# Upper Macoupin Creek Watershed Plan

**Funded by and Created for The American Farmland Trust**

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Prepared and Submitted by Northwater Consulting
and the American Farmland Trust

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## Acronyms

1. ACEP – Agricultural Conservation Easement Program
2. AFT – American Farmland Trust
3. AQI – Aesthetic Quality Index
4. BMP – Best Management Practice
5. CCA – Certified Crop Advisors
6. CREP – Conservation Reserve and Enhancement Program
7. CRP – Conservation Reserve Program
8. CSP – Conservation Stewardship Program
9. CWS – Community Water Supply
10. EMC – Event Mean Concentration
11. EQIP – Environmental Quality Incentive Program
12. GIS – Geographic Information System
13. HUC – Hydrologic Unit Code
14. ICBMP – Illinois Council on Best Management Practices
15. ICGA – Illinois Corn Growers Association
16. IDNR – Illinois Department of Natural Resources
17. IDOA – Illinois Department of Agriculture
18. IEPA – Illinois Environmental Protection Agency
19. INAI – Illinois Nature Areas Inventory
20. INLRS – Illinois Nutrient Loss Reduction Strategy
21. INPC – Illinois Nature Preserves Commission
22. INSAC – Illinois Nutrient Science Advisory Committee
23. ISA – Illinois Stewardship Alliance
24. ISAP – Illinois Sustainable Ag Partnership
25. ISGS – Illinois State Geologic Survey
26. LA – Load Allocation
27. LC – Loading Capacity
28. LRR – Lateral Recession Rate
29. MCFB – Macoupin County Farm Bureau
30. MOS – Margin of Safety
31. MRBI – Mississippi River Basin Healthy Watersheds Initiative
32. NCWS – Non-Community Water Supply
33. NFWF – National Fish and Wildlife Foundation
34. NGRREC – National Great Rivers Research and Education Council
35. NH4 – Ammonia
36. NO2 – Nitrite
37. NO3 – Nitrate
38. NPDES – National Pollutant Discharge Elimination System
39. NPS– Nonpoint Source Pollution
40. NRCS – National Resource Conservation Service
41. NTCHS – National Technical Committee for Hydric Soils
42. NVSS – Nonvolatile Suspended Solids
43. NWI – National Wetlands Inventory
44. NWISweb – National Water Information System: Web Interface
45. NWQL – National Water Quality Laboratory
46. PCM – Precision Conservation Management
47. RC – Reserve Capacity
48. RCPP – Regional Conservation Partnership Program
49. SHP – Soil Heath Partnership
50. SRP – Soluble Reactive Phosphorus
51. STAR – Saving Tomorrow's Agriculture Resources Program
52. STEPL – Spreadsheet Tool for Estimating Pollutant Loads
53. STP – Sewage Treatment Plant
54. SWCD – Soil and Water Conservation District
55. TKN – Total Kjeldahl Nitrogen
56. TMDL – Total Maximum Daily Load
57. TN – Total Nitrogen
58. TNC – The Nature Conservancy
59. TP – Total Phosphorus
60. TSI – Trophic State Index
61. TSP – Technical Service Providers
62. TSS – Total Suspended Solids
63. UMC – Upper Macoupin Creek
64. USDA – U.S. Department of Agriculture
65. USEPA – U.S. Environmental Protection Agency
66. USFWS – U.S. Fish and Wildlife Service
67. USGS – United States Geological Survey
68. USLE – Universal Soil Loss Equation
69. VSS – Volatile Suspended Solids
70. WASCB – Water and Sediment Control Basin
71. WIP – Watershed Implementation Plan
72. WLA – Waste Load Allocation
73. WRAS – Watershed Restoration Action Strategy

# Executive Summary

## The Macoupin Creek Watershed

The Upper Macoupin Creek (UMC) Watershed Plan includes 137,682 acres from six United States Geological Survey (USGS) Hydrologic Unit Code (HUC)-12 watersheds located in the greater Macoupin Creek basin. The plan provides a road map to achieve watershed goals developed by the UMC Steering Committee; these water quality goals are in alignment with the Illinois Nutrient Loss Reduction Strategy (INLRS). This plan is intended to be adapted and updated as cost-effective implementation activities continue to achieve the highest load reductions. Priority areas identified for in-field management practices should serve as a starting point to guide implementation and outreach efforts, as project partners recognize the need for these practices on more acreage than what is currently prioritized.

Many people and groups in the UMC watershed work to enhance water resources and improve water quality. The UMC Watershed Partnership, headed by the UMC Steering Committee, is comprised of local stakeholders such as farmers, state and federal agency staff, local agricultural retailers, and non-profit groups and will support efforts and execution of this plan. Projects underway during plan development include a grant from the National Fish and Wildlife Federation to fund a Conservation Technician in conjunction with their Conservation Partners Program, as well as active grants from the Natural Resources Conservation Service for priority Best Management Practices (BMPs) and water quality monitoring through the Regional Conservation Partners and Mississippi River Basin Healthy Watersheds Initiative Programs.

The current goals adopted by the Committee are as follows:

1. Improve awareness and understanding of the water quality issues in the UMC, the INLRS, and the benefits of improved soil health and nutrient management.
2. Increase conservation activity in the watershed by 40%.
3. Improve farmer profitability.
4. Reduce ephemeral gully erosion by 50%.
5. No application of commercial fertilizer or manure on snow-covered or frozen ground.
6. All livestock manure will be effectively stored with no potential runoff.
7. Achieve a 25% reduction in total phosphorus loads and a 15% reduction in nitrate-nitrogen loads.

Characteristics of the UMC watershed are summarized below:

- The UMC watershed occupies a northeastern section of the larger Macoupin Creek HUC8 watershed.
- The HUC12 subwatersheds within the UMC project area are Bullard Lake-Middle Macoupin Creek, Coop Branch, Dry Fork, Honey Creek-Upper Macoupin Creek, Hurricane Creek, and Spanish Needle Creek-Upper Macoupin Creek.
- There are 329 miles of perennial streams in the watershed.
  - Only 6.7%, or 22 miles of streams, have been channelized.
  - 85% of the streams are adequately buffered.

- There are 1,978 acres of ponds and lakes in the watershed.
- There are 4,010 acres of 100-year floodplain along Macoupin Creek and tributaries.
- The City of Carlinville, the Town of Shipman and the Village of Royal Lakes are contained within the watershed.
- The UMC watershed spans 15 townships and 2 counties, although 99.8% is in Macoupin County.
- The Macoupin Creek HUC8 was identified by the INLRS Science Assessment with greater than 2 lb/acre/yr of phosphorus being lost from nonpoint sources (NPS).
- Two USGS water quality monitoring stations are on Macoupin Creek, east and west of the UMC watershed, installed in 2017.
- Five Illinois Environmental Protection Agency (IEPA) sampling sites exist on major tributaries in 5 of the 6 subwatersheds.
- The watershed has an average slope of 2.2% and ranges in elevation from 487 to 756 feet above sea level.
- Average annual precipitation is 45 inches.
- 31 landuse categories cover the watershed. The three most prominent are:
    - 80,679 acres of cropland, or 59% of the watershed.
    - 31,944 acres of forest, or 23% of the watershed.
    - 10,096 acres of grassland, or 7.3% of the watershed.
- 54 unique soil types can be found in the watershed:
    - Herrick Silt loam is the dominant type and covers 16%, or 21,340 acres.
    - 33%, or 45,727 acres of the watershed, contains highly erodible or potentially highly erodible soils; 13%, or 10,477 acres of all cropped soils, are highly erodible or potentially highly erodible.
    - 15%, or 20,043 acres of the watershed, are hydric soils.
    - 54% of soils have moderately high runoff potential.
    - 90% of all soils are classified as very limited for septic system suitability.
- National Wetlands Inventory (NWI) estimates 1.9%, or 2,555 acres of the watershed, are classified as wetlands, excluding open water streams, ponds and lakes.
    - Landuse analysis from aerial imagery shows only 0.18% of the watershed, or 250 acres, are wetlands.
- Conventional and reduced-till represent 51% of all cropland in the watershed.
    - 77% of the corn and 27% of the soybeans use conventional tillage systems.
    - 11% of the corn and 24% of the soybeans use reduced-till systems.
    - 10% of the corn and 24% of the soybeans use mulch-tillage systems.
    - 2% of the corn and 25% of the soybeans use no-till/strip-till systems.
- About 16% of all cropland is believed to be tile drained.
- A substantial number of structural practices have already been installed to reduce gully erosion and trap surface runoff:
    - 1,139 Water and Sediment Control Basins (WASCBs).
    - 1,068 acres of grassed waterways.
    - 971 acres of ponds.
- Total nutrient and sediment loading from all sources is 164,519 lbs/year phosphorus, 145,531 tons/year sediment, and 1,536,119 lbs/year nitrogen.

- Cropland surface runoff, or sheet and rill erosion, is responsible for 61% (100,449 lbs) of the annual watershed phosphorus load and 69% (99,309 tons) of the annual sediment load.
- Streambank erosion is responsible for 8.2% (13,356 lbs) of the total annual phosphorus load and 15.2% (21,971 tons) of the total annual sediment load.
- Gully erosion is most severe in steep forested draws; there are 486 miles of eroding gullies in the watershed.
    - Gully erosion is responsible for 7.5% (12,364 lbs) of the annual phosphorus load and 14.9% (21,483 tons) of the sediment load.
- Conventional tillage has the highest average per-acre loading of phosphorus (18.6 lbs/ac/yr) and is used on 22% (18,142 ac) of cropland.
    - Mulch-till has the second highest average per-acre loading (17.6 lbs/ac/yr) phosphorus and is used on 30% (24,510 ac) of cropland.
    - Reduced-till has the third highest average per-acre loading (15.4 lbs/ac/yr) phosphorus and is used on 29% (23,594 ac) of cropland.
    - All other tillage types account for 10% or less of total crop acres.
- The most effective, critical in-field management practices for addressing phosphorus and sediment loss include practices targeted to cropland exporting greater than 2 lbs/ac/yr phosphorus and have been prioritized for short-term implementation. Practices and reductions are:
    - Cover crops on 7,275 acres will achieve a 4.5% total phosphorus reduction, 7.8% reduction in total sediment load, and a 4.1% total nitrogen reduction.
    - No-till or strip-till on 3,803 acres will achieve a total phosphorus reduction of 4.3% and a 9.3% reduction in sediment load.
    - Nutrient management applied to 11,100 acres will achieve a 3.2% reduction in nitrogen losses and a 1.6% reduction in phosphorus.
    - Combined, these practices will reduce total NPS loading by
        - Nitrogen: 8% Phosphorus: 10% Sediment: 17%
- The most effective, critical structural practices for addressing phosphorus and sediment losses are those which cost less than $696/lb of phosphorus reduced. A total of 658 structural practices are considered critical and have been prioritized for short-term implementation. Total expected reductions are:
        - Nitrogen: 6% Phosphorus: 13% Sediment: 18%
- Watershed modeling indicates that UMC needs an annual phosphorus reduction of 41,000 lbs to meet the 25% reduction goal set forth in the INLRS and this plan.
- An estimated expenditure of $8,665,232.83 is likely needed to meet NPS reduction targets of 25% for phosphorus, 15.5% for nitrogen and 38% for sediment.
    - The total estimated cost to implement all recommended structural practices and achieve a 15% reduction in phosphorus loading is $8,038,718.
    - The total estimated cost to implement all recommended in-field management practices and achieve a 10% reduction in phosphorus loading is $626,513 per year.

## Results of the Watershed Assessment

### Table 1 – UMC Watershed Problem Ranking

| Assessment Item | Summary | Ranking |
|---|---|---|
| Landuse and Watershed Characteristics | Cropland has the greatest influence on water quality and covers 59% of the watershed, followed by forest (23%), and grassland (7%); natural cover is high compared to many watersheds in the Midwest. Further conversion to agriculture is not expected to occur in significant amounts in the future; prioritized in-field practices will significantly reduce loading from cropland, and edge-of-field and structural practices (e.g., field borders, filter strips, wetlands, grassed waterways, and WASCBs) will address higher-risk areas and further reduce loading. | Medium |
| Nutrient and Sediment Loading | Nutrient and sediment loading from cropland is high and is responsible for the greatest percentage of the watershed's phosphorus (61%) and nitrogen (83%) load. Agricultural BMPs will be most effective in reducing sediment and nutrient loads, especially considering cost and feasibility. | High |
| Landuse Change | The watershed is sparsely populated and there is little evidence that development will increase and lead to major changes in landuse. Many small communities are decreasing slowly in population. Much of the tillable acres are already converted to cropland and little conversion from natural area to cropland is likely to occur, although these areas should be conserved. | Low |
| Streambank Erosion | Streambank erosion is responsible for a moderate portion of the watershed sediment (15%) and phosphorus (8%) load. Although it is a natural process, bank erosion can be severe at certain locations, such as forested stream corridors. Due to access constraints and costs associated with stabilization, addressing other sources of sediment and nutrients should be prioritized. | Low |
| Gully Erosion | Gully erosion occurring is responsible for a moderate portion of the watershed sediment (15%) and phosphorus (8%) load. Gullies on non-cropland can be addressed through structural practices, while cropland gullies can be addressed though in-field as well as structural practices. | Medium |
| Tillage and HEL Soils | Conventional and reduced-till systems in the watershed are common on 51% of all field acres; these acres are responsible for 55% of the phosphorus and 58% of the cropland sediment load. Highly Erodible Land (HEL) soils exist on 13% of cropland and account for 27% of phosphorus, 36% of sediment, and 27% of nitrogen loading from cropland. A shift away from conventional or reduced-till and the protection of HEL soils may have the largest impact on improving water quality. | High |
| Septic Systems | There are an estimated 1,745 homes with septic systems in the watershed. It is possible that up to 15% of these may be failing. Failing systems are estimated to account for a small portion of the overall nutrient load (0.5% phosphorus, 1.9% nitrogen). A septic system inspection and maintenance program can prevent loading from failing systems in the future. | Low |

| Assessment Item | Summary | Ranking |
|---|---|---|
| Lake Shoreline Erosion | Lake shoreline erosion is responsible for less than 1% of watershed sediment and phosphorus loads, and less than 0.1% of the nitrogen load. Given the overall loading from shoreline erosion is low compared to other sources, stabilization of any areas should be addressed case-by-case. | Low |
| NDPES Dischargers | NPDES (National Pollutant Discharge Elimination System) permitted facilities discharge 11% of the total watershed phosphorus load but only 4% of the nitrogen and less than 1% of the sediment load. As these facilities are permitted through the IEPA and United States Environmental Protection Agency (USEPA), these facilities are considered low priority for watershed managers. | Low |
| Chemical Water Quality | Water quality data collected and analyzed indicates sustained high levels of phosphorus and sediment. Nitrogen concentrations are low overall. Many waterbodies are impaired for parameters such as phosphorus, sedimentation, and low dissolved oxygen. Many waterbodies within the UMC watershed were addressed in the 2015 Total Maximum Daily Load (TMDL) and the INLRS lists the UMC watershed as one of the three highest contributors of phosphorus loading in Illinois. Chemical water quality is of high concern and a priority in the UMC watershed. | High |

## Recommendations

Primary watershed recommendations include:

1. Conduct targeted outreach and one-on-one communication with producers and landowners identified as having critical areas of the highest nutrient and sediment losses.
2. Execute an integrated methodology for priority in-field management practices such that no-till/strip-till, cover crops, and nutrient management are adopted in a tiered approach as part of a conservation cropping system. Stacking these with structural practices will achieve the best possible outcomes.
3. Provide education activities for landowners and producers on conservation practice adoption, management and benefits.
4. Develop a watershed management and implementation tracking system to monitor practice adoption, load reductions achieved, and progress made towards meeting water quality targets.
5. Continue existing water quality monitoring efforts.
6. Commit to a long-term strategy of continued, targeted outreach, implementation and adaptive management.

## 1.0 Introduction

The focus of this plan is the 137,682-acre Upper Macoupin Creek (UMC) watershed, located mostly in Macoupin County, Illinois. Six United States Geological Survey (USGS) Hydrologic Unit Code (HUC)-12 subwatersheds make up the UMC project area: Bullard Lake-Middle Macoupin Creek, Coop Branch, Dry Fork, Honey Creek-Upper Macoupin Creek, Hurricane Creek, and Spanish Needle Creek-Upper Macoupin Creek. The UMC is part of the greater Macoupin Creek HUC8 basin (07130012), which is tributary to the Illinois River. For the purpose of this report, the subwatersheds will be referred to as: Bullard Lake, Coop Branch, Dry Fork, Honey Creek, Hurricane Creek, and Spanish Needle Creek. Figure 1 shows the location of the UMC watershed and subwatershed boundaries and locations.

This plan characterizes the UMC watershed and defines an achievable implementation strategy to address water quality concerns, specifically, nutrients and sediment. It also summarizes and unites ongoing efforts to identify, prioritize and plan new projects, following over two decades of collaborative restoration and conservation activities. The plan will, therefore, provide a road map to achieve watershed goals developed by the UMC Steering Committee in alignment with the Illinois Nutrient Loss Reduction Strategy (INLRS). This plan is intended to be adapted and updated as implementation activities progress in order to achieve the highest load reductions for the least possible investment. Priority areas for in-field management and structural practices are a starting point to guide implementation and outreach efforts.

The UMC was identified by the 2015 INLRS' Science Assessment as one of the three highest phosphorus loading watersheds. The importance of phosphorus reduction in the UMC is also evidenced by frequent water quality impairments and efforts from the Illinois Environmental Protection Agency (IEPA) to address them. Therefore, phosphorus reduction is the primary driver of this plan. The 25% phosphorus reduction goal aligns with the INLRS target, as does the nitrogen target, necessary to improve water quality statewide. The 38% reduction in sediment load goal is based off the achieved reduction when the phosphorus target is met. If all recommended projects are implemented and constructed, the phosphorus and nitrogen goals will be exceeded by 0.4% and 0.5%, respectively. These goals reflect reductions in nonpoint (NPS) loading only, as point source pollution reduction is beyond the scope of this plan. This report includes the required Watershed Based Plan components and is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Watershed History
- Section 3 – Watershed Resource Inventory
- Section 4 – Pollutant Loading
- Section 5 – Sources of Watershed Impairments
- Section 6 – Nonpoint Source Management Measures and Load Reductions
- Section 7 – Cost Estimates
- Section 8 – Water Quality Targets
- Section 9 – Critical Areas
- Section 10 – Technical and Financial Assistance
- Section 11 – Implementation Milestones, Objectives and Schedule
- Section 12 – Information and Education
- Section 13 – Water Quality Monitoring Strategy

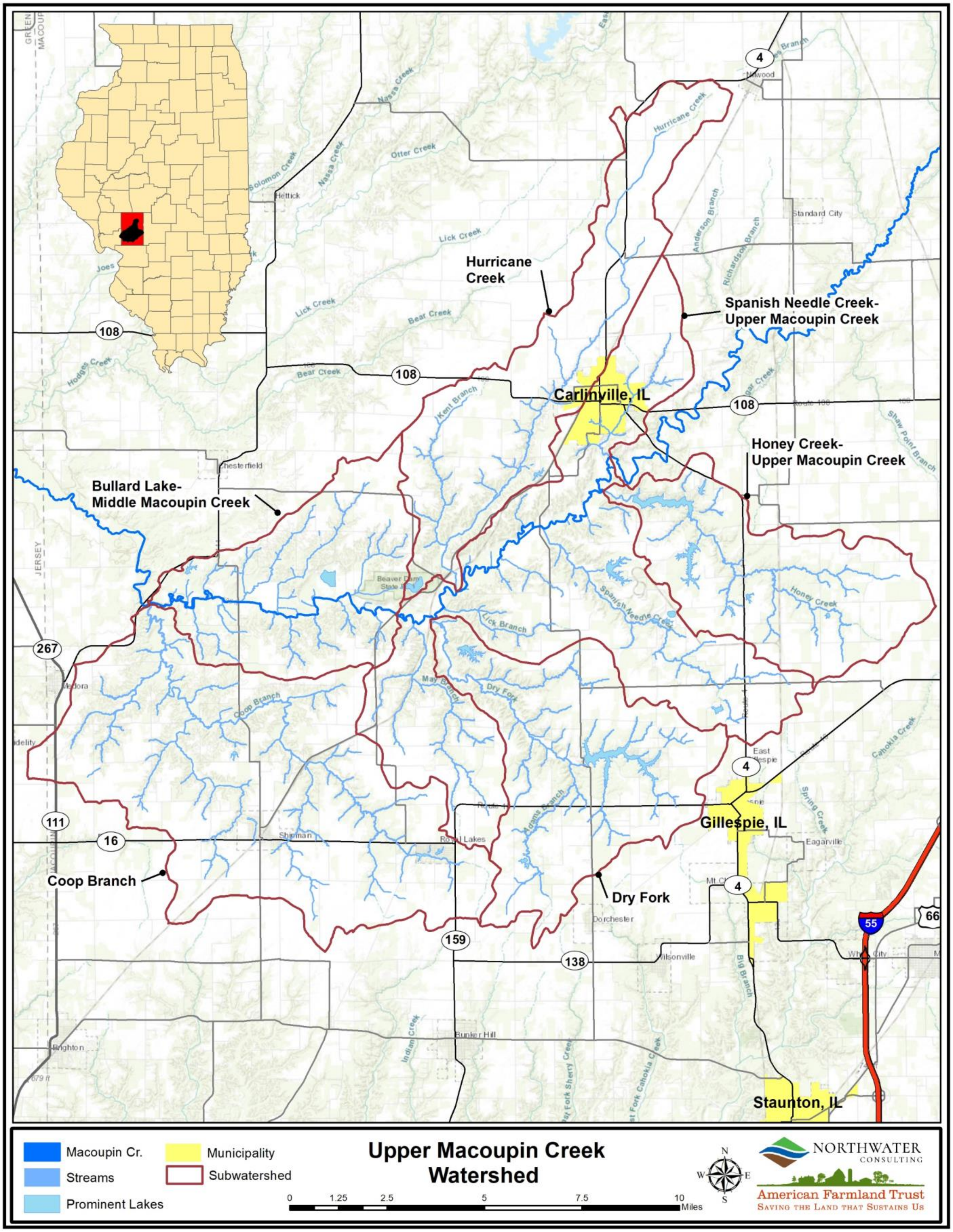



**Figure 1 – UMC Watershed**

## 2.0 Watershed History

Significant conservation efforts have taken place in the Macoupin and UMC watershed. Between 1993 and 2016, EPA Section 319 grants have provided over $3 million in funding for project implementation, shown below in Table 2.

**Table 2 – EPA 319 Projects in Macoupin County, 1994–2016**

| Fiscal Year | Project Title | Total 319 Funds |
|---|---|---|
| 1994 | Macoupin Co. Public Water Supply Watershed Protection/Education Project | $71,133 |
| 1994 | Macoupin County Public Water Supply Watershed Project | $18,867 |
| 1999 | Macoupin Creek WRAS Development | $67,108 |
| 1999 | Village of Royal Lakes – Shad Lake Restoration Project | $60,349 |
| 2002 | Otter Lake In-Lake Sediment Control Project | $560,808 |
| 2002 | Priority Lake and Watershed Implementation Program | $195,343 |
| 2005 | Carlinville Lake Watershed Plan | $109,340 |
| 2007 | Otter Lake Shoreline Erosion Control | $236,590 |
| 2010 | Otter Lake Shoreline Erosion Control and TMDL Implementation | $319,991 |
| 2011 | Lake Carlinville Improvements | $259,151 |
| 2013 | Otter Lake TMDL Implementation | $214,434 |
| 2014 | Lake Carlinville Improvements - Phase 2 | $306,000 |
| 2016 | Otter Lake Watershed Plan and TMDL Implementation | $180,381 |
| 2016 | Upper Silver Creek BMP Implementation | $572,131 |

In 2003, the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) published the UMC Watershed Restoration Action Strategy (WRAS). The WRAS reflected the efforts of 22 stakeholders over two years to identify resource concerns and develop implementation plans for a 256,850-acre area draining to Macoupin Creek. Through a voting process, the WRAS Planning Committee decided the most important strategies were riparian corridor restoration, upland conservation tillage practices, and nutrient management. Second-tier strategies included upland conservation and structural practices, field borders, crop rotation, and identifying funding sources. These priorities were developed to address the WRAS's six goals:

1. Reduce streambank erosion to an attainable level.
2. Manage flooding in the UMC watershed.
3. Reduce nutrients and contaminants that threaten aquatic ecosystems to acceptable levels.
4. Utilize information needed to address pollution from mine run-off, materials used for highway maintenance, spills from commercial transportation, and illegal dumping.
5. Secure adequate funding to implement environmental solutions.
6. Improve conditions for native species in the watershed.
7. Reduce sediment entering the stream.

In 2006, Lake Carlinville, New Gillespie, and Old Gillespie lakes were listed on the IEPA Section 303(d) List of Impaired Waters for not meeting designated uses and numerical water quality standards for phosphorus; modeling indicated that reductions of 48%-74% were needed to meet those standards. Federally funded projects were initiated to address these and other water quality impairments (Table 2).

The 2007 Total Maximum Daily Load (TMDL) Implementation Plan, developed by Limnotech, cites several environmental challenges, including steep slopes and highly erodible soils. The plan identified several solutions including strategic siting of BMPs, including wetland restoration. In addition, the TMDL recommended the following priority activities be conducted:

1. Tributary monitoring to better understand water quality and watershed loading.
2. Stream erosion assessment to prioritize implementation of streambank and grade stabilization projects.
3. BMP inventory to document existing practices in the watershed (e.g., water and sediment control systems, terracing, conservation tillage), and their effectiveness and maintenance level.
4. BMP implementation assessment to determine where new practices should be prioritized to maximize effectiveness and optimize resources to achieve water quality goals.

Starting in 2015, over 20 agricultural and environmental partners developed the Mississippi River Basin Healthy Watersheds Initiative (MRBI) project in the three most eastern watersheds of the UMC, and in 2017, a Regional Conservation Partnership Program Project (RCPP) covering the entire UMC watershed. These projects aim to encourage adoption of soil health and conservation practices to improve farm profitability and water quality. Both projects are led by the American Farmland Trust (AFT) and guided by the UMC Steering Committee, a 17-member group of farmers, agricultural retailers, and national and local conservation agency representatives. Ongoing activities include farmer and non-operator landowner outreach (field days, workshops, farmer interviews), soil transect surveys, water quality monitoring, a partnership with local retailers to offer reduced rate custom conservation tillage and cover crop application, and a partnership with Blackburn College to raise awareness of phosphorus and sediment loading of un-managed woodlands.

The current goals adopted by the Committee are as follows:

1. Improve awareness and understanding of the water quality issues in the UMC, the INLRS, and the benefits of improved soil health and nutrient management.
2. Increase conservation activity in the watershed by 40%.
3. Improve farmer profitability.
4. Reduce ephemeral gully erosion by 50%.
5. No application of commercial fertilizer or manure on snow-covered or frozen ground.
6. All livestock manure will be effectively stored with no potential runoff.
7. Achieve a 25% reduction in total phosphorus loads and a 15% reduction in nitrate-N loads.

There are many partners in the watershed active in protection and conservation activities that provide technical assistance, education and outreach. The UMC Watershed Partnership is a coalition also led by the AFT and headed by the Upper Macoupin Steering Committee. The Partnership has over 30 federal, state, and local government partners, agricultural trade associations, environmental groups, agricultural retailers, and a local college. They work to achieve goals to reduce nitrogen and phosphorus loading, increasing conservation activities, increasing awareness and understanding of water quality issues and the benefits of nutrient management and increasing soil health, reducing ephemeral gully erosion, and improving farmer profitability, among others. Some major partners include:

- American Farmland Trust
- Blackburn College
- CHS Shipman
- Cities of Gillespie and Carlinville
- Environmental Tillage Systems
- Illinois Corn Growers Association
- Illinois Department of Agriculture
- Illinois Environmental Protection Agency
- Illinois Stewardship Alliance
- M&M Service Co.
- Macoupin County Farm Bureau
- Macoupin County Pork Producers
- Macoupin County Soil and Water Conservation District (SWCD)
- The Upper Macoupin Steering Committee
- USDA-NRCS Carlinville Service Center

# 3.0 Watershed Resource Inventory

The resource inventory summarizes characteristics specific to the watershed. It includes information on hydrology, landuse, soils, habitat and water quality, demographics, and other relevant information.

## 3.1 Location and Watershed Boundary

Figure 1 shows the location of the watershed and its subwatersheds. The 137,682-acre UMC watershed is located almost entirely (99.8%) in Macoupin County; a very small portion to the west (0.2%) falls within Jersey County. The watershed contains six HUC12 subwatersheds, which are located within the larger Macoupin Creek HUC8 watershed (07130012) and tributary to the Illinois River. This plan focuses on the area and subwatersheds of Macoupin Creek east to Carlinville at the confluence of Macoupin Creek and Honey Creek, and west to Route 11 northeast of Summerville, at the confluence of Macoupin Creek and Coop Branch. The subwatersheds are Bullard Lake, Coop Branch, Dry Fork, Honey Creek, Hurricane Creek, and Spanish Needle Creek.

## 3.2 Water Quality Standards, Impairments and TMDLs

This section gives an overview of standards of importance, past and current impairments in the watershed, and ongoing TMDLs. Recent water quality is compared to standards and recommended levels.

### 3.2.1 Standards and Impairments

Water quality standards are laws or regulations that states establish to enhance water quality and protect public health and welfare. Standards consist of water quality criteria necessary to support and protect a specific “designated use” of a waterbody, and an antidegradation policy. Examples of designated uses are primary contact, fish consumption, aesthetic quality, protection of aquatic life, and public and food processing water supply. Criteria are expressed numerically for standards with a numeric limit (e.g., 10% of samples over a time period cannot exceed the standard expressed as a concentration), or as narrative description for qualitative standards without a numeric limit (e.g., increased algae growth not meeting aesthetic standards). Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected (CDM Smith, 2014). Waterbodies are considered impaired when they exceed these standards, meeting the criteria to be defined as impaired. Section 303(d) of the 1972 Clean Water Act requires the States to define impaired waters and identify them on the 303(d) list. When no numeric or narrative criteria is set for a parameter, guidelines are described for a specific use.

#### *Relevant Standards and Water Quality Parameters*

Standards which are relevant to this watershed plan are phosphorus, total suspended solids (TSS), and nitrogen. Phosphorus loading in the watershed is of high importance. The 2007 TMDL recommended reductions of 51%, 74%, and 48% to meet state standards in Lake Carlinville, New Gillespie, and Old Gillespie lakes, respectively. In addition, the INLRS identified the watershed as 1 of 3 top phosphorus exporting watersheds in Illinois and recommended a reduction of 25%. TSS can be a large importer of phosphorus and can cause siltation and sedimentation of waterbodies. Nitrogen is another prominent issue; Illinois is a top contributor of nitrogen to the Gulf of Mexico. The ILNRS calls for a 15% reduction in nitrogen, while the Gulf Hypoxia Action Plan (2008) calls for a 45% reduction in stream nitrogen to address and reduce the hypoxic zone and achieve plan goals. Each parameter and associated standards are discussed below.

**Phosphorus** is a major cellular component of organisms. Phosphorus can be found in dissolved and sediment-bound forms but is often “locked up” as components in aquatic biota, primarily algae. Major sources of phosphorus in the watershed include fertilizers and human and animal waste. In freshwater systems, phosphorous occurs naturally in smaller concentrations than nitrogen, making it the limiting nutrient in these freshwater aquatic systems. Increased nutrient concentrations (especially phosphorus) in a waterbody stimulates algae growth, which can lead to large populations, forming a bloom that can be harmful to water quality and aquatic life. Dissolved phosphorus is especially important because it is readily usable by algae and other plants. The two common forms of phosphorus are:

- **Soluble reactive phosphorus (SRP)** – is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae and cycled very rapidly. Sources of dissolved phosphorus include fertilizers, animal wastes, and septic systems.

- **Total phosphorus (TP)** – includes dissolved and particulate forms of phosphorus. According to Illinois water quality standards, total phosphorus must not be greater than 0.05 mg/L in lakes greater than 20 acres in size; streams may not exceed 0.05 mg/L at the point of entry into a lake.

The Illinois Nutrient Science Advisory Committee (INSAC) recommends a 0.1 mg/L standard for non-wadable rivers; for wadable streams, 0.113 mg/L is recommended for the northern ecoregion of Illinois and 0.110 mg/L for the southern ecoregion (INSAC 2018). The Macoupin Creek watershed falls in the northern ecoregion.

**Nitrogen** The various forms of nitrogen differ in respect to lake health and standards. Inorganic forms of nitrogen are readily available by algae for growth and other forms of nitrogen, and in high concentrations, can be toxic to fish and other aquatic organisms. Excess nitrogen also aids in excessive algal growth and blooms. The four common forms of nitrogen are:

- **Nitrite (NO2)** – an inorganic form, is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate.

- **Nitrate (NO3)** – an inorganic form, generally occurs in trace quantities in surface water but may attain high levels in some groundwater. Nitrate travels easily through soil carried by water into surface waterbodies and groundwater. The current standard of 10 mg/L for nitrate-nitrogen (nitrogen from nitrate) in drinking water is specifically designated to protect human health.

- **Ammonia (NH4)** – is present naturally in surface waters. Bacteria produce ammonia as they decompose dead plant and animal matter. In Illinois, the total ammonia general use standard is 15 mg/L.

- **Organic nitrogen (TKN)** – is defined functionally as organically bound nitrogen in the tri-negative oxidation state. Organic nitrogen includes nitrogen found in plants and animal materials, which includes such natural materials as proteins and peptides, nucleic acids and urea. In the analytical procedures, Total Kjeldahl Nitrogen (TKN) determines both organic nitrogen and ammonia. Raw sewage will typically contain more than 20 mg/L.

- **Total nitrogen (TN)** is the sum of TKN (ammonia, organic and reduced nitrogen) and nitrate-nitrite, and for the purposes of this report. INSAC recommended wadable stream standards of 3.98 mg/L for the northern ecoregion and 0.910 mg/L for the southern ecoregion (INSAC 2018). The Macoupin Creek watershed falls in the northern ecoregion.

**Total Suspended Solids (TSS)** TSS refers to the portion of total solids retained by a filter; it can vary greatly from season to season with climate conditions such as precipitation, temperature causing lake turnover, stream velocity, and is impacted by many other environmental circumstances such as human disturbance. It includes both organic forms and inorganic forms and can be divided into volatile suspended solids (VSS), which include organic materials such as algae and decomposing organic matter and nonvolatile suspended solids (NVSS), which includes non-organic "mineral" substances (IEPA, 2016).

No numerical standard for TSS exists for streams, but a guideline of 116 mg/L has been used as an indicator of water column quality to support aquatic life use support (ALUS), as described in the 2003 TMDLs for Rayse Creek and the East Fork Kaskaskia River. TSS is, however, included in standards for lakes. In lakes, the Aesthetic Quality Index (AQI) represents a point system used to assess the aesthetic quality designated use. The AQI represents the extent to which recreational activities and aesthetic enjoyment are available and is based primarily on physical and chemical water quality data. Three evaluation factors are used in establishing the number of AQI points; the higher AQI scores indicate increased impairment (IEPA, 2018):

1. Median Trophic State Index (TSI); data collected May–October and calculated from total phosphorus (at 1 ft depth), chlorophyll a, and Secchi disk transparency.
2. Macrophyte Coverage; average percentage of lake surface area covered by macrophytes during peak growing season.
3. Nonvolatile Suspended Solids (NVSS) concentration; median lake surface NVSS concentration for samples collected at 1 ft depth (reported in mg/L).

Although NVSS is only one of three evaluation criteria for determining the AQI, the maximum number points (15) is achieved when NVSS concentrations are greater than or equal to 15 mg/L. The previous guideline for listing TSS for aquatic life in lakes is a NVSS greater than 12 mg/L. As VSS and NVSS data are not available for this watershed plan, this analysis will compare TSS to the 15 mg/L standard as a proxy.

### *Impairments*

Water quality impairments occur dating back to at least the 1990s. Figure 2 depicts waterbodies listed in the 2004 and 2018 303(d) lists, along with their IEPA assessment code. Below, Table 3 lists waterbodies on the 2004 303(d) list, their historical impairments and a description of causes. Numerous waterbodies were impaired for total phosphorus, dissolved oxygen, total nitrogen, habitat, TSS, sedimentation, algal growth, flow regime alteration, and fecal coliform.

**Table 3 – Historical Impairments on 2004 IEPA 303(d) List**

| Assessment ID | Waterbody | Year Listed | Cause |
|---|---|---|---|
| DA-04 | Macoupin Creek | 1998 | Manganese, dissolved oxygen, fecal coliform, sedimentation/siltation, total phosphorus (statistical guideline) |
| DA-05 | Macoupin Creek | 1998 | Manganese, dissolved oxygen, total nitrogen as N, other flow regime alterations, total phosphorus (statistical guideline) |
| DAZN | Briar Creek | 2002 | Dissolved oxygen, habitat assessment, total phosphorus (statistical guideline) |
| RDG | Lake Carlinville | 1996 | Manganese, total phosphorus, total suspended solids, excess algal growth, total phosphorus (statistical guideline) |
| RDH | Beaver Dam Lake | 1998 | Total phosphorus, excess algal growth, total phosphorus (statistical guideline) |
| SDT | Old Gillespie Lake | 2002 | Manganese, total phosphorus, total suspended solids, excess algal growth, total phosphorus (statistical guideline) |
| SDU | New Gillespie Lake | 2002 | Total phosphorus, TSS, excess algal growth, total phosphorus (statistical guideline) |

Current impairments from the 2018 303(d) list are shown in Table 4; phosphorus and sediment are still widespread and have persisted through time, although the total number of impairments has decreased since 2004. For instance, Briar Creek is no longer listed for low dissolved oxygen. More information on impairments can be obtained by contacting the IEPA.

### Table 4 – 2018 303(d) Impaired Waterbodies

| Assessment ID | Waterbody | Size (ac or mi) | Designated Use | Cause |
|---|---|---|---|---|
| RDH | Beaver Dam Lake | 57 | Fish Consumption | Mercury |
| DAZN | Briar Creek | 4.4 | Aquatic Life | Oxygen, Dissolved |
| DAZN | Briar Creek | 4.4 | Aquatic Life | Phosphorus (Total) |
| RDG | Lake Carlinville | 168 | Fish Consumption | Mercury |
| SDT | Old Gillespie Lake | 71 | Fish Consumption | Mercury |
| WDW | Loveless (Carlinville II) | 121 | Aesthetic Quality | Phosphorus (Total) |
| WDW | Loveless (Carlinville II) | 122 | Public Food and Water Processing Supplies | Simazine |
| DA-05 | Macoupin Creek | 46 | Aquatic Life | Total Suspended Solids |

**Lake Carlinville**

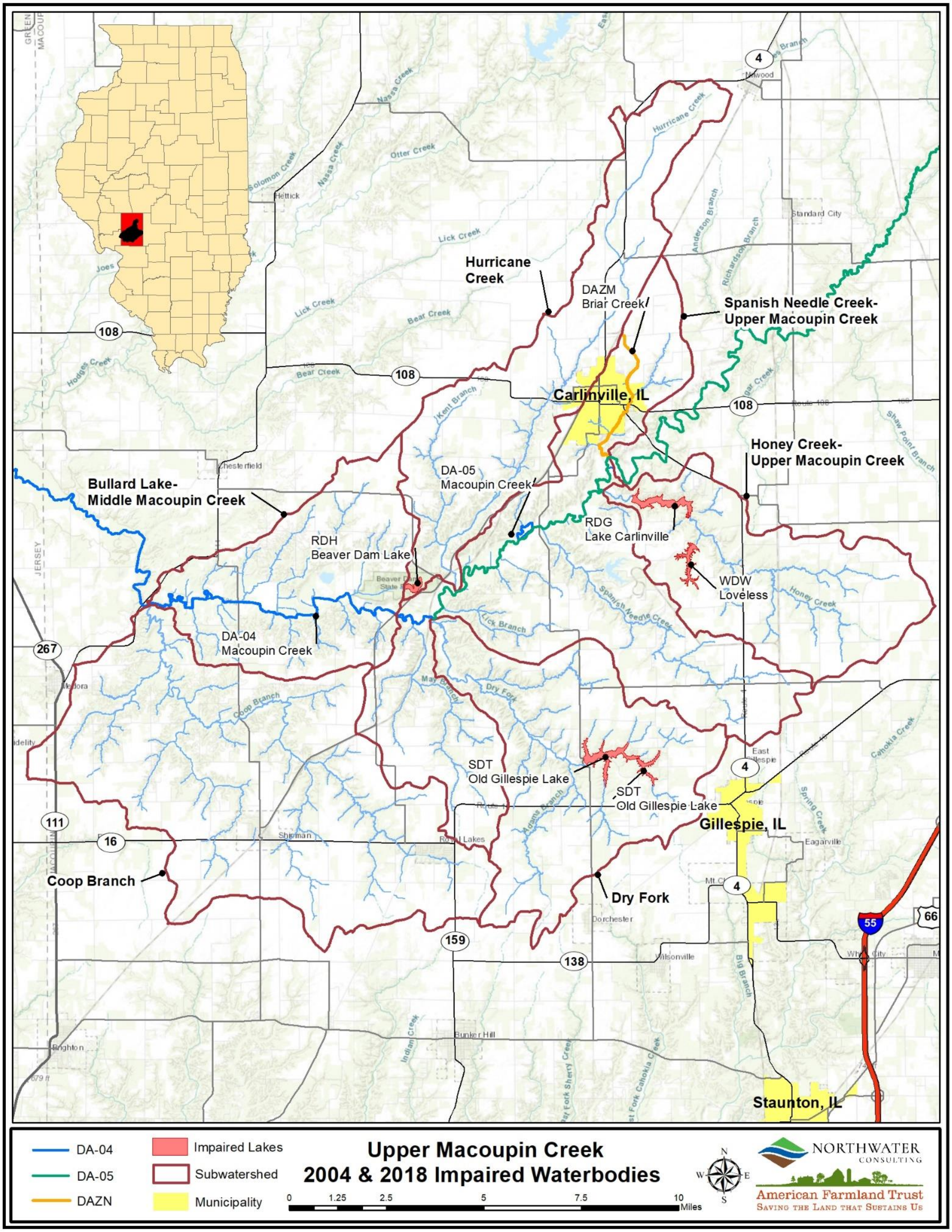



Figure 2 – Impaired Waterbodies in 2004 and 2018

### 3.2.2 TMDL Overview

Impaired bodies of water can be prioritized for TMDL development. A TMDL is a calculation of the maximum quantity of a pollutant that a water body can receive while still achieving water quality standards. The TMDL development accounts for seasonal variability of pollutant loads so that water quality standards are met during all seasons of the year. TMDL plans within the UMC watershed include the Lake Carlinville Atrazine TMDL (2015) and the Macoupin Creek Watershed TMDL Report (2007).

The 2015 Lake Carlinville TMDL addressed atrazine, which has a standard maximum contaminant level (MCL) of 0.33 mg/L. No more than 10 percent of the raw water samples can exceed the MCL or there can be no exceedances of the MCL for the quarterly average concentration. For finished drinking water, no sample can be over the MCL. From 2003 to 2011, 7.1% of finished water and 18% of the untreated water samples exceeded the standard. The recommended reduction was 74.9%.

Table 5 below lists waterbodies and parameters addressed in the 2007 Macoupin Creek Watershed TMDL. Phosphorus impairments were widespread with most samples exceeding the standard. Excess phosphorus can amplify other issues such as decreased dissolved oxygen through the process of eutrophication, increased algae and aquatic plant growth and die-off. Details on sampling and exceedances can be found in the TMDL report.

**Table 5 – Recommended Reductions in 2007 Macoupin Creek Watershed TMDL**

| Assessment ID | Waterbody | TMDL Parameter | TMDL Recommended Reductions: Percent Load (%) or Load Capacities (lb/day) |
|---|---|---|---|
| DA-04 | Macoupin Creek | Dissolved Oxygen | n/a (caused by low flow)[3] |
| | | Manganese | 35% |
| | | Fecal Coliform | 94%–99% from 4.8 cfs–206 cfs |
| DA-05 | Macoupin Creek | Dissolved Oxygen | n/a (caused by low flow)[3] |
| | | Manganese | 85% |
| RDG | Lake Carlinville | Total Phosphorus | 51% |
| | | Manganese | Targeted reduction of phosphorus[1] |
| RDH | Beaver Dam Lake | Total phosphorus | 0%[2] |
| SDT | Old Gillespie Lake | Total Phosphorus | 74% |
| | | Manganese | Targeted reduction of phosphorus[1] |
| SDU | New Gillespie Lake | Total phosphorus | 48% |

[1] *Phosphorus reduction is targeted to address the manganese TMDLs for Carlinville and Old Gillespie Lakes: elevated manganese is attributed to release of manganese from sediments, which occurs when dissolved oxygen is depressed in the bottom waters of the lakes; this oxygen depletion is attributed to excessive loading of phosphorus.* [2] *Beaver Dam is expected to reach equilibrium.* [3] *TMDLs cannot address low dissolved oxygen caused by low flow.*

## 3.3 Water Quality

As described in Section 3.2.1, waterbodies have exceeded state standards since at least 1990. Impairments have included: total phosphorus, TSS, dissolved oxygen, manganese, and atrazine in Lake Carlinville, as well as sedimentation, algal growth, and habitat loss. Many of these impairments are interrelated; for example, excessive sedimentation can increase phosphorus loading leading to increased macrophytic plant and algae growth, and low dissolved oxygen. Numerous studies have shown that high phosphorus loading leads to high phytoplankton biomass, turbid water and often undesired biological changes (Sondergaard, Jensen and Jeppesen, 2003).

This section synthesizes recent water quality data for watershed streams and lakes, comparing them to applicable standards. Table 6 lists monitoring stations and sampling dates, and Figure 3 depicts their location. Stream data parameters include total phosphorus, TSS and nitrate+nitrite; lake data includes total phosphorus, TSS, nitrate+nitrite, Kjeldahl nitrogen, and ammonia-nitrogen. Lake data was obtained from the IEPA and stream data was collected through sampling performed by watershed partners through an AFT partnership with the 2015 MRBI program and a 2017 RCPP contract. Analysis of the data presented in this section is narrow due to a relatively short sampling period and small number of samples, and as a result, the ability to perform a meaningful trend analysis is limited.

**Table 6 – Historic Water Quality Sampling Sites, 2015–2018**

| Station Code | Supporting Agency | Waterbody | Range of Data | Location |
|---|---|---|---|---|
| 5586647 | USGS | Macoupin Creek (upstream station) | Weekly June 2017–July 2018 | Macoupin Creek at Hwy 108 near Carlinville, IL |
| 5586745 | | Macoupin Creek (downstream station) | Weekly June 2017–July 2018 | Macoupin Creek at Hwy 111 near Summerville, IL |
| DAH-01 | IEPA | Dry Fork Creek | Monthly October 2015–June 2018 | Lake Catoga Rd., 3 mi NE of Plainview |
| DAI-01 | | Hurricane Creek | Monthly January 2017–June 2018 | Shipman Rd., 5.7 mi SW of Carlinville near Beaver Dam State Park |
| DAZI-01 | | Coop Branch | Monthly January 2017–July 2017 | Coop Rd. bridge, 3 mi E Medora |
| DAZL-SM-C2 | | Spanish Needle Creek | October 2015–December 2018 | Off Stagecoach Rd, 0.3 mi upstream from Macoupin Creek confluence |
| DAZM-01 | | Honey Creek | Monthly October 2015–June 2018 | Linwood Ln, 0.2 mi W of Illinois Rt 4 and 5.6 mi SE of Carlinville |
| RDG-1 | | Lake Carlinville | Monthly April–October 2009 and 2014 | Site 1, near dam |
| RDG-2 | | | | Site 2, 1 MI E dam near boy scout camp |
| RDG-3 | | | | Site 3, E end of lake near beach |
| RDH-1 | | Beaver Dam Lake | Monthly April–October 2015 | Site 1, 400 ft east of dam |
| SDT-1 | | Old Gillespie Lake | Monthly April–October 2009 and 2014 | Site 1 |
| SDT-2 | | | | Site 2 |
| SDU-1 | | New Gillespie Lake | Monthly April–October 2009 and 2014 | Site 1, 50 yds north of dam spillway |
| SDU-2 | | | | Site 2, 50 yds west of boat dock |
| SDU-3 | | | | Site 3, 1000 yd west of boat dock |
| WDW-1 | | Loveless (Carlinville II) | Monthly April–October 2014 | n/a |
| WDW-2 | | | | n/a |
| WDW-3 | | | | n/a |

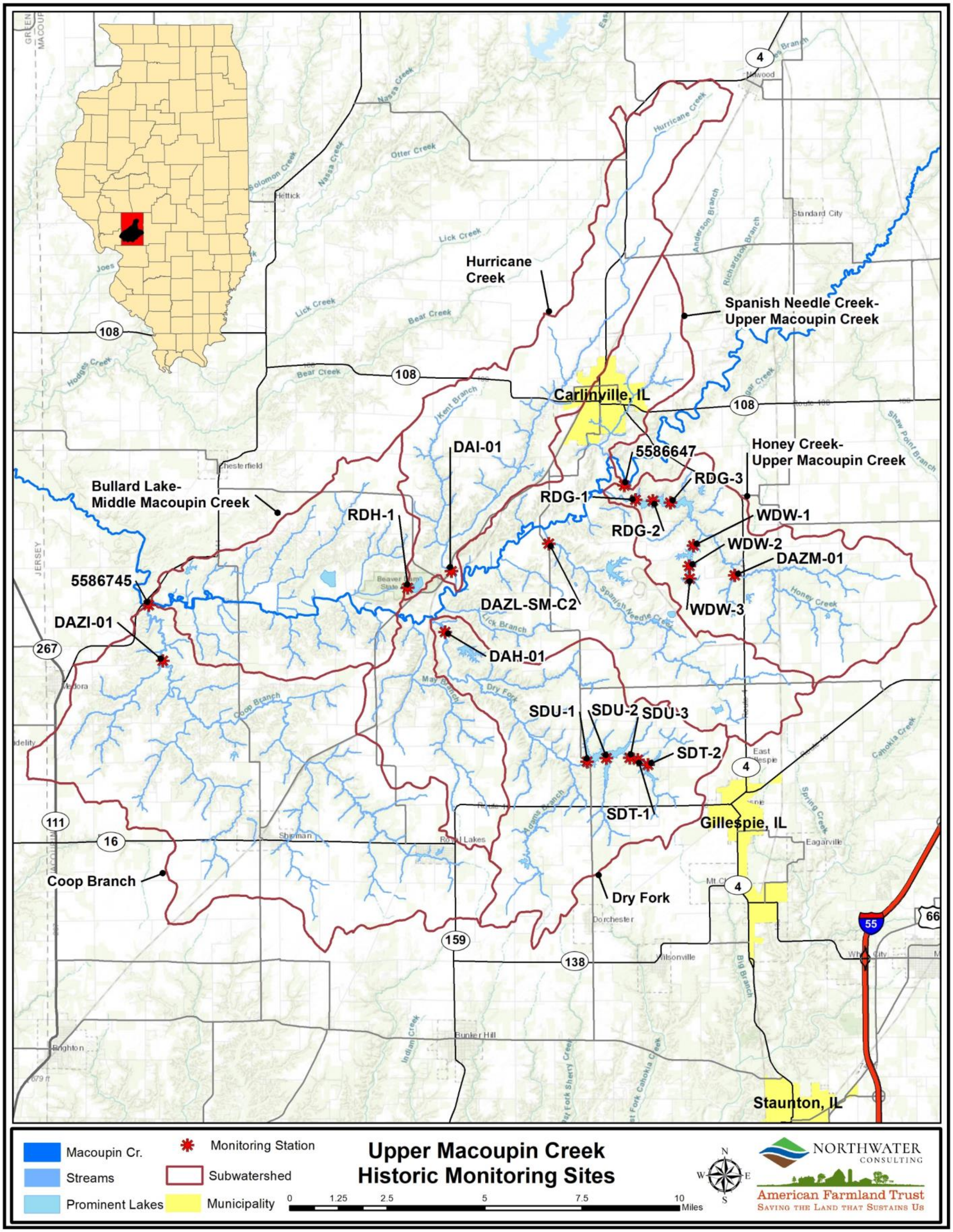



**Figure 3 – Water Quality Sampling Stations, 2009–2018**

### 3.3.1 Stream Total Phosphorus

Streams have regularly exceeded the INSAC recommended total phosphorus limit (0.113 mg/L). For all sampling stations, 57% to 92% of samples taken exceeded the INSAC limit (Table 7). Figure 4 shows changes in total phosphorus concentrations through time. Values over the sampling period seem to reflect the timing of agricultural activities and seasonal changes, with higher concentrations during the fall and spring. Fall 2015 and spring 2016 exhibited the highest concentrations; fall 2016 and spring 2017 had the lowest. However, 64% of all stream samples exceeded INSAC recommendations, marking the prevalence of high concentrations found in streams and the need to reduce loading.

**Table 7 – Stream Total Phosphorus Results by Monitoring Station**

| Station Code | Waterbody | Total Samples | Average Value (mg/L) | Minimum Value (mg/L) | Maximum Value (mg/L) | Exceeded INSAC Recommendation | |
|---|---|---|---|---|---|---|---|
| | | | | | | Count | Percent |
| 5586647 | Macoupin Creek (upstream station) | 34 | 0.192 | 0.004 | 0.466 | 25 | 74% |
| 5586745 | Macoupin Creek (downstream station) | 35 | 0.147 | 0.005 | 0.518 | 18 | 51% |
| DAH-01 | Dry Fork Creek | 27 | 0.240 | 0.023 | 1.26 | 13 | 48% |
| DAI-01 | Hurricane Creek | 14 | 0.160 | 0.048 | 0.390 | 8 | 57% |
| DAZI-01 | Coop Branch | 6 | 0.158 | 0.094 | 0.286 | 4 | 67% |
| DAZL-SM-C2 | Spanish Needle Creek | 25 | 0.336 | 0.044 | 1.38 | 23 | 92% |
| DAZM-01 | Honey Creek | 29 | 0.261 | 0.031 | 1.07 | 18 | 62% |

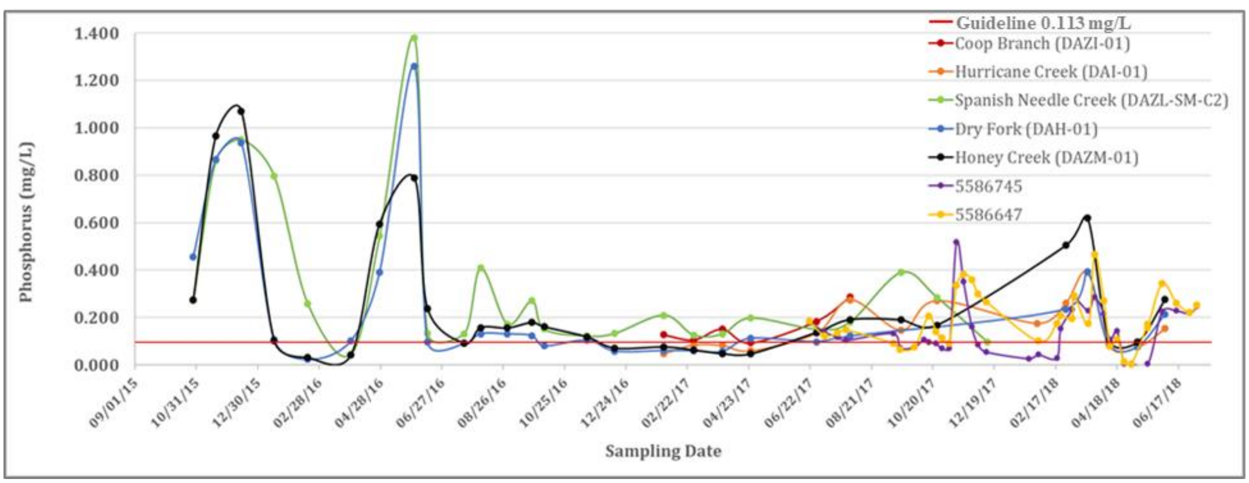



**Figure 4 – Stream Total Phosphorus Concentrations, 2015–2018**

### 3.3.2 Lake Total Phosphorus

Total phosphorus concentrations in all sampled lakes routinely exceed the state water quality standard of 0.05 mg/L (Table 8). Average phosphorus concentrations were higher in 2014 than in 2009 in Lake Carlinville and Old Gillespie Lake, whereas New Gillespie Lake had lower concentrations in 2014.

Table 8 shows sample concentrations and exceedances of the standard. Every sample from Old Gillespie Lake exceeded the standard within the two-year sampling period. During only one year of sampling, Beaver Dam Lake exceeded the limit 42% of the time, and Loveless Lake 66%. All other lakes exceeded the standard 65% to 97% of the time. At individual sampling stations, average annual values ranged 1.4 to 16 times the standard, while maximum values ranged from 2 to 88 times. Even minimum values in Old Gillespie Lake were 1.6 to 4.3 times the standard. These consistently high phosphorus values demonstrate the need for further watershed management and the challenges associated with nutrient loading.

### Table 8 – Lake Total Phosphorus Results by Monitoring Station

| Waterbody | Station Code | Year | Total Samples | Number Exceeded | Percent Exceeded | Average Value (mg/L) | Minimum Value (mg/L) | Maximum Value (mg/L) |
|---|---|---|---|---|---|---|---|---|
| Lake Carlinville | RDG-1 | Both Years | 61 | 44 | 72% | 0.14 | 0.01 | 0.51 |
| | | 2009 | 31 | 20 | 65% | 0.11 | 0.01 | 0.46 |
| | | 2014 | 30 | 24 | 80% | 0.17 | 0.02 | 0.51 |
| | RDG-2 | Both Years | 21 | 14 | 67% | 0.11 | 0.01 | 0.31 |
| | | 2009 | 11 | 7 | 64% | 0.09 | 0.01 | 0.18 |
| | | 2014 | 10 | 7 | 70% | 0.13 | 0.03 | 0.31 |
| | RDG-3 | Both Years | 20 | 16 | 80% | 0.16 | 0.02 | 0.51 |
| | | 2009 | 10 | 7 | 70% | 0.12 | 0.02 | 0.25 |
| | | 2014 | 10 | 9 | 90% | 0.19 | 0.05 | 0.51 |
| Beaver Dam Lake | RDH-1 | 2015 | 12 | 5 | 42% | 0.06 | 0.01 | 0.14 |
| Old Gillespie Lake | SDT-1 | Both Years | 40 | 40 | 100% | 0.77 | 0.09 | 4.42 |
| | | 2009 | 20 | 20 | 100% | 0.74 | 0.22 | 4.42 |
| | | 2014 | 20 | 20 | 100% | 0.80 | 0.09 | 3.04 |
| | SDT-2 | Both Years | 30 | 30 | 100% | 0.35 | 0.08 | 0.76 |
| | | 2009 | 20 | 20 | 100% | 0.37 | 0.21 | 0.64 |
| | | 2014 | 10 | 10 | 100% | 0.31 | 0.08 | 0.76 |
| New Gillespie Lake | SDU-1 | Both Years | 40 | 35 | 88% | 0.52 | 0.02 | 2.92 |
| | | 2009 | 20 | 19 | 95% | 0.58 | 0.02 | 2.92 |
| | | 2014 | 20 | 16 | 80% | 0.45 | 0.02 | 2.66 |
| | SDU-2 | Both Years | 57 | 49 | 86% | 0.12 | 0.02 | 0.27 |
| | | 2009 | 30 | 29 | 97% | 0.15 | 0.03 | 0.27 |
| | | 2014 | 27 | 20 | 74% | 0.09 | 0.02 | 0.17 |
| | SDU-3 | Both Years | 20 | 17 | 85% | 0.18 | 0.02 | 0.66 |
| | | 2009 | 10 | 10 | 100% | 0.17 | 0.07 | 0.25 |
| | | 2014 | 10 | 7 | 70% | 0.19 | 0.02 | 0.66 |
| Loveless (Carlinville II) | WDW-1 | 2014 | 30 | 21 | 70% | 0.23 | 0.01 | 1.23 |
| | WDW-1 | 2014 | 10 | 6 | 60% | 0.06 | 0.01 | 0.10 |
| | WDW-3 | 2014 | 10 | 6 | 60% | 0.07 | 0.01 | 0.14 |

### 3.3.3 Stream Nitrogen

Stream data was recorded as nitrate+nitrite, also known as inorganic nitrogen. Inorganic forms are easily available for macrophytic plant and algae uptake. As inorganic forms are a part of total nitrogen, it was compared to the INSAC recommended total nitrogen concentration of 3.98 mg/L. Inorganic data was collected once at IEPA sampling sites (Table 9) and over the period of one year at USGS sampling sites (Table 10). IEPA samples were not close to exceeding the recommended standard, although it is notable that Hurricane creek and Coop Branch had higher concentrations than Dry Fork Creek and Spanish Needle Creek.

**UMC Watershed Stream**

The INSAC limit was exceeded 7 times (21% of samples) at the upstream Macoupin Creek USGS site and 4 times (11% of samples) at the downstream site. Sample concentrations upstream were generally higher; the upstream station had 5 samples exceeded 5 mg/L, whereas the downstream station only had 2 samples greater than 5 mg/L. Higher values seem to correlate with seasonal agricultural activity and precipitation through the spring and early summer (Figure 5). Lower concentrations in the downstream samples may be a result from the effects of dilution. These results show opportunity to decrease inorganic nitrogen levels with strategically placed BMPs.

**Table 9 – Stream Nitrate+Nitrite Results from IEPA Sampling Sites**

| Station Code | Waterbody | Sample Date | Total Samples | Nitrate+Nitrite (mg/L) | Exceeded INSAC Recommendation? |
|---|---|---|---|---|---|
| DAH-01 | Dry Fork Creek | 03/28/17 | 1 | 0.048 | No |
| DAZI-01 | Hurricane Creek | 03/28/17 | 1 | 1.000 | No |
| DAZL-SM-C2 | Coop Branch | 03/28/17 | 1 | 1.090 | No |
| DAZM-01 | Spanish Needle Creek | 03/28/17 | 1 | 0.043 | No |

**Table 10 – Stream Nitrate+Nitrite Results from USGS Sampling Sites**

| Station Code | Waterbody | Number of Samples | Av. (mg/L) | Min (mg/L) | Max (mg/L) | Exceeded INSAC Recommendation | |
|---|---|---|---|---|---|---|---|
| | | | | | | Count | Percent |
| 5586647 | Macoupin Creek (upstream station) | 34 | 2.4 | 0.04 | 10.9 | 7 | 21% |
| 5586745 | Macoupin Creek (downstream station) | 35 | 1.6 | 0.04 | 8.29 | 4 | 11% |

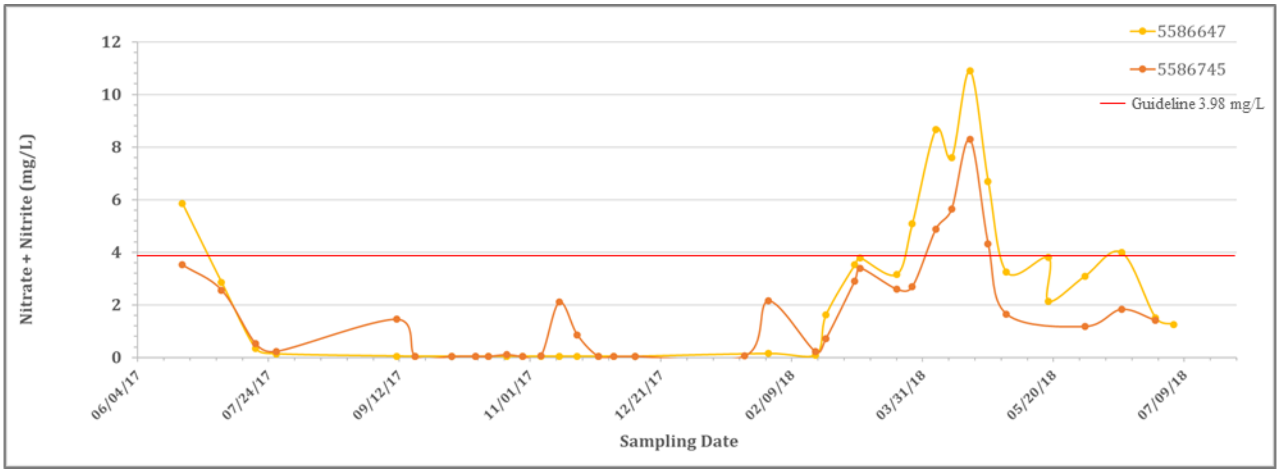



**Figure 5 – Nitrate+Nitrite Concentrations in Streams, 2017–2018**

### 3.3.4 Lake Nitrogen

Table 11 shows nitrate+nitrite (inorganic nitrogen) data compared to the drinking water standard of 10 mg/L for nitrate-nitrogen. Inorganic nitrogen was used because nitrate is the dominant form of inorganic nitrogen. Inorganic nitrogen rarely exceeded 1 mg/L (7.9% of samples), and no samples exceeded the drinking water standard. Average inorganic concentrations for concentrations in 2009, 2014, and both sampling years are also below 1 mg/L; maximum levels did not exceed 2 mg/L. Minimum values at all sampling sites and all years was 0.1 mg/L. Average inorganic nitrogen was lower in 2014 than in 2009. Overall, lakes exhibit minimum, maximum and average concentrations of inorganic nitrogen well below the drinking water standard and lower than stream concentrations.

