓ Best Management Practices - Repeat of Meeting 2
- Implementation and Monitoring Strategy – Meeting 3
- Final Meeting 4

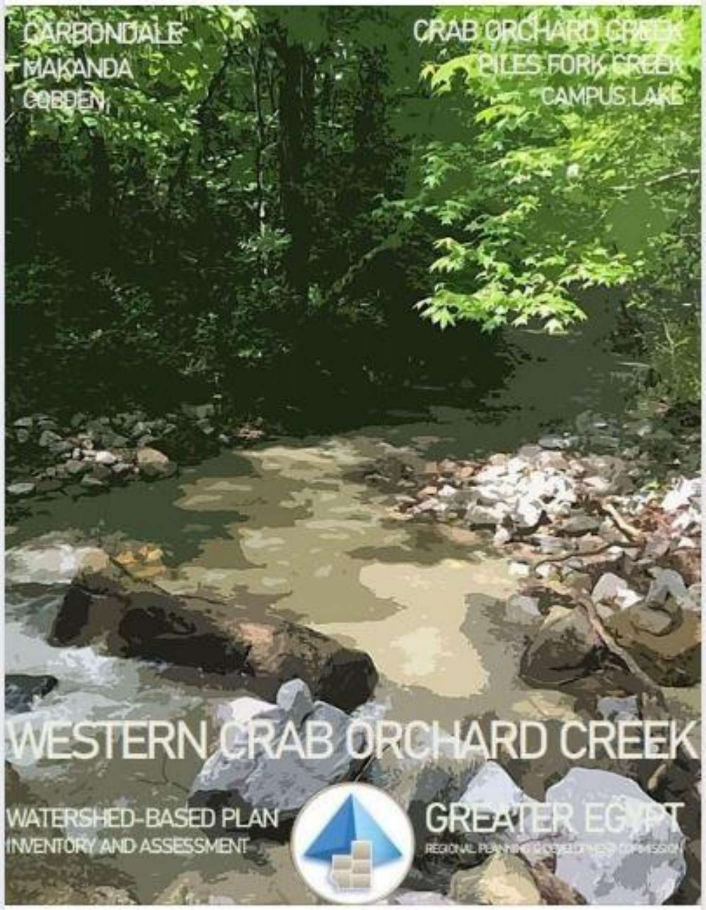
Meeting adjourned.

August 12 Public Meeting

Greater Egypt Regional Planning and Development Commission
July 29 ·

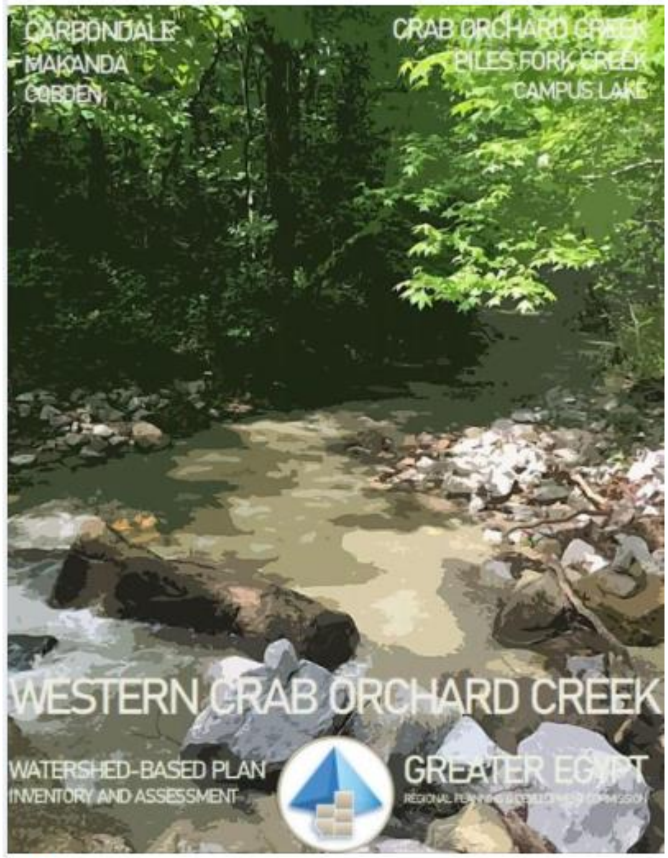
REMINDER: Greater Egypt will host a public meeting Thursday, August 12 to provide information and receive public input on the Western Crab Orchard Watershed-based Plan. The meeting will be an exhibit style withs maps and posters displayed, a running slideshow, and the Environmental Planning Team on-site to answer any questions. This will be the public's opportunity to learn about the watershed and provide any management suggestions before the final plan is published.

The meeting will be from 6pm to 8pm at the Carbondale Civic Center room 118.



City of Carbondale Government
August 12 ·

REMINDER: Greater Egypt will host a public meeting this evening, Thursday, August 12, from 6pm to 8pm at the Carbondale Civic Center room 118, to provide information and receive public input on the Western Crab Orchard Watershed-based Plan. The meeting will be an exhibit style with maps and posters displayed, a running slideshow, and the Environmental Planning Team on site to answer any questions. This will be the public's opportunity to learn about the watershed and provide ... See more



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Western Crab Orchard Creek Watershed-based Plan

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Western Crab Orchard Creek Watershed Planning Committee

October 7, 2021
10:00 AM

[Zoom Meeting Link (click)]
[Watershed-based Plan Information (click)]

AGENDA

1.) Welcome and Introductions

2.) Review of Previous Meetings

3.) Element C: Best Management Practices Review
- a. Watershed-wide Practices
- b. Site-specific Practices
- c. Load Reductions

5.) Element D: Technical and Financial Assistance
- a. Funding/Grants

6.) Element E: Education and Outreach

7.) Elements F-I: Implementation and Monitoring Strategy

8.) Remaining Meeting Schedule

9.) Adjourn

Greater Egypt Regional Planning and Development Commission
3117 Civic Circle Blvd, Suite A
Marion, IL 62959 (618) 997-9351

Planning Committee Meeting 3 – Minutes
October 7th, 2021 10:00AM
Virtual Meeting (Zoom)

Greater Egypt Staff Present:
Tyler Carpenter, *GIS and Environmental Planning Director*
Kelsey Bowe, *Environmental Planner*
Gabrielle Reed, *Environmental Planner*

Greater Egypt Introduction

Mr. Carpenter gave opening remarks appreciation for the planning committee and their commitment in the watershed. He briefly reviewed the past meetings, agenda, and the remaining components of the watershed plan. The Nine Minimum Elements guidelines were discussed with the planning committee and the importance of the 9 Minimum Elements was expressed. Mr. Carpenter spoke about how without meeting the minimum elements, plans may not be accepted and approved by the EPA. He discussed the preliminary goals of the watershed plan such as identifying shoreline erosion, agricultural runoff, nutrient and sediment load reduction targets, possible BMPs, and the involvement of the planning committee.

- ✓ Detailed information regarding the watershed – based plan can be found in the Crab Orchard Creek Inventory and Assessment found on our website: http://greateregypt.org/wp-content/uploads/2018/12/FINAL-Western-C.O.C.-Watershed-Inventory-and-Assessment-1.pdf

Western Crab Orchard Creek Watershed Planning

- Review of previous meetings
- Element C BMPs- Load reduction through identifying pollution sources and impairments. Existing loads of sediment, nitrogen, and phosphorus. Detailed maps were presented and watershed wide BMPs and site specific BMPs were discussed.
- Element D Technical and Financial Assistance- Possible funding sources such as the EPA 319 Grant, USDA Grants, DOT funding, and landowners. BMP technical assistance can be possible through contractors, public workers, volunteers, or landowners.
- Element E Enhancing public understanding and involvement- Tyler emphasizes the importance of public involvement and the possible opportunities for outreach and education. Demonstration sites, and information pamphlets are discussed, as well as workshops and surveys.
- Elements F-I Implementing a Schedule- Interim measurable milestones must be set in place, benchmarks for load reduction targets must be established, and monitoring strategies need to be established. These elements are responsible for measuring how successful the BMPs for the plan are.

Future Meetings

Mr. Carpenter discussed the watershed plan schedule and the planning committee schedule moving forward into the next phase of the Western Crab Orchard Creek Watershed-based Plan:

- ✓ Watershed Planning Elements – Meeting 1
- ✓ Best Management Practices – Meeting 2
- ✓ Best Management Practices - Repeat of Meeting 2
- ✓ Implementation and Monitoring Strategy – Meeting 3
- Final Meeting 4

Meeting adjourned.

Greater Egypt Regional Planning and Development Commission
3117 Civic Circle Boulevard, Suite A
Marion, IL 62959 (618) 997-9351

Western Crab Orchard Creek Watershed Planning Committee

November 16, 2021
10:00 AM

Zoom Meeting Link (click)
Watershed-based Plan Information (click)

AGENDA

1.) Welcome and Introductions

2.) Review of Previous Meetings

3.) Watershed-based Plan Draft

4.) Review of Watershed-based Plan – Elements of Plan

A. Identification of Causes and Impairments
B. Estimate Load Reductions from Management Measures
C. Nonpoint Source Measures to Achieve Load Reductions
D. Estimate Technical and Financial Assistance Needed
E. Education/Information Component
F. Schedule of Implementing Nonpoint Source Measures
G. Description of Interim Milestones for Measures
H. Criteria to Measure Progress of Load Reductions by Measures
I. Monitoring Component of Management Measures

5.) Remaining Meeting Schedule

6.) Adjourn

Greater Egypt Regional Planning and Development Commission
3117 Civic Circle Blvd, Suite A
Marion, IL 62959 (618) 997-9351

Planning Committee Meeting 4 – Minutes
November 16, 2021 10:00AM
Virtual Meeting (Zoom)

Greater Egypt Staff Present:
Tyler Carpenter, *GIS and Environmental Planning Director*
Kelsey Bowe, *Environmental Planner*
Gabrielle Reed, *Environmental Planner*

Planning Committee Present:
Tina Shingleton, President- Village of Makanda
Stephanie Eichholz, Director- Green Earth, Inc.
Tom Brummer- Director- SIUC Touch of Nature
Tony Harrison- Director of Utilities, City of Carbondale, IL

Introductions were made by Tyler Carpenter, including the overview of the purpose of the meeting. The purpose of the meeting is to review the ongoing work in the Wester Crab orchard Creek Watershed Based Plan document. Mr. Carpenter informed the attendees of the new draft release date and the final submission dates on November 18th and November 30th. The previous meetings held concerning the watershed-based plan were reiterated by Tyler, as well as the expectations for the remaining time frame. He also discussed the past meeting conducted on Zoom and the publications of previous drafts on the Greater Egypt website.

