Embarras River Watershed
MANAGEMENT PLAN

Prepared by:

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Coles County Soil & Water Conservation District — Rich in Lincoln Lore

Illinois Extension
University of Illinois Urbana-Champaign

Illinois Farm Bureau — Farm. Family. Food.™

Champaign, Clark, Coles, Crawford, Cumberland, Douglas, Edgar, Effingham, Jasper, Lawrence, Richland and Vermilion Counties

Illinois FINAL
Dec. 2022

Illinois Environmental Protection Agency

Funding for this project provided, in part, by the Illinois Environmental Protection Agency through Section 319 of the Clean Water Act

Acknowledgments

Financial Contributors:
Champaign County Soil and Water Conservation District
City of Charleston
City of Newton
Clark County Board
Clark County Farm Bureau
Clark County Soil and Water Conservation District
Claybrook Acres, LTD
Claybrook Excavating, LLC
Coles County Soil and Water Conservation District
Crawford County Soil and Water Conservation District
Cumberland County Board
Cumberland County Soil and Water Conservation District
Douglas County Soil and Water Conservation District
Edgar County Soil and Water Conservation District
EJ Water Cooperative
Illinois Farm Bureau
Jasper County Board
Jasper County Farm Bureau
Jasper County Soil and Water Conservation District
Lawrence County Soil and Water Conservation District
North Fork Conservancy District
Richland County Soil and Water Conservation District
Village of Greenup
Village of Toledo

Letters of Support:
Brad Halbrook, State Representative, 102nd District
Champaign County Farm Bureau
Chapin Rose, State Senator, 51st District
Chris Miller, State Representative, 110th District
Coles County Farm Bureau
Crawford County Farm Bureau
Cumberland County Farm Bureau
Dale Righter, State Senator, 55th District
Douglas County Farm Bureau
Edgar County Farm Bureau
Tammy Duckworth, US Senator
John Shimkus, Member of Congress
Lawrence County Farm Bureau
Richland County Farm Bureau
Rodney Davis, Member of Congress
Vermilion County Farm Bureau

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Section 1 – Executive Summary

The Embarras River is in southeast Illinois and has its origins on the University of Illinois campus in the City of Champaign. The river flows generally south through primarily rural and agricultural land for approximately 189.5 miles until it converges with the Wabash River in Lawrence County. The watershed consists of approximately 1,558,063 acres (2,435 square miles) of mixed land use and encompasses portions of Champaign, Clark, Coles, Crawford, Cumberland, Douglas, Edgar, Effingham, Jasper, Lawrence, Richland, and Vermilion Counties.

In 1996, the now dissolved non-profit Embarras River Management Association (ERMA), in conjunction with many partner agencies, developed a comprehensive Embarras River Basin Resource Management Plan. This plan provided long-term solutions to the existing resource concerns, and guided the group's work to preserve and restore the natural character and resources of the watershed region. In 2009, ERMA, with support from the City of Charleston, began work on a new, updated plan that was finalized in 2011.

The Coles County Soil and Water Conservation District (SWCD) then took an active leadership role in 2020 to begin developing a watershed plan for the Embarras River watershed. Working in conjunction with the University of Illinois Extension and other partners, the SWCD received funding from the Illinois Environmental Protection Agency (Illinois EPA) to develop the plan.

A Watershed Management Plan (WMP), funded by the Illinois EPA, is required to meet nine minimum elements to ensure that the projects make progress towards restoring waters impaired by nonpoint source (NPS) pollution. This updated plan incorporates a substantial amount of information from the 2011 plan and the required nine minimum elements.

The Embarras River WMP is intended as a guide for the protection and enhancement of the environment and quality of the watershed, while balancing the different uses and demands of the community on this natural resource. This updated plan will address items such as:

- Education and outreach.
- Increasing preservation, restoration, and protection of this vital system.
- Increasing cooperation, coordination, and collaboration among all stakeholders in the watershed.
- Maintaining a solid organization to look to the welfare of this important natural resource.

The WMP follows the Illinois EPA requirements for watershed management plans, including sections on: watershed inventory, pollutant load analysis, watershed impairment and problem identification, source identification, priority watershed areas, setting goals and indicator selection for performance assessment, calculating load reductions, implementation of planned measures, monitoring indicators, and plan evaluation and adaptation.

Embarras River WMP Highlights

<u>Watershed Inventory</u>

- The watershed inventory is a comprehensive inventory that quantifies, describes, and summarizes available data.

- The watershed is approximately 2,435 square miles and the river flows generally south for approximately 190 miles until it converges with the Wabash River in Lawrence County.
- The Embarras River has several major tributaries, including North Fork Embarras River, Muddy Creek, Brushy Fork, Crooked Creek, Big Creek, and Range Creek, as well as several smaller tributaries, totaling approximately 482 river miles.
- The watershed is generally a rural area and sparsely populated. There are nine primary urban areas with all or portions of their limits located within. The most significant urban area is Charleston, with a population of 21,117 in 2019.
- Overall, the total population within the watershed decreased between the 2010 and 2019 Census by 2.3%. The largest increase was seen in the East Branch – Embarras River Subwatershed at 2.6%; and the largest decrease was seen in the Range Creek – Embarras River Subwatershed at -5.8%.
- With approximately 84% of the watershed covered by agriculture and forest, the Embarras River watershed remains primarily rural and agricultural. The developed areas (approximately 3%) are concentrated inside or on the fringe of established urban areas.
- Illinois Natural Area Inventory Sites (INAI) are natural landscape features and communities of the highest quality still remaining in Illinois. Forty-two INAI sites are located within the watershed.
- The watershed contains 40 Conservation and Recreation Land sites totaling approximately 7,250 acres.
- The surficial geology of the Embarras River drainage basin includes: (1) Illinois-age Glasford Formation in the southern part, and (2) Late Wisconsin-age Wedron Group in the northern part. The Glasford Formation is dominantly composed of glacial till and outwash sand and gravel deposits. Late Wisconsin-age deposits in the basin are composed of glacial tills, lacustrine silts and clays, outwash sand and gravels, and loess.
- Approximately 55% of the basin area is composed of three soil associations. The Catlin-Flanagan-Drummer series is prevalent in the northern portion of the watershed, while the Hoyleton-Cisne-Huey and Ava-Bluford-Wynoose series are predominantly found in the southern portion of the watershed.
- Within the Embarras River Watershed, all hydrologic soil groups can be found, however, the majority fall within group B (45%).
- A total of approximately 78,822 acres, or 5% of the watershed, is considered highly erodible (HEL) or potentially highly erodible.
- Approximately 664,713 acres, or 43% of the soils in the watershed, are considered hydric.
- The United States Geological Survey (USGS) maintains four active stream gages within the Embarras River. These gages provide real-time data on gage height and discharge, as well as historical daily, monthly, and annual statistics.
- The 100-year floodplain, which is defined as an area inundated by 100-year flooding, comprises 187,849 acres (12% of the watershed). The 500-year floodplain (0.2% chance of annual flooding) comprises only 235 acres (0.02% of the watershed).
- There are 41,252 acres (2.6% of the watershed) of wetlands scattered throughout. Among the three wetland classifications, 1,322 acres are considered lacustrine, 37,647 acres are palustrine, and 2,283 acres are riverine.
- Available biological data from Illinois EPA was obtained and evaluated to determine where water-quality problems were noted in the watershed. Data included macroinvertebrate (bug) and fisheries data, where available.
- Macroinvertebrate data ranged from severely impaired to no impairment.

- A majority of the population within the watershed relies on groundwater for potable water supply. The Embarras River is also used; therefore, the entire contributing watershed of the Embarras River affects the water supply quality.
- According to the Illinois EPA, approximately 245 miles of streams were impaired at the time of the 2018 listing.
- Available water quality data from the USGS, Illinois EPA and others was obtained and evaluated to determine where water-quality problems were noted within the watershed.
- A total of 54 National Pollutant Discharge Elimination System (NPDES) permits (95 discharge points) and 49 landfills are located within the watershed.
- According to the Natural Resources Conservation Service (NRCS) soil data, approximately 98% of the soils are rated as very limited for septic systems. An approximate total of 60,643 septic systems are possible within the watershed.

Pollutant Load Analysis

- Pollutant loading is the sum of point sources and NPSs. Due to the large size and rural nature of the watershed, NPS pollutants are the primary concern.
- Total nitrogen, total phosphorus, and total suspended sediment were identified as the priority pollutants.
- A customized GIS-based model was used to calculate NPS pollutant loads to assess the relative contribution of priority pollutants.
- Total nitrogen NPS loading in the watershed is 16,964,442 lbs/year, averaging 10.9 lbs/acre per year for the entire watershed.
- Total phosphorus NPS loading in the watershed is 2,168,395 lbs/year, averaging 1.4 lbs/acre per year over the entire watershed.
- Total suspended sediment loading is 1,019,369 tons per year, averaging 0.65 tons/acre per year for the entire watershed.
- Fecal coliform bacteria NPS loading in the watershed is 3.115×10^9 coliform units per year. This averages 2.02×10^9 coliform units per acre/year.

Identification of Watershed Impairments and Problems

- The results of the watershed Inventory and analysis of the stakeholder concerns indicate that the group concerns can be described in four general areas: soil, water, wildlife and natural character, and human factors.
- The stakeholder concerns that were identified during the public meetings were prioritized by the planning committee. Seventeen of the concerns were identified as priority resource concerns and are included as part of this WMP.
- Problem statements were developed during the planning process in an effort to link the watershed concerns with existing and historical water quality data and the four major concern categories.
- Flooding Problem Statement: Excessive flow rates and volumes of water are causing damage and loss within the Embarras River Watershed.
- Erosion/Water Quality Problem Statement: Soil erosion and sedimentation within the watershed is degrading the water quality/quantity and limiting the aesthetics, wildlife habitat, and aquatic health of the streams within the watershed. Agriculture and typical urban area practices within the watershed contribute a significant amount of pollutants, thereby contributing to the frequent exceedances of water quality targets.

- Wetland, Wildlife and Natural Character Problem Statement: Impacts to the natural resources of the watershed are degrading the quality and amount of wetlands, wildlife habitat and limiting recreational opportunities.
- Information and Public Communication Problem Statement: Stakeholders in the Embarras River watershed are not knowledgeable about their daily impact on the watershed and its water quality.