**Table 11 – Lake Nitrate + Results**

| Waterbody | Station Code | Year | Total Samples | Nitrate+Nitrite Concentration Av. (mg/L) | Min (mg/L) | Max (mg/L) | Exceeded Nitrate-Nitrogen Standard (count) |
|---|---|---|---|---|---|---|---|
| Lake Carlinville | RDG-1 | Both Years | 31 | 0.48 | 0.01 | 1.82 | 0 |
| | | 2009 | 16 | 0.63 | 0.01 | 1.82 | 0 |
| | | 2014 | 15 | 0.33 | 0.01 | 0.94 | 0 |
| | RDG-2 | Both Years | 11 | 0.52 | 0.01 | 1.94 | 0 |
| | | 2009 | 6 | 0.65 | 0.01 | 1.94 | 0 |
| | | 2014 | 5 | 0.37 | 0.01 | 0.808 | 0 |
| | RDG-3 | Both Years | 10 | 0.56 | 0.01 | 2.00 | 0 |
| | | 2009 | 5 | 0.60 | 0.01 | 2.00 | 0 |
| | | 2014 | 5 | 0.52 | 0.01 | 1.06 | 0 |
| Beaver Dam Lake | RDH-1 | 2015 | 6 | 0.04 | 0.01 | 0.132 | 0 |
| Old Gillespie Lake | SDT-1 | Both Years | 20 | 0.34 | 0.01 | 1.42 | 0 |
| | | 2009 | 10 | 0.43 | 0.01 | 1.42 | 0 |
| | | 2014 | 10 | 0.25 | 0.01 | 0.878 | 0 |
| | SDT-2 | Both Years | 15 | 0.42 | 0.01 | 1.52 | 0 |
| | | 2009 | 10 | 0.48 | 0.01 | 1.52 | 0 |
| | | 2014 | 5 | 0.31 | 0.01 | 0.925 | 0 |
| | SDU-1 | Both Years | 20 | 0.13 | 0.01 | 0.677 | 0 |

| Waterbody | Station Code | Year | Total Samples | Nitrate+Nitrite Concentration Av. (mg/L) | Min (mg/L) | Max (mg/L) | Exceeded Nitrate-Nitrogen Standard (count) |
|---|---|---|---|---|---|---|---|
| New Gillespie Lake | | 2009 | 10 | 0.20 | 0.01 | 0.677 | 0 |
| | | 2014 | 10 | 0.05 | 0.01 | 0.117 | 0 |
| | SDU-2 | Both Years | 30 | 0.17 | 0.01 | 0.824 | 0 |
| | | 2009 | 15 | 0.26 | 0.01 | 0.824 | 0 |
| | | 2014 | 15 | 0.08 | 0.01 | 0.336 | 0 |
| | SDU-3 | Both Years | 10 | 0.21 | 0.01 | 0.781 | 0 |
| | | 2009 | 5 | 0.28 | 0.01 | 0.781 | 0 |
| | | 2014 | 5 | 0.14 | 0.01 | 0.601 | 0 |
| Loveless (Carlinville II) | WDW-1 | 2014 | 15 | 0.03 | 0.01 | 0.084 | 0 |
| | WDW-2 | 2014 | 5 | 0.03 | 0.01 | 0.052 | 0 |
| | WDW-3 | 2014 | 5 | 0.03 | 0.01 | 0.067 | 0 |

### 3.3.5 Stream Total Suspended Solids

TSS values vary greatly based on the season, climate conditions and other watershed factors; this is reflected in stream TSS data, which demonstrates a relatively large range between minimum and maximum concentrations (Table 12). High maximum values occur at downstream Macoupin Creek, Dry Fork and Spanish Needle Creeks, which are up to twice that of other sites. Minimum values are 5 mg/L or less, and likely reflect low flow conditions. Average TSS is greatest at Dry Fork Creek and the lowest at Coop Branch. The Macoupin Creek upstream site likely has lower maximum and average TSS values than its downstream counterpart due to increased stream flow.

TSS values were compared to the IEPA guideline of 166 mg/L. A range of 0%-17% of samples exceeded the guideline; exceedances occurred in April, May, June, July, and December. However, TSS was not collected routinely at all sites, further limiting any trend analysis. Installation of watershed BMPs targeted to reduce soil loss will help to reduce sediment concentrations.

**Table 12 – Stream Total Suspended Solids Results**

| Station Code | Waterbody | Total Samples | Average TSS (mg/L) | Minimum TSS (mg/L) | Maximum TSS (mg/L) | Exceeded IEPA Guideline | |
|---|---|---|---|---|---|---|---|
| | | | | | | Count | Percent |
| 5586647 | Macoupin Creek (upstream station) | 19 | 50 | 5 | 424 | 1 | 5% |
| 5586745 | Macoupin Creek (downstream station) | 34 | 85 | 2 | 1,030 | 5 | 15% |
| DAH-01 | Dry Fork Creek | 23 | 146 | 4 | 1,820 | 4 | 17% |
| DAI-01 | Hurricane Creek | 12 | 18 | 4 | 64 | 0 | 0% |
| DAZI-01 | Coop Branch | 4 | 11 | 4 | 29 | 0 | 0% |
| DAZL-SM-C2 | Spanish Needle Creek | 20 | 92 | 4 | 1,180 | 3 | 15% |
| DAZM-01 | Honey Creek | 26 | 62 | 4 | 645 | 3 | 12% |

### 3.3.6 Lake Total Suspended Solids

As VSS and NVSS data is unavailable, TSS is compared to the 15 mg/L NVSS standard as a proxy. Table 13 lists information about sample concentrations and exceedances. Lake Carlinville has the highest average TSS of all lakes (26 mg/L), followed by Old and New Gillespie Lakes (18 mg/L and 17 mg/L, respectively). Lake Carlinville also has the highest maximum TSS reading (172 mg/L), which may be in part due to its size and fetch. The smallest lakes, Beaver and Loveless, have lower average (13 mg/L and 8 mg/L, respectively) and maximum (16 mg/L and 17 mg/L, respectively) concentrations. By lake, Loveless exceeded AQI standards twice (10% of total samples), and Old Gillespie Lake exceeded it 17 times (49% of total samples). All other lakes exceeded the limit 53% to 73% of the time.

**Table 13 – Lake Total Suspended Solids Results**

| Waterbody | Station Code | Year | Total Samples | Average TSS (mg/L) | Minimum TSS (mg/L) | Maximum TSS (mg/L) | Samples Exceeding AQI Standard | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Count | Percent |
| Lake Carlinville | RDG-1 | Both Years | 31 | 18 | 9 | 56 | 20 | 65% |
| | | 2009 | 16 | 19 | 9 | 56 | 11 | 69% |
| | | 2014 | 15 | 17 | 10 | 27 | 9 | 60% |
| | RDG-2 | Both Years | 11 | 22 | 11 | 44 | 8 | 73% |
| | | 2009 | 6 | 19 | 11 | 31 | 4 | 67% |
| | | 2014 | 5 | 26 | 13 | 44 | 4 | 80% |
| | RDG-3 | Both Years | 10 | 53 | 22 | 172 | 10 | 100% |
| | | 2009 | 5 | 36 | 22 | 65 | 5 | 100% |
| | | 2014 | 5 | 70 | 22 | 172 | 5 | 100% |
| Beaver Dam Lake | RDH-1 | 2014 | 3 | 13 | 8 | 16 | 2 | 67% |
| Old Gillespie Lake | SDT-1 | Both Years | 20 | 20 | 7 | 48 | 11 | 55% |
| | | 2009 | 10 | 19 | 7 | 46 | 4 | 40% |
| | | 2014 | 10 | 21 | 12 | 48 | 7 | 70% |
| | SDT-2 | Both Years | 15 | 16 | 9 | 32 | 6 | 40% |
| | | 2009 | 10 | 16 | 9 | 32 | 3 | 30% |
| | | 2014 | 5 | 17 | 10 | 24 | 3 | 60% |
| New Gillespie Lake | SDU-1 | Both Years | 20 | 16 | 5 | 42 | 10 | 50% |
| | | 2009 | 10 | 16 | 8 | 24 | 6 | 60% |
| | | 2014 | 10 | 16 | 5 | 42 | 4 | 40% |
| | SDU-2 | Both Years | 30 | 17 | 9 | 46 | 13 | 43% |
| | | 2009 | 15 | 16 | 11 | 26 | 8 | 53% |
| | | 2014 | 15 | 17 | 9 | 46 | 5 | 33% |
| | SDU-3 | Both Years | 10 | 19 | 13 | 25 | 9 | 90% |
| | | 2009 | 5 | 18 | 13 | 20 | 4 | 80% |
| | | 2014 | 5 | 19 | 16 | 25 | 5 | 100% |
| Loveless (Carlinville II) | WDW-1 | 2014 | 12 | 8 | 4 | 17 | 2 | 17% |
| | WDW-2 | 2014 | 4 | 6 | 5 | 7 | 0 | 0% |
| | WDW-3 | 2014 | 4 | 7 | 5 | 10 | 0 | 0% |

## 3.4 Watershed Jurisdictions and Demographics

The UMC watershed is located primarily within Macoupin County with only 273 acres (0.2%) within Jersey County; it encompasses 15 townships (Table 14, Figure 6). The City of Carlinville, the Town of Shipman and the Village of Royal Lakes are the only incorporated municipalities within the watershed; no other incorporated or unincorporated areas exist (Figure 6). The City of Carlinville occupies three subwatersheds: 1,609 acres of Spanish Needle Creek, 340 acres of Hurricane Creek, and 59 acres of Honey Creek. The Town of Shipman and the Village of Royal Lakes occupy 850 acres and 328 acres of Coop Branch subwatershed, respectively.

### 3.4.1 Watershed Jurisdictions and Jurisdictional Responsibilities

Figure 6 depicts all jurisdictional entities and jurisdictional areas. New Gillespie Lake is the water supply for Gillespie City; the city is the primary entity responsible for the management and improvement of the lake. Lake Carlinville and Loveless Lake are the water supplies for the City of Carlinville. The City is responsible for the management of these lakes and is currently transitioning to groundwater as their primary water supply.

The watershed spans 15 townships; Table 14 lists townships by subwatershed.

**Table 14 – Townships by Subwatershed**

| Subwatershed | HUC12 Code | Township Name | Area (ac) |
|---|---|---|---|
| Bullard Lake | 071300120402 | Chesterfield | 5,055 |
| | | Bird | 81 |
| | | Polk | 10,383 |
| Coop Branch | 071300120401 | Fidelity | 268 |
| | | Chesterfield | 3,082 |
| | | Bunker Hill | 486 |
| | | Brighton | 41 |
| | | Hillyard | 14,695 |
| | | Polk | 442 |
| | | Shipman | 16,000 |
| Dry Fork | 071300120108 | Gillespie | 14,075 |
| | | Dorchester | 128 |
| | | Bunker Hill | 39 |
| | | Brushy Mound | 1,634 |
| | | Hillyard | 1,795 |
| | | Polk | 1,772 |
| Honey Creek | 071300120106 | Cahokia | 8.2 |
| | | Brushy Mound | 6,369 |
| | | Honey Point | 9,301 |
| Hurricane Creek | 071300120107 | South Otter | 3,838 |
| | | Bird | 3,198 |
| | | Brushy Mound | 586 |
| | | Carlinville | 7,326 |

| Subwatershed | HUC12 Code | Township Name | Area (ac) |
|---|---|---|---|
| | | Polk | 4,366 |
| Spanish Needle Creek | 071300120109 | Cahokia | 1,140 |
| | | Gillespie | 1,631 |
| | | Brushy Mound | 12,799 |
| | | Carlinville | 5,307 |
| | | Hillyard | 6,403 |
| | | Honey Point | 559 |
| | | Polk | 4,874 |

The U.S. Fish and Wildlife Service (USFWS) owns one property within the watershed, the Malham FSA (Farm Service Agency) unit of the Two Rivers FSA (Figure 6). There are no other federally owned or administered lands such as the U.S. Forest Service (USFS) within the basin. The IDNR manages several natural sites such as state parks, nature preserves (Illinois Nature Preserves Commission, or INPC), and natural inventory sites (Illinois Natural Area Inventory, or INAI). These areas are listed below and depicted in Figure 6.

- Beaver Dam State Park
- Roderick Prairie Nature Preserve
- Bullard Lake Club Natural Heritage Landmark Nature Preserve
- Denby Prairie Nature Preserve
- INAI: Bullard Lake Club
- INAI: Carlinville Railroad Prairie
- INAI: Reiher Barrens
- INAI: Denby Prairie
- INAI: Roderick Barrens
- INAI: Macoupin003
- INAI: Macoupin105
- INAI: Beaver Dam Gravel Hill Prairie

The IEPA Bureau of Water regulates wastewater and stormwater discharges to streams, rivers, and lakes through the National Pollutant Discharge Elimination System (NPDES). Seven NPDES permits exist within 4 of the 6 subwatersheds and are discussed further in Section 3.15.1.

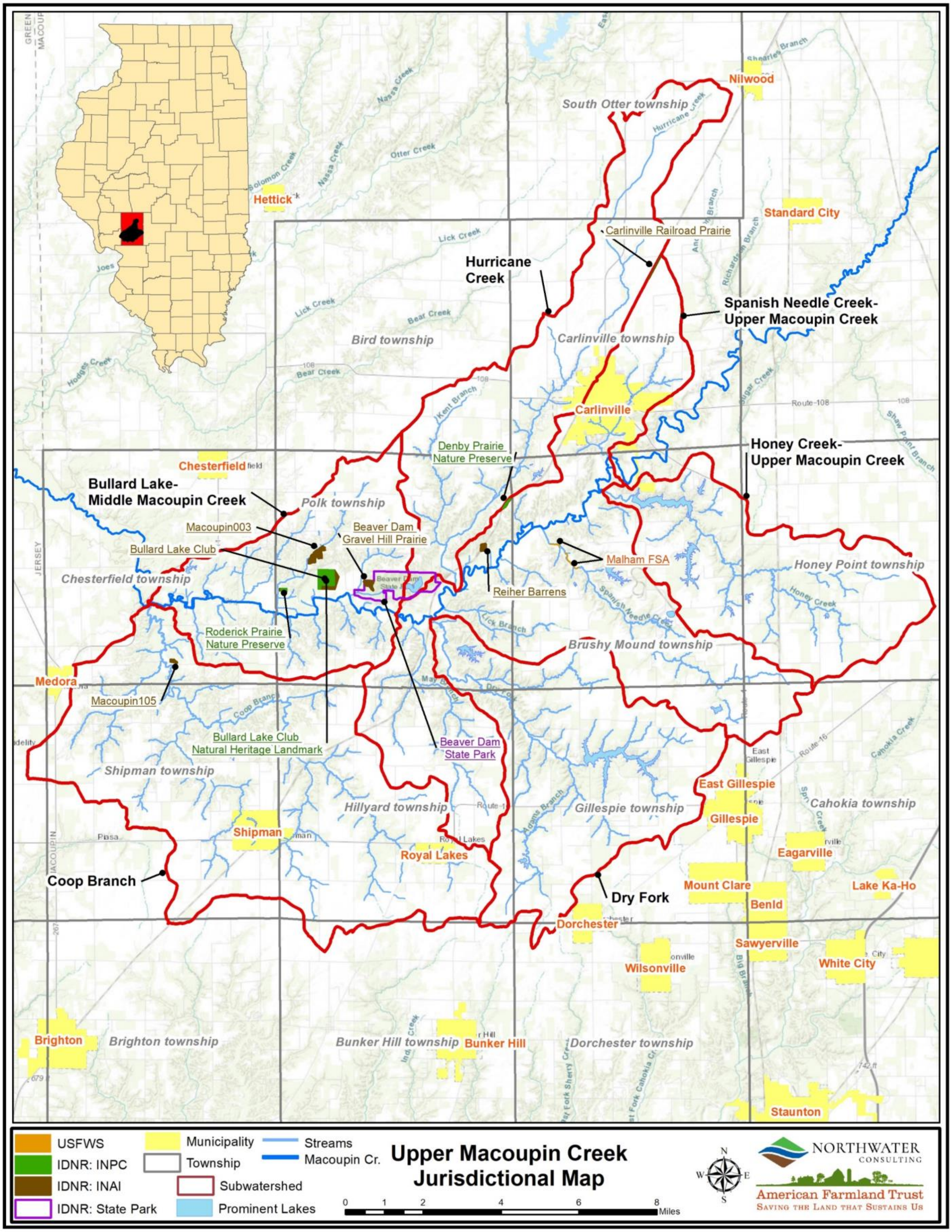



**Figure 6 – Jurisdictional Boundaries**

### 3.4.2 Demographics

According to 2018 estimates from the United States Census, the City of Carlinville has a population of 5,543, a 6.3% decrease from 2010. The Village of Royal Lakes also decreased in population from 2010 to 2018; from 197 to 185 (-6.1%). The Town of Shipman decreased by 4.8%, from 624 in 2010 to 594 in 2018. Analysis of 2017 aerial imagery indicates that 1,394 rural homes exist outside the incorporated municipalities (Figure 7). These homes are scattered throughout the watershed, with the greatest densities around recreational waterbodies.

Based on 2017 data from the United States Census Bureau, the total population in the watershed is estimated to be 10,388. Median household income is estimated to be $60,674; approximately 17.5% of the population is over the age of 65. Table 15 shows census statistics for each subwatershed.

**Table 15 – Household Income and Percent of Population Over 65 Years of Age**

| Subwatershed | HUC12 Code | Mean Income (USD) | Median Income (USD) | Population Over 65 (%) |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | $81,146 | $65,958 | 16.5% |
| Coop Branch | 071300120401 | $74,910 | $61,296 | 17.4% |
| Dry Fork | 071300120108 | $65,113 | $49,741 | 19.9% |
| Honey Creek | 071300120106 | $78,707 | $64,139 | 16.8% |
| Hurricane Creek | 071300120107 | $78,492 | $63,594 | 16.9% |
| Spanish Needle Creek | 071300120109 | $75,307 | $60,614 | 17.3% |
| **Grand Total** | | **$75,259 av.** | **$60,674 av.** | **17.5% av.** |

**Watershed Tributary Stream**

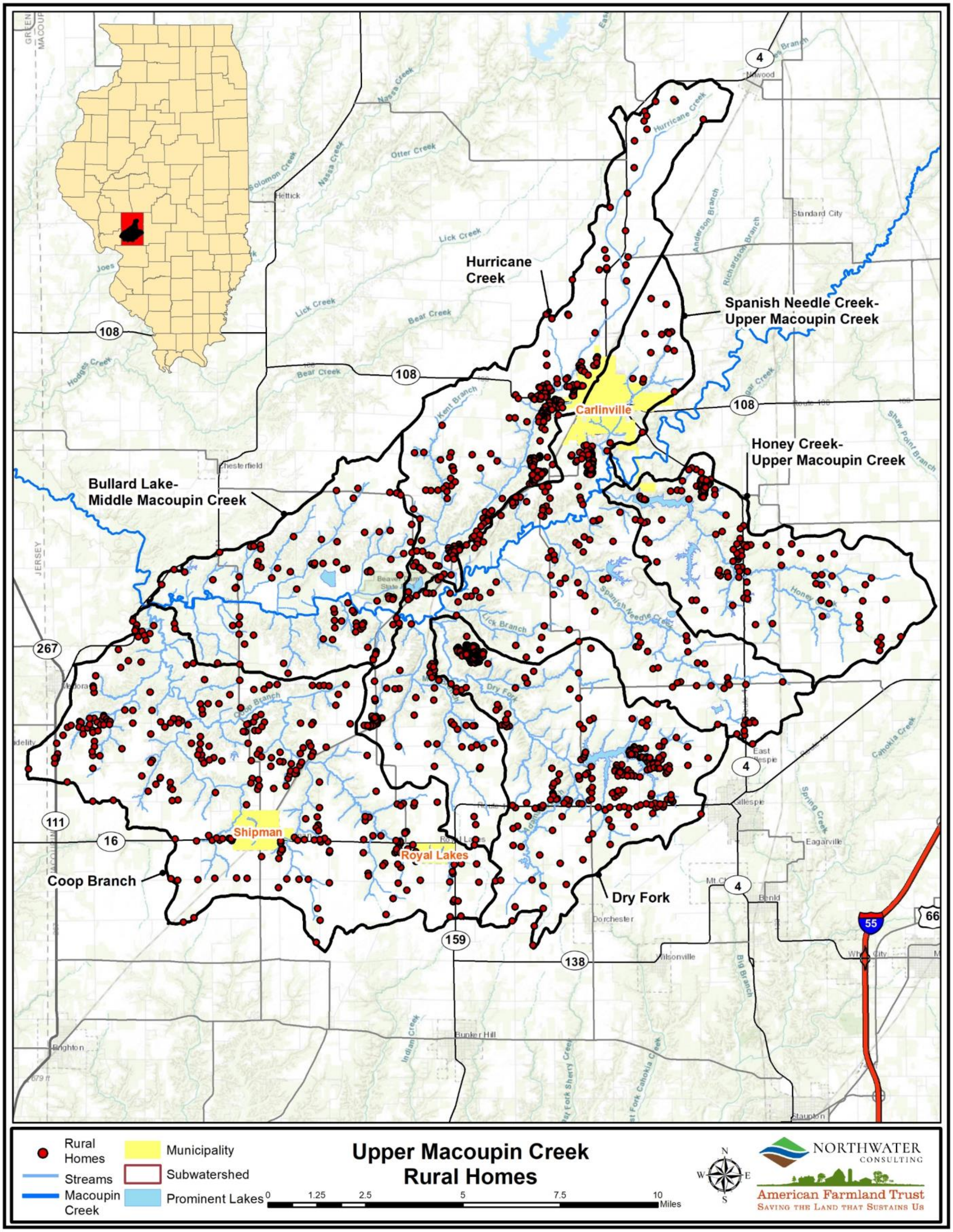



Figure 7 – Rural Homes

## 3.5 Geology, Hydrogeology, Topography

This section includes information on surficial geology and hydrogeology, in addition to wells, surface elevation, and slope.

### 3.5.1 Geology

The watershed is in the central portion of the Springfield Till Plain region of Illinois. The surficial materials and hydrology of the watershed have been shaped by glacial processes of deposition and erosion. The primary cover is loess, a fine-grained windblown glacial deposit which is highly erodible on steeper slopes. Beneath this veneer of loess is typically a sandy or loamy glacial till with variable thickness and composition. The spatial extents and statistics of each surficial deposit type are illustrated in Figure 8 and Table 16.

Surficial geology was adapted from Illinois State Geologic Survey (ISGS) 1995 Stack-Unit mapping of the top 15 meters of earth materials. Drift thickness varies from less than 25 feet to over 100 feet. Two buried bedrock valleys traverse the watershed from east to west, resulting in thicker drift deposits along the central and northern portion of the watershed. The unconsolidated deposits are primarily underlain by the Pennsylvanian-aged Patoka shale formation with small eastern zones underlain by Pennsylvanian-aged Bond formation limestones and shales. Bedrock is typically mapped within 25 feet of the ground surface in across the watershed with the notable exceptions of the buried bedrock valleys. The widespread veneer of highly erodible and fine-grained glacial loess is a potential source of sediment via erosion.

**Table 16 – Surficial Geology**

| Surficial Geology | Description[1] | Area (acres) | Percent of Watershed |
|---|---|---|---|
| **Alluvium** | Thin alluvium underlain by thin loamy and sandy Glasford till. Pennsylvanian shale present within 6 m of the surface. | 2,650 | 2% |
| | Thin alluvium underlain by thin loamy and sandy Glasford till. Pennsylvanian shale present within 15 m of the surface. | 10,300 | 7% |
| | Thin alluvium with Pennsylvanian shale of within 6 m of the surface. | 879 | 1% |
| **Loess** | Shallow loess underlain by clayey, gravely and sandy sequences of Glasford till. Bedrock at depths greater than 15 m from surface. | 18,398 | 13% |
| | Shallow loess underlain by thick loamy and sandy Glasford till. Bedrock at depths greater than 15 m from surface. | 7,202 | 5% |
| | Shallow loess underlain by thick loamy and sandy Glasford till. Pennsylvanian shale at depths between 6 and 15 m from surface. | 82,277 | 60% |
| | Shallow loess underlain by thick loamy and sandy Glasford till with discontinuous layers of sand and gravel. Bedrock at depths greater than 15 m from surface. | 1,477 | 1% |
| | Shallow loess underlain by thin loamy and sandy Glasford till. Pennsylvanian shale at depths less than 6 m from surface. | 3,512 | 3% |
| **Till** | Loamy and sandy Glasford till deposits underlain by Pennsylvanian shale at depths greater than 15 m from surface | 6,263 | 5% |
| | Loamy and sandy Glasford till deposits underlain by Pennsylvanian shale at depths between 6 and 15 m from surface | 4,723 | 3% |

[1] Adapted from Illinois State Geological Survey *Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters*

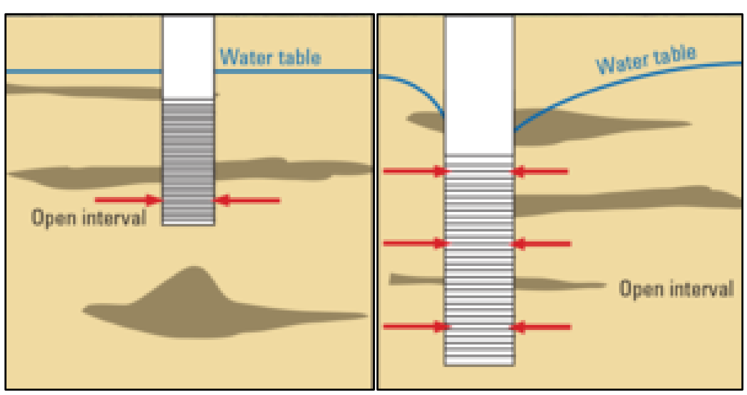
### 3.5.2 Hydrogeology

There are estimated to be at least 322 private water wells within the watershed based on ISGS Wells and Borings database. There are no Community Water Supply (CWS) and only two Non-Community Water Supply (NCWS) wells found in the state database. Based on the available dataset of private wells, the average depth is 50 feet with a minimum of 15 feet and a maximum of 600 feet. An inferred average depth to water bearing units of 22 feet was calculated based on the 246 wells which denoted depth to top of screened interval. Table 17 provides depth and completion information for available water wells grouped by subwatershed.

The recorded wells are primarily completed in the unconsolidated gravels, sands and clays of the Glasford till formation; only 21 of the wells reported producing from bedrock units. ISGS mapping for major sand and gravel aquifers and major bedrock aquifers show no regional sand and gravel or bedrock aquifers present in the watershed. Limited well yield data was available; of the 7 wells with reported yield, all but one had yields less than 30 gpm.

**Table 17 – Well Counts and Descriptions**

| Subwatershed | HUC12 Code | Total Depth (ft) | | | Top of Water Bearing Unit (fbgs) | | | Water Bearing Interval Thickness (ft) | | | Average Drift Thickness (ft) | Primary Aquifer Material |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Av. | Min | Max | Av. | Min | Max | Av. | Min | Max | | |
| Bullard Lake | 071300120402 | 41 | 17 | 150 | 20 | 10 | 105 | 9 | 1 | 45 | 26 | Gravel |
| Coop Branch | 071300120401 | 46 | 15 | 305 | 26 | 8 | 305 | 7 | 1 | 33 | 22 | Gravel, clay, sand |
| Dry Fork | 071300120108 | 46 | 23 | 200 | 16 | 10 | 25 | 8 | 2 | 19 | 30 | Gravel, clay |
| Honey Creek | 071300120106 | 46 | 25 | 117 | 20 | 10 | 55 | 7 | 1 | 25 | 113 | Gravel, sand |
| Hurricane Creek | 071300120107 | 53 | 26 | 200 | 18 | 3 | 41 | 9 | 1 | 36 | 66 | Gravel, sand |
| Spanish Needle Creek | 071300120109 | 57 | 20 | 600 | 22 | 9 | 225 | 10 | 1 | 66 | 31 | Gravel, clay, sand |
| **Grand Total** | **n/a** | **50** | **15** | **600** | **22** | **3** | **305** | **8** | **1** | **66** | **41** | **n/a** |




**Diagrams of a Domestic Well (left) and Public-Supply Well (right)**
*Credit: USGS 2014*

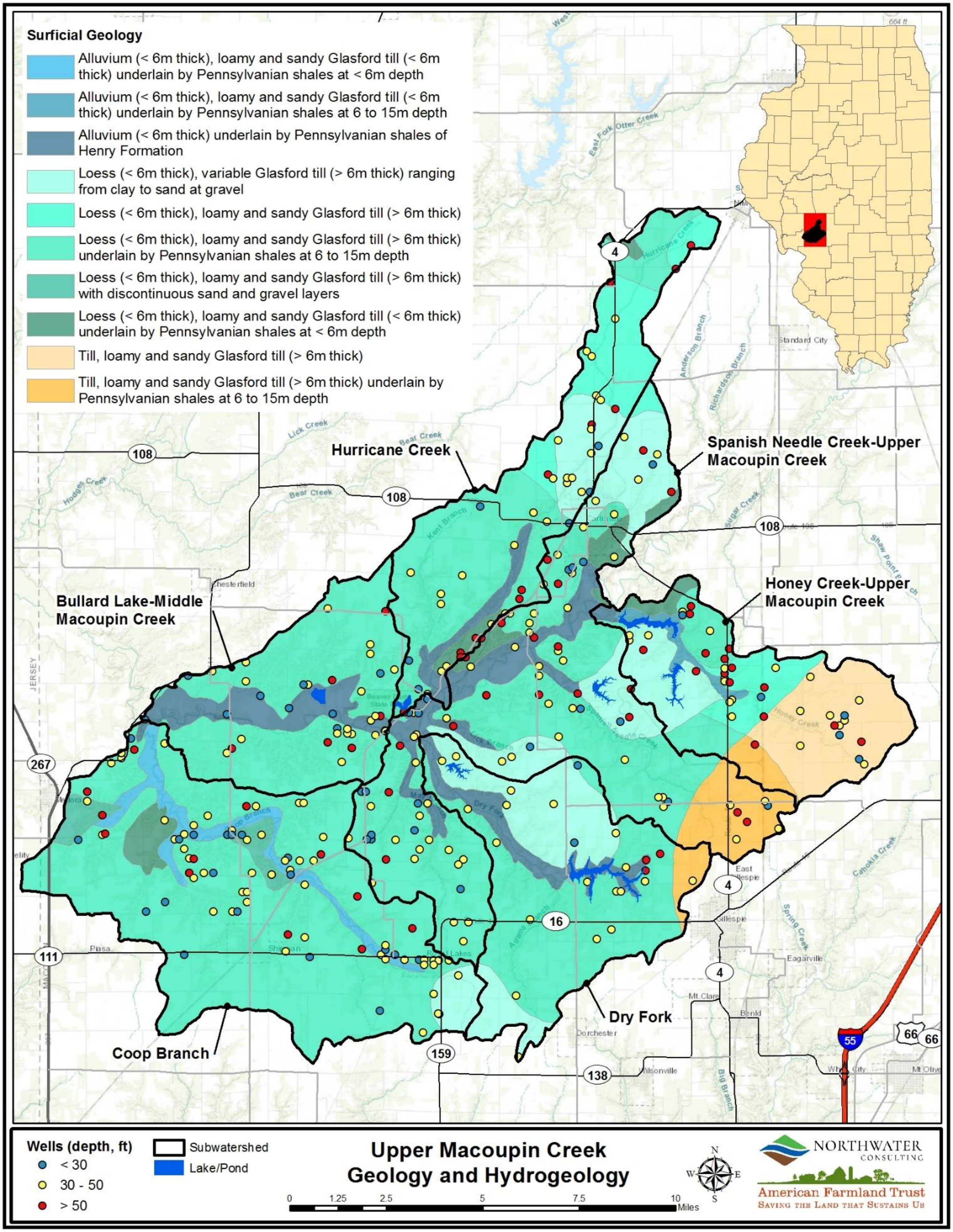



Figure 8 – Geology and Wells

### 3.5.3 Topography

Elevation statistics by subwatershed are found in Table 18, and watershed elevation is shown in Figure 9. Elevation ranges from about 487 to 756 feet above sea level (fasl). Most of the watershed is at 640 fasl or lower, with an average elevation of about 619 fasl. The lowest elevations can be found along Macoupin Creek and its tributaries. Bullard Lake subwatershed has the lowest average elevation (577.4 fasl), while Honey Creek has the highest (641.9 fasl).

Slope statistics by subwatershed are found in Table 19 and watershed slopes are shown in Figure 10. Most of the watershed slopes are 6%; the average is 2.2% (1.23°) and the maximum slope is 514% (79°). Headwaters and upland areas are flatter, transitioning to steeper slopes adjacent to stream corridors and major waterbodies.

**Table 18 – Elevation by Subwatershed in Feet Above Sea Level**

| Subwatershed | HUC12 Code | Average Elevation (fasl) | Minimum Elevation (fasl) | Maximum Elevation (fasl) |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | 577.4 | 487.4 | 627.0 |
| Coop Branch | 071300120401 | 615.0 | 487.4 | 678.4 |
| Dry Fork | 071300120108 | 637.2 | 514.0 | 679.8 |
| Honey Creek | 071300120106 | 641.9 | 530.3 | 698.6 |
| Hurricane Creek | 071300120107 | 623.9 | 517.7 | 669.3 |
| Spanish Needle Creek | 071300120109 | 616.2 | 509.4 | 756.3 |
| **UMC Average** | | **618.5** | **487.4** | **756.3** |

**Table 19 – Slope by Subwatershed in Percent**

| Subwatershed | HUC12 Code | Average Slope (%) | Maximum Slope (%) |
|---|---|---|---|
| Bullard Lake | 071300120402 | 9.0 | 321 |
| Coop Branch | 071300120401 | 6.5 | 290 |
| Dry Fork | 071300120108 | 7.5 | 387 |
| Honey Creek | 071300120106 | 5.8 | 400 |
| Hurricane Creek | 071300120107 | 4.6 | 369 |
| Spanish Needle Creek | 071300120109 | 7.3 | 514 |
| **UMC Average** | | **2.2** | **514** |

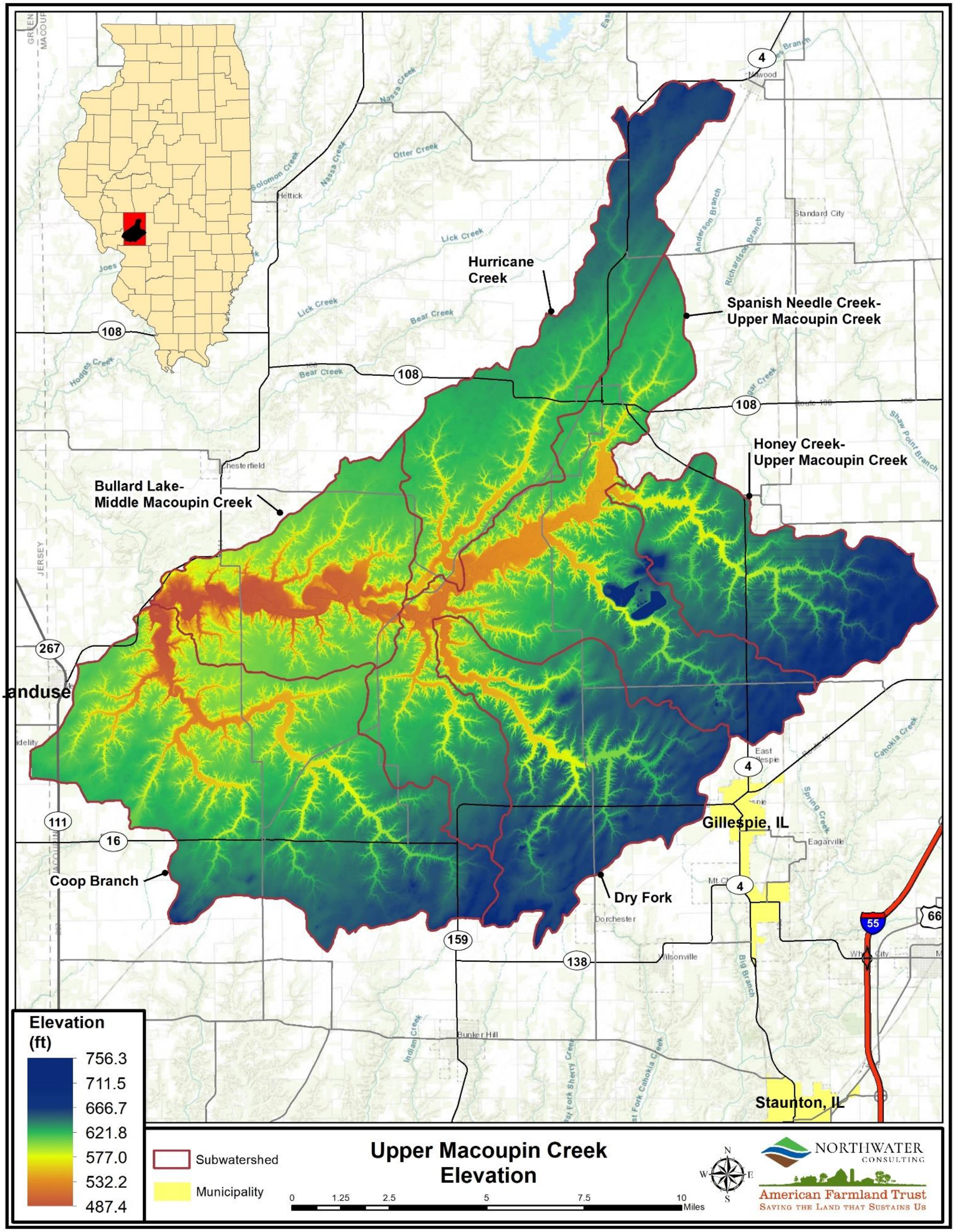



Figure 9 – Surface Elevation in Feet

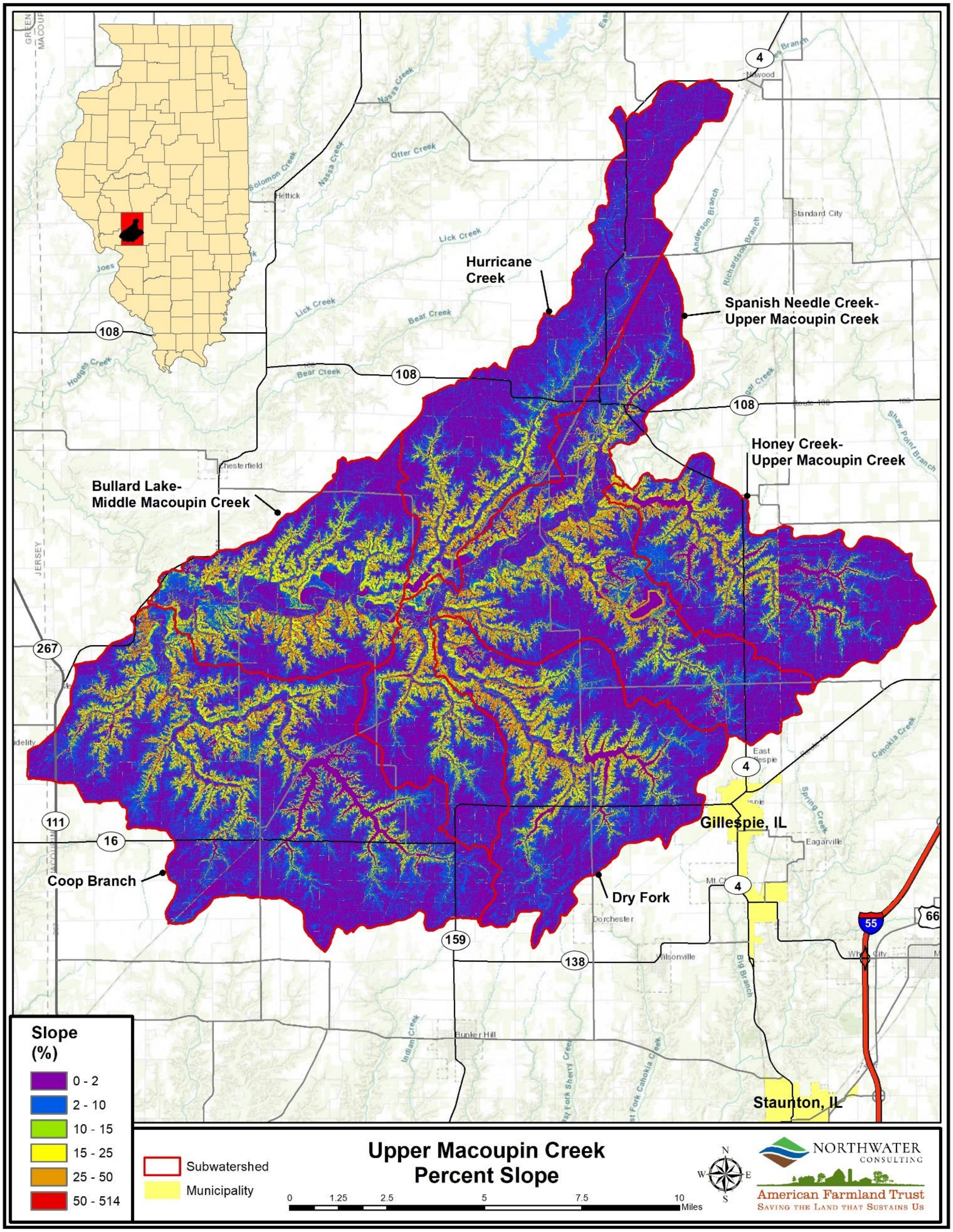



Figure 10 – Surface Slope in Percent

## 3.6 Climate

Climate data was obtained for 15 years (January 2004–December 2018) from the PRISM Climate Group, part of the Northwest Alliance for Computational Science and Engineering based at Oregon State University and supported by the USDA Risk Management Agency. Average monthly temperature and precipitation statistics are listed in Table 20.

Annually, the average temperature is 52.4° F, the minimum temperature is 44.3° F, and the maximum temperature is 64.1° F. The highest and lowest temperatures occur in July and January respectively. The highest average monthly value is 86.2° F (July) and the lowest is 20.3° F (January). Average monthly temperatures above 70° F occur June–August, while monthly maximum temperatures above 80° F occur June through September.

Average monthly precipitation is 3.5 inches and the average annual precipitation is 45.2 inches. The wettest part of the year is April–June with an average precipitation of nearly 5 inches; precipitation then drops in August–October to an average of roughly 3.5 inches. January and February are typically the driest months with 2.2 and 2.3 inches, respectively.

**Table 20 – Monthly Climate, 2004–2018**

| Month | Average Temp. (°F) | Minimum Temp. (°F) | Maximum Temp. (°F) | Average Precipitation (in) |
|---|---|---|---|---|
| Jan | 28.6 | 20.3 | 36.9 | 2.2 |
| Feb | 31.1 | 22.1 | 40.2 | 2.3 |
| Mar | 43.6 | 33.8 | 53.4 | 3.2 |
| Apr | 54.5 | 43.6 | 65.5 | 4.7 |
| May | 65.2 | 55.0 | 75.4 | 4.9 |
| Jun | 74.1 | 64.1 | 84.0 | 4.7 |
| Jul | 76.2 | 66.3 | 86.2 | 4.0 |
| Aug | 74.8 | 64.3 | 85.3 | 3.5 |
| Sep | 68.6 | 56.8 | 80.4 | 3.5 |
| Oct | 56.3 | 45.1 | 67.4 | 3.4 |
| Nov | 43.9 | 34.3 | 53.6 | 3.2 |
| Dec | 33.1 | 25.5 | 40.7 | 3.0 |
| **UMC Average** | **54.2** | **44.3** | **64.1** | **3.5 (42.5 total)** |

## 3.7 Landuse

In order to characterize watershed landuse and NPS pollution, a custom geographic information system (GIS) landuse layer was developed from 2017 aerial imagery and verified through field surveys. Table 21 lists the results of landuse classification and Figure 11 shows its distribution.

The predominant landuse in the watershed is row crop agriculture which makes up about 58.6% (80,679 acres) of the total watershed area. Crops are primarily a corn-soy bean rotation with a very small number of fields in wheat. Forest covers about 23.2% and grassland 7.3% of the total area. Row crops comprise approximately 47%-69% of each subwatershed, while forests cover 15%–32% and grasslands 5%–11%; other landuses cover less than 1% of each subwatershed.

### Table 21 – Landuse Categories and Total Area

| Landuse Category | Area (ac) | Percent Total Area | Landuse Category | Area (ac) | Percent Total Area |
|---|---|---|---|---|---|
| Camp Site | 8.9 | 0.01% | Open Water Pond/Reservoir | 1,978 | 1.4% |
| Cemetery | 21 | 0.02% | Orchards and Nurseries | 93 | 0.07% |
| Commercial | 203 | 0.15% | Parks and Recreation | 198 | 0.14% |
| Confinement | 18 | 0.01% | Pasture | 3,828 | 2.8% |
| Farm Building | 573 | 0.42% | Railroad | 182 | 0.13% |
| Feed Area | 71 | 0.05% | Resource Extraction | 388 | 0.28% |
| Forest | 31,944 | 23.2% | Roads | 1,189 | 0.86% |
| Golf Course | 34 | 0.03% | Row Crops | 80,679 | 58.6% |
| Grasslands | 10,096 | 7.3% | Rural Residential | 492 | 0.36% |
| Industrial | 56 | 0.04% | Urban Open Space | 3,471 | 2.52% |
| Institutional | 144 | 0.10% | Urban Residential | 518 | 0.38% |
| Junk Yard | 18 | 0.01% | Utilities | 30 | 0.02% |
| Manufacturing | 87 | 0.06% | Warehousing | 60 | 0.04% |
| Manure Storage | 1.5 | 0.00% | Wetlands | 250 | 0.18% |
| Marina | 2.3 | 0.002% | Winery | 4.5 | 0.003% |
| Open Water - Stream | 1,041 | 0.76% | – | – | – |

**Pasture**

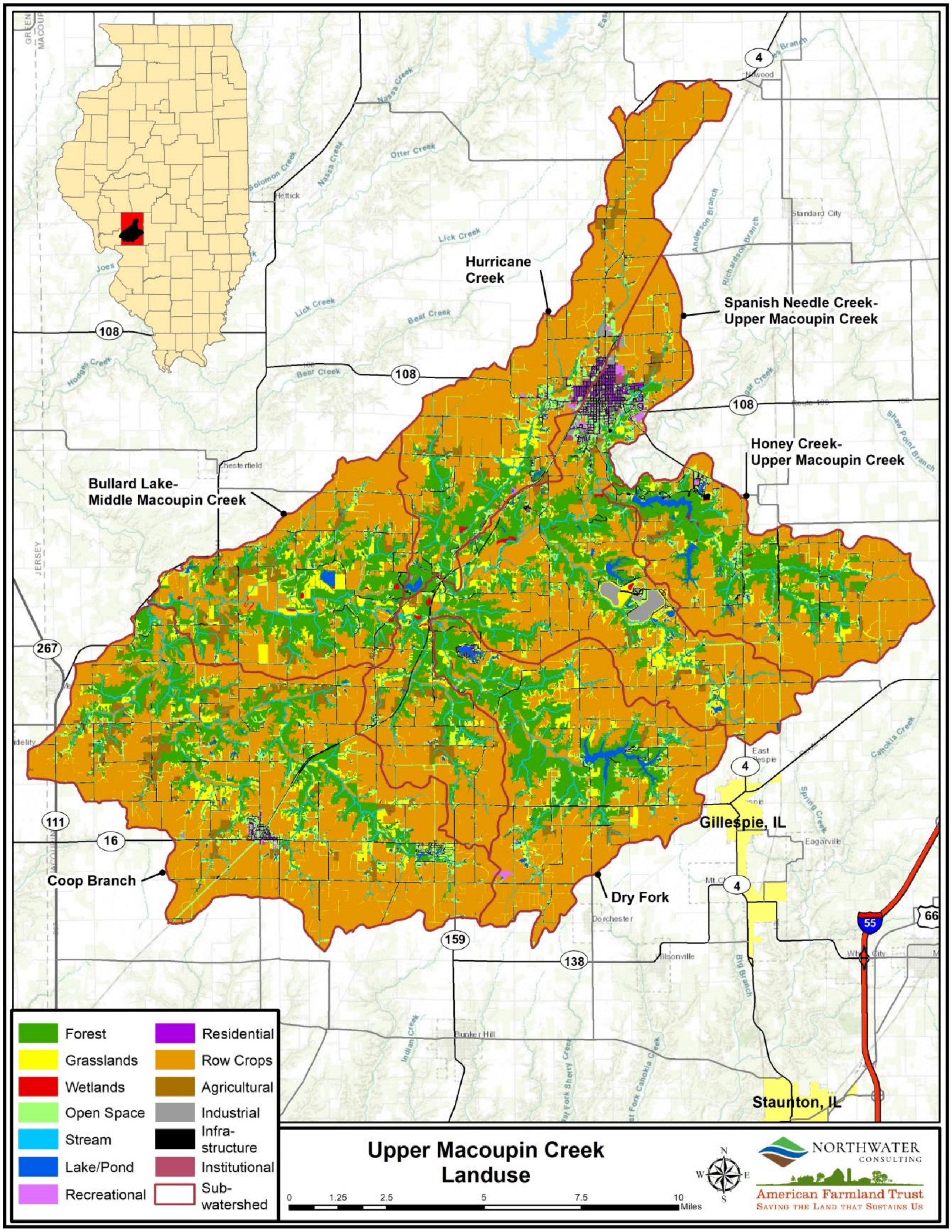



**Figure 11 – Landuse**

## 3.8 Soils

Based on soils data from the NRCS National Cooperative Soil Survey, 51 soil types exist in the watershed (Table 22, Figure 12); other categories include water, landfills and mines. Herrick silt loam is the dominant soil, accounting for 16% of the entire watershed, or 21,430 acres. Virdin silty clay loam and Herrick-Biddle-Piasa silt loams are also prevalent and account for 10% (13,907 acres) and 9% (12,815 acres), respectively. Eighteen other soil types each account for 1% to 7% of the total watershed area, while the remaining thirty individual soil types together only account for less than 9.8%.

The NRCS gives official soil series descriptions (NRCS 2018b). Herrick silt loams consisting of very deep, somewhat poorly drained, moderately slowly permeable soils. They are formed in loess on ground moraines, with slopes ranging from 0 to 5 percent. The Virden series consists of very deep, poorly drained, moderately slowly permeable soils formed in loess on nearly level summits on till plains and have slope ranging from 0 to 2 percent. Biddle soils are on level or nearly level parts of broad interfluves on till plains. These soils formed in loess, or in loess and the underlying silty pedisediment, with slopes ranging from 0 to 2 percent. A typical Biddle pedon occurs in a Herrick-Biddle-Piasa complex in a cultivated field at an elevation of about 145 meters above sea level.

**Table 22 – Soil Types and Total Area**

| Soil Type | Acres | Percent of Watershed |
|---|---|---|
| Herrick silt loam, 0 to 2 percent slopes | 21,430 | 15.6% |
| Virden silty clay loam, 0 to 2 percent slopes | 13,907 | 10.1% |
| Herrick-Biddle-Piasa silt loams, 0 to 2 percent slopes | 12,815 | 9.3% |
| Hickory silt loam, 18 to 35 percent slopes | 9,294 | 6.8% |
| Homen silt loam, 2 to 5 percent slopes | 8,678 | 6.3% |
| Marine silt loam, 0 to 2 percent slopes | 8,060 | 5.9% |
| Hickory silt loam, 18 to 35 percent slopes, eroded | 7,390 | 5.4% |
| Hickory silt loam, 10 to 18 percent slopes, eroded | 5,068 | 3.7% |
| Keomah silt loam, 0 to 2 percent slopes | 4,969 | 3.6% |
| Coffeen silt loam, 0 to 2 percent slopes, frequently flooded | 4,649 | 3.4% |
| Hickory silt loam, 35 to 60 percent slopes | 3,507 | 2.5% |
| Rozetta silt loam, 2 to 5 percent slopes | 3,474 | 2.5% |
| Wakeland silt loam, 0 to 2 percent slopes, frequently flooded | 3,300 | 2.4% |
| Lawson silt loam, cool mesic, 0 to 2 percent slopes, frequently flooded | 2,703 | 2.0% |
| Oconee silt loam, 0 to 2 percent slopes | 2,315 | 1.7% |
| Bunkum-Atlas silt loams, 5 to 10 percent slopes, eroded | 2,100 | 1.5% |
| Rozetta silt loam, 0 to 2 percent slopes | 1,932 | 1.4% |
| Virden-Fosterburg silt loams, 0 to 2 percent slopes | 1,823 | 1.3% |
| Elco silt loam, 5 to 10 percent slopes, eroded | 1,741 | 1.3% |
| Cowden-Piasa silt loams, 0 to 2 percent slopes | 1,654 | 1.2% |
| Keller silt loam, 2 to 5 percent slopes | 1,540 | 1.1% |
| 30 Other Soil Types (each less than 1,000 ac and less than 1% watershed area) | 13,444 | 9.8% |
| Water, Mines, Landfills | 1,887 | 1.4% |

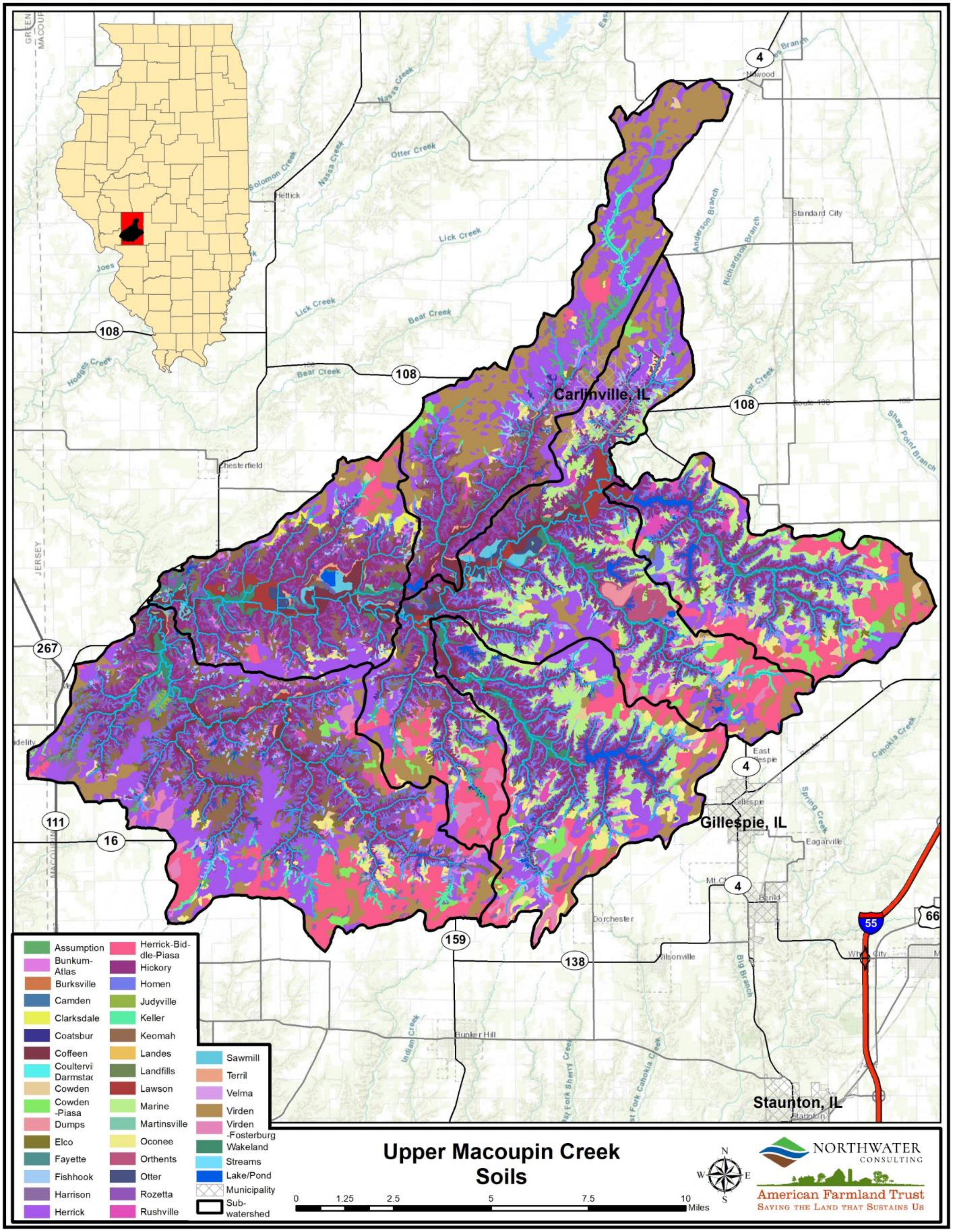



Figure 12 – Soils

### 3.8.1 Highly Erodible Soils

As defined by the NRCS, a highly erodible soil (HEL), or soil map unit, has a maximum potential for erosion that is greater than eight times the tolerable erosion rate. The maximum erosion potential is calculated without consideration to crop management or conservation practices, which can markedly lower the actual erosion rate on a given field.

The location and extent of HEL soils were identified using the USDA-NRCS SSURGO database and county frozen soils lists. About 45,727 acres of HEL or potentially HEL (PHEL) soils exist, representing 33% of the total watershed area (Table 23, Figure 13). These soils are generally located immediately adjacent to streams and in steep forested or grassed areas. Coop Branch and Honey Creek subwatersheds contain the highest percentage (37% each) whereas Hurricane Creek contains the least (16%). A small percentage of HEL soils (7.6%) are being cropped as described next in Section 3.8.2.

**Table 23 – HEL Soils**

| Subwatershed | HUC12 Code | Subwatershed Area (acres) | Acres HEL/PHEL | Percentage of Subwatershed |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | 15,519 | 5,565 | 36% |
| Coop Branch | 071300120401 | 35,013 | 12,825 | 37% |
| Dry Fork | 071300120108 | 19,443 | 7,359 | 38% |
| Honey Creek | 071300120106 | 15,678 | 5,824 | 37% |
| Hurricane Creek | 071300120107 | 19,313 | 3,169 | 16% |
| Spanish Needle Creek | 071300120109 | 32,714 | 10,985 | 34% |
| **Grand Total** | | **137,682** | **45,727** | **33%** |

### 3.8.2 Cropped Highly Erodible Soils

If a producer has a field identified as HEL and wishes to participate in a voluntary NRCS cost-share program, that producer is required to maintain a conservation system of practices that maintains erosion rates at a substantial reduction of soil loss. Fields that are determined not to be HEL are not required to maintain a conservation system to reduce erosion.

Of the 80,679 acres of cropland, 7.6%, or 10,477 acres (13% of the watershed), are considered HEL/PHEL and could be targeted for erosion control measures (Table 24). Coop Branch subwatershed has the highest portion of HEL/PHEL cropland (18%), followed by Dry Fork and Honey Creek (14% each); Hurricane Creek has the lowest portion, or 5%. Cropped HEL soils and tillage practices are further discussed in Section 5.0.

### Table 24 – Cropland HEL Soils

| Subwatershed | HUC12 Code | Subwatershed Area (acres) | Cropland Area (acres) | HEL/PHEL Cropland Area (acres) | Percentage of Subwatershed as Cropped HEL/PHEL | Percentage of Cropland as HEL/PHEL |
|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | 15,519 | 7,248 | 927 | 6.0% | 13% |
| Coop Branch | 071300120401 | 35,013 | 22,102 | 3,998 | 11% | 18% |
| Dry Fork | 071300120108 | 19,443 | 10,925 | 1,497 | 7.7% | 14% |
| Honey Creek | 071300120106 | 15,678 | 9,208 | 1,313 | 8.4% | 14% |
| Hurricane Creek | 071300120107 | 19,313 | 13,492 | 677 | 3.5% | 5% |
| Spanish Needle Creek | 071300120109 | 32,714 | 17,703 | 2,065 | 6.3% | 12% |
| **Grand Total** | | **137,682** | **80,679** | **10,477** | **7.6%** | **13%** |

**Erosion – Forested Area**

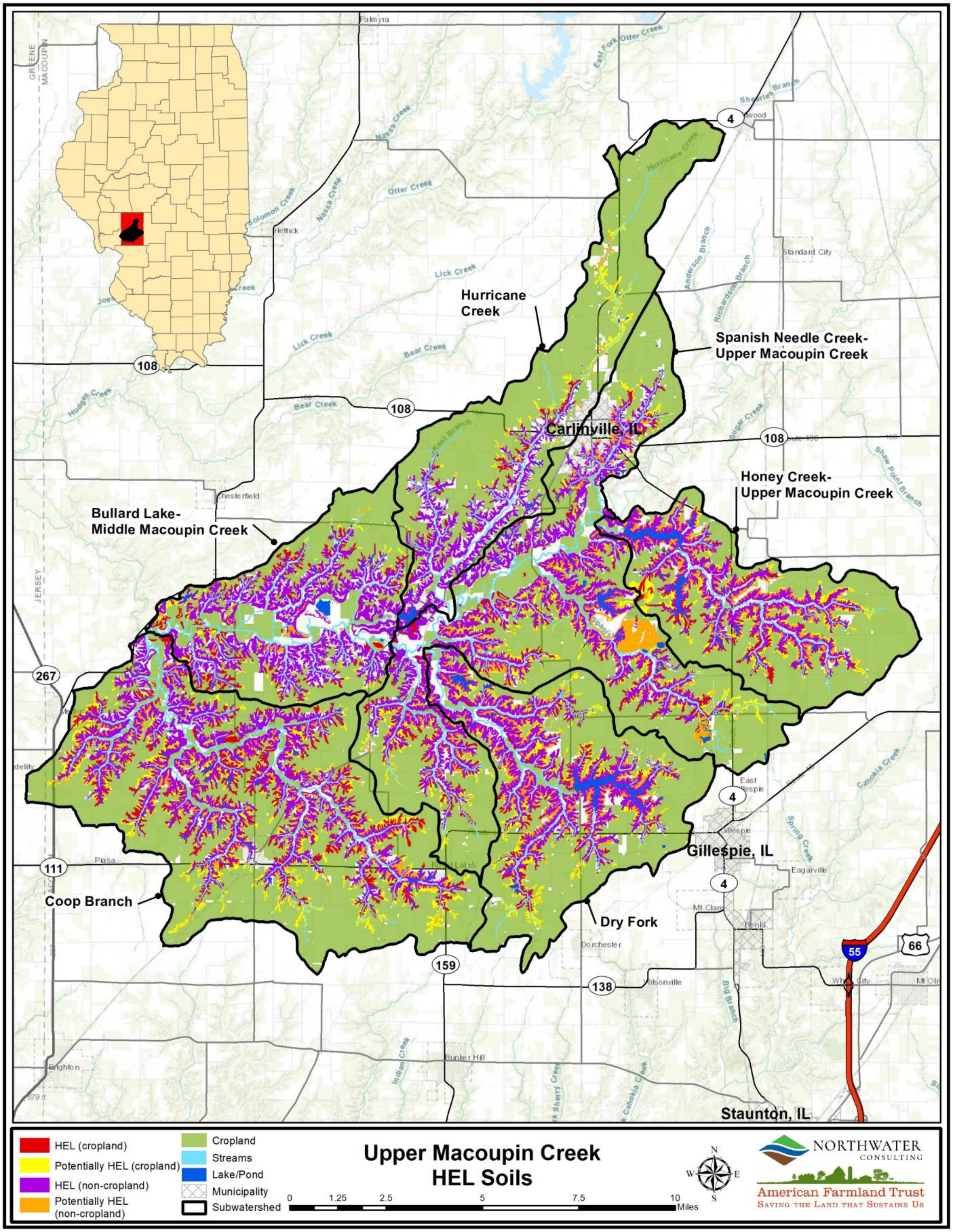



**Figure 13 – HEL Soils**

### 3.8.3 Hydric Soils

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation (NRCS 2018). Table 25 describes the total area of hydric soils by subwatershed and Figure 14 depicts their location. As an indicator of the potential for wetland development, understanding where hydric soils are located can inform wetland restoration and creation activities.

Hydric soils are scattered throughout the watershed and are an indicator of former wetlands and potential areas for wetland development. These soils are typically wet and will flood if overland or tile drainage is not present. There are six different hydric soils within the watershed totaling 20,043 acres (Table 25), located primarily in flat areas around the periphery of the watershed, adjacent to subwatershed boundaries and along Macoupin Creek (Figure 14). Virden silty clay loam is the dominant hydric soil. The Hurricane Creek subwatershed contains the highest percentage of hydric soils, or 32%, followed by Honey Creek and Hurricane Creek (14% each); Bullard Lake contains the smallest percentage of hydric soils, or 8%.