Mr. Carpenter reviewed the *Nine Minimum Elements* necessary for a watershed plan to be conducted and finalized for grant approval and for IEPA guidelines. He covered the preliminary goals of the planning process and the load reduction targets desired for the watershed. Mr. Carpenter made a point to note that the IEPA have not made any comments on the plan draft. He talked with the planning committee about the 303d impaired waters list and what constitutes as an impaired water. Pollutant loads from urban and rural areas are discussed and the concerns for the future o the watershed.

The best management practices necessary to aid in the load reduction targets were discussed in the meeting by Tyler, and the possible points of nonpoint source pollution. The agricultural impact of nonpoint source pollution is made apparent, as well as the means to mitigate the points of interest. Tyler discussed with the planning partners about the estimated 42 million needed for the project to be completed in its entirety. Tyler spoke about the sources of funding and the ways that the planning partners can prepare for funding sources. Public education demonstrations and meeting have been held in previous meeting and events to raise awareness and to educate the public and partners of their impact on their watershed.

The timeline of the watershed-based plan is set for a two-year implementation schedule for funding of the plan. The best management practices necessary are discussed by Tyler and explained for the use and placement of the BMPs, such as cover crops and no till areas in agricultural settings. The interim milestones were discussed within this meeting and the importance of flowing the milestones for the best outcome of funding and of successful mitigation for the plan.

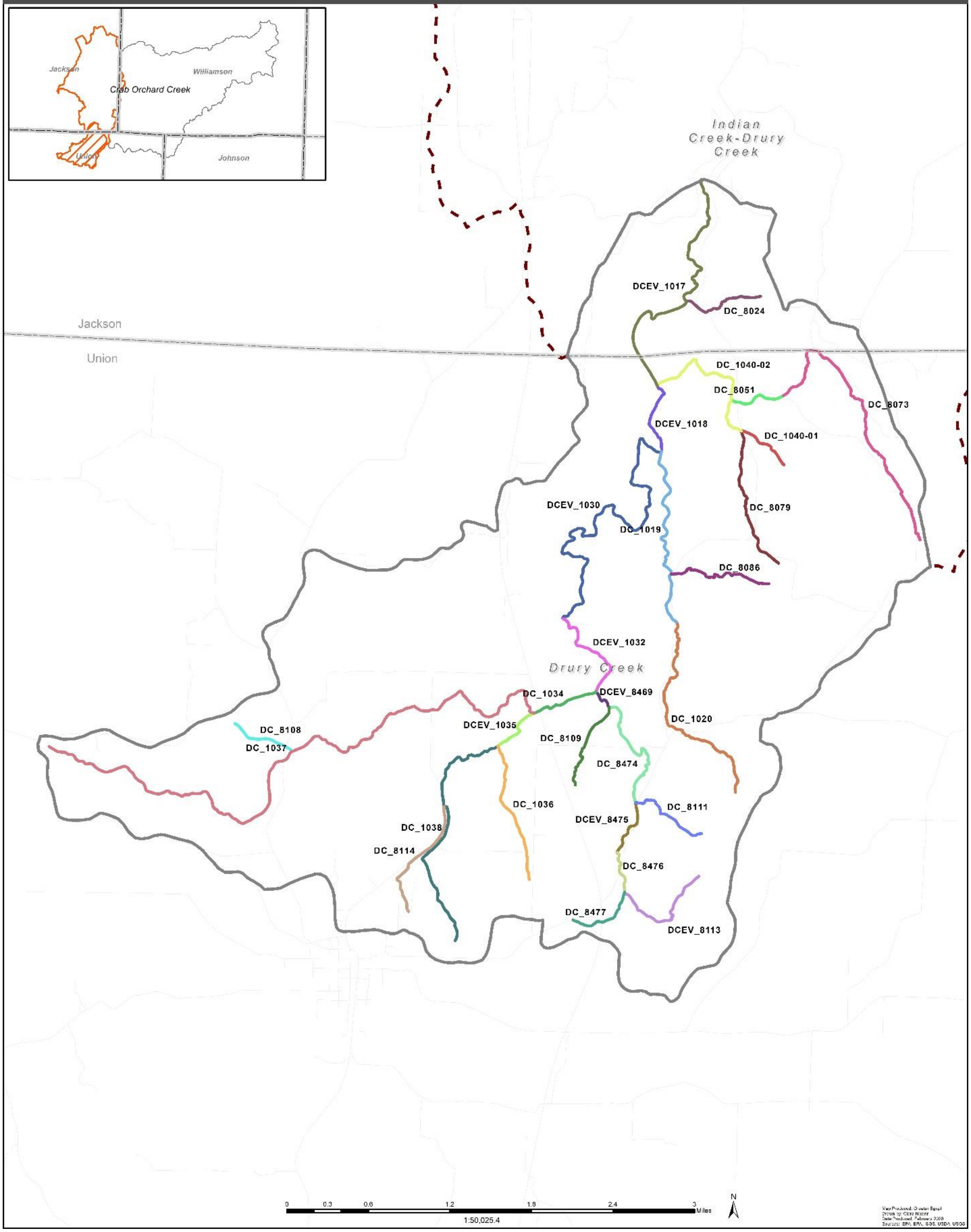
Mr. Carpenter discussed the remaining timeline of the Western Crab Orchard Creek watershed-Based Plan and the expectations of the planning committee and of Greater Egypt.

Meeting adjourned.

APPENDIX B: Assessed Reach Information

Drury Creek Subwatershed- Assessed Stream Reach Information					
Reach Code	**Stream Name**	**Subwatershed Management Unit**	**STEPL ID**	**IEPA ID**	**Stream Length (ft.)**
7140106001019		Shiloh	DC_1019		7941.15
7140106001020		Shiloh	DC_1020		8942.99
7140106001034		Cobden-North	DC_1034		2647.97
7140106001036		Cobden-North	DC_1036		5649.85
7140106001037		Cobden-North	DC_1037		25659.1
7140106001038		Cobden-North	DC_1038		10185
7140106001040		Giant City	DC_1040-01		2251.76
7140106001040		Giant City	DC_1040-02		6155.92
7140106008024		Makanda-South Drury Creek	DC_8024		3325.76
7140106008051		Giant City	DC_8051		2275.57
7140106008073		Giant City	DC_8073		11670.3
7140106008079		Giant City	DC_8079		5909.99
7140106008086		Shiloh	DC_8086		4443.7
7140106008108		Cobden-North	DC_8108		2614.58
7140106008109		Upper Drury Creek	DC_8109		3662.84
7140106008111		Upper Drury Creek	DC_8111		3322.79
7140106008114		Cobden-North	DC_8114		5015.49
7140106008474	Drury Creek	Upper Drury Creek	DC_8474	IL_NDC-01	5457.82
7140106008476	Drury Creek	Upper Drury Creek	DC_8476	IL_NDC-01	1752.82
7140106008477		Upper Drury Creek	DC_8477		2834
7140106001017	Drury Creek	Makanda-South Drury Creek	DCEV_1017	IL_NDC-01	11421.9
7140106001018	Drury Creek	Shawnee Drury Creek	DCEV_1018	IL_NDC-01	3009.95
7140106001030	Drury Creek	Shawnee Drury Creek	DCEV_1030	IL_NDC-01	15204.7
7140106001032	Drury Creek	Shawnee Drury Creek	DCEV_1032	IL_NDC-01	4243.3
7140106001035		Cobden-North	DCEV_1035		2121.39
7140106008113	Drury Creek	Upper Drury Creek	DCEV_8113	IL_NDC-01	4600.41
7140106008469	Drury Creek	Upper Drury Creek	DCEV_8469	IL_NDC-01	905.118
7140106008475	Drury Creek	Upper Drury Creek	DCEV_8475	IL_NDC-01	2333.39

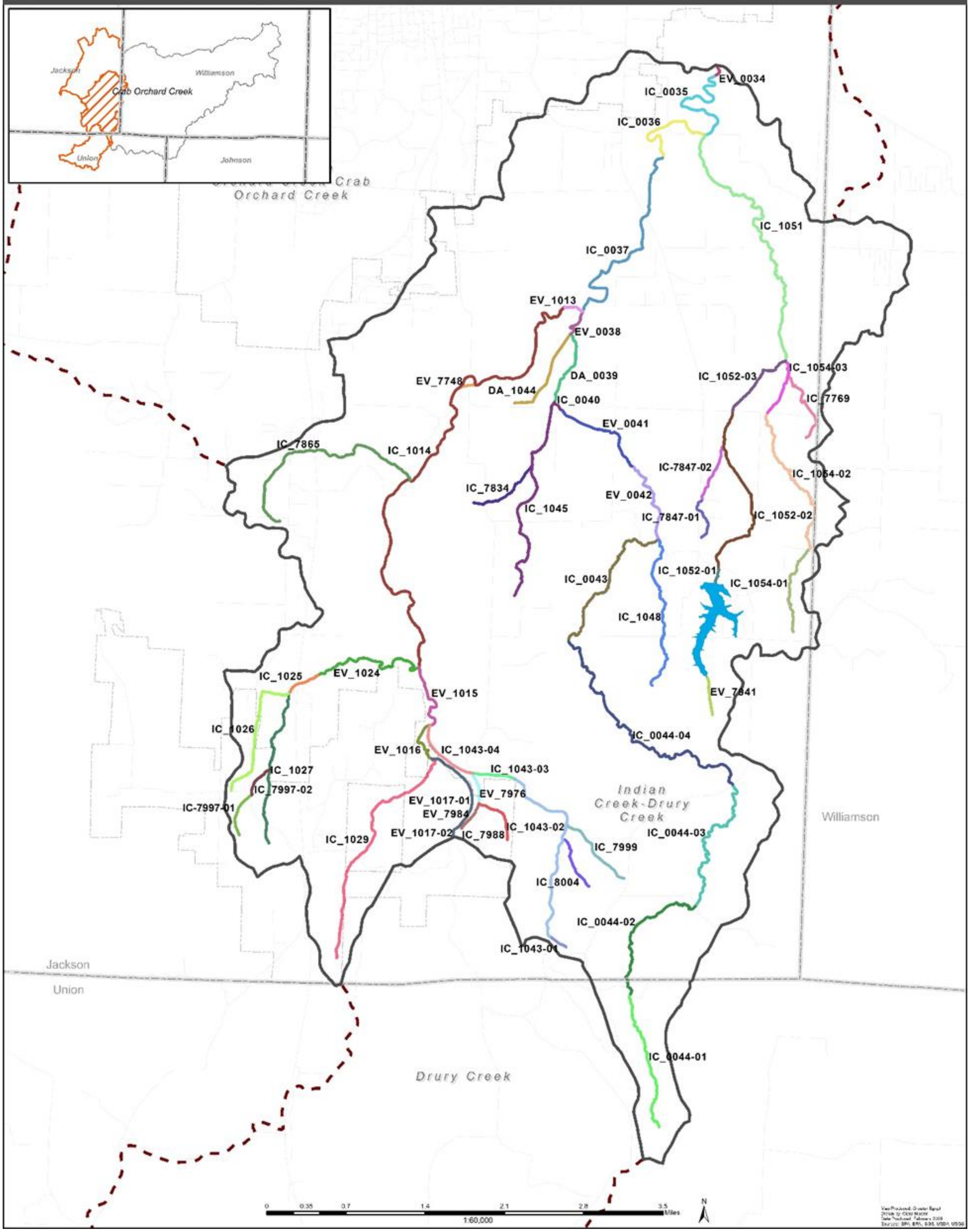
Drury Creek Subwatershed - Assessment STEPL ID