Identification of Sources and Priority Areas

- Potential sources were identified for each problem statement based on the information analyzed in the Watershed Inventory.
- The priority areas within the watershed were identified based on the watershed Inventory, the identified problems and the goals of the WMP, GIS analysis and stakeholder input.
- Stakeholder-identified project priority locations: a series of one-on-one meetings were held with selected stakeholders in December of 2009. A total of 68 specific projects were identified. These projects are still relevant and have been carried over from the 2011 plan.
- Priority areas based on pollutant load analysis were identified by utilizing a statistical GIS analysis allowing identification of areas within the watershed that contributed the highest combined load of nitrogen, phosphorus, and sediment collectively.
- Priority areas from the previous plan based on wetland restoration potential: Eastern Illinois University (EIU) performed a detailed soils analysis for the entire watershed to identify ideal locations within the watershed for wetland and bottomland restoration.
- Priority areas identified in 2011 based on fecal coliform loading and septic density: a statistical GIS analysis was applied to identify the highest statistically significant areas in the watershed contributing Fecal Coliform.
- Priority areas identified in 2011 based on hydric soils under agricultural land cover: these areas are important locations for wetland restoration that will reduce flooding problems and pollutant loading.
- Priority areas identified in 2011 based on HEL soils under agricultural or pasture land cover: these areas are important focus areas because project implementation will have the highest bang for the buck and contribute significant load reductions.
- Pasture land near streams identified in 2011: these areas are important areas that can be evaluated for project implementation that would significantly reduce nutrient loading and fecal coliform bacteria loading.
- Smaller subwatershed were identified using data-driven criteria and stakeholder input for more detailed planning as part of the 2020 update. Polecat Creek and The Slough were selected. A schedule of future subwatershed planning is provided in Section 9.
- Partners conducted modeling of potential treatment practices for the West Branch Hurricane Creek and Riley Creek subwatersheds. These areas are also considered priority.

Set Goals and Load Reductions

- Load reduction goals are utilized in the watershed planning process to provide a numeric reference goal for a watershed plan.
- Sediment, nitrogen and phosphorus have recommended reductions based on the Illinois Nutrient Loss Reduction Strategy (INLRS).

- Target load reductions of sediment, nitrogen, phosphorus, and fecal coliform are 45%, 45%, 45%, and 50%, respectively.
- Based on the identified concerns and pollutant loading analysis, goal statements were developed for each priority resource concern category.
- Flooding Goal Statement: Reduce flood damage in the Embarras River watershed.
- Erosion/Water Quality Goal Statement: Protect and improve water quality and erosion in the Embarras River Watershed.
- Wildlife and Natural Character Goal Statement: Protect and enhance natural resources and provide associated recreational opportunities.
- Information and Public Communication Goal Statement: Develop and implement an education and outreach program within the watershed.

Watershed Wide Implementation

- The 2011 watershed planning committee chose eight priority subwatersheds to focus in on due to the large scale of the watershed. Implementation is still needed and encouraged for the entire watershed.
- The selected measures and Best Management Practices (BMP) for improvement are categorized as agricultural/rural and urban, as well as preventative measures.
- Load reduction calculations were estimated for nitrogen, phosphorus and sediment based on the potential BMPs.

Subwatershed Based Implementation Plan

- In 2011, several factors went into selecting priority subwatersheds which include: Level of stakeholder interest and involvement potential, results from watershed inventory, modeling and GIS analysis, and Illinois EPA 303(d) list.
- The 2011 priority subwatersheds included: East Branch Embarras River, Scattering Fork, Deer Creek – Embarras River, Kickapoo Creek, Range Creek – Embarras River, Big Creek, Honey Creek – Embarras River, and Paul Creek – Muddy River.
- A subwatershed inventory, analysis of data, and implementation plan is provided for each 2011 priority subwatershed in Appendix D.
- In 2020, smaller subwatersheds were selected for detailed planning alongside the update to the larger Embarras plan. Polecat Creek and The Slough were selected based on criteria such as pollution loading, existing conservation practices, and stakeholder interest.

Implementation Costs

- Cost estimates are generalized for watershed-scale planning purposes. The estimates also do not account for load reductions from education and outreach and policy/regulation since direct impacts are not easily determined.
- 3-year target loading estimated costs - $148,952,116. The INLRS 2025 long-term target loading estimated costs (total) - $185,799,432. The high costs associated with phosphorus removal are the limiting factor in the estimates.
- Costs of stakeholder-identified projects are estimated at $25,645,241 to $55,645,241.

Implementation Schedule

- An implementation schedule for years 1-10 of the WMP has been provided.

Measuring Success

- Indicators are measurable parameters or criteria which can used to determine the progress being made toward achieving a goal. Indicators were developed for each goal and objective.
- The WMP will be evaluated by assessing the progress made.
- The plan should be evaluated every five years to assess the progress made, as well as to revise the plan, if appropriate, based on the progress achieved. It will also have a comprehensive revision every 10 years.

Financing Resources

- There are numerous financing resources to implement projects.
- A list of funding sources is included in the WMP.

Section 2 – Watershed Community Initiative

A WMP funded through the Illinois EPA funding is required to meet nine minimum elements to ensure that the projects make progress towards restoring waters impaired by NPS pollution. This update incorporates information from the 2011 plan and incorporates the required nine minimum elements.

Although now dissolved, the non-profit Embarras River Management Association (ERMA) was active in the watershed, focusing on restoring the natural character and resources of the basin. The organization operated a number of conservation, education, and research projects and, in 2009, ERMA, in conjunction with many partner agencies, began developing a comprehensive Embarras River Basin Resource Management Plan. Completed in 2011, the plan provided long-term solutions to the existing resource concerns, and guided work to preserve and restore the natural character and resources of the watershed region.

The current planning effort and update incorporates much of the same information from 2011 and at a similar scale. The exception is two more detailed subwatershed plans prepared under the umbrella of the larger Embarras basin. This document addresses the entire Embarras River watershed and has been updated from 2011. More specific and actionable subwatershed plans were completed as separate documents.

Intentions of the Watershed Management Plan

The Embarras River WMP is intended as a guide for the protection and enhancement of the environment and quality of the watershed while balancing the different uses and demands of the community on this natural resource. This plan addresses items such as:

- Education and outreach.
- Increasing preservation, restoration and protection of this vital system.
- Increasing cooperation, coordination and collaboration among all stakeholders in the watershed.
- Maintaining a solid organization to look to the welfare of this important natural resource.

The WMP follows the Illinois EPA requirements for watershed management plans, including sections on: watershed inventory, pollutant load analysis, watershed impairment and problem identification, source identification, priority watershed areas, setting goals and indicator selection for performance assessment, calculating load reductions, implementation of planned measures, monitoring indicators, and plan evaluation and adaptation.

Public input is essential for the sustainability and success of the watershed improvement effort. Stakeholder input was sought and included during all aspects of the planning process. This local input was essential for developing a plan that would have broad appeal throughout the watershed and continued support.

The plan identifies problem areas and suggested improvement measures for both water quality and other concerns identified by stakeholders. The watershed is large and diverse, and thus has a variety of issues and concerns that need to be addressed. To address some of these issues, planning partners and agencies will work with local stakeholder groups to pursue BMPs that will result in the improvement of water quality. Because of the size of the task at hand, this plan will also be used as a platform upon which to pursue additional grants and other funding for the many different improvement measures recommended.

Stakeholder Involvement

Stakeholders include many important partners in conservation. Stakeholders such as SWCDs, County Farm Bureaus (CFBs), County Boards, municipalities, state and federal conservation and natural resource agencies, and local businesses and landowners all played active roles in sharing feedback for the watershed plan.

Meeting fliers and other related information is available in Appendix C.

Planning Process

Plan Development

The working group was directly involved in all aspects of the development of the plan, including input at public meetings, work group meetings, and data collection. The following objectives were established:

- Outreach to stakeholders.
- Develop watershed management partnership with relevant stakeholders.
- Solicit public input on watershed problems and opportunities.
- Formulate project goals and objectives for watershed plan.
- Identify and collect existing studies and other watershed data.
- Synthesize and summarize existing watershed data.
- Collect new data where needed.
- Evaluate and rank Hydrologic Unit Code (HUC) 12 subwatersheds based on data-driven criteria.
- Based on rankings, select two HUC 12 subwatersheds on which to prioritize detailed planning efforts.
- Complete assessment of watershed conditions.
- Identify BMPs and policies appropriate for the priority watersheds.
- Develop an action plan recommending watershed improvement projects and policies.
- Identify potential funding sources for watershed improvements.
- Obtain public official and general public input from review of draft watershed plans.
- Develop implementation schedule and complete final watershed management plans.

In addition to regularly held planning calls among the working group members to perform tasks such as gathering data and ranking subwatersheds, progress toward meeting objectives was accomplished through actions such as watershed-wide planning meetings, subwatershed field days, subwatershed planning meetings, and one-on-one meetings with landowners and watershed stakeholders.

Watershed-Wide Planning Meetings

Starting in January 2020, the working group, 10 CFBs, and 10 SWCDs across the watershed hosted a series of nine planning meetings. The purpose of these preliminary meetings was to update landowners and farmers of the status of the watershed plan and to provide stakeholders with the opportunity to share their resource concerns and interests with the working group. These meetings also served as a mechanism to assist with subwatershed prioritization and selection, allowing the working group to identify landowners and other stakeholders who identified high levels of interest in the planning efforts.

Subwatershed Field Days

With the assistance from the IFB Nutrient Stewardship Grant program, the working group participated in field days in Coles and Richland counties in 2021, in locations near The Slough and Polecat Creek subwatersheds. These field days provided the working group with opportunities to present to local farmers on a variety of topics related to the watershed, including providing watershed planning updates, information about assistance programs for implementing conservation practices, as well as hear from local producers about the practices they have implemented across the watershed. Attendees were also encouraged to share additional observations and feedback for the watershed-wide and subwatershed plans.

Subwatershed Planning Meetings

In January 2022, the working group held additional subwatershed-focused stakeholder meetings for landowners located in The Slough and Polecat Creek subwatersheds. Landowners situated outside of those subwatersheds were, however, still encouraged to attend if they were interested in the process or in providing general watershed feedback. These meetings focused on providing attendees with updates on watershed planning efforts to date, including preliminary findings from watershed resource evaluations and observations. They also allowed landowners to identify targeted areas where they had resource concerns.

One-On-One Landowner Meetings and Agency Input

Following the 2020 working group meetings, the planning team reached out to County SWCDs and NRCS staff to identify priority practices and scheduled field visits with individual landowners to document site-specific projects. These practices are included in section 8.

Previous Stakeholder Project Identification Outreach Workshops

To support the previous plan development, the planning committee identified eight priority subwatersheds to focus on in terms of identifying specific on-the ground implementation opportunities to improve conditions in those subwatersheds.

During the development of the previous plan, one-on-one workshops were held with several counties and municipalities in the priority subwatersheds to identify specific project opportunities based on local knowledge or known issues and impairments. Large, detailed plotted maps showing aerial imagery and parcel ID information were used to facilitate effective discussion. The meetings were held in December of 2009 with the stakeholders shown on Table 2-1. Exhibit 22 on page 116 also illustrates the project locations and additional details. These implementation projects are further detailed in Sections 8 & 9 of this plan. In total, 68 potential projects were identified in this process, 2 which have been implemented and 66 retained from the 2011 plan and are the recommended projects for implementation. A two-stage ditch was constructed in Tuscola and 2,200 feet of shoreline stabilization was completed in Lake Charleston.