**Table 25 – Hydric Soils**

| Subwatershed | HUC12 Code | Subwatershed Area (acres) | Acres Hydric Soils | Percentage of Subwatershed |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | 15,519 | 1,249 | 8% |
| Coop Branch | 071300120401 | 35,013 | 3,246 | 9.3% |
| Dry Fork | 071300120108 | 19,443 | 2,371 | 12% |
| Honey Creek | 071300120106 | 15,678 | 2,217 | 14% |
| Hurricane Creek | 071300120107 | 19,313 | 6,270 | 32% |
| Spanish Needle Creek | 071300120109 | 32,714 | 4,691 | 14% |
| **Grand Total** | | **137,682** | **20,043** | **15%** |

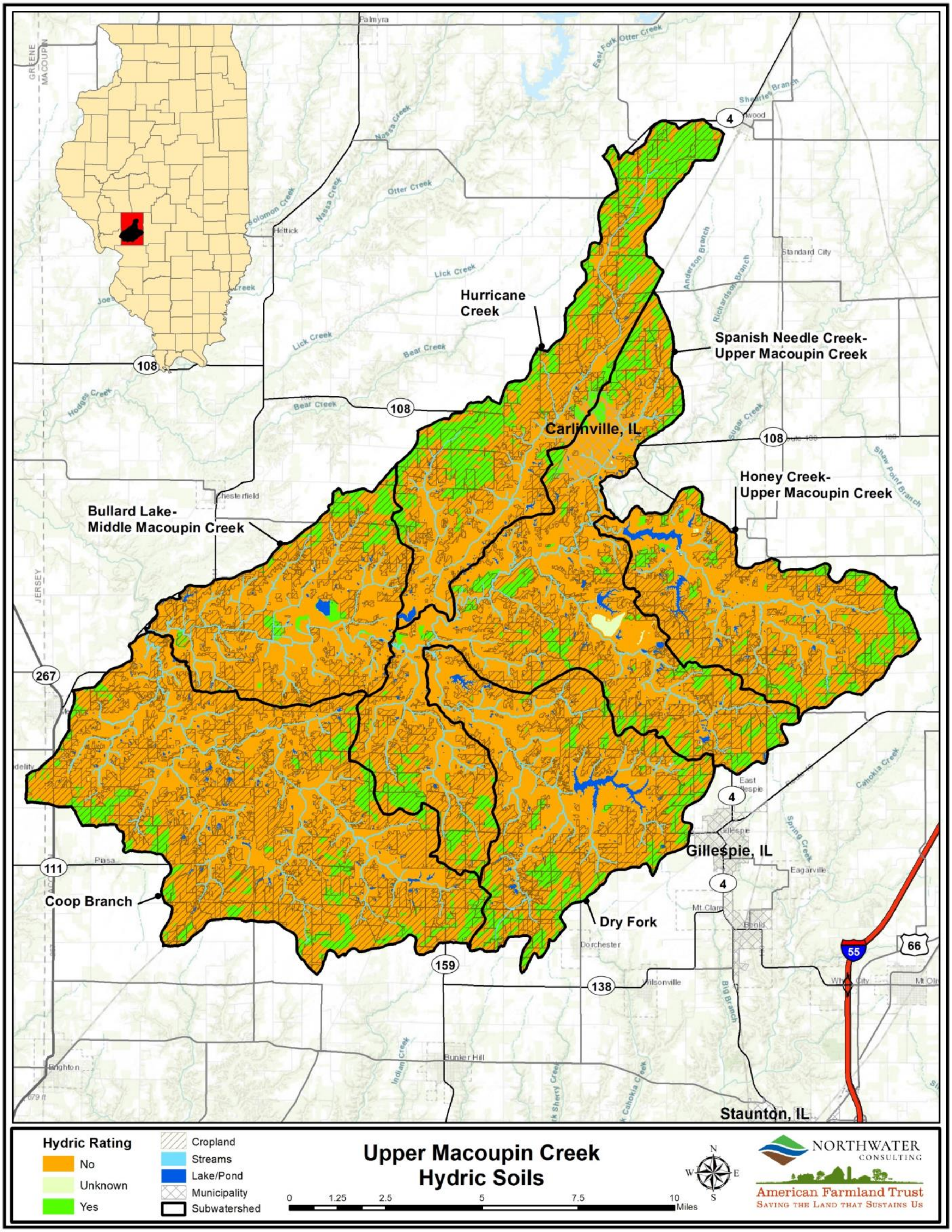



Figure 14 – Hydric Soils

### 3.8.4 Hydrologic Soil Groups

The NRCS has four hydrologic soil groups based on infiltration capacity and runoff potential. The groups are A, B, C, and D. Group A has the greatest infiltration capacity and least runoff potential, while D has the least infiltration capacity and greatest runoff potential. A hydrologic soil group is determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to an impermeable layer or to a water table (USDA, 2007). For those soils with two groups, certain wet soils are tabulated as D based solely on the presence of a water table within 24 inches of the surface, even though the saturated hydraulic conductivity may be favorable for water transmission. When adequately drained to a seasonal water table at least 24 inches below surface, dual hydrologic groups (A/D, B/D, C/D) are given, based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition (USDA, 2007). This analysis uses current USDA National Cooperative Soil Survey data.

Figure 15 shows the distribution of soil groups in the watershed and Table 26 describes the total area of each. The dominant group is C/D, which account for 54% of watershed soils, indicating potentially high rates of runoff, followed by group B encompassing 24% with moderately low runoff potential. The Coop Branch and Spanish Needle Creek subwatersheds have the highest and second-highest acres of C/D soils. Out of cropland, 78% (69,704 acres) C or C/D groups, and only 9% (8,485 acres) are B or B/D.

**Table 26 – Hydrologic Soil Groups**

| Subwatershed | HUC12 Code | Subwatershed Area (acres) | Hydrologic Groupings and Total Area (acres) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | B/D | C | C/D | D | Unclassified |
| Bullard Lake | 071300120402 | 15,519 | 0 | 6,802 | 2,789 | 221 | 5,541 | 14 | 152 |
| Coop Branch | 071300120401 | 35,013 | 88 | 9,091 | 2,200 | 4,697 | 18,276 | 403 | 258 |
| Dry Fork | 071300120108 | 19,443 | 4 | 3,965 | 1,279 | 2,326 | 10,951 | 510 | 408 |
| Honey Creek | 071300120106 | 15,678 | 0 | 2,901 | 744 | 2,288 | 8,326 | 1,025 | 395 |
| Hurricane Creek | 071300120107 | 19,313 | 0 | 3,377 | 807 | 796 | 14,005 | 207 | 122 |
| Spanish Needle Creek | 071300120109 | 32,714 | 0 | 6,598 | 3,732 | 3,626 | 17,640 | 566 | 553 |
| **Grand Total** | | **137,682** | **92** | **32,734** | **11,552** | **13,952** | **74,738** | **2,726** | **1,887** |
| **Total, Percent** | | | **0.1%** | **24%** | **8.4%** | **10%** | **54%** | **2%** | **1.4%** |

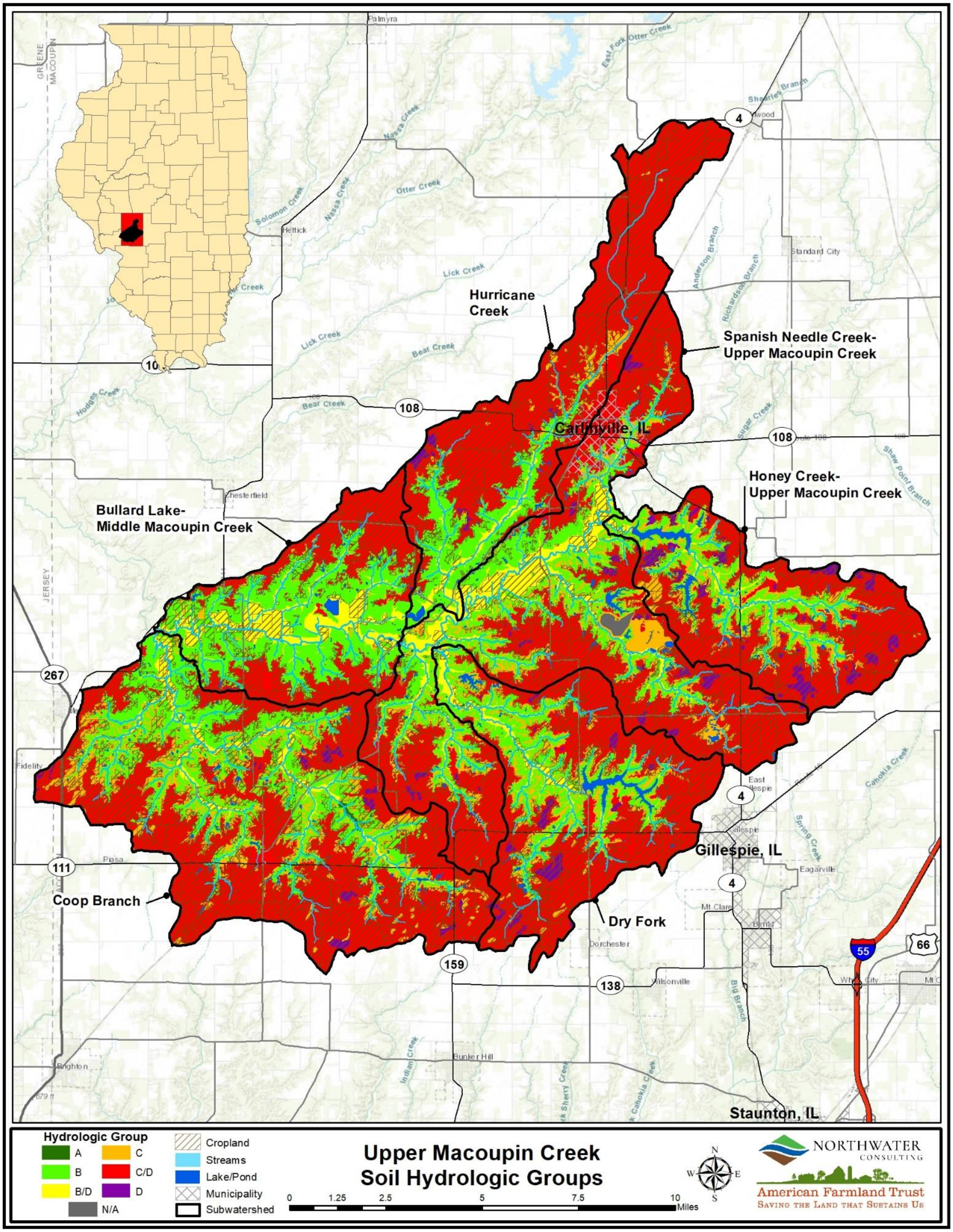



Figure 15 – Soil Hydrologic Groups

### 3.8.5 Septic System Suitability

Not all soil types support septic systems and improper construction can lead to failure and leaching of wastewater into groundwater and surrounding waterways. Soil data was analyzed by subwatershed for the ability to support septic systems.

Results show that 90%, or 123,621 acres (Table 27), of the watershed contain soils classified as "very limited" with respect to septic suitability. This does not indicate that soils are unsuitable for septic systems, but special consideration is required when establishing systems within most of the watershed. A total of 1,362 residences believed to have septic systems are located on soils classified as very limited. Figure 16 illustrates the extent of limiting soils for septic fields along with the location of homes.

**Table 27 – Soil Septic System Suitability, Total Area and Home Count**

| Subwatershed | HUC12 Code | Total Area (acres) | Total Homes on Septic | "Very Limited" | | "Somewhat Limited" | | "Not Rated" | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Area (acres) | Homes on Septic | Area (acres) | Homes on Septic | Area (acres) | Homes on Septic |
| Bullard Lake | 071300120402 | 15,519 | 88 | 11,980 | 33 | 3,386 | 55 | 152 | 0 |
| Coop Branch | 071300120401 | 35,013 | 623 | 30,693 | 550 | 4,063 | 73 | 258 | 0 |
| Dry Fork | 071300120108 | 19,443 | 330 | 18,367 | 235 | 669 | 95 | 408 | 0 |
| Honey Creek | 071300120106 | 15,678 | 151 | 14,747 | 113 | 537 | 38 | 395 | 0 |
| Hurricane Creek | 071300120107 | 19,313 | 269 | 17,535 | 175 | 1,656 | 94 | 122 | 0 |
| Spanish Needle Creek | 071300120109 | 32,714 | 284 | 30,378 | 256 | 1,783 | 28 | 553 | 0 |
| **Grand Total** | | **137,682** | **1,745** | **123,621** | **1,362** | **12,094** | **383** | **1,887** | **0** |

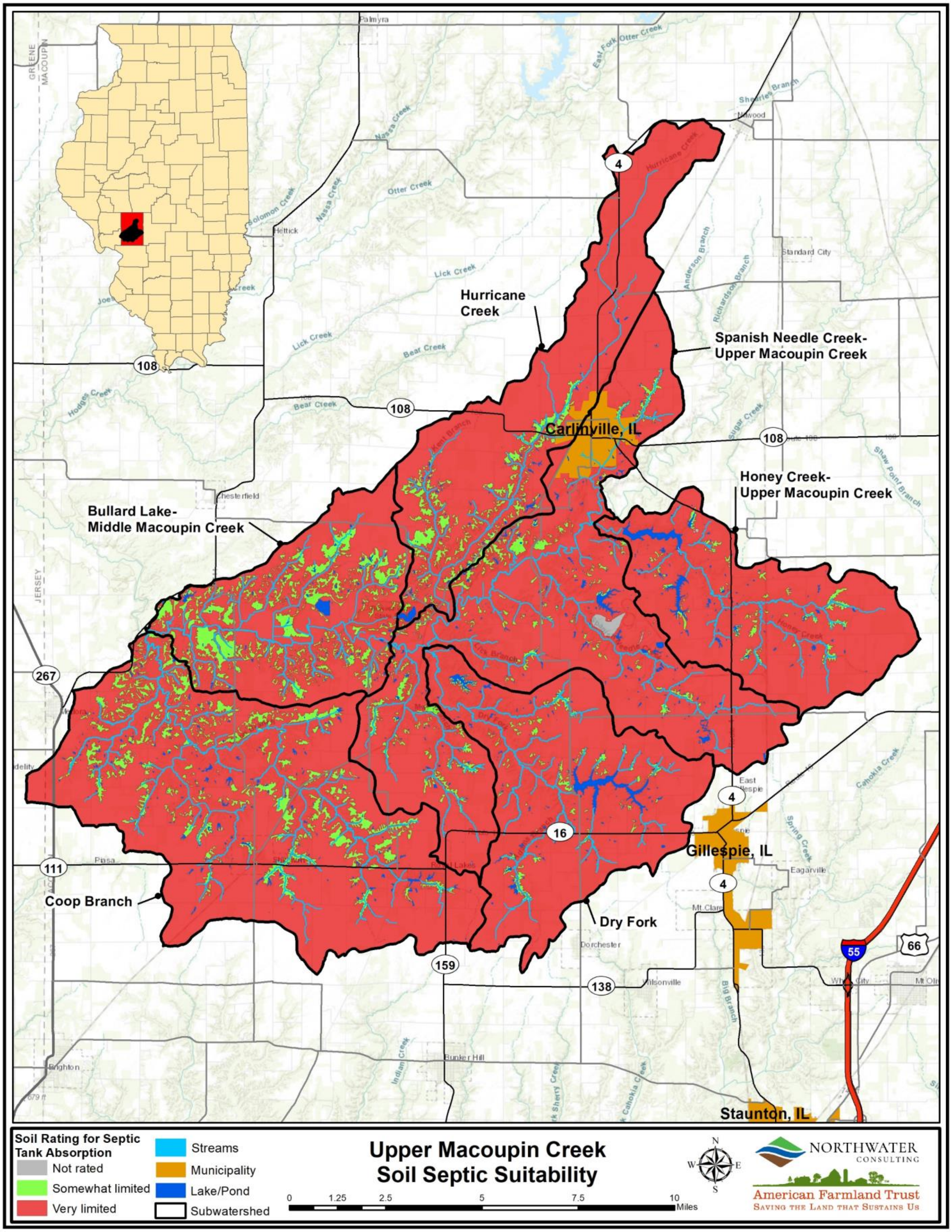



Figure 16 – Soil Septic Suitability

## 3.9 Tillage


Conventional Tillage

As part of an annual spring tillage transect survey, Macoupin County SWCD, the AFT and partners collect data from approximately 386 fields along a specific route within each county after the crops are planted. According to the 2019 survey, approximately 77.3% of the corn and 26.7% of the soybean acreage uses conventional tillage methods which leave little or no residue on the surface. An additional 11.4% of corn acres and 24.2% of soybean acres use reduced-till, which can reduce soil loss by 30% compared to conventional tillage. The remaining 11.3% of corn and 49.1% of soybean acres are mulch-till or no-till. Mulch-till leaves 30% residue of the previous year's crop and can reduce soil loss by 75%. These two conservation tillage systems can significantly reduce soil loss in the watershed.

A more detailed field-based assessment of tillage practices was performed in the spring of 2018 in order to better characterize current conditions. Table 28 and Figure 17 show the acres of tillage types and distribution in the watershed; pollution loading by tillage is discussed in more detail in Section 5.0. Tillage is grouped into 7 categories: conventional, reduced-till, mulch-till, strip-till, no-till, wheat or hay, and cover crops.

Results of the more extensive survey show that mulch-till and reduced-till make up the largest portions of the UMC watershed (30% and 29%, respectively) followed by conventional tillage (22%). No-till and strip-till account for 10% and 1.6%, respectively; cover crops are found on 2,833 acres or 3.5% of cropland. Mulch-till is the most extensive in Bullard Lake subwatershed (41%); reduced-till is most extensive in Dry Fork and Hurricane Creek (36% each); conventional tillage is most extensive in Hurricane Creek (30%).

**Table 28 – Tillage Types, Acres and Percent of Cropland**

| Subwatershed/ HUC12 Code | Conventional | | Cover Crops | | Mulch-Till | | No-Till | | Reduced-Till | | Strip-Till | | Wheat/Hay | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % | Acres | % |
| Bullard Lake 071300120402 | 1,506 | 21% | 222 | 3.1% | 2,994 | 41% | 813 | 11% | 1,453 | 20% | 65 | 0.90% | 193 | 2.7% |
| Coop Branch 071300120401 | 6,041 | 27% | 290 | 1.3% | 7,312 | 33% | 2,216 | 10% | 5,434 | 25% | 129 | 0.58% | 680 | 3.1% |
| Dry Fork 071300120108 | 1,724 | 16% | 189 | 1.7% | 2,375 | 22% | 2,094 | 19% | 3,973 | 36% | 314 | 2.9% | 254 | 2.3% |
| Honey Creek 071300120106 | 1,193 | 13% | 729 | 7.9% | 2,711 | 29% | 881 | 9.6% | 3,253 | 35% | 179 | 1.9% | 262 | 2.8% |
| Hurricane Creek 071300120107 | 4,071 | 30% | 752 | 5.6% | 2,636 | 20% | 783 | 5.8% | 4,865 | 36% | 241 | 1.8% | 143 | 1.1% |
| Spanish Needle Creek 071300120109 | 3,606 | 20% | 649 | 3.7% | 6,481 | 37% | 1,534 | 8.7% | 4,615 | 26% | 383 | 2.2% | 435 | 2.5% |
| **Grand Total** | **18,142** | **22%** | **2,833** | **3.5%** | **24,510** | **30%** | **8,322** | **10%** | **23,594** | **29%** | **1,312** | **1.6%** | **1,967** | **2.4%** |

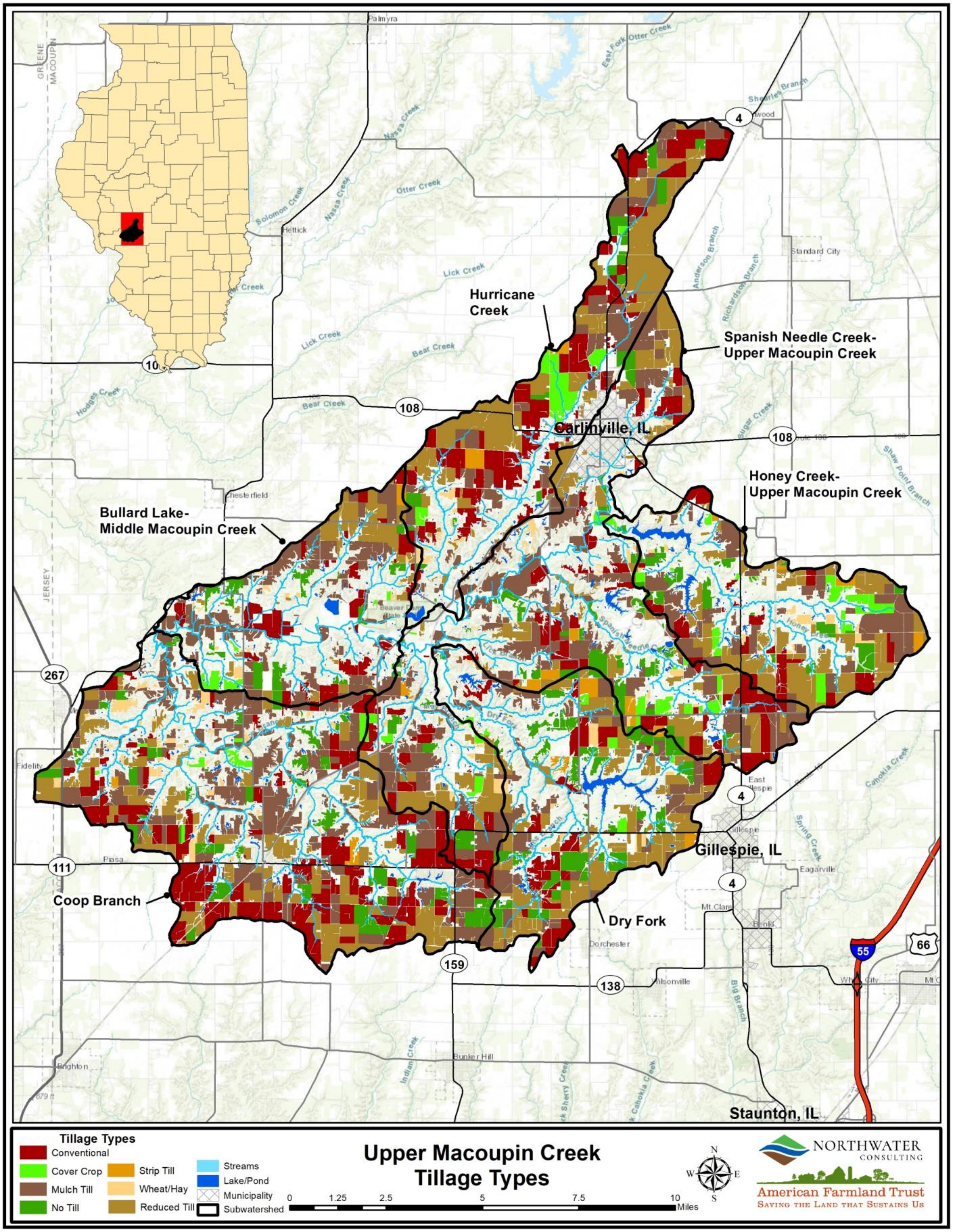



Figure 17 – Tillage Types

## 3.10 Existing Conservation Practices

Existing management practices within the watershed are extensive and include sediment basins, grass riparian buffers, grass waterways, ponds and lakes, terraces, water and sediment control basins (WASCB), wetlands, diversions, grade control structures, grass swales, and streambank stabilization. Table 29 below shows the total number or area of each management practice; Figure 18 shows existing WASCBs and Figure 19 shows all other practices. The greatest number of WASCBs are located in the Coop Branch subwatershed; Spanish Needle contains the most acres of wetlands and Coop Branch the most acres of grass waterways and buffers.

With relatively large reductions still required to meet the phosphorus, sediment and nitrogen reduction goals stated in this plan, substantial opportunities exist to install new practices. This is especially true where sediment and nutrient loading is the greatest or where pollutants may bypass existing BMPs, such as tile water bypassing a filter strip. It is important to note that each practice varies in its ability to effectively remove pollutants, however, these practices are providing benefits to water quality and have been accounted for in the watershed pollutant loading estimates.

**Table 29 – Existing Conservation Practices**

| Subwatershed | HUC12 Code | Best Management Practice | Count / Area |
|---|---|---|---|
| Bullard Lake | 071300120402 | Sediment Basin | 1 |
| | | Grass Riparian Buffer | 10.7 (acres) |
| | | Grass Waterway | 78 (acres) |
| | | Pond/Lake/Reservoir | 122 |
| | | Terrace | 1 |
| | | WASCB | 102 |
| | | Wetland | 22 (acres) |
| Coop Branch | 071300120401 | Sediment Basin | 34 |
| | | Grass Riparian Buffer | 22 (acres) |
| | | Grass Waterway | 360 (acres) |
| | | Pond/Lake/Reservoir | 273 |
| | | Terrace | 9 |
| | | WASCB | 334 |
| | | Wetland | 11 (acres) |
| Dry Fork | 071300120108 | Sediment Basin | 14 |
| | | Diversion | 1 |
| | | Grass Riparian Buffer | 13 (acres) |
| | | Grass Waterway | 211 (acres) |
| | | Pond/Lake/Reservoir | 118 |
| | | Terrace | 12 |
| | | WASCB | 156 |
| | | Wetland | 11 (acres) |
| Honey Creek | 071300120106 | Sediment Basin | 1 |
| | | Grade Control (with wetland) | 3 |
| | | Grass Riparian Buffer | 0.65 (acres) |
| | | Grass Swale | 1 |
| | | Grass Waterway | 150 (acres) |
| | | Pond/Lake/Reservoir | 104 |
| | | Riffle | 4 |

| Subwatershed | HUC12 Code | Best Management Practice | Count / Area |
|---|---|---|---|
| | | Terrace | 10 |
| | | WASCB | 239 |
| | | Wetland | 11 (acres) |
| Hurricane Creek | 071300120107 | Sediment Basin | 1 |
| | | Grass Riparian Buffer | 8 (acres) |
| | | Grass Waterway | 64 (acres) |
| | | Pond/Lake/Reservoir | 101 |
| | | Terrace | 5 |
| | | WASCB | 64 |
| | | Wetland | 1.7 (acres) |
| Spanish Needle Creek | 071300120109 | Sediment Basin | 6 |
| | | Grass Riparian Buffer | 12 (acres) |
| | | Grass Waterway | 205 (acres) |
| | | Pond/Lake/Reservoir | 253 |
| | | Terrace | 5 |
| | | WASCB | 244 |
| | | Wetland | 59 (acres) |

*Calculation of grass riparian buffers are an estimation and include grassed areas within 35 feet of a flowing stream.*

**Newly Constructed WASCB**

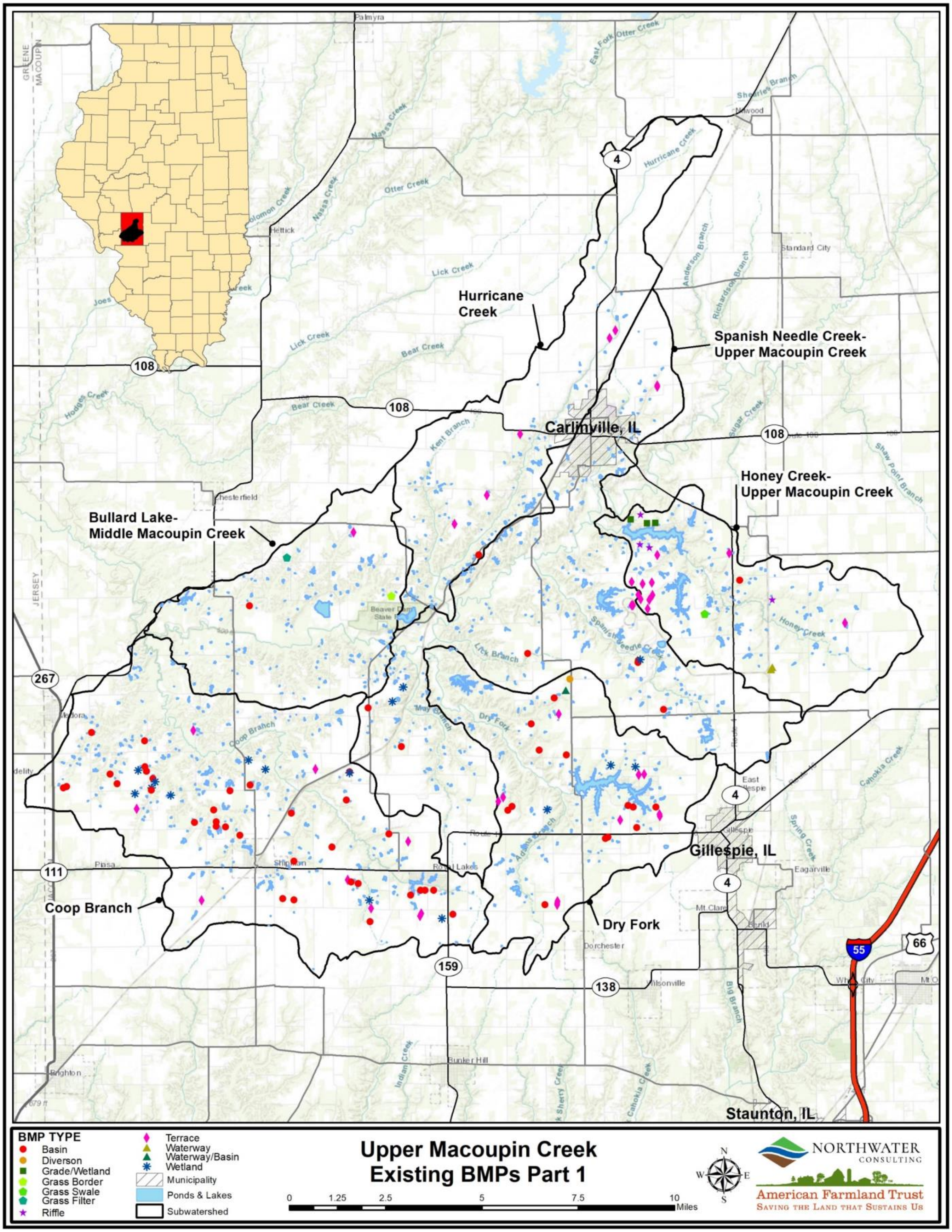



Figure 18 – Existing BMPs Part 1

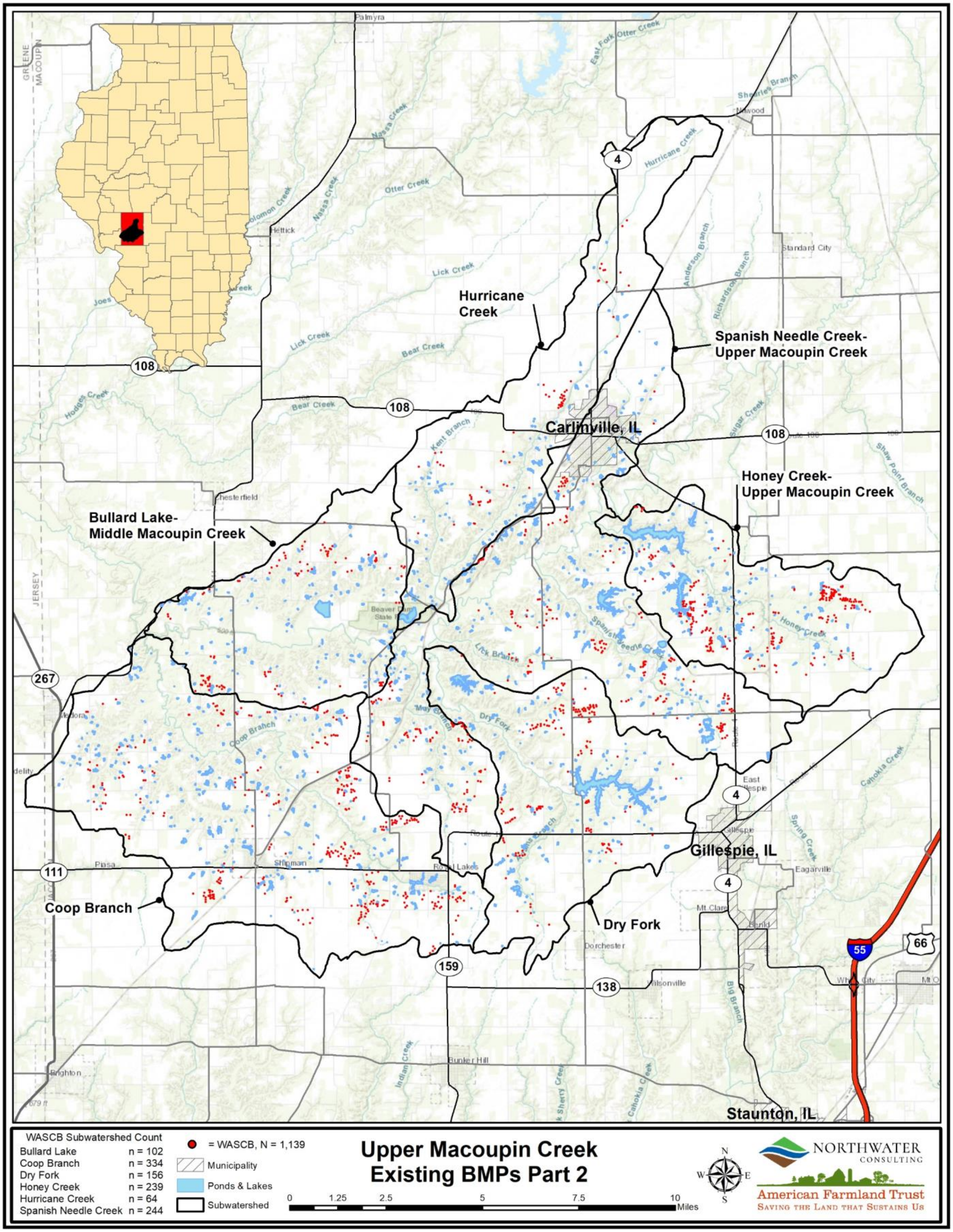



Figure 19 – Existing BMPs Part 2

## 3.11 Hydrology and Drainage System

Two USGS stream gauging stations (discussed in Section 3.3) were added in 2017; upstream station 05586647 for Macoupin Creek near Carlinville, and downstream Macoupin Creek station 05586745 at the watershed outlet. At station 05586745, average annual gauge height is 7.5 ft and annual discharge is 291 $ft^3$/sec; at station 05586647 they are 9.2 ft and 141 $ft^3$/sec, respectively. Due to the relatively recent addition of stream gauges and a lack of long-term measurements, USGS StreamStats was used to retrieve peak flow data (Table 30).

**Table 30 – Peak Flow Data for Macoupin Creek and Named Tributaries**

| Stream | HUC12 | Peak Flow Data ($ft^3$/s) by Recurrence Level Interval (yrs) | | | | Drainage Area ($mi^2$) | Stream Slope (ft/mi) |
|---|---|---|---|---|---|---|---|
| | | 2 yrs | 5 yrs | 10 yrs | 500 yrs | | |
| Macoupin Creek (upstream) | 071300120109 | 4,100 | 70,50 | 9,120 | 20,900 | 199.8 | 3.0 |
| Macoupin Creek (downstream) | 071300120401 | 6,270 | 10,700 | 13,700 | 31,200 | 383.4 | 2.6 |
| Coop Branch | 071300120401 | 2,280 | 4,090 | 5,420 | 13,400 | 54.8 | 8.1 |
| Dry Fork | 071300120108 | 1,610 | 2,930 | 3,910 | 9,880 | 30.0 | 10.5 |
| Honey Creek | 071300120106 | 1,400 | 2,540 | 3,400 | 8,640 | 24.3 | 10.9 |
| Hurricane Creek | 071300120107 | 1,590 | 2,860 | 3,800 | 9,470 | 32.3 | 8.5 |
| May Branch | 071300120109 | 1,040 | 1,940 | 2,630 | 6,940 | 12.4 | 18.1 |
| Spanish Needle Creek | 071300120109 | 1,090 | 2,000 | 2,690 | 6,940 | 16.7 | 13.1 |

### *Streams*

Because of limitations with the accuracy of the National Hydrography Dataset (NHD), the custom landuse layer was used to better represent the actual wetted extent of streams in the watershed; Table 31 shows perennial open water tributary stream length. Results show a total of 329 miles of streams; major tributaries to Macoupin Creek include: Coop Branch, Dry Fork, Honey, Hurricane, and Spanish Needle Creeks. Coop Branch is 18.7 miles long while Dry Fork is 8.1; all other named tributaries total 17.5 miles, and unnamed tributaries total 226 miles. Although accuracy is limited, the NHD shows intermittent or ephemeral tributaries, forested gullies, and subsurface drainage ways totaling 195 miles.

Ponds and reservoirs total 1,978 acres, or 1.4% of the watershed (Table 31). They range in size from 280 to less than an acre, with larger lakes and ponds found in the eastern half of the watershed. Together, New Gillespie and Old Gillespie lakes are the largest bodies of water at 280 acres; Lake Carlinville is the second largest at 186 acres. The watershed drainage system is depicted in Figure 20.

### Table 31 – Open Water Perennial Streams and Tributaries

| Tributary Name | Length (ft) | Length (mi) | Tributary Name | Length (ft) | Length (mi) |
|---|---|---|---|---|---|
| Briar Creek | 19,727 | 3.7 | Lick Branch | 22,427 | 4.2 |
| Coop Branch | 98,781 | 18.7 | Macoupin Creek | 113,212 | 21.4 |
| Dry Fork | 42,976 | 8.1 | May Branch | 37,933 | 7.2 |
| Elm Creek | 12,452 | 2.4 | Spanish Needle Creek | 60,592 | 11.5 |
| Honey Creek | 49,187 | 9.3 | Unnamed Tributaries | 1,193,105 | 226.0 |
| Hurricane Creek | 85,230 | 16.1 | | | |
| **Grand Total** | | | | **1,735,622** | **328.7** |

### Table 32 – Surface Water Inventory by Subwatershed

| Subwatershed | HUC12 Code | Perennial Streams (mi) | NHD Waters* (mi) | Ponds and Lakes (ac) |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | 51.0 | 22.7 | 197 |
| Coop Branch | 071300120401 | 83.2 | 73.7 | 338 |
| Dry Fork | 071300120108 | 49.5 | 20.9 | 463 |
| Honey Creek | 071300120106 | 29.5 | 24.1 | 428 |
| Hurricane Creek | 071300120107 | 35.6 | 19.1 | 150 |
| Spanish Needle Creek | 071300120109 | 79.8 | 34.5 | 402 |
| **Grand Total** | – | **328.7** | **195.0** | **1,978** |

** = all other NHD water sources outside open water perennial streams, i.e. intermittent or ephemeral tributaries, forested gullies and subsurface drainageways*

**Tributary Stream**

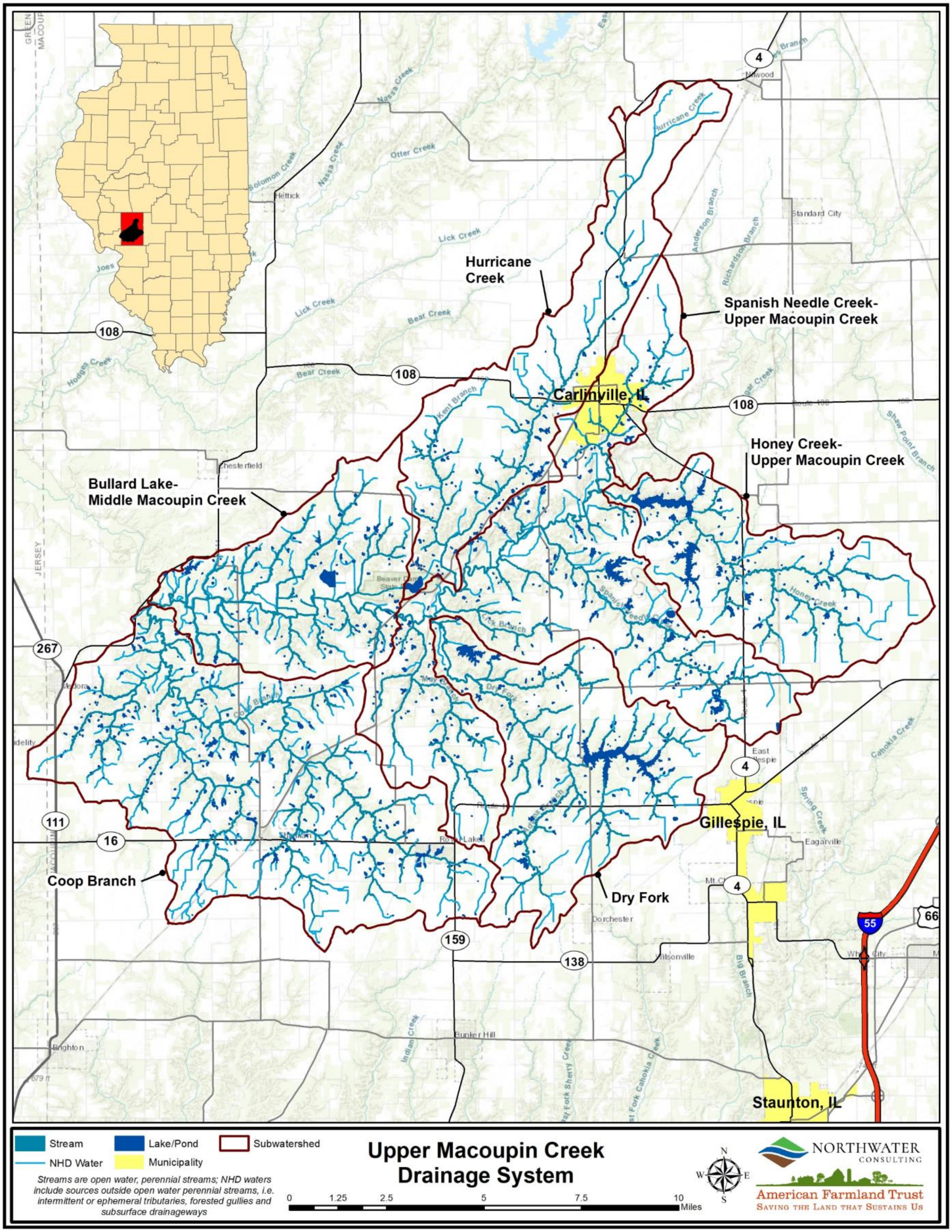



**Figure 20 – Drainage System**

### 3.11.1 Tile Drainage

The true extent of tile drainage in the watershed is largely unknown, but a combination of field surveys and GIS analysis indicate that it is low compared to other adjacent watersheds. The method used to estimate tile drainage included direct observations performed during a watershed windshield survey and analysis of soils and landuse data–fields with 5 or more acres of Group D silt and silty clay loam soils on 0–2 percent slopes.

It is estimated that 222 fields, or 12,721 acres in the watershed, are likely tile drained. This corresponds to approximately 16% of all cropland or 9% of the watershed. Coop Branch subwatershed likely has the greatest total area, or 3,111 acres, and Bullard Lake the lowest, or 297 acres. As a percentage of total cropland acreage, Honey Creek likely has the highest, or 32%, followed by Dry Fork (23%). Table 33 shows estimated tiled area by subwatershed and Figure 21 shows its distribution in the watershed.

**Table 33 – Tile Drained Cropland**

| Subwatershed | HUC12 Code | Subwatershed Area (ac) | Cropped Area (ac) | Tiled Area (ac) | Percent Cropped Area Tiled (%) | Percent Subwatershed Area Tiled (%) |
|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | 15,519 | 7,248 | 297 | 4.1% | 1.9% |
| Coop Branch | 071300120401 | 35,013 | 22,102 | 3,111 | 14% | 16% |
| Dry Fork | 071300120108 | 19,443 | 10,925 | 2,545 | 23% | 13% |
| Honey Creek | 071300120106 | 15,678 | 9,208 | 2,962 | 32% | 8.5% |
| Hurricane Creek | 071300120107 | 19,313 | 13,492 | 930 | 6.9% | 6.0% |
| Spanish Needle Creek | 071300120109 | 32,714 | 17,703 | 2,875 | 16% | 8.8% |
| **Grand Total** | | **137,682** | **80,679** | **12,721** | **15.8%** | **9%** |

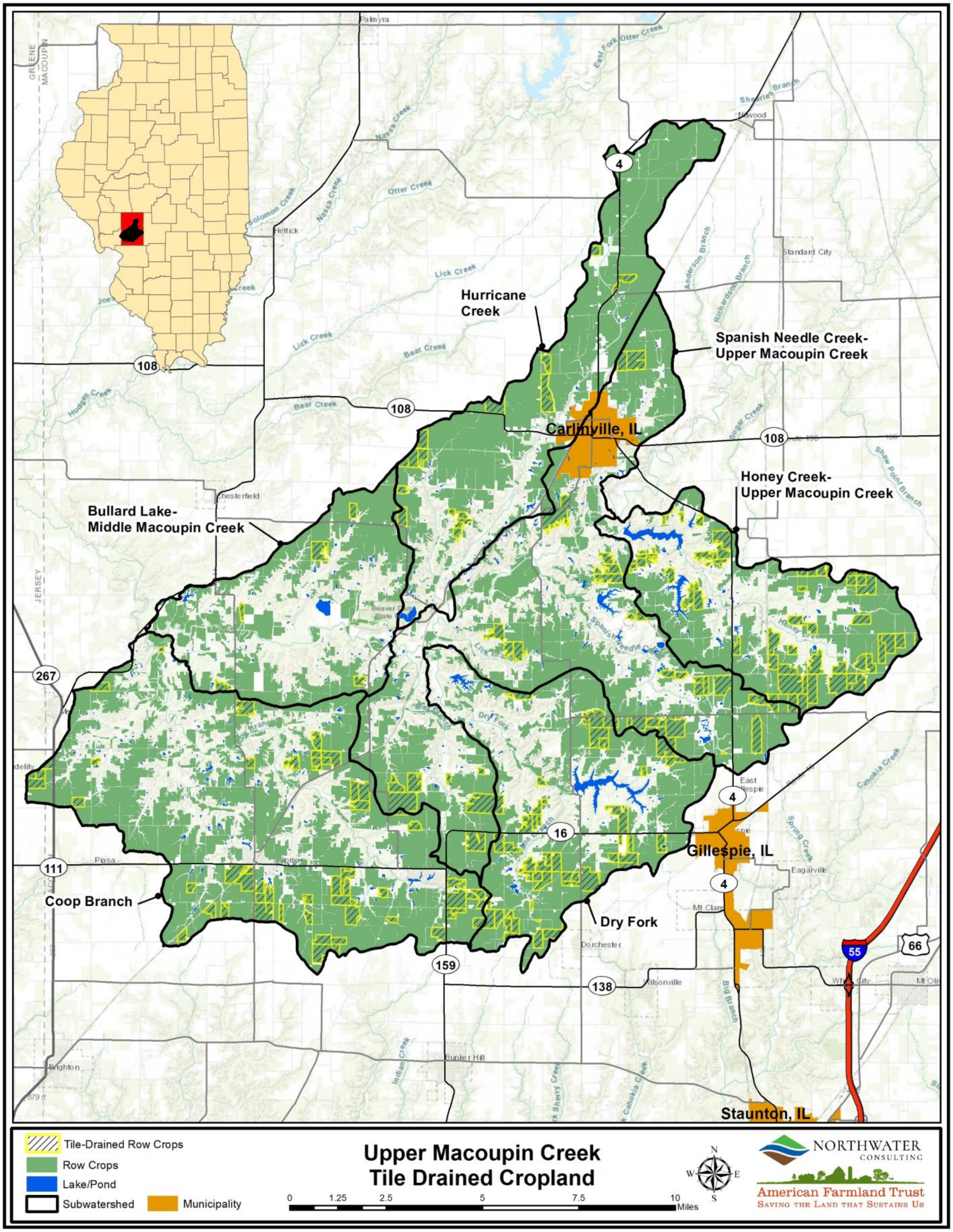



Figure 21 – Distribution of Tile Drained Cropland

### 3.11.2 Stream Channelization

Stream channelization is the engineering of a river or stream by modifying channel cross section profiles into smooth and uniform trapezoidal or rectangular forms, and can include activities such as straightening, widening or deepening the channel, clearing riparian and aquatic vegetation, and bank reinforcement. Typically, this causes increased volume and/or velocity of the water which disrupts stream equilibrium, causing conditions such as channel downcutting and bank erosion (known as the Channel Evolution Model; Simon 1989). Aerial imagery from 2017 was evaluated to determine the extent of stream channelization (Table 34 and Figure 22). Results indicate that channelization is low. Out of a total of 328 stream miles, 6.7% (22 miles) are channelized. Hurricane Creek and Bullard Lake contain the highest percentages (14% and 10%, respectively); all other subwatersheds contain less than 6.5%.

**Table 34 – Length of Channelized Streams**

| Subwatershed | HUC12 Code | Total (ft) | Total (mi) | Channelized (ft) | Channelized (mi) | % Stream Length Channelized |
|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | 269,315 | 51 | 26,005 | 4.9 | 10% |
| Coop Branch | 071300120401 | 439,750 | 83 | 21,472 | 4.1 | 4.9% |
| Dry Fork | 071300120108 | 261,512 | 50 | 16,949 | 3.2 | 6.5% |
| Honey Creek | 071300120106 | 155,903 | 30 | 2,661 | 0.5 | 1.7% |
| Hurricane Creek | 071300120107 | 187,965 | 36 | 25,934 | 4.9 | 14% |
| Spanish Needle Creek | 071300120109 | 421,415 | 80 | 22,469 | 4.3 | 5.4% |
| **Grand Total** | | **1,735,860** | **328** | **115,490** | **22** | **6.7%** |

**Channelized Stream**

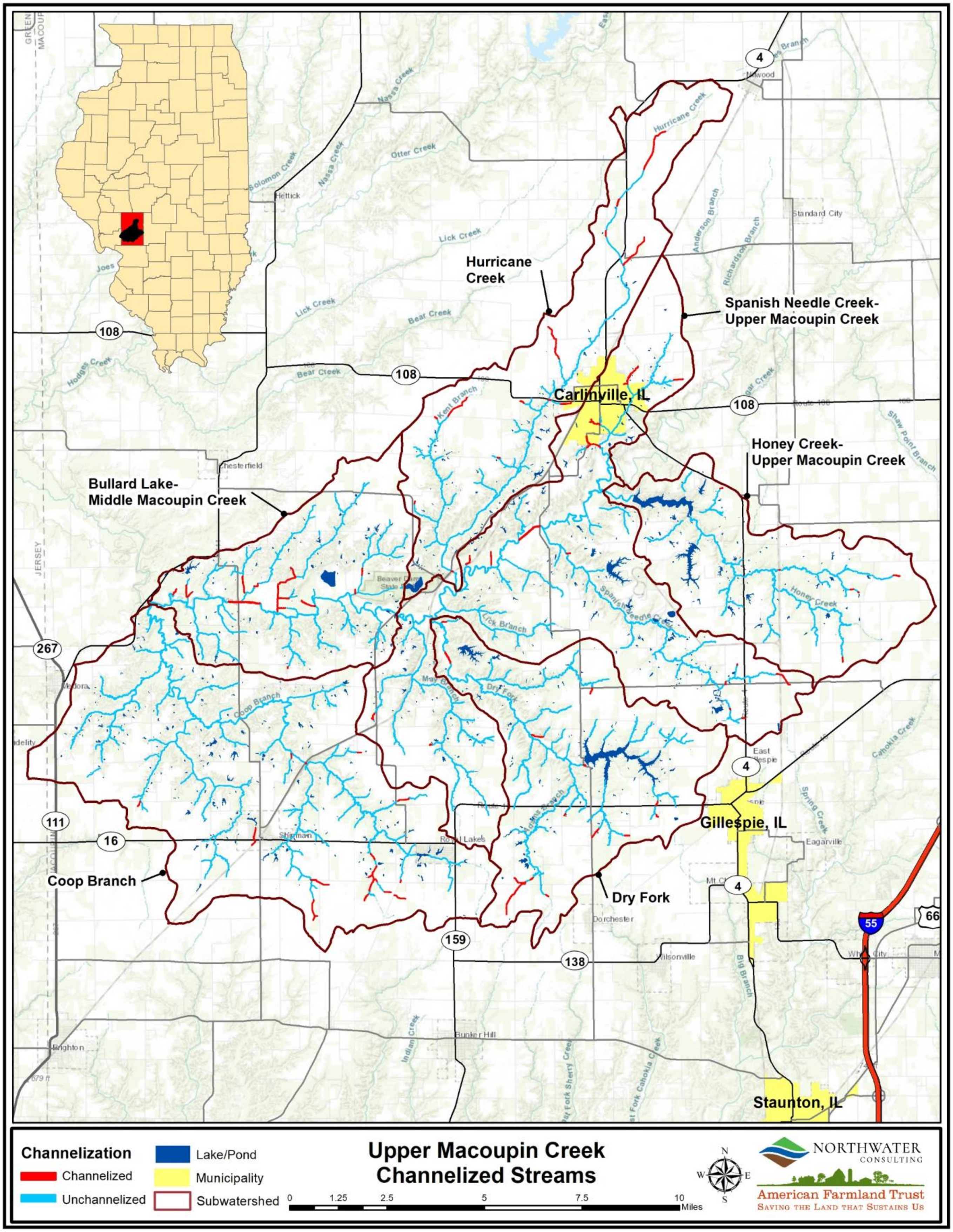



Figure 22 – Channelized Streams

### 3.11.3 Riparian Areas and Buffers

Substantial riparian and buffer areas exist adjacent to streams and lakes in the watershed. A field assessment combined with analysis of recent aerial imagery was used to determine the adequacy and relative extent of natural stream and lake buffers.

**Methods –** A buffer quality ranking system was developed and applied to individual stream reaches. Stream reaches are organized into a sequential numbering system based on road crossings. Two categories of buffer quality include:

1. Adequate – greater than or equal to 35 feet of un-impacted riparian or buffer area, either forest grass, or wetland.
2. Inadequate – less than 35 feet riparian or buffer area impacted or degraded. Inadequate buffer areas include row crops, moderately to highly overgrazed pasture, roads, buildings, and urban open space.

Existing literature was reviewed to determine the minimum adequate buffer with; a buffer width of 35 feet was selected based on the following references:

1. The USDA-NRCS requires a minimum of a 20-foot buffer to be eligible for the Conservation Reserve Program (NRCS, 2010).
2. A study performed in Kansas determined that buffers between 27 and 53 feet significantly removed nitrogen, phosphorus, and suspended solids from entering the stream (Mankin, et al. 2007).

#### *Stream Buffers*

Streams are generally well buffered; approximately 85% of all stream miles (Table 35). Although most streams are well buffered, areas exist where improvements can be made; buffers can be expanded on over 92 miles (15%), mostly located in the headwaters (Figure 23). Honey Creek has the highest percentage (94%) of adequately buffered stream miles, while Hurricane Creek has the lowest, or 77%.

Buffer type varies, with forest accounting for 75% of all stream miles. Grassland makes up 9.4% of miles, row crops 8.4%, and pasture 5.1%; the 17 other categories combined make up roughly another 2%.

**Table 35 – Stream Buffer Adequacy**

| Subwatershed | HUC12 Code | Total (ft) | Total (mi) | Inadequate (mi) | Adequate (mi) | Inadequate (%) | Adequate (%) |
|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | 505,449 | 96 | 14 | 82 | 14% | 86% |
| Coop Branch | 071300120401 | 826,848 | 157 | 29 | 127 | 19% | 81% |
| Dry Fork | 071300120108 | 483,332 | 92 | 12 | 80 | 13% | 87% |
| Honey Creek | 071300120106 | 286,787 | 54 | 3.5 | 51 | 6% | 94% |
| Hurricane Creek | 071300120107 | 360,159 | 68 | 16 | 53 | 23% | 77% |
| Spanish Needle Creek | 071300120109 | 792,384 | 150 | 19 | 131 | 13% | 87% |
| **Grand Total** | | **3,254,960** | **616** | **92** | **524** | **15%** | **85%** |

### Table 36 – Stream Buffer Landuse Categories

| Buffer Type | Total Miles | % of Stream Length |
|---|---|---|
| Forest | 465 | 75% |
| Grasslands | 58 | 9.4% |
| Row Crops | 52 | 8.4% |
| Pasture | 31 | 5.1% |
| Urban Open Space | 5.7 | 0.92% |
| Roads | 2.0 | 0.32% |
| Wetlands | 0.72 | 0.12% |
| Manufacturing | 0.39 | 0.06% |
| Railroad | 0.33 | 0.05% |
| Farm Building | 0.30 | 0.05% |
| Urban Residential | 0.29 | 0.05% |
| Open Water - Stream | 0.24 | 0.04% |
| Rural Residential | 0.22 | 0.04% |
| Feed Area | 0.14 | 0.02% |
| Open Water Pond/Reservoir | 0.13 | 0.02% |
| Institutional | 0.04 | 0.01% |
| Utilities | 0.02 | 0.004% |
| Industrial | 0.01 | 0.002% |
| Parks and Recreation | 0.01 | 0.002% |
| **Grand Total** | **616** | **100%** |

**Eroding Streambank with Adequate Forested Buffer and Inadequate Grass Buffer**

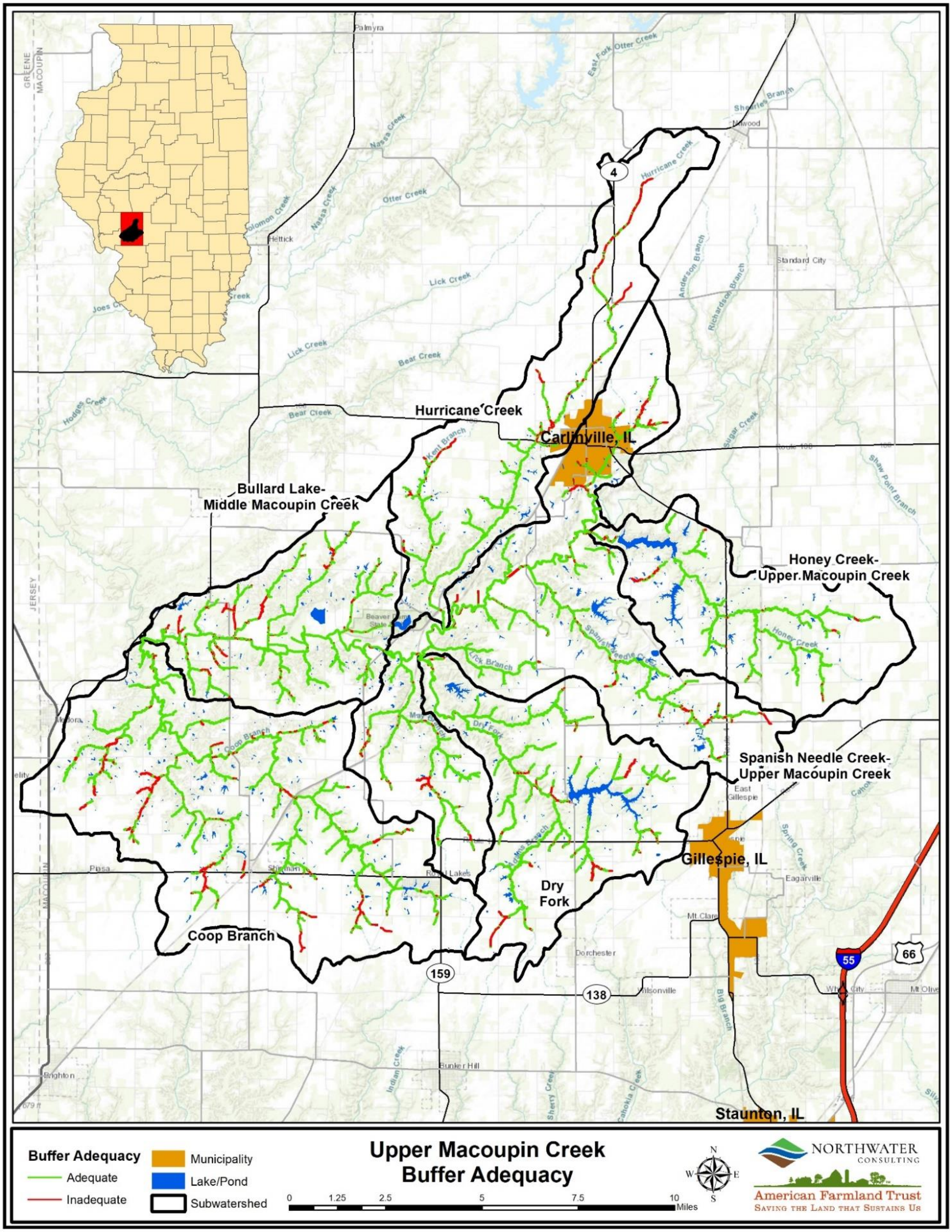



Figure 23 – Stream Buffers

### *Lake Buffers*

Lakes are generally well buffered and contain large, contiguous riparian areas. Analysis shows that 86% (42 mi) of shoreline is adequately buffered (Table 37). Forested areas account for 78% of all lake buffer area, grassland 8%, and rural residential 5% (Table 38).

Bullard Lake and Spanish Needle Creek subwatersheds have the greatest percentage of well-buffered shoreline; 100% and 95%, respectively. Honey Creek has the lowest portion at only 79%. All other watersheds are over 82%.

**Table 37 – Lake Buffer Adequacy**

| Watershed Name | HUC12 Code | Lake Name | Total (ft) | Total (mi) | Inadequate (mi) | Adequate (mi) | Inadequate (%) | Adequate (%) |
|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | Bullard Lake | 8,276 | 1.6 | 0.00 | 1.6 | 0% | 100% |
| *Bullard Lake, Total* | | | 8,276 | 1.6 | 0.00 | 1.6 | 0% | 100% |
| Coop Branch | 071300120401 | Meshach Lake | 5,291 | 1.0 | 0.12 | 0.88 | 12% | 88% |
| | | Mowens Lake | 6,230 | 1.2 | 0.38 | 0.80 | 32% | 68% |
| | | Royal Lake | 1,441 | 0.27 | 0.00 | 0.27 | 2% | 98% |
| | | Shad Lake | 6,455 | 1.2 | 0.10 | 1.1 | 8% | 92% |
| | | Shadrach Lake | 2,794 | 0.53 | 0.09 | 0.43 | 18% | 82% |
| | | Shipman Reservoir | 4,992 | 0.95 | 0.24 | 0.70 | 26% | 74% |
| *Coop Branch, Total* | | | 27,203 | 5.2 | 0.95 | 4.2 | 18% | 82% |
| Dry Fork | 071300120108 | Lake Catatoga | 28,189 | 5.3 | 2.0 | 3.3 | 38% | 62% |
| | | New Gillespie Lake | 49,930 | 9.5 | 0.33 | 9.1 | 4% | 96% |
| | | Old Gillespie Lake | 25,387 | 4.8 | 0.22 | 4.6 | 5% | 95% |
| *Dry Fork, Total* | | | 103,505 | 19.6 | 2.6 | 17.0 | 13% | 87% |
| Honey Creek | 071300120106 | Deer Run Lake | 6,094 | 1.2 | 0.57 | 0.59 | 49% | 51% |
| | | French Lake | 3,141 | 0.59 | 0.05 | 0.54 | 9% | 91% |
| | | Gillespie Country Club Lake | 6,815 | 1.3 | 0.40 | 0.89 | 31% | 69% |
| | | Lake Carlinville | 35,020 | 6.6 | 0.55 | 6.1 | 8% | 92% |
| | | Lake Williamson | 7,977 | 1.5 | 0.78 | 0.73 | 52% | 48% |
| *Honey Creek, Total* | | | 59,048 | 11.2 | 2.4 | 8.8 | 21% | 79% |
| Hurricane Creek | 071300120107 | Beaver Dam Lake | 9,381 | 1.8 | 0.13 | 1.6 | 7% | 93% |
| | | Lake Rinaker | 8,353 | 1.6 | 0.13 | 1.5 | 8% | 92% |
| | | Macoupin Lake | 1,302 | 0.25 | 0.02 | 0.22 | 10% | 90% |
| *Hurricane Creek, Total* | | | 19,035 | 3.6 | 0.28 | 3.3 | 8% | 92% |
| Spanish Needle Creek | 071300120109 | Smith Lake | 37,064 | 7.0 | 0.08 | 6.9 | 1% | 99% |
| | | Suhling Pond | 2,163 | 0.41 | 0.31 | 0.10 | 77% | 23% |
| *Spanish Needle Creek, Total* | | | 39,227 | 7.4 | 0.39 | 7.0 | 5% | 95% |
| **Grand Total** | | | **256,294** | **49** | **6.6** | **42** | **14%** | **86%** |

**Table 38 – Lake Buffer Landuse Categories**

| Buffer Type | Total Miles | Percent Of Lake Length |
|---|---|---|
| Forest | 38 | 78% |
| Grasslands | 3.7 | 8% |
| Rural Residential | 2.5 | 5% |
| Urban Open Space | 2.1 | 4% |
| Row Crops | 0.5 | 1% |
| Pasture | 0.5 | 1% |
| Wetlands | 0.37 | 1% |
| Roads | 0.35 | 1% |
| Parks and Recreation | 0.32 | 1% |
| Marina | 0.13 | 0.3% |
| Open Water - Stream | 0.05 | 0.1% |
| Farm Building | 0.03 | 0.1% |
| Open Water Pond/Reservoir | 0.03 | 0.1% |
| **Grand Total** | **49** | **100%** |

### 3.11.4 Wetlands

Wetlands provide numerous valuable functions that are necessary for the health of the watershed. They play a critical role in protecting and moderating water quality through a combination of filtering and stabilizing processes. Wetlands remove pollutants through absorption, assimilation, and denitrification. This effective treatment of nutrients and physical stabilization leads to an increase in overall water quality to downstream reaches.