Indian Creek- Drury Creek Subwatershed- Assessed Stream Reach Information					
Reach Code	Stream Name	Subwatershed Management Unit	STEPL ID	IEPA ID	Stream Length (ft.)
7140106000034	Drury Creek	Lower Drury Creek	EV_0034		673.292
7140106000035	Drury Creek	Lower Drury Creek	IC_0035		6825.71
7140106000036	Drury Creek	Lower Drury Creek	IC_0036	IL_NDC-01	5177.35
7140106000037	Drury Creek	Lower Drury Creek	IC_0037	IL_NDC-01	11091.8
7140106000038	Indian Creek	Lower Indian Creek	EV_0038	IL_NDCB-01	1550.04
7140106000039	Indian Creek	Lower Indian Creek	DA_0039	IL_NDCB-01	3711.12
7140106000040	Indian Creek	Lower Indian Creek	IC_0040	IL_NDCB-01	403.187
7140106000041	Indian Creek	Lower Indian Creek	EV_0041	IL_NDCB-01	4881.48
7140106000042	Indian Creek	Lower Indian Creek	EV_0042	IL_NDCB-01	4533.61
7140106000043	Indian Creek	Middle Indian Creek	IC_0043	IL_NDCB-01	7988.86
7140106000044	Indian Creek	Upper Idian Creek	IC_0044-01	IL_NDCB-01	6946.11
7140106000044	Indian Creek	Upper Idian Creek	IC_0044-02	IL_NDCB-01	7255.38
7140106000044	Indian Creek	Upper Idian Creek	IC_0044-03	IL_NDCB-01	8278.33
7140106000044	Indian Creek	Upper Idian Creek	IC_0044-04	IL_NDCB-01	13623
7140106001013	Drury Creek	Boskeydale- Drury Creek	EV_1013	IL_NDC-01	922.405
7140106001014	Drury Creek	Boskeydale- Drury Creek	IC_1014	IL_NDC-01	25431.3
7140106001015	Drury Creek	Middle Drury Creek	EV_1015	IL_NDC-01	3562.55
7140106001016	Drury Creek	Middle Drury Creek	EV_1016	IL_NDC-01	2337.37
7140106001017	Drury Creek	Middle Drury Creek	EV_1017-01	IL_NDC-01	4959.78
7140106001017	Drury Creek	Middle Drury Creek	EV_1017-02	IL_NDC-01	46.7841
7140106001024		Makanda-North	EV_1024		6552.98
7140106001025		Makanda-North	IC_1025		1686.86
7140106001026		Makanda-North	IC_1026		6463.3
7140106001027		Makanda-North	IC_1027		7626.95
7140106001029		Middle Drury Creek	IC_1029		11794.9
7140106001043		Middle Drury Creek	IC_1043-01		932.727
7140106001043		Middle Drury Creek	IC_1043-02		9442.9
7140106001043		Middle Drury Creek	IC_1043-03		1910.24
7140106001043		Middle Drury Creek	IC_1043-04		3371.69
7140106001044		Lower Indian Creek	DA_1044		4580.59
7140106001045		Lower Indian Creek	IC_1045		10947.5
7140106001048		Middle Indian Creek	IC_1048		8019.44
7140106001051	Sycamore Creek	Lower Sycamore Creek	IC_1051	IL_NDCA	14593.3
7140106001052	Sycamore Creek	Upper Sycamore Creek	IC_1052-01	IL_NDCA	821.104
7140106001052	Sycamore Creek	Middle Sycamore Creek	IC_1052-02	IL_NDCA	8930.28
7140106001052	Sycamore Creek	Middle Sycamore Creek	IC_1052-03	IL_NDCA	3750.19
7140106001054		Middle Sycamore Creek	IC_1054-01		4532.77

Indian Creek- Drury Creek Subwatershed- Assessed Stream Reach Information					
Reach Code	Stream Name	Subwatershed Management Unit	STEPL ID	IEPA ID	Stream Length (ft.)
7140106001054		Middle Sycamore Creek	IC_1054-02		8185.93
7140106001054		Middle Sycamore Creek	IC_1054-03		2853.76
7140106007748		Boskeydale- Drury Creek	EV_7748		821.134
7140106007769		Middle Sycamore Creek	IC_7769		3904.74
7140106007834		Lower Indian Creek	IC_7834		3629.95
7140106007847		Middle Sycamore Creek	IC_7847-01		2305.15
7140106007847		Middle Sycamore Creek	IC-7847-02		2790.5
7140106007865		Boskeydale- Drury Creek	IC_7865		10976.8
7140106007941	Sycamore Creek	Upper Sycamore Creek	EV_7941	IL_NDCA	1794.98
7140106007976		Middle Drury Creek	EV_7976		1545.92
7140106007984		Middle Drury Creek	EV_7984		1436.92
7140106007988		Middle Drury Creek	IC_7988		2492.5
7140106007997		Makanda-North	IC-7997-01		2222.37
7140106007997		Makanda-North	IC_7997-02		1568.24
7140106007999		Middle Drury Creek	IC_7999		3955.31
7140106008004		Middle Drury Creek	IC_8004		2711.82

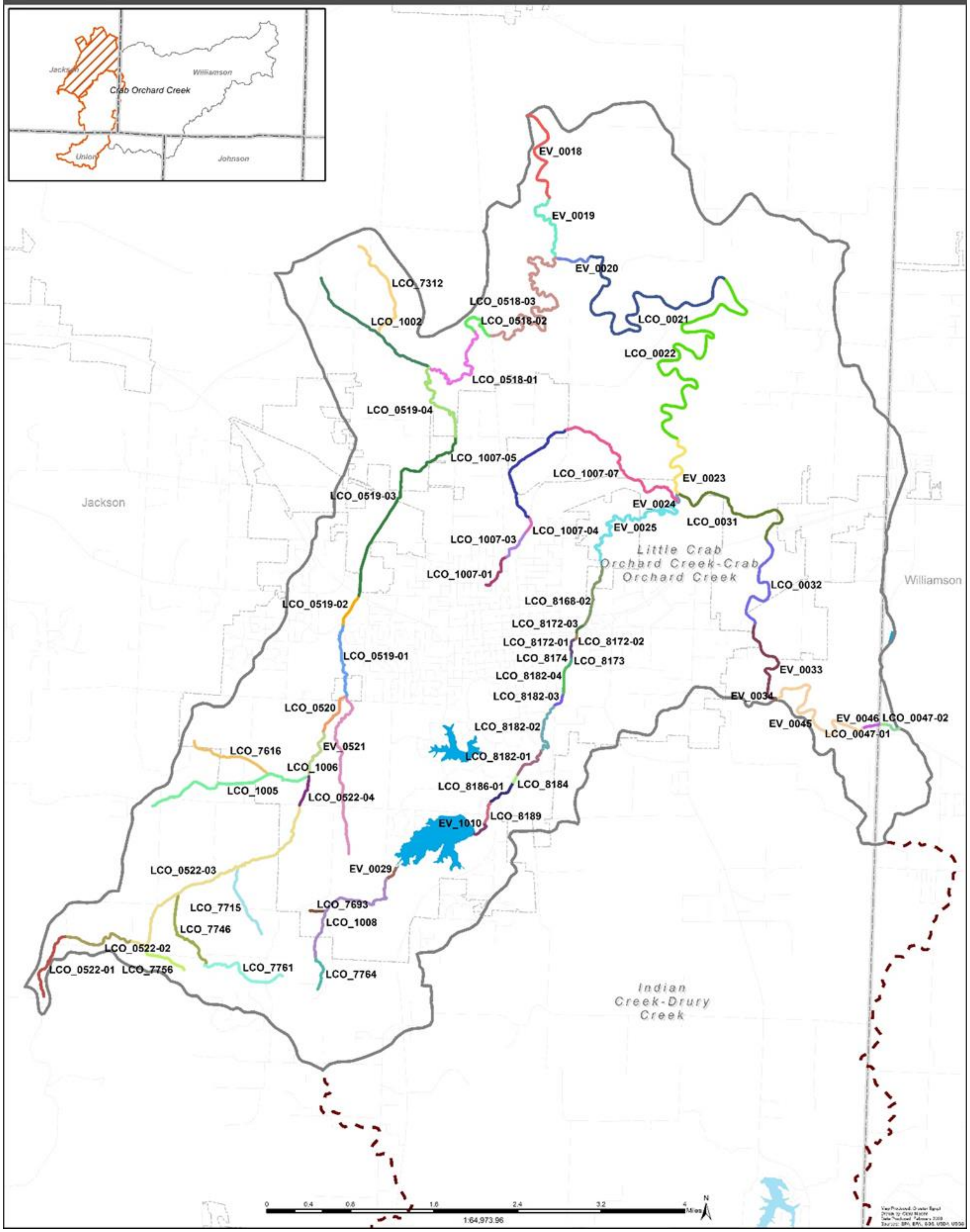
Indian Creek Subwatershed - Assessment STEPL ID