Table 2-1: Project Identification Workshops		
Entity	**# Projects Identified**	**Project Types**
Champaign County SWCD/NRCS	16	Runoff control at dairy farm; wetland restoration; filter strips
Coles County SWCD/NRCS	8	Terrace, grassed waterway, streambank stabilization
Douglas County SWCD/NRCS	5	Agricultural BMPs, wetland restoration, streambank stabilization
Jasper County SWCD/NRCS	5	Floodplain easements, streambank stabilization, waste management and runoff BMPs from livestock operations
City of Charleston	7	Shoreline stabilization, runoff control BMPs, wetland restoration
City of Newton	6	Urban runoff BMPs, streambank stabilization, wetland restoration (acquisition)
City of Tuscola	5	Urban runoff control, stream restoration to improve flood issues, flood mitigation
City of Villa Grove	7	Urban runoff control, wetland restoration, stream maintenance to prevent flooding
Crawford County SWCD/NRCS	2	WASCB/Waterway, boat access to reduce erosion
Cumberland County SWCD/NRCS	5	WASCB, grassed waterway, agricultural BMPs, streambank stabilization
Total	**66**	

Top Priority Resource Concerns

The priority resource concerns that were identified during the planning process and plan development are listed in Section 5 with the top 17 listed below. Specific concerns were taken from the stakeholders and later listed in categories to aid understanding of the issues. The information was used to prioritize watershed issues and aid in the planning and implementation process.

Priority Resource Concerns:

- Erosion
- Sedimentation
- Water Quality
- Flooding
- Drainage
- Beaver-related problems
- Log jams
- Wildlife, Recreation Opportunities & Impacts

- Natural Character of River
- Wetlands
- Infrastructure and Bridges
- Communication
- Private Property Rights
- Economic Costs (Funding Solutions)
- Water Usage and Supply
- Land Use and Ownership Changes
- Lack of Education

Section 3 – Watershed Inventory

The watershed inventory quantifies, describes, and summarizes available data and historical planning efforts and research. It is used to determine the current conditions of the watershed and identify any linkages between stakeholder concerns.

Relationship to Other Plans, Studies, & Initiatives

The watershed has been the subject of research, planning, and implementation. This section summarizes those activities and reports to date and their relationship to the current plan. A concerted effort was made to secure all relevant documents/studies and recognize previous initiatives and projects that have helped to generate improvements to water quality and engaged stakeholders. Those relevant to and utilized by this plan are presented in Table 3-1.

Table 3-1: Relevant Plans and Studies

Work Product	Year	Notes/Relevance
Statewide Instream Sediment Monitoring Program for Illinois: Annual Water Report – Water Year 1981	1981	Sediment monitoring report prepared by University of Illinois. Study provided some historical estimates of sediment yield in the Embarras. Used to inform model calibration.
Embarras River Basin Resource Management Plan	1996	The first known plan for the entire basin. Provides context and a baseline for stakeholder goals and objectives, watershed history, trends, and practice recommendations.
Charleston Side Channel Reservoir Total Maximum Daily Load Report	2003	Total phosphorus Total Maximum Daily Load (TMDL). An 87% reduction in phosphorus load is needed for the lake to meet the State's 0.05mg/L phosphorus standard. The TMDL report was used as part of a subwatershed prioritization process.
Wabash River Watershed TMDL Report	2006	Fecal Coliform TMDL for the Wabash Basin. An average 80% reduction in fecal coliform load is needed for the Embarras River to meet the standard. The TMDL report was used as part of a subwatershed prioritization process.
Walnut Point Lake Watershed TMDL Report	2007	Total phosphorus TMDL. An average 72% reduction in phosphorus load is needed for the lake to meet the State's 0.05mg/L phosphorus standard. The TMDL report was used as part of a subwatershed prioritization process.
Lake Oakland Watershed TMDL Report	2008	Total phosphorus TMDL. An 80% reduction in phosphorus load is needed for the lake to meet the State's 0.05mg/L phosphorus standard. The TMDL report was used as part of a subwatershed prioritization process.
Nutrient and Sediment Export from Illinois-Quantification through a Continuous Loadings Network: Preliminary Results through Water Year 2019	2019	Sediment monitoring report prepared by USGS. Study provided some more recent estimates of nutrient and sediment yield in the Embarras. Used for model calibration.

Table 3-1: Relevant Plans and Studies		
Work Product	**Year**	**Notes/Relevance**
Nitrate and Total Phosphorus Loads in Illinois Rivers: Update Through the 2017 Water Year	2019	Report prepared by Gregory McIsaac at the University of Illinois. The purpose of the report was to update estimates and quantify changes in riverine nitrate-N and total phosphorus (TP) loads and yields in Illinois as part of the Illinois Nutrient Loss Reduction Strategy process. Used for model calibration.
Assessing the impacts of climate change on the hydrology, water quality and crop yield in an agricultural watershed in East-Central Illinois	N/A	Research paper summarizing results of a hydrological model for the upper portion of the Embarras. Used for general informational purposes
2019 Embarras River Farm Bureau Sampling	2019	Report synthesizing nutrient sampling and loading across the Embarras. Included historical data and more recent sampling at additional sampling stations. The report was relied on for model calibration and a water quality trend analysis.
Embarras River Watershed Management Plan	2011	Primary foundation for the current plan update. All aspects utilized to inform the 2022 plan.
Trends in Nutrient and Soil Loss in Illinois Rivers, 1978–2017	2020	The USGS study investigated the effects of watershed management on nutrient and soil losses in the State of Illinois during two periods: 1978 to 2017, and 2008 to 2017. Used to inform model calibration.
2015 Illinois Nutrient Loss Reduction Strategy & 2017, 2019, and 2021 Biennial Reports	2015 - 2021	The INLRS guides state efforts to improve water quality at home and downstream by reducing nitrogen and phosphorus levels in our lakes, streams, and rivers. The strategy lays out a comprehensive suite of best management practices for reducing nutrient loads from wastewater treatment plants (WWTPs) and urban and agricultural runoff. It is the key driver of this watershed plan update. The initial strategy and biennial reports were used for model calibration and to inform practice recommendations.

Several key implementation projects have been undertaken in the Embarras following the completion of past watershed plans and funded through the Illinois EPA Section 319 program. Highlights include:

- **1996-2000 North Fork Embarras Watershed Project** - This project protected and improved the water quality of the North Fork Embarras River by reducing NPS pollutants. It included watershed protection, information, and education programs. Upland BMPs installed included 33 grassed waterways, 25 sediment and nutrient retention structures, 3 critical area seedings, 3 water and sediment control basins, 2 terrace systems, and 13 grade stabilization structures. Eight streambank stabilization projects were installed on 2,373 linear feet of bank on the main channel and its tributaries.
- **2002-2007 North Fork Embarras Watershed Project** – Phase 2, 3, and 4. A continuation of the efforts initiated with Section 319 funding under federal fiscal year 1996, this project included 39 acres grassed waterways, 27 sediment basins, 24 water and sediment control basins, 12 ponds, 4 terraces, and 13 grade stabilization

structures. Three streambank stabilization projects were installed on 4,894 linear feet of bank.

- 2004 - ERMA purchased six Rainfall Simulator/Crop Residue Demonstration Units (Simulator) and trailers. The Simulators and trailers were supplied to six county SWCDs that shared the Simulators' use and ownership with six other SWCDs all in the watershed. These simulators were used by the NRCS and SWCD personnel at conservation education field days and tours to demonstrate the value of crop residues in reducing soil erosion and nutrient leaching.
- 2020 – The City of Charleston used an Illinois EPA Section 319 grant and the previous watershed plan to address 2,200 feet of eroding shoreline on the north and south end of Lake Charleston. This project used rock breakwater techniques and achieved annual reductions of 109 lbs of phosphorus, 218 lbs of nitrogen and 109 tons of sediment.
- **2012 Clean Water: Helping Agriculture Protect the Headwaters**. The Champaign County SWCD worked cooperatively with local agribusinesses and producers to minimize soil and nutrients from moving into local streams and drainage ditches through the adoption of strip till and deep placement of fertilizer in crop production. The project covered Champaign County with special emphasis on the Salt Fork Vermilion River, Embarrass River, and the Little Vermilion River segments in the county.
- **2014 City of Tuscola NPS Pollution Reduction Project**. This project constructed 2,700 feet of two-stage drainage ditch along Scattering Fork, a tributary of the Embarras River. The floodplain shelf on the west bank was expanded 30 feet and one acre of bioswale installed along the channel to maximize the impact the floodplain shelf has on the stormwater runoff. A stormwater treatment wetland was constructed outside of the channel at the north end of the project site to trap urban runoff from residential areas. This wetland receives and treats runoff from high flow events in Scattering Fork and tile flow from adjacent crop ground was modified to discharge directly into the wetland prior to reaching the stream.
- **2016 monitoring of Kickapoo Creek**. A stream restoration project was completed on Kickapoo Creek downstream of Mattoon in September 2010 by the Illinois Department of Natural Resources (IDNR). This project investigated the success of the restoration project by looking at the stream habitat and biota. Eastern Illinois University conducted biological surveys on fish and macroinvertebrate populations and the USGS monitored water quality and gauging of the stream to separate the effects of unstable channels from the water quality effects of point sources.

Location and Characteristics of the Embarras River Watershed

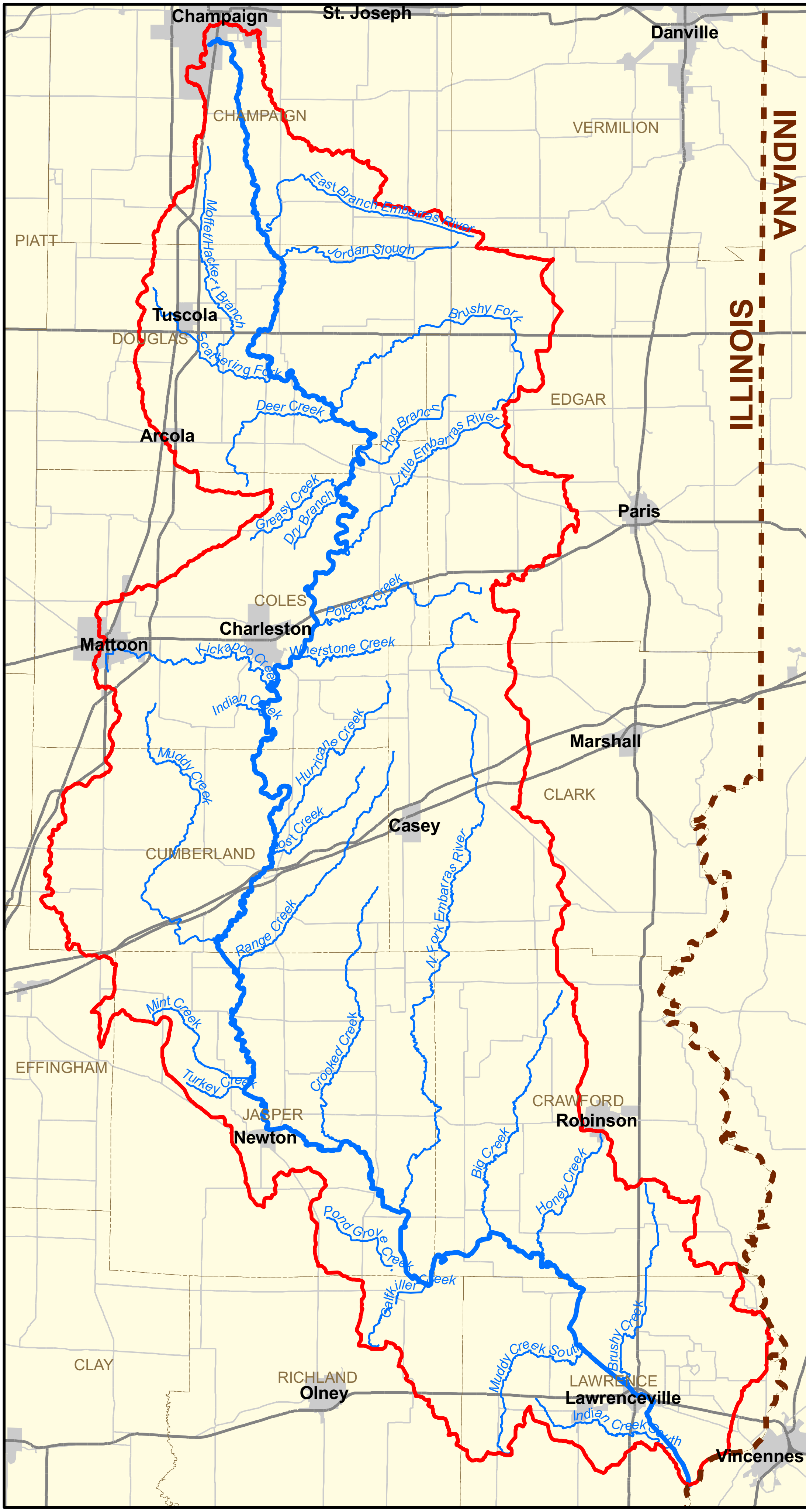
The Embarras River is in southeast Illinois and has its origins on the University of Illinois campus in the City of Champaign. The river flows generally south through primarily rural and agricultural land for approximately 189.5 miles until in converges with the Wabash River in Lawrence County (Exhibit 1). The Embarras River has several major tributaries, including North Fork Embarras River, Muddy Creek, Brushy Fork, Crooked Creek, Big Creek, and Range Creek, as well as several smaller tributaries, totaling approximately 482 river miles.