**Restored Wetland**

In addition, wetlands can increase stormwater detention capacity and attenuation, and moderate high flows. These benefits help to reduce flooding and erosion. Wetlands also facilitate groundwater recharge by allowing water to seep slowly into the ground, thus replenishing underlying aquifers. Groundwater recharge is also valuable to wildlife and stream biota during the summer months when precipitation is low and the base flow of the river draws on the surrounding groundwater table.

Excluding stream, ponds, and lakes, United States USFWS National Wetlands Inventory (NWI) indicates there is a total of 1,555 acres (1.9%) of wetlands within the watershed. These wetlands are categorized as freshwater emergent and forested shrub wetlands. Results are shown in Table 39.

Considering the outdated nature of the NWI dataset, an analysis of open water wetlands was performed using 2017 aerial imagery to better understand their current extent. Results show only 250 acres (0.18%)

of wetlands in the watershed. Comparing to NWI data indicates approximately 108 acres of previously delineated wetlands may have been drained or modified; therefore, opportunities exist to restore these areas.

**Table 39 – Wetlands**

| Subwatershed | HUC12 Code | Current Wetlands | | | NWI Wetlands | | | |
|---|---|---|---|---|---|---|---|---|
| | | Area (acres) | % Total | % Difference From NWI | Emergent (acres) | Forested/Shrub (acres) | Total (acres) | Converted (acres) |
| Bullard Lake | 071300120402 | 67 | 27% | 71% | 12 | 216 | 228 | 29 |
| Coop Branch | 071300120401 | 20 | 7.8% | 90% | 17 | 179 | 196 | 17 |
| Dry Fork | 071300120108 | 16 | 6.4% | 94% | 13 | 243 | 255 | 10 |
| Honey Creek | 071300120106 | 24 | 9.5% | 91% | 14 | 256 | 270 | 4.1 |
| Hurricane Creek | 071300120107 | 19 | 7.6% | 86% | 8 | 128 | 136 | 6.8 |
| Spanish Needle Creek | 071300120109 | 105 | 42% | 78% | 34 | 436 | 470 | 41 |
| **Grand Total** | | **250** | **100%** | **84%** | **97** | **1,458** | **1,555** | **108** |

**Natural Wetland**

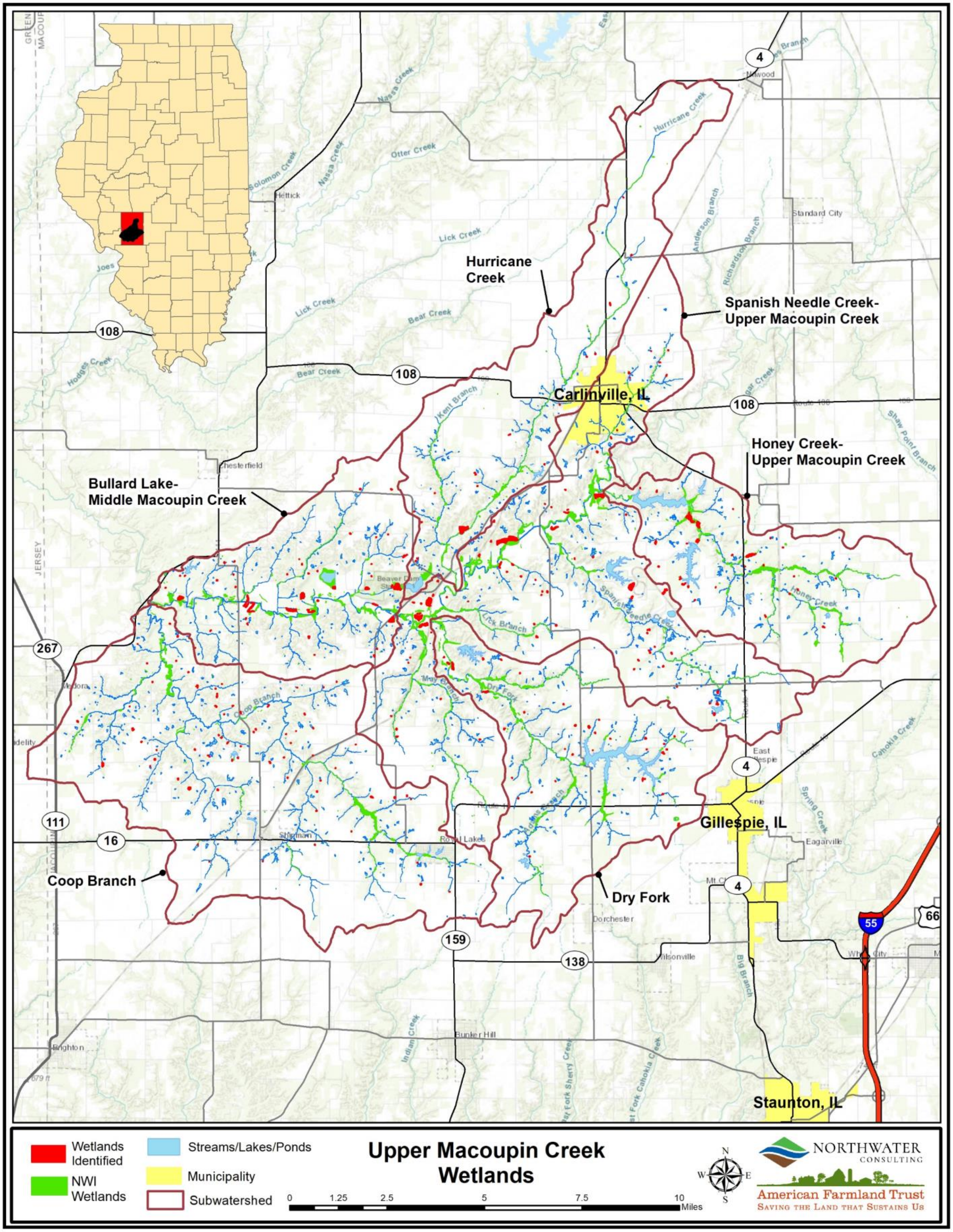



Figure 24 – Wetlands

### 3.11.5 Floodplain

A review and analysis of the most recent Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Maps (DFIRM) indicates there are 4,010 acres of 100-year floodplain within the watershed, or 2.9% of the total watershed area (Table 40, Figure 25). Flood hazard areas on the Flood Insurance Rate Map are identified as a Special Flood Hazard Areas (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year but are broken up into different zones based on severity of flood hazard risk. The 1-percent annual chance flood is also referred to as the base flood, or 100-year flood (FEMA 2018). The Spanish Needle Creek subwatershed contains the greatest area in the 100-year floodplain, or 2,068 acres, followed by Bullard Lake and Dry Fork; Honey Creek has the least, at 55 acres.

**Table 40 – 100-Year Floodplains**

| Subwatershed | HUC12 Code | Area (ac) | Percent Area of Subwatershed |
|---|---|---|---|
| Bullard Lake | 071300120402 | 939 | 6.1% |
| Coop Branch | 071300120401 | 280 | 0.8% |
| Dry Fork | 071300120108 | 405 | 2.1% |
| Honey Creek | 071300120106 | 55 | 0.4% |
| Hurricane Creek | 071300120107 | 263 | 1.4% |
| Spanish Needle Creek | 071300120109 | 2,068 | 6.3% |
| **Grand Total** | | **4,010** | **2.9%** |

**Macoupin Creek and Adjacent 100-Year Floodplain**

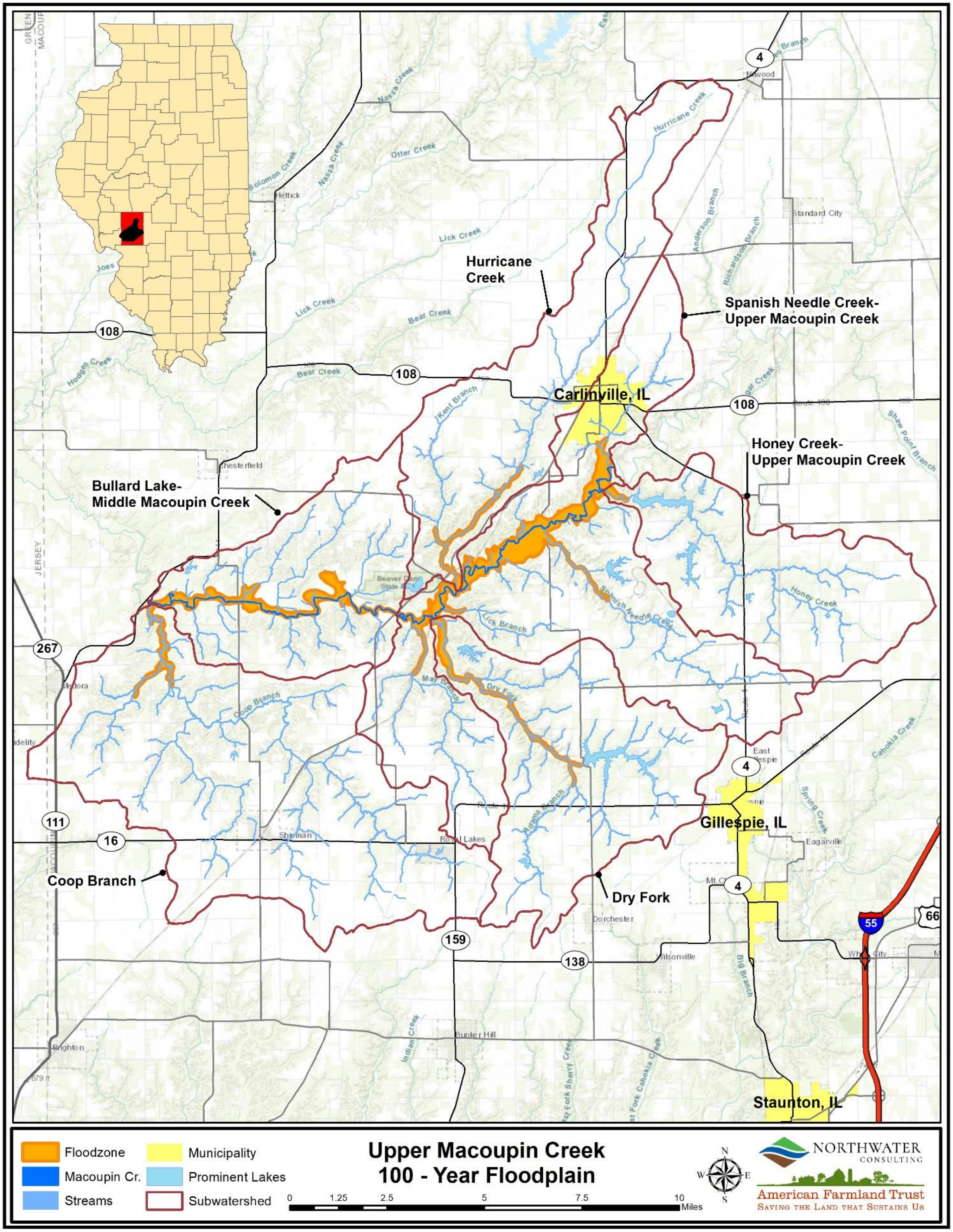



Figure 25 – 100-Year Floodplains

## 3.12 Lake Shoreline and Streambank Erosion

Lake shoreline and streambank erosion is a source of sediment and nutrients within the watershed. An evaluation of the extent and severity of these sources was performed to quantify sediment, nitrogen and phosphorus loading. Streambank erosion was evaluated through direct observations during a windshield survey in the spring of 2018. Data was captured with a GPS receiver at each road crossing to estimate average eroding bank height and annual recession rates. Results were extrapolated upstream and downstream from each crossing to the next observation point. Data was transferred into GIS to create a map layer representing general estimates of annual soil loss from streambank erosion.

All named lakes in the watershed were assessed in the spring of 2019 by direct observation at all lake access points. Erosion rates and bank heights were estimated from the shore and marked with a GPS receiver and transferred into a series of line files used to quantify soil loss and nutrient loading.

Annual sediment, nitrogen and phosphorus loads were calculated using equations derived from the EPA Region 5 load reduction spreadsheet and adjusted to account for the trapping efficiency of reservoirs and other BMPs. Eroding bank height, bank length and lateral recession rates (LRR) estimated in the field were transferred to GIS. Lake bank soil nutrient concentrations were estimated from data obtained at nearby lakes. Soil nutrient concentrations for streambanks were measured directly at 7 locations in the watershed and average values applied to each bank. The following equations were used to estimate total annual loads for sediment, nitrogen and phosphorus:

**Sediment Load (tons/yr)** = Eroding Bank Length (ft) * Lateral Recession Rate (ft/yr) * Eroding Bank Height (ft) * Soil Weight Dry Density (tons/ft$^3$)

**Nitrogen Load (lbs/yr)** = Sediment Load (tons/yr) * N concentration in soil (stream: 0.000643 lbs/lb; lake: 0.000312 lbs/lb) * 2,000 (lbs/ton)

**Phosphorus Load (lbs/yr)** = Sediment Load (tons/yr) * P concentration in soil (stream: 0.000304 lbs/lb; lake: 0.000352 lbs/lb) X 2,000 (lbs/ton)

### 3.12.1 Streambank Erosion

Streambank erosion is a natural process but the rate at which it occurs is often increased by anthropogenic (human) activities such as urbanization and agriculture. Bank erosion is typically a result of streambed incision and channel widening. Field observations indicate that the severity of streambank erosion is variable. Highly unstable channels were noted on smaller tributaries which appear to be attempting to accommodate higher flows.

Results indicate that bank erosion is responsible for delivering 21,971 tons of sediment, 2,802 lbs of nitrogen, and 133,356 lbs of phosphorus annually to watershed streams. The UMC average LRR is 0.10 ft/yr (moderate) and an average eroding bank height of 1.3 ft.

The Spanish Needle Creek subwatershed is estimated to have the highest total streambank sediment and phosphorus load (7,916 tons/yr, 4,656 lbs/yr, respectively), accounting for 36% of the total sediment load from streambank erosion. The Spanish Needle Creek subwatershed has the highest average sediment and phosphorus load per foot, or 50 tons/ft/yr and 29 lbs/ft, respectively. Average per-foot sediment and phosphorus loads are lowest in the Honey Creek subwatershed.

**Table 41 – Streambank Erosion and Loading**

| Subwatershed | HUC12 Code | Bank Length (mi) | Average LRR (ft/yr) | Average Bank Height (ft) | Sediment Load | | Nitrogen Load | | Phosphorus Load | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | tons/yr | tons/ft/yr | lbs/yr | lbs/ft/yr | lbs/yr | lbs/ft/yr |
| Bullard Lake | 071300120402 | 102 | 0.09 | 1.3 | 2,887 | 28 | 3,762 | 37 | 1,770 | 17 |
| Coop Branch | 071300120401 | 167 | 0.08 | 1.3 | 4,556 | 27 | 5,611 | 34 | 2,741 | 16 |
| Dry Fork | 071300120108 | 99 | 0.11 | 1.3 | 3,238 | 33 | 4,384 | 44 | 2,049 | 21 |
| Honey Creek | 071300120106 | 59 | 0.08 | 0.9 | 373 | 6.3 | 824 | 14 | 370 | 6.3 |
| Hurricane Creek | 071300120107 | 71 | 0.09 | 1.4 | 3,001 | 42 | 3,671 | 52 | 1,770 | 25 |
| Spanish Needle Creek | 071300120109 | 159 | 0.13 | 1.7 | 7,916 | 50 | 9,549 | 60 | 4,656 | 29 |
| **Grand Total** | | **657** | **0.10** | **1.3** | **21,971** | **33** | **27,802** | **42** | **13,356** | **20** |

### 3.12.2 Lake Shoreline Erosion

A total of 263,495 feet, or 50 miles of shoreline, was evaluated (Table 42) and most lakes have shorelines which are eroding at low rates (0.1 ft/yr average) with low eroding bank heights (1 ft average). Seawall, rock, and other bank stabilization measures are common on many of the lakes. Accounting for the trapping efficiency of each lake, annual sediment loading from lake bank erosion is estimated to be 978 tons, nitrogen 610 lbs, and phosphorus 689 lbs.

New Gillespie Lake and Lake Carlinville are responsible for most loading from lake shoreline erosion. It is estimated that lake bank erosion on New Gillespie Lake is responsible for 393 tons/yr sediment, while Lake Carlinville is responsible for 363 tons/yr sediment. Old Gillespie Lake and Beaver Dam lake are also significant sources of sediment compared to other lakes, and together contribute 147 tons/yr. These four lakes are the source of 92% of all sediment loading from lake shoreline erosion.

**Table 42 – Lake Shoreline Erosion and Pollutant Loading**

| Subwatershed | HUC12 Code | Lake Name | Bank Length (ft) | Average Eroding Bank Height (ft) | Average LRR (ft/yr) | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Sediment Load (tons/yr) |
|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | Bullard Lake | 8,641 | 1.3 | 0.3 | 9.7 | 11 | 16 |
| Coop Branch | 071300120401 | Meshach Lake | 5,251 | 0.5 | 0.1 | 3.3 | 3.7 | 5.3 |
| | | Mowens Lake | 6,255 | 0.5 | 0.1 | 1.8 | 2.0 | 2.9 |
| | | Royal Lake | 1,223 | 0.5 | 0.1 | 0.7 | 0.8 | 1.2 |
| | | Shad Lake | 6,459 | 0.8 | 0.1 | 5.3 | 6.0 | 8.5 |
| | | Shadrach Lake | 2,576 | 0.5 | 0.1 | 1.0 | 1.1 | 1.5 |
| | | Shipmans Reservoir | 5,374 | 0.5 | 0.1 | 3.3 | 3.7 | 5.3 |

| Subwatershed | HUC12 Code | Lake Name | Bank Length (ft) | Average Eroding Bank Height (ft) | Average LRR (ft/yr) | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Sediment Load (tons/yr) |
|---|---|---|---|---|---|---|---|---|
| Dry Fork | 071300120108 | Lake Catatoga | 29,236 | 0.7 | 0.0 | 0.7 | 0.8 | 1.2 |
| | | New Gillespie Lake | 50,884 | 0.5 | 0.1 | 245 | 277 | 393 |
| | | Old Gillespie Lake | 26,036 | 1.2 | 0.2 | 55 | 62 | 88 |
| Honey Creek | 071300120106 | Deer Run Lake | 6,203 | 0.5 | 0.1 | 1.9 | 2.1 | 3.0 |
| | | French Lake | 3,115 | 0.5 | 0.1 | 3.1 | 3.5 | 5.0 |
| | | Gillespie Country Club Lake | 7,476 | 0.4 | 0.1 | 1.1 | 1.3 | 1.8 |
| | | Lake Carlinville | 37,172 | 2.4 | 0.4 | 227 | 256 | 363 |
| | | Lake Williamson | 7,914 | 0.5 | 0.0 | 0.6 | 0.7 | 0.9 |
| Hurricane Creek | 071300120107 | Beaver Dam Lake | 9,774 | 1.8 | 0.4 | 37 | 42 | 60 |
| | | Lake Rinaker | 8,259 | 0.5 | 0.0 | 1.9 | 2.1 | 3.0 |
| | | Macoupin Lake | 1,087 | 0.5 | 0.1 | 0.5 | 0.6 | 0.8 |
| Spanish Needle Creek | 071300120109 | Smith Lake | 38,575 | 0.9 | 0.1 | 10 | 11 | 16 |
| | | Suhling Pond | 1,985 | 0.5 | 0.1 | 1.3 | 1.4 | 2.0 |
| **Grand Total** | | | **263,495** | **1.0 (av.)** | **0.1 (av.)** | **610** | **689** | **978** |

## 3.13 Gully Erosion

Gully erosion is the removal of soil along drainage lines by surface water runoff. Once started, gullies will continue to move by headward erosion or by slumping of the side walls unless steps are taken to stabilize the disturbance. Gully erosion occurs when water is channeled across unprotected land and washes away the soil along the drainage lines. Under natural conditions, run-off is moderated by vegetation which generally holds the soil together, protecting it from excessive run-off and direct rainfall. To repair gullies, the object is to divert and modify the flow of water moving into and through the gully so that scouring is reduced, sediment accumulates, and vegetation can establish. Stabilizing the gully head is important to prevent damaging water flow and headward erosion. In most cases, gullies can be prevented by good land management practices (Water Resources Solutions 2014).

Gully erosion was evaluated during a watershed windshield survey and estimated using GIS. Gully erosion presented in this section represents both ephemeral (those that form each year) and permanent (those that receive intermittent streamflow and expand over time such as a forested ditch or channel).

For those ephemeral gullies not visible from a road or observed during the windshield survey, GIS was used to estimate their location and extent. Gullies were delineated in GIS using aerial imagery and high-resolution elevation data, and a conservative average estimated width, depth, and years eroding were applied. For gullies observed in the field, dimensions were directly measured in the field and transferred to GIS for analysis.

Total net erosion in tons/year and estimates of nitrogen and phosphorus loading were calculated using GIS and equations derived from the EPA Region 5 Load Reduction Model. A distance-based delivery ratio was applied to account for distance to a receiving waterbody. Sediment trapping efficiency was accounted for, if the gully drained to a reservoir or other BMP. The following equations were applied to estimate gully erosion:

**Sediment (tons/yr)** = Length (ft) * Width (ft) * Depth (ft) / Years Eroding * Soil Weight Dry Density (tons/ft3)

**Nitrogen (lbs/yr)** = Sediment (tons/yr) * N concentration in soil (0.001 lbs/lb) * 2,000 (lbs/ton) * Correction Factor

**Phosphorus (lbs/yr)** = Sediment (tons/yr) * P concentration in soil (0.000262 lbs/lb) X 2,000 (lbs/ton) * Correction Factor

**Delivery Ratio** = Gully distance from lake or receiving perennial stream (ft)$^{-0.2069}$

Gully erosion in the watershed is prevalent, especially in steep forested draws or ephemeral water courses adjacent to major perennial drainage ways. Gully erosion is also evident on crop ground; conservation practices observed in the watershed, such as WASCBs or grassed waterways and other grade control structures, have been widely implemented to address this type of erosion.

Results indicate that there are 486 miles of eroding gullies, with an average depth of 1.1 ft and an average height of 1.4 ft (Table 43). These eroding gullies are responsible for the annual delivery of 21,483 tons of sediment, 12,364 lbs of phosphorus and 20,294 lbs of nitrogen. The highest sediment and nutrient loads from gully erosion are originating from the Coop Branch subwatershed; this subwatershed accounts for 31% of the gully sediment, 35% of the gully phosphorus load, and 36% of the gully nitrogen load. The Honey Creek subwatershed has the lowest total length and least sediment and nutrient loading from gully erosion of all subwatersheds.

**Eroding Forested Gully**

### Table 43 – Gully Erosion and Pollutant Loading

| Subwatershed | HUC12 Code | Gully Length Total (ft) | Gully Length Total (mi) | Average Gully Width (ft) | Average Gully Depth (ft) | Nitrogen (lb/yr) | Phosphorus (lb/yr) | Sediment (tons/yr) |
|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 71300120402 | 323,381 | 61 | 1.4 | 1.1 | 2,742 | 1,966 | 2,937 |
| Coop Branch | 071300120401 | 724,798 | 137 | 1.5 | 1.2 | 7,305 | 4,289 | 6,689 |
| Dry Fork | 071300120108 | 474,038 | 90 | 1.5 | 1.2 | 3,266 | 2,161 | 4,122 |
| Honey Creek | 071300120106 | 271,626 | 51 | 1.4 | 1.1 | 1,445 | 825 | 1,740 |
| Hurricane Creek | 071300120107 | 223,837 | 42 | 1 | 0.9 | 1,760 | 663 | 1,241 |
| Spanish Needle Creek | 071300120109 | 547,236 | 104 | 1.5 | 1.2 | 3,775 | 2,459 | 4,754 |
| **Grand Total** | | **2,564,915** | **486** | **1.4** | **1.1** | **20,294** | **12,364** | **21,483** |

**Ephemeral Cropland Gully**

**Stable Forested Gully**

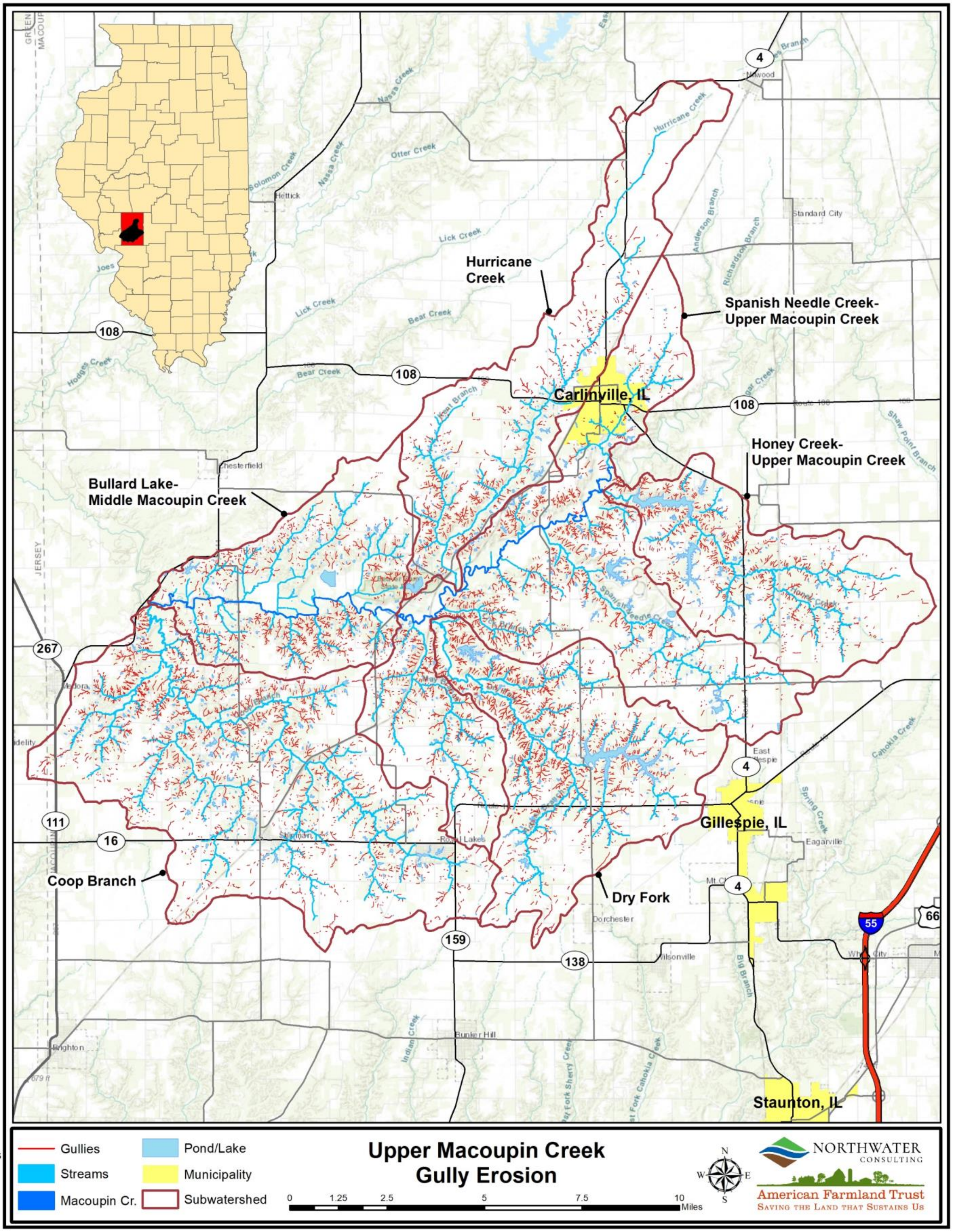



Figure 26 – Gully Erosion

## 3.14 Sheet and Rill Erosion


Erosion Control Structure

Through rain and shallow water flows, sheet erosion removes the thin layer of topsoil. When sheet flows begin to concentrate on the surface through increased water flow and velocity, rill erosion occurs. Rill erosion scours the land even more, carrying off rich nutrients and adding to the turbidity and sedimentation of waterways. The extent of sheet and rill erosion in the Waverly Lake watershed was calculated using the Universal Soil Loss Equation (USLE), which is widely used to estimate rates of soil erosion caused by rainfall and associated overland flow. This method relies on soil properties, precipitation, slope, cover types and conservation practices (if applicable). A map-based USLE model was developed for all cropped soils within the watershed and used to quantify sediment loading from agricultural ground and identify locations with the potential for excessive erosion.

Analysis shows sheet and rill erosion from cropland is responsible for the annual delivery of 99,309 tons of sediment and an average 0.81 tons/ac/yr of sediment is delivered from cropland (Table 44). Modeled results indicate that the majority of sheet and rill erosion is originating from conventionally tilled fields and from tilled HEL soils (Section 5) and those fields closest to a stream or the lake.

Coop Branch subwatershed contributes the highest amount of sediment from sheet and rill erosion (34,849 lbs/yr) while Honey Creek contributes the least or 2,990 lbs/yr (Table 44). Tillage methods that on average erode greater than 1 ton/ac/yr represent 56% of all cropland and are responsible for the annual delivery of 71% of the entire cropland sediment load (Table 45).

**Table 44 – Sheet and Rill Erosion Pollutant Loading**

| Subwatershed | HUC12 Code | Cropland Area (acres) | Sediment Load (tons/yr) | Sediment Load (tons/ac/yr) |
|---|---|---|---|---|
| Bullard Lake | 071300120402 | 7,248 | 13,117 | 0.55 |
| Coop Branch | 071300120401 | 22,102 | 34,849 | 0.63 |
| Dry Fork | 071300120108 | 10,925 | 11,015 | 0.99 |
| Honey Creek | 071300120106 | 9,208 | 2,990 | 3.1 |
| Hurricane Creek | 071300120107 | 13,492 | 14,257 | 0.95 |
| Spanish Needle Creek | 071300120109 | 17,703 | 23,081 | 0.77 |
| **Grand Total** | | **80,679** | **99,309** | **0.81** |

**Table 45 – Sheet and Rill Erosion Pollutant Loading by Tillage Type**

| Tillage Type | Total Area (ac) | % Cropland area (acres) | Sediment Load (tons/yr) | Sediment Load (tons/ac/yr) | % of Total Sediment Load from Sheet and Rill Erosion |
|---|---|---|---|---|---|
| Conventional | 18,142 | 22% | 35,484 | 4.4 | 36% |
| Cover Crop | 2,960 | 4% | 1,121 | 1.4 | 1.1% |
| Mulch-Till | 24,406 | 30% | 33,900 | 1.4 | 34% |
| No-Till | 8,322 | 10% | 5,830 | 0.70 | 5.9% |
| Reduced-Till | 23,594 | 29% | 21,989 | 1.0 | 22% |
| Strip-Till | 1,287 | 2% | 621 | 0.48 | 0.63% |
| Wheat/Hay | 1,967 | 2% | 365 | 0.42 | 0.37% |
| **Grand Total** | **80,679** | **100%** | **99,309** | **1.4 av.** | **100%** |

## 3.15 Point Source Pollution and Septic Systems

Point source pollution in the watershed comes from NPDES permitted dischargers. Septic systems, although typically considered to be a nonpoint source issue, exist in the watershed and may be contributing to nutrient loading in certain areas. Failing septic systems can leach wastewater into groundwater and surrounding waterways. Point source pollution is defined by the United States Environmental Protection Agency (USEPA) as “any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack” (Hill 1997). The NPDES, a provision of the Clean Water Act, prohibits point source discharge of pollutants into waters of the U.S. unless a permit is issued by the EPA or a state or tribal government. Individual permits are specific to individual facilities (e.g., water or wastewater treatment facilities), and general permits are for a group of facilities in a geographical area. Permits describe the allowed discharge of pollutant concentrations (mg/L) and loads (lbs/day). NPDES discharges contribute the greatest portion of annual point source pollution. This can be expected, as there are many more people dependent on wastewater treatment plants than on septic systems. Total loading from all point sources in the watershed is 20,588 lbs/yr of phosphorus and 66,643 lbs/yr of nitrogen.

### 3.15.1 NPDES Dischargers

A coal mining discharge, 5 sewage treatment plants (STP), and the City of Carlinville water treatment plant are the only permitted discharges in the watershed. These permitted dischargers are located within 4 of the 6 subwatersheds. Sediment and nutrient loading were calculated using permit data from the USEPA. For wastewater treatment plants without nutrient limits, average measured concentrations from other plants were used.

Permitted NPDES dischargers account for a total of 9.5 tons/yr sediment, 17,401 lbs/yr phosphorus, and 55,506 lbs/yr nitrogen (Table 46). The Spanish Needle Creek subwatershed is the highest contributor of sediment (6.4 tons/yr; 67%) and phosphorus (16,256 lbs/yr; 93%) from permitted discharges. Bullard Lake subwatershed has no permitted facilities and therefore no NPDES loading.

**Table 46 – NPDES Facilities and Pollutant Loading**

| Subwatershed | Subwatershed | NPDES Permit Number | Facility Name | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Sediment Load (tons/yr) | Average Daily Flow (MGD) |
|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | IL0071391 | Village of Royal Lakes STP | 94 | 27 | 0.04 | 0.004 |
| | | IL0063088 | Shipman STP | 1,492 | 434 | 0.24 | 0.062 |
| *Coop Branch Subwatershed, Total* | | | | 1,586 | 461 | 0.28 | 0.066 |
| Honey Creek | 071300120106 | ILG640065 | Carlinville Waterworks System | 60 | 18 | 0.001 | 0.003 |
| | | IL0045373 | Lake Williamson Christian Center STP | 722 | 210 | 0.53 | 0.03 |
| *Honey Creek, Total* | | | | 782 | 228 | 0.53 | 0.033 |
| Hurricane Creek | 071300120107 | ILG580147 | Village of Herrick STP | 1,564 | 455 | 2.3 | 0.065 |
| *Hurricane Creek Subwatershed, Total* | | | | 1,564 | 455 | 2.3 | 0.065 |
| Spanish Needle Creek | 071300120109 | IL0022675 | Carlinville STP | 3,445 | 2,244 | 0.69 | 1.2 |
| | | IL0056022 | Macoupin Energy LLC | 48,128 | 14,012 | 5.7 | 2 |
| *Spanish Needle Creek Subwatershed, Total* | | | | 51,573 | 16,256 | 6.4 | 3 |
| **Grand Total** | | | | **55,506** | **17,401** | **9.52** | **3.36** |

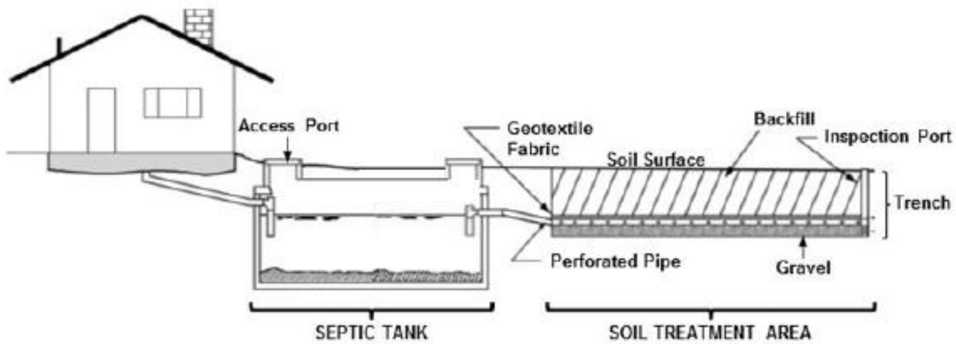
### 3.15.2 Septic Systems

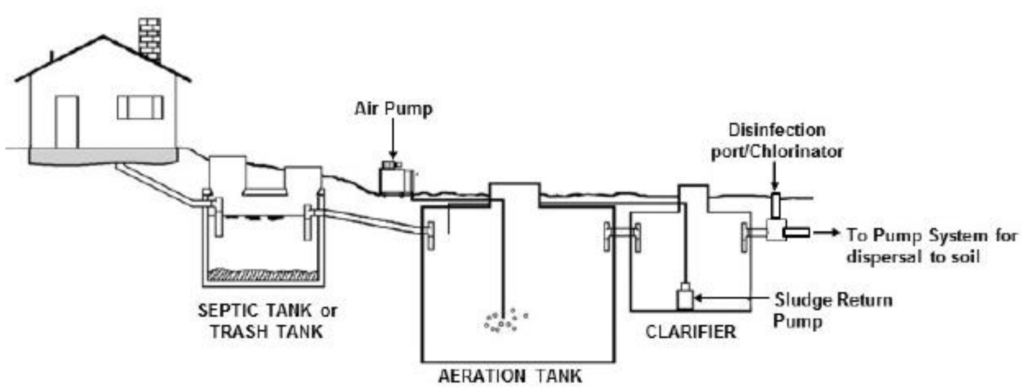
Outside of the City of Carlinville, septic systems provide treatment of wastewater from individual properties. Failing septic systems are typically an active source of pollutants. Faulty or leaking septic systems are sources of bacteria, nitrogen, and phosphorus. Typical national septic system failure rates are 10-20% but vary widely depending on the local definition of failure; no failure rates are reported specifically for Illinois (USEPA 2002). Therefore, a 15% failure rate was used for analysis.

Every home in the watershed outside the City of Carlinville was located and mapped using GIS to estimate the number of individual residential homes using septic systems (Figure 27). Corresponding nitrogen and phosphorus loads were then estimated using the Spreadsheet Tool for Estimating Pollution Loading (STEPL). Assuming a septic system failure rate of 15%, it is possible that 262 homes have failing septic systems (Table 47); due to the planning nature of this analysis, the exact locations of these systems are unknown. Potentially failing septic systems contribute an estimated 3,187 lbs/yr of phosphorus and 8,137 lbs/yr of nitrogen. For the purposes of this report, it is assumed that these loadings do make it waterways; however, loading is a function of location to a waterway and it is possible that septic water from a portion of failing systems may be absorbed or filtered prior to entering waterways. The greatest number of potential failing systems (623), and ultimately loading is in the Coop Branch subwatershed; Bullard Lake contains the least (88).

### Table 47 – Potentially Failing Septic Systems Nutrient Loading

| Subwatershed | HUC12 Code | Septic System Count | Failing Septic Systems Count | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) |
|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | 88 | 13 | 410 | 161 |
| Coop Branch | 071300120401 | 623 | 93 | 2,905 | 1,138 |
| Dry Fork | 071300120108 | 330 | 50 | 1,539 | 603 |
| Honey Creek | 071300120106 | 151 | 23 | 704 | 276 |
| Hurricane Creek | 071300120107 | 269 | 40 | 1,254 | 491 |
| Spanish Needle Creek | 071300120109 | 284 | 43 | 1,324 | 519 |
| **Grand Total** | | **1,745** | **262** | **8,137** | **3,187** |




**Septic Systems: Conventional (above) and Aerobic Treatment (below)**
*Credit: OSU 2017*

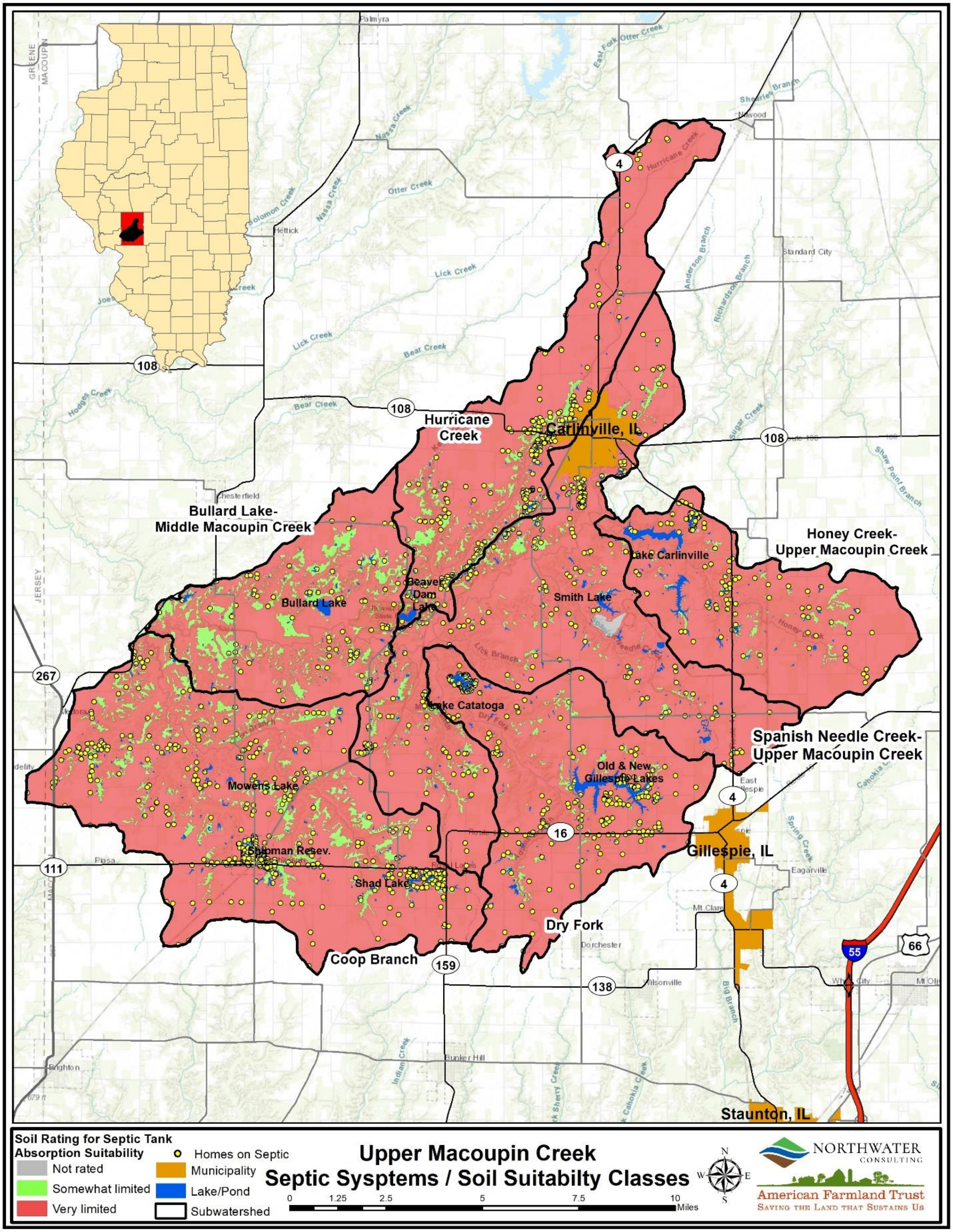



Figure 27 – Homes with Septic Systems and Soil Suitability Classes

# 4.0 Pollutant Loading

## 4.1 Introduction and Methodology

A watershed survey was completed to gain an understanding of conditions and features and to collect field-specific data. Data collected included tillage practices, cover types, project (BMP) locations and site suitability, and sources of sediment and gully erosion. This survey, combined with interpretation of aerial imagery, resulted in the identification of site-specific BMP locations. Drainage areas were then delineated for each site.

A spatially and field-specific GIS-based pollution loading model (SWAMM) was developed to estimate loading from direct runoff. Model methodology is provided in Appendix A; the model simulates surface runoff using the curve number approach, local precipitation, the USLE, and Event Mean Concentrations (EMCs) specific to landuse and soil types in the watershed. In addition, field survey data was incorporated into the model, such as tillage practices, gully erosion and existing conservation practices.

## 4.2 Pollutant Loading

Pollutant load estimates are presented in this section. Estimates are provided for loading resulting from septic systems, NPDES dischargers, surface runoff, gully erosion, and streambank and lake shoreline erosion. Gully and streambank erosion were observed in the field to the extent it was visible; lake shoreline erosion was directly assessed for those lakes which are named. Loading from septic systems was estimated based on those homes not connected to a wastewater treatment system, and NPDES discharge data was acquired from the USEPA. Results from the GIS-based direct surface runoff pollution load model are illustrated in Figure 28, Figure 29, and Figure 30. Loading from direct, surface runoff accounts for what is contributed from overland flow.

As presented in Table 48, total annual loading to the watershed from all sources is 164,519 lbs of phosphorus, 145,531 tons of sediment, and 1,536,119 lbs of nitrogen. Direct runoff is responsible for nearly 72% of the phosphorus, 70% of the sediment load, and 93% of the nitrogen load. All other sources combined- failing septic systems, point source discharges, lake shoreline, streambank erosion, and gully erosion- account for 28% of the phosphorus load, 30% of the sediment load, and 7.1% of the nitrogen load.

**Table 48 – Pollution Loading Summary**

| Pollution Source | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Sediment Load (tons/yr) | Nitrogen Load (% total) | Phosphorus Load (% total) | Sediment Load (% total) |
|---|---|---|---|---|---|---|
| Gully Erosion | 20,294 | 12,364 | 21,483 | 1.3% | 7.5% | 14.8% |
| Surface Runoff | 1,423,770 | 117,522 | 101,089 | 92.7% | 71.4% | 69.5% |
| Streambank Erosion | 27,802 | 13,356 | 21,971 | 1.8% | 8.1% | 15.1% |
| Lake Shoreline Erosion | 610 | 689 | 978 | 0.04% | 0.42% | 0.67% |
| Septic Systems | 8,137 | 3,187 | 0 | 0.53% | 1.9% | 0.00% |
| NPDES Discharge | 55,506 | 17,401 | 9.5 | 3.6% | 10.6% | 0.01% |
| **Grand Total** | **1,536,119** | **164,519** | **145,531** | **100%** | **100%** | **100%** |

Modeled pollution loading from surface runoff is reported in Table 49, and depicted in Figure 28, Figure 29, and Figure 30. Per-acre results are calculated by dividing the total annual load of a given landuse category by the total number of acres. Results show that cropland contributes the greatest total amount of per-acre loadings of phosphorus, nitrogen, and sediment; the notable exception are livestock confinements, feed areas and pasture, which on average exceed the per-acre phosphorus and nitrogen loadings from cropland. Cropland delivers 100,449 lbs/yr of phosphorus, or 1.2 lbs/ac/yr; 1,280,157 lbs/yr of nitrogen, or 15.9 lbs/ac/yr; and 99,309 tons, or 1.2 tons/ac/yr of sediment. It is important to note that these results represent delivered loads for all fields in the watershed combined; individual fields deliver soil and nutrients at different rates based on tillage practices, soil and slope characteristics, proximity to a waterbody, and whether a BMP is in place.

Modeled per-acre sediment delivery rates from cropland range from 0.001 tons/ac/yr–78 tons/ac/yr. Phosphorus delivery rates range from 0.05 lbs/ac/yr–39 lbs/ac/yr and nitrogen delivery rates range from 0.5 lbs/ac/yr to as high as 190 lbs/ac/yr.

Other landuse categories, such pasture, ponds and lakes, forests, streams, and grasslands, are the next highest contributors of total nutrient and sediment loads from surface runoff, respectively. Although per-acre loading from forest, grasslands, ponds and lakes is low compared to other landuse categories, the watershed contains a high percentage of these landuses and, therefore, cumulative loading is higher.

### Table 49 – Pollution Loading from Surface Runoff by Landuse

| Landuse Category | Area (acres) | Nitrogen Load | | Phosphorus Load | | Sediment Load | |
|---|---|---|---|---|---|---|---|
| | | lbs/yr | lbs/ac/yr | lbs/yr | lbs/ac/yr | tons/yr | tons/ac/yr |
| Camp Site | 8.9 | 15 | 1.7 | 1.8 | 0.2 | 0.16 | 0.02 |
| Cemetery | 21 | 45 | 2.1 | 6.5 | 0.31 | 0.37 | 0.02 |
| Commercial | 203 | 1,053 | 5.2 | 162 | 0.8 | 25 | 0.12 |
| Confinement | 18 | 289 | 16 | 71 | 3.9 | 3.4 | 0.19 |
| Farm Building | 573 | 5,570 | 9.7 | 391 | 0.68 | 67 | 0.12 |
| Feed Area | 71 | 1,433 | 20.2 | 313 | 4.4 | 14 | 0.2 |
| Forest | 31,944 | 30,217 | 0.95 | 3,318 | 0.1 | 521 | 0.02 |
| Golf Course | 34 | 85 | 2.5 | 17 | 0.49 | 0.8 | 0.02 |
| Grasslands | 10,096 | 5,172 | 0.51 | 720 | 0.07 | 64 | 0.01 |
| Industrial | 56 | 231 | 4.1 | 33 | 0.59 | 6.2 | 0.11 |
| Institutional | 144 | 773 | 5.4 | 101 | 0.7 | 16 | 0.11 |
| Junk Yard | 18 | 56 | 3 | 8.3 | 0.45 | 2.3 | 0.12 |
| Manufacturing | 87 | 476 | 5.4 | 74 | 0.85 | 16 | 0.18 |
| Manure Storage | 1.5 | 17 | 11.2 | 3.1 | 2 | 0.16 | 0.1 |
| Marina | 2.3 | 14 | 6.2 | 1.7 | 0.76 | 0.11 | 0.05 |
| Open Water - Stream | 1,041 | 16,700 | 16 | 1,920 | 1.8 | 333 | 0.32 |
| Open Water Pond/Reservoir | 1,978 | 24,518 | 12.4 | 2,324 | 1.2 | 41 | 0.02 |
| Orchards and Nurseries | 93 | 157 | 1.7 | 22 | 0.23 | 1.5 | 0.02 |
| Parks and Recreation | 198 | 388 | 2 | 89 | 0.45 | 1.6 | 0.01 |
| Pasture | 3,828 | 37,226 | 9.7 | 4,829 | 1.3 | 356 | 0.09 |
| Railroad | 182 | 479 | 2.6 | 90 | 0.5 | 18 | 0.1 |
| Resource Extraction | 388 | 381 | 0.98 | 69 | 0.18 | 6.8 | 0.02 |
| Roads | 1,189 | 6,948 | 5.8 | 1,087 | 0.92 | 152 | 0.13 |
| Row Crops | 80,679 | 1,280,157 | 15.9 | 100,449 | 1.2 | 99,309 | 1.2 |

| Landuse Category | Area (acres) | Nitrogen Load | | Phosphorus Load | | Sediment Load | |
|---|---|---|---|---|---|---|---|
| | | lbs/yr | lbs/ac/yr | lbs/yr | lbs/ac/yr | tons/yr | tons/ac/yr |
| Rural Residential | 492 | 1,770 | 3.6 | 257 | 0.52 | 31 | 0.06 |
| Urban Open Space | 3,471 | 7,071 | 2 | 798 | 0.23 | 54 | 0.02 |
| Urban Residential | 518 | 1,862 | 3.6 | 308 | 0.59 | 40 | 0.08 |
| Utilities | 30 | 49 | 1.6 | 10 | 0.33 | 0.9 | 0.03 |
| Warehousing | 60 | 270 | 4.5 | 46 | 0.76 | 7.4 | 0.12 |
| Wetlands | 250 | 341 | 1.4 | 4.9 | 0.02 | 0.22 | 0.001 |
| Winery | 4.5 | 10 | 2.2 | 1.5 | 0.34 | 0.12 | 0.03 |
| **Grand Total** | **137,682** | **1,423,770** | **10.3 av.** | **117,522** | **0.85 av.** | **101,089** | **0.73 av.** |

Table 50 compares the loadings originating from direct runoff with the summed watershed load from all sources. Row crops are the greatest contributor, responsible for 62% of the total phosphorus, 83% of total nitrogen load, and 69% of the total sediment loads. Pasture and forest are the second and third highest contributors of surface runoff nutrient loads, at 2.9% and 2.0% of phosphorus and 2.4% and 2.0% of nitrogen, respectively. Forest is the second highest contributor of sediment (0.36%) and pasture is third highest (0.25%). Livestock confinements, feed areas, pasture, and open waters contribute some of the highest per-acre nitrogen and phosphorus loads (Table 49). Roads can deliver relatively high per-acre and total sediment loads; this is primarily a function of higher runoff rates and less infiltration, and the fact they usually cover a relatively large percent of the watershed.

### Table 50 – Loading from Surface Runoff by Landuse as Percentage of Total Watershed Load

| Landuse Category | Area (acres) | Nitrogen Load | | Phosphorus Load | | Sediment Load | |
|---|---|---|---|---|---|---|---|
| | | lbs/yr | % Total Watershed Load | lbs/yr | % Total Watershed Load | tons/yr | % Total Watershed Load |
| Camp Site | 8.9 | 15 | 0.001% | 1.8 | 0.001% | 0.16 | 0.0001% |
| Cemetery | 21 | 45 | 0.003% | 6.5 | 0.004% | 0.37 | 0.0003% |
| Commercial | 203 | 1,053 | 0.07% | 162 | 0.10% | 25 | 0.02% |
| Confinement | 18 | 289 | 0.02% | 71 | 0.04% | 3.4 | 0.002% |
| Farm Building | 573 | 5,570 | 0.36% | 391 | 0.24% | 67 | 0.05% |
| Feed Area | 71 | 1,433 | 0.09% | 313 | 0.19% | 14 | 0.01% |
| Forest | 31,944 | 30,217 | 2.0% | 3,318 | 2.0% | 521 | 0.36% |
| Golf Course | 34 | 85 | 0.01% | 17 | 0.01% | 0.8 | 0.001% |
| Grasslands | 10,096 | 5,172 | 0.34% | 720 | 0.44% | 64 | 0.04% |
| Industrial | 56 | 231 | 0.02% | 33 | 0.02% | 6.2 | 0.004% |
| Institutional | 144 | 773 | 0.05% | 101 | 0.06% | 16 | 0.01% |
| Junk Yard | 18 | 56 | 0.004% | 8.3 | 0.01% | 2.3 | 0.002% |
| Manufacturing | 87 | 476 | 0.03% | 74 | 0.05% | 16 | 0.01% |
| Manure Storage | 1.5 | 17 | 0.001% | 3.1 | 0.002% | 0.16 | 0.0001% |
| Marina | 2.3 | 14 | 0.001% | 1.7 | 0.001% | 0.11 | 0.0001% |
| Open Water - Stream | 1,041 | 16,700 | 1.1% | 1,920 | 1.2% | 333 | 0.23% |
| Open Water Pond/Reservoir | 1,978 | 24,518 | 1.6% | 2,324 | 1.4% | 41 | 0.03% |
| Orchards and Nurseries | 93 | 157 | 0.01% | 22 | 0.01% | 1.5 | 0.001% |
| Parks and Recreation | 198 | 388 | 0.03% | 89 | 0.05% | 1.6 | 0.001% |
| Pasture | 3,828 | 37,226 | 2.4% | 4,829 | 2.9% | 356 | 0.25% |
| Railroad | 182 | 479 | 0.03% | 90 | 0.06% | 18 | 0.01% |
| Resource Extraction | 388 | 381 | 0.02% | 69 | 0.04% | 6.8 | 0.005% |

| Landuse Category | Area (acres) | Nitrogen Load | | Phosphorus Load | | Sediment Load | |
|---|---|---|---|---|---|---|---|
| | | lbs/yr | % Total Watershed Load | lbs/yr | % Total Watershed Load | tons/yr | % Total Watershed Load |
| Roads | 1,189 | 6,948 | 0.45% | 1,087 | 0.66% | 152 | 0.11% |
| Row Crops | 80,679 | 1,280,157 | 83.4% | 100,449 | 61.3% | 99,309 | 68.7% |
| Rural Residential | 492 | 1,770 | 0.12% | 257 | 0.16% | 31 | 0.02% |
| Urban Open Space | 3,471 | 7,071 | 0.46% | 798 | 0.49% | 54 | 0.04% |
| Urban Residential | 518 | 1,862 | 0.12% | 308 | 0.19% | 40 | 0.03% |
| Utilities | 30 | 49 | 0.003% | 10 | 0.01% | 0.9 | 0.001% |
| Warehousing | 60 | 270 | 0.02% | 46 | 0.03% | 7.4 | 0.01% |
| Wetlands | 250 | 341 | 0.02% | 4.9 | 0.003% | 0.22 | 0.0002% |
| Winery | 4.5 | 10 | 0.001% | 1.5 | 0.001% | 0.12 | 0.0001% |
| **Grand Total** | **137,682** | **1,423,770** | **92.7%** | **117,522** | **71.7%** | **101,089** | **69.9%** |

*Note: Percentages do not add up to 100% because direct runoff is not the only source of loading in the watershed. Streambank erosion, lake shoreline erosion, gully erosion, septic systems, and NPDES dischargers are responsible for the remaining percentage.*

**UMC Watershed Road**

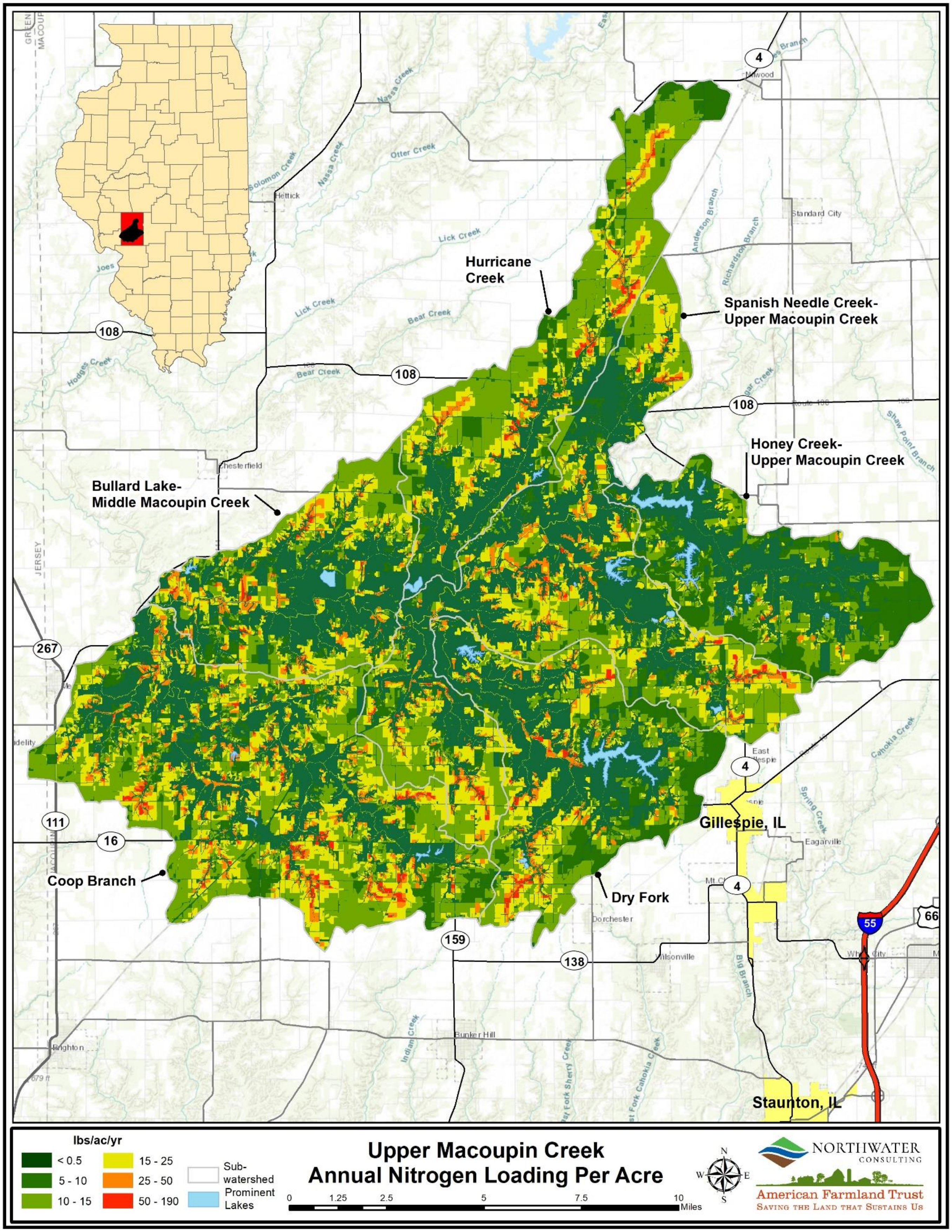



Figure 28 – Annual Nitrogen Loading Per Acre from Direct Surface Runoff

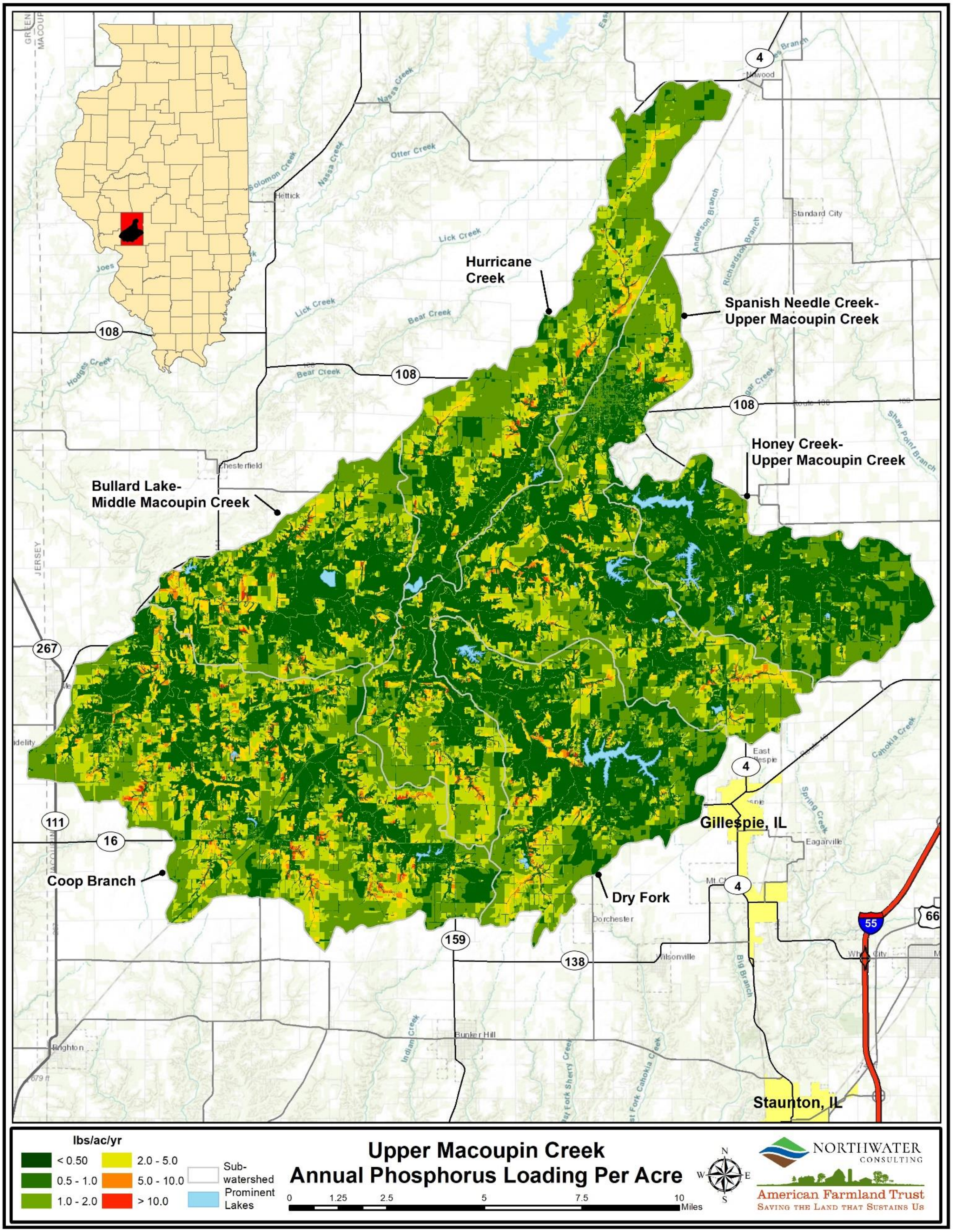



Figure 29 – Annual Phosphorus Loading Per Acre from Direct Surface Runoff

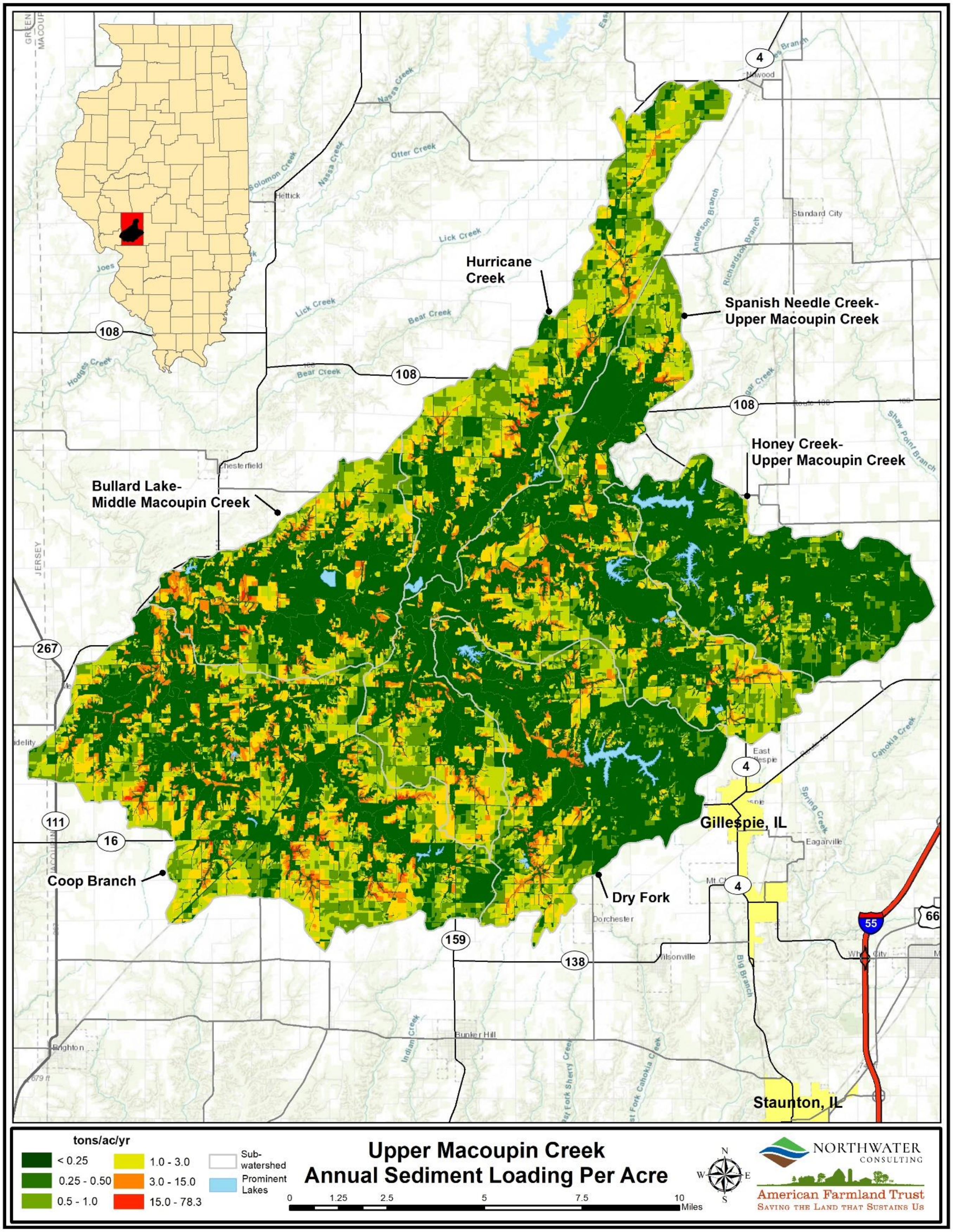



Figure 30 – Annual Sediment Loading Per Acre from Direct Surface Runoff

# 5.0 Sources of Watershed Impairments

Watershed impairments originate from either NPS or point source pollution. A description of point source pollution is given in Section 3.15.1. NPS pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. The term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source." Unlike pollution from point sources like industrial and sewage treatment plants, NPS pollution comes from many diffuse sources and is caused by rainfall or snowmelt moving over and through the ground. The runoff picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters (USEPA 2018).