Little Crab Orchard Creek-Crab Orchard Creek Subwatershed- Assessed Stream Reach Information					
Reach Code	Stream Name	Subwatershed Management Unit	STEPL ID	IEPA ID	Stream Length (ft.)
7140106000029	Piles Fork	Carbondale Reservoir- Piles Fork Creek	EV_0029	IL_NDB-03	789.861
7140106000025	Piles Fork	Lower Piles Fork Creek	EV_0025	IL_NDB-03	10040.7
7140106000019	Crab Orchard Creek	Lower Crab Orchard Creek	EV_0019	IL_ND-01	4667.05
7140106001010	Piles Fork	Carbondale Reservoir- Piles Fork Creek	EV_1010	IL_NDB-03	1016.39
7140106000046	Crab Orchard Creek	Upper Crab Orchard Creek	EV_0046	IL_ND-01	1028.47
7140106000045	Crab Orchard Creek	Upper Crab Orchard Creek	EV_0045	IL_ND-01	8861.68
7140106000018	Crab Orchard Creek	Lower Crab Orchard Creek	EV_0018	IL_ND-01	5999.07
7140106000024	Piles Fork	Lower Piles Fork Creek	EV_0024	IL_NDB-03	683.855
7140106000020	Crab Orchard Creek	Middle- Crab Orchard Creek	EV_0020	IL_ND-01	2037.27
7140106000021	Crab Orchard Creek	Middle- Crab Orchard Creek	LCO_0021	IL_ND-01	16475.5
7140106000022	Crab Orchard Creek	Middle- Crab Orchard Creek	LCO_0022	IL_ND-01	21699
7140106000023	Crab Orchard Creek	Middle- Crab Orchard Creek	EV_0023	IL_ND-01	4084
7140106000031	Crab Orchard Creek	Eastern Carbondale- Crab Orchard Creek	LCO_0031	IL_ND-01	8441.8
7140106000032	Crab Orchard Creek	Eastern Carbondale- Crab Orchard Creek	LCO_0032	IL_ND-01	6354.75
7140106000033	Crab Orchard Creek	Eastern Carbondale- Crab Orchard Creek	EV_0033	IL_ND-11	5335.53
7140106000034	Drury Creek	Upper Crab Orchard Creek	EV_0034	IL_NDC-02	41.9101
7140106000047	Crab Orchard Creek	Upper Crab Orchard Creek	LCO_0047-01	IL_ND-01	878.503
7140106000047	Crab Orchard Creek	Upper Crab Orchard Creek	LCO_0047-02	IL_ND-01	185.811
7140106000518	Little Crab Orchard Creek	Lower Little Crab Orchard Creek	LCO_0518-01	IL_NDA-01	6085.78
7140106000518	Little Crab Orchard Creek	Lower Little Crab Orchard Creek	LCO_0518-02	IL_NDA-01	2769.34
7140106000518	Little Crab Orchard Creek	Lower Little Crab Orchard Creek	LCO_0518-03	IL_NDA-01	15417.7
7140106000519	Little Crab Orchard Creek	Middle Little Crab Orchard Creek	LCO_0519-01	IL_NDA-01	4058.2
7140106000519	Little Crab Orchard Creek	Middle Little Crab Orchard Creek	LCO_0519-02	IL_NDA-01	1679.4
7140106000519	Little Crab Orchard Creek	Middle Little Crab Orchard Creek	LCO_0519-03	IL_NDA-01	10748.6
7140106000519	Little Crab Orchard Creek	Middle Little Crab Orchard Creek	LCO_0519-04	IL_NDA-01	5268.52
7140106000520	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	LCO_0520	IL_NDA-01	2360.14
7140106000521	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	EV_0521	IL_NDA-01	2793.77
7140106000522	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	LCO_0522-01	IL_NDA-01	3863.53
7140106000522	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	LCO_0522-02	IL_NDA-01	3945.82
7140106000522	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	LCO_0522-03	IL_NDA-01	12936.9
7140106000522	Little Crab Orchard Creek	Upper Little Crab Orchard Creek	LCO_0522-04	IL_NDA-01	1581
7140106001002		Aviation	LCO_1002		7549.38
7140106001005		Upper Little Crab Orchard Creek	LCO_1005		8865.21
7140106001006		Upper Little Crab Orchard Creek	LCO_1006		8926.26
7140106001007	Eek Creek	Eek Creek	LCO_1007-01	IL_NDBA-01	1167.58
7140106001007	Eek Creek	Eek Creek	LCO_1007-01	IL_NDBA-01	872.115
7140106001007	Eek Creek	Eek Creek	LCO_1007-03	IL_NDBA-01	1769.74
7140106001007	Eek Creek	Eek Creek	LCO_1007-04	IL_NDBA-01	903.863
7140106001007	Eek Creek	Eek Creek	LCO_1007-05	IL_NDBA-01	6383.12
7140106001007	Eek Creek	Eek Creek	LCO_1007-07	IL_NDBA-01	7981.69
7140106001008	Piles Fork	Upper Piles Fork	LCO_1008	IL_NDB-03	7279.4
7140106001009	Piles Fork	Upper Piles Fork	LCO_7764	IL_NDB-03	1386.48
7140106007312		Aviation	LCO_7312		5803.78
7140106007616		Upper Little Crab Orchard Creek	LCO_7616		4413.2
7140106007693		Upper Piles Fork	LCO_7693		788.921
7140106007715		Upper Little Crab Orchard Creek	LCO_7715		3868.81
7140106007746		Upper Little Crab Orchard Creek	LCO_7746		4616.89
7140106007756		Upper Little Crab Orchard Creek	LCO_7756		2582.15
7140106007761		Upper Little Crab Orchard Creek	LCO_7761		4797.93

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed- Assessed Stream Reach Information					
Reach Code	Stream Name	Subwatershed Management Unit	STEPL ID	IEPA ID	Stream Length (ft.)
7140106007764	Piles Fork	Upper Piles Fork	LCO_7764	IL_NDB-03	406.674
7140106008168	Piles Fork	Lower Piles Fork Creek	LCO_8168-02	IL_NDB-03	3340.79
7140106008172	Piles Fork	Lower Piles Fork Creek	LCO_8172-02	IL_NDB-03	483.85
7140106008172	Piles Fork	Lower Piles Fork Creek	LCO_8172-03	IL_NDB-03	445.754
7140106008172	Piles Fork	Lower Piles Fork Creek	LCO_8172-01	IL_NDB-03	764.764
7140106008173	Piles Fork	Lower Piles Fork Creek	LCO_8173	IL_NDB-03	284.133
7140106008174	Piles Fork	Lower Piles Fork Creek	LCO_8174	IL_NDB-03	449.49
7140106008182	Piles Fork	Lower Piles Fork Creek	LCO_8182-01	IL_NDB-03	2011
7140106008182	Piles Fork	Lower Piles Fork Creek	LCO_8182-02	IL_NDB-03	3220.06
7140106008182	Piles Fork	Lower Piles Fork Creek	LCO_8182-03	IL_NDB-03	789.726
7140106008182	Piles Fork	Lower Piles Fork Creek	LCO_8182-04	IL_NDB-03	1388.42
7140106008184	Piles Fork	Lower Piles Fork Creek	LCO_8184	IL_NDB-03	458.899
7140106008186	Piles Fork	Carbondale Reservoir- Piles Fork Creek	LCO_8186-01	IL_NDB-03	1587.08
7140106008189	Piles Fork	Carbondale Reservoir- Piles Fork Creek	LCO_8189	IL_NDB-03	1186.88

Litttle Crab Orchard Creek Subwatershed - Assessment STEPL ID



APPENDIX C: Inventory & Assessment Data Forms

WESTERN CRAB ORCHARD CREEK WATERSHED LAKE INVENTORY

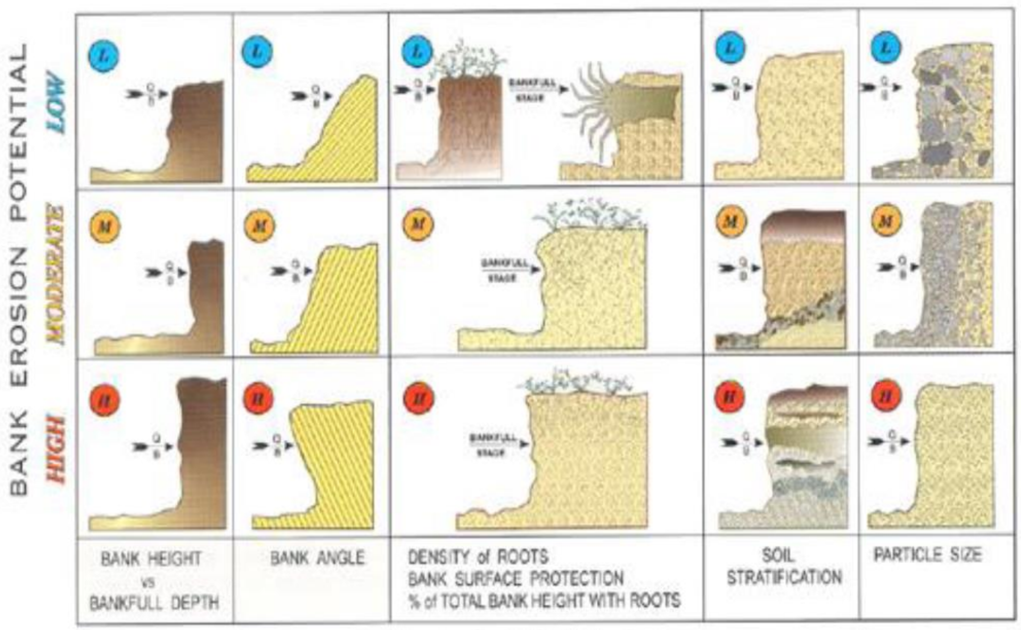
DATE: ___________LAKE NAME: __________________SHORE ID: ___________________