The watershed consists of approximately 1,558,063 acres (2,435 square miles) of mixed land use and encompasses portions of Champaign, Clark, Coles, Crawford, Cumberland, Douglas, Edgar, Effingham, Jasper, Lawrence, Richland, and Vermilion Counties. The distribution of watershed area within each county is shown in Table 3-2.

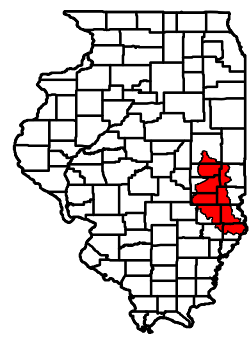
Table 3-2: Counties Within the Watershed		
County	**Acres**	**Percentage**
Champaign	92,795	6.0%
Clark	137,073	8.8%
Coles	225,678	14.5%
Crawford	179,956	11.6%
Cumberland	200,438	12.9%
Douglas	192,595	12.4%
Edgar	123,745	7.9%
Effingham	2,247	0.1%
Jasper	215,774	13.9%
Lawrence	152,522	9.8%
Richland	33,603	2.2%
Vermilion	1,637	0.1%
Total	1,558,063	100.2%*
*Note – Percent totals do not add to 100% due to rounding		

Hydrologic unit codes were developed by the USGS in cooperation with the United States Water Resource Council (USWRC) and USDA-NRCS. Most federal and state agencies use this coding system. Hydrologic unit codes, or HUCs, are a way of cataloguing portions of the landscape according to their drainage. Landscape units are nested within each other and described as successively smaller units.

Exhibit 1



Embarras River Watershed



Town	Popoulation (2000)
Arcola	2,634
Casey	3,154
Champaign	123,669
Charleston	20,899
Lawrenceville	7,802
Mattoon	19,105
Newton	3,110
Robinson	8,297
Tuscola	4,482

Legend

Urban Area
Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed

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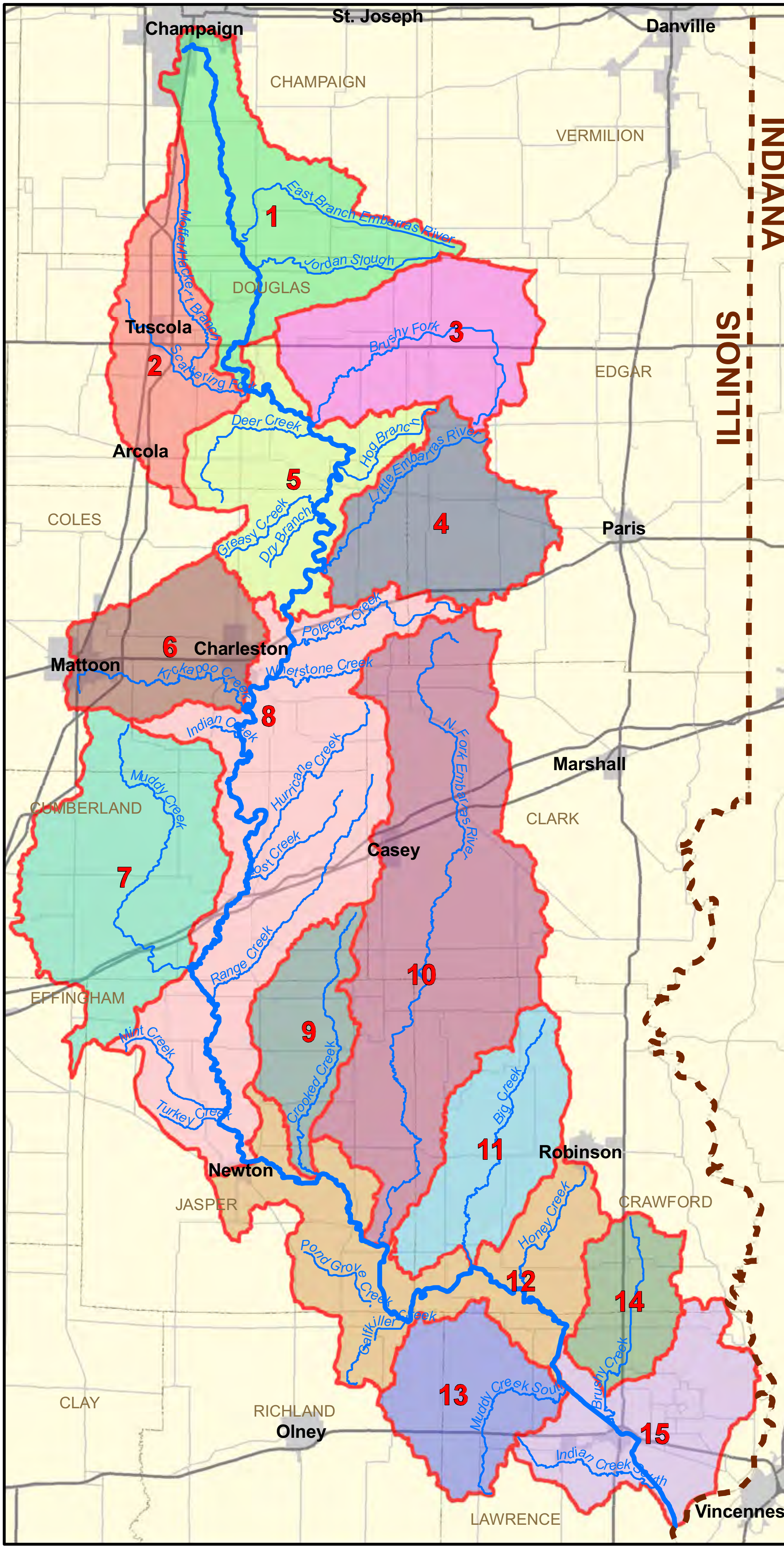
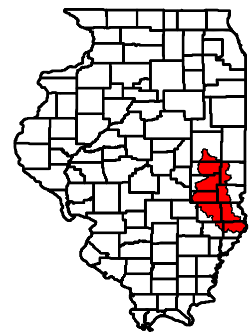
Exhibit 2

Embarras River Watershed

Subwatershed Location Map





Sub-watershed #	Subwatershed Name	Acres
1	East Branch Embarras River	122,219
2	Scattering Fork	69,875
3	Brushy Fork	94,410
4	Little Embarras River	83,744
5	Deer Creek-Embarras River	94,017
6	Kickapoo Creek	65,461
7	Muddy Creek	135,559
8	Range Creek-Embarras River	222,342
9	East Crooked Creek	49,974
10	North Fork Embarras River	229,692
11	Big Creek	72,143
12	Honey Creek-Embarras River	130,554
13	Paul Creek-Muddy River	63,468
14	Brushy Creek	41,508
15	Indian Creek-Embarras River	83,097

Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds

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The hydrologic code attached to a specific watershed is unique, enabling different agencies to have common terms of reference and agree on boundaries. This fosters understanding of how landscapes function, where water quality problems should be addressed, and who needs to be involved in the planning process.

The Embarras River Watershed is an 8-digit HUC watershed (05120112) and consists of fifteen 10-digit HUCs (Table 3-3, Exhibit 2). It should be noted that the Charleston Side Channel Reservoir is located within the Range Creek – Embarras River subwatershed. The drainage area to the reservoir was included as a high priority subwatershed in the 2011 plan (Appendix D); however, information in the watershed inventory refers to the entire subwatershed of Range Creek – Embarras River.

Table 3-3: Subwatersheds

Number	HUC Code	Name	Acres	Percentage
1	0512011201	East Branch Embarras River	122,219	7.8%
2	0512011202	Scattering Fork	69,875	4.5%
3	0512011203	Brushy Fork	94,410	6.1%
4	0512011204	Little Embarras River	83,744	5.4%
5	0512011205	Deer Creek-Embarras River	94,017	6%
6	0512011206	Kickapoo Creek	65,461	4.2%
7	0512011207	Muddy Creek	135,559	8.7%
8	0512011208	Range Creek-Embarras River	222,342	14.3%
9	0512011209	East Crooked Creek	49,974	3.2%
10	0512011210	North Fork Embarras River	229,692	14.7%
11	0512011211	Big Creek	72,143	4.6%
12	0512011212	Honey Creek-Embarras River	130,554	8.4%
13	0512011213	Paul Creek-Muddy River	63,468	4.1%
14	0512011214	Brushy Creek	41,508	2.7%
15	0512011215	Indian Creek-Embarras River	83,097	5.3%
Total			**1,558,063**	**100%**

Population Characteristics

Human Geography and Economy

There is a direct correlation between the number and location of people living within the watershed and impacts to water quality. The watershed is generally a rural area and sparsely populated. There are nine primary urban areas with all, or portions of, their limits located within the watershed (Table 3-4, Exhibit 1). The table includes population information for the entire urban area and is not limited to only those living within the watershed boundaries. Data was obtained from the United States Census Bureau. The most significant urban area located entirely within the watershed is Charleston, with a population of 20,117 in 2019, which is located adjacent to the Embarras River.