**Cropland Surface Erosion**

In the UMC watershed, sources of sediment and nutrients are thought to be originating from cropland, gullies, streambank and lake shoreline erosion. Point source discharges contribute to watershed loading and leaking or improperly maintained septic systems may also be a source of nutrients.

The following section provides pollutant source descriptions identified at the significant subcategory level, along with estimates to the extent they are present in the watershed. The section looks at the greatest contributions and spatial extent of loading by each major source.

## 5.1 Phosphorus and Nitrogen

The primary source of both nitrogen and phosphorus in the watershed is surface runoff from cropland, which is responsible for 83% of the total watershed nitrogen and 61% of the phosphorus load (Table 51). Secondary sources include eroding gullies (agricultural and non-agricultural), surface runoff from non-croplands, stream and lake bank erosion, septic systems, and point sources.

**Table 51 – Nutrient Loading from all Sources**

| Pollutant Source | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Nitrogen Load (% total) | Phosphorus Load (% total) |
|---|---|---|---|---|
| Gully Erosion (cropland) | 9,598 | 2,508 | 0.6% | 1.5% |
| Gully Erosion (non-cropland) | 10,696 | 9,856 | 0.7% | 6.0% |
| Surface Runoff: Cropland | 1,280,157 | 100,449 | 83% | 61% |
| Streambank Erosion | 27,802 | 13,356 | 1.8% | 8.2% |
| Lake Shoreline Erosion | 610 | 689 | 0.04% | 0.42% |
| Septic Systems | 8,137 | 3,187 | 0.5% | 1.9% |
| NPDES Discharges (point source) | 55,506 | 17,401 | 3.6% | 11% |
| Surface Runoff: Non-Cropland | 143,613 | 17,073 | 9.4% | 10% |
| **Grand Total** | **1,536,119** | **164,519** | **100%** | **100%** |

### 5.1.1 Cropland

The amount of nutrients originating from cropland depends on tillage practices, proximity to a receiving waterbody, and the presence or absence of conservation practices; although tiling was not directly investigated as a source or loads quantified, tile flow can have large impacts on nitrogen loading. To better understand the extent of nutrient loading from cropland, an analysis was performed to investigate the total and per-acre loading by tillage type and soil HEL designation. Results are presented in Table 52 and Table 53.

#### *Tillage*

Conventional till has the highest annual per-acre loading of nutrients and contributes about 29% of the phosphorus and 26% of total nitrogen loads from cropland (Table 52). Together, conventional, mulch-till, and reduced-till are responsible for most of the cropland nutrient loading or 89% and 88% of phosphorus and nitrogen, respectively. Cover crops, no-till, strip-till, and wheat/hay combined only produce 11% of phosphorus load and 12% of the nitrogen. Annual per-acre loadings from conventional, mulch and reduced-till range 1.1–1.6 lbs/ac for phosphorus and 15.4–18.6 lbs/ac for nitrogen. In contrast, annual per-acre loading from cover crops, no-till, strip-till, and wheat/hay range 0.4–0.9 lbs/ac for phosphorus and 4.9–12.7 lbs/ac for nitrogen.

**Table 52 – Cropland Nutrient Loading by Tillage Type**

| Tillage Type | Area (ac) | Area (% cropland) | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Nitrogen Load (% cropland total) | Phosphorus Load (% cropland total) | Nitrogen Load per Acre (lbs/ac/yr) | Phosphorus Load per Acre (lbs/ac/yr) |
|---|---|---|---|---|---|---|---|---|
| Conventional | 18,142 | 22% | 338,127 | 28,860 | 26.4% | 28.7% | 18.6 | 1.6 |
| Cover Crop | 2,833 | 3.5% | 20,281 | 1,655 | 1.6% | 1.6% | 7.2 | 0.59 |
| Mulch-Till | 24,510 | 30% | 429,621 | 34,326 | 33.6% | 34.2% | 17.5 | 1.4 |
| No-Till | 8,322 | 10% | 105,613 | 7,548 | 8.3% | 7.5% | 12.7 | 0.91 |
| Reduced-Till | 23,594 | 29% | 362,896 | 26,378 | 28.3% | 26.3% | 15.4 | 1.1 |
| Strip-Till | 1,312 | 1.6% | 13,993 | 898 | 1.1% | 0.9% | 10.7 | 0.68 |
| Wheat/Hay | 1,967 | 2.4% | 9,626 | 784 | 0.8% | 0.8% | 4.9 | 0.40 |
| **Grand Total** | **80,679** | **100%** | **1,280,157** | **100,449** | **100%** | **100%** | **15.9** | **1.2** |

#### *HEL Soils*

An analysis was performed to better understand the extent of nutrient loading based on HEL soils in combination with tillage practices; results are presented in Table 53.

Even though HEL soils make up only 13% of total area, they account for 27% of phosphorus and 19% of nitrogen loading from cropland. These soils have much higher per-acre nutrient loading than non-HEL soils; on average, phosphorus loading per acre is twice as high on HEL soils, and nitrogen loading is 1.5 times higher.

Conventional tillage of HEL soils has the highest annual per-acre phosphorus (3.8 lbs/ac) and nitrogen (32 lbs/ac) load. Annual per-acre loadings of HEL soil from conventional, mulch and reduced-till range 2.6–3.8 lbs/ac for phosphorus and 24.6–32 lbs/ac for nitrogen. In contrast, HEL annual per-acre loading from cover crops, no-till, strip-till, and wheat/hay range 0.5–2.2 lbs/ac for phosphorus and 4.7–20.7 lbs/ac for nitrogen. Per-acre loadings of HEL soils, regardless of tillage type, are about two times higher than non-HEL. For example, annual per-acre loading of conventional tillage on HEL soils (32.0 lbs/ac) is nearly twice that of non-HEL soils (17.0 lbs/ac/yr). Although most cropland nutrient loading comes from non-HEL soils, HEL soils contribute higher loading per acre.

**Table 53 – Cropland Nutrient Loading by HEL Soils and Tillage Type**

| Tillage Type | Soil Type* | Area (ac) | Area (% cropland) | Nitrogen Load (lbs/yr) | Phosphorus Load (lbs/yr) | Nitrogen Load (% cropland total) | Phosphorus Load (% cropland total) | Nitrogen Load per Acre (lbs/ac/yr) | Phosphorus Load per Acre (lbs/ac/yr) |
|---|---|---|---|---|---|---|---|---|---|
| Conventional | HEL | 2,011 | 2.5% | 64,418 | 7,612 | 5.0% | 7.6% | 32.0 | 3.8 |
| | NHEL | 16,130 | 20.0% | 273,709 | 21,248 | 21.4% | 21.2% | 17.0 | 1.3 |
| Cover Crop | HEL | 612 | 0.8% | 5,658 | 604 | 0.4% | 0.6% | 9.1 | 0.96 |
| | NHEL | 2,221 | 2.8% | 15,596 | 1,151 | 1.1% | 1.1% | 6.6 | 0.48 |
| Mulch-Till | HEL | 3,378 | 4.2% | 85,744 | 9,473 | 6.7% | 9.4% | 25.4 | 2.8 |
| | NHEL | 21,131 | 26.2% | 343,051 | 24,766 | 26.9% | 24.7% | 16.3 | 1.2 |
| No-Till | HEL | 1,538 | 1.9% | 26,458 | 2,731 | 2.1% | 2.7% | 17.2 | 1.8 |
| | NHEL | 6,783 | 8.4% | 79,155 | 4,816 | 6.2% | 4.8% | 11.7 | 0.71 |
| Reduced-Till | HEL | 2,230 | 2.8% | 54,959 | 5,788 | 4.3% | 5.8% | 24.6 | 2.6 |
| | NHEL | 21,364 | 26.5% | 307,937 | 20,590 | 24.1% | 20.5% | 14.4 | 0.96 |
| Strip-Till | HEL | 114 | 0.1% | 2,363 | 247 | 0.2% | 0.2% | 20.7 | 2.2 |
| | NHEL | 1,197 | 1.5% | 11,483 | 639 | 0.9% | 0.6% | 9.7 | 0.54 |
| Wheat/Hay Till | HEL | 593 | 0.7% | 2,795 | 294 | 0.2% | 0.3% | 4.7 | 0.50 |
| | NHEL | 1,374 | 1.7% | 6,831 | 490 | 0.5% | 0.5% | 5.0 | 0.36 |
| ***HEL*** | | ***10,477*** | ***13%*** | ***242,396*** | ***26,749*** | ***19%*** | ***27%*** | ***23.1*** | ***2.6*** |
| ***NHEL*** | | ***70,202*** | ***87%*** | ***1,037,761*** | ***73,700*** | ***81%*** | ***73%*** | ***14.8*** | ***1.0*** |
| **Cropland, Total** | | **80,679** | **100%** | **1,280,157** | **100,449** | **100%** | **100%** | **15.9** | **1.2** |
| **HEL = highly erodible soils and potentially highly erodible soils; NHEL = non-highly erodible soils.* | | | | | | | | | |

## 5.1.2 Gullies, Lake Shorelines, Streambanks, Septic Systems, and Point Sources

Surface runoff from non-cropland is the second highest source of phosphorus (10%) and nitrogen (9.4%) loading (Table 51). NPDES dischargers are the next highest source, contributing 11% of the phosphorus and 3.6% of the total nitrogen loads. Streambank erosion delivers only 2% of the total annual nitrogen load and 8% of the total phosphorus load. Gully erosion delivers only 1.3% of the total annual nitrogen and 7.5% of the total phosphorus load; gullies on cropland deliver a large portion, or 20% of phosphorus and 47% of nitrogen, of total gully loading. Annually, lake shoreline erosion and potentially failing septic systems together deliver about 2% of the phosphorus and 0.5% of the nitrogen loads.

## 5.2 Total Suspended Solids

The primary source of TSS in the watershed is cropland sheet and rill erosion, responsible for 69% of the entire sediment load (Table 54). Secondary sources include eroding gullies (agricultural and non-agricultural), surface runoff from non-croplands, stream and lake bank erosion, septic systems, and point sources.

**Table 54 – Sediment Loading from All Sources**

| Pollutant Source | Sediment Load (tons/yr) | Sediment Load (% total) |
|---|---|---|
| Gully Erosion (cropland) | 4,796 | 3.3% |
| Gully Erosion (non-cropland) | 16,687 | 12% |
| Surface Runoff: Cropland | 99,309 | 69% |
| Streambank Erosion | 21,971 | 15% |
| Lake Shoreline Erosion | 978 | 0.7% |
| Septic Systems | 0 | 0% |
| NPDES Discharges (point source) | 9.5 | 0.007% |
| Surface Runoff: Non-Cropland | 1,780 | 1.2% |
| **Grand Total** | **144,562** | **100%** |

### 5.2.1 Cropland

The amount of sediment originating from cropland depends on tillage practices, proximity to a receiving waterbody, the presence or absence of conservation practices, and land slope. To better understand the extent of sediment loading from cropland, an analysis was performed to investigate the total and per-acre loading by tillage practices and soil HEL designation. Results are presented in Table 55 and Table 56.

#### *Tillage*

Conventional till contributes the highest annual per-acre load of sediment (2 tons/ac) and the largest portion (36%) of the total load from cropland, even though it is only applied on 22% of all cropped acres (Table 55). Together, conventional, mulch and reduced-till are responsible for 92% of sediment loading, while cover crops, no-till, strip-till, and wheat/hay till are only responsible for 8%. Annual per-acre loadings from conventional, mulch and reduced-till range from 0.9–2.0 tons/ac, while per-acre loading from cover crops, no-till, strip-till, and wheat/hay is 0.2–0.7 tons/ac.

**Table 55 – Cropland Sediment Loading by Tillage Type**

| Tillage Type | Area (ac) | Area (% cropland) | Sediment Load (tons/yr) | Sediment Load (% Cropland total) | Sediment Load per Acre (tons/ac/yr) |
|---|---|---|---|---|---|
| Conventional | 18,142 | 22% | 35,484 | 35.7% | 2.0 |
| Cover Crop | 2,960 | 3.5% | 1,121 | 1.0% | 0.37 |
| Mulch-Till | 24,406 | 30% | 33,900 | 34.2% | 1.4 |

| Tillage Type | Area (ac) | Area (% cropland) | Sediment Load (tons/yr) | Sediment Load (% Cropland total) | Sediment Load per Acre (tons/ac/yr) |
|---|---|---|---|---|---|
| No-Till | 8,322 | 10% | 5,830 | 5.9% | 0.70 |
| Reduced-Till | 23,594 | 29% | 21,989 | 22.1% | 0.93 |
| Strip-Till | 1,287 | 1.6% | 621 | 0.6% | 0.48 |
| Wheat/Hay | 1,967 | 2.4% | 365 | 0.4% | 0.19 |
| **Grand Total** | **80,679** | **100%** | **99,309** | **100%** | **1.2** |

### *HEL Designation*

An analysis was performed to better understand the extent of sediment loading based on HEL soils and tillage; results are presented in Table 56.

Although HEL soils make up only 13% of total watershed cropland area, they account for 36% of its sediment load. On average, HEL soils have nearly four times higher annual per-acre loading rates than non-HEL soils (3.4 tons/ac vs. 0.9 tons/ac).

Conventional tillage of HEL soils results in the greatest annual per-acre sediment loading (6.1 tons/ac), which is 2-7 times higher than other tillage types. Annual per-acre loads of HEL soils from conventional, mulch and reduced-till range from 3.1–6.1 lbs/ac, while per-acre loads from cover crops, no-till, strip-till, and wheat/hay range from only 0.3–2.5 tons/ac. Per-acre loadings of HEL soils, regardless of tillage type, are about three times higher than non-HEL. For example, conventional tillage of HEL soils is over four times that of non-HEL soils or 6.1 tons/ac/yr versus 1.4 tons/ac/yr. Although most of the cropland total sediment load comes from non-HEL soils, HEL soils contribute higher loads per acre.

**Table 56 – Cropland Sediment Loading by HEL Soils and Tillage Type**

| Tillage Type | Soil Type* | Area (ac) | Area (% of copped soil) | Sediment Load (tons/yr) | Sediment Load (% total) | Sediment Load per Acre (tons/ac/yr) |
|---|---|---|---|---|---|---|
| Conventional | HEL | 2,011 | 2.5% | 12,228 | 12.3% | 6.1 |
| | NHEL | 16,130 | 20.0% | 23,255 | 23.4% | 1.4 |
| Cover Crop | HEL | 612 | 0.8% | 543 | 0.5% | 0.9 |
| | NHEL | 2,221 | 2.8% | 492 | 0.5% | 0.2 |
| Mulch-Till | HEL | 3,378 | 4.2% | 12,607 | 12.7% | 3.7 |
| | NHEL | 21,131 | 26.2% | 21,372 | 21.5% | 1.0 |
| No-Till | HEL | 1,538 | 1.9% | 2,826 | 2.8% | 1.8 |
| | NHEL | 6,783 | 8.4% | 3,004 | 3.0% | 0.4 |
| Reduced-Till | HEL | 2,230 | 2.8% | 6,995 | 7.0% | 3.1 |
| | NHEL | 21,364 | 26.5% | 14,994 | 15.1% | 0.7 |
| Strip-Till | HEL | 114 | 0.1% | 281 | 0.3% | 2.5 |
| | NHEL | 1,197 | 1.5% | 348 | 0.4% | 0.3 |
| Wheat/Hay Till | HEL | 593 | 0.7% | 203 | 0.2% | 0.3 |
| | NHEL | 1,374 | 1.7% | 162 | 0.2% | 0.1 |
| ***HEL*** | | ***10,477*** | ***13%*** | ***35,682*** | ***36%*** | ***3.4*** |
| ***NHEL*** | | ***70,202*** | ***87%*** | ***63,626*** | ***64%*** | ***0.9*** |
| **Cropland, Total** | | **80,679** | **100%** | **99,309** | **100%** | **1.2** |

**HEL = highly erodible soils and potentially highly erodible soils; NHEL = non-highly erodible soils.*

### 5.2.2 Gullies, Lake Shorelines, Streambanks, and Point Sources

Streambank erosion is the second highest source of sediment loading (15.2%), followed closely by gully erosion at 14.9% (Table 54). Of all locations, 22% of the gully sediment load comes from cropland. Combined, lake shorelines, point sources, and surface runoff from non-cropland are responsible for less than 2% of the total watershed sediment load.

## 6.0 Nonpoint Source Management Measures and Load Reductions

This section details the recommended BMPs for the watershed, their quantities and expected annual pollution load reductions. Although reductions presented below include nitrogen, phosphorus and sediment, special attention is given to phosphorus. As phosphorus is the most common water quality impairment in the watershed, practices that reduce phosphorus and sediment loading receive priority.

BMPs can be described as a practice or procedure to prevent or reduce water pollution and address stakeholder concerns. BMPs typically include treatment requirements, operating procedures, and practices to control surface runoff and mitigate pollution loading. This section of the plan describes all site-specific BMPs needed to achieve measurable load reductions in phosphorus, nitrogen and sediment.

Expected load reductions are calculated using average pollutant reduction percentages based on the Illinois Nutrient Loss Reduction Strategy, existing literature, and local expertise. Ranges of pollutant reduction efficiencies used to calculate expected load reductions can be found in Table 57.

**Table 57 – Pollutant Reduction Efficiency Ranges by BMP**

| BMP | Nitrogen Reduction (%) | Phosphorus Reduction (%) | Sediment Reduction (%) |
|---|---|---|---|
| **WASCB/Terrace[1]** | 20% | 60% | 70% |
| **Grade Control/Riffle[1,2]** | 0–10% | 0–25% | 0–45% |
| **Detention Basin/Pond** | 20–31% | 34–60% | 55–90% |
| **Grassed Waterway[2]** | 12–30% | 10–25% | 20–45% |
| **Filter Strip** | 10% | 40% | 65% |
| **Field Border[2]** | 10% | 40% | 65% |
| **Critical Area Planting** | 90% | 80% | 90% |
| **Livestock Stream Fencing** | 10% | 40% | 65% |
| **Wetland[2]** | 25–46% | 30–80% | 38–73% |
| **No-Till/Strip-Till** | 10% | 50% | 70% |
| **Cover Crop** | 30% | 30% | 40% |
| **Nutrient Management[3]** | 15% | 7% | 0% |

*[1] = Controls 100% of gully erosion. [2] = Reduction percentage includes maintenance of existing structures. [3] = Nitrogen reduction percentage only applies to tile nitrogen.*

## 6.1 Best Management Practices and Expected Load Reductions

Load reductions were calculated for each recommended BMP using the GIS-based loading model. Where applicable, a drainage area was delineated for each individual practice; therefore, expected load reductions are spatially explicit and all estimated reductions represent delivered pollutants.

Table 58 lists all proposed BMPs, quantities, area treated, and expected annual load reductions. BMP project locations are shown in Figure 31, Figure 32, and Figure 33. The largest total expected reductions can be achieved from changes in tillage practices and nutrient management. However, these practices will require willing landowners to implement. Further information on BMP costs, reductions, critical practices, technical and financial assistance and implementation goals can be found in sections 7–11. Individual BMP load reductions and details are listed in Appendix B.

**Table 58 – Recommended BMPs and Load Reduction Summary**

| BMP Class | BMP | Quantity | Area Treated (ac) | Nitrogen Reduction (lbs/yr) | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) |
|---|---|---|---|---|---|---|
| **In-Field Practices** | Cover Crop | 7,275 (ac) | 7,275 | 60,345 | 6,551 | 11,308 |
| | No-Till/Strip-Till | 3,803 (ac) | 3,803 | 11,502 | 6,245 | 13,420 |
| | Nutrient Management | 11,110 (ac) | 11,110 | 47,497 | 2,408 | 0 |
| *In-Field Practices Subtotal* | | *n/a* | *22,189* | *119,344* | *15,204* | *24,728* |
| **Structural Practices** | Critical Area Planting | 22 (#), 118 (ac) | 118 | 3,389 | 356 | 581 |
| | Detention Basins / Ponds | 2 (# basins) / 138 (# ponds) | 14,152 | 49,494 | 9,994 | 13,543 |
| | Field Border | 272 (#), 541 (ac) | 7,874 | 10,453 | 2,775 | 3,441 |
| | Filter Strip | 166 (#), 271 (ac) | 4,989 | 10,463 | 3,595 | 6,409 |
| | Grade Control | 26 (# locations), 53 (structures) | 619 | 812 | 625 | 750 |
| | Grassed Waterway | 56 (#), 85 (ac) | 3,162 | 14,355 | 1,391 | 2,043 |
| | Pasture Management (Livestock Fencing / Crossings) | 24 (# fences), 40,665 (ft) / 24 (crossings) | 637 | 827 | 352 | 296 |
| | Streambed Stabilization (Riffle) | 3 (# locations), 12 (structures) | 989 | 656 | 223 | 345 |
| | WASCB / Terrace | 142 (#), 311 (basins) / 1 (#), 1,200 (ft) | 768 | 4,077 | 1,162 | 1,687 |
| | Wetland, Constructed | 26 (#) / 47 (ac) | 4,116 | 14,844 | 1,538 | 1,083 |
| *Structural Practices Subtotal* | | *n/a* | *37,446* | *109,371* | *22,010* | *30,176* |
| **Total** | | **n/a** | **59,634** | **228,715** | **37,214** | **54,904** |

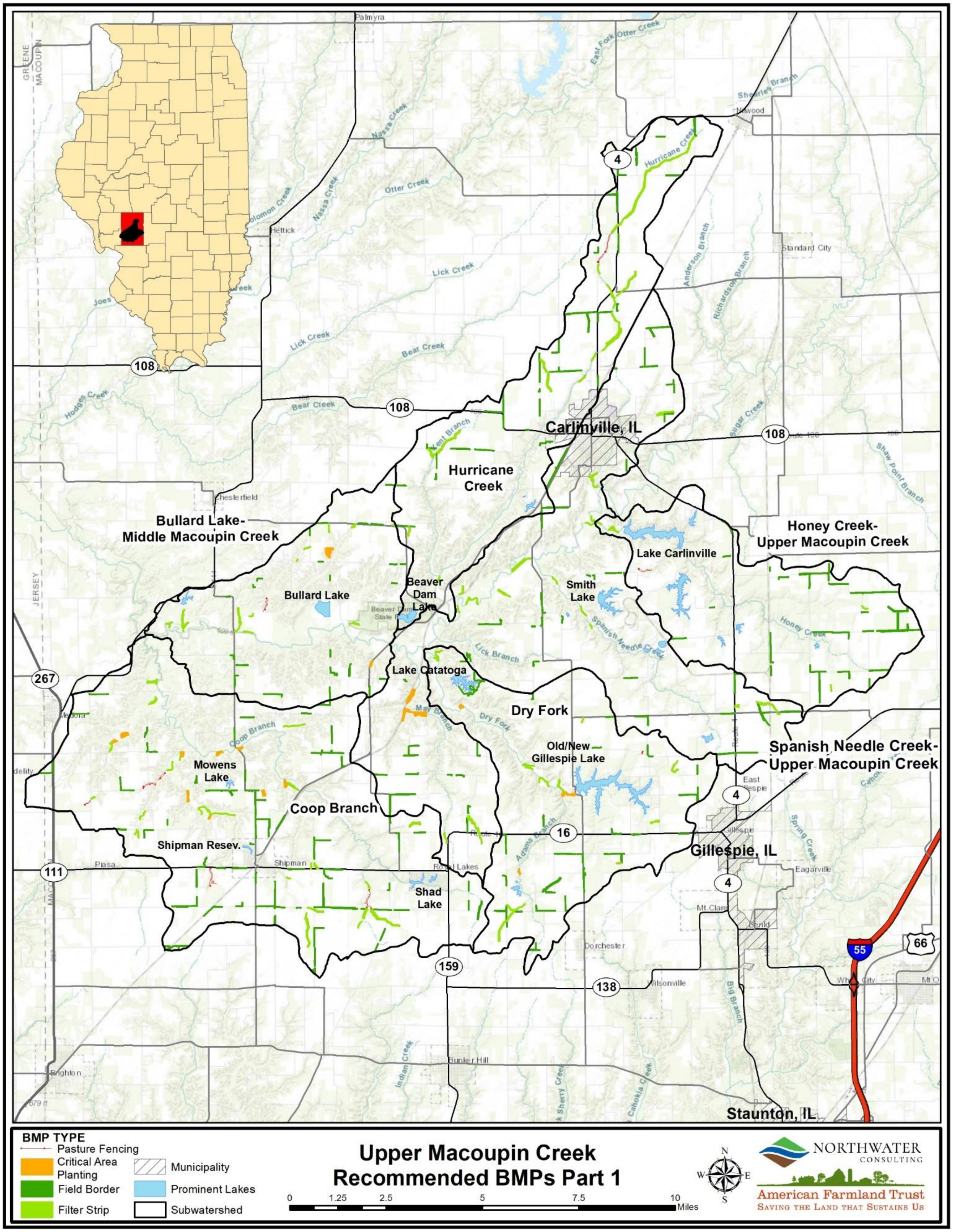



Figure 31 – Recommended BMPs Part 1, Structural Practices

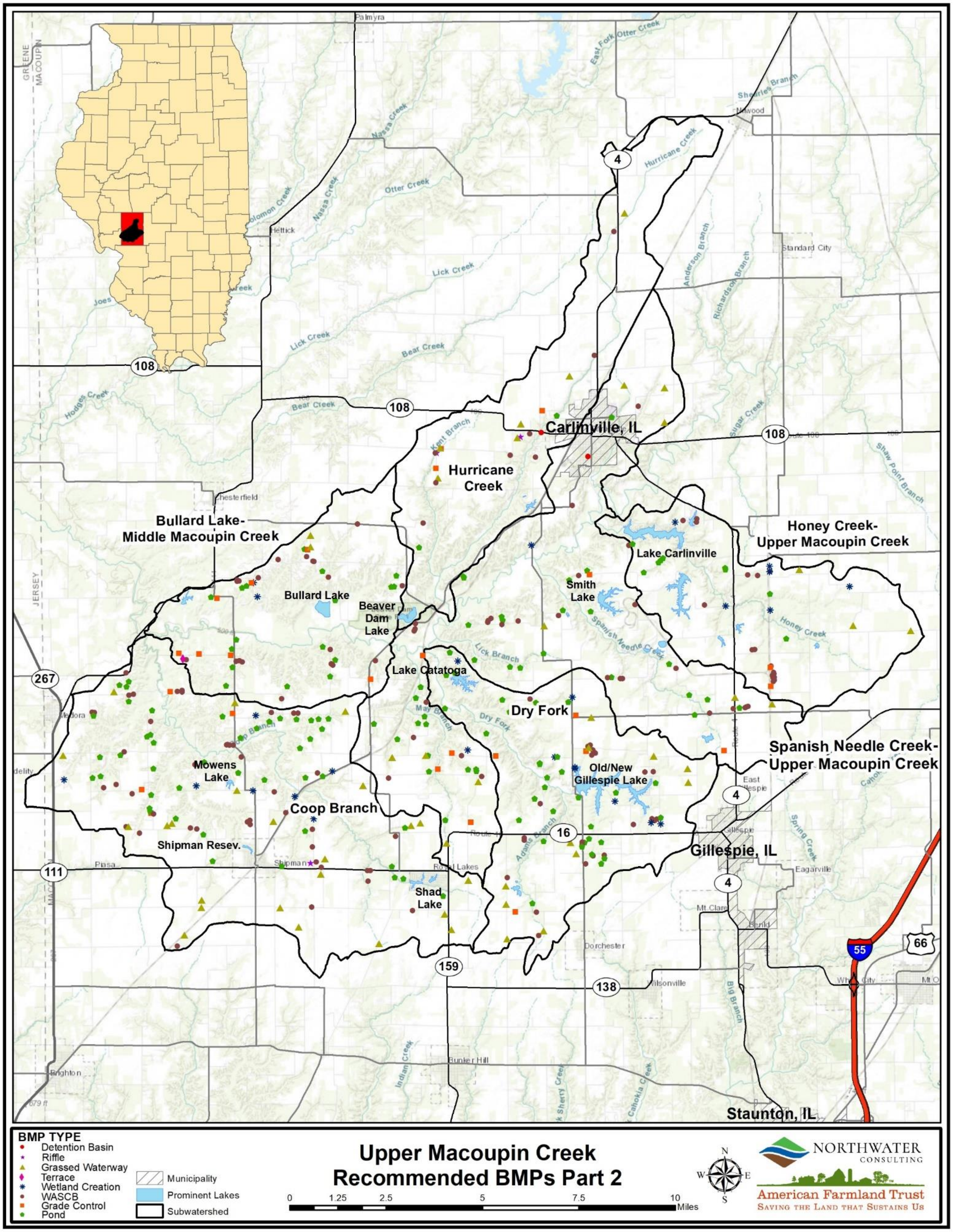



Figure 32 – Recommended BMPs Part 2, Structural Practices

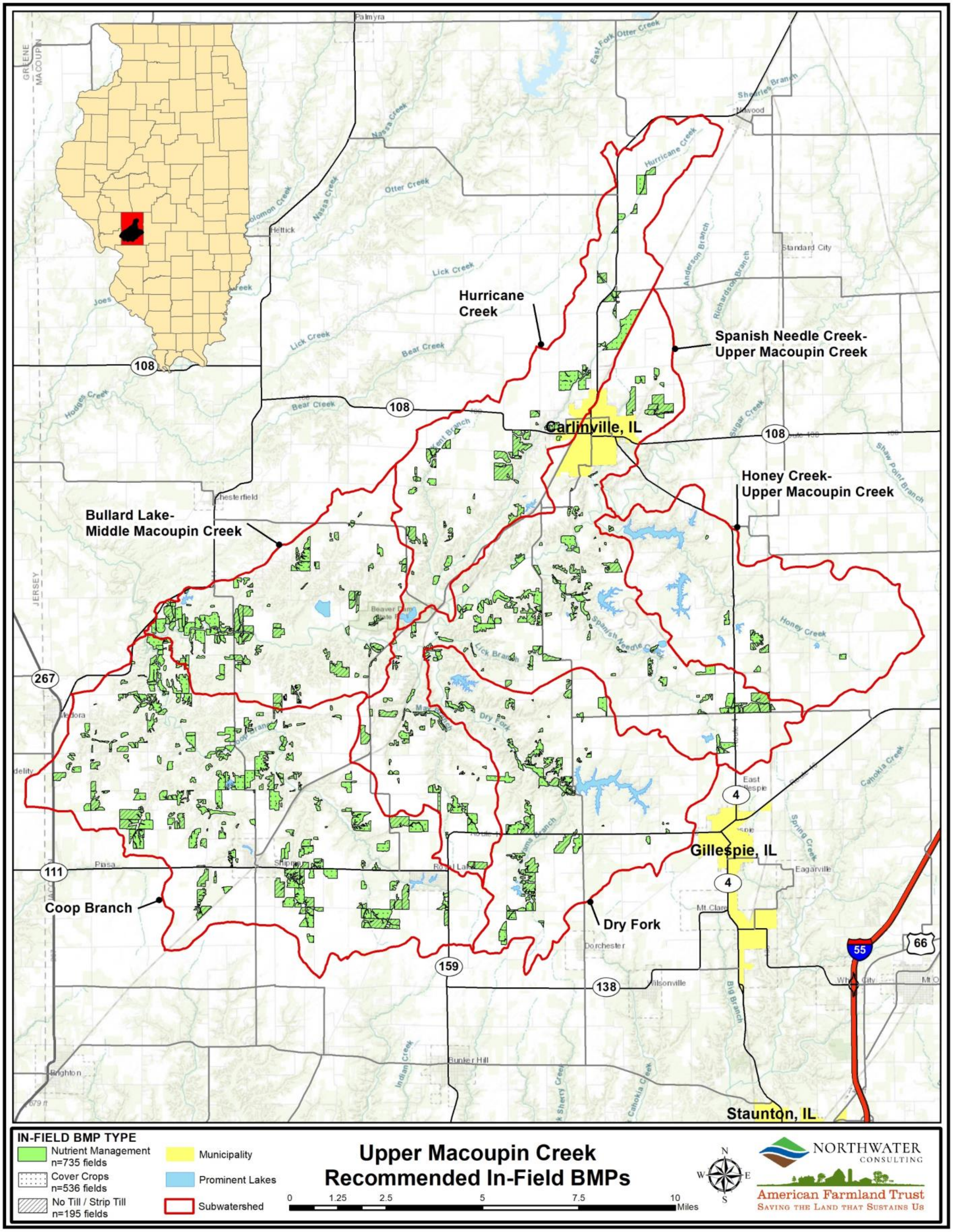



Figure 33 – Recommended In-Field BMPs

### 6.1.1 In-Field Best Management Practice Summary

In-field management measures are proposed to help achieve water quality targets. These measures focus on sediment and nutrient loading coming from cropland. Due to the focus on cropland loading and priorities of the AFT, these in-field practices are considered critical areas; however, they can be expanded to a substantially higher number of fields throughout the watershed.

#### *Cover Crops*

A cover crop is a temporary vegetative cover that is grown to provide protection for the soil and improve soil conditions. Cover crops can be applied over a broad area in the watershed.

**Cover Crops in the UMC Watershed**

Fields with some type of reduced tillage system (no-till, strip-till, reduced-till, mulch-till) and phosphorus loading over 2 lbs/acre were selected. Cover crops are proposed for 536 fields in the watershed for a total of 7,275 acres. If all acres are installed, the following load reductions are expected:

- 60,345 lbs/yr of nitrogen
- 6,551 lbs/yr of phosphorus
- 11,308 tons/yr of sediment

It is believed that as more producers shift toward non-conventional tillage systems, such as strip-till or no-till, the acreage of farm ground where cover crops can be reasonably implemented will also increase.

#### *No-Till or Strip-Till*

No-till can be defined as farming where the soil is left relatively undisturbed from harvest to planting. During the planting operation, a narrow seedbed is prepared, or holes are drilled in which seeds are planted. A switch from conventional tillage to no-till is often a prerequisite for the installation of cover crops. Strip-till is a good alternative to no-till, especially for those producers that are not willing to move to no-till. Strip-till is a minimum tillage system that combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till by disturbing only the portion of the soil that is to contain the seed row.

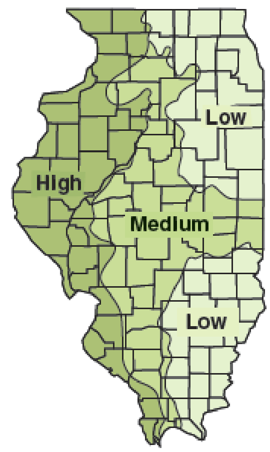
**No-Till in the UMC Watershed**

No-till or strip-till is proposed for fields where conventional tillage is employed and have over 2 lbs/acre phosphorus loading; 195 fields are recommended for this practice, for a total of 3,803 acres. If all acres are treated, the following load reductions are expected:

- 11,502 lbs/yr nitrogen
- 6,245 lbs/yr phosphorus
- 13,420 tons/yr sediment

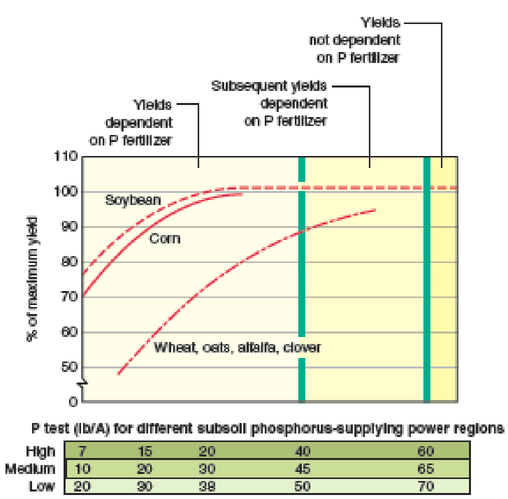
### *Nutrient Management*

Nutrient management is the practice of using nutrients essential for plant growth such as nitrogen and phosphorus fertilizers in proper quantities and at appropriate times for optimal economic and environmental benefits. Nutrient management is a non-structural practice that can be applied to all fields in the watershed, primarily to address nitrogen; it is well-suited to the flat topography and productive nature of soils in the watershed although, if a field is being farmed, nutrient management should be practiced regardless of these factors. The nutrient management system now being promoted by the Illinois Council on Best Management Practices (ICBMP) utilizes the approach commonly called the "4Rs":




- Right Source: Matches fertilizer type to crop needs.
- Right Rate: Matches amount of fertilizer to crop needs.
- Right Time: Makes nutrients available when crops need them.
- Right Place: Keeps nutrients where crops can use them.

Promoting smart soil testing is also important as the spatial variability of available nutrients in a field makes soil sampling the most common and greatest source of error in a soil test (University of Illinois 2012). Proper soil testing is the foundation of good nutrient management as it relates to nitrogen and phosphorus.




As described in the Chapter 8 of the Illinois Agronomy Handbook, regional differences in P-supplying power shown in the adjacent figure were broadly defined primarily by parent material and degree of weathering factors. Within a region, variability in parent material, degree of weathering, native vegetation, and natural drainage cause differences in the soil's P-supplying power. For example, soils developed under forest cover appear to have more available subsoil P than those developed under grass.

Minimum soil test levels required to produce optimal crop yields vary depending on the crop to be grown and the soil's P-supplying power (see adjacent figure). Near maximal yields of corn and soybeans are obtained when levels of available P are maintained at 30, 40, and 45 pounds per acre for soils in the high, medium, and low P-supplying regions, respectively. Since these are minimal values, to ensure soil P availability will not restrict crop yield, it is recommended that soil test results be built up to 40, 45, and 50 pounds per acre for soils in the high, medium, and low P-supplying regions, respectively. This is a practical approach because P is not easily lost from the soil, other than through crop removal or soil erosion.

Several methods described in Chapter 8 of the Illinois Agronomy Handbook can be used to manage crop nutrient loss: variable rate technology (VRT) and deep fertilizer placement.

VRT can improve the efficacy of fertilization and promote more environmentally sound placement of fertilizer compared to single-rate applications derived from the conventional practice of collecting a composite soil sample to represent a large area of the field. Research has shown that this technology often reduces the amount of fertilizer applied over an entire field. However, one of the drawbacks of this placement method is the expense associated with these technologies. Also, VRT can only be as accurate as the soil test information used to guide the application rate (University of Illinois 2012).

Deep fertilizer placement is where any combination of nitrogen, phosphorus, and potassium can be injected at a depth of 4 to 8 inches. Subsurface applications may be beneficial (if the subsurface band application does not create a channel for water and soil movement) is when the potential for surface water runoff is high (University of Illinois 2012). Implementing a nutrient management plan can reduce phosphorus losses by up to 7% and 15% nitrogen through tile flow.

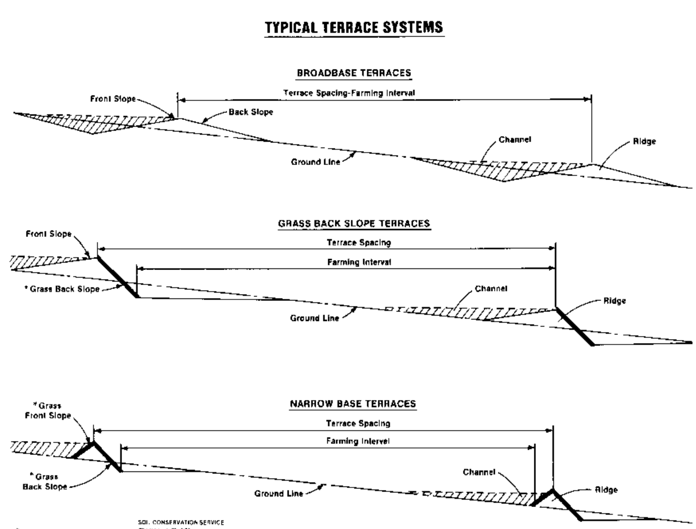
Fields with over a 2 lb/acre phosphorus load were chosen for nutrient management. If applied to all 735 fields selected (11,110 acres), expected annual load reductions would total 2,196 lbs of nitrogen and 720 lbs of phosphorus.

### 6.1.2 Structural Best Management Practice Summary

This section provides a brief description of each BMP and their expected load reductions. BMPs are divided into two subsections, covering structural and in-field practices.

#### *Water and Sediment Control Basins (WASCB)/Terrace*

Earth embankment and/or channel constructed across a slope to intercept runoff water and trap soil. WASCBs are often constructed to mitigate gully erosion where concentrated flow is occurring and where drainage areas are relatively small. Terraces, like a WASCB in design, are placed in areas where concentrated flow paths are less defined, such as long, wide-sloping fields. These practices are both popular with landowners in the watershed and applicable in many situations. Future maintenance activities can include excavation behind the basin, raising ridge height and replacing risers.



NRCS Detail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WASCBs are recommended at 142 locations and one terrace is recommended, for a total of 311 basins and 22,500 feet (150-foot average per WASCB, 1,200 ft of terrace). If all practices are installed, a total of 768 acres will be treated. Expected load reductions (including gully stabilization) will total:

- 4,077 lbs/yr of nitrogen
- 1,162 lbs/yr of phosphorus
- 1,687 tons/yr of sediment

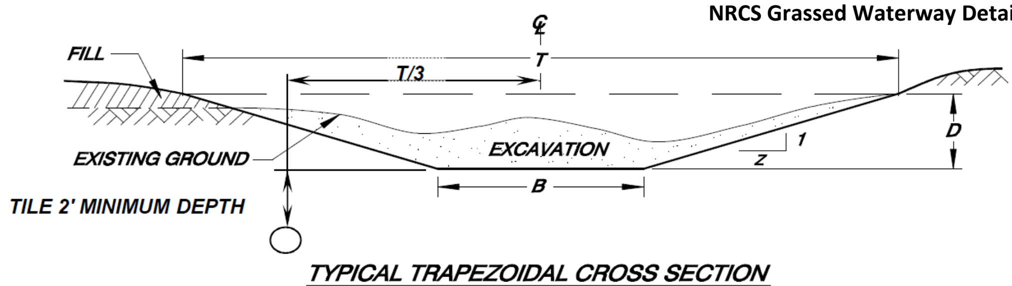
### *Grassed Waterways*

A grassed waterway is a grassed strip in a field that acts as an outlet for water to control silt, filter nutrients and limit gully formation. Grassed waterways are applicable in the watershed in areas with very large drainage areas and low-moderate slopes. Although these practices are not popular with local producers, they are often the only feasible practice in a field that drains a very large area.

Grassed waterways are recommended at 56 locations for a total of 85 acres. Three recommended waterways include maintenance of existing structures such as widening, shaping and re-seeding (2,650 feet). If all grass waterways are installed, a total of 3,162 acres will be treated. Expected load reductions (including gully stabilization) are:

- 14,355 lbs/yr of nitrogen
- 1,391 lbs/yr of phosphorus
- 2,043 tons/yr of sediment

**NRCS Grassed Waterway Detail**




### *Constructed Wetlands*

A constructed wetland is a shallow water area constructed by creating an earth embankment or excavation area. Constructed wetlands can include a water control structure and are designed to mimic natural wetland hydrology, store sediment and filter nutrients. Constructed wetlands have been identified in areas where hydric soils support their establishment or where local topography does not allow for the construction of a pond.

Wetlands are recommended at 26 locations in the watershed for a total wetland area of 47 acres. If all

**Constructed Wetland**

wetlands are implemented, they will treat 4,116 acres and the expected load reductions (including gully stabilization) are:

- 14,844 lbs/yr of nitrogen
- 1,538 lbs/yr of phosphorus
- 1,083 tons/yr of sediment

### *Filter Strips, Field Borders, and Critical Area Plantings*

A *filter strip* is a band of grass or other permanent vegetation used to reduce sediment, nutrients, pesticides and other contaminants. Only those areas directly adjacent to an openly flowing ditch or stream where existing buffer areas are either inadequate or nonexistent were selected for the placement of filter strips. *Field borders* are like filter strips but are located along field edges adjacent to timbered areas; they can range in width from 30 – 120 feet. *Critical area plantings* consist of removing land from production and planting native vegetation. This practice is recommended on sites that are expected to have high erosion rates.

**Field Border**

**Field borders** are recommended at 272 locations for a total of 541 acres. If all borders are planted, they will treat 7,874 acres. Expected load reductions (including gully stabilization) are:

- 10,453 lbs/yr of nitrogen
- 2,775 lbs/yr of phosphorus
- 3,441 tons/yr of sediment

**Filter strips** are recommended at 166 locations for a total of 271 acres. If all strips are planted, they will treat 4,989 acres. Expected load reductions (including gully stabilization) are:

- 10,463 lbs/yr of nitrogen
- 3,595 lbs/yr of phosphorus
- 6,409 tons/yr of sediment

**Critical area plantings** are recommended at 22 locations totaling 118 acres of planting. The treated area is equal to the planted area. If all areas are planted, expected load reductions (including gully stabilization) are:

- 3,389 lbs/yr of nitrogen
- 356 lbs/yr of phosphorus
- 581 tons/yr of sediment

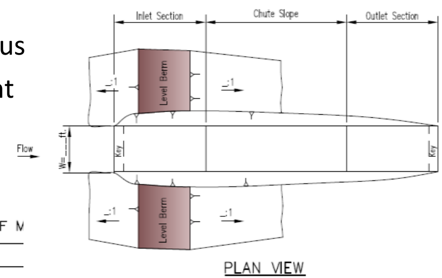
### *Grade Control Structures*

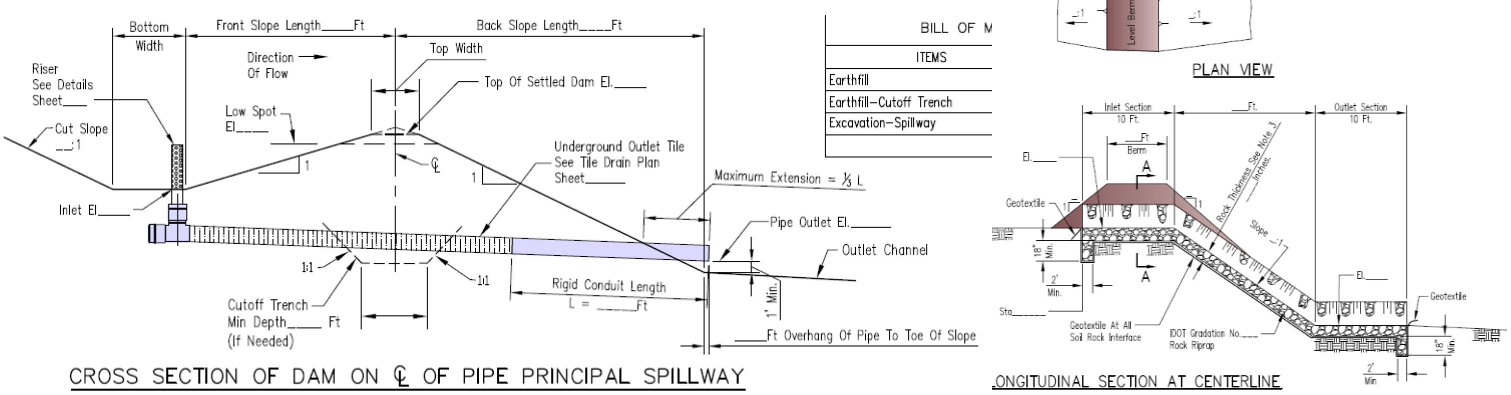
A grade control structure consists of a constructed berm or a rock/modular block structure (NRCS detail provided below) designed to address gully erosion and control vertical downcutting. Grade control structures are recommended at locations where slopes are very steep and gully erosion is considered very severe; areas where other practices are just not feasible. Rock riffles are also possible at locations where grade control is required and can be used in place of the practices below; rock riffles described in the streambank stabilization section.

**Grade Control Structure**

Grade control structures are recommended at 26 locations for a total of 53 individual structures. If all structures are installed, they will treat a total of 619 acres. Expected load reductions (including gully stabilization) are:

- 812 lbs/yr of nitrogen
- 625 lbs/yr of phosphorus
- 750 tons/yr of sediment



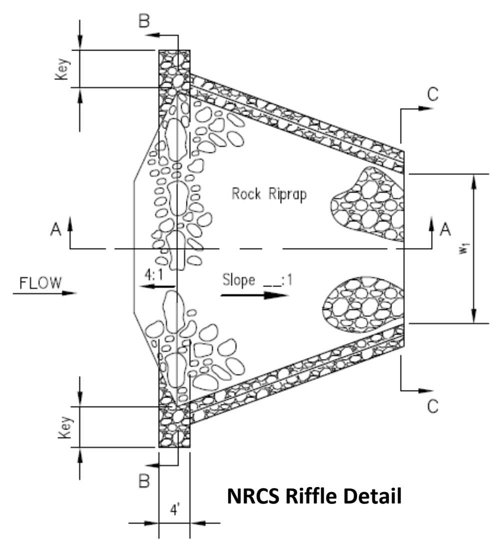

**NRCS Grade Control Details**

## *Streambed Stabilization: Riffles*

Streambed stabilization consists of the placement of rock riffles to control stream grade. Stream channel incision or deepening can lead to bank erosion and often, grade control or rock riffle structures are needed. Three stream riffle sites are recommended for a total of 12 riffle structures. Locations were selected based on sediment load, accessibility and cost effectiveness.

If all riffles are implemented, they will treat a total of 989 acres and the expected load reductions are:

- 656 lbs/yr of nitrogen
- 223 lbs/yr of phosphorus
- 345 tons/yr of sediment




**NRCS Riffle Detail**

### *Detention Basins/Ponds*

A detention basin or pond is a sediment or water impoundment made by constructing an earthen dam. A total of 138 ponds and 2 detention basins are recommended to treat 14,152 acres. These structures will trap sediment and nutrients from runoff and will control gully erosion in steep forested draws.

**Pond in Otter Lake, IL**

If all ponds and detention basins are installed, expected load reductions (including streambank and gully stabilization) are:

- 49,494 lbs/yr of nitrogen
- 9,994 lbs/yr of phosphorus
- 13,543 tons/yr of sediment

### *Pasture Management and Livestock Fencing*

Pasture management consists of stream fencing to exclude livestock from the stream, appropriate stream crossings for cattle use and an alternate water supply (if needed). Stream fencing is placed back from the stream edge to allow for a vegetated buffer to filter runoff.

**Stream fencing**

Stream fencing is recommended at 24 pasture locations in the watershed; each location includes a stream crossing. A total of 40,665 feet of fence is recommended.

If each system is installed, 637 acres would be treated. Expected load reductions are:

- 827 lbs/yr of nitrogen
- 352 lbs/yr of phosphorus
- 296 tons/yr of sediment

## 7.0 Cost Estimates

BMP costs were calculated based on professional judgment and expertise, rates provided by the NRCS, and unit costs used in other watershed plans. Many of the estimates are based on field visits and known quantities for a given practice. Cost estimates should be considered as estimates only and revisited during implementation, as required.

General cost estimates and assumptions include:

1. Filter strips includes land prep and seeding and is estimated at $184/ac.
2. Field borders and critical areas planting includes land prep and seeding and is estimated at $120/ac.
3. Riffles are estimated as $7,528.00 per riffle.
4. Livestock stream fencing is estimated as $1.56 per foot. Each system includes a stream crossing estimated at $3,560.00 per crossing.
5. Grade control structures are estimated at $600.00 per structure.
6. Grass waterways assume $3,700 per acre, plus an estimated cost of $2.50 per foot of tile.
7. WASCBs costs were estimated at a base cost of $2,100.00 per basin (av. of 700 $yd^3$ soil), in addition to an estimated $3.50 per foot of tile.
8. Terraces are estimated at a base cost of $2.56 per foot, plus an additional cost of $3.50 per foot of tile.
9. Constructed wetlands are based on a unit cost of $4,248.00 per acre.
10. Urban detention basins are estimated as an average cost of $60,000 per basin.
11. Ponds are estimated as an average cost of $40,000 per pond (av. 10,000 $yd^3$ soil). Cost can range from $25,000 - $60,000 depending on the size of the berm and primary spillway pipe, the extent of clearing needed, and size of rock at outfall structures.
12. Nutrient Management Plan cost is estimated to be $16.00 an acre for 1 year, based on Sangamon County SWCD rates.
13. No-Till and strip-till assume $22.35/ac for 1 year.
14. Cover crops assume $50/ac for 1 year of non-winter terminating crop.

Table 59 below provides a detailed breakdown of cost estimates for each BMP type and the cost per unit of loading reduced. The total cost of implementing all BMPs is estimated to be **$8,665,232.83**. Average cost per pound of nitrogen removed is $37.89; average cost per pound of phosphorus removed is $232.85, and the average cost for a ton of sediment removed is $157.82. Per pound of phosphorus reduction, no-till/strip-till is the most effective in-field practice, followed by cover crops and then nutrient management; for structural practices, filter strips are the most cost-effective, followed by field borders and critical area plantings. Overall, no-till/strip-till is the most cost effective per pound of phosphorus reduction and can also result in large overall load reductions, if adopted throughout the watershed.

In addition to the costs presented in this section for BMP implementation, there will be costs associated with education and outreach. For example, it is estimated that costs for education and outreach could range from $10,000 – $20,000 per year, including staff time to contact and educate landowners, organize workshops, and develop grant applications.

**Table 59 – BMP Cost Summary by BMP Type**

| | TYPE | Quantity | Total Cost (USD) | Cost/lb Nitrogen Reduction | Cost/lb Phosphorus Reduction | Cost/ton Sediment Reduction |
|---|---|---|---|---|---|---|
| **In-Field Practices** | Cover Crop | 7,275 (ac) | $363,741.45 | $6.03 | $55.53 | $32.17 |
| | No-Till/Strip-Till | 4,334 (ac) | $85,005.26 | $7.39 | $13.61 | $6.33 |
| | Nutrient Management | 11,100 (ac) | $177,766.74 | $3.74 | $73.83 | n/a |
| *In-Field Practices Subtotal / Av.* | | *n/a* | *$626,513.45* | *$5.25* | *$41.21* | *$25.34* |
| **Structural Practices** | Critical Area Planting | 22 (#), 118 (ac) | $14,121.98 | $4.17 | $39.70 | $24.32 |
| | Detention Basins / Ponds | 2 (# basins) / 138 (# ponds) | $6,020,000.00 | $121.63 | $602.36 | $444.51 |
| | Field Border | 272 (#), 541 (ac) | $66,662.57 | $6.38 | $24.03 | $19.38 |
| | Filter Strip | 166 (#), 271 (ac) | $49,805.70 | $4.76 | $13.86 | $7.77 |
| | Grade Control | 26 (# locations), 53 (structures) | $33,280.00 | $40.98 | $53.24 | $44.40 |
| | Grassed Waterway | 56 (#), 85 (ac) | $499,298.43 | $34.78 | $359.07 | $244.34 |
| | Pasture Management (Livestock Fencing / Crossings) | 24 (# fences), 40,665 (ft) / 24 (crossings) | $148,877.40 | $179.96 | $423.08 | $503.09 |
| | Streambank Stabilization (Riffle) | 3 (# locations), 12 (structures) | $90,336.00 | $137.78 | $404.68 | $262.20 |
| | WASCB / Terrace | 142 (#), 311 (basins) / 1 (#), 1,200 (ft) | $918,379.50 | $225.26 | $790.18 | $544.29 |
| | Wetland, Constructed | 26 (#) / 47 (ac) | $197,956.80 | $13.34 | $128.70 | $182.78 |
| *Structural Practices Subtotal / Av.* | | *n/a* | *$8,038,718.37* | *$73.50* | *$365.23* | *$266.39* |
| **Grand Total** | | **n/a** | **$8,665,231.83** | **$37.89** | **$232.85** | **$157.82** |

# 8.0 Water Quality Targets

This section describes water quality targets and those implementation actions required to meet targets.

The primary constituent of concern in the UMC watershed is phosphorus; therefore, the phosphorus reduction target is set at 25% and aligned with INLRS goals. A nitrogen target of 15% reduction was set and is also in alignment with INLRS goals. A sediment reduction goal of 38% was based off the reductions achieved when all recommended practices are installed. If all practices are installed, the phosphorus and nitrogen target reductions will be exceeded (Table 60). Because this watershed plan focuses on the reduction of NPS pollution, and point source and lake shoreline erosion reduction are beyond the scope of this plan, both were omitted from this analysis.

Results indicate that implementation of both in-field and structural practices recommended in this plan can achieve targets for phosphorus, nitrogen, and sediment. Additional reductions will be achieved over time as in-field management becomes more widespread and new opportunities for structural solutions present themselves.

Conversion to no-till and strip-till methods will likely provide the greatest potential total reductions; 9.3% for sediment, 4.5% for phosphorus, and 4.1% for nitrogen. Combined, in-field practices will achieve similar reductions in phosphorus and sediment and a greater reduction in nitrogen when compared to structural practices; 17.1% sediment, 10.4% phosphorus, and 8.1% nitrogen (Table 60). In-field management is less costly on an annual basis but requires a long-term commitment to ensure reductions are realized over multiple years.

Looking at the effects of structural practices, detention basins and ponds together can achieve overall reductions of 6.8% for phosphorus, 9.4% for sediment and 3.3% for nitrogen. All structural practices combined can reduce total phosphorus loads by 15%, sediment loads by 20.9%, and nitrogen by 7.4%.

**Table 60 – Water Quality Targets and Load Reductions**

| | TYPE | Quantity | Nitrogen Reduction (% of total load) | Phosphorus Reduction (% of total load) | Sediment Reduction (% of total load) |
|---|---|---|---|---|---|
| **In-Field Practices** | Cover Crop | 7,275 (ac) | 4.1% | 4.5% | 7.8% |
| | No-Till/Strip-Till | 3,803 (ac) | 0.8% | 4.3% | 9.3% |
| | Nutrient Management | 11,100 (ac) | 3.2% | 1.6% | 0.0% |
| *In-Field Practices Subtotal* | | *n/a* | 8.1% | 10.4% | 17.1% |
| **Structural Practices** | Critical Area Planting | 22 (#), 118 (ac) | 0.2% | 0.2% | 0.4% |
| | Detention Basins / Ponds | 2 (# basins) / 138 (# ponds) | 3.3% | 6.8% | 9.4% |
| | Field Border | 272 (#), 541 (ac) | 0.7% | 1.9% | 2.4% |
| | Filter Strip | 166 (#), 271 (ac) | 0.7% | 2.5% | 4.4% |
| | Grade Control | 26 (# locations), 53 (structures) | 0.1% | 0.4% | 0.5% |
| | Grassed Waterway | 56 (#), 85 (ac) | 1.0% | 0.9% | 1.4% |
| | Pasture Management (Livestock Fencing / Crossings) | 24 (# fences), 40,665 (ft) / 24 (crossings) | 0.1% | 0.2% | 0.2% |
| | Streambank Stabilization (Riffle) | 3 (# locations), 12 (structures) | 0.0% | 0.2% | 0.2% |
| | WASCB / Terrace | 142 (#), 311 (basins) / 1 (#), 1,200 (ft) | 0.3% | 0.8% | 1.2% |
| | Wetland, Constructed | 26 (#) / 47 (ac) | 1.0% | 1.1% | 0.7% |
| *Structural Practices Subtotal.* | | *n/a* | 7.4% | 15.0% | 20.9% |
| **Grand Total Reductions and Targets** | | **n/a** | **15.5% (target exceeded)** | **25.4% (target exceeded)** | **38% (target met)** |

# 9.0 Critical Areas

Critical areas are those BMP locations throughout the watershed where implementation activities should be focused. This includes locations targeted for in-field and structural practices. In-field management practices will provide the greatest "bang-for-the-buck" and benefit to water quality. They will improve soil structure and health, and overall farm profitability. Structural practices, although more costly upfront, will prove benefits over multiple years and address locations where other measures are infeasible. Critical areas focus on maximizing reductions in phosphorus, and like Section 8.0, point source and lakeshore erosion, were omitted from analysis as they are beyond the scope of this plan.

## 9.1 In-Field Management

In-field practices recommended are nutrient management, no-till, strip-till, and cover crops. Critical areas are primarily based on total per-acre phosphorus loading; fields with phosphorus loads greater than 2 lbs/ac were considered critical. Additional considerations are provided by management practice type and are discussed in the following subsections. These critical areas represent all the recommended in-field practices listed in Section 6.1.1 and are required to meet water quality targets listed in Section 8.0.

### 9.1.1 Nutrient management

All fields with a phosphorus load greater 2 lbs/acre are critical and well-suited for nutrient management as this practice can be applied without additional management changes. A total of 735 fields, or 11,110 acres, are recommended (Table 60, Figure 34). If implemented, annual reductions of 720 lbs of phosphorus and 2,196 lbs of nitrogen are expected; this represents 1.6% and 3.2% of total NPS pollution load reductions, respectively.

**Table 61 – Total Critical Area of Nutrient Management**

| Subwatershed | HUC12 Code | Area (acres) |
|---|---|---|
| Bullard Lake | 071300120402 | 1,631 |
| Coop Branch | 071300120401 | 4,276 |
| Dry Fork | 071300120108 | 1,288 |
| Honey Creek | 071300120106 | 147 |
| Hurricane Creek | 071300120107 | 1,353 |
| Spanish Needle Creek | 071300120109 | 2,415 |
| **Grand Total** | | **11,110** |

### 9.1.2 No-till or strip-till

No-till or strip-till critical areas represent fields with phosphorus loading greater than 2 lbs/ac with conventional tillage practiced. A total of 195 fields, or 3,803 acres, were selected (Table 62, Figure 34). If implemented, annual reductions of 6,245 lbs of phosphorus, 11,502 lbs nitrogen, and 13,420 tons sediment are expected; this represents 4.3%, 0.8%, and 9.3% of the total NPS pollution load reductions respectively.

**Table 62 – Total Critical Area of No-Till or Strip-Till**

| Subwatershed | HUC12 Code | Area (acres) |
|---|---|---|
| Bullard Lake | 071300120402 | 655 |
| Coop Branch | 071300120401 | 1,188 |
| Dry Fork | 071300120108 | 409 |
| Honey Creek | 071300120106 | 27 |
| Hurricane Creek | 071300120107 | 720 |
| Spanish Needle Creek | 071300120109 | 804 |
| **Grand Total** | | **3,803** |

### 9.1.3 Cover crops

Cover crop critical area were identified based on fields ranked as medium or high priority already with some form of reduced tillage (mulch-till, no-till, reduced-till, strip-till). Generally, producers who have had success integrating cover crops into their management operations already utilize some form of reduced tillage and are therefore good candidate sites. A total of 536 fields, or 7,275 acres, were selected for cover crop implementation (Table 63, Figure 34). If implemented, annual reductions of 6,551 lbs of phosphorus, 60,345 lbs nitrogen, and 11,308 tons of sediment are expected; this represents 4.5%, 4.1%, and 7.5% of the total NPS pollution load reductions, respectively.