MAP ID: __________SMU ID: ____________ASSESSMENT UNIT ID:__________________

PHOTOS: ________ APPROXIMATE LENGTH: ________ FIELD ASSESSOR: ___________

DEGREE OF SHORELINE EROSION

NONE	LOW	MODERATE	HIGH
Stable: less than 5% of banks affected	Moderately Stable: 5-33% banks have areas of erosion	Moderatley Unstable: 33-66% of banks have areas of erosion	Unstable: 66-100% of banks have high levels of erosion



MEAN BANK HEIGHT: _____________________

CONDITION OF RIPARIAN AREA

Land Cover (%): Scrub/Shrub: _____ Lawn: _____ Wetlands: ______ Crops: _______
Wooded: ______ Pasture: _______ Impervious: __________ Prairie: _________

ENVIRONMENTAL CONDITION OF RIPARIAN AREA: Good: ___Fair:____ Poor: ____
COMMENT:____
____

DEBRIS BLOCKAGES (Overbank)
LOW: ________ MODERATE: ________ HIGH: _________
COMMENT: ____

WESTERN CO CREEK WATERSHED STREAM INVENTORY

DATE: ___________STREAM NAME: __________________REACH ID: ________________

MAP ID: __________SMU ID: ____________ASSESSMENT UNIT ID:__________________

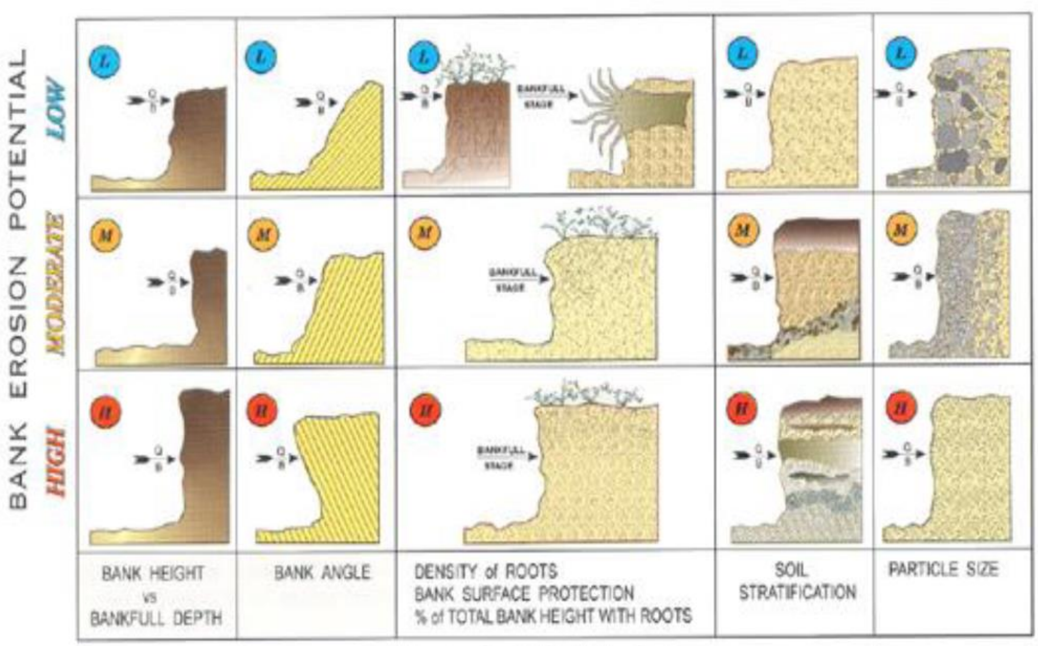
PHOTOS: ________ APPROXIMATE LENGTH: ________ FIELD ASSESSOR: ___________

DEGREE OF STREAMBED EROSION

NONE	LOW	MODERATE	HIGH
Stable: less than 5% of banks affected	Moderately Stable: 5-33% banks have areas of erosion	Moderatley Unstable: 33-66% of banks have areas of erosion	Unstable: 66-100% of banks have high levels of erosion

DEGREE OF STREAMBANK EROSION

NONE	LOW	MODERATE	HIGH
Stable: less than 5% of banks affected	Moderately Stable: 5-33% banks have areas of erosion	Moderatley Unstable: 33-66% of banks have areas of erosion	Unstable: 66-100% of banks have high levels of erosion



MEAN BANK HEIGHT AND CHANNEL WIDTH (in feet, facing downstream)

LEFT BANK HEIGHT	MEAN CHANNEL WIDTH	RIGHT BANK HEIGHT

CONDITION OF RIPARIAN AREA
Land Cover (%): Scrub/Shrub: _____ Lawn: _____ Wetlands: ______ Crops: _______
Wooded: ______ Pasture: _______ Impervious: __________ Prairie: _________

ENVIRONMENTAL CONDITION OF RIPARIAN AREA: Good: ___Fair:____ Poor: ____
COMMENT**:**____
____

DEGREE OF CHANNELIZATION
NONE: ___________LOW: ___________ MODERATE: _________ HIGH: ___________

DEBRIS BLOCKAGES (Instream/ Overbank)
LOW: ________ MODERATE: ________ HIGH: _________
COMMENT: ____

APPENDIX D: MLRC Land Cover Classifications

Value	Definition
11	Open Water - All areas of open water, generally with less than 25% cover or vegetation or soil
21	Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent 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 -Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
23	Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
24	Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.
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.
41	Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
42	Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
52	Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
71	Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
81	Pasture/Hay - 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 percent of total vegetation.
82	Cultivated 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 percent of total vegetation. This class also includes all land being actively tilled.
90	Woody Wetlands - Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Source: National Land Cover Database

APPENDIX E: Load Reductions by SMU

Streambank Stabilization Load Reductions

Drury Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
1	Upper Drury Creek	07140106008474	5457.8198	Moderate	1364.455	90.45	90.45	180.95	L
		07140106008475	2333.3899	Moderate	583.3475	25.8	25.8	51.55	L
		07140106008111	3322.79	Low	332.279	2.54	2.54	5.08	L
		07140106008469	905.118	Moderate	226.2795	10	10	20	L
		07140106008112	3571	Low	357.1	1.82	1.82	3.64	L
		07140106008113	4600.4102	Moderate	1150.1026	50.85	50.85	101.65	L
		07140106008109	3662.8401	Low	366.284	2.8	2.8	5.6	L
		07140106008476	1752.8199	Moderate	438.205	14.55	14.55	29.05	L
		07140106008477	2834	High	1417	240.9	240.9	481.8	L
2	Cobden - North	07140106001038	10185	High	5092.5	865.7	865.7	1731.5	H
		07140106001035	2121.3899	Low	212.139	2.16	2.16	4.32	L
		07140106008108	2614.5801	Low	261.458	2	2	4	L
		07140106008114	5015.4902	Low	501.549	6.4	6.4	12.78	L
		07140106001034	2647.97	Low	264.797	3.38	3.38	6.76	L
		07140106001036	5649.8501	Moderate	1412.4625	31.2	31.2	62.45	L
		07140106001037	25659.0996	Moderate	6414.7749	496.2	496.2	992.35	M
3	Shiloh	07140106001020	8942.9902	Moderate	2235.7476	49.4	49.4	98.8	L
		07140106001039	7404.7202	Low	740.472	3.78	3.78	7.56	L
		07140106008103	2500.3301	Low	250.033	1.28	1.28	2.56	L
		07140106001019	7941.1499	Moderate	1985.2875	131.6	131.6	263.25	L
		07140106008086	4443.7002	High	2221.8501	302.2	302.2	604.3	M
4	Shawnee - Drury Creek	07140106008074	3176.53	Low	317.653	1.62	1.62	3.24	L
		07140106001018	3009.95	Moderate	752.4875	33.25	33.25	66.5	L
		07140106001030	15204.7002	Moderate	3801.1751	168	168	336	L
		07140106008082	2975.99	Low	297.599	1.52	1.52	3.04	L
		07140106001032	4243.2998	Moderate	1060.825	46.9	46.9	93.8	L
		07140106001040	6155.9302	High	3077.9651	627.9	627.9	1255.8	H
		07140106001017	11421.9004	High	5710.9502	1165	1165	2330	H
5	Flamm	07140106008098	2911.05	Low	291.105	1.48	1.48	2.96	L
		07140106008096	4054.72	Low	405.472	2.06	2.06	4.14	L
		07140106008097	2726.8999	Low	272.69	1.4	1.4	2.78	L
		07140106001031	12287.2998	Low	1228.73	6.26	6.26	12.54	L

Drury Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
6	Giant City	07140106008070	3674.1399	Low	367.414	1.88	1.88	3.74	L
		07140106008051	2275.5701	Low	227.557	2.9	2.9	5.8	L
		07140106008073	11670.2998	Low	1167.03	8.92	8.92	17.86	L
		07140106008055	2605.74	Low	260.574	1.32	1.32	2.66	L
		07140106001042	5393.0898	Low	539.309	2.76	2.76	5.5	L
		07140106001041	5945.3799	Low	594.538	3.04	3.04	6.06	L
		07140106008079	5909.9902	Low	590.999	6.02	6.02	12.06	L
		07140106008070	234.705	Low	23.4705	0.12	0.12	0.24	L
		07140106001040	2251.76	Low	225.176	1.72	1.72	3.44	L
		07140106001040	6155.9302	High	3077.9651	627.9	627.9	1255.8	H
7	Makanda - South: Drury Creek	07140106008041	3497.8601	Low	349.786	1.78	1.78	3.56	L
		07140106008025	2839.3401	Low	283.934	1.44	1.44	2.9	L
		07140106008024	3325.76	Low	332.576	3.4	3.4	6.78	L
		07140106001017	11421.9004	High	5710.9502	1165	1165	2330	H