Table 3-4: Urban Areas Within the Watershed		
Urban Area	**Population in 2019**	**Percent Change from 2010**
Arcola	2,731	-11%
Casey	2,620	-5.4%
Champaign	88,909	+5.4%
Charleston	21,117	-7.9%
Lawrenceville	4,165	-4.2%
Mattoon	17,615	-5.1%
Newton	2,810	-1.4%
Robinson	7,341	-4.9%
Tuscola	4,564	-13%

With over 77% of the land within the watershed devoted to agriculture (cultivated crops and pasture), it plays a major role in the economy. Information from the 2007 and 2017 Census of Agriculture was analyzed to determine the average size of each farm and the economic value of agricultural production (Tables 3-5 and 3-6). Information was only available on a county-wide scale; therefore, this analysis pertains to the entire county and not only the portions located within the watershed.

Table 3-5: Average Farm Size									
County	**Number of Farms**			**Total Farm Acreage**			**Average Acreage/Farm**		
	2007	**2017**	**% Chg**	**2007**	**2017**	**% Chg**	**2007**	**2017**	**% Chg**
Champaign	1,389	1,214	-12.6%	550,481	582,689	5.9%	396.3	480	21.1%
Clark	588	733	24.7%	238,706	261,080	9.4%	406	356.2	-12.3%
Coles	729	701	-3.8%	254,869	236,864	-7.1%	349.6	337.9	-3.3%
Crawford	615	566	-8%	205,356	219,649	7%	333.9	388.1	16.2%
Cumberland	654	724	10.7%	144,981	171,760	18.5%	221.7	237.2	7%
Douglas	657	600	-8.7%	261,513	244,832	-6.4%	398	408.1	2.5%
Edgar	670	637	-4.9%	352,535	318,164	-9.7%	526.2	499.5	-5.1%
Effingham	1,150	1,193	3.7%	242,009	299,389	23.7%	210.4	251	19.3%
Jasper	882	913	3.5%	243,451	249,617	2.5%	276	273.4	-0.9%
Lawrence	421	426	1.2%	194,035	224,949	15.9%	460.9	528	14.6%
Richland	579	596	2.9%	202,860	178,481	-12%	350.4	299.5	-14.5%
Vermilion	1,014	1,049	3.5%	457,375	471,468	3.1%	451.1	449.4	-0.4%
Total	**9,348**	**9,352**	**0.04%**	**3,348,171**	**3,458,942**	**3.3%**	**358.2**	**369.9**	**3.3%**

Table 3-6: Average Agricultural Production Value									
County	Number of Farms			Total Value of Agriculture Production			Average Production/Farm		
	2007	2017	% Chg	2007	2017	% Chg	2007	2017	% Chg
Champaign	1,389	1,214	-12.6%	$311,463,000	$375,550,000	20.6%	$224,265	$309,349	37.9%
Clark	588	733	24.7%	$103,451,000	$163,310,000	57.9%	$175,937	$222,797	26.6%
Coles	729	701	-3.8%	$123,862,000	$133,942,000	8.1%	$169,907	$191,073	12.5%
Crawford	615	566	-8%	$74,665,000	$108,442,000	45.2%	$121,407	$191,594	57.8%
Cumberland	654	724	10.7%	$71,817,000	$120,625,000	68.0%	$109,812	$166,609	51.7%
Douglas	657	600	-8.7%	$133,949,000	$159,533,000	19.1%	$203,880	$265,888	30.4%
Edgar	670	637	-4.9%	$189,946,000	$223,816,000	17.8%	$283,501	$351,359	23.9%
Effingham	1,150	1,193	3.7%	$127,316,000	$195,062,000	53.2%	$110,710	$163,505	47.7%
Jasper	882	913	3.5%	$112,946,000	$165,883,000	46.9%	$128,057	$181,690	41.9%
Lawrence	421	426	1.2%	$90,058,000	$156,360,000	73.6%	$213,914	$367,042	71.6%
Richland	579	596	2.9%	$82,821,000	$119,796,000	44.6%	$143,041	$201,000	40.5%
Vermilion	1,014	1,049	3.5%	$223,968,000	$283,001,000	26.4%	$220,876	$269,782	22.1%
Total	**9,348**	**9,352**	**0.04%**	**$1,646,262,000**	**$2,205,320,000**	**34%**	**$176,108**	**$235,813**	**33.9%**

Between 2007 and 2017, the total land devoted to agricultural production in the twelve counties increased by approximately 3%. Even with this increase in acreage, the number of farms stayed the same and the total value of the agricultural production increased by approximately 34% in the same timeframe.

Population Trends

As discussed previously, the Embarras River Watershed is considered a rural area and is relatively sparsely populated. Census information from 2010 and 2019 was analyzed to determine population trends. Table 3-7 shows the changes in population for each subwatershed. The analysis was completed at the county census tract level and only accounts for the portion of the tract located within the watershed.

Table 3-7: Population Trends				
Number	Subwatershed	2010 Population	2019 Population	Percent Change
1	East Branch Embarras River	25,197	25,852	2.6%
2	Scattering Fork	9,579	9,666	1%
3	Brushy Fork	1,671	1,678	0.4%
4	Little Embarras River	1,910	1,816	-4.9%
5	Deer Creek- Embarras River	2,470	2,475	0.2%
6	Kickapoo Creek	30,194	28,914	-4.2%
7	Muddy Creek	6,798	6,652	2.1%
8	Range Creek- Embarras River	15,688	14,783	-5.8%
9	East Crooked Creek	1,275	1,284	0.7%
10	North Fork Embarras River	9,509	9,393	-1.2%
11	Big Creek	3,773	3,578	-5.2%
12	Honey Creek- Embarras River	6,918	6,524	-5.7%
13	Paul Creek- Muddy River	2,086	2,042	-2.1%
14	Brushy Creek	1,128	1,129	0.01%
15	Indian Creek- Embarras River	9,821	9,349	-4.8%
Total		**128,016**	**125,135**	**-2.3%**

Overall, the total population within the watershed decreased between 2010 and 2019 by 2.3%. The largest increase was seen in the East Branch – Embarras River subwatershed at 2.6% and likely a result of population from the City of Champaign. The largest decrease was seen in the Range Creek – Embarras River subwatershed at -5.8%.

Land Cover

Land Cover and Pre-Settlement Vegetation

The Embarras River Watershed consists of approximately 1,558,908 acres of mixed land use, according to the 2016 National Land Cover Dataset (NLCD), (Exhibit 3; Table 3-7). Table 3-8 and Exhibit 3 illustrate the distribution of land cover.

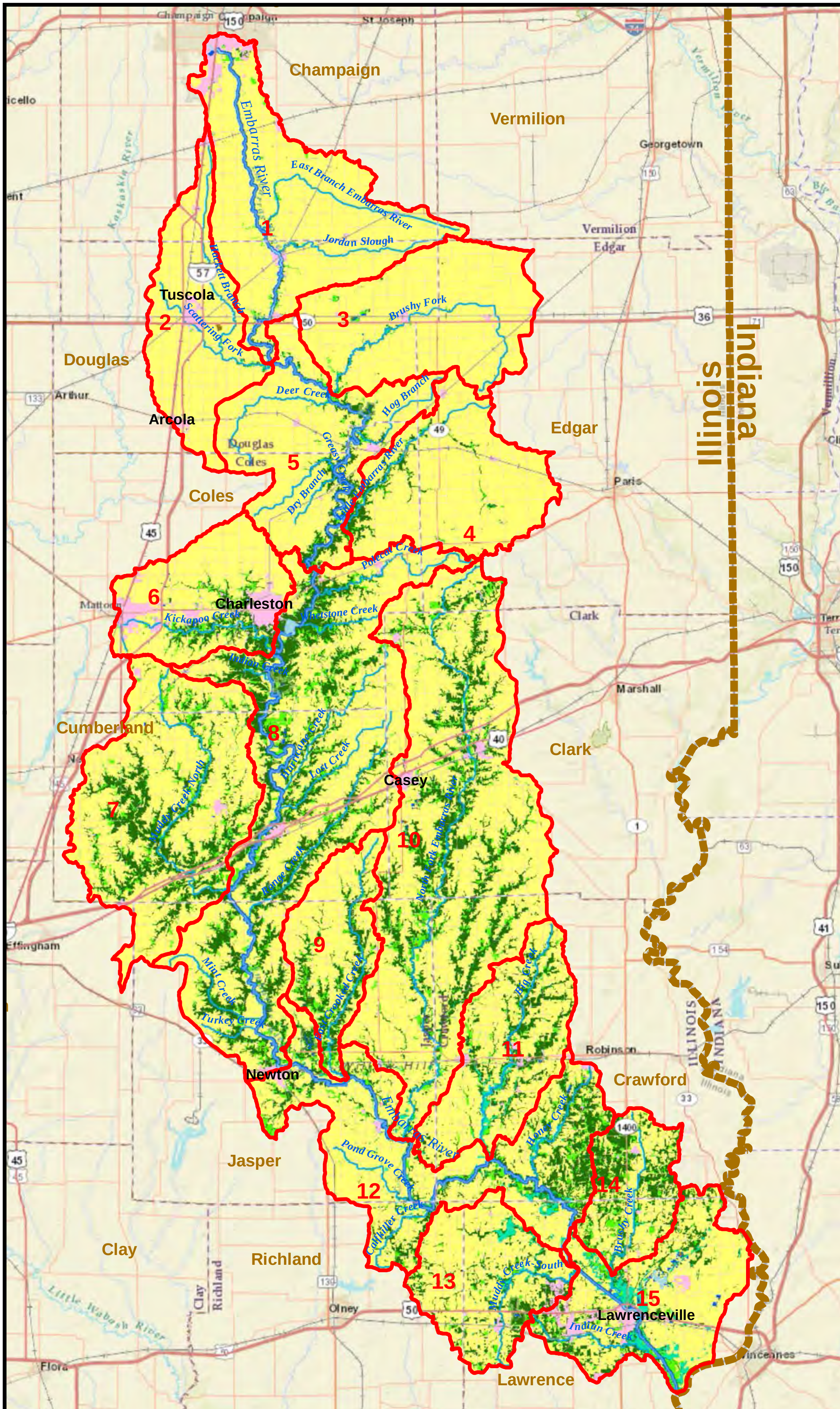
Table 3-8: Watershed Land Cover

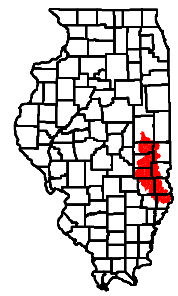
Land Cover Classification	Acres	Percentage
Cultivated Crops	1,142,782	73%
Deciduous Forest	169,256	11%
Open Space	65,310	4.2%
Hay/Pasture	62,591	4%
Mixed Forest	45,849	2.9%
Developed	41,616	2.7%
Woody Wetlands	18,105	1.2%
Open Water	6,515	0.4%
Herbaceous	3,859	0.2%
Barren Land	1,498	0.1%
Emergent Herbaceous Wetlands	1,290	0.08%
Shrub/Scrub	237	0.02%
Total	**1,558,908**	**100%**

Exhibit 3

Embarras River Watershed

Landcover Map





Legend

- Embarras River
- Embarras RIver Tributaries
- Embarras River Watershed & Subwatersheds
- Counties

Landcover

- Agricultural
- Barren Land
- Developed
- Forest
- Grasslands
- Open Water
- Wetlands

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With approximately 88% of the watershed covered by agriculture and forest, the Embarras still remains primarily rural and agricultural. The developed areas (approximately 7%) are concentrated inside or on the fringe of established urban areas.