**Cereal Rye Cover Crops in the UMC Watershed**

**Table 63 – Total Critical Area of Cover Crop**

| Subwatershed | HUC12 Code | Area (acres) |
|---|---|---|
| Bullard Lake | 071300120402 | 977 |
| Coop Branch | 071300120401 | 3,062 |
| Dry Fork | 071300120108 | 875 |
| Honey Creek | 071300120106 | 120 |
| Hurricane Creek | 071300120107 | 633 |
| Spanish Needle Creek | 071300120109 | 1,609 |
| **Grand Total** | | **7,275** |

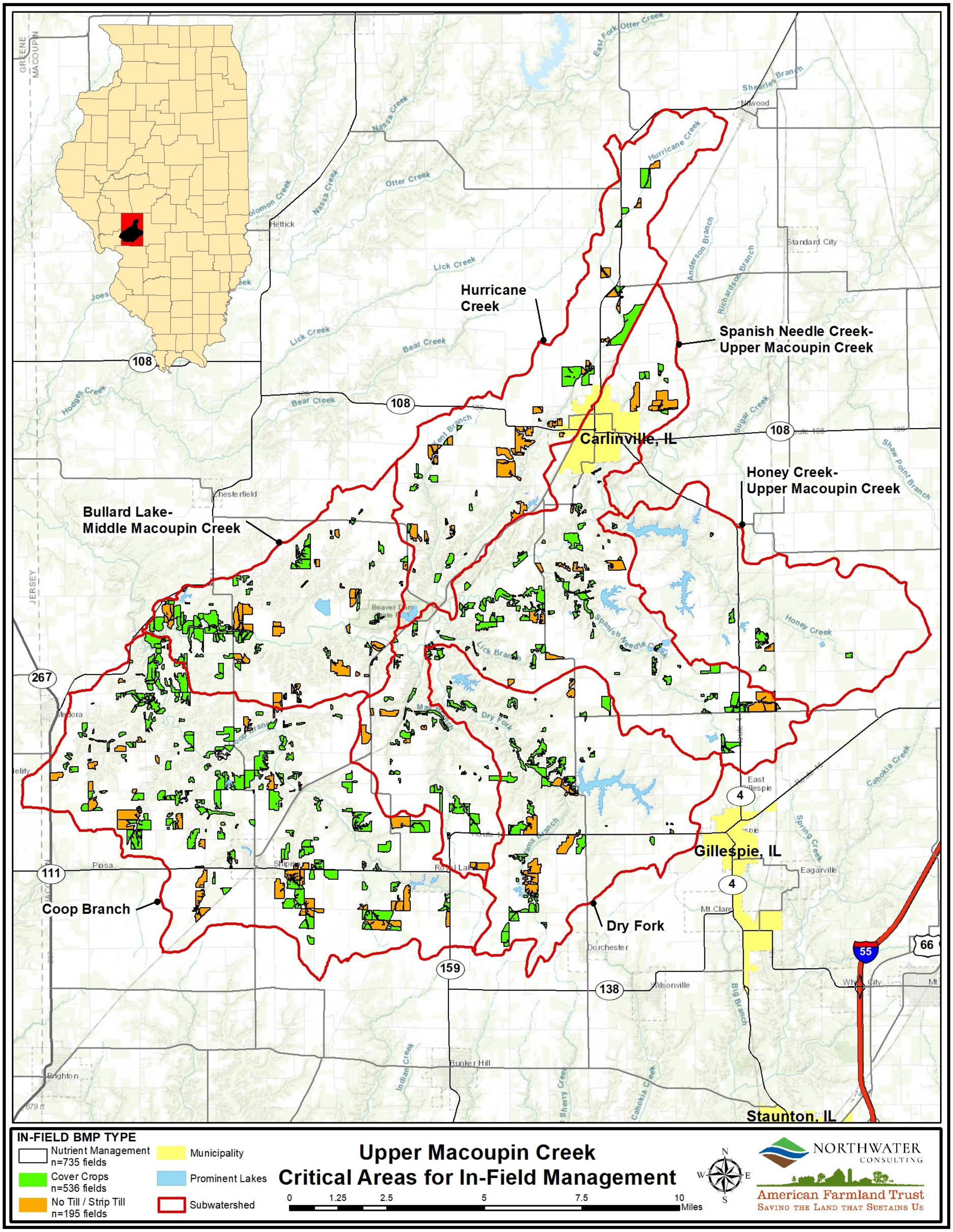



Figure 34 – Critical Areas for In-Field Management

## 9.2 Structural BMPs

A total of 878 structural practices are recommended throughout the watershed (Figure 31, Figure 32). Structural practices are prioritized for implementation based on quartiles of cost-per-pound-reductions in phosphorus (Table 64); "very high" priority projects cost below $24/lb, "high" priority projects between $24 and $91/lb, "medium" priority between $91 and $696/lb, and "low" priority projects cost above $700/lb. Low priority projects are selected for long-term (10+ yrs) implementation.

**Table 64 – Structural BMP Priority and Pollutant Reductions**

| Priority Level | Phosphorus Reduction | | | Nitrogen Reduction | | | Sediment Reduction | | |
|---|---|---|---|---|---|---|---|---|---|
| | lbs/yr | % Structural Practice Reduction Total | % NPS Pollution Total | lbs/yr | % Structural Practice Reduction Total | % NPS Pollution Total | tons/yr | % Structural Practice Reduction Total | % NPS Pollution Total |
| Very high (critical) | 5,846 | 27% | 4% | 19,321 | 18% | 1% | 9,090 | 30% | 6% |
| High (critical) | 2,469 | 11% | 2% | 15,746 | 14% | 1% | 2,566 | 9% | 2% |
| Medium (critical) | 10,878 | 49% | 7% | 60,525 | 55% | 4% | 14,714 | 49% | 10% |
| Low | 2,817 | 13% | 2% | 13,779 | 13% | 1% | 3,807 | 13% | 3% |
| **Grand Total** | **22,010** | **100%** | **15%** | **109,371** | **100%** | **7%** | **30,176** | **100%** | **21%** |

**Critical structural BMPs** are those practices with cost-per-pound phosphorus reductions below $696 (priority ranking medium to very high). These structures have a short-term (less than 10 years) implementation goal. A total of 658 projects are considered critical (Table 65, Figure 35). If all practices are installed, annual reductions of 19,193 lbs of phosphorus, 26,370 tons of sediment, and 95,592 lbs of nitrogen are expected (Table 65); this represents total NPS pollution reductions of 13% for phosphorus, 18% for sediment, and 6% for nitrogen (Table 64).

**Table 65 – Critical BMP Load Reductions**

| Name | HUC12 | Nitrogen Reduction (lbs/yr) | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Critical Structural BMPs Count |
|---|---|---|---|---|---|
| Bullard Lake | 71300120402 | 7,991 | 1,884 | 3,117 | 73 |
| Coop Branch | 071300120401 | 29,131 | 6,191 | 8,740 | 208 |
| Dry Fork | 071300120108 | 22,720 | 3,394 | 4,174 | 96 |
| Honey Creek | 071300120106 | 6,696 | 1,058 | 967 | 58 |
| Hurricane Creek | 071300120107 | 13,346 | 3,213 | 4,279 | 102 |
| Spanish Needle Creek | 071300120109 | 15,709 | 3,454 | 5,093 | 121 |
| **Grand Total** | | **95,592** | **19,193** | **26,370** | **658** |

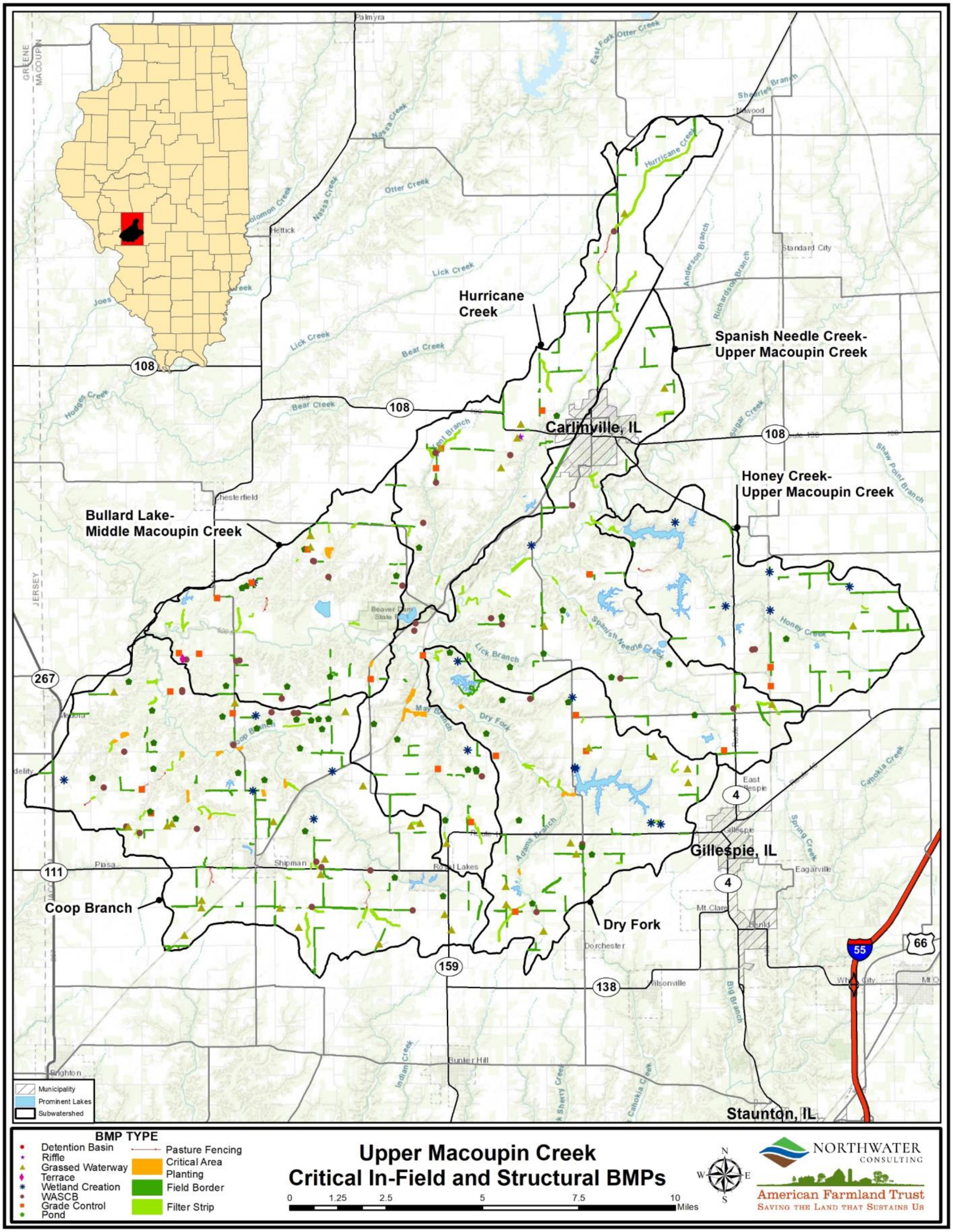



Figure 35 – Critical In-Field and Structural Practices

## 10.0 Technical and Financial Assistance

Entities listed below are potentially available for plan implementation and funding. For those that can provide funding specific to the UMC watershed, descriptions of the programs or financial assistance mechanisms are provided, with a separate list of entities providing in-kind contributions to watershed efforts. Entities that may not have a direct avenue to a funding apparatus are listed under the Section 10.1 Technical Assistance.

With implementation, primary responsibility lies with the owner of the land first; any agency or entity also providing a role in implementation will need to work with willing landowners but do not have the primary decision-making authority. All implementation is completely voluntary.

**Farmers/Landowners** In the UMC watershed, there are varying business arrangements on who farms the land and makes important conservation decisions. If the farmer is the landowner, then the farmer–landowner is considered the primary responsible party. If the person/entity who owns the land is an absentee owner, then it could be either the farmer-tenant or the absentee landowner who is responsible. In some cases, the conservation practice decisions are made together in a collaborative fashion by the tenant and landowner. Frequently, the lease terms will determine who makes conservation decisions on the agricultural parcel.

> **Financial Assistance:** Private funds can come from foundations, individual farmers, and landowners and can be used as cash match for Section 319 funds or as private contributions to UMC conservation activity.

**Natural Resources Conservation Service (NRCS)** The United States Department of Agriculture has local offices in most Illinois counties which include the NRCS. The Macoupin County – Carlinville Field Office services the UMC watershed. The NRCS provides both conservation technical assistance and financial assistance to farmers and landowners. One of the programs frequently used for financial assistance is the Environmental Quality Incentive Program (EQIP). Most applicable to the UMC watershed, the EQIP program provides cost sharing for implementation of approved conservation program practices. The farmer/landowner applies to the NRCS for conservation program funds and they are assisted by NRCS staff to complete the application process, certify the practices and make payments. Four additional programs administered by the NRCS also discussed below: The Regional Conservation Partnership Program (RCPP), the Mississippi River Basin Healthy Watersheds Initiative (MRBI), the Conservation Stewardship Program (CSP); and the Agricultural Conservation Easement Program (ACEP).

> **Financial Assistance:**
>
> **NRCS EQIP** EQIP is a cost-share program for farmers and landowners to share the expenses of implementation and maintenance of approved soil and water conservation practices on farmland for qualified entities and is a dedicated source of funding available in the watershed through the Macoupin County NRCS office.
>
> http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
>
> **NRCS/USDA RCPP** The RCPP promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS aids producers through partnership

agreements and through program contracts or easement agreements. It combines the authorities of four former conservation programs – the Agricultural Water Enhancement Program, the Chesapeake Bay Watershed Program, the Cooperative Conservation Partnership Initiative and the Great Lakes Basin Program. Assistance is delivered in accordance with the rules of other NRCS programs. RCPP encourages partners to join in efforts with producers to increase restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. Through RCPP, NRCS and its partners help producers install and maintain conservation activities in selected project areas. The UMC has been part of an RCPP project since 2017.

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/

**NRCS MRBI** Launched in 2009, the 13-state Mississippi River Basin Healthy Watersheds Initiative (MRBI) uses several Farm Bill programs, including the Environmental Quality Incentives Program (EQIP) and the Agricultural Conservation Easement Program (ACEP), to help landowners sustain America's natural resources through voluntary conservation. The overall goals of MRBI are to improve water quality, restore wetlands, and enhance wildlife habitat while ensuring economic viability of agricultural lands.

States within the Mississippi River Basin have developed nutrient reduction strategies to minimize the contributions of nitrogen and phosphorus to surface waters within the basin, and ultimately to the Gulf of Mexico. MRBI uses a small watershed approach to support the states' reduction strategies. Avoiding, controlling, and trapping practices are implemented to reduce the amount of nutrients flowing from agricultural land into waterways and to improve the resiliency of working lands. UMC has been part of an MRBI project since 2015.

https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1048200

**NRCS CSP** Through CSP, the NRCS provides conservation program payments. CSP participants will receive an annual landuse payment for operation-level environmental benefits they produce. Under CSP, participants are paid for conservation performance: the higher the operational performance, the higher their payment.

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

**NRCS ACEP** The ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps Native American tribes, state and local governments, and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

**Illinois Environmental Protection Agency (IEPA)** In Illinois, the IEPA Bureau of Water's Watershed Management Section provides program direction and financial assistance for water quality protection through the Clean Water Act Section 319 program.

**Financial Assistance:** Administered by the IEPA, the Section 319 program provides funds for addressing NPS pollution. The purpose of IEPA's 319 program is to work cooperatively with units of local government and other organizations toward the mutual goal of protecting the water quality in Illinois through the control of NPS pollution. The program includes providing funding to these groups to implement projects that utilize cost-effective BMPs on a watershed scale.

Projects may include structural BMPs, such as detention basins and filter strips; non-structural BMPs, such as construction erosion control ordinances; and setback zones to protect community water supply wells. Technical assistance and information and education programs are also eligible. Section 319 funds are reimbursable and require a match of either cash or in-kind services, or a combination of both cash and in-kind contributions. Applications for Section 319 funding are due August 1st of each year.

http://www.epa.illinois.gov/topics/water-quality/watershed-management/nonpoint-sources/section-319/index

**National Fish and Wildlife Foundation (NFWF)** NFWF supports conservation in all 50 states and US territories. Their projects are rigorously evaluated and awarded to some of the nation's largest environmental organizations, as well as some of the smallest. NFWF focuses on bringing all partners to the table, getting results, and building a future for our world. The UMC watershed was able to hire a full-time conservation technician to focus primarily on targeted technical assistance and outreach with a grant from the NFWF Conservation Partners Program, awarded in 2019.

## In-Kind Services

**Watershed Agricultural Retailers**

**CHS Shipman** CHS Shipman is a locally owned, locally governed ag service center that is part of CHS, Inc. CHS's top priority is to help their farmer-owners and customers grow, which means providing quality products, the latest in innovation and first-class customer service. From harvesting and selling crops, to custom fertility and crop protection solutions to quality nutrition for livestock, CHS is a full-service ag service center. CHS provides soil testing, nutrient management, cover crop seed, variable rate fertilizer application, and assists the AFT to identify landowners in the critical areas of the watershed.

**M&M Service Company** M&M is a locally owned agricultural cooperative serving the supply, marketing, and service needs of members since 1927. Their goals include improving the profitability of their customers and promoting the welfare of the community and environment, among others. M&M Service Company provides their customers with custom strip-till services, cover crop seed, soil testing, and variable rate fertilizer application. M&M Service Company provides a discount to customers in the watershed for custom strip-till services.

**Blackburn College** As one of only 7 work colleges in the US, Blackburn College in Carlinville offers a unique experience for their students to gain real-world experience while earning their degree. Through a partnership with Blackburn, 2 students assist in monthly stream sampling for the current UMC water quality monitoring program each year.

**Illinois Corn Growers Association (ICGA)** Established in 1972, it is a grassroots membership organization with approximately 5,000 members. Currently, they provide funding for a USGS water sampling technician and water monitoring equipment for measurement of nitrates in tile water drainage from farm fields.

ICGA also runs the Precision Conservation Management Program described in the Technical Assistance section.

**Illinois Soybean Association** The Association is a statewide organization that strives to enable soybean producers to be the most knowledgeable and profitable soybean producers around the world. They represent more than 43,000 soybean farmers in Illinois through two primary roles; the state soybean checkoff and legislative and regulatory advocacy efforts. The Association supports the watershed by promoting watershed events, doing farmer profiles, and providing media coverage of watershed events.

**Macoupin County Farm Bureau (MCFB**) MCFB is an organization of 4,500 members who support agriculture in Macoupin County and Illinois. They provide meeting space for watershed committee meetings and promotion of watershed events.

**The Mosaic Company** is the world's leading producer and marketer of phosphate and crop nutrient products. They currently fund planning, monitoring, and outreach efforts in the UMC watershed and are particularly interested in efficient, sustainable, and environmentally responsible agricultural phosphorus applications.

**US Geological Survey (USGS)** USGS is the nation's largest water, earth, and biological science and civilian mapping agency. USGS collects, monitors, analyzes, and provides information about natural resource conditions, issues, and problems. In the watershed, there are two monitoring stations that provide upstream and downstream water quality data. This data is analyzed on an annual basis by USGS and provided to the UMC Partners and Steering Committees.

**Walton Family Foundation (WFF)** WFF focuses on improving water quality and restoring habitat in the Mississippi River watershed. Their goal is to ensure improved water quality and restored habitat that benefits people and nature in the Mississippi River Basin and ultimately the Gulf of Mexico by reforming the incentives that drive water quality degradation. WFF currently supports ongoing planning, monitoring, and outreach efforts in the UMC watershed.

**McKnight Foundation** focuses on restoring water quality and resilience in the Mississippi River watershed. Their goal is to restore the Mississippi River and to ensure a clean, resilient river system for communities across the American heartland. McKnight currently supports ongoing planning, monitoring, and outreach efforts in the UMC watershed.

## 10.1 Technical Assistance

In addition to the technical assistance provided by the entities listed below, there are conservation technical assistance resources provided through the University of Illinois Cooperative Extension Service (Coop Ext.) and by private professional consultants such as Certified Crop Advisors (CCA) or Technical Service Providers (TSP) which producers rely upon. Technical assistance relevant to the UMC watershed is also provided via non-profit organizations, such as the ISA, the AFT, Quail and Pheasants Forever, and The Nature Conservancy (TNC), among others.

**American Farmland Trust (AFT)** The AFT currently leads the UMC Watershed Partnership Steering and Advisory Committees and is the lead partner for ongoing RCPP and MRBI projects in the watershed. The mission of the AFT is to protect farmland, promote sound farming practices, and keep farmers on the land. The AFT advocates for programs and policies that protect farmland, food, and the environment, and conduct education and outreach and promote conservation.

**Illinois Department of Agriculture (IDOA)** The IDOA's Bureau of Land and Water Resources distributes funds to Illinois' 98 soil and water conservation districts for programs aimed at reducing soil loss and protecting water quality. It also helps to organize the state's soil survey every two years which tracks progress toward the goal of reducing soil loss on Illinois cropland to tolerable levels.

**Illinois Department of Natural Resources (IDNR)** IDNR provides technical assessments of streams for the IDOA's streambank stabilization program. The request for local assessment assistance comes through local county SWCDs. The IDNR also manages other state programs related to wildlife and forestry and oversees the state portion of the Conservation Reserve and Enhancement Program (CREP).

**Illinois Stewardship Alliance (ISA)** The ISA is a membership-based organization whose mission is to promote environmentally sustainable, economically viable, socially just, local food systems through policy development, advocacy, and education. Most relevant to the UMC watershed is ISA's work to promote cover crops and educate producers on their benefits. ISA staff can assist with landowner outreach and education programs related to conservation.

**Illinois Sustainable Ag Partnership (ISAP)** ISAP's mission is to create a network to support a systems approach to improve soil health and reduce nutrient loss. They provide a platform for disseminating relevant research, coordinate field days and events, provide expertise through collaboration, resources for soil health networks, and outreach and education.

**Macoupin County Soil Water Conservation District (SWCD)** In many Illinois counties, it is the local county SWCD that takes a lead role in providing information, guidance and funding arrangements for local conservation practices on farmland in the county. The Macoupin County SWCD provides a range of support in achieving UMC water quality goals, including serving on both the Partners and Steering Committees, identifying farmers and landowners within targeted conservation areas, conducting annual tillage and cover crop transect surveys specific to the UMC watershed, and promoting and assisting in watershed programming and events.

**National Great Rivers Research and Education Council (NGRREC)** The Council was formed in 2002 from a unique partnership between the Illinois National History Survey, University of Illinois at Urbana-Champaign and Lewis and Clark Community College. NGRREC is dedicated to the study of great river systems and the communities that use them. Most relevant to the UMC watershed is their goal of continuing research and policy development and promoting adaptive management to continuously improve strategies by applying new knowledge learned to ongoing sustainable management practices.

**Precision Conservation Management (PCM)** PCM is a farmer-led effort developed to address natural resource concerns on a field-by-field basis by identifying conservation practices that effectively address environmental issues in a financially viable way. PCM specialists work with farmers to identify conservation needs and use data from agronomic management practices, economic models, and sustainability metrics to develop customized solutions. Macoupin County is one of the counties PCM is active in and they also provide staff support and promotion of watershed events.

**Soil Heath Partnership (SHP)** SHP is a farmer-led initiative that fosters transformation in agriculture through improved soil health, benefiting farmer profitability, a stable food supply, and the environment. Through a scientific program administered by the National Corn Growers Association, SHP brings together diverse partners to work toward common goals. With more than 100 working farms enrolled within 12 states, the SHP tests, measures, and advances progressive farm management practices that will enhance sustainability and farm economics for generations to come. SHP has several demonstration farms sites within the watershed and provide staff support and promotion of watershed events.

## 11.0 Implementation Milestones, Objectives and Schedule

Implementation milestones and goals are intended to be measured by NRCS EQIP, CSP and Conservation Reserve Program (CRP) contracts, RCPP and MRBI program funding, 319 and SWCD funded cost-share measures, and UMC Watershed Partnership initiated projects including practices promoted and implemented via agricultural retailer partners. The goals are meant to be both measurable and realistic. Targeted outreach and on-farm visits with landowners are vital to the success of future activities and will be a component of every effort to ensure the adoption of the BMPs listed below. Communication and outreach will also help to ensure practices are maintained over time.

**Grade/Control/Riffle**

An aggressive 10-year implementation schedule is presented in Table 66. The milestones or objectives presented are intended to be achievable and realistic over a 10-year period, though actual implementation will depend on interested landowners and funding availability. The schedule takes into consideration limited NRCS and SWCD staff capacity in the watershed and incorporates the total number of acres and practices necessary to achieve water quality targets. All in-field BMPs, and medium–very high priority structural BMPs (under $696/lb phosphorus reduction, Table 64) are considered critical (Section 9.0) and prioritized for implementation within 10 years. Milestones noted after 10 years are considered long-term. In-field practice long-term goals are simply a continuation of short- and medium-term objectives.  Structural practices targeted for long-term implementation are anticipated to cost in excess of $696/lb of phosphorus reduced and will require more substantial capital expenditures; however, a few long-term projects will begin after the 6$^{th}$ year to allow more time for implementation. Long-term milestones will help to ensure water quality targets are met and maintained.

Table 67 summarizes BMP milestones or objectives, those responsible entities and the primary technical/financial assistance available. The implementation milestones or objectives will meet water quality targets and are divided between those that are realistic within a 10-year period and those that should be pursued as long-term management measures. Given the high cost and limited resources available, it is anticipated that more than 10 years will be required to fully meet water quality targets and maintain it over time.

### Table 66 – Implementation Milestones and Timeframe

| Timeframe | Milestone |
|---|---|
| **Years 1–2** | 1. Continue targeted outreach and one-one-one communication with producers.<br>2. Plant 2,425 acres of cover crops.<br>3. Convert conventional tillage to strip-till or no-till on 1,268 acres.<br>4. Complete phosphorus management activities on 3,703 new acres.<br>5. Install 18 critical area plantings.<br>6. Install 50 filter strips.<br>7. Install 100 high priority field borders.<br>8. Install 12 grade control structures.<br>9. Install 10 grassed waterways.<br>10. Install stream fencing on 5 pastures.<br>11. Install 1 rock riffle.<br>12. Install or conduct maintenance of 20 medium priority WASCBs.<br>13. Install 4 high priority wetlands.<br>14. Implement septic system maintenance and inspection program. |
| **Years 3–5** | 1. Continue targeted outreach and one-one-one communication with producers.<br>2. Plant 2,425 new acres of cover crops.<br>3. Convert conventional tillage to strip-till or no-till on 1,268 acres.<br>4. Complete phosphorus management activities on 3,703 new acres.<br>5. Install 4 critical area plantings.<br>6. Install 50 filter strips.<br>7. Install 100 field borders.<br>8. Install 12 grade control structures,<br>9. Install 10 grassed waterways.<br>10. Install stream fencing on 5 pastures.<br>11. Install 25 ponds.<br>12. Install 1 rock riffle.<br>13. Install or conduct maintenance of 30 WASCBs.<br>14. Install 7 wetlands.<br>15. Implement septic system maintenance and inspection program. |
| **Years 6–10** | 1. Continue targeted outreach and one-one-one communication with producers.<br>2. Plant 2,425 new acres of cover crops.<br>3. Convert conventional tillage to strip-till or no-till on 1,268 acres.<br>4. Complete phosphorus management activities on 3,703 new acres.<br>5. Install 30 filter strips.<br>6. Install 50 field borders.<br>7. Install 1 detention basin.<br>8. Install 2 grade control structures.<br>9. Install 10 grassed waterways.<br>10. Install stream fencing on 5 pastures.<br>11. Install 25 ponds.<br>12. Install 1 rock riffle.<br>13. Install or conduct maintenance of 20 WASCBs.<br>14. Install 8 wetlands.<br>15. Implement septic system maintenance and inspection program. |
| **10 + Years** | 1. Continue targeted outreach and one-one-one communication with producers.<br>2. Continue to plant new acres of cover crops.<br>3. Continue to identify fields ready for no-till/strip-till conversion<br>4. Continue to identify fields for phosphorus management activities. |

| Timeframe | Milestone |
|---|---|
| | 5. Install 36 priority filter strips.<br>6. Install 22 field borders.<br>7. Install 1 detention basin.<br>8. Install 26 grassed waterways.<br>9. Install stream fencing on 9 pastures.<br>10. Install 88 ponds.<br>11. Install or conduct maintenance of 72 WASCBs.<br>12. Install 7 wetlands.<br>13. Continue septic system maintenance and inspection program. |

### Table 67 – Implementation Objectives, Responsible Parties and Technical Assistance

| BMP/Objective | Responsible Party | Primary Technical Assistance/Funding Mechanism |
|---|---|---|
| **Watershed BMPs/Education and Outreach (1–10 years)** | | |
| **BMP:** Cover Crops<br>**Objective:** Install 7,275 acres | Landowner/SWCD/NRCS/ Ag Retailers | **Technical Assistance**: SWCD/NRCS/AFT/ISAP/SHP/PCM/Ag Retailers<br>**Funding Mechanism**: 319 Grant/Private Funds/NRCS and State Programs |
| **BMP:** No-Till/Strip-Till<br>**Objective**: Convert 3,803 acres | Landowner/SWCD/NRCS/ Ag Retailers | **Technical Assistance**: SWCD/NRCS/AFT/ISAP/SHP/PCM/Ag Retailers<br>**Funding Mechanism**: 319 Grant/Private Funds/NRCS and State Programs |
| **BMP:** Ponds<br>**Objective:** Install 50 ponds | Landowners/SWCD/NRCS | **Technical Assistance:** NRCS/SWCD/Consultants<br>**Funding Mechanism:** 319 Grant/Private Funds/NRCS |
| **BMP:** Wetland Creation<br>**Objective:** Install 19 wetlands | Landowner/SWCD/NRCS | **Technical Assistance**: SWCD/NRCS/Consultants/ USFWS/TWI<br>**Funding Mechanism**: 319/Private Funds/NRCS |
| **BMP:** Grassed waterway<br>**Objective:** Install 30 waterways | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA / Consultants<br>**Funding Mechanism**: 319 Grant/ NRCS and USDA Programs |
| **BMP:** Filter strips<br>**Objective:** Install 130 filter strips | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA/ Consultants<br>**Funding Mechanism**: 319 Grant/NRCS and USDA Programs/State Cost Share |
| **BMP:** Field Borders<br>**Objective:** Install 250 field borders | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA /Consultants<br>**Funding Mechanism**: 319 Grant/NRCS and USDA Programs/Private Funds/State Cost Share |
| **BMP:** Riffle<br>**Objective:** Install 3 Riffles | Landowners SWCD/NRCS/IDOA | **Technical Assistance:** SWCD/NRCS/Consultants<br>**Funding Mechanism:** 319 Grant/Private Funds/NRCS and State Cost-share |
| **BMP:** Grade Control<br>**Objective:** Install 26 structures | Landowners /NRCS/SWCD | **Technical Assistance:** NRCS/Consultants<br>**Funding Mechanism:** 319 Grant/NRCS and USDA Programs/Private Funds/State Cost Share |
| **BMP:** WASCB<br>**Objective:** Install or conduct maintenance on 70 WASCBs | Landowner/SWCD/NRCS | **Technical Assistance**: SWCD/NRCS/Consultant<br>**Funding Mechanism:** NRCS Programs/Private Funds/State Cost Share |
| **BMP:** Pasture Fencing | Landowners/NRCS | **Technical Assistance:** NRCS/Consultants |

| BMP/Objective | Responsible Party | Primary Technical Assistance/Funding Mechanism |
|---|---|---|
| **Objective:** Install fencing on 15 pastures | | **Funding Mechanism:** NRCS EQIP/319 Grant/State Cost Share |
| **BMP:** Nutrient Management<br>**Objective:** Apply nutrient reducing practices on 11,110 acres | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD/NRCS/AFT/PCM/Ag Retailers<br>**Funding Mechanism**: 319 Grant/Private Funds/ NRCS and USDA Programs/State Cost Share |
| **BMP:** Septic System Maintenance<br>**Objective:** Initiate a septic system inspection and maintenance program | Landowner/City of Carlinville | **Technical Assistance**: IL Department of Public Health<br>**Funding Mechanism**: 319 Grant/Private or City Funds |
| **BMP**: Education and Outreach<br>**Objective:** Stakeholder engagement | AFT/ISA/SWCD/NRCS/Coop Ext. | **Technical Assistance:** SWCD/NRCS/ISA/AFT/C - BMP/Coop Ext.<br>**Funding Mechanism:** 319 Grant/City Funds/Private Funds |
| **Long-Term Management Measures (10+ years)** | | |
| **BMP**: Education and Outreach<br>**Objective:** Stakeholder engagement | AFT/ISA/SWCD/NRCS/Coop Ext. | **Technical Assistance:** SWCD/NRCS/ISA/AFT/Coop Ext.<br>**Funding Mechanism:** 319 Grant/City Funds |
| **BMP:** No-Till/Strip-Till<br>**Objective**: Continue to identify fields for conversion and prevent already converted fields from being tilled | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD/NRCS/AFT/PCM<br>**Funding Mechanism**: 319 Grant/Private Funds/ NRCS and USDA Programs |
| **BMP:** Nutrient Management<br>**Objective:** Continue to work with landowners on ways to apply nutrients more efficiently | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD/NRCS/PCM/AFT<br>**Funding Mechanism**: 319 Grant/Private Funds/ NRCS and USDA Programs |
| **BMP:** Cover Crops<br>**Objective**: Continue to identify fields for cover crop plantings | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD/NRCS/AFT/PCM<br>**Funding Mechanism**: 319 Grant/Private Funds/ NRCS and USDA Programs |
| **BMP:** Detention Basin<br>**Objective:** Install 1 Basin | Landowners/SWCD/NRCS | **Technical Assistance:** NRCS/SWCD/Consultants<br>**Funding Mechanism:** 319 Grant/Private Funds |
| **BMP:** Ponds<br>**Objective:** Install 88 ponds | Landowners/SWCD/NRCS | **Technical Assistance:** NRCS/SWCD/Consultants<br>**Funding Mechanism:** 319 Grant/Private Funds/NRCS |
| **BMP:** Wetland Creation<br>**Objective:** Install 7 wetlands | Landowner/SWCD/NRCS | **Technical Assistance**: SWCD/NRCS/Consultants/ USFWS/TWI<br>**Funding Mechanism**: 319/Private Funds/NRCS |
| **BMP:** Grassed waterway<br>**Objective:** Install 26 waterways | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA / Consultants<br>**Funding Mechanism**: 319 Grant/ NRCS and USDA Programs |
| **BMP:** Filter strips<br>**Objective:** Install 36 filter strips | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA/ Consultants<br>**Funding Mechanism**: 319 Grant/NRCS and USDA Programs/State Cost Share |
| **BMP:** Field Borders<br>**Objective:** Install 22 field borders | Landowner/SWCD/NRCS | **Technical Assistance:** SWCD /NRCS /FSA /Consultants<br>**Funding Mechanism**: 319 Grant/NRCS and USDA Programs/Private Funds/State Cost Share |
| **BMP:** WASCB<br>**Objective:** Install or conduct maintenance on 72 WASCBs | Landowner/SWCD/NRCS | **Technical Assistance**: SWCD/NRCS/Consultant<br>**Funding Mechanism:** NRCS Programs/Private Funds/State Cost Share |
| **BMP:** Pasture Fencing<br>**Objective:** Install fencing on 9 pastures | Landowners/NRCS | **Technical Assistance:** NRCS/Consultants<br>**Funding Mechanism:** NRCS EQIP/319 Grant/State Cost Share |

## 12.0 Information and Education

AFT, in partnership with staff from the NRCS, SWCD and the UMC Steering Committee, actively conduct education and outreach throughout the watershed. Outreach and education activities organized from 2016 to 2018 are listed in Table 68.

The UMC Steering and Partners Committee acknowledge that effective education and outreach are crucial to a watershed plan's success since many watershed problems and solutions result from human actions. AFT and watershed partner staff are currently in the process of developing a communications plan to guide future outreach. Identified communications goals, outputs and strategies are listed below.

**UMC communication goals:**

1. Partners and steering committee are engaged and promote best practices for the watershed.
2. General public in UMC watershed have an increased awareness of the watershed issues and are advocates for solutions.
3. Early adopter farmers are engaged, share their experience, and promote best practices and assistance programs with their peers.
4. Middle adopter farmers are aware of the watershed issues, knowledgeable of solutions for their farms, and engaged with using best practices for the watershed.
5. Non-operating landowners are engaged in land management discussions with their tenants and their families, aware of the watershed issues, and encourage the use of best practices on their land.
6. There is an active, online presence of the UMC that includes: regular blog posts, monthly Facebook updates, regular email updates, and regular downloadable outreach items.

**UMC communications objectives:**

1. Gain new attendees at farmer workshops.
2. Gain new hits to online media sources.
3. Earn increases in local media.
4. Increase project visibility on the landscape, via watershed signage and visible practices.
5. Increase the volume of voluntary adoption of NRCS/SWC programs and incentives.
6. Increase farmer application of best practices.
7. Establish frequent use of the interactive watershed model.
8. Increase consistent use and visibility of key messages.

**UMC communication strategies** to meet goals and objectives:

1. Writing press releases with common terminology in which the target audience can readily understand and speaks to their values and priorities.
2. Create flyers with consistent language, graphics, and photos.
3. Host workshops with repeated key messages often and consistently.
4. Encouraging placement of signage about conservation practices: Saving Tomorrow's Agriculture Resources (STAR) Program and watershed signs.

5. Write frequent blog posts on watershed success stories from early adopter and middle adopter farmers.
6. Create an interactive watershed map for the target audiences, such as the interactive watershed model.
7. Create unique fact sheets that use AFT and partner mission values.
8. Organize watershed tours with diverse target audiences.

Future outreach and implementation in the watershed will focus on the critical areas identified in this plan. Furthermore, AFT, NRCS and SWCD staff will continue to promote the priority practices identified through targeted funds and the work of the Conservation Technician. A general schedule of the targeted outreach plan is outlined below.

**UMC Targeted Outreach Plan**

1. Initial contact: Targeted mailings in Coop Branch and Spanish Needle
    a. Goal: Get farmers to either 1) call after mailing or 2) open to receiving a call.
    b. Tasks:
        i. Generate mailing list identifying producers farming critical area fields.
        ii. Send letter describing project (35–50 letters in the first round).
    c. Resources included:
        i. UMC watershed fact sheet.
        ii. Phosphorus management resource.
2. Follow-up contact
    a. Goal: Schedule initial meetings and conservation planning consultations.
    b. Task:
        i. Place individual calls to all letter recipients.
3. Initial Meeting and Consultation
    a. Goal: Create in interest in improving the soil health of their operation
    b. Tasks:
        i. Assess current management practices and summarize available technical and financial resources.
        ii. Identify field level resource concerns and individualized practices to remedy stated concerns.
        iii. Discuss feasible and preferred options for phosphorus reduction.
4. Follow-up
    a. Goal: Practice implementation
    b. Tasks:
        i. Assist in any federal or state program enrollment, including paperwork, providing proper cut-off dates and contact info, etc.
        ii. Create farm-specific map siting practices, associated benefits and next steps.

**Table 68 – Outreach and Education Events, 2016–2019**

| Event | No. of Attendees | Date | Location |
|---|---|---|---|
| UMC Partnership Winter Kick-off Meeting | n/a | 1/5/2016 | Carlinville Elks Lodge |
| Soil Field Day | 2 | 7/14/2016 | Johnson Pork Farm (Hettick) |
| Soils Warrior Strip-till Meeting | 13 | 11/10/2016 | M&M Service Company, Carlinville |
| CHS Cover Crops Field Day | 13 | 11/16/2016 | CHS-Shipman |
| UMC Partnerships Winter Meeting | 59 | 2/8/2017 | Carlinville Elks Lodge |
| Johnson Pork Field Day | 19 | 3/22/2017 | Johnson Pork Farm (Hettick) |
| Heyen Soil Health Field Day | 34 | 8/17/2017 | Heyen Farms (Gillespie) |
| Otter Lake Field Day | n/a | 11/21/2017 | Dave Killam Farm (Girard) |
| UMC Partnerships Winter Meeting | 64 | 1/31/2018 | Carlinville Elks Lodge |
| Phosphorus Management Workshop | 40 | 8/9/2018 | University of Illinois Extension Office (Carlinville) |
| UMC Partnerships Winter Meeting | 77 | 2/6/2019 | Carlinville Elks Lodge |

# 13.0 Water Quality Monitoring Strategy

Monitoring is an effective way to measure progress toward meeting water quality objectives; however, one challenge with in-stream indicators is isolating dependent variables. There are likely many variables influencing monitoring results, so drawing conclusions about one specific constituent should be done with caution. Still, indicators are excellent for assessing overall changes in watershed condition.

The purpose of the monitoring strategy is to utilize existing monitoring data and a sampling routine to monitor and evaluate the condition and health of the watershed in a consistent and on-going manner. It also serves to assess the effectiveness of plan implementation and its watershed-scale contribution towards achieving the goals and objectives of the plan. While programmatic monitoring tracks progress through achievement of actions, this section outlines a strategy to directly monitor the effectiveness actions on water quality.

Continuous and discrete water quality sampling is being executed through an AFT partnership with the 2015 MRBI program and a 2017 RCPP contract which expires October 2022. At that time, funding and partner commitments will discontinue. Future monitoring activities and financial resources will be planned and secured before the end of the contract. Current funding sources and partnerships can be reestablished, or new ones can be sought through volunteer groups or programs. If funding allows, the addition of edge-of-field practice monitoring to measure the effectiveness of BMPs and nitrogen monitoring at IEPA sites is recommended to effectively monitor progress towards reduction goals.

## 13.1 Approach

The primary focus of monitoring is to determine changes in sediment and phosphorus concentrations and loadings over time resulting from management practices and educational outreach. Table 69 and Figure 36 describe and depict monitoring stations and their locations. The ongoing, comprehensive effort to assess the effectiveness of nutrient-reduction practices includes monitoring at two USGS stations on Macoupin Creek (one upstream and one downstream station) and five IEPA stations on major tributaries to Macoupin Creek. This comprehensive monitoring program was designed by the IEPA, the ISA, Blackburn College, the AFT, and the USGS to characterize water quality and determine agriculture nonpoint source loading in Macoupin Creek and five major tributaries.

The USGS stations are just outside the UMC watershed boundary. The upstream station is located at the Highway 4 bridge near Carlinville near the eastern edge of the watershed; the downstream station is at the Highway 111 bridge between Medora and Chesterfield near the western edge. IEPA stations are located on the tributaries of Honey Creek, Spanish Needle Creek, Dry Fork, Coop Branch and Hurricane Creek (one station each); most are near their confluences to Macoupin Creek (less than 1 mile), although DAZI-01 is about 2.7 stream miles and DAZM-01 is about 5.5 stream miles upstream from their confluences with Macoupin Creek (Table 69, Figure 36).

**Table 69 – Water Quality Monitoring Stations**

| Station Code | Supporting Agency | Waterbody Name | Location |
|---|---|---|---|
| DAH-01 | IEPA | Dry Fork | Lake Catoga Rd, 3 mi NE of Plainview |
| DAI-01 | IEPA | Hurricane Creek | Shipman Rd, 5.7 mi SW of Carlinville, near Beaver Dam State Park |
| DAZI-01 | IEPA | Coop Branch | Coop Rd, 3 mi E Medora |
| DAZL-SM-C2 | IEPA | Spanish Needle Creek | Off Stagecoach Rd, 0.3 mi upstream from Macoupin Creek confluence |
| DAZM-01 | IEPA | Honey Creek | Linwood Ln, 0.2 mi W of Illinois Rt. 4 and 5.6 mi SE of Carlinville |
| 5586745 | USGS | Macoupin Creek | Macoupin Creek at Hwy 111 near Summerville, IL |
| 5586647 | USGS | Macoupin Creek | Macoupin Creek at Hwy 108 near Carlinville, IL |


**USGS Sampling Stations**

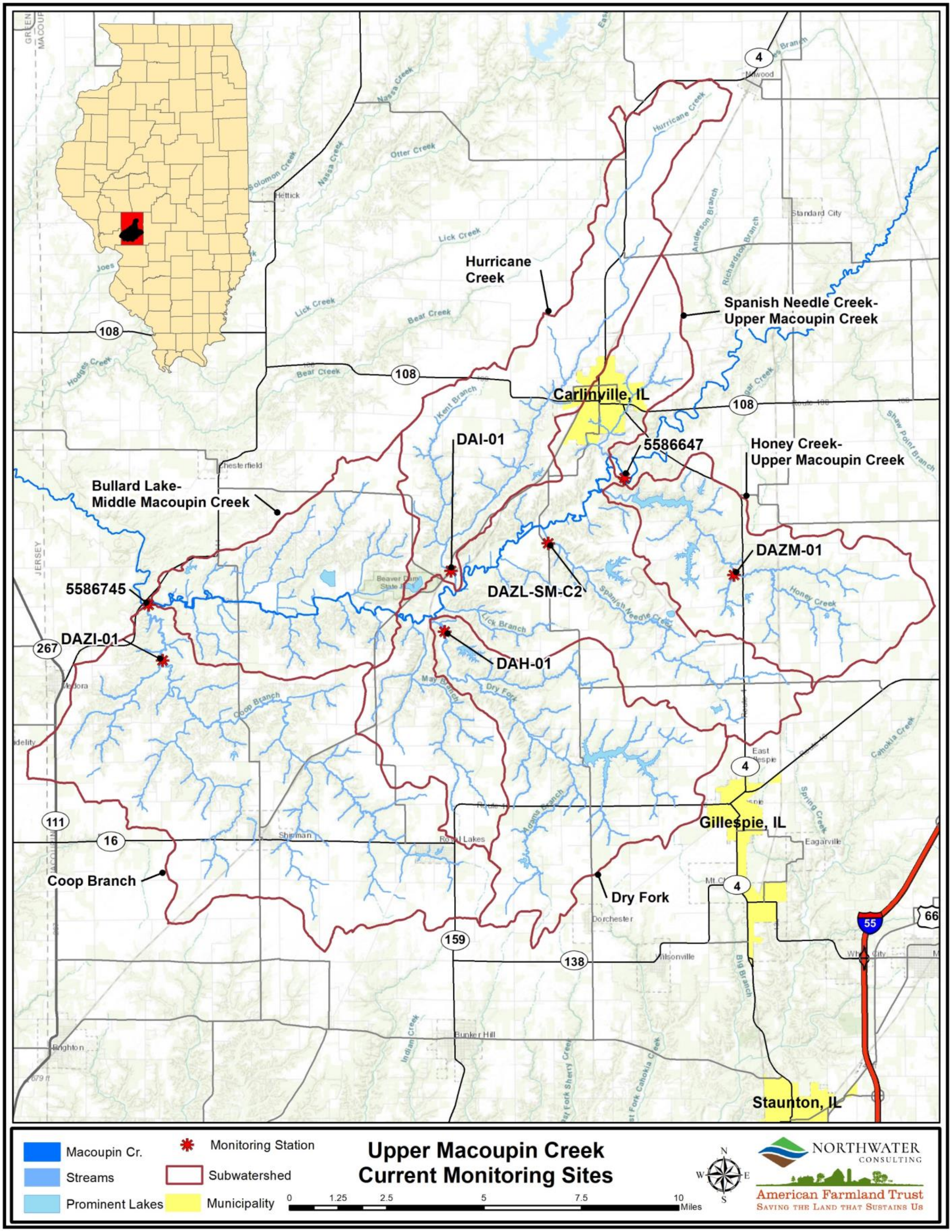



Figure 36 – Water Quality Monitoring Strategy Sites, Current

## 13.2 Continuous and Discrete Sample Collection

Continuous and discrete water quality data are collected at the USGS sampling sites. Discrete samples are taken weekly, for the parameters of total phosphorus, dissolved phosphorus, orthophosphate, nitrate+nitrite, and TSS. TSS is analyzed at the USGS Illinois-Iowa Water Science Center; all other parameters are analyzed at the USGS National Water Quality Laboratory (NWQL). Continuous readings of stream discharge are taken.

Discrete water quality sampling is performed at the IEPA sites on a routine schedule, one per month, for the parameters of total phosphorus, TSS, and VSS. Samples are analyzed at the IEPA laboratory. Blackburn College is primarily responsible for sampling; it is performed by students under the supervision of the water monitoring project coordinator, Dr. James Bray. Composite samples are collected using a weighted-bottle sampler.

Routine, discrete sampling serves to document ambient water quality which captures climatic, land-use, and seasonal differences and effects on quality. Low- and high-flow events, known as base-flow and storm-event sampling, are collected. Storm event samples are collected between 6–8 times per year.

Quality assurance and control is conducted as part of the sampling routine and through laboratory analysis. Field-based quality control consists of quarterly to semi-annual sample replicates. Sample blanks are used to assess contamination potential from deionized water and sample processing equipment. All samples are taken in accordance with and adhere to IEPA laboratory requirements; laboratory quality control measures include procedures such as measuring precision and accuracy.

### 13.2.1 Data analyses components

1. Calculations of annual sediment, phosphorus, and nitrate loads at the two USGS monitoring stations will be computed, as practical, from the discrete sample and continuous streamflow data and provided by the USGS.
2. Basic statistical summaries of measured and sampled concentrations and loadings, including storm-event samples, will be conducted and provided by the USGS.

### 13.2.2 Reporting

1. Continuous streamflow and discrete water-quality data are and will continue to be quality-assured and available via USGS National Water Information System: Web Interface (NWISweb) on a continuous basis.
2. Informal annual summaries of monitoring activities, data statistics, and sediment, phosphorus, and nitrate loads have been and will continue to be provided by USGS.
3. A final report, including sediment, phosphorus, and nitrate loading estimates, will be produced by the USGS following completion of the current monitoring agreement (2022).

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# Appendix A: Nonpoint Source Pollution Load Model Methodology (SWAMM)

# Upper Macoupin Creek Watershed SWAMM Pollutant Load Model Methodology

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# Tables



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## 1.0 Introduction

A GIS spatially based pollution load model or SWAMM (Spatial Watershed Assessment and Management Model) was developed to estimate field level annual pollutant loading from, phosphorus, nitrogen, and sediment. Constructed using soils, landuse, and precipitation data the model provides annual loading for individual land parcels within the Lower Macoupin Creek watershed. Results are organized through a unique combination of landuse and soils, delineated into individual units of pollution loading. Accepted equations for calculating runoff and soil erosion are integrated into the model to provide realistic estimations of the quantity and distribution of annual pollution loading throughout the study area. Model calibration was attempted using flow and sampled water quality data (See Section 3.0). A time period of 4/1/2003 to 4/1/2018 was used for generating rainfall values.

The GIS data set is organized in such a way that results can easily be queried by landuse. Results can also be analyzed based on user defined boundaries and presented in map format, easily overlaid on existing base maps. The model includes over 240,000 unique records from which to assess pollution loading. The following methodology document provides key model equations and values and references.

## 2.0 Methodology

The custom SWAMM model consists of two primary components:

- Universal Soil Loss Equation (USLE) Component.
- Event Mean Concentration (EMC) Component for surface runoff.

### 2.1 USLE Component

The overall analysis methodology modified by Northwater from:

*Mitasova and Lubos Mitas: Modeling soil detachment with RUSLE3d using GIS, 1999; University of Illinois. http:/skagit.meas.ncsu.edu/~helena/gmslab/erosion/usle.html*

The Universal Soil Loss Equation (USLE) component of the model is applied to agricultural land uses within the watershed (row crops and pasture), forest and grassland. The USLE methodology incorporated into the model is summarized below:

- 1:24,000 NRCS Soil Survey Geographic Database (SSURGO) Digital Soils.
- Selected appropriate soil types and relevant USLE factors identified and calculated from SSURGO soils dataset. LS factors provided by county NRCS staff. C factors generated from county NRCS staff and the USDA's national Engineering handbook.
- USLE erosion calculated with the following equation: LS * K * C * R *P.

### Table 1 – USLE factors

| C Factor[1] | K Factor | LS Factor | R Factor | P Factor |
|---|---|---|---|---|
| Initial C factors<br>Reduced-Till = 0.25<br>Mulch-Till = 0.23<br>Wheat = 0.02<br>No-Till/Strip-Till = 0.12<br>No-Till and Cover Crop = 0.04<br>Tilled Cover Crop = 0.12<br>Hay/Other Ag = 0.01<br>Conventional = 0.42 | Values included in SSURGO tabular data | See Section 2.1.1 | 185 | 1 |

[1] – See Section 3 for C Factors following model calibration

### 2.1.1 LS Factor

In order to more accurately depict spatial patterns of erosion, an LS-factor raster layer was calculated using ArcMap 10.2.1 and a modified version of the LS-factor for the Unit Stream Power Erosion and Deposition Model (USPED) (Mitasova et al. 1996; Mitas and Mitasova 1999), taken from Oliveira et al. (2013). This method has been used in other agricultural areas with similar soil types and slopes, susceptible to erosion (Pistocchi et al 2002; Pericope 2009; Rodriguez and Suarez 2012). Topographic calculations from Oliveira et al. (2013) included:

$$L = \left(\frac{A}{22.1}\right)^m$$

Where, L is the slope length factor for a standardized 22.1, m is the unit plot length; $\lambda$ is the area upland flow; and $m$ is an adjustable value depending on the soil's susceptibility to erosion. For LS factors determined here, $A$ was calculated as the flow accumulation raster multiplied by cell resolution. Furthermore, $m$ values for were assigned according to soil slope. For 0-1% slopes, $m$ =0.2; for 1-3% slopes, $m$ =0.3; for 3-4.5% slopes, $m$ =0.4; for slopes ≥ 4.5%, $m$ =0.5.

$$S = \left(\frac{\sin\left(0.01745 \times \theta_{deg}\right)}{0.09}\right)^n$$

Where, $\theta$ is the slope in degrees; 0.09 is the slope-gradient constant; and $n$ is an adjustable value depending on the soil's susceptibility to erosion. For LS factors calculated here, a value of $n$ =1.4 was used as furrow erosion is common in the Macoupin Creek watershed (Oliveira et al. (2013).

***Sources***


1. *Mitas, L., & Mitasova, H. (1998). Distributed soil erosion simulation for effective erosion prevention. Water Resources Research, 34(3), 505-516.*
2. *Mitasova, H., Hofierka, J., Zlocha, M., & Iverson, L. R. (1996). Modelling topographic potential for erosion and deposition using GIS. International Journal of Geographical Information Systems, 10(5), 629-641.*
3. *Oliveira, A. H., da Silva, M. A., Silva, M. L. N., Curi, N., Neto, G. K., & de Freitas, D. A. F. (2013). Development of topographic factor modeling for application in soil erosion models. In Soil processes and current trends in quality assessment. InTech.*
4. *Pistocchi, A., Cassani, G., & Zani, O. (2002). Use of the USPED model for mapping soil erosion and managing best land conservation practices. International Congress on Environmental Modelling and Software. 191.*
5. *Pricope, N. G. (2009). Assessment of spatial patterns of sediment transport and delivery for soil and water conservation programs. Journal of Spatial Hydrology, 9(1).*

6. *Rodriguez, J. L. G., & Suarez, M. C. G. (2012). Methodology for estimating the topographic factor LS of RUSLE3D and USPED using GIS. Geomorphology, 175, 98-106.*

## 2.2 EMC Component

A) All formulas and selected variables are derived from: *STEPL (Spreadsheet Tool for Estimation of Pollutant Load) Version 3, Tetra Tech, 2004.*

B) Event Mean Concentration Values and Curve Numbers were derived from the following sources:

1. *Northwater Consulting, 2017. Hunter Lake Spatial Watershed Assessment and Management Model. Prepared for the City of Springfield, IL.*
2. *Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) Technical Guide, Version 1.0 Release 1, November 2004.*
3. *Northwater Consulting, 2010. Lower DuPage River Watershed Plan Pollution Load Model Methodology.*
4. *V3 Companies, 2008. Elkhart River Watershed Management Plan, Appendix J; Pollutant Load Model Documentation for Critical Areas.*
5. *Price, Thomas H., 1993. Unit Area Pollutant Load Estimates for Lake County Illinois Lake Michigan Watersheds.*
6. *Todd D. Stuntebeck, Matthew J. Komiskey, Marie C. Peppler, David W. Owens, and Dennis R. Frame 2011. Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field. Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–08.*
7. *Northwater Consulting, 2013. Nine- Lakes Spatial Watershed Assessment and Management Model. Prepared for Chicago Metropolitan Agency for Planning, Chicago, IL.*
8. *Northwater Consulting, 2014. Pigeon Creek Spatial Watershed Assessment and Management Model. Prepared for Steuben County SWCD, Angola, IN.*
9. *Northwater Consulting, 2014. Big Ditch and Big/Long Creek Spatial Watershed Assessment and Management Model. Prepared for the Agricultural Watershed Institute, Decatur, IL.*
10. *Northwater Consulting, 2016 Spatial Watershed Assessment and Management Model for Lake Springfield. Prepared for the Sangamon County SWCD, Springfield, Illinois.*
11. *Northwater Consulting, 2017. Spatial Watershed Assessment and Management Model for Waverly Lake. Prepared for the City of Waverly and the IEPA, Waverly, Illinois.*
12. *United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division, 1986. Urban Hydrology for Small Watersheds, TR-55 Technical Release 55.*
13. *Battiata, J., Collins, K., Hirchman, D., and Hoffman G., 2010. The Runoff Reduction Method. Universities Council on Water Resources, Journal of Contemporary Water Research & Education, Issue 146.*
14. *Fernandez, F. G., and Schaefer, D. (2011). Assessment of soil phosphorus and potassium following real time kinematic-guided broadcast and deep-band placement in strip-till and no-till. Soil Sci. Soc. Am. J. 76, 1090–1099. doi: 10.2136/sssaj2011.0352*
15. *Daverede, I. C., Kravchenko, A. N., Hoeft, R. G., Nafziger, E. D., Bullock, D. G., Warren, J. J., & Gonzini, L. C. (2003). Phosphorus runoff: Effect of tillage and soil phosphorus levels. Journal of Environmental Quality, 32(4), 1436-1444.*
16. *Sharpley, A.N., T. Daniel, T. Sims, J. Lemunyon, R. Stevens, and R. Parry. 2003. Agricultural Phosphorus and Eutrophication, 2nd ed. U.S. department of Agriculture, Agricultural Research Service, ARS.149, 44 pp.*
17. *Module 5: VSMP Water Quantity Requirements, 2016. Accessed online at http://www.deq.virginia.gov/Portals/0/DEQ/ConnectwithDEQ/Training/SWM/PlanReviewSWM_PG_Module5.pdf.*

C) Precipitation: annual precipitation, number of rain days and correction factors were acquired through the PRISM dataset (Parameter-elevation Relationships on Independent Slopes Model). Datasets were acquired by 4km grid and extrapolated into 10ac grid squares. The resulting grid file was appended to the model layer.