Indian Creek-Drury Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
8	Upper Indian Creek	07140106000044	6946.1099	Moderate	1736.5275	57.55	57.55	115.15	L
		07140106000044	7255.3799	Moderate	1813.845	60.15	60.15	120.25	L
		07140106000044	8278.3301	Moderate	2069.5825	160.1	160.1	320.15	L
		07140106000044	13623	Moderate	3405.75	263.45	263.45	526.85	M
9	Middle Drury Creek	07140106007976	1545.92	Low	154.592	1.58	1.58	3.16	L
		07140106008004	2711.8201	Low	271.182	4.14	4.14	8.3	L
		07140106001029	11794.9004	Low	1179.49	12.04	12.04	24.06	L
		07140106007999	3955.3101	Low	395.531	7.06	7.06	14.12	L
		07140106007988	2492.5	Low	249.25	1.9	1.9	3.82	L
		07140106001043	932.727	Low	93.2727	0.48	0.48	0.96	L
		07140106001043	9442.9004	Low	944.29	7.22	7.22	14.44	L
		07140106001043	1910.24	Moderate	477.56	31.65	31.65	63.3	L
		07140106001043	3371.6899	Moderate	842.9225	37.25	37.25	74.5	L
		07140106007984	1436.92	None	0	0	0	0	L
		07140106001016	2337.3701	Severe	1753.0276	447	447	894	M
		07140106001015	3562.55	Severe	2671.9125	681.3	681.3	1362.75	H
		07140106001017	4959.7798	Severe	3719.8349	948.6	948.6	1897.05	H
		07140106001017	46.7841	Severe	35.0881	9	9	17.85	L
10	Makanda - North	07140106001024	6552.98	Moderate	1638.245	144.8	144.8	289.65	L
		07140106001027	7626.9502	Low	762.695	13.62	13.62	27.22	L
		07140106001025	1686.86	Moderate	421.715	18.65	18.65	37.3	L
		07140106001026	6463.2998	None	0	0	0	0	L
		07140106007997	2222.3701	Low	222.237	0.56	0.56	1.14	L
		07140106007997	1568.24	None	0	0	0	0	L
11	Upper Sycamore Creek- Spring Arbor	07140106007941	1794.98	Low	179.498	0.92	0.92	1.84	L
		07140106001052	821.104	Moderate	205.276	9.05	9.05	18.15	L
		07140106001052	8930.2803	Moderate	2232.5701	172.7	172.7	345.4	L
12	Middle Indian Creek	07140106000043	7988.8599	Moderate	1997.215	176.55	176.55	353.1	L
		07140106001048	8019.4399	Moderate	2004.86	132.9	132.9	265.85	L

Indian Creek-Drury Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
13	Middle Sycamore Creek	07140106007769	3904.74	Low	390.474	1	1	2	L
		07140106001051	14593.2998	Severe	10944.9749	4651.65	4651.65	9303.3	H
		07140106001054	4532.77	High	2266.385	385.3	385.3	770.6	M
		07140106001054	8185.9302	Low	818.593	4.18	4.18	8.34	L
		07140106001054	2853.76	Low	285.376	3.64	3.64	7.28	L
		07140106007847	2305.1499	Low	230.515	1.18	1.18	2.36	L
		07140106007847	2790.5	High	1395.25	237.2	237.2	474.4	L
		07140106001052	8930.2803	Moderate	2232.5701	172.7	172.7	345.4	L
		07140106001052	3750.1899	Moderate	937.5475	82.9	82.9	165.75	L
14	Lower Indian Creek	07140106001044	4580.5898	Moderate	1145.1475	12.65	12.65	25.3	L
		07140106000042	4533.6099	High	2266.805	462.4	462.4	924.9	M
		07140106000041	4881.48	High	2440.74	497.9	497.9	995.8	M
		07140106000040	403.187	Moderate	100.7968	11.15	11.15	22.3	L
		07140106000039	3711.1201	Moderate	927.78	30.75	30.75	61.5	L
		07140106000038	1550.04	High	775.02	210.8	210.8	421.6	L
		07140106007834	3629.95	Low	362.995	1.86	1.86	3.7	L
		07140106001045	10947.5	Low	1094.75	5.58	5.58	11.16	L
15	Boskydell - Drury Creek	07140106007748	821.134	Low	82.1134	0.62	0.62	1.26	L
		07140106001014	25431.3008	Moderate	6357.8252	491.8	491.8	983.55	M
		07140106001013	922.405	High	461.2025	125.4	125.4	250.9	L
		07140106007865	10976.7998	Low	1097.68	14	14	28	L
16	Lower Sycamore Creek	07140106001051	14593.2998	Severe	10944.9749	4651.65	4651.65	9303.3	H
17	Lower Drury Creek	07140106000034	673.292	High	336.646	91.6	91.6	183.1	L
		07140106000036	5177.3501	High	2588.6751	880.1	880.1	1760.3	H
		07140106000037	11091.7998	Severe	8318.8499	3535.5	3535.5	7075.5	H
		07140106000035	6825.71	High	3412.855	1160.4	1160.4	2320.7	H

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
18	Upper Piles Fork Creek	7140106000029	789.861	Low	78.9861	0.4	0.4	0.8	L
		7140106007764	406.674	Low	40.6674	0.2	0.2	0.42	L
		7140106007693	788.921	Low	78.8921	0.4	0.4	0.8	L
		7140106001008	7279.4	Low	727.94	7.42	7.42	14.84	L
		7140106001009	1386.48	Low	138.648	0.7	0.7	1.42	L
19	Upper Little Crab Orchard Creek	7140106001006	8926.26	Low	892.626	9.1	9.1	18.2	L
		7140106007746	4616.89	Low	461.689	3.54	3.54	7.06	L
		7140106000521	2793.77	Moderate	698.4425	61.75	61.75	123.5	L
		7140106000520	2360.14	High	1180.07	601.8	601.8	1203.7	H
		7140106007756	2582.15	Low	258.215	1.98	1.98	3.96	L
		7140106007616	4413.2	Moderate	1103.3	24.4	24.4	48.75	L
		7140106001005	8865.21	Low	886.521	6.78	6.78	13.56	L
		7140106007761	4797.93	Moderate	1199.4825	53	53	106.05	L
		7140106007715	3868.81	Moderate	967.2025	42.75	42.75	85.5	L
		7140106000522	3863.53	None	0	0	0	0	L
		7140106000522	3945.82	Low	394.582	4.02	4.02	8.04	L
		7140106000522	12936.9	Low	1293.69	16.5	16.5	32.98	L
		7140106000522	1581	Moderate	395.25	43.7	43.7	87.35	L
20	Carbondale Reservoir- Piles Fork Creek	7140106001010	1016.39	Low	101.639	1.04	1.04	2.08	L
		7140106008189	1186.88	Low	118.688	2.42	2.42	4.84	L
21	Campus Lake								
22	Upper Crab Orchard Creek	7140106000046	1028.47	High	514.235	69.9	69.9	139.9	L
		7140106000045	8861.68	Moderate	2215.42	97.9	97.9	195.85	L
		7140106000034	41.9101	High	20.9551	7.1	7.1	14.2	L
		7140106000047	878.503	High	439.2515	209.1	209.1	418.2	L
		7140106000047	185.811	High	92.9055	44.2	44.2	88.4	L
23	Eastern Carbondale - Crab Orchard Creek	7140106000031	8441.8	Moderate	2110.45	116.6	116.6	233.2	L
		7140106000032	6354.75	Low	635.475	8.1	8.1	16.2	L
		7140106000033	5335.53	High	2667.765	544.2	544.2	1088.4	H
24	Lower Piles Fork Creek	7140106000025	10040.7	Low	1004.07	10.24	10.24	20.48	L
		7140106000024	683.855	Low	68.3855	0.7	0.7	1.4	L
		7140106008173	284.133	Low	28.4133	1.08	1.08	2.18	L
		7140106008168	3340.79	Low	334.079	12.78	12.78	25.56	L
		7140106008186	1587.08	Low	158.708	3.64	3.64	7.28	L
		7140106008174	449.49	Low	44.949	1.72	1.72	3.44	L
		7140106008184	458.899	Low	45.8899	0.82	0.82	1.64	L
		7140106008172	483.85	Moderate	120.9625	16.05	16.05	32.1	L
		7140106008172	445.754	Moderate	111.4385	14.8	14.8	29.55	L
		7140106008172	764.764	Low	76.4764	2.34	2.34	4.68	L
		7140106008182	2011	Moderate	502.75	33.35	33.35	66.65	L
		7140106008182	3220.06	Moderate	805.015	53.35	53.35	106.75	L
		7140106008182	789.726	Moderate	197.4315	21.8	21.8	43.65	L
		7140106008182	1388.42	Low	138.842	1.78	1.78	3.54	L

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed - Streambank Stabilization by Reachcode									
SMU ID	Subwatershed	Reachcode	Total Length (ft)	Erosion	Length of Proposed Stabilization (ft)	SLR	PLR	NLR	Priority
25	Eek Creek	7140106001007	1167.58	None	0	0	0	0	L
		7140106001007	872.115	None	0	0	0	0	L
		7140106001007	1769.74	Low	176.974	0.46	0.46	0.9	L
		7140106001007	903.863	Low	90.3863	1.38	1.38	2.76	L
		7140106001007	6383.12	Low	638.312	6.52	6.52	13.02	L
		7140106001007	7981.69	Moderate	1995.4225	176.4	176.4	352.8	L
26	Middle Little Crab Orchard Creek	7140106000519	4058.2	Severe	3043.65	1293.6	1293.6	2587.05	H
		7140106000519	1679.4	Low	167.94	3.42	3.42	6.86	L
		7140106000519	10748.6	Low	1074.86	19.18	19.18	38.38	L
		7140106000519	5268.52	Low	526.852	9.4	9.4	18.8	L
27	Reed Station								
28	Middle Crab Orchard Creek	7140106000020	2037.27	Low	203.727	5.2	5.2	10.4	L
		7140106000021	16475.5	High	8237.75	1680.5	1680.5	3361	H
		7140106000022	21699	Severe	16274.25	4841.55	4841.55	9683.25	H
		7140106000023	4084	Moderate	1021	135.4	135.4	270.75	L
29	Lower Little Crab Orchard Creek	7140106000518	6085.78	High	3042.89	827.7	827.7	1655.3	H
		7140106000518	2769.34	Moderate	692.335	38.25	38.25	76.5	L
		7140106000518	15417.7	Moderate	3854.425	212.95	212.95	425.9	L
30	Aviation	7140106007312	5803.78	Low	580.378	4.44	4.44	8.88	L
		7140106001002	7549.38	Low	754.938	5.78	5.78	11.56	L
31	Creekside								
32	Lower Crab Orchard Creek	7140106000019	4667.05	High	2333.525	793.4	793.4	1586.8	H
		7140106000018	5999.07	Moderate	1499.7675	165.7	165.7	331.45	H