Out of the 15 subwatersheds included within the Embarras River basin (Table 3-9), Kickapoo Creek has the highest percentage of developed land (13%) associated with the cities of Mattoon and Charleston, while East Crooked Creek subwatershed had the lowest percentage (0.81%). The highest percentage of agricultural land among all the subwatersheds was Brushy Fork with 93% compared to the Brushy Creek subwatershed which had the lowest at 55%.

Table 3-9: Watershed Land Cover by Subwatershed

Number	Subwatershed	Agricul-tural	Barren	Developed	Forest	Grassland / Pasture / Open Space	Open Water	Wetlands
1	East Branch Embarras River	87%	0.002%	5.4%	1.7%	5.5%	0.06%	0.68%
2	Scattering Fork	89%	0.14%	6.9%	0.5%	3.5%	0.2%	0.16%
3	Brushy Fork	93%	0.02%	1.7%	1.1%	3.9%	0.1%	0.47%
4	Little Embarras River	88%	0.01%	1.2%	5.8%	4.7%	0.04%	0.12%
5	Deer Creek-Embarras River	82%	0.03%	1.7%	11%	5.1%	0.21%	1.3%
6	Kickapoo Creek	67%	0.04%	13%	10%	10%	0.25%	0.14%
7	Muddy Creek	70%	0.03%	1.1%	20%	10%	0.14%	0.15%
8	Range Creek-Embarras River	62%	0.11%	2%	25%	11%	0.84%	0.47%
9	East Crooked Creek	70%	0.11%	0.81%	20%	10%	0.13%	0.43%
10	North Fork Embarras River	71%	0.15%	1.7%	19%	9.4%	0.24%	0.48%
11	Big Creek	71%	0.16%	1.4%	20%	8.3%	0.27%	2.9%
12	Honey Creek-Embarras River	67%	0.12%	1.5%	22%	9.7%	1.1%	2.9%
13	Paul Creek- Muddy River	74%	0.07%	1.2%	18%	8.4%	0.24%	2.8%
14	Brushy Creek	55%	0.23%	1%	33%	12%	0.19%	1.1%
15	Indian Creek-Embarras River	63%	0.25%	3.9%	20%	12%	1.5%	7.2%

Knowledge of pre-settlement conditions in a watershed is useful for interpreting the past and identifying appropriate restoration activities that can mimic historical landscape characteristics. During the establishment of the Public Land Survey System (PLSS) in Illinois (1804 through 1843), the surveyors were required to keep field notebooks with details about the survey and landscape. In the 1850s, these notebooks, along with the original maps, were compiled by the General Land Office (GLO) to create a more complete map of each township surveyed. The Illinois Natural History Survey used these maps to create the Early 1800's Land Cover Map which can be used as a guide to the pre-settlement vegetation. Table 3-10 and Exhibit 4 illustrate the distribution of pre-settlement vegetation.

Table 3-10: Watershed Pre-Settlement Vegetation		
Classification	**Acres**	**Percentage**
Prairie	873,010	56%
Forest	655,520	42%
Water	19,041	1.2%
Bottomland	6,665	0.4%
Swamp	2,320	0.1%
Barrens	1,127	0.07%
Other Wetland	401	0.03%
Wet Prairie	319	0.02%
Marsh	304	0.02%
Cultural	107	0.01%
Topo/geo	62	0.004%
Slough	31	0.002%
Total	**1,558,908**	**100%**

Prior to European settlement in the 1830s, the Embarras River watershed was predominantly comprised of prairie and forest lands. These forests, largely oak/hickory species, were found in the central and southern parts of the watershed with a majority along the tributaries of the Embarras River.

Significant Natural Areas

Illinois Natural Area Inventory Sites (INAI) are natural landscape features and communities of the highest quality still remaining in Illinois. In most cases, these sites are also where State and/or Federally listed Threatened and Endangered species have been found. As of 2021, there are 42 of these species found in the watershed. Table 3-11 summarizes the INAI sites.

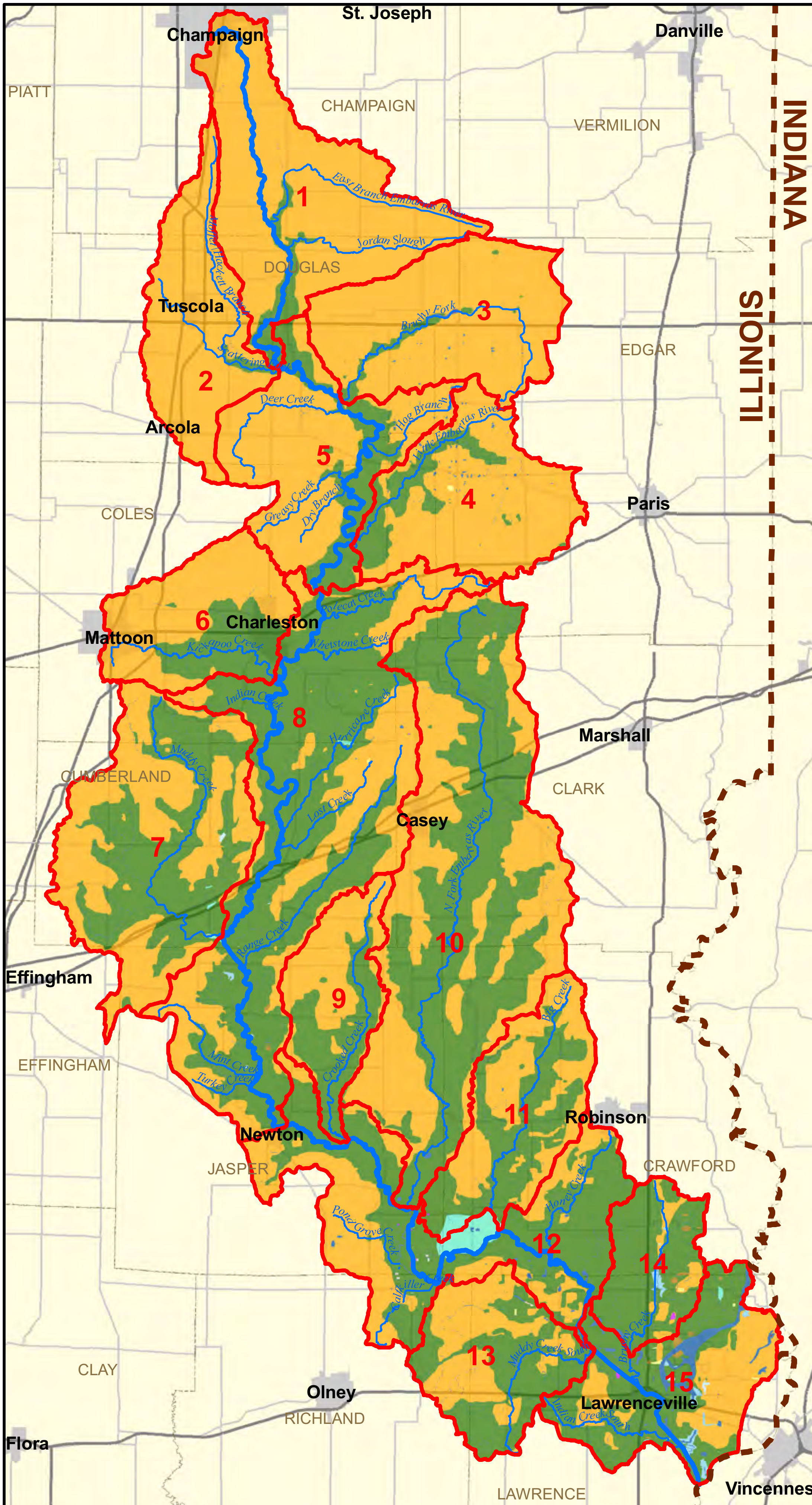

Exhibit 4

Embarras River Watershed

Pre Settlement Vegetation Map

Type	Acres	Percent
Barrens	1,126	0.07%
Bottomland	6,661	0.43%
Cultural	107	0.01%
Forest	655,152	42.05%
Marsh	304	0.02%
Other Wetland	401	0.03%
Prairie	872,560	56.00%
Slough	31	0.00%
Swamp	2,308	0.15%
Topo/geo	62	0.00%
Water	19,030	1.22%
Wet Prairie	319	0.02%

Legend

Urban Area
Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed & Subwatersheds

Pre Settlement Vegetation

Barrens
Cultural
Forest
Marsh
Wet prairie
Other wetland
Prairie
Water
Slough
Swamp
Topo/geo
Bottomland

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Miles

Table 3-11: INAI Sites		
INAI Site Name	**INAI Category**	**Subwatershed (Number)**
Allison Ditch	II	Indian Creek-Embarras River (15)
Ambraw Woods	II	Range Creek-Embarras River (8)
Baber Woods	I, III	North Fork Embarras River (10)
Barnhart Prairie	II, III	East Branch Embarras River (1)
Brushy Fork Newman Segment	II, VI	Brushy Fork (3)
Center School Geological Area	IV	Range Creek-Embarras River (8)
Centerville Cemetery	II	Indian Creek-Embarras River (15)
Chauncey Marsh	I, II, II-R, III	Honey Creek-Embarras River (12)
Coles002	I	Range Creek-Embarras River (8)
Deer Creek Hindsboro Reach	II, VI	Deer Creek-Embarras River (5)
Edward V. Price Woods	III	Big Creek (11), Honey Creek-Embarras River (12)
Edna Edwards Burnett	III	East Branch Embarras River (1)
Embarras River	II, III, VI	Range Creek-Embarras River (8), North Fork Embarras River (10), Honey Creek-Embarras River (12), Range Creek-Embarras River (8)
Embarras River-Camargo	II, III, VI	Brushy Fork (3), Deer Creek-Embarras River (5), East Branch Embarras River (1), Range Creek-Embarras River (8), Scattering Fork (2)
Embarras River - Nanney Research Reach	VI	East Branch Embarras River (1)
Embarras River Bottoms	II, VI	Indian Creek-Embarras River (15)
Embarras River Land and Water Reserve	III	Range Creek-Embarras River (8)
Emma Vance Woods	I	North Fork Embarras River (10)
Five-Mile Hill Prairie	I	Range Creek-Embarras River (8)
Green Prairie	I, III	Range Creek-Embarras River (8)
Hillside Marsh	I, III	Range Creek-Embarras River (8)
Huddlestun Woods	I, III	East Crooked Creek (9)
Hutton Geological Area	IV	Range Creek-Embarras River (8)
Jewett Geological Area	IV	Muddy Creek (7)
John Clyde Spitler Woods	I	Muddy Creek (7)
Lawrenceville Airport	II	Indian Creek-Embarras River (15)
Little Embarras River Ashmore Segment	II	Indian Creek-Embarras River (15)
Miller Pond	I	Indian Creek-Embarras River (15)
North Fork Embarras River Yale Reach	VI	North Fork Embarras River (10)
Prairie Ridge-Jasper County	II, III	Honey Creek-Embarras River (12)
Red Hills Seep Springs	II, III	Paul Creek-Muddy River (13)
Red Hills Woods	I, III	Paul Creek-Muddy River (13)
Riley Creek	VI	Kickapoo Creek (6)
Sargent's Woods	I, III	Range Creek-Embarras River (8)
Stevens Hill Prairie	I	Range Creek-Embarras River (8)
Strickland Woods	I	Range Creek-Embarras River (8)

Thacker-Pauly Marsh	II	Paul Creek-Muddy River (13)
Wabash River-Mount Carmel	II, III, VI	Indian Creek-Embarras River (15)
Walnut Point	I, II, III	Deer Creek-Embarras River (5)
Warbler Woods	I, II, III	Range Creek-Embarras River (8)
Water Works Hill Prairie	I, III	Range Creek-Embarras River (8)
Woodyard Memorial Conservation Area	III	Range Creek-Embarras River (8)

Illinois Natural Areas Inventory sites are categorized based on habitat and/or ownership status. Descriptions of the categories are provided below.