### Table 2 – Rainfall Factors

| Extent | Average Number of Rain Days | Rain Days Correction Factor | P Value (inches) |
|---|---|---|---|
| 4km Grid | 109.8 – 121.93 | 0.454 – 0.5 | 0.67 – 0.7 |

D) Delivery Ratio; distance based delivery ratio: *Minnesota Board of Water & Soil Resources, "Pollution Reduction Estimator Water Erosion - Microsoft Excel® Version September 2010."*

*Polygon distance from major stream (ft)* ^-0.2069

### Table 3 – Model Values

| Rain days | Correction Factor (precipitation and rain days) | Curve Number (by soil hydrologic group) | Runoff (by soil hydrologic group in inches) | Initial N Concentration in sediment[1] | P Concentration in sediment (only for erosion from crop ground)[1,] | EMC for N, P, TSS |
|---|---|---|---|---|---|---|
| See Table 2 | Table 2 | Table 4 | Calculated using the following equation: $Q = \frac{((P-(IaXS))^2}{P + 0.8 X S}$ $S = \frac{1000}{CN} - 10$ Q = Runoff (inches) P = Precipitation (inches) S = Potential max retention (inches) CN = Curve Number Ia = Initial abstraction factor; set to 0 for annual runoff | Table 4 | Table 4 | Table 5 |

[1] – Soil N and P concentration based on soil samples obtained within the Lower Macoupin Creek and Horse Creek watershed as well as EPA Region 5 model default values

### Table 4 – Soil Concentration Values

| Landuse Category | Nitrogen Concentration (lbs/lb) | Phosphorus Concentration (lbs/lb) |
|---|---|---|
| **Camp Site** | 0.001 | 0.0005 |
| **Cemetery** | 0.001 | 0.0005 |
| **Commercial** | 0.001 | 0.0005 |
| **Confinement** | 0.001 | 0.0005 |
| **Farm Building** | 0.001 | 0.0005 |
| **Feed Area (Very High/High)** | 0.001 | 0.00193 |
| **Feed Area (Medium)** | 0.001 | 0.001775 |
| **Feed Area (Low)** | 0.001 | 0.001775 |
| **Forest** | 0.000252 | 0.000184583 |
| **Golf Course** | 0.001 | 0.0005 |
| **Grasslands** | 0.001 | 0.00018 |
| **Industrial** | 0.001 | 0.0005 |

| Landuse Category | Nitrogen Concentration (lbs/lb) | Phosphorus Concentration (lbs/lb) |
|---|---|---|
| **Institutional** | 0.001 | 0.0005 |
| **Junk Yard** | 0.001 | 0.0005 |
| **Manufacturing** | 0.001 | 0.0005 |
| **Manure Storage** | 0.001 | 0.001775 |
| **Marina** | 0.001 | 0.0005 |
| **Open Water - Stream** | 0 | 0 |
| **Open Water Pond/Reservoir** | 0 | 0 |
| **Orchards & Nurseries** | 0.001 | 0.00030475 |
| **Parks & Recreation** | 0.001 | 0.0005 |
| **Pasture (Very High/High)** | 0.001 | 0.001775 |
| **Pasture (Medium)** | 0.001 | 0.0004105 |
| **Pasture (Low)** | 0.001 | 0.00018 |
| **Railroad** | 0.001 | 0.0005 |
| **Resource Extraction** | 0.001 | 0.0005 |
| **Roads** | 0.001 | 0.0005 |
| **Row Crops (no-till/Strip-till, Cover Crop/Organic, Wheat, Hay)** | 0.001 | 0.00030475 |
| **Row Crops (Reduced/Mulch)** | 0.001 | 0.0002625 |
| **Row Crops (Conventional)** | 0.001 | 0.0002325 |
| **Rural Residential** | 0.001 | 0.0005 |
| **Urban Open Space** | 0.001 | 0.0005 |
| **Urban Residential** | 0.001 | 0.0005 |
| **Utilities** | 0.001 | 0.0005 |
| **Wetlands** | 0 | 0 |
| **Warehousing** | 0.001 | 0.0005 |
| **Winery** | 0.001 | 0.00030475 |
| **Streambanks** | 0.000643 | 0.000304 |

### Table 5 – Event Mean Concentrations & Curve Numbers

| Landuse Category | EMC N (mg/l) | EMC P (mg/l) | EMC TSS (mg/l) | Curve # A Group | Curve # B Group | Curve # C Group | Curve # D Group |
|---|---|---|---|---|---|---|---|
| **Camp Ground (Medium)** | 3.2 | 0.39 | 150 | 61 | 75 | 83 | 87 |
| **Cemetery (Low)** | 3.1 | 0.46 | 84 | 39 | 61 | 74 | 80 |
| **Cemetery (Medium)** | 3.1 | 0.46 | 84 | 49 | 69 | 79 | 84 |
| **Cemetery (High)** | 3.1 | 0.46 | 84 | 68 | 79 | 86 | 89 |
| **Commercial (Very High)** | 3.2 | 0.45 | 206 | 96 | 96 | 96 | 96 |
| **Commercial (High)** | 3 | 0.42 | 200 | 89 | 92 | 94 | 95 |
| **Commercial (Medium)** | 2.8 | 0.4 | 153 | 77 | 85 | 90 | 92 |
| **Confinement (Very High)** | 7.1 | 1.8 | 240 | 96 | 96 | 96 | 96 |
| **Confinement (High)** | 7.1 | 1.8 | 240 | 89 | 92 | 94 | 95 |
| **Confinement (Low)** | 4.05 | 1 | 60 | 61 | 75 | 83 | 87 |

| Landuse Category | EMC N (mg/l) | EMC P (mg/l) | EMC TSS (mg/l) | Curve # A Group | Curve # B Group | Curve # C Group | Curve # D Group |
|---|---|---|---|---|---|---|---|
| Farm Building (Very High) | 7.1 | 0.45 | 280 | 96 | 96 | 96 | 96 |
| Farm Building (High) | 6.8 | 0.42 | 280 | 81 | 88 | 91 | 93 |
| Farm Building (Medium) | 6.8 | 0.42 | 160 | 61 | 75 | 83 | 87 |
| Farm Building (Low) | 6.8 | 0.42 | 72 | 51 | 68 | 79 | 84 |
| Feed Area (Very High) | 16.87 | 3.25 | 487 | 77 | 86 | 91 | 94 |
| Feed Area (High) | 13.5 | 2.6 | 390 | 77 | 86 | 91 | 94 |
| Feed Area (Medium) | 10.1 | 1.5 | 240 | 76 | 85 | 90 | 93 |
| Feed Area (Low) | 6.75 | 0.75 | 120 | 68 | 79 | 86 | 89 |
| Forest | 1.4 | 0.15 | 60 | 36 | 60 | 73 | 79 |
| Grassland (Prairie) | 0.7 | 0.13 | 30 | 30 | 58 | 71 | 78 |
| Grassland (Waterway) | 1.9 | 0.1 | 36 | 49 | 69 | 79 | 84 |
| Grassland (Filter Strip) | 0.7 | 0.13 | 30 | 30 | 58 | 71 | 78 |
| Golf Corse | 3.6 | 0.7 | 84 | 51 | 71 | 79 | 84 |
| Industrial (Very High) | 2.6 | 0.35 | 230 | 96 | 96 | 96 | 96 |
| Industrial (High) | 2.4 | 0.31 | 215 | 89 | 92 | 94 | 95 |
| Industrial (Medium) | 2.2 | 0.28 | 200 | 81 | 88 | 91 | 93 |
| Industrial (Low) | 2.2 | 0.28 | 200 | 61 | 75 | 83 | 87 |
| Institutional (Very High) | 3.2 | 0.4 | 220 | 96 | 96 | 96 | 96 |
| Institutional (High) | 3.2 | 0.4 | 206 | 89 | 92 | 94 | 95 |
| Institutional (Medium) | 3 | 0.38 | 153 | 77 | 85 | 90 | 92 |
| Institutional (Low) | 3 | 0.38 | 153 | 61 | 75 | 83 | 87 |
| Junkyard (High) | 2.6 | 0.31 | 300 | 89 | 92 | 94 | 95 |
| Junkyard (Medium) | 2.6 | 0.31 | 300 | 51 | 68 | 79 | 84 |
| Junkyard (low) | 2.6 | 0.31 | 300 | 49 | 69 | 79 | 84 |
| Manufacturing (Very High) | 2.6 | 0.35 | 230 | 96 | 96 | 96 | 96 |
| Manufacturing (High) | 2.4 | 0.31 | 215 | 89 | 92 | 94 | 95 |
| Manure Storage (Medium) | 10.1 | 1.5 | 240 | 76 | 85 | 90 | 93 |
| Marina (High) | 2.16 | 0.29 | 153 | 89 | 92 | 94 | 95 |
| Open Water - Pond/Reservoir | 2.22 | 0.27 | 18.64 | 100 | 100 | 100 | 100 |
| Open Water - Stream | 1.9 | 0.22 | 78.5 | 100 | 100 | 100 | 100 |
| Orchards and Nurseries (Medium) | 3.4 | 0.55 | 120 | 49 | 69 | 79 | 84 |
| Orchards and Nurseries (Low and Winery) | 3.4 | 0.55 | 120 | 39 | 58 | 71 | 78 |
| Park/Recreation (High) | 2.5 | 0.6 | 30 | 68 | 79 | 86 | 89 |
| Park/Recreation (Medium) | 2.5 | 0.6 | 30 | 49 | 69 | 79 | 84 |
| Park/Recreation (Low) | 2.5 | 0.6 | 30 | 39 | 61 | 74 | 80 |
| Pasture (Very High) | 13.5 | 2.6 | 390 | 77 | 86 | 91 | 94 |
| Pasture (High) | 10.1 | 1.5 | 240 | 75 | 84 | 89 | 91 |
| Pasture (Medium) | 6 | 0.6 | 150 | 68 | 79 | 86 | 89 |
| Pasture (Low) | 3.6 | 0.36 | 70 | 39 | 58 | 71 | 78 |
| Railroad | 2 | 0.34 | 240 | 89 | 89 | 89 | 89 |
| Resource Extraction (High) | 1.79 | 0.31 | 94 | 76 | 83 | 86 | 90 |
| Resource Extraction (Low) | 0.89 | 0.155 | 47 | 44 | 64 | 74 | 79 |

| Landuse Category | EMC N (mg/l) | EMC P (mg/l) | EMC TSS (mg/l) | Curve # A Group | Curve # B Group | Curve # C Group | Curve # D Group |
|---|---|---|---|---|---|---|---|
| **Roads** | 2.3 | 0.34 | 153 | 98 | 98 | 98 | 98 |
| **Row Crops (Conventional Tillage High)** | 13 | 0.6 | N/A* | 76 | 85 | 90 | 93 |
| **Row Crops (Conventional Tillage)** | 13 | 0.6 | N/A* | 74 | 83 | 88 | 90 |
| **Row Crops (Reduced and Mulch Tillage)** | 13 | 0.6 | N/A* | 72 | 81 | 88 | 91 |
| **Row Crops (Reduced Tillage Organic)** | 7 | 0.42 | N/A* | 72 | 81 | 88 | 91 |
| **Row Crops (No Till and Strip Till)** | 12 | 0.5 | N/A* | 67 | 78 | 85 | 89 |
| **Row Crops (Cover Crops)** | 7 | 0.42 | N/A* | 64 | 75 | 82 | 85 |
| **Row Crops (Cover Crops - Tilled)** | 7 | 0.42 | N/A* | 67 | 78 | 85 | 89 |
| **Row Crops (Wheat)** | 7 | 0.42 | N/A* | 58 | 72 | 81 | 85 |
| **Row Crops (Wheat Organic)** | 3.5 | 0.21 | N/A* | 58 | 72 | 81 | 85 |
| **Row Crops (Hay)** | 2.5 | 0.33 | N/A* | 39 | 58 | 71 | 78 |
| **Row Crops (Manure Spread)** | added 25% | added 25% | N/A* | - | - | - | - |
| **Rural Residential (High)** | 3.3 | 0.5 | 260 | 77 | 85 | 90 | 92 |
| **Rural Residential (Medium)** | 3.1 | 0.42 | 130 | 61 | 75 | 83 | 87 |
| **Rural Residential (Low)** | 3.1 | 0.42 | 65 | 51 | 68 | 79 | 84 |
| **Urban Open Space** | 2.5 | 0.15 | 60 | 49 | 69 | 79 | 84 |
| **Urban Open Space (Roads/Ditches)** | 3.6 | 0.7 | 84 | 49 | 69 | 79 | 84 |
| **Urban Residential (Very High)** | 3.2 | 0.5 | 206 | 96 | 96 | 96 | 96 |
| **Urban Residential (High)** | 3.2 | 0.5 | 206 | 81 | 88 | 91 | 93 |
| **Urban Residential (Medium)** | 3.2 | 0.5 | 160 | 61 | 75 | 83 | 87 |
| **Urban Residential (Low)** | 3.2 | 0.5 | 160 | 54 | 70 | 80 | 85 |
| **Utilities (Very High)** | 2.1 | 0.34 | 153 | 96 | 96 | 96 | 96 |
| **Utilities (High)** | 2.1 | 0.33 | 153 | 89 | 92 | 94 | 95 |
| **Utilities (Medium)** | 1.3 | 0.3 | 77 | 77 | 85 | 90 | 92 |
| **Utilities (Low)** | 1.3 | 0.3 | 65 | 57 | 72 | 81 | 86 |
| **Warehousing (Very High)** | 2.6 | 0.4 | 206 | 96 | 96 | 96 | 96 |
| **Warehousing (High)** | 2.6 | 0.4 | 206 | 89 | 92 | 94 | 95 |
| **Wetlands (Forested)** | 1 | 0.105 | 36 | 31 | 55 | 68 | 74 |
| **Wetland (Open Water)** | 0.7 | 0.01 | 1 | 85 | 85 | 85 | 85 |
| **Wetland (Needs Restoration)** | 1.9 | 0.1 | 36 | 49 | 69 | 79 | 84 |

*USLE equation used

## 3.0 Model Calibration

Model calibration was performed to verify the model results against water quality and streamflow data. The model is estimating accumulated/delivered pollutant loading, represented mostly in the literature. Important notes on the model include:

- The model estimates direct runoff and does not directly account for point source pollution, lake bank or streambank erosion, gully erosion, septic systems, or tile loading.
- The model estimates annual pollutant mobilization from individual parcels of land and does not take into account fate and transport watershed processes.

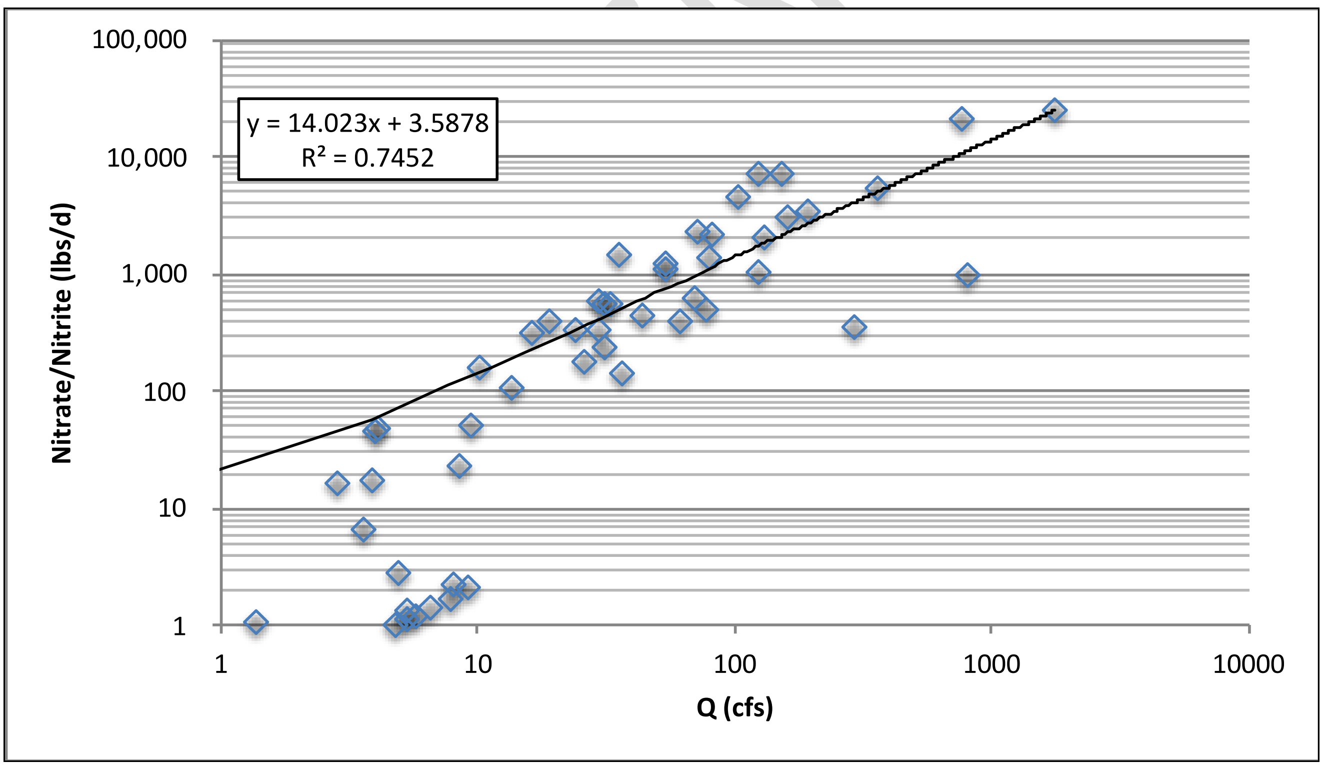
Model calibration to water quality and streamflow was attempted; no adjustments were made. Lack of directly measured flow data to correspond with the analysis of sediment (TSS), nitrate/nitrite, and phosphorus is a major limitation to estimate loading for the model area, and the stations where water quality data was collected. Limitations exist with the application of the standard drainage area correction ratio for stations that have drainage areas less than 20% of the reference gage. In the case of this dataset, most of the sample stations did not achieve 20%.

However, the correction ratio method was applied to all of the water quality data from 2015 through 2018 in order to make generalized estimates of possible nutrient and sediment loading from the watershed. The USGS Macoupin Gage at Kane was used for this flow correction (USGS 05587000, 868-mi$^2$).

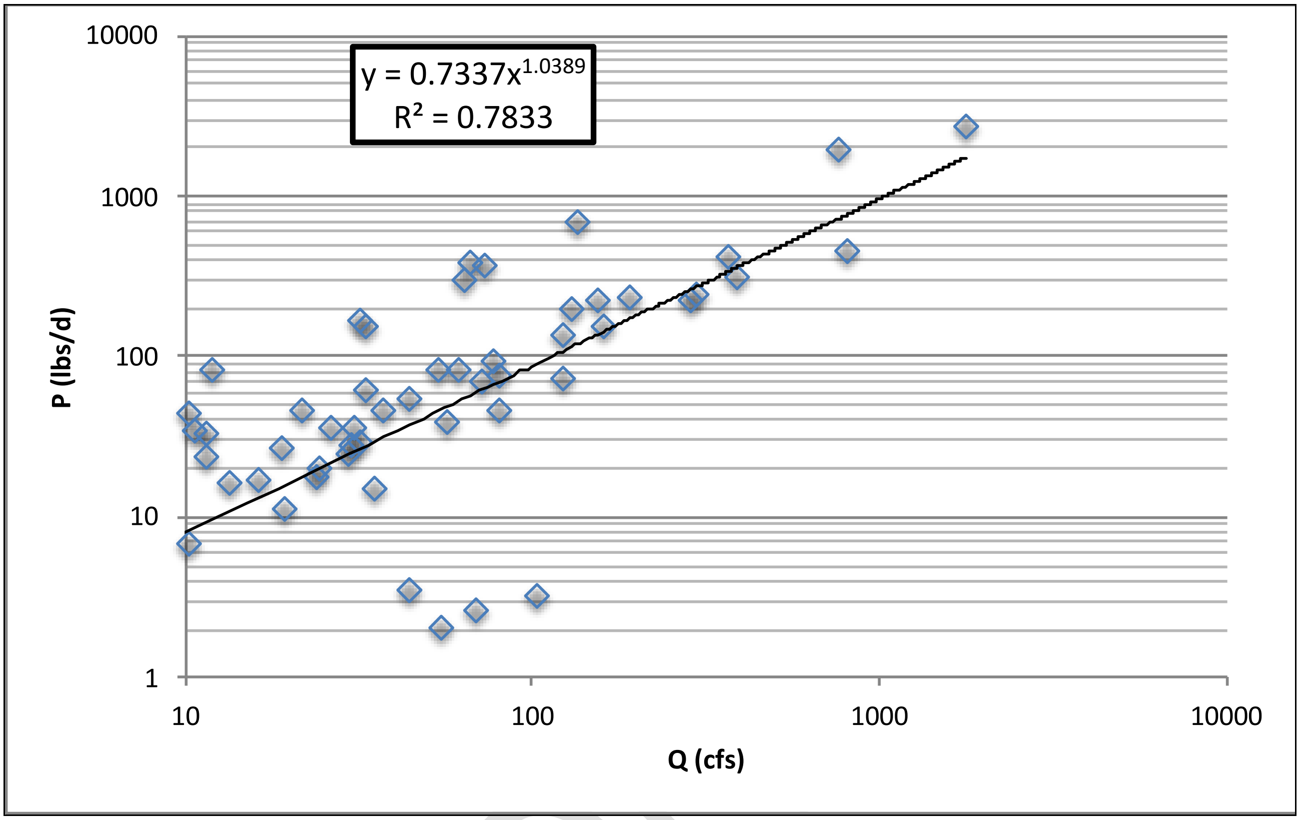
Based on these datasets and flow corrections, the relationships between daily loading and flow are shown below for nitrate/nitrite, and total phosphorus.



**Figure 1 – Nitrate/Nitrite Flow/Load Relationship**



### Figure 2 – Total Phosphorus Flow/Load Relationship






***Results***

An average water year was selected based on an analysis of the USGS Macoupin gage at Kane; this was then applied to derive annual loading estimates for the 215-mi$^2$ watershed area.

### Table 6 – Loading Results

| Parameter | Result | Units | Notes |
|---|---|---|---|
| **Water Yield** | 115,336 | Ac-ft/yr | This value is based on a drainage area correction ratio (215 / 868) |
| **Nitrate/Nitrite Load** | 818,160 | Lbs/yr | This equates to 5.94 lbs/ac/yr for the model area. |
| **Total Phosphorus Load** | 56,069 | Lbs/yr | This equates to 0.407 lbs/ac/yr for the model area. |
| **Total Suspended Sediment Load** | 26,108 | Tons/yr | This equates to 0.190 tons/ac/yr, this includes a 20% bedload estimate. |

The values in Table 6 likely underestimate the actual loading of phosphorus, nitrogen, and TSS:

1. Streamflow was not measured during sample collection, so very rough methods were applied to estimate flow based on a USGS station that is far away from the sampling sites and with a much larger drainage area. This introduces a great source of error in utilizing the water quality data to derive estimates of sediment and nutrient loads.
2. Nitrate/Nitrate: Water quality analysis did not include all factions of nitrogen, so the nitrate/nitrite certainly underestimates the loading as it does not account for ammonia and TKN.

3. Samples were likely not collected using the appropriate methods and protocols to estimate sediment yield, and nutrient loading associated with sediment transport. Special methods are necessary to sample the water column, especially during runoff events. It is common for grab samples to underestimate sediment and nutrient loading as a result.
4. A large portion of sediment and nutrient loading occurs during large runoff events, there were very few samples collected to represent these higher flow events. Further, the measurement or estimation of flows during these large events is important to support more accurate estimates of loading. Making flow corrections based on the Kane gage introduces a large potential source of error, considering the weight that only a few samples can have on the overall analysis and loading estimates.
5. For many of the lower flow sampling events, the drainage area correction method resulted in very low flow estimates which are much lower than what we would have expected based on our knowledge and observations in the watershed. This also likely contributes to lower estimates than what is actually occurring.

**Calibration Notes:**

1. The model uses a distance-based delivery ratio and accounts for differences between the delivery of sediment versus the delivery of dissolved pollutants. Since the delivery ratio is based on studies of sediment transport and not dissolved pollutants, an adjustment or multiplier of **1.25** was applied to the delivery ratio for nitrogen and phosphorous to get the results within acceptable regional ranges. The assumption was made that dissolved pollutants are delivered at a slightly higher rate than that of sediment.
2. Total loading representing other sources of sediment and nutrients were estimated. Other sources include: streambank and gully erosion.
3. Model results were compared against expected values and results from other similar, calibrated watersheds to ensure they fell within the correct range. Model EMCs were selected based on literature and values from other calibrated watershed models.

## 4.0 Additional Model Notes

1. A custom landuse layer was created for the watershed by digitizing recent aerial imagery and labeling polygons.
2. Data on field specific tillage practices and existing BMPs was incorporated.
3. High, medium and low developed areas were determined based on a visual interpretation of density. Very high areas generally represented 85 - 100%, high areas generally represented 60 - 85% impervious, medium 40-60% impervious and low, 20-40%.
4. The model accounts for areas with detention/retention in place and existing BMPs; literature based pollutant removal efficiencies were use to correct initial loading results.
5. Pasture was classified into very high, high, medium, and low based on pasture quality and the observed impact to water quality during a windshield survey.
6. A custom generated stream/waterbody file was used to run proximity calculations for the purposes of determining a delivery ratio.
7. Open water EMC's were generated from historical stream and lake data; average concentrations were used.
8. Curve Numbers were reduced for forest stands where timber stand improvement and invasive species removal was known and conducted.