Gully Stabilization Load Reductions

Drury Creek Subwatershed - Gully Stabilization by Reachcode								
SMU ID	Subwatershed	Map ID	Target Area (Reach Code)	Amount (feet)	SLR	PLR	NLR	Priority
1	Upper Drury Creek	12	07140106008109	620.26	27.1	27.1	54.1	H
		13	07140106008109	784.32	27.8	27.8	55.7	H
		30	07140106008474	610.71	12	12	24	M
		37	07140106008474	767.27	57	57	114.1	H
		38	07140106008474	639.85	11.8	11.8	23.5	M
2	Cobden - North	1	07140106001037	620.26	25.2	25.2	50.4	M
		2	07140106001037	784.32	31.9	31.9	63.8	H
		3	07140106001037	610.71	24.8	24.8	49.7	M
		4	07140106001037	767.27	31.2	31.2	62.4	H
		5	07140106001037	639.85	26	26	52	H
		6	07140106001037	194.73	11.4	11.4	22.8	M
		7	07140106001036	100.07	9.4	9.4	18.7	M
		8	07140106001037	151.14	6.1	6.1	12.3	M
		9	07140106001036	390.08	22.8	22.8	45.6	M
		10	07140106001036	740.10	43.2	43.2	86.5	H
		11	07140106001036	1528.84	62.2	62.2	124.3	H
		14	07140106001034	680.78	39.8	39.8	79.6	H
		15	07140106001036	286.43	22.3	22.3	44.6	M
		24	07140106001037	299.11	12.2	12.2	24.3	M
		25	07140106001037	246.79	19.2	19.2	38.5	M
		26	07140106001037	393.59	13.1	13.1	26.3	M
		27	07140106001037	607.39	20.3	20.3	40.6	M
		28	07140106001037	354.04	14.4	14.4	28.8	M
3	Shiloh	34	07140106001020	759.46	30.9	30.9	61.7	H
		35	07140106001020	476.44	19.4	19.4	38.7	M
		36	07140106001020	795.37	32.3	32.3	64.7	H
4	Shawnee - Drury Creek							
5	Flamm	16	07140106001031	1,052.77	61.5	61.5	123	H
		17	07140106001031	271.61	23.1	23.1	46.2	M
		18	07140106008096	199.38	11.7	11.7	23.3	M
		19	07140106001031	714.34	41.7	41.7	83.5	H
		20	07140106001031	857.60	57.3	57.3	114.6	H
		21	07140106008097	972.56	56.8	56.8	113.7	H
		22	07140106001031	300.83	20.1	20.1	40.2	M
		23	07140106001031	350.30	19.3	19.3	38.5	M
		29	07140106001031	507.22	20.6	20.6	41.2	M
6	Giant City	31	07140106008079	686.02	27.9	27.9	55.8	H
		32	07140106008070	225.95	13.2	13.2	26.4	M
		33	07140106008070	383.14	15.6	15.6	31.2	M
		39	07140106008073	445.05	26	26	52	H
7	Makanda - South: Drury Creek							

Indian Creek-Drury Creek Subwatershed - Gully Stabilization by Reachcode								
SMU ID	Subwatershed	Map ID	Target Area (Reach Code)	Amount (feet)	SLR	PLR	NLR	Priority
8	Upper Indian Creek							
9	Middle Drury Creek	40	07140106001029	410.26	16.7	16.7	33.4	M
		41	07140106001029	162.63	9.5	9.5	19	M
		42	07140106001017	105.65	4.3	4.3	8.6	L
		48	07140106007953	156.90	6.4	6.4	12.8	M
		49	07140106007953	538.00	21.9	21.9	43.7	M
10	Makanda - North	43	07140106007997	274.90	16.1	16.1	32.1	M
		44	07140106001026	143.98	5.9	5.9	11.7	M
		45	07140106001026	298.28	12.1	12.1	24.3	M
		46	07140106001026	790.24	26.4	26.4	52.8	H
		47	07140106001026	346.65	14.1	14.1	28.2	M
11	Upper Sycamore Creek- Spring Arbor	54	07140106007941	1,029.16	41.8	41.8	83.7	H
12	Middle Indian Creek	50	07140106007923	875.84	35.6	35.6	71.2	H
		53	07140106000043	339.03	13.8	13.8	27.6	M
		55	07140106001048	377.49	12.6	12.6	25.2	M
		56	07140106001048	228.97	9.3	9.3	18.6	M
13	Middle Sycamore Creek	67	07140106001054	237.68	13.1	13.1	26.1	M
		68	07140106001054	450.36	24.8	24.8	49.5	M
		69	07140106001054	501.69	33.5	33.5	67	H
		70	07140106001054	456.15	30.5	30.5	60.9	H
		71	07140106001054	689.57	46.1	46.1	92.1	H
		72	07140106001054	395.36	16.1	16.1	32.1	M
		73	07140106007769	838.46	34.1	34.1	68.2	H
		75	07140106001051	345.43	20.2	20.2	40.4	M
14	Lower Indian Creek	57	07140106001045	293.37	9.8	9.8	19.6	M
		60	07140106001044	3,112.61	171.2	171.2	342.4	H
		61	07140106001045	309.94	24.1	24.1	48.3	M
		74	07140106001049	1,361.01	55.3	55.3	110.7	H
15	Boskydell - Drury Creek	51	07140106007905	289.93	16.9	16.9	33.9	M
		52	07140106007905	257.42	10.5	10.5	20.9	M
		58	07140106007905	328.56	19.2	19.2	38.4	M
		59	07140106007905	135.98	5.5	5.5	11.1	M
		62	07140106007905	415.51	24.3	24.3	48.6	M
		63	07140106007905	268.45	9	9	17.9	M
		64	07140106001014	691.92	40.4	40.4	80.9	H
		65	07140106001014	787.47	46	46	92	H
		66	07140106001014	221.24	12.9	12.9	25.9	M
16	Lower Sycamore Creek	76	07140106001050	497.61	20.2	20.2	40.4	M
		77	07140106001050	261.81	10.6	10.6	21.2	M
		78	07140106007670	399.55	22	22	44	M
		79	07140106007670	1,133.66	46.1	46.1	92.2	H
		80	07140106007670	493.10	28.8	28.8	57.6	H
		81	07140106007670	183.87	10.7	10.7	21.4	M
		82	07140106007670	221.48	9	9	18	M
		83	07140106007670	251.65	10.2	10.2	20.4	M
17	Lower Drury Creek	84	07140106000035	205.9	12	12	24	M
		85	07140106007618	265.4	10.8	10.8	21.6	M
		86	07140106000035	534.1	35.7	35.7	71.4	H
		87	07140106000035	1679.6	68.3	68.3	136.6	H
		88	07140106007618	239.4	13.2	13.2	26.4	M
		89	07140106007585	671.4	27.3	27.3	54.6	H
		90	07140106000037	211.2	11.6	11.6	23.2	M
		91	07140106000037	277.1	11.3	11.3	22.6	M

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed - Gully Stabilization by Reachcode								
SMU ID	Subwatershed	Map ID	Target Area (Reach Code)	Amount (feet)	SLR	PLR	NLR	Priority
18	Upper Piles Fork Creek	99	07140106001008	883.4	59	59	118	H
19	Upper Little Crab Orchard Creek	92	07140106007655	205.9	11.3	11.3	22.6	M
		93	07140106000522	1403.0	57	57	114	H
		94	07140106000522	1042.8	42.4	42.4	84.8	H
		95	07140106001005	393.5	16	16	32	M
		96	07140106000522	770.9	51.5	51.5	103	H
		97	07140106001005	871.4	35.4	35.4	70.8	H
		98	07140106001006	2394.9	97.4	97.4	194.8	H
		101	07140106001005	215.1	16.8	16.8	33.6	M
		102	07140106000521	2260.7	176.1	176.1	352.2	H
		103	07140106001005	914.6	37.2	37.2	74.4	H
		104	07140106000520	351.2	19.3	19.3	38.6	M
		105	07140106000520	244.4	13.4	13.4	26.8	M
		106	07140106000520	1298.6	86.7	86.7	173.4	H
20	Carbondale Reservoir-Piles Fork Creek	100	07140106080903	1263.1	51.3	51.3	102.6	H
21	Campus Lake	107	07140106080904	2631.9	144.8	144.8	289.6	H
		108	07140106080904	1495.3	60.8	60.8	121.6	H
		109	07140106080904	1895.0	147.6	147.6	295.2	H
		110	07140106080904	925.8	50.9	50.9	101.8	H
		111	07140106080904	2224.3	90.4	90.4	180.8	H
22	Upper Crab Orchard Creek	108	07140106000045	1495.3	60.8	60.8	121.6	H
23	Eastern Carbondale - Crab Orchard Creek	109	07140106000033	1895.0	147.6	147.6	295.2	H
		110	07140106000033	925.8	50.9	50.9	101.8	H
		111	07140106000033	2224.3	90.4	90.4	180.8	H
		112	07140106000032	1963.9	65.6	65.6	131.2	H
		114	07140106000032	86.8	5.1	5.1	10.2	L
24	Lower Piles Fork Creek	113	07140106000025	1021.0	34.1	34.1	68.2	H
25	Eek Creek	138	07140106001007	3541.4	144	144	288	H
		139	07140106001007	2238.7	91	91	182	H
		140	07140106001007	2858.5	116.2	116.2	232.4	H
		141	07140106001007	486.7	28.4	28.4	56.8	H
26	Middle Little Crab Orchard Creek	107	07140106000519	2631.9	144.8	144.8	289.6	H
		144	07140106000519	1415.0	57.5	57.5	115	H
		146	07140106000519	3717.4	124.1	124.1	248.2	H
		163	07140106000519	550.7	22.4	22.4	44.8	M
		164	07140106000519	793.1	32.2	32.2	64.4	H
		165	07140106000519	431.8	17.6	17.6	35.2	M
		166	07140106000519	389.0	15.8	15.8	31.6	M
27	Reed Station	115	07140106001195	380.9	20.9	20.9	41.8	M
		116	07140106001195	1064.9	83	83	166	H
		117	07140106007388	1020.8	41.5	41.5	83	H
		118	07140106007388	763.1	31	31	62	H
		119	07140106001196	2508.1	137.9	137.9	275.8	H
		120	07140106001196	306.0	16.8	16.8	33.6	M
		125	07140106001196	600.2	24.4	24.4	48.8	M