- Category I – High quality natural community and natural community restorations.
- Category II – Specific suitable habitat for state-listed species or state-listed species relocations.
- Category III – State-dedicated Nature Preserves, Land and Water Reserves, and Natural Heritage Landmarks.
- Category IV – Outstanding geological features.
- Category V – Not used at this time.
- Category VI – Unusual concentration of flora or fauna and high quality streams.

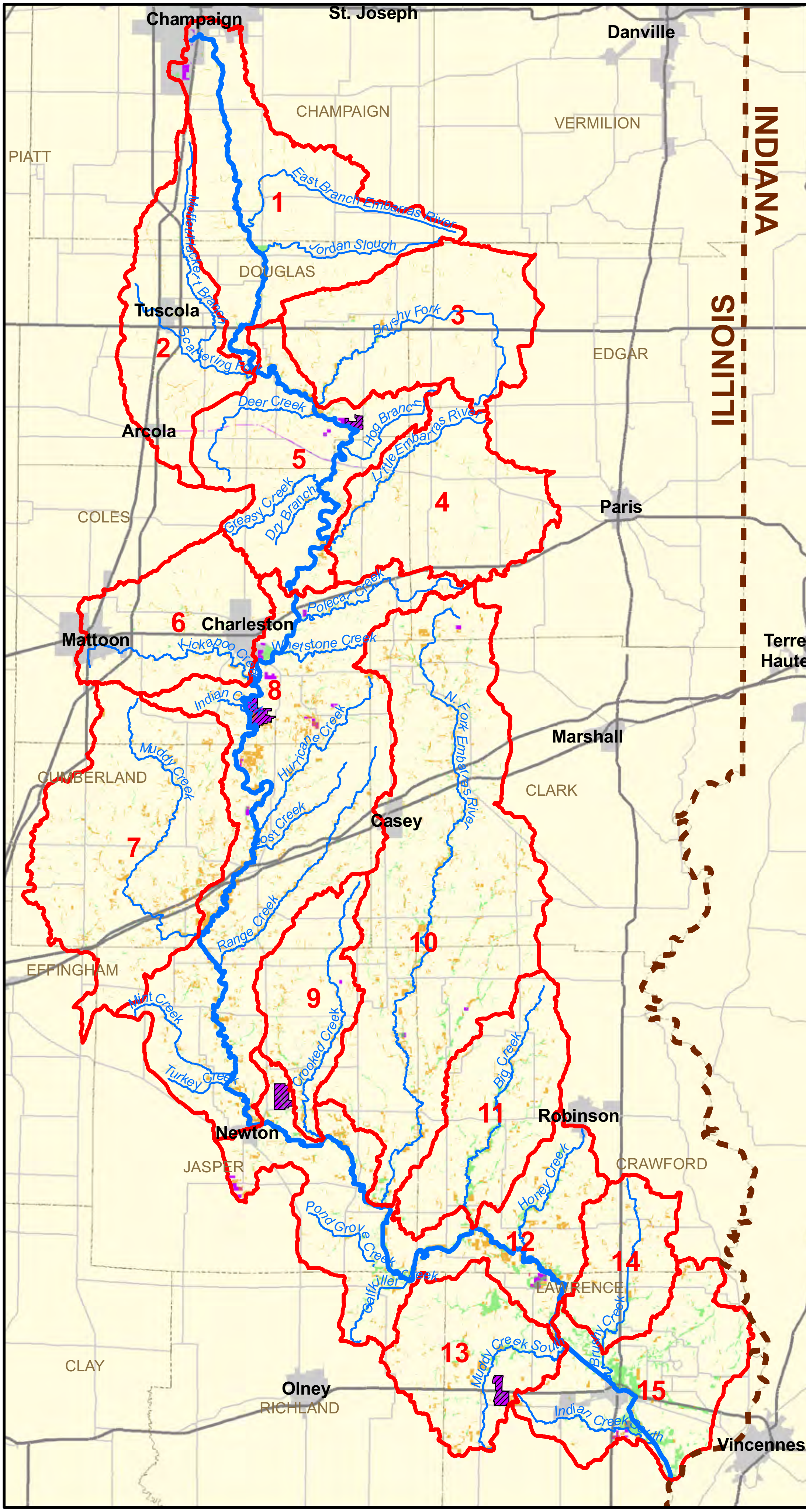
Conservation and Recreation Lands (CARL)

The Embarras River Watershed contains a number of significant natural resources that are worthy of protection. To a large extent, sustaining biodiversity in the watershed will depend on future decisions related to land use. Habitats, such as wetlands, and remnant savanna, prairies and forest, will have to be maintained in order to ensure the survival of threatened and endangered species and the natural communities.

Knowing where existing conservation and recreation lands are located and what level of protection exists can have a profound impact on the ability of organizations that own land to plan and implement conservation activities. The Conservation and Recreation Lands (CARL) map layer contains information on conservation and recreation lands in the Great Lakes region. It can be used in conjunction with other layers for developing landscape and long-term planning perspectives for conservation activities. CARL was developed by Duck's Unlimited by incorporating existing layers with hard-copy maps and online information.

The watershed contains 40 CARL sites totaling approximately 7,250 acres. Table 3-12 and Exhibit 5 summarize the sites.

Exhibit 5



Embarras River Watershed

National Wetland Inventory and Conservation Map

Type of Wetland	Acres	Percent
Bottomland Forest	30,005	72.22%
Deep Marsh	327	0.79%
Deepwater Lake	1,319	3.17%
Lake Shore	3	0.01%
Open Water Wetlands	4,243	10.21%
Perennial Deepwater River	2,194	5.28%
Perennial Riverine	89	0.21%
Shallow Marsh/Wet Meadow	2,222	5.35%
Shrub-Scrub Wetlands	656	1.58%
Swamp	194	0.47%
Other	296	0.71%

Legend

- Urban Area
- Wetlands
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds
- CARL
- Conservation Reserve Program
- State Parks

N E S W

5 0 5 10 Miles

Table 3-12: CARL Sites		
CARL Site Name	**Ownership**	**Subwatershed**
Red Hills Woods Nature Preserve	State	Paul Creek – Muddy River
Red Hills State Park	State	Paul Creek – Muddy River
Richard and Jean Graber Grassland and Water R.	Local	Honey Creek – Embarras River
Sam Parr State Park	State	Honey Creek – Embarras River
Grandville Woods Nat. Heritage Landmark	Federal	North Fork Embarras River
Cox Timber Nat. Heritage Landmark	Federal	North Fork Embarras River
Emma Vance Woods Nat. Heritage Landmark	Federal	North Fork Embarras River
Huddlestun Nat. Heritage Landmark	Federal	East Crooked Creek
Huddleston Woods - Leon Tract NHL	Local	East Crooked Creek
Huddleston Woods Nat. Heritage Landmark	Federal	East Crooked Creek
Cecil E. Meeker	State	Range Creek – Embarras River
Grissom Farm Nat. Heritage Landmark	Federal	Range Creek – Embarras River
Sholem Farm Nat. Heritage Landmark	Federal	Range Creek – Embarras River
Wady / Cutright Farm Nat. Heritage Landmark	Local	Range Creek – Embarras River
Burris	State	Range Creek – Embarras River
Sargent’s Woods Land and Water R.	Local	Range Creek – Embarras River
Fox Ridge State Park	State	Range Creek – Embarras River
Warbler Woods	Private	Range Creek – Embarras River
Baber Woods Nature Preserve	NGO	North Fork Embarras River
Fishel Hillside Marsh Nat. Heritage Landmark	Federal	Range Creek – Embarras River
Upper Embarras Woods Nature Preserve	State	Deer Creek – Embarras River
Walnut Point State Park	State	Deer Creek – Embarras River
Prairie Wind Trail	State	Scattering Fork, Deer Creek – Embarras River
Hazen Park	Local	East Branch Embarras River
Hale Park	Local	East Branch Embarras River
University of Illinois Public Golf Course	Private	East Branch Embarras River
Jones Park	Local	East Branch Embarras River
Burwash Park	Local	East Branch Embarras River
Noel Park	Local	East Branch Embarras River
Moore Park	Local	East Branch Embarras River
Mattis Park	Local	East Branch Embarras River
Hessel Park	Local	East Branch Embarras River
Jasper County Prairie Chicken Sanctuary Nature Pre.	State	Honey Creek – Embarras River
Shellbark Bottoms Nat. Heritage Landmark	Federal	Indian Creek – Embarras River
Hindsboro Habitat Area	State	Deer Creek – Embarras River
Fox Ridge	State	Range Creek – Embarras River
Green Prairie	State	Range Creek – Embarras River
Green Prairie Nat. Heritage Landmark	Federal	Range Creek – Embarras River
Woodyard Mem. Cons. Area Land and Water R.	Local	Range Creek – Embarras River
Chauncey Marsh Nature Preserve	State	Honey Creek – Embarras River

Climate

The Embarras River Watershed is within a humid continental climate region. The humid continental climate is marked by variable weather patterns and a large seasonal variance. Summers are often warm and humid with frequent thunderstorms and winters can be very cold with frequent snowfall and persistent snow cover.

The Illinois State Climatologist publishes the normals of average monthly and annual maximum, minimum, and mean temperature, monthly and annual total precipitation (inches), and heating and cooling degree days for individual locations throughout the state. The monthly precipitation and temperature normals were obtained for Illinois for the period of 1991 – 2020. Out of the 284 climate stations within Illinois, 8 were selected that fall within the watershed (Tables 3-13 and 3-14).