# Appendix B: BMP Table

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | Critical Area Planting | 399CA | High | 10 | 15 | 87 | $33.08 | $338.18 |
| Bullard Lake | 071300120402 | Critical Area Planting | 116CA | Medium | 23 | 37 | 266 | $95.15 | $2,176.77 |
| Bullard Lake | 071300120402 | Field Border | 167FB | Very High | 16 | 29 | 47 | $12.13 | $198.90 |
| Bullard Lake | 071300120402 | Field Border | 181FB | Very High | 26 | 33 | 94 | $12.59 | $327.64 |
| Bullard Lake | 071300120402 | Field Border | 87FB | Very High | 12 | 22 | 40 | $14.05 | $174.72 |
| Bullard Lake | 071300120402 | Field Border | 168FB | Very High | 23 | 46 | 67 | $16.21 | $372.56 |
| Bullard Lake | 071300120402 | Field Border | 91FB | Very High | 11 | 11 | 45 | $19.21 | $211.10 |
| Bullard Lake | 071300120402 | Field Border | 115FB | Very High | 5.9 | 6.7 | 23 | $20.73 | $122.42 |
| Bullard Lake | 071300120402 | Field Border | 89FB | Very High | 9.7 | 9.5 | 44 | $20.82 | $202.93 |
| Bullard Lake | 071300120402 | Field Border | 114FB | Very High | 4.2 | 8.0 | 11 | $23.11 | $96.35 |
| Bullard Lake | 071300120402 | Field Border | 125FB | Very High | 2.9 | 4.7 | 8.8 | $23.90 | $68.96 |
| Bullard Lake | 071300120402 | Field Border | 170FB | High | 5.7 | 11 | 18 | $25.62 | $146.63 |
| Bullard Lake | 071300120402 | Field Border | 127FB | High | 2.5 | 3.0 | 9.3 | $26.28 | $66.13 |
| Bullard Lake | 071300120402 | Field Border | 90FB | High | 5.9 | 5.8 | 23 | $26.51 | $155.50 |
| Bullard Lake | 071300120402 | Field Border | 124FB | High | 3.5 | 5.8 | 11 | $27.25 | $95.74 |
| Bullard Lake | 071300120402 | Field Border | 183FB | High | 8.9 | 13 | 33 | $28.03 | $250.45 |
| Bullard Lake | 071300120402 | Field Border | 179FB | High | 10 | 24 | 27 | $32.65 | $328.25 |
| Bullard Lake | 071300120402 | Field Border | 166FB | High | 3.5 | 7.7 | 7.5 | $35.23 | $121.85 |
| Bullard Lake | 071300120402 | Field Border | 178FB | High | 5.8 | 8.8 | 19 | $38.23 | $221.89 |
| Bullard Lake | 071300120402 | Field Border | 103FB | High | 3.6 | 3.5 | 14 | $41.18 | $146.40 |
| Bullard Lake | 071300120402 | Field Border | 117FB | High | 1.8 | 2.3 | 6.3 | $43.56 | $78.09 |
| Bullard Lake | 071300120402 | Field Border | 169FB | High | 2.9 | 4.5 | 10 | $49.02 | $144.17 |
| Bullard Lake | 071300120402 | Field Border | 128FB | High | 1.5 | 2.9 | 3.5 | $49.37 | $75.58 |
| Bullard Lake | 071300120402 | Field Border | 177FB | High | 3.1 | 2.8 | 13 | $49.55 | $151.72 |
| Bullard Lake | 071300120402 | Field Border | 126FB | High | 3.0 | 4.0 | 10 | $49.55 | $147.74 |
| Bullard Lake | 071300120402 | Field Border | 165FB | High | 1.3 | 1.1 | 5.7 | $66.83 | $84.92 |
| Bullard Lake | 071300120402 | Filter Strip | 385FS | Very High | 16 | 48 | 28 | $7.64 | $123.06 |
| Bullard Lake | 071300120402 | Filter Strip | 391FS | Very High | 33 | 98 | 58 | $9.53 | $316.43 |
| Bullard Lake | 071300120402 | Filter Strip | 383FS | Very High | 36 | 84 | 90 | $10.79 | $387.42 |
| Bullard Lake | 071300120402 | Filter Strip | 392FS | Very High | 25 | 68 | 52 | $11.43 | $288.47 |
| Bullard Lake | 071300120402 | Filter Strip | 384FS | Very High | 34 | 87 | 69 | $11.45 | $393.71 |
| Bullard Lake | 071300120402 | Filter Strip | 386FS | Very High | 11 | 31 | 21 | $12.62 | $138.86 |
| Bullard Lake | 071300120402 | Filter Strip | 388FS | Very High | 11 | 22 | 27 | $14.41 | $156.76 |
| Bullard Lake | 071300120402 | Filter Strip | 390FS | Very High | 19 | 44 | 39 | $15.41 | $299.27 |
| Bullard Lake | 071300120402 | Filter Strip | 369FS | Very High | 6.2 | 13 | 15 | $16.04 | $99.87 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | Filter Strip | 374FS | Very High | 9.7 | 18 | 27 | $16.83 | $163.48 |
| Bullard Lake | 071300120402 | Filter Strip | 118FS | Very High | 3.5 | 9.8 | 4.7 | $17.22 | $59.86 |
| Bullard Lake | 071300120402 | Filter Strip | 102FS | Very High | 12 | 16 | 40 | $18.76 | $217.60 |
| Bullard Lake | 071300120402 | Filter Strip | 393FS | Very High | 6.7 | 16 | 17 | $18.93 | $127.66 |
| Bullard Lake | 071300120402 | Filter Strip | 389FS | Very High | 26 | 60 | 56 | $19.31 | $509.47 |
| Bullard Lake | 071300120402 | Filter Strip | 387FS | Very High | 15 | 29 | 38 | $22.44 | $332.08 |
| Bullard Lake | 071300120402 | Filter Strip | 92FS | High | 4.3 | 8.3 | 11 | $33.70 | $143.29 |
| Bullard Lake | 071300120402 | Filter Strip | 396FS | High | 2.7 | 2.2 | 11 | $41.50 | $110.26 |
| Bullard Lake | 071300120402 | Filter Strip | 394FS | High | 2.0 | 1.7 | 8.4 | $45.44 | $89.25 |
| Bullard Lake | 071300120402 | Filter Strip | 395FS | High | 1.6 | 0.37 | 8.7 | $60.34 | $95.66 |
| Bullard Lake | 071300120402 | Filter Strip | 93FS | Medium | 0.78 | 0.39 | 3.7 | $121.72 | $95.33 |
| Bullard Lake | 071300120402 | Grade Control | 39GC | Very High | 74 | 19 | 39 | $8.06 | $600.00 |
| Bullard Lake | 071300120402 | Grade Control | 75GC | Very High | 56 | 150 | 88 | $21.24 | $1,200.00 |
| Bullard Lake | 071300120402 | Grade Control | 154GC | Very High | 83 | 154 | 86 | $21.73 | $1,800.00 |
| Bullard Lake | 071300120402 | Grade Control | 81GC | High | 9.7 | 26 | 37 | $61.55 | $600.00 |
| Bullard Lake | 071300120402 | Grade Control | 137GC | Medium | 8.3 | 6.1 | 10 | $144.71 | $1,200.00 |
| Bullard Lake | 071300120402 | Grade Control | 138GC | Medium | 2.6 | 6.5 | 7.1 | $683.11 | $1,800.00 |
| Bullard Lake | 071300120402 | Grade Control | 133GC | Low | 0.69 | 1.3 | 2.6 | $873.94 | $600.00 |
| Bullard Lake | 071300120402 | Grassed Waterway | 40GW | Medium | 65 | 114 | 462 | $123.92 | $8,096.42 |
| Bullard Lake | 071300120402 | Grassed Waterway | 37GW | Medium | 26 | 42 | 299 | $339.67 | $8,771.12 |
| Bullard Lake | 071300120402 | Pasture Fencing/Crossing | 6FN | Medium | 25 | 34 | 40 | $280.29 | $6,987.32 |
| Bullard Lake | 071300120402 | Pasture Fencing/Crossing | 5FN | Medium | 12 | 1.3 | 19 | $600.89 | $7,438.16 |
| Bullard Lake | 071300120402 | Pond | 76PND | Medium | 142 | 233 | 459 | $281.13 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 170PND | Medium | 142 | 229 | 745 | $282.40 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 155PND | Medium | 135 | 163 | 899 | $296.44 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 38PND | Medium | 123 | 149 | 527 | $324.95 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 156PND | Medium | 115 | 105 | 858 | $348.96 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 54PND | Medium | 109 | 177 | 793 | $366.41 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 74PND | Medium | 79 | 215 | 434 | $507.18 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 58PND | Low | 20 | 37 | 96 | $1,968.41 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 141PND | Low | 17 | 45 | 23 | $2,407.75 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 131PND | Low | 13 | 1.9 | 28 | $3,177.37 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 69PND | Low | 8.7 | 17 | 32 | $4,581.72 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 70PND | Low | 7.1 | 17 | 15 | $5,615.98 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 128PND | Low | 4.7 | 12 | 13 | $8,586.34 | $40,000.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Bullard Lake | 071300120402 | Pond | 132PND | Low | 2.7 | 0.21 | 7.7 | $14,573.22 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 80PND | Low | 2.5 | 3.8 | 12 | $16,104.22 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 83PND | Low | 0.50 | 0.44 | 2.9 | $79,307.83 | $40,000.00 |
| Bullard Lake | 071300120402 | Pond | 129PND | Low | 0.21 | 0.59 | 0.43 | $192,021.65 | $40,000.00 |
| Bullard Lake | 071300120402 | Terrace | 140TER | Medium | 37 | 69 | 92 | $170.32 | $6,222.00 |
| Bullard Lake | 071300120402 | WASCB | 71WASCB | Medium | 24 | 10 | 22 | $118.46 | $2,870.00 |
| Bullard Lake | 071300120402 | WASCB | 171WASCB | Medium | 18 | 36 | 52 | $305.56 | $5,425.00 |
| Bullard Lake | 071300120402 | WASCB | 135WASCB | Medium | 27 | 58 | 70 | $306.43 | $8,400.00 |
| Bullard Lake | 071300120402 | WASCB | 134WASCB | Medium | 16 | 36 | 36 | $328.16 | $5,250.00 |
| Bullard Lake | 071300120402 | WASCB | 55WASCB | Medium | 32 | 52 | 138 | $598.43 | $19,250.00 |
| Bullard Lake | 071300120402 | WASCB | 68WASCB | Medium | 9.6 | 13 | 44 | $601.57 | $5,775.00 |
| Bullard Lake | 071300120402 | WASCB | 139WASCB | Medium | 13 | 24 | 31 | $650.89 | $8,400.00 |
| Bullard Lake | 071300120402 | WASCB | 56WASCB | Medium | 4.7 | 7.7 | 20 | $673.09 | $3,150.00 |
| Bullard Lake | 071300120402 | WASCB | 72WASCB | Low | 3.7 | 4.4 | 16 | $797.52 | $2,975.00 |
| Bullard Lake | 071300120402 | WASCB | 136WASCB | Low | 3.1 | 6.4 | 8.8 | $840.08 | $2,625.00 |
| Bullard Lake | 071300120402 | WASCB | 78WASCB | Low | 6.5 | 11 | 22 | $864.90 | $5,600.00 |
| Bullard Lake | 071300120402 | WASCB | 57WASCB | Low | 7.0 | 6.7 | 33 | $898.69 | $6,300.00 |
| Bullard Lake | 071300120402 | WASCB | 28WASCB | Low | 5.8 | 7.1 | 24 | $934.50 | $5,425.00 |
| Bullard Lake | 071300120402 | WASCB | 142WASCB | Low | 5.0 | 7.6 | 20 | $1,053.06 | $5,250.00 |
| Bullard Lake | 071300120402 | WASCB | 143WASCB | Low | 4.4 | 6.9 | 13 | $1,205.69 | $5,250.00 |
| Bullard Lake | 071300120402 | WASCB | 59WASCB | Low | 14 | 19 | 68 | $1,349.35 | $18,900.00 |
| Bullard Lake | 071300120402 | WASCB | 127WASCB | Low | 3.2 | 6.6 | 12 | $1,865.42 | $5,950.00 |
| Bullard Lake | 071300120402 | WASCB | 77WASCB | Low | 2.6 | 4.0 | 11 | $3,211.03 | $8,400.00 |
| Bullard Lake | 071300120402 | WASCB | 79WASCB | Low | 0.87 | 1.1 | 4.6 | $3,217.01 | $2,800.00 |
| Bullard Lake | 071300120402 | WASCB | 130WASCB | Low | 1.4 | 1.8 | 6.1 | $3,932.99 | $5,600.00 |
| Bullard Lake | 071300120402 | Wetland Creation | 73WTLND | Medium | 11 | 10 | 116 | $234.92 | $2,548.80 |
| Bullard Lake | 071300120402 | Wetland Creation | 82WTLND | Low | 2.7 | 0.78 | 24 | $4,768.59 | $12,744.00 |
| Coop Branch | 071300120401 | Critical Area Planting | 441CA | Very High | 9.5 | 16 | 79 | $22.99 | $218.48 |
| Coop Branch | 071300120401 | Critical Area Planting | 238CA | High | 25 | 43 | 182 | $26.21 | $646.61 |
| Coop Branch | 071300120401 | Critical Area Planting | 437CA | High | 24 | 39 | 220 | $27.41 | $657.71 |
| Coop Branch | 071300120401 | Critical Area Planting | 419CA | High | 11 | 17 | 104 | $30.06 | $329.05 |
| Coop Branch | 071300120401 | Critical Area Planting | 420CA | High | 35 | 53 | 351 | $32.84 | $1,147.41 |
| Coop Branch | 071300120401 | Critical Area Planting | 424CA | High | 5.1 | 5.6 | 72 | $90.53 | $462.85 |
| Coop Branch | 071300120401 | Critical Area Planting | 436CA | Medium | 6.1 | 6.2 | 87 | $100.73 | $615.73 |
| Coop Branch | 071300120401 | Critical Area Planting | 425CA | Medium | 4.9 | 5.0 | 51 | $125.75 | $614.19 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Critical Area Planting | 423CA | Medium | 3.2 | 2.2 | 43 | $150.47 | $485.14 |
| Coop Branch | 071300120401 | Field Border | 277FB | Very High | 15 | 28 | 42 | $8.01 | $119.61 |
| Coop Branch | 071300120401 | Field Border | 229FB | Very High | 20 | 38 | 55 | $9.15 | $183.19 |
| Coop Branch | 071300120401 | Field Border | 220FB | Very High | 11 | 15 | 41 | $9.51 | $107.54 |
| Coop Branch | 071300120401 | Field Border | 206FB | Very High | 35 | 42 | 149 | $9.74 | $337.47 |
| Coop Branch | 071300120401 | Field Border | 219FB | Very High | 12 | 18 | 40 | $9.99 | $124.02 |
| Coop Branch | 071300120401 | Field Border | 353FB | Very High | 29 | 33 | 111 | $10.04 | $295.09 |
| Coop Branch | 071300120401 | Field Border | 203FB | Very High | 22 | 35 | 67 | $10.26 | $220.87 |
| Coop Branch | 071300120401 | Field Border | 271FB | Very High | 54 | 83 | 176 | $12.30 | $664.73 |
| Coop Branch | 071300120401 | Field Border | 262FB | Very High | 6.3 | 7.6 | 22 | $12.79 | $80.44 |
| Coop Branch | 071300120401 | Field Border | 276FB | Very High | 16 | 29 | 58 | $13.44 | $212.26 |
| Coop Branch | 071300120401 | Field Border | 234FB | Very High | 15 | 13 | 56 | $13.88 | $214.42 |
| Coop Branch | 071300120401 | Field Border | 261FB | Very High | 2.8 | 6.0 | 6.7 | $14.61 | $41.49 |
| Coop Branch | 071300120401 | Field Border | 246FB | Very High | 6.6 | 5.8 | 27 | $15.02 | $99.71 |
| Coop Branch | 071300120401 | Field Border | 218FB | Very High | 13 | 11 | 56 | $15.09 | $198.75 |
| Coop Branch | 071300120401 | Field Border | 263FB | Very High | 19 | 39 | 53 | $15.79 | $297.72 |
| Coop Branch | 071300120401 | Field Border | 244FB | Very High | 37 | 43 | 145 | $16.80 | $625.59 |
| Coop Branch | 071300120401 | Field Border | 278FB | Very High | 19 | 47 | 42 | $17.43 | $332.73 |
| Coop Branch | 071300120401 | Field Border | 233FB | Very High | 14 | 19 | 53 | $18.15 | $259.25 |
| Coop Branch | 071300120401 | Field Border | 265FB | Very High | 9.4 | 11 | 35 | $18.21 | $171.11 |
| Coop Branch | 071300120401 | Field Border | 316FB | Very High | 3.4 | 4.6 | 12 | $19.05 | $64.96 |
| Coop Branch | 071300120401 | Field Border | 266FB | Very High | 32 | 60 | 98 | $19.06 | $613.05 |
| Coop Branch | 071300120401 | Field Border | 302FB | Very High | 4.1 | 8.9 | 9.6 | $19.33 | $79.17 |
| Coop Branch | 071300120401 | Field Border | 237FB | Very High | 9.2 | 15 | 30 | $21.05 | $194.23 |
| Coop Branch | 071300120401 | Field Border | 322FB | Very High | 8.4 | 12 | 29 | $21.83 | $183.42 |
| Coop Branch | 071300120401 | Field Border | 319FB | Very High | 19 | 25 | 74 | $22.70 | $438.28 |
| Coop Branch | 071300120401 | Field Border | 182FB | Very High | 16 | 22 | 59 | $22.90 | $365.10 |
| Coop Branch | 071300120401 | Field Border | 185FB | Very High | 7.2 | 13 | 24 | $22.95 | $165.71 |
| Coop Branch | 071300120401 | Field Border | 247FB | Very High | 47 | 53 | 176 | $23.93 | $1,114.69 |
| Coop Branch | 071300120401 | Field Border | 348FB | Very High | 10 | 19 | 33 | $23.98 | $248.66 |
| Coop Branch | 071300120401 | Field Border | 215FB | High | 12 | 15 | 46 | $24.02 | $287.04 |
| Coop Branch | 071300120401 | Field Border | 320FB | High | 17 | 26 | 59 | $25.11 | $423.68 |
| Coop Branch | 071300120401 | Field Border | 308FB | High | 8.6 | 13 | 30 | $25.18 | $216.57 |
| Coop Branch | 071300120401 | Field Border | 355FB | High | 3.7 | 3.6 | 15 | $26.53 | $99.33 |
| Coop Branch | 071300120401 | Field Border | 314FB | High | 2.5 | 4.6 | 7.6 | $28.01 | $69.31 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Field Border | 236FB | High | 4.3 | 12 | 8.8 | $28.69 | $122.16 |
| Coop Branch | 071300120401 | Field Border | 323FB | High | 4.9 | 7.3 | 17 | $29.30 | $142.47 |
| Coop Branch | 071300120401 | Field Border | 296FB | High | 3.8 | 1.8 | 23 | $29.34 | $112.08 |
| Coop Branch | 071300120401 | Field Border | 232FB | High | 14 | 14 | 55 | $29.58 | $408.05 |
| Coop Branch | 071300120401 | Field Border | 223FB | High | 14 | 14 | 54 | $29.96 | $414.18 |
| Coop Branch | 071300120401 | Field Border | 180FB | High | 11 | 12 | 42 | $30.56 | $338.45 |
| Coop Branch | 071300120401 | Field Border | 300FB | High | 3.2 | 5.9 | 10 | $30.78 | $98.29 |
| Coop Branch | 071300120401 | Field Border | 317FB | High | 11 | 10 | 55 | $31.30 | $329.43 |
| Coop Branch | 071300120401 | Field Border | 351FB | High | 6.3 | 11 | 19 | $31.79 | $201.43 |
| Coop Branch | 071300120401 | Field Border | 297FB | High | 4.2 | 1.9 | 25 | $32.20 | $135.79 |
| Coop Branch | 071300120401 | Field Border | 281FB | High | 5.6 | 4.0 | 29 | $32.24 | $179.27 |
| Coop Branch | 071300120401 | Field Border | 305FB | High | 4.6 | 5.6 | 18 | $34.69 | $159.32 |
| Coop Branch | 071300120401 | Field Border | 354FB | High | 2.0 | 2.5 | 7.2 | $35.60 | $71.18 |
| Coop Branch | 071300120401 | Field Border | 315FB | High | 12 | 14 | 49 | $36.42 | $422.87 |
| Coop Branch | 071300120401 | Field Border | 280FB | High | 6.2 | 7.9 | 23 | $36.82 | $229.70 |
| Coop Branch | 071300120401 | Field Border | 306FB | High | 8.8 | 12 | 34 | $36.83 | $322.97 |
| Coop Branch | 071300120401 | Field Border | 350FB | High | 4.5 | 7.7 | 13 | $37.04 | $167.10 |
| Coop Branch | 071300120401 | Field Border | 205FB | High | 5.6 | 10 | 16 | $38.02 | $213.66 |
| Coop Branch | 071300120401 | Field Border | 301FB | High | 8.6 | 12 | 29 | $38.50 | $332.55 |
| Coop Branch | 071300120401 | Field Border | 202FB | High | 6.3 | 11 | 21 | $39.30 | $249.20 |
| Coop Branch | 071300120401 | Field Border | 184FB | High | 6.8 | 10 | 26 | $40.58 | $276.65 |
| Coop Branch | 071300120401 | Field Border | 295FB | High | 4.2 | 1.5 | 23 | $41.00 | $171.91 |
| Coop Branch | 071300120401 | Field Border | 341FB | High | 12 | 11 | 50 | $41.84 | $513.28 |
| Coop Branch | 071300120401 | Field Border | 243FB | High | 6.2 | 7.1 | 23 | $43.05 | $265.76 |
| Coop Branch | 071300120401 | Field Border | 204FB | High | 3.9 | 8.0 | 9.8 | $43.56 | $171.66 |
| Coop Branch | 071300120401 | Field Border | 352FB | High | 3.3 | 3.2 | 13 | $44.23 | $144.86 |
| Coop Branch | 071300120401 | Field Border | 294FB | High | 2.7 | 1.5 | 15 | $44.62 | $120.30 |
| Coop Branch | 071300120401 | Field Border | 324FB | High | 3.5 | 3.8 | 13 | $45.73 | $158.50 |
| Coop Branch | 071300120401 | Field Border | 279FB | High | 8.3 | 10 | 31 | $46.60 | $388.93 |
| Coop Branch | 071300120401 | Field Border | 303FB | High | 3.7 | 1.5 | 23 | $47.96 | $178.96 |
| Coop Branch | 071300120401 | Field Border | 275FB | High | 5.7 | 9.1 | 16 | $51.24 | $291.52 |
| Coop Branch | 071300120401 | Field Border | 321FB | High | 3.3 | 3.8 | 12 | $52.87 | $176.85 |
| Coop Branch | 071300120401 | Field Border | 264FB | High | 1.3 | 2.3 | 3.6 | $53.14 | $68.42 |
| Coop Branch | 071300120401 | Field Border | 298FB | High | 2.6 | 4.7 | 8.4 | $53.78 | $139.50 |
| Coop Branch | 071300120401 | Field Border | 216FB | High | 5.6 | 3.9 | 25 | $55.32 | $309.68 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Field Border | 230FB | High | 1.1 | 1.7 | 3.2 | $58.55 | $63.73 |
| Coop Branch | 071300120401 | Field Border | 260FB | High | 5.6 | 9.3 | 18 | $60.73 | $340.91 |
| Coop Branch | 071300120401 | Field Border | 304FB | High | 5.3 | 4.9 | 22 | $62.10 | $330.78 |
| Coop Branch | 071300120401 | Field Border | 217FB | High | 3.7 | 5.5 | 15 | $63.02 | $234.35 |
| Coop Branch | 071300120401 | Field Border | 349FB | High | 2.2 | 3.3 | 7.9 | $64.29 | $143.57 |
| Coop Branch | 071300120401 | Field Border | 318FB | High | 2.0 | 2.9 | 6.8 | $77.57 | $156.93 |
| Coop Branch | 071300120401 | Field Border | 231FB | High | 1.3 | 1.2 | 5.8 | $87.24 | $116.66 |
| Coop Branch | 071300120401 | Field Border | 235FB | High | 2.0 | 2.4 | 5.8 | $90.60 | $183.08 |
| Coop Branch | 071300120401 | Field Border | 299FB | Medium | 1.8 | 3.1 | 6.4 | $93.83 | $164.72 |
| Coop Branch | 071300120401 | Field Border | 248FB | Medium | 1.5 | 3.7 | 3.9 | $95.63 | $143.68 |
| Coop Branch | 071300120401 | Field Border | 259FB | Medium | 6.8 | 9.1 | 26 | $117.66 | $795.23 |
| Coop Branch | 071300120401 | Field Border | 293FB | Medium | 1.6 | 0.85 | 13 | $135.39 | $215.89 |
| Coop Branch | 071300120401 | Field Border | 307FB | Medium | 1.8 | 1.9 | 7.3 | $156.76 | $284.26 |
| Coop Branch | 071300120401 | Filter Strip | 438FS | Very High | 82 | 252 | 134 | $1.49 | $121.75 |
| Coop Branch | 071300120401 | Filter Strip | 421FS | Very High | 61 | 113 | 119 | $4.89 | $297.72 |
| Coop Branch | 071300120401 | Filter Strip | 418FS | Very High | 89 | 198 | 194 | $5.84 | $522.25 |
| Coop Branch | 071300120401 | Filter Strip | 456FS | Very High | 33 | 64 | 90 | $6.33 | $208.88 |
| Coop Branch | 071300120401 | Filter Strip | 442FS | Very High | 129 | 255 | 288 | $6.35 | $816.71 |
| Coop Branch | 071300120401 | Filter Strip | 454FS | Very High | 12 | 36 | 19 | $6.73 | $79.53 |
| Coop Branch | 071300120401 | Filter Strip | 222FS | Very High | 11 | 24 | 22 | $6.80 | $75.61 |
| Coop Branch | 071300120401 | Filter Strip | 331FS | Very High | 30 | 50 | 97 | $7.59 | $229.50 |
| Coop Branch | 071300120401 | Filter Strip | 444FS | Very High | 34 | 75 | 83 | $9.30 | $317.63 |
| Coop Branch | 071300120401 | Filter Strip | 329FS | Very High | 32 | 73 | 84 | $9.33 | $300.65 |
| Coop Branch | 071300120401 | Filter Strip | 408FS | Very High | 15 | 33 | 33 | $10.44 | $155.91 |
| Coop Branch | 071300120401 | Filter Strip | 309FS | Very High | 21 | 51 | 41 | $10.72 | $226.30 |
| Coop Branch | 071300120401 | Filter Strip | 273FS | Very High | 15 | 39 | 24 | $10.86 | $161.89 |
| Coop Branch | 071300120401 | Filter Strip | 313FS | Very High | 25 | 59 | 54 | $11.18 | $279.00 |
| Coop Branch | 071300120401 | Filter Strip | 325FS | Very High | 19 | 39 | 55 | $11.43 | $219.24 |
| Coop Branch | 071300120401 | Filter Strip | 345FS | Very High | 39 | 62 | 134 | $12.82 | $499.35 |
| Coop Branch | 071300120401 | Filter Strip | 449FS | Very High | 23 | 53 | 48 | $13.28 | $306.41 |
| Coop Branch | 071300120401 | Filter Strip | 310FS | Very High | 24 | 49 | 58 | $14.49 | $343.27 |
| Coop Branch | 071300120401 | Filter Strip | 312FS | Very High | 21 | 47 | 56 | $15.78 | $333.88 |
| Coop Branch | 071300120401 | Filter Strip | 344FS | Very High | 29 | 32 | 108 | $16.14 | $463.64 |
| Coop Branch | 071300120401 | Filter Strip | 272FS | Very High | 5.5 | 14 | 9.6 | $17.87 | $97.97 |
| Coop Branch | 071300120401 | Filter Strip | 221FS | Very High | 13 | 33 | 25 | $18.30 | $246.12 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Filter Strip | 326FS | Very High | 13 | 26 | 39 | $18.67 | $243.79 |
| Coop Branch | 071300120401 | Filter Strip | 311FS | Very High | 39 | 98 | 79 | $19.06 | $741.77 |
| Coop Branch | 071300120401 | Filter Strip | 274FS | Very High | 6.4 | 20 | 9.8 | $19.61 | $125.44 |
| Coop Branch | 071300120401 | Filter Strip | 342FS | Very High | 26 | 46 | 78 | $19.86 | $514.37 |
| Coop Branch | 071300120401 | Filter Strip | 422FS | Very High | 9.1 | 17 | 25 | $20.33 | $185.49 |
| Coop Branch | 071300120401 | Filter Strip | 440FS | Very High | 23 | 46 | 57 | $20.53 | $473.21 |
| Coop Branch | 071300120401 | Filter Strip | 459FS | Very High | 6.7 | 17 | 15 | $21.34 | $143.60 |
| Coop Branch | 071300120401 | Filter Strip | 443FS | Very High | 14 | 31 | 33 | $21.74 | $310.83 |
| Coop Branch | 071300120401 | Filter Strip | 327FS | Very High | 3.7 | 8.4 | 9.4 | $22.98 | $84.32 |
| Coop Branch | 071300120401 | Filter Strip | 330FS | Very High | 2.9 | 4.7 | 9.0 | $23.01 | $67.68 |
| Coop Branch | 071300120401 | Filter Strip | 439FS | Very High | 5.0 | 8.4 | 11 | $23.87 | $119.48 |
| Coop Branch | 071300120401 | Filter Strip | 343FS | High | 12 | 21 | 33 | $24.36 | $286.21 |
| Coop Branch | 071300120401 | Filter Strip | 407FS | High | 9.1 | 20 | 20 | $25.65 | $234.49 |
| Coop Branch | 071300120401 | Filter Strip | 245FS | High | 7.4 | 16 | 16 | $26.17 | $193.28 |
| Coop Branch | 071300120401 | Filter Strip | 434FS | High | 11 | 19 | 29 | $32.43 | $359.80 |
| Coop Branch | 071300120401 | Filter Strip | 328FS | High | 1.7 | 4.0 | 4.3 | $33.26 | $57.17 |
| Coop Branch | 071300120401 | Filter Strip | 405FS | High | 8.4 | 16 | 22 | $34.24 | $288.65 |
| Coop Branch | 071300120401 | Filter Strip | 406FS | High | 6.7 | 14 | 16 | $38.20 | $256.27 |
| Coop Branch | 071300120401 | Filter Strip | 435FS | High | 8.6 | 13 | 27 | $41.35 | $357.56 |
| Coop Branch | 071300120401 | Filter Strip | 460FS | High | 4.2 | 4.3 | 19 | $48.43 | $205.31 |
| Coop Branch | 071300120401 | Grade Control | 281GC | High | 41 | 33 | 73 | $29.23 | $1,200.00 |
| Coop Branch | 071300120401 | Grade Control | 209GC | High | 34 | 41 | 88 | $53.11 | $1,800.00 |
| Coop Branch | 071300120401 | Grade Control | 160GC | Medium | 8.4 | 23 | 12 | $142.50 | $1,200.00 |
| Coop Branch | 071300120401 | Grade Control | 307GC | Medium | 4.3 | 8.5 | 10 | $422.68 | $1,800.00 |
| Coop Branch | 071300120401 | Grassed Waterway | 394GW | Medium | 94 | 108 | 700 | $93.36 | $8,771.12 |
| Coop Branch | 071300120401 | Grassed Waterway | 311GW | Medium | 96 | 231 | 861 | $97.97 | $9,445.82 |
| Coop Branch | 071300120401 | Grassed Waterway | 165GW | Medium | 19 | 14 | 135 | $108.34 | $2,024.10 |
| Coop Branch | 071300120401 | Grassed Waterway | 318GW | Medium | 45 | 37 | 475 | $119.46 | $5,397.61 |
| Coop Branch | 071300120401 | Grassed Waterway | 320GW | Medium | 64 | 120 | 709 | $126.61 | $8,096.42 |
| Coop Branch | 071300120401 | Grassed Waterway | 385GW | Medium | 25 | 53 | 143 | $205.17 | $5,060.26 |
| Coop Branch | 071300120401 | Grassed Waterway | 319GW | Medium | 26 | 48 | 256 | $309.38 | $8,096.42 |
| Coop Branch | 071300120401 | Grassed Waterway | 383GW | Medium | 16 | 7.7 | 41 | $341.93 | $5,397.61 |
| Coop Branch | 071300120401 | Grassed Waterway | 390GW | Medium | 34 | 50 | 279 | $354.82 | $12,144.63 |
| Coop Branch | 071300120401 | Grassed Waterway | 368GW | Medium | 39 | 65 | 564 | $379.70 | $14,843.43 |
| Coop Branch | 071300120401 | Grassed Waterway | 382GW | Medium | 22 | 36 | 312 | $394.92 | $8,771.12 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Grassed Waterway | 312GW | Medium | 11 | 14 | 187 | $471.07 | $5,397.61 |
| Coop Branch | 071300120401 | Grassed Waterway | 313GW | Medium | 9.9 | 17 | 117 | $476.36 | $4,722.91 |
| Coop Branch | 071300120401 | Grassed Waterway | 391GW | Medium | 33 | 62 | 403 | $488.34 | $16,192.84 |
| Coop Branch | 071300120401 | Grassed Waterway | 363GW | Medium | 22 | 45 | 236 | $520.49 | $11,469.93 |
| Coop Branch | 071300120401 | Grassed Waterway | 389GW | Medium | 24 | 41 | 221 | $555.76 | $13,494.03 |
| Coop Branch | 071300120401 | Grassed Waterway | 197GW | Medium | 19 | 29 | 242 | $599.35 | $11,469.93 |
| Coop Branch | 071300120401 | Grassed Waterway | 169GW | Medium | 11 | 17 | 145 | $615.20 | $6,747.02 |
| Coop Branch | 071300120401 | Grassed Waterway | 295GW | Medium | 17 | 24 | 249 | $617.66 | $10,795.22 |
| Coop Branch | 071300120401 | Grassed Waterway | 384GW | Medium | 12 | 30 | 100 | $665.83 | $8,096.42 |
| Coop Branch | 071300120401 | Grassed Waterway | 373GW | Low | 13 | 23 | 149 | $709.88 | $9,445.82 |
| Coop Branch | 071300120401 | Grassed Waterway | 252GW | Low | 3.9 | 5.4 | 24 | $858.63 | $3,373.51 |
| Coop Branch | 071300120401 | Grassed Waterway | 291GW | Low | 2.4 | 3.2 | 32 | $1,704.49 | $4,048.21 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 19FN | Medium | 39 | 37 | 79 | $187.04 | $7,250.96 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 17FN | Medium | 36 | 47 | 73 | $228.38 | $8,127.68 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 16FN | Medium | 15 | 9.2 | 33 | $360.41 | $5,393.00 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 23FN | Medium | 19 | 9.1 | 41 | $377.54 | $7,127.72 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 13FN | Medium | 13 | 12 | 28 | $394.64 | $5,065.40 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 15FN | Medium | 13 | 14 | 30 | $425.37 | $5,400.80 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 24FN | Medium | 11 | 29 | 22 | $488.44 | $5,237.00 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 10FN | Medium | 10 | 7.6 | 19 | $581.52 | $6,034.16 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 14FN | Medium | 7.7 | 0.71 | 11 | $675.45 | $5,218.28 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 22FN | Low | 8.8 | 5.7 | 24 | $823.13 | $7,265.00 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 9FN | Low | 5.6 | 0.62 | 8.5 | $953.76 | $5,368.04 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 11FN | Low | 5.2 | 0.50 | 7.4 | $1,007.75 | $5,286.92 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 18FN | Low | 4.1 | 0.92 | 9.4 | $1,460.88 | $5,957.72 |
| Coop Branch | 071300120401 | Pasture Fencing/Crossing | 12FN | Low | 2.9 | 0.40 | 5.7 | $1,849.34 | $5,305.64 |
| Coop Branch | 071300120401 | Pond | 379PND | Medium | 361 | 402 | 2,817 | $166.09 | $60,000.00 |
| Coop Branch | 071300120401 | Pond | 208PND | Medium | 196 | 208 | 1,219 | $203.65 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 199PND | Medium | 186 | 69 | 177 | $214.62 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 314PND | Medium | 227 | 311 | 1,153 | $264.81 | $60,000.00 |
| Coop Branch | 071300120401 | Pond | 372PND | Medium | 146 | 280 | 241 | $273.46 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 162PND | Medium | 137 | 141 | 180 | $292.56 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 279PND | Medium | 136 | 259 | 671 | $293.83 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 254PND | Medium | 127 | 69 | 541 | $314.39 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 249PND | Medium | 125 | 210 | 500 | $321.19 | $40,000.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Pond | 222PND | Medium | 115 | 152 | 754 | $348.65 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 200PND | Medium | 96 | 30 | 99 | $418.00 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 345PND | Medium | 129 | 204 | 586 | $465.85 | $60,000.00 |
| Coop Branch | 071300120401 | Pond | 202PND | Medium | 85 | 60 | 264 | $471.99 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 201PND | Medium | 76 | 150 | 309 | $527.72 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 198PND | Medium | 75 | 48 | 236 | $532.71 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 210PND | Medium | 69 | 84 | 152 | $579.74 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 220PND | Medium | 65 | 117 | 310 | $611.11 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 284PND | Medium | 64 | 115 | 338 | $625.39 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 308PND | Medium | 63 | 85 | 312 | $636.14 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 247PND | Medium | 93 | 133 | 527 | $644.71 | $60,000.00 |
| Coop Branch | 071300120401 | Pond | 280PND | Medium | 61 | 96 | 298 | $655.73 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 321PND | Low | 56 | 57 | 425 | $715.13 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 253PND | Low | 55 | 115 | 201 | $722.94 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 214PND | Low | 54 | 86 | 311 | $735.41 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 164PND | Low | 52 | 53 | 279 | $769.11 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 250PND | Low | 51 | 60 | 195 | $785.57 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 361PND | Low | 50 | 52 | 370 | $800.90 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 221PND | Low | 48 | 80 | 124 | $837.38 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 166PND | Low | 46 | 97 | 196 | $865.32 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 246PND | Low | 44 | 74 | 233 | $898.93 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 288PND | Low | 36 | 19 | 56 | $1,110.53 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 215PND | Low | 34 | 65 | 119 | $1,165.01 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 360PND | Low | 41 | 62 | 241 | $1,469.76 | $60,000.00 |
| Coop Branch | 071300120401 | Pond | 366PND | Low | 25 | 41 | 117 | $1,596.82 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 283PND | Low | 23 | 36 | 122 | $1,726.28 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 276PND | Low | 14 | 23 | 89 | $2,850.56 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 348PND | Low | 14 | 27 | 51 | $2,923.15 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 278PND | Low | 13 | 21 | 62 | $3,199.52 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 203PND | Low | 12 | 17 | 44 | $3,215.73 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 306PND | Low | 12 | 12 | 40 | $3,280.22 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 255PND | Low | 11 | 16 | 44 | $3,746.64 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 248PND | Low | 10 | 13 | 46 | $3,852.37 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 367PND | Low | 9.4 | 5.9 | 44 | $4,277.68 | $40,000.00 |
| Coop Branch | 071300120401 | Pond | 163PND | Low | 4.8 | 4.3 | 21 | $8,335.93 | $40,000.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | Pond | 289PND | Low | 3.4 | 7.5 | 8.9 | $11,753.15 | $40,000.00 |
| Coop Branch | 071300120401 | Riffle | 365RIF | Low | 5.5 | 9.0 | 12 | $4,127.82 | $22,584.00 |
| Coop Branch | 071300120401 | WASCB | 206WASCB | Medium | 19 | 28 | 64 | $289.08 | $5,600.00 |
| Coop Branch | 071300120401 | WASCB | 204WASCB | Medium | 31 | 48 | 103 | $293.34 | $9,100.00 |
| Coop Branch | 071300120401 | WASCB | 381WASCB | Medium | 18 | 33 | 54 | $332.13 | $5,950.00 |
| Coop Branch | 071300120401 | WASCB | 310WASCB | Medium | 15 | 28 | 50 | $368.07 | $5,670.00 |
| Coop Branch | 071300120401 | WASCB | 364WASCB | Medium | 8.8 | 11 | 37 | $415.52 | $3,675.00 |
| Coop Branch | 071300120401 | WASCB | 349WASCB | Medium | 13 | 23 | 34 | $428.78 | $5,460.00 |
| Coop Branch | 071300120401 | WASCB | 157WASCB | Medium | 14 | 24 | 41 | $456.38 | $6,300.00 |
| Coop Branch | 071300120401 | WASCB | 370WASCB | Medium | 7.9 | 11 | 32 | $487.07 | $3,850.00 |
| Coop Branch | 071300120401 | WASCB | 362WASCB | Medium | 33 | 54 | 105 | $490.95 | $16,100.00 |
| Coop Branch | 071300120401 | WASCB | 205WASCB | Medium | 21 | 28 | 84 | $541.99 | $11,550.00 |
| Coop Branch | 071300120401 | WASCB | 216WASCB | Medium | 16 | 30 | 36 | $551.72 | $9,100.00 |
| Coop Branch | 071300120401 | WASCB | 347WASCB | Medium | 5.2 | 8.8 | 15 | $608.59 | $3,150.00 |
| Coop Branch | 071300120401 | WASCB | 286WASCB | Medium | 10 | 12 | 41 | $609.56 | $6,300.00 |
| Coop Branch | 071300120401 | WASCB | 158WASCB | Medium | 9.6 | 16 | 29 | $621.30 | $5,950.00 |
| Coop Branch | 071300120401 | WASCB | 251WASCB | Medium | 18 | 32 | 67 | $627.33 | $11,375.00 |
| Coop Branch | 071300120401 | WASCB | 380WASCB | Medium | 9.4 | 12 | 42 | $673.26 | $6,300.00 |
| Coop Branch | 071300120401 | WASCB | 350WASCB | Low | 16 | 20 | 66 | $749.16 | $11,900.00 |
| Coop Branch | 071300120401 | WASCB | 315WASCB | Low | 11 | 17 | 40 | $779.92 | $8,750.00 |
| Coop Branch | 071300120401 | WASCB | 309WASCB | Low | 7.7 | 11 | 36 | $839.56 | $6,475.00 |
| Coop Branch | 071300120401 | WASCB | 217WASCB | Low | 22 | 40 | 53 | $875.94 | $19,600.00 |
| Coop Branch | 071300120401 | WASCB | 293WASCB | Low | 6.3 | 8.0 | 26 | $888.26 | $5,600.00 |
| Coop Branch | 071300120401 | WASCB | 343WASCB | Low | 17 | 33 | 64 | $891.70 | $15,400.00 |
| Coop Branch | 071300120401 | WASCB | 257WASCB | Low | 5.7 | 8.4 | 19 | $1,018.09 | $5,775.00 |
| Coop Branch | 071300120401 | WASCB | 287WASCB | Low | 6.1 | 5.7 | 26 | $1,026.71 | $6,300.00 |
| Coop Branch | 071300120401 | WASCB | 393WASCB | Low | 8.3 | 13 | 32 | $1,031.40 | $8,575.00 |
| Coop Branch | 071300120401 | WASCB | 211WASCB | Low | 5.6 | 9.2 | 18 | $1,053.39 | $5,950.00 |
| Coop Branch | 071300120401 | WASCB | 346WASCB | Low | 8.2 | 11 | 31 | $1,073.33 | $8,750.00 |
| Coop Branch | 071300120401 | WASCB | 159WASCB | Low | 5.5 | 9.5 | 16 | $1,083.91 | $5,950.00 |
| Coop Branch | 071300120401 | WASCB | 316WASCB | Low | 2.8 | 4.2 | 9.4 | $1,091.36 | $3,062.50 |
| Coop Branch | 071300120401 | WASCB | 282WASCB | Low | 13 | 15 | 63 | $1,117.54 | $15,050.00 |
| Coop Branch | 071300120401 | WASCB | 305WASCB | Low | 4.7 | 6.8 | 18 | $1,162.07 | $5,425.00 |
| Coop Branch | 071300120401 | WASCB | 168WASCB | Low | 4.9 | 8.4 | 15 | $1,225.97 | $5,950.00 |
| Coop Branch | 071300120401 | WASCB | 213WASCB | Low | 13 | 17 | 48 | $1,233.26 | $16,450.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Coop Branch | 071300120401 | WASCB | 212WASCB | Low | 11 | 15 | 36 | $1,253.31 | $13,300.00 |
| Coop Branch | 071300120401 | WASCB | 161WASCB | Low | 3.8 | 4.6 | 20 | $1,389.02 | $5,250.00 |
| Coop Branch | 071300120401 | WASCB | 167WASCB | Low | 3.9 | 6.8 | 11 | $1,466.40 | $5,775.00 |
| Coop Branch | 071300120401 | WASCB | 344WASCB | Low | 1.9 | 2.7 | 6.3 | $1,480.73 | $2,800.00 |
| Coop Branch | 071300120401 | WASCB | 317WASCB | Low | 7.2 | 11 | 25 | $1,523.90 | $11,025.00 |
| Coop Branch | 071300120401 | WASCB | 369WASCB | Low | 4.5 | 6.7 | 13 | $1,553.90 | $7,000.00 |
| Coop Branch | 071300120401 | WASCB | 371WASCB | Low | 6.0 | 8.1 | 25 | $1,625.36 | $9,800.00 |
| Coop Branch | 071300120401 | WASCB | 219WASCB | Low | 3.2 | 5.3 | 7.6 | $1,750.78 | $5,600.00 |
| Coop Branch | 071300120401 | WASCB | 218WASCB | Low | 2.8 | 4.8 | 6.5 | $1,976.88 | $5,600.00 |
| Coop Branch | 071300120401 | WASCB | 277WASCB | Low | 3.0 | 4.2 | 12 | $2,075.86 | $6,300.00 |
| Coop Branch | 071300120401 | WASCB | 256WASCB | Low | 2.7 | 3.4 | 9.3 | $2,173.67 | $5,950.00 |
| Coop Branch | 071300120401 | Wetland Creation | 285WTLND | High | 437 | 286 | 2,668 | $34.03 | $14,868.00 |
| Coop Branch | 071300120401 | Wetland Creation | 292WTLND | Medium | 27 | 45 | 194 | $126.17 | $3,398.40 |
| Coop Branch | 071300120401 | Wetland Creation | 207WTLND | Medium | 9.9 | 13 | 101 | $427.73 | $4,248.00 |
| Coop Branch | 071300120401 | Wetland Creation | 245WTLND | Medium | 22 | 27 | 223 | $448.88 | $9,770.40 |
| Coop Branch | 071300120401 | Wetland Creation | 304WTLND | Medium | 9.8 | 9.7 | 103 | $651.71 | $6,372.00 |
| Coop Branch | 071300120401 | Wetland Creation | 303WTLND | Low | 4.4 | 5.5 | 54 | $775.03 | $3,398.40 |
| Coop Branch | 071300120401 | Wetland Creation | 294WTLND | Low | 1.7 | 1.3 | 16 | $2,970.20 | $5,097.60 |
| Coop Branch | 071300120401 | Wetland Creation | 290WTLND | Low | 1.1 | 0.98 | 12 | $3,135.68 | $3,398.40 |
| Dry Fork | 071300120108 | Critical Area Planting | 431CA | Very High | 64 | 133 | 487 | $16.10 | $1,031.38 |
| Dry Fork | 071300120108 | Critical Area Planting | 453CA | Very High | 9.1 | 19 | 71 | $21.94 | $199.98 |
| Dry Fork | 071300120108 | Critical Area Planting | 415CA | High | 9.0 | 12 | 104 | $47.77 | $429.27 |
| Dry Fork | 071300120108 | Field Border | 333FB | Very High | 8.5 | 11 | 29 | $7.73 | $65.31 |
| Dry Fork | 071300120108 | Field Border | 347FB | Very High | 25 | 33 | 88 | $8.62 | $212.68 |
| Dry Fork | 071300120108 | Field Border | 257FB | Very High | 37 | 48 | 146 | $10.30 | $382.05 |
| Dry Fork | 071300120108 | Field Border | 287FB | Very High | 27 | 26 | 109 | $12.85 | $347.70 |
| Dry Fork | 071300120108 | Field Border | 332FB | Very High | 16 | 16 | 61 | $18.68 | $291.39 |
| Dry Fork | 071300120108 | Field Border | 334FB | Very High | 6.0 | 10 | 26 | $18.96 | $114.15 |
| Dry Fork | 071300120108 | Field Border | 253FB | Very High | 12 | 16 | 43 | $19.41 | $234.98 |
| Dry Fork | 071300120108 | Field Border | 201FB | Very High | 7.7 | 8.0 | 30 | $22.02 | $169.28 |
| Dry Fork | 071300120108 | Field Border | 174FB | High | 9.5 | 5.7 | 47 | $24.65 | $233.02 |
| Dry Fork | 071300120108 | Field Border | 285FB | High | 12 | 19 | 39 | $25.26 | $301.61 |
| Dry Fork | 071300120108 | Field Border | 163FB | High | 3.2 | 5.6 | 10 | $25.50 | $80.54 |
| Dry Fork | 071300120108 | Field Border | 268FB | High | 16 | 10 | 77 | $26.58 | $434.02 |
| Dry Fork | 071300120108 | Field Border | 282FB | High | 6.4 | 5.8 | 27 | $27.99 | $179.48 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Dry Fork | 071300120108 | Field Border | 241FB | High | 9.7 | 2.5 | 50 | $28.60 | $278.13 |
| Dry Fork | 071300120108 | Field Border | 284FB | High | 12 | 10 | 51 | $28.71 | $339.91 |
| Dry Fork | 071300120108 | Field Border | 455FB | High | 7.7 | 11 | 34 | $29.41 | $226.37 |
| Dry Fork | 071300120108 | Field Border | 290FB | High | 9.7 | 7.9 | 39 | $32.05 | $312.20 |
| Dry Fork | 071300120108 | Field Border | 186FB | High | 4.8 | 7.1 | 16 | $33.38 | $161.86 |
| Dry Fork | 071300120108 | Field Border | 210FB | High | 3.3 | 3.4 | 12 | $33.60 | $110.49 |
| Dry Fork | 071300120108 | Field Border | 286FB | High | 12 | 5.7 | 53 | $35.22 | $428.40 |
| Dry Fork | 071300120108 | Field Border | 175FB | High | 19 | 12 | 88 | $41.43 | $768.74 |
| Dry Fork | 071300120108 | Field Border | 346FB | High | 3.5 | 3.1 | 15 | $57.12 | $200.76 |
| Dry Fork | 071300120108 | Field Border | 270FB | High | 3.2 | 1.6 | 13 | $60.55 | $191.87 |
| Dry Fork | 071300120108 | Field Border | 288FB | High | 7.0 | 9.9 | 25 | $60.70 | $424.71 |
| Dry Fork | 071300120108 | Field Border | 240FB | High | 8.2 | 2.1 | 43 | $61.94 | $510.98 |
| Dry Fork | 071300120108 | Field Border | 267FB | High | 3.0 | 1.1 | 15 | $81.45 | $244.69 |
| Dry Fork | 071300120108 | Field Border | 209FB | High | 1.9 | 0.51 | 10 | $82.84 | $156.88 |
| Dry Fork | 071300120108 | Field Border | 224FB | Medium | 1.2 | 0.81 | 4.4 | $98.00 | $116.82 |
| Dry Fork | 071300120108 | Field Border | 283FB | Medium | 1.7 | 0.06 | 9.3 | $100.42 | $173.72 |
| Dry Fork | 071300120108 | Field Border | 255FB | Medium | 1.9 | 0.75 | 5.8 | $102.24 | $197.75 |
| Dry Fork | 071300120108 | Field Border | 269FB | Medium | 3.6 | 3.0 | 18 | $109.48 | $394.87 |
| Dry Fork | 071300120108 | Field Border | 254FB | Medium | 1.5 | 0.47 | 7.7 | $113.16 | $170.38 |
| Dry Fork | 071300120108 | Field Border | 289FB | Medium | 1.5 | 1.2 | 6.4 | $138.97 | $209.24 |
| Dry Fork | 071300120108 | Field Border | 256FB | Medium | 2.1 | 0.42 | 8.4 | $139.47 | $287.23 |
| Dry Fork | 071300120108 | Field Border | 211FB | Medium | 0.80 | 0.46 | 3.3 | $205.77 | $165.00 |
| Dry Fork | 071300120108 | Filter Strip | 446FS | Very High | 6.8 | 8.2 | 12 | $7.61 | $51.65 |
| Dry Fork | 071300120108 | Filter Strip | 457FS | Very High | 34 | 49 | 115 | $7.63 | $262.56 |
| Dry Fork | 071300120108 | Filter Strip | 340FS | Very High | 30 | 39 | 107 | $9.04 | $271.66 |
| Dry Fork | 071300120108 | Filter Strip | 430FS | Very High | 43 | 121 | 82 | $9.79 | $425.16 |
| Dry Fork | 071300120108 | Filter Strip | 292FS | Very High | 24 | 41 | 70 | $10.07 | $241.41 |
| Dry Fork | 071300120108 | Filter Strip | 339FS | Very High | 22 | 29 | 77 | $11.01 | $241.78 |
| Dry Fork | 071300120108 | Filter Strip | 428FS | Very High | 42 | 91 | 95 | $11.03 | $461.13 |
| Dry Fork | 071300120108 | Filter Strip | 338FS | Very High | 30 | 31 | 123 | $11.59 | $349.88 |
| Dry Fork | 071300120108 | Filter Strip | 427FS | Very High | 21 | 54 | 35 | $12.66 | $261.94 |
| Dry Fork | 071300120108 | Filter Strip | 337FS | Very High | 19 | 25 | 64 | $13.21 | $246.32 |
| Dry Fork | 071300120108 | Filter Strip | 426FS | Very High | 17 | 44 | 31 | $13.82 | $241.19 |
| Dry Fork | 071300120108 | Filter Strip | 335FS | Very High | 18 | 34 | 51 | $15.56 | $285.59 |
| Dry Fork | 071300120108 | Filter Strip | 458FS | Very High | 12 | 20 | 35 | $17.53 | $205.55 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Dry Fork | 071300120108 | Filter Strip | 429FS | Very High | 8.7 | 22 | 20 | $18.03 | $157.63 |
| Dry Fork | 071300120108 | Filter Strip | 445FS | Very High | 3.7 | 3.1 | 7.1 | $19.15 | $71.34 |
| Dry Fork | 071300120108 | Filter Strip | 402FS | High | 8.0 | 13 | 24 | $25.40 | $202.81 |
| Dry Fork | 071300120108 | Filter Strip | 417FS | High | 5.9 | 10 | 16 | $26.33 | $155.53 |
| Dry Fork | 071300120108 | Filter Strip | 400FS | High | 5.1 | 11 | 11 | $27.21 | $139.76 |
| Dry Fork | 071300120108 | Filter Strip | 447FS | High | 1.8 | 1.4 | 3.7 | $30.97 | $55.55 |
| Dry Fork | 071300120108 | Filter Strip | 403FS | High | 5.2 | 9.2 | 13 | $31.03 | $161.54 |
| Dry Fork | 071300120108 | Filter Strip | 448FS | High | 1.7 | 1.4 | 3.3 | $34.39 | $58.44 |
| Dry Fork | 071300120108 | Filter Strip | 401FS | High | 2.9 | 4.6 | 9.3 | $34.53 | $101.73 |
| Dry Fork | 071300120108 | Filter Strip | 433FS | High | 10 | 5.8 | 34 | $34.88 | $350.44 |
| Dry Fork | 071300120108 | Filter Strip | 291FS | High | 1.9 | 3.5 | 5.1 | $45.49 | $85.01 |
| Dry Fork | 071300120108 | Filter Strip | 336FS | High | 5.5 | 9.5 | 16 | $45.95 | $254.20 |
| Dry Fork | 071300120108 | Filter Strip | 451FS | High | 1.2 | 0.31 | 6.5 | $82.33 | $97.94 |
| Dry Fork | 071300120108 | Filter Strip | 432FS | Medium | 1.5 | 1.1 | 4.9 | $116.13 | $178.10 |
| Dry Fork | 071300120108 | Filter Strip | 452FS | Medium | 0.66 | 0.39 | 2.5 | $163.98 | $107.71 |
| Dry Fork | 071300120108 | Grade Control | 231GC | Very High | 111 | 29 | 61 | $16.26 | $1,800.00 |
| Dry Fork | 071300120108 | Grade Control | 377GC | High | 24 | 10 | 24 | $49.82 | $1,200.00 |
| Dry Fork | 071300120108 | Grade Control | 192GC | Medium | 8.3 | 22 | 14 | $143.97 | $1,200.00 |
| Dry Fork | 071300120108 | Grade Control | 237GC | Medium | 3.3 | 8.6 | 5.6 | $364.84 | $1,200.00 |
| Dry Fork | 071300120108 | Grassed Waterway | 378GW | Medium | 53 | 21 | 210 | $101.23 | $5,397.61 |
| Dry Fork | 071300120108 | Grassed Waterway | 340GW | Medium | 81 | 57 | 444 | $159.19 | $12,819.33 |
| Dry Fork | 071300120108 | Grassed Waterway | 271GW | Medium | 42 | 31 | 764 | $224.71 | $9,445.82 |
| Dry Fork | 071300120108 | Grassed Waterway | 353GW | Medium | 34 | 27 | 210 | $274.81 | $9,371.12 |
| Dry Fork | 071300120108 | Grassed Waterway | 270GW | Medium | 34 | 33 | 547 | $280.43 | $9,445.82 |
| Dry Fork | 071300120108 | Grassed Waterway | 375GW | Medium | 34 | 14 | 258 | $402.18 | $13,494.03 |
| Dry Fork | 071300120108 | Grassed Waterway | 387GW | Medium | 43 | 77 | 596 | $428.47 | $18,216.94 |
| Dry Fork | 071300120108 | Grassed Waterway | 234GW | Medium | 8.9 | 6.8 | 165 | $452.74 | $4,048.21 |
| Dry Fork | 071300120108 | Grassed Waterway | 226GW | Medium | 11 | 7.1 | 230 | $593.97 | $6,747.02 |
| Dry Fork | 071300120108 | Grassed Waterway | 191GW | Low | 13 | 24 | 103 | $755.38 | $10,120.52 |
| Dry Fork | 071300120108 | Grassed Waterway | 392GW | Low | 3.3 | 5.2 | 34 | $1,462.80 | $4,891.59 |
| Dry Fork | 071300120108 | Pasture Fencing/Crossing | 8FN | Low | 2.6 | 0.12 | 6.1 | $1,682.93 | $4,383.68 |
| Dry Fork | 071300120108 | Pasture Fencing/Crossing | 7FN | Low | 2.2 | 0.62 | 7.0 | $1,953.38 | $4,368.08 |
| Dry Fork | 071300120108 | Pond | 376PND | Medium | 398 | 523 | 2,873 | $150.71 | $60,000.00 |
| Dry Fork | 071300120108 | Pond | 174PND | Medium | 190 | 90 | 350 | $210.67 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 224PND | Medium | 174 | 436 | 342 | $230.43 | $40,000.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Dry Fork | 071300120108 | Pond | 179PND | Medium | 341 | 598 | 2,786 | $234.43 | $80,000.00 |
| Dry Fork | 071300120108 | Pond | 355PND | Medium | 165 | 99 | 1,279 | $242.09 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 324PND | Medium | 265 | 456 | 1,534 | $302.16 | $80,000.00 |
| Dry Fork | 071300120108 | Pond | 123PND | Medium | 63 | 140 | 200 | $632.37 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 339PND | Medium | 61 | 40 | 408 | $655.80 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 334PND | Low | 57 | 61 | 343 | $705.34 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 358PND | Low | 81 | 44 | 664 | $743.19 | $60,000.00 |
| Dry Fork | 071300120108 | Pond | 332PND | Low | 53 | 35 | 446 | $757.34 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 175PND | Low | 46 | 79 | 133 | $866.74 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 265PND | Low | 46 | 73 | 276 | $867.19 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 325PND | Low | 40 | 63 | 202 | $996.97 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 357PND | Low | 56 | 20 | 571 | $1,062.42 | $60,000.00 |
| Dry Fork | 071300120108 | Pond | 272PND | Low | 33 | 17 | 268 | $1,214.78 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 176PND | Low | 31 | 33 | 214 | $1,305.47 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 151PND | Low | 28 | 73 | 43 | $1,428.78 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 144PND | Low | 55 | 108 | 166 | $1,464.96 | $80,000.00 |
| Dry Fork | 071300120108 | Pond | 336PND | Low | 23 | 44 | 80 | $1,745.40 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 352PND | Low | 22 | 41 | 76 | $1,847.14 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 173PND | Low | 16 | 40 | 24 | $2,577.07 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 300PND | Low | 19 | 32 | 45 | $3,095.61 | $60,000.00 |
| Dry Fork | 071300120108 | Pond | 236PND | Low | 12 | 13 | 52 | $3,263.95 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 264PND | Low | 11 | 20 | 47 | $3,554.04 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 263PND | Low | 11 | 18 | 44 | $3,808.69 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 326PND | Low | 10 | 8.4 | 63 | $4,014.94 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 335PND | Low | 8.8 | 15 | 33 | $4,537.56 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 298PND | Low | 8.0 | 16 | 28 | $5,003.09 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 262PND | Low | 7.2 | 14 | 26 | $5,580.43 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 299PND | Low | 3.1 | 5.7 | 7.2 | $12,726.62 | $40,000.00 |
| Dry Fork | 071300120108 | Pond | 297PND | Low | 2.7 | 6.5 | 4.6 | $14,926.15 | $40,000.00 |
| Dry Fork | 071300120108 | WASCB | 386WASCB | Medium | 27 | 24 | 128 | $250.72 | $6,650.00 |
| Dry Fork | 071300120108 | WASCB | 338WASCB | Medium | 12 | 13 | 43 | $463.90 | $5,425.00 |
| Dry Fork | 071300120108 | WASCB | 177WASCB | Medium | 6.3 | 4.0 | 33 | $578.85 | $3,675.00 |
| Dry Fork | 071300120108 | WASCB | 329WASCB | Low | 7.2 | 8.0 | 24 | $772.44 | $5,600.00 |
| Dry Fork | 071300120108 | WASCB | 302WASCB | Low | 7.4 | 9.2 | 29 | $808.70 | $5,950.00 |
| Dry Fork | 071300120108 | WASCB | 269WASCB | Low | 6.9 | 7.8 | 25 | $916.18 | $6,300.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Dry Fork | 071300120108 | WASCB | 268WASCB | Low | 11 | 8.7 | 46 | $996.00 | $10,500.00 |
| Dry Fork | 071300120108 | WASCB | 354WASCB | Low | 5.5 | 5.8 | 20 | $1,041.00 | $5,775.00 |
| Dry Fork | 071300120108 | WASCB | 232WASCB | Low | 6.7 | 6.3 | 31 | $1,046.24 | $7,000.00 |
| Dry Fork | 071300120108 | WASCB | 341WASCB | Low | 5.6 | 8.5 | 20 | $1,060.37 | $5,950.00 |
| Dry Fork | 071300120108 | WASCB | 337WASCB | Low | 9.7 | 11 | 40 | $1,099.04 | $10,675.00 |
| Dry Fork | 071300120108 | WASCB | 342WASCB | Low | 5.7 | 8.5 | 20 | $1,102.77 | $6,300.00 |
| Dry Fork | 071300120108 | WASCB | 330WASCB | Low | 1.8 | 1.6 | 7.8 | $1,673.25 | $3,080.00 |
| Dry Fork | 071300120108 | WASCB | 356WASCB | Low | 5.2 | 3.7 | 24 | $1,686.28 | $8,750.00 |
| Dry Fork | 071300120108 | WASCB | 374WASCB | Low | 3.7 | 5.2 | 18 | $1,711.01 | $6,387.50 |
| Dry Fork | 071300120108 | WASCB | 388WASCB | Low | 1.8 | 3.3 | 6.8 | $1,770.21 | $3,150.00 |
| Dry Fork | 071300120108 | WASCB | 327WASCB | Low | 4.9 | 3.7 | 22 | $1,787.18 | $8,750.00 |
| Dry Fork | 071300120108 | WASCB | 359WASCB | Low | 5.8 | 3.2 | 26 | $1,923.03 | $11,200.00 |
| Dry Fork | 071300120108 | WASCB | 328WASCB | Low | 7.0 | 6.3 | 29 | $2,010.98 | $14,000.00 |
| Dry Fork | 071300120108 | WASCB | 228WASCB | Low | 3.3 | 4.5 | 17 | $2,183.79 | $7,175.00 |
| Dry Fork | 071300120108 | WASCB | 233WASCB | Low | 1.3 | 1.1 | 6.5 | $2,805.99 | $3,675.00 |
| Dry Fork | 071300120108 | WASCB | 229WASCB | Low | 2.3 | 2.8 | 14 | $3,368.81 | $7,700.00 |
| Dry Fork | 071300120108 | WASCB | 227WASCB | Low | 1.7 | 1.2 | 11 | $3,402.46 | $5,862.50 |
| Dry Fork | 071300120108 | WASCB | 230WASCB | Low | 0.81 | 0.68 | 5.1 | $3,762.09 | $3,062.50 |
| Dry Fork | 071300120108 | Wetland Creation | 331WTLND | High | 243 | 141 | 3,514 | $69.80 | $16,992.00 |
| Dry Fork | 071300120108 | Wetland Creation | 333WTLND | High | 150 | 75 | 2,371 | $70.58 | $10,620.00 |
| Dry Fork | 071300120108 | Wetland Creation | 267WTLND | Medium | 8.5 | 15 | 39 | $250.20 | $2,124.00 |
| Dry Fork | 071300120108 | Wetland Creation | 178WTLND | Medium | 23 | 19 | 239 | $411.29 | $9,345.60 |
| Dry Fork | 071300120108 | Wetland Creation | 124WTLND | Medium | 4.3 | 5.8 | 35 | $497.28 | $2,124.00 |
| Dry Fork | 071300120108 | Wetland Creation | 266WTLND | Medium | 5.8 | 3.2 | 21 | $654.38 | $3,823.20 |
| Dry Fork | 071300120108 | Wetland Creation | 301WTLND | Low | 2.5 | 3.4 | 24 | $1,016.22 | $2,548.80 |
| Dry Fork | 071300120108 | Wetland Creation | 235WTLND | Low | 7.9 | 16 | 16 | $1,071.76 | $8,496.00 |
| Honey Creek | 071300120106 | Field Border | 159FB | Very High | 12 | 14 | 43 | $15.54 | $192.05 |
| Honey Creek | 071300120106 | Field Border | 161FB | Very High | 14 | 13 | 60 | $23.81 | $321.97 |
| Honey Creek | 071300120106 | Field Border | 110FB | High | 6.5 | 6.3 | 25 | $25.15 | $164.15 |
| Honey Creek | 071300120106 | Field Border | 149FB | High | 23 | 13 | 102 | $29.80 | $681.38 |
| Honey Creek | 071300120106 | Field Border | 151FB | High | 6.6 | 3.8 | 30 | $30.63 | $203.43 |
| Honey Creek | 071300120106 | Field Border | 157FB | High | 9.5 | 8.2 | 37 | $33.19 | $314.06 |
| Honey Creek | 071300120106 | Field Border | 162FB | High | 9.0 | 4.4 | 54 | $35.17 | $316.40 |
| Honey Creek | 071300120106 | Field Border | 153FB | High | 10 | 5.8 | 46 | $35.26 | $364.42 |
| Honey Creek | 071300120106 | Field Border | 134FB | High | 3.2 | 3.5 | 17 | $36.47 | $117.06 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Honey Creek | 071300120106 | Field Border | 145FB | High | 11 | 8.0 | 49 | $36.57 | $414.10 |
| Honey Creek | 071300120106 | Field Border | 106FB | High | 3.8 | 1.8 | 19 | $37.05 | $142.44 |
| Honey Creek | 071300120106 | Field Border | 156FB | High | 4.4 | 3.0 | 18 | $37.92 | $166.60 |
| Honey Creek | 071300120106 | Field Border | 105FB | High | 1.8 | 1.3 | 7.5 | $38.12 | $66.97 |
| Honey Creek | 071300120106 | Field Border | 150FB | High | 7.1 | 4.2 | 31 | $38.29 | $273.23 |
| Honey Creek | 071300120106 | Field Border | 98FB | High | 6.7 | 3.9 | 29 | $41.74 | $277.79 |
| Honey Creek | 071300120106 | Field Border | 143FB | High | 2.8 | 2.1 | 12 | $43.02 | $119.77 |
| Honey Creek | 071300120106 | Field Border | 152FB | High | 16 | 8.6 | 72 | $44.42 | $701.47 |
| Honey Creek | 071300120106 | Field Border | 147FB | High | 7.5 | 4.8 | 32 | $45.77 | $341.30 |
| Honey Creek | 071300120106 | Field Border | 111FB | High | 6.6 | 4.2 | 28 | $50.93 | $336.51 |
| Honey Creek | 071300120106 | Field Border | 132FB | High | 8.2 | 4.4 | 35 | $54.03 | $441.40 |
| Honey Creek | 071300120106 | Field Border | 154FB | High | 3.2 | 1.8 | 14 | $60.05 | $194.58 |
| Honey Creek | 071300120106 | Field Border | 135FB | High | 1.1 | 0.60 | 5.2 | $61.69 | $68.64 |
| Honey Creek | 071300120106 | Field Border | 107FB | High | 2.8 | 3.5 | 8.6 | $63.83 | $177.95 |
| Honey Creek | 071300120106 | Field Border | 148FB | High | 2.3 | 1.1 | 10 | $71.28 | $162.01 |
| Honey Creek | 071300120106 | Field Border | 160FB | High | 2.4 | 1.3 | 1.8 | $77.84 | $184.89 |
| Honey Creek | 071300120106 | Field Border | 113FB | High | 2.3 | 1.5 | 8.8 | $81.19 | $189.14 |
| Honey Creek | 071300120106 | Field Border | 194FB | High | 7.3 | 2.1 | 28 | $85.43 | $623.98 |
| Honey Creek | 071300120106 | Field Border | 158FB | Medium | 5.1 | 4.0 | 20 | $94.22 | $483.27 |
| Honey Creek | 071300120106 | Field Border | 131FB | Medium | 2.2 | 0.85 | 7.9 | $94.79 | $208.65 |
| Honey Creek | 071300120106 | Field Border | 133FB | Medium | 1.7 | 1.3 | 6.7 | $104.33 | $180.48 |
| Honey Creek | 071300120106 | Field Border | 146FB | Medium | 1.9 | 1.0 | 8.7 | $109.75 | $211.37 |
| Honey Creek | 071300120106 | Field Border | 104FB | Medium | 1.3 | 1.4 | 4.1 | $110.52 | $141.84 |
| Honey Creek | 071300120106 | Field Border | 155FB | Medium | 1.6 | 1.3 | 6.2 | $117.24 | $185.60 |
| Honey Creek | 071300120106 | Field Border | 120FB | Medium | 2.8 | 1.4 | 15 | $118.15 | $331.47 |
| Honey Creek | 071300120106 | Field Border | 144FB | Medium | 1.6 | 0.91 | 8.6 | $125.29 | $205.59 |
| Honey Creek | 071300120106 | Field Border | 108FB | Medium | 1.2 | 0.91 | 5.9 | $125.82 | $155.58 |
| Honey Creek | 071300120106 | Field Border | 109FB | Medium | 0.90 | 0.27 | 6.3 | $180.83 | $163.63 |
| Honey Creek | 071300120106 | Field Border | 112FB | Medium | 0.33 | 0.05 | 2.2 | $461.75 | $153.23 |
| Honey Creek | 071300120106 | Filter Strip | 398FS | Very High | 7.3 | 7.1 | 19 | $17.79 | $129.00 |
| Honey Creek | 071300120106 | Filter Strip | 99FS | Very High | 3.0 | 5.5 | 7.1 | $21.78 | $64.67 |
| Honey Creek | 071300120106 | Filter Strip | 101FS | High | 7.8 | 10 | 27 | $26.19 | $204.00 |
| Honey Creek | 071300120106 | Filter Strip | 404FS | High | 5.0 | 3.4 | 20 | $32.20 | $159.62 |
| Honey Creek | 071300120106 | Filter Strip | 100FS | High | 4.0 | 6.4 | 11 | $46.95 | $189.31 |
| Honey Creek | 071300120106 | Filter Strip | 367FS | High | 3.9 | 2.9 | 12 | $51.32 | $197.62 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Honey Creek | 071300120106 | Grade Control | 109GC | High | 8.6 | 2.2 | 4.5 | $69.53 | $600.00 |
| Honey Creek | 071300120106 | Grade Control | 117GC | Medium | 4.2 | 3.9 | 29 | $142.98 | $600.00 |
| Honey Creek | 071300120106 | Grassed Waterway | 105GW | Medium | 18 | 15 | 327 | $557.95 | $9,783.17 |
| Honey Creek | 071300120106 | Grassed Waterway | 47GW | Low | 8.7 | 15 | 84 | $776.29 | $6,747.02 |
| Honey Creek | 071300120106 | Grassed Waterway | 106GW | Low | 3.4 | 3.0 | 59 | $1,958.24 | $6,747.02 |
| Honey Creek | 071300120106 | Pasture Fencing/Crossing | 21FN | Medium | 26 | 27 | 77 | $253.50 | $6,495.92 |
| Honey Creek | 071300120106 | Pasture Fencing/Crossing | 20FN | Medium | 11 | 5.9 | 45 | $633.96 | $7,082.48 |
| Honey Creek | 071300120106 | Pond | 107PND | Medium | 162 | 307 | 735 | $247.17 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 43PND | Medium | 101 | 67 | 189 | $395.25 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 63PND | Low | 39 | 44 | 256 | $1,012.94 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 62PND | Low | 15 | 16 | 82 | $2,751.75 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 53PND | Low | 12 | 14 | 78 | $3,329.83 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 52PND | Low | 6.1 | 6.6 | 33 | $6,546.19 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 51PND | Low | 5.6 | 5.6 | 37 | $7,170.61 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 87PND | Low | 1.4 | 1.8 | 6.9 | $28,855.65 | $40,000.00 |
| Honey Creek | 071300120106 | Pond | 50PND | Low | 0.99 | 2.8 | 1.8 | $40,214.56 | $40,000.00 |
| Honey Creek | 071300120106 | WASCB | 119WASCB | Medium | 9.3 | 13 | 26 | $319.77 | $2,975.00 |
| Honey Creek | 071300120106 | WASCB | 118WASCB | Medium | 12 | 19 | 34 | $437.53 | $5,425.00 |
| Honey Creek | 071300120106 | WASCB | 34WASCB | Low | 3.8 | 4.6 | 15 | $736.84 | $2,800.00 |
| Honey Creek | 071300120106 | WASCB | 45WASCB | Low | 6.2 | 7.3 | 29 | $903.36 | $5,600.00 |
| Honey Creek | 071300120106 | WASCB | 114WASCB | Low | 2.9 | 3.5 | 9.7 | $1,052.83 | $3,062.50 |
| Honey Creek | 071300120106 | WASCB | 33WASCB | Low | 2.1 | 2.2 | 8.6 | $1,360.10 | $2,800.00 |
| Honey Creek | 071300120106 | WASCB | 113WASCB | Low | 3.9 | 5.4 | 14 | $1,464.67 | $5,775.00 |
| Honey Creek | 071300120106 | WASCB | 108WASCB | Low | 3.7 | 5.3 | 15 | $1,596.25 | $5,950.00 |
| Honey Creek | 071300120106 | WASCB | 112WASCB | Low | 2.0 | 1.6 | 7.7 | $1,608.59 | $3,150.00 |
| Honey Creek | 071300120106 | WASCB | 49WASCB | Low | 3.5 | 3.9 | 11 | $1,610.48 | $5,600.00 |
| Honey Creek | 071300120106 | WASCB | 110WASCB | Low | 5.1 | 4.3 | 20 | $1,718.72 | $8,750.00 |
| Honey Creek | 071300120106 | WASCB | 111WASCB | Low | 1.7 | 1.5 | 6.4 | $1,849.71 | $3,062.50 |
| Honey Creek | 071300120106 | WASCB | 116WASCB | Low | 3.5 | 5.3 | 13 | $2,004.31 | $7,000.00 |
| Honey Creek | 071300120106 | WASCB | 115WASCB | Low | 1.4 | 1.3 | 5.2 | $2,123.55 | $2,975.00 |
| Honey Creek | 071300120106 | WASCB | 31WASCB | Low | 1.2 | 0.66 | 6.3 | $2,210.16 | $2,712.50 |
| Honey Creek | 071300120106 | WASCB | 85WASCB | Low | 0.96 | 0.80 | 7.0 | $2,541.69 | $2,450.00 |
| Honey Creek | 071300120106 | WASCB | 48WASCB | Low | 1.6 | 1.6 | 6.2 | $3,585.14 | $5,600.00 |
| Honey Creek | 071300120106 | Wetland Creation | 86WTLND | Very High | 305 | 226 | 2,296 | $9.74 | $2,973.60 |
| Honey Creek | 071300120106 | Wetland Creation | 88WTLND | Medium | 64 | 29 | 813 | $119.46 | $7,646.40 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Honey Creek | 071300120106 | Wetland Creation | 46WTLND | Medium | 36 | 30 | 433 | $234.52 | $8,496.00 |
| Honey Creek | 071300120106 | Wetland Creation | 32WTLND | Medium | 51 | 39 | 637 | $331.78 | $16,992.00 |
| Honey Creek | 071300120106 | Wetland Creation | 89WTLND | Medium | 6.2 | 3.6 | 38 | $621.59 | $3,823.20 |
| Honey Creek | 071300120106 | Wetland Creation | 44WTLND | Low | 7.4 | 4.5 | 110 | $865.48 | $6,372.00 |
| Hurricane Creek | 071300120107 | Detention Basin | 13DET | Low | 1.7 | 0.39 | 6.3 | $35,460.19 | $60,000.00 |
| Hurricane Creek | 071300120107 | Field Border | 58FB | Very High | 24 | 27 | 105 | $3.60 | $87.37 |
| Hurricane Creek | 071300120107 | Field Border | 74FB | Very High | 58 | 62 | 224 | $3.82 | $221.87 |
| Hurricane Creek | 071300120107 | Field Border | 62FB | Very High | 55 | 85 | 189 | $3.82 | $210.64 |
| Hurricane Creek | 071300120107 | Field Border | 61FB | Very High | 19 | 36 | 58 | $4.22 | $79.76 |
| Hurricane Creek | 071300120107 | Field Border | 81FB | Very High | 36 | 65 | 135 | $6.04 | $216.34 |
| Hurricane Creek | 071300120107 | Field Border | 24FB | Very High | 23 | 39 | 74 | $6.20 | $140.06 |
| Hurricane Creek | 071300120107 | Field Border | 60FB | Very High | 26 | 29 | 99 | $8.16 | $212.61 |
| Hurricane Creek | 071300120107 | Field Border | 68FB | Very High | 6.1 | 6.7 | 23 | $8.27 | $50.82 |
| Hurricane Creek | 071300120107 | Field Border | 1FB | Very High | 33 | 32 | 135 | $8.56 | $285.32 |
| Hurricane Creek | 071300120107 | Field Border | 57FB | Very High | 16 | 19 | 59 | $9.32 | $148.16 |
| Hurricane Creek | 071300120107 | Field Border | 11FB | Very High | 29 | 30 | 120 | $9.71 | $285.20 |
| Hurricane Creek | 071300120107 | Field Border | 23FB | Very High | 32 | 33 | 125 | $9.98 | $318.98 |
| Hurricane Creek | 071300120107 | Field Border | 88FB | Very High | 16 | 25 | 55 | $10.46 | $166.62 |
| Hurricane Creek | 071300120107 | Field Border | 32FB | Very High | 33 | 33 | 133 | $10.59 | $352.72 |
| Hurricane Creek | 071300120107 | Field Border | 47FB | Very High | 28 | 33 | 105 | $10.83 | $301.82 |
| Hurricane Creek | 071300120107 | Field Border | 10FB | Very High | 10 | 14 | 38 | $10.85 | $109.84 |
| Hurricane Creek | 071300120107 | Field Border | 63FB | Very High | 4.9 | 10 | 14 | $12.24 | $60.57 |
| Hurricane Creek | 071300120107 | Field Border | 18FB | Very High | 24 | 24 | 92 | $13.55 | $318.50 |
| Hurricane Creek | 071300120107 | Field Border | 31FB | Very High | 13 | 13 | 52 | $15.93 | $204.42 |
| Hurricane Creek | 071300120107 | Field Border | 29FB | Very High | 11 | 15 | 38 | $16.24 | $177.82 |
| Hurricane Creek | 071300120107 | Field Border | 12FB | Very High | 16 | 19 | 60 | $16.60 | $269.92 |
| Hurricane Creek | 071300120107 | Field Border | 46FB | Very High | 24 | 42 | 84 | $17.94 | $432.50 |
| Hurricane Creek | 071300120107 | Field Border | 72FB | Very High | 16 | 17 | 64 | $18.53 | $305.16 |
| Hurricane Creek | 071300120107 | Field Border | 94FB | Very High | 17 | 15 | 69 | $19.60 | $340.83 |
| Hurricane Creek | 071300120107 | Field Border | 9FB | Very High | 5.3 | 6.5 | 20 | $20.98 | $110.51 |
| Hurricane Creek | 071300120107 | Field Border | 48FB | Very High | 15 | 19 | 53 | $21.40 | $318.70 |
| Hurricane Creek | 071300120107 | Field Border | 71FB | Very High | 5.6 | 5.1 | 24 | $21.84 | $122.36 |
| Hurricane Creek | 071300120107 | Field Border | 53FB | High | 6.5 | 5.8 | 27 | $24.77 | $162.01 |
| Hurricane Creek | 071300120107 | Field Border | 30FB | High | 3.5 | 3.7 | 14 | $28.31 | $99.61 |
| Hurricane Creek | 071300120107 | Field Border | 37FB | High | 10 | 11 | 41 | $30.84 | $319.21 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Hurricane Creek | 071300120107 | Field Border | 8FB | High | 4.8 | 3.0 | 23 | $31.14 | $149.30 |
| Hurricane Creek | 071300120107 | Field Border | 45FB | High | 6.1 | 9.7 | 21 | $32.10 | $196.80 |
| Hurricane Creek | 071300120107 | Field Border | 69FB | High | 7.6 | 11 | 26 | $33.23 | $251.76 |
| Hurricane Creek | 071300120107 | Field Border | 59FB | High | 25 | 25 | 100 | $34.83 | $871.57 |
| Hurricane Creek | 071300120107 | Field Border | 70FB | High | 4.4 | 4.4 | 18 | $41.65 | $183.76 |
| Hurricane Creek | 071300120107 | Field Border | 95FB | High | 5.6 | 3.6 | 27 | $43.66 | $244.22 |
| Hurricane Creek | 071300120107 | Field Border | 2FB | High | 2.7 | 3.0 | 10 | $43.71 | $117.48 |
| Hurricane Creek | 071300120107 | Field Border | 3FB | High | 3.4 | 6.3 | 10 | $44.22 | $148.45 |
| Hurricane Creek | 071300120107 | Field Border | 15FB | High | 5.6 | 5.8 | 22 | $46.75 | $262.04 |
| Hurricane Creek | 071300120107 | Field Border | 73FB | High | 1.2 | 1.2 | 4.9 | $71.82 | $86.95 |
| Hurricane Creek | 071300120107 | Field Border | 86FB | High | 1.6 | 1.8 | 6.1 | $73.27 | $117.81 |
| Hurricane Creek | 071300120107 | Field Border | 33FB | High | 4.9 | 9.9 | 15 | $78.24 | $384.28 |
| Hurricane Creek | 071300120107 | Field Border | 42FB | Medium | 3.1 | 1.6 | 11 | $111.09 | $344.27 |
| Hurricane Creek | 071300120107 | Filter Strip | 357FS | Very High | 75 | 80 | 288 | $6.68 | $499.42 |
| Hurricane Creek | 071300120107 | Filter Strip | 13FS | Very High | 89 | 108 | 331 | $7.03 | $627.54 |
| Hurricane Creek | 071300120107 | Filter Strip | 14FS | Very High | 72 | 82 | 269 | $7.96 | $576.19 |
| Hurricane Creek | 071300120107 | Filter Strip | 17FS | Very High | 38 | 40 | 147 | $8.72 | $331.55 |
| Hurricane Creek | 071300120107 | Filter Strip | 7FS | Very High | 136 | 164 | 514 | $9.12 | $1,243.38 |
| Hurricane Creek | 071300120107 | Filter Strip | 16FS | Very High | 36 | 43 | 135 | $9.15 | $332.01 |
| Hurricane Creek | 071300120107 | Filter Strip | 4FS | Very High | 48 | 59 | 185 | $9.57 | $460.82 |
| Hurricane Creek | 071300120107 | Filter Strip | 361FS | Very High | 16 | 31 | 46 | $9.87 | $161.97 |
| Hurricane Creek | 071300120107 | Filter Strip | 20FS | Very High | 20 | 26 | 68 | $10.51 | $207.80 |
| Hurricane Creek | 071300120107 | Filter Strip | 6FS | Very High | 101 | 166 | 336 | $11.47 | $1,158.64 |
| Hurricane Creek | 071300120107 | Filter Strip | 27FS | Very High | 47 | 55 | 177 | $11.61 | $549.13 |
| Hurricane Creek | 071300120107 | Filter Strip | 371FS | Very High | 19 | 47 | 45 | $11.72 | $221.88 |
| Hurricane Creek | 071300120107 | Filter Strip | 35FS | Very High | 96 | 192 | 252 | $12.02 | $1,151.18 |
| Hurricane Creek | 071300120107 | Filter Strip | 80FS | Very High | 25 | 64 | 54 | $12.38 | $307.29 |
| Hurricane Creek | 071300120107 | Filter Strip | 34FS | Very High | 120 | 210 | 461 | $13.15 | $1,578.18 |
| Hurricane Creek | 071300120107 | Filter Strip | 28FS | Very High | 27 | 54 | 77 | $13.23 | $360.78 |
| Hurricane Creek | 071300120107 | Filter Strip | 358FS | Very High | 16 | 34 | 47 | $13.95 | $229.06 |
| Hurricane Creek | 071300120107 | Filter Strip | 75FS | Very High | 63 | 78 | 234 | $14.34 | $907.97 |
| Hurricane Creek | 071300120107 | Filter Strip | 380FS | Very High | 17 | 36 | 42 | $14.55 | $253.61 |
| Hurricane Creek | 071300120107 | Filter Strip | 76FS | Very High | 59 | 62 | 229 | $15.02 | $885.33 |
| Hurricane Creek | 071300120107 | Filter Strip | 26FS | Very High | 49 | 62 | 191 | $15.32 | $753.36 |
| Hurricane Creek | 071300120107 | Filter Strip | 19FS | Very High | 30 | 33 | 117 | $15.75 | $465.99 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Hurricane Creek | 071300120107 | Filter Strip | 25FS | Very High | 16 | 24 | 69 | $15.77 | $254.08 |
| Hurricane Creek | 071300120107 | Filter Strip | 38FS | Very High | 20 | 27 | 49 | $16.31 | $322.27 |
| Hurricane Creek | 071300120107 | Filter Strip | 54FS | Very High | 22 | 44 | 42 | $16.71 | $373.40 |
| Hurricane Creek | 071300120107 | Filter Strip | 5FS | Very High | 39 | 51 | 144 | $17.11 | $659.65 |
| Hurricane Creek | 071300120107 | Filter Strip | 360FS | Very High | 7.1 | 12 | 21 | $18.82 | $133.88 |
| Hurricane Creek | 071300120107 | Filter Strip | 21FS | Very High | 14 | 25 | 35 | $18.87 | $266.47 |
| Hurricane Creek | 071300120107 | Filter Strip | 356FS | Very High | 4.2 | 3.7 | 17 | $20.19 | $85.02 |
| Hurricane Creek | 071300120107 | Filter Strip | 79FS | High | 12 | 29 | 30 | $25.56 | $310.02 |
| Hurricane Creek | 071300120107 | Filter Strip | 77FS | High | 5.6 | 14 | 13 | $26.36 | $146.75 |
| Hurricane Creek | 071300120107 | Filter Strip | 359FS | High | 4.7 | 9.2 | 12 | $26.78 | $126.86 |
| Hurricane Creek | 071300120107 | Filter Strip | 370FS | High | 7.5 | 13 | 21 | $27.64 | $206.47 |
| Hurricane Creek | 071300120107 | Filter Strip | 22FS | High | 8.1 | 6.8 | 29 | $34.99 | $283.99 |
| Hurricane Creek | 071300120107 | Filter Strip | 78FS | High | 5.3 | 10 | 16 | $37.68 | $198.41 |
| Hurricane Creek | 071300120107 | Filter Strip | 56FS | High | 14 | 14 | 42 | $42.64 | $609.85 |
| Hurricane Creek | 071300120107 | Filter Strip | 44FS | High | 8.1 | 3.5 | 28 | $54.38 | $441.38 |
| Hurricane Creek | 071300120107 | Filter Strip | 55FS | High | 11 | 12 | 30 | $55.35 | $597.03 |
| Hurricane Creek | 071300120107 | Filter Strip | 43FS | Medium | 3.8 | 1.7 | 14 | $123.95 | $469.97 |
| Hurricane Creek | 071300120107 | Grade Control | 17GC | Very High | 56 | 15 | 29 | $10.72 | $600.00 |
| Hurricane Creek | 071300120107 | Grade Control | 8GC | Medium | 7.4 | 11 | 40 | $282.89 | $2,080.00 |
| Hurricane Creek | 071300120107 | Grade Control | 21GC | Medium | 1.6 | 4.5 | 9.0 | $371.67 | $600.00 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 22GW | Medium | 29 | 64 | 234 | $210.66 | $6,072.31 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 7GW | Medium | 54 | 94 | 832 | $372.68 | $20,241.05 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 18GW | Medium | 13 | 18 | 233 | $507.18 | $6,747.02 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 1GW | Medium | 15 | 22 | 264 | $532.67 | $8,096.42 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 16GW | Medium | 11 | 25 | 135 | $623.77 | $6,747.02 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 26GW | Low | 5.1 | 6.8 | 81 | $1,591.22 | $8,096.42 |
| Hurricane Creek | 071300120107 | Grassed Waterway | 6GW | Low | 6.9 | 12 | 93 | $2,455.97 | $16,867.54 |
| Hurricane Creek | 071300120107 | Pasture Fencing/Crossing | 2FN | Medium | 31 | 28 | 79 | $254.39 | $7,871.84 |
| Hurricane Creek | 071300120107 | Pasture Fencing/Crossing | 1FN | Medium | 27 | 15 | 85 | $289.01 | $7,910.84 |
| Hurricane Creek | 071300120107 | Pasture Fencing/Crossing | 3FN | Medium | 19 | 8.8 | 65 | $322.49 | $6,174.56 |
| Hurricane Creek | 071300120107 | Pasture Fencing/Crossing | 4FN | Low | 6.3 | 0.93 | 13 | $975.44 | $6,126.20 |
| Hurricane Creek | 071300120107 | Pond | 9PND | Medium | 323 | 261 | 1,829 | $123.71 | $40,000.00 |
| Hurricane Creek | 071300120107 | Pond | 36PND | Medium | 237 | 372 | 1,127 | $169.04 | $40,000.00 |
| Hurricane Creek | 071300120107 | Riffle | 15RIF | Medium | 127 | 207 | 325 | $236.54 | $30,112.00 |
| Hurricane Creek | 071300120107 | Riffle | 19RIF | Medium | 90 | 129 | 320 | $416.11 | $37,640.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Hurricane Creek | 071300120107 | WASCB | 29WASCB | Medium | 13 | 16 | 55 | $210.73 | $2,800.00 |
| Hurricane Creek | 071300120107 | WASCB | 27WASCB | Medium | 11 | 16 | 41 | $267.26 | $2,975.00 |
| Hurricane Creek | 071300120107 | WASCB | 23WASCB | Medium | 19 | 42 | 47 | $296.45 | $5,775.00 |
| Hurricane Creek | 071300120107 | WASCB | 2WASCB | Medium | 17 | 25 | 61 | $330.19 | $5,600.00 |
| Hurricane Creek | 071300120107 | WASCB | 20WASCB | Medium | 12 | 21 | 56 | $519.90 | $6,300.00 |
| Hurricane Creek | 071300120107 | WASCB | 3WASCB | Low | 8.7 | 9.1 | 33 | $722.65 | $6,300.00 |
| Hurricane Creek | 071300120107 | WASCB | 24WASCB | Low | 4.6 | 6.8 | 19 | $1,243.81 | $5,775.00 |
| Hurricane Creek | 071300120107 | WASCB | 14WASCB | Low | 3.1 | 5.2 | 12 | $1,892.28 | $5,950.00 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 64CA | High | 8.2 | 13 | 74 | $25.01 | $203.90 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 413CA | High | 36 | 60 | 298 | $25.97 | $927.38 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 410CA | High | 20 | 31 | 193 | $30.83 | $606.79 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 414CA | High | 8.2 | 13 | 77 | $32.16 | $262.93 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 412CA | High | 4.1 | 6.0 | 43 | $46.47 | $189.13 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 65CA | High | 5.4 | 6.3 | 72 | $52.59 | $283.10 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 411CA | High | 6.1 | 7.6 | 79 | $63.23 | $388.41 |
| Spanish Needle Creek | 071300120109 | Critical Area Planting | 409CA | High | 30 | 40 | 346 | $64.14 | $1,907.58 |
| Spanish Needle Creek | 071300120109 | Detention Basin | 25DET | Low | 33 | 21 | 146 | $1,828.28 | $60,000.00 |
| Spanish Needle Creek | 071300120109 | Field Border | 195FB | Very High | 16 | 29 | 48 | $7.52 | $116.58 |
| Spanish Needle Creek | 071300120109 | Field Border | 196FB | Very High | 14 | 26 | 42 | $8.57 | $119.15 |
| Spanish Needle Creek | 071300120109 | Field Border | 207FB | Very High | 39 | 50 | 151 | $9.70 | $382.78 |
| Spanish Needle Creek | 071300120109 | Field Border | 225FB | Very High | 6.2 | 8.3 | 21 | $9.82 | $60.40 |
| Spanish Needle Creek | 071300120109 | Field Border | 208FB | Very High | 29 | 32 | 110 | $10.26 | $297.46 |
| Spanish Needle Creek | 071300120109 | Field Border | 129FB | Very High | 22 | 52 | 45 | $11.87 | $259.25 |
| Spanish Needle Creek | 071300120109 | Field Border | 226FB | Very High | 12 | 14 | 42 | $12.83 | $148.47 |
| Spanish Needle Creek | 071300120109 | Field Border | 39FB | Very High | 14 | 9.8 | 63 | $13.52 | $193.05 |
| Spanish Needle Creek | 071300120109 | Field Border | 83FB | Very High | 15 | 22 | 48 | $13.74 | $203.05 |
| Spanish Needle Creek | 071300120109 | Field Border | 50FB | Very High | 8.6 | 6.5 | 37 | $13.95 | $119.48 |
| Spanish Needle Creek | 071300120109 | Field Border | 67FB | Very High | 17 | 26 | 61 | $14.00 | $239.29 |
| Spanish Needle Creek | 071300120109 | Field Border | 193FB | Very High | 22 | 13 | 97 | $15.22 | $332.70 |
| Spanish Needle Creek | 071300120109 | Field Border | 137FB | Very High | 9.5 | 17 | 30 | $15.54 | $147.15 |
| Spanish Needle Creek | 071300120109 | Field Border | 212FB | Very High | 15 | 16 | 57 | $16.35 | $243.24 |
| Spanish Needle Creek | 071300120109 | Field Border | 200FB | Very High | 29 | 39 | 110 | $17.82 | $517.51 |
| Spanish Needle Creek | 071300120109 | Field Border | 213FB | Very High | 11 | 11 | 45 | $18.24 | $203.35 |
| Spanish Needle Creek | 071300120109 | Field Border | 130FB | Very High | 5.6 | 11 | 14 | $18.43 | $103.44 |
| Spanish Needle Creek | 071300120109 | Field Border | 239FB | Very High | 69 | 63 | 281 | $18.53 | $1,271.47 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Spanish Needle Creek | 071300120109 | Field Border | 172FB | Very High | 28 | 38 | 102 | $19.17 | $530.10 |
| Spanish Needle Creek | 071300120109 | Field Border | 142FB | Very High | 4.8 | 11 | 12 | $19.25 | $92.01 |
| Spanish Needle Creek | 071300120109 | Field Border | 214FB | Very High | 13 | 9.9 | 55 | $19.72 | $250.52 |
| Spanish Needle Creek | 071300120109 | Field Border | 199FB | Very High | 13 | 21 | 39 | $19.88 | $254.13 |
| Spanish Needle Creek | 071300120109 | Field Border | 85FB | Very High | 20 | 22 | 81 | $21.71 | $436.38 |
| Spanish Needle Creek | 071300120109 | Field Border | 140FB | Very High | 4.6 | 9.1 | 12 | $22.20 | $102.31 |
| Spanish Needle Creek | 071300120109 | Field Border | 173FB | Very High | 10 | 12 | 38 | $23.75 | $244.01 |
| Spanish Needle Creek | 071300120109 | Field Border | 51FB | High | 6.7 | 11 | 23 | $24.47 | $164.07 |
| Spanish Needle Creek | 071300120109 | Field Border | 242FB | High | 7.5 | 10 | 27 | $26.45 | $197.80 |
| Spanish Needle Creek | 071300120109 | Field Border | 228FB | High | 7.9 | 7.4 | 32 | $30.93 | $245.02 |
| Spanish Needle Creek | 071300120109 | Field Border | 198FB | High | 4.8 | 7.9 | 16 | $31.86 | $154.02 |
| Spanish Needle Creek | 071300120109 | Field Border | 139FB | High | 2.8 | 3.3 | 11 | $32.28 | $91.99 |
| Spanish Needle Creek | 071300120109 | Field Border | 49FB | High | 3.7 | 3.5 | 15 | $32.86 | $123.17 |
| Spanish Needle Creek | 071300120109 | Field Border | 123FB | High | 1.9 | 2.4 | 6.6 | $33.04 | $61.58 |
| Spanish Needle Creek | 071300120109 | Field Border | 52FB | High | 4.2 | 4.4 | 16 | $34.62 | $145.77 |
| Spanish Needle Creek | 071300120109 | Field Border | 171FB | High | 4.6 | 5.5 | 19 | $36.94 | $169.43 |
| Spanish Needle Creek | 071300120109 | Field Border | 40FB | High | 10 | 9.0 | 44 | $38.25 | $395.65 |
| Spanish Needle Creek | 071300120109 | Field Border | 36FB | High | 11 | 10 | 47 | $38.84 | $437.93 |
| Spanish Needle Creek | 071300120109 | Field Border | 138FB | High | 2.8 | 5.8 | 7.2 | $38.93 | $108.11 |
| Spanish Needle Creek | 071300120109 | Field Border | 176FB | High | 1.7 | 2.5 | 5.2 | $40.42 | $69.09 |
| Spanish Needle Creek | 071300120109 | Field Border | 82FB | High | 12 | 12 | 48 | $42.76 | $522.78 |
| Spanish Needle Creek | 071300120109 | Field Border | 197FB | High | 11 | 12 | 41 | $43.46 | $472.78 |
| Spanish Needle Creek | 071300120109 | Field Border | 141FB | High | 6.2 | 11 | 17 | $45.78 | $283.04 |
| Spanish Needle Creek | 071300120109 | Field Border | 119FB | High | 1.4 | 2.1 | 4.5 | $50.67 | $69.47 |
| Spanish Needle Creek | 071300120109 | Field Border | 164FB | High | 5.6 | 11 | 16 | $53.47 | $298.51 |
| Spanish Needle Creek | 071300120109 | Field Border | 227FB | High | 3.6 | 2.9 | 15 | $55.83 | $199.72 |
| Spanish Needle Creek | 071300120109 | Field Border | 97FB | High | 4.1 | 3.7 | 16 | $62.73 | $255.48 |
| Spanish Needle Creek | 071300120109 | Field Border | 96FB | High | 3.3 | 2.5 | 17 | $63.81 | $210.44 |
| Spanish Needle Creek | 071300120109 | Field Border | 122FB | High | 1.3 | 2.1 | 4.2 | $63.88 | $85.22 |
| Spanish Needle Creek | 071300120109 | Field Border | 249FB | High | 13 | 21 | 45 | $67.66 | $883.56 |
| Spanish Needle Creek | 071300120109 | Field Border | 121FB | Medium | 2.4 | 2.1 | 7.7 | $110.64 | $260.32 |
| Spanish Needle Creek | 071300120109 | Field Border | 41FB | Medium | 1.9 | 1.3 | 9.0 | $348.04 | $665.23 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 397FS | Very High | 16 | 30 | 39 | $6.09 | $96.85 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 188FS | Very High | 17 | 33 | 41 | $6.63 | $109.89 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 250FS | Very High | 52 | 103 | 136 | $7.09 | $368.50 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Spanish Needle Creek | 071300120109 | Filter Strip | 450FS | Very High | 31 | 34 | 117 | $8.39 | $257.26 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 362FS | Very High | 45 | 102 | 117 | $9.69 | $436.80 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 378FS | Very High | 14 | 30 | 29 | $9.85 | $133.92 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 187FS | Very High | 12 | 24 | 33 | $10.22 | $126.90 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 251FS | Very High | 59 | 108 | 164 | $10.25 | $603.34 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 189FS | Very High | 36 | 64 | 112 | $11.25 | $400.29 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 192FS | Very High | 16 | 22 | 57 | $12.82 | $201.41 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 363FS | Very High | 17 | 17 | 30 | $14.65 | $255.68 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 375FS | Very High | 13 | 33 | 25 | $15.93 | $213.00 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 191FS | Very High | 7.7 | 12 | 25 | $17.88 | $137.92 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 84FS | Very High | 7.4 | 10 | 24 | $20.62 | $152.35 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 377FS | Very High | 9.3 | 21 | 13 | $20.81 | $193.12 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 372FS | Very High | 36 | 62 | 107 | $22.00 | $796.70 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 136FS | Very High | 14 | 23 | 38 | $23.13 | $332.34 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 258FS | High | 15 | 21 | 49 | $25.05 | $368.30 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 190FS | High | 13 | 22 | 41 | $25.55 | $323.63 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 382FS | High | 23 | 40 | 67 | $26.65 | $616.16 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 252FS | High | 7.5 | 16 | 21 | $27.03 | $203.53 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 381FS | High | 5.8 | 9.7 | 17 | $27.96 | $161.07 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 376FS | High | 13 | 16 | 48 | $28.68 | $373.67 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 66FS | High | 7.2 | 14 | 19 | $31.07 | $224.06 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 373FS | High | 15 | 23 | 46 | $31.15 | $458.68 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 416FS | High | 2.2 | 2.4 | 8.5 | $36.21 | $80.46 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 366FS | High | 5.1 | 4.0 | 16 | $46.35 | $236.37 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 364FS | High | 3.1 | 3.6 | 11 | $66.20 | $206.99 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 379FS | High | 3.5 | 1.2 | 17 | $69.45 | $243.74 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 368FS | High | 3.1 | 3.0 | 9.1 | $81.83 | $250.06 |
| Spanish Needle Creek | 071300120109 | Filter Strip | 365FS | Medium | 1.0 | 1.3 | 5.6 | $121.51 | $126.59 |
| Spanish Needle Creek | 071300120109 | Grade Control | 126GC | High | 44 | 113 | 92 | $41.05 | $1,800.00 |
| Spanish Needle Creek | 071300120109 | Grade Control | 61GC | High | 13 | 4.1 | 7.2 | $45.92 | $600.00 |
| Spanish Needle Creek | 071300120109 | Grade Control | 225GC | Medium | 3.5 | 8.0 | 9.9 | $172.34 | $600.00 |
| Spanish Needle Creek | 071300120109 | Grade Control | 258GC | Medium | 9.7 | 25 | 13 | $248.13 | $2,400.00 |
| Spanish Needle Creek | 071300120109 | Grade Control | 323GC | Medium | 6.0 | 19 | 19 | $300.41 | $1,800.00 |
| Spanish Needle Creek | 071300120109 | Grade Control | 240GC | Low | 2.0 | 5.3 | 2.9 | $1,191.96 | $2,400.00 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 188GW | Medium | 14 | 29 | 101 | $282.39 | $3,973.51 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 4GW | Medium | 26 | 46 | 181 | $494.85 | $12,819.33 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 104GW | Medium | 15 | 31 | 111 | $552.04 | $8,096.42 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 351GW | Medium | 25 | 53 | 287 | $648.87 | $16,192.84 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 274GW | Low | 9.6 | 17 | 97 | $982.39 | $9,445.82 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 243GW | Low | 10 | 24 | 139 | $1,103.95 | $11,469.93 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 182GW | Low | 9.3 | 17 | 112 | $1,158.45 | $10,795.22 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 242GW | Low | 4.0 | 6.9 | 41 | $1,337.18 | $5,397.61 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 5GW | Low | 3.3 | 4.9 | 30 | $2,067.29 | $6,747.02 |
| Spanish Needle Creek | 071300120109 | Grassed Waterway | 12GW | Low | 1.8 | 3.8 | 12 | $2,265.12 | $4,048.21 |
| Spanish Needle Creek | 071300120109 | Pond | 196PND | Medium | 432 | 633 | 1,790 | $185.36 | $80,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 92PND | Medium | 209 | 526 | 268 | $191.01 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 190PND | Medium | 174 | 81 | 837 | $229.44 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 261PND | Medium | 173 | 229 | 733 | $231.64 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 94PND | Medium | 167 | 179 | 448 | $239.61 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 322PND | Medium | 219 | 334 | 2,009 | $365.66 | $80,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 120PND | Medium | 109 | 161 | 884 | $368.49 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 259PND | Medium | 94 | 141 | 395 | $425.07 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 122PND | Medium | 80 | 141 | 406 | $500.03 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 260PND | Medium | 72 | 88 | 505 | $558.77 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 244PND | Medium | 62 | 122 | 268 | $645.90 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 146PND | Medium | 60 | 68 | 299 | $665.91 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 149PND | Medium | 59 | 78 | 240 | $675.09 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 121PND | Low | 57 | 83 | 331 | $700.10 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 275PND | Low | 56 | 26 | 318 | $709.00 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 195PND | Low | 47 | 20 | 61 | $843.22 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 60PND | Low | 45 | 72 | 114 | $884.85 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 181PND | Low | 39 | 47 | 259 | $1,022.34 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 65PND | Low | 39 | 47 | 103 | $1,034.54 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 100PND | Low | 36 | 69 | 177 | $1,107.52 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 194PND | Low | 33 | 60 | 156 | $1,210.71 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 193PND | Low | 29 | 13 | 51 | $1,400.29 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 125PND | Low | 27 | 54 | 113 | $1,460.38 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 184PND | Low | 24 | 32 | 121 | $1,644.73 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 153PND | Low | 21 | 48 | 47 | $1,933.75 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 95PND | Low | 19 | 47 | 53 | $2,119.17 | $40,000.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Spanish Needle Creek | 071300120109 | Pond | 152PND | Low | 18 | 39 | 39 | $2,188.61 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 241PND | Low | 17 | 20 | 107 | $2,321.29 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 180PND | Low | 14 | 17 | 82 | $2,776.20 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 10PND | Low | 6.9 | 1.4 | 23 | $5,799.64 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 67PND | Low | 4.2 | 6.7 | 17 | $9,424.18 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 90PND | Low | 3.7 | 3.3 | 11 | $10,879.69 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | Pond | 66PND | Low | 1.7 | 1.6 | 6.4 | $23,714.03 | $40,000.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 183WASCB | Medium | 12 | 20 | 36 | $229.13 | $2,712.50 |
| Spanish Needle Creek | 071300120109 | WASCB | 97WASCB | Medium | 9.0 | 2.2 | 5.5 | $291.50 | $2,625.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 30WASCB | Medium | 15 | 15 | 63 | $377.50 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 96WASCB | Medium | 4.9 | 7.4 | 19 | $499.89 | $2,450.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 99WASCB | Medium | 9.5 | 12 | 23 | $589.57 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 101WASCB | Medium | 4.7 | 8.1 | 14 | $591.81 | $2,800.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 148WASCB | Medium | 11 | 16 | 39 | $629.17 | $7,000.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 273WASCB | Medium | 9.2 | 11 | 40 | $682.54 | $6,300.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 187WASCB | Low | 12 | 21 | 42 | $761.07 | $9,100.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 84WASCB | Low | 7.3 | 10 | 27 | $762.96 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 223WASCB | Low | 7.4 | 13 | 23 | $851.62 | $6,300.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 102WASCB | Low | 3.1 | 5.3 | 9.3 | $907.99 | $2,800.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 150WASCB | Low | 6.0 | 8.3 | 25 | $994.30 | $5,950.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 147WASCB | Low | 14 | 20 | 47 | $1,087.12 | $14,700.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 189WASCB | Low | 2.4 | 2.5 | 8.8 | $1,160.90 | $2,800.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 186WASCB | Low | 4.9 | 8.3 | 18 | $1,184.62 | $5,845.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 64WASCB | Low | 2.3 | 3.6 | 8.2 | $1,202.91 | $2,800.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 296WASCB | Low | 2.3 | 2.1 | 15 | $1,297.37 | $2,975.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 98WASCB | Low | 4.1 | 3.6 | 10 | $1,323.08 | $5,425.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 93WASCB | Low | 4.1 | 6.2 | 15 | $1,359.64 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 185WASCB | Low | 3.4 | 5.8 | 12 | $1,734.34 | $5,845.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 103WASCB | Low | 2.8 | 4.3 | 9.6 | $2,010.87 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 11WASCB | Low | 2.5 | 3.2 | 9.4 | $2,340.57 | $5,950.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 91WASCB | Low | 1.1 | 1.5 | 5.0 | $2,610.36 | $2,875.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 145WASCB | Low | 2.1 | 2.5 | 6.9 | $2,727.84 | $5,600.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 238WASCB | Low | 0.73 | 0.69 | 1.6 | $3,238.54 | $2,362.50 |
| Spanish Needle Creek | 071300120109 | WASCB | 172WASCB | Low | 0.65 | 1.5 | 0.97 | $4,050.28 | $2,625.00 |
| Spanish Needle Creek | 071300120109 | WASCB | 41WASCB | Low | 1.4 | 1.5 | 5.6 | $6,362.43 | $8,750.00 |

| Subwatershed | HUC12 | BMP Type | BMP ID | Priority Rank | Phosphorus Reduction (lbs/yr) | Sediment Reduction (tons/yr) | Nitrogen Reduction (lbs/yr) | Cost-Per-Pound of Phosphorus Reduction (USD/lb/yr) | Total Cost (USD) |
|---|---|---|---|---|---|---|---|---|---|
| Spanish Needle Creek | 071300120109 | WASCB | 42WASCB | Low | 0.69 | 0.65 | 2.6 | $7,869.72 | $5,425.00 |
| Spanish Needle Creek | 071300120109 | Wetland Creation | 239WTLND | Medium | 60 | 33 | 411 | $140.90 | $8,496.00 |
| Spanish Needle Creek | 071300120109 | Wetland Creation | 35WTLND | Medium | 36 | 40 | 337 | $593.05 | $21,240.00 |