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed - Gully Stabilization by Reachcode								
SMU ID	Subwatershed	Map ID	Target Area (Reach Code)	Amount (feet)	SLR	PLR	NLR	Priority
28	Middle Crab Orchard Creek	121	07140106000022	315.0	26.8	26.8	53.6	H
		122	07140106000022	480.4	26.4	26.4	52.8	H
		123	07140106000022	373.4	20.5	20.5	41	M
		124	07140106001196	1043.3	42.4	42.4	84.8	H
		126	07140106001196	896.5	69.8	69.8	139.6	H
		127	07140106007369	629.4	21	21	42	M
		128	07140106001197	535.1	21.8	21.8	43.6	M
		129	07140106001197	373.6	15.2	15.2	30.4	M
		130	07140106001197	158.7	9.3	9.3	18.6	M
		131	07140106001197	1356.4	79.3	79.3	158.6	H
		132	07140106001197	361.9	19.9	19.9	39.8	M
		133	07140106001197	1324.1	53.8	53.8	107.6	H
		134	07140106001197	266.9	14.7	14.7	29.4	M
		135	07140106001198	473.3	19.2	19.2	38.4	M
		136	07140106000022	702.0	28.5	28.5	57	H
		137	07140106000022	1659.97	67.5	67.5	135	H
		147	07140106000021	381.4	15.5	15.5	31	M
		148	07140106000021	257.9	15.1	15.1	30.2	M
		149	07140106000021	852.993	34.7	34.7	69.4	H
		152	07140106001198	1437.9	58.5	58.5	117	H
29	Lower Little Crab Orchard Creek	150	07140106007276	435.7	17.7	17.7	35.4	M
		151	07140106007276	948.1	38.5	38.5	77	H
		153	07140106007276	333.6	13.6	13.6	27.2	M
		154	07140106007276	249.9	14.6	14.6	29.2	M
		156	07140106007276	1546.7	62.9	62.9	125.8	H
		160	07140106007250	960.8	39.1	39.1	78.2	H
		168	07140106000518	335.3	13.6	13.6	27.2	M
		169	07140106000518	811.9	50.6	50.6	101.2	H
		170	07140106000518	807.6	50.3	50.3	100.6	H
30	Aviation	142	07140106001002	5407.63	180.6	180.6	361.2	H
		143	07140106001002	1272.1	51.7	51.7	103.4	H
		145	07140106007312	764.5	31.1	31.1	62.2	H
		161	07140106001002	319.8	13	13	26	M
		162	07140106001002	960.8	10.1	10.1	20.2	M
31	Creekside	159	07140106007183	389	43.7	43.7	87.4	H
		167	07140106007183	831.4	28.8	28.8	57.6	H
32	Lower Crab Orchard Creek	155	07140106000019	786.3	81.7	81.7	163.4	H
		157	07140106000018	261.9	14.4	14.4	28.8	M
		158	07140106000018	215.7	12.6	12.6	25.2	M

Shoreline Stabilization Load Reductions

Indian Creek-Drury Creek Subwatershed - Shoreline Stabilization by Shore Code							
SMU ID	Subwatershed	Shore Code	Amount (feet)	SLR	PLR	NLR	Priority
11	Upper Sycamore Creek- Spring Arbor	IL_RNZG-03	786.00	2.9	2.9	5.7	L
		IL_RNZG-04	634.00	6.7	6.7	13.3	M
		IL_RNZG-07	930.00	3.4	3.4	6.8	L
		IL_RNZG-08	461.00	6	6	12.1	M
		IL_RNZG-09	316.00	0.4	0.4	0.8	L
		IL_RNZG-10	491.00	0.9	0.9	1.8	L
		IL_RNZG-11	375.00	3.9	3.9	7.9	L
		IL_RNZG-12	315.00	0.8	0.8	1.5	L
		IL_RNZG-13	368.00	47.5	47.5	95.1	H
		IL_RNZG-14	361.00	17.5	17.5	35.1	M
		IL_RNZG-15	708.00	57.2	57.2	114.3	H
		IL_RNZG-16	504.00	7.9	7.9	15.9	M
		IL_RNZG-17	315.00	3.3	3.3	6.6	L
		IL_RNZG-18	604.00	12.7	12.7	25.4	M
		IL_RNZG-19	543.00	1.3	1.3	2.6	L
		IL_RNZG-20	420.00	17	17	33.9	M
		IL_RNZG-21	286.00	3	3	6	L
		IL_RNZG-22	571.00	6	6	12	M
		IL_RNZG-23	421.00	0.8	0.8	1.5	L
		IL_RNZG-24	426.00	1	1	2.1	L
		IL_RNZG-25	433.00	1	1	2.1	L
		IL_RNZG-26	299.00	0.7	0.7	1.4	L
		IL_RNZG-27	436.00	1.1	1.1	2.1	L
		IL_RNZG-28	505.00	8	8	15.9	M
		IL_RNZG-29	409.00	6.4	6.4	12.9	M
		IL_RNZG-30	351.00	45.3	45.3	90.7	H
		IL_RNZG-31	744.00	60.1	60.1	120.2	H
		IL_RNZG-32	349.00	45.1	45.1	90.2	H
		IL_RNZG-33	562.00	18.2	18.2	36.3	M
		IL_RNZG-34	719.00	7.5	7.5	15.1	M
		IL_RNZG-35	243.00	3.5	3.5	7.1	L
		IL_RNZG-36	665.00	7	7	14	M
		IL_RNZG-37	639.00	1.5	1.5	3.1	L
		IL_RNZG-38	600.00	6.3	6.3	12.6	M
		IL_RNZG-39	324.00	3.4	3.4	6.8	L
		IL_RNZG-40	638.00	1.5	1.5	3.1	L

Little Crab Orchard Creek-Crab Orchard Creek Subwatershed - Gully Stabilization by Reachcode							
SMU ID	Subwatershed	Shore Code	Amount (feet)	SLR	PLR	NLR	Priority
20	Carbondale Reservoir- Piles Fork Creek	IL_RNI-06	465.6	56.3	56.3	112.6	H
		IL_RNI-07	372.9	37.5	37.5	75.1	H
		IL_RNI-08	325.2	6.6	6.6	13.1	M
		IL_RNI-09	405.6	8.2	8.2	16.4	M
		IL_RNI-10	301.3	0.4	0.4	0.7	L
		IL_RNI-12	497.8	0.6	0.6	1.2	L
		IL_RNI-13	524.1	8.3	8.3	16.5	M
		IL_RNI-14	1037.8	2.5	2.5	5	L
		IL_RNI-15	512.6	82.7	82.7	165.4	H
		IL_RNI-16	465.5	18.8	18.8	37.5	M
		IL_RNI-19	476.4	1.2	1.2	2.3	L
		IL_RNI-20	476.5	28.8	28.8	57.7	H
		IL_RNI-21	634.9	128	128	256	H
		IL_RNI-22	479.4	96.7	96.7	193.4	H
		IL_RNI-23	747.1	1.8	1.8	3.6	L
		IL_RNI-24	677.1	71.1	71.1	142.1	H
		IL_RNI-32	325.2	3.4	3.4	6.8	L
		IL_RNI-33	448.6	4.7	4.7	9.4	L
		IL_RNI-34	425.2	4.5	4.5	9	L
		IL_RNI-35	590.6	9.3	9.3	18.6	M
		IL_RNI-36	609.8	36.9	36.9	73.8	H
		IL_RNI-37	324.6	5.1	5.1	10.2	L
		IL_RNI-38	436.2	6.9	6.9	13.7	M
		IL_RNI-39	233.9	3.7	3.7	7.3	L
		IL_RNI-40	386.0	0.9	0.9	1.9	L
21	Campus Lake	IL_RNZH-03	434.7	1.1	1.1	2.1	L
		IL_RNZH-07	396.2	1	1	1.9	L
		IL_RNZH-12	202.7	0.5	0.5	1	L
		IL_RNZH-13	207.0	0.5	0.5	1	L
		IL_RNZH-16	203.4	0.5	0.5	1	L
		IL_RNZH-17	299.7	0.8	0.8	1.5	L
		IL_RNZH-18	398.6	1	1	2	L
		IL_RNZH-19	424.4	34.2	34.2	68.5	H
		IL_RNZH-20	265.3	24.1	24.1	48.2	M
		IL_RNZH-21	338.3	1.2	1.2	2.5	L
		IL_RNZH-22	471.3	7.4	7.4	14.8	M
		IL_RNZH-23	407.6	0.7	0.7	1.5	L
		IL_RNZH-24	315.9	0.8	0.8	1.6	L
		IL_RNZH-26	372.2	0.9	0.9	1.9	L
		IL_RNZH-29	299.8	0.8	0.8	1.5	L
		IL_RNZH-30	256.0	2.7	2.7	5.4	L
		IL_RNZH-31	466.6	4.9	4.9	9.8.	L
		IL_RNZH-32	337.9	1.8	1.8	3.5	L
		IL_RNZH-33	300.6	3.2	3.2	6.3	L
		IL_RNZH-34	373.7	0.7	0.7	1.4	L
		IL_RNZH-35	322.3	0.8	0.8	1.6	L
		IL_RNZH-36	256.4	0.8	0.8	1.6	L
		IL_RNZH-37	308.2	0.8	0.8	1.6	L
		IL_RNZH-39	208.2	3.4	3.4	6.9	L
		IL_RNZH-40	277.8	22.4	22.4	44.9	M