Table 3-13: Average Temperature (°F), 1991- 2020

Month	Charleston	Mattoon	Tuscola	Urbana
January	29.3	27.5	26	25.7
February	33.9	31.5	30	29.8
March	44	42.1	40.5	40.8
April	55.7	53.8	52.5	52.4
May	65.6	64.1	63.6	63.2
June	74.2	73.3	72.6	72.4
July	77.2	76.4	75.1	75.2
August	75.5	74.8	73.5	73.8
September	69	67.9	66.9	67.2
October	57.3	56.5	54.8	54.8
November	44.6	42.7	41.8	41.4
December	34.3	32.5	31.4	31.1

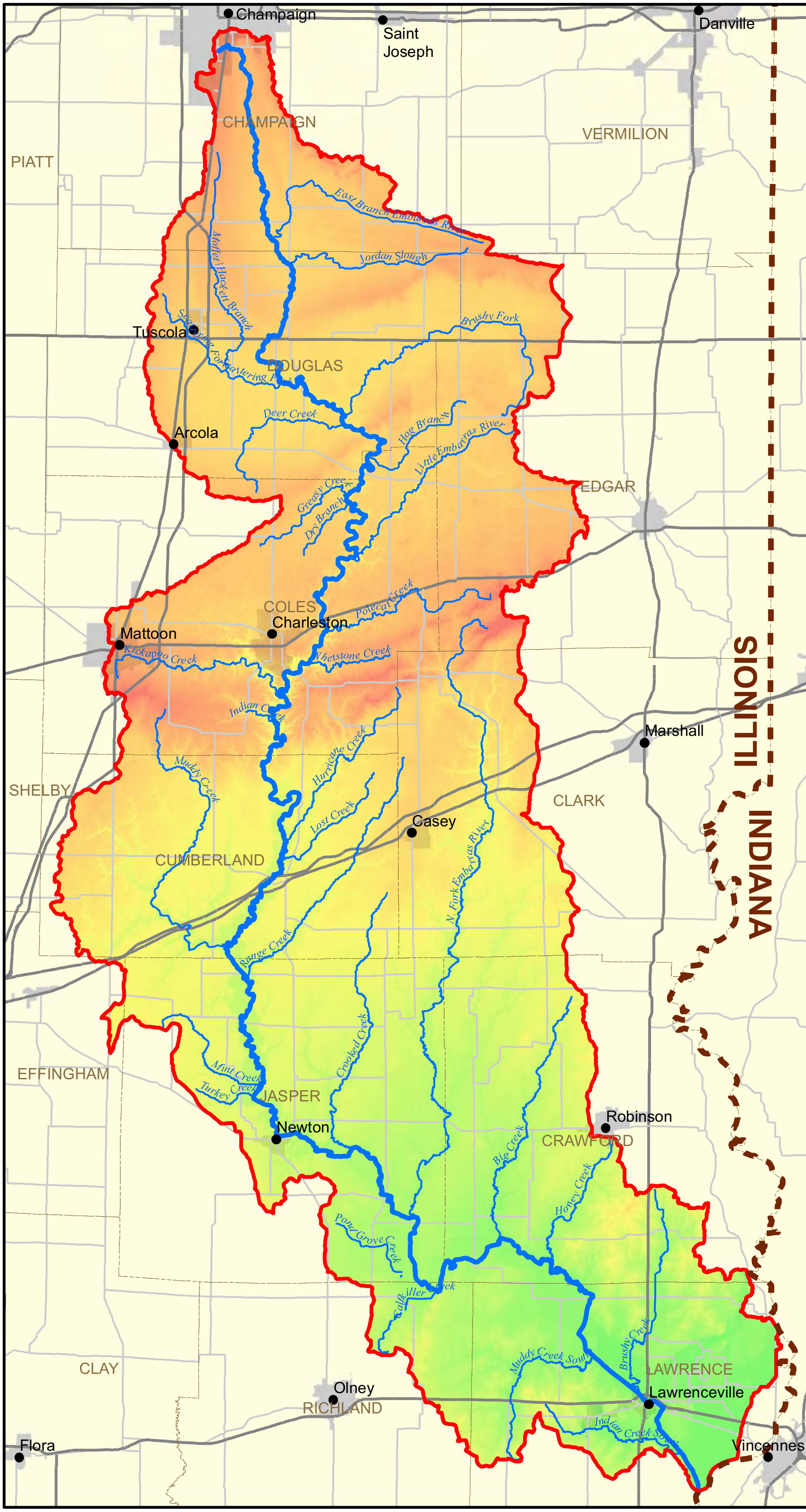
Table 3-14: Average Precipitation (inches), 1991- 2020

Month	Casey	Charleston	Lawrenceville	Mattoon	Newman	Ste Marie	Tuscola	Urbana
January	3.25	2.54	3.26	2.61	2.25	3.2	2.44	2.44
February	2.6	2.69	2.68	2.18	1.93	2.47	2.07	2.09
March	3.34	3.11	3.62	2.81	2.76	3.53	2.87	2.75
April	5.07	5.09	4.38	4.78	4.24	4.85	4.52	3.91
May	4.48	4.52	5.33	4.1	4.15	4.91	4.24	4.52
June	5.16	4.84	5.17	4.71	4.68	4.85	4.84	4.75
July	4.64	4.4	4.15	4.26	4.2	4.49	4.38	4.41
August	3.03	2.94	3.07	2.85	2.62	3.47	2.97	3.47
September	3.07	3.15	3.56	3.11	3.4	3.79	3.07	3.16
October	3.81	3.94	3.86	3.77	3.36	3.53	3.25	3.13
November	4.03	3.74	4.09	3.56	3.42	3.67	3.37	3.12
December	3.06	2.79	3.43	2.55	2.28	2.91	2.53	2.44

Physical Geography and Geomorphology

The topography of the Embarras River basin is the result of recent modification of glacial activity during the Wisconsinan and Illinoian glacial periods (Exhibit 7). The northern part of the basin, above the Cumberland -Coles County line, is within the Bloomington Ridged Plain

Exhibit 6



Embarras River Watershed

Shaded Relief Map

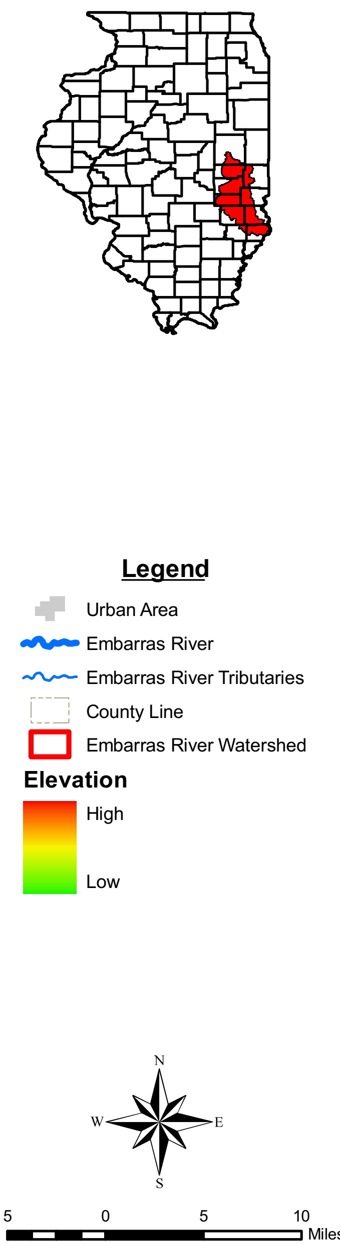
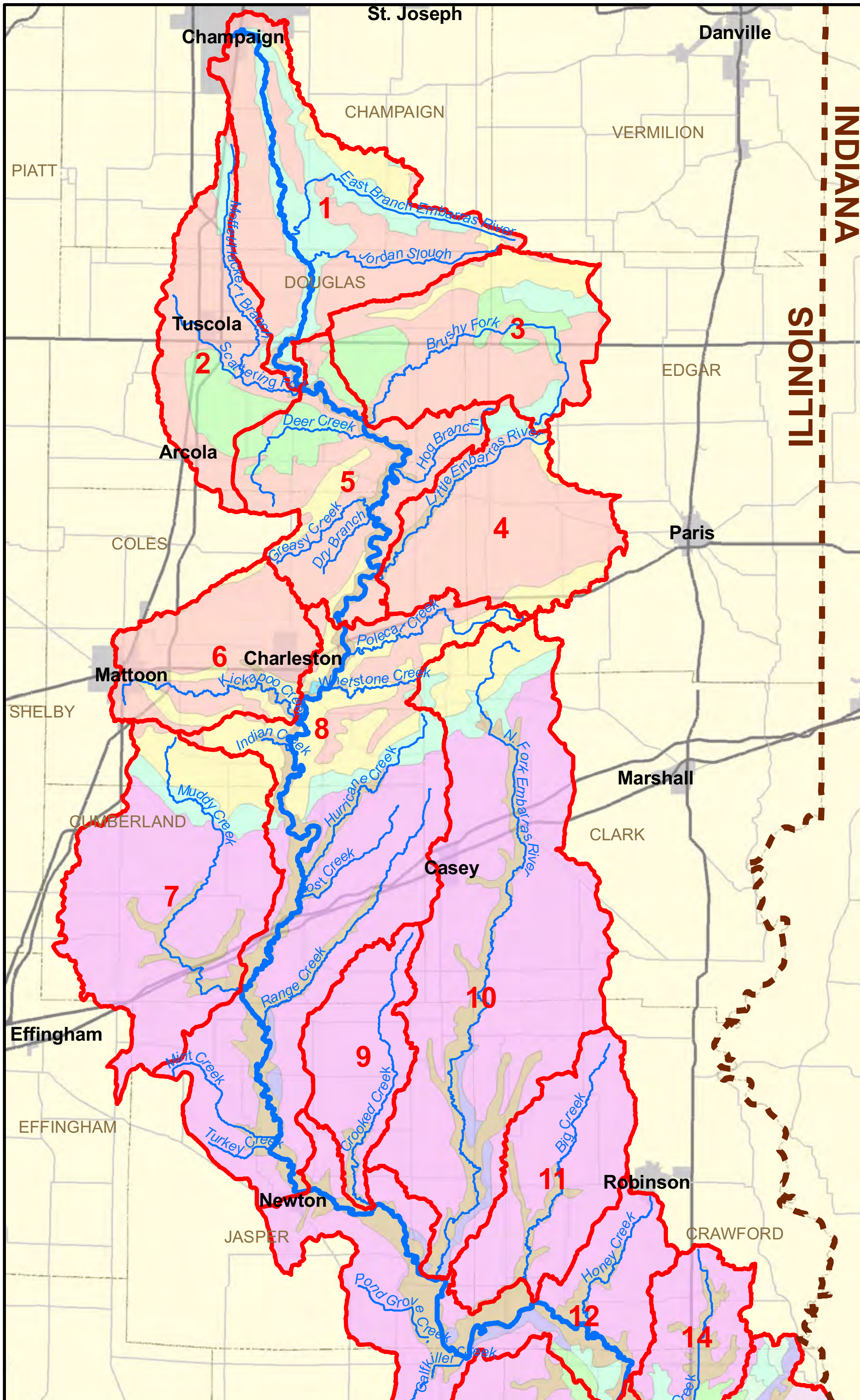


Exhibit 7

Embarras River Watershed

Surficial Geology Map



#	Soil parent material
1	Thick loess (>60 inches)
2	Moderately thick to thin loess (10-60+ inches) on Illinoian drift with or without paleosols
4	Moderately thick loess (40-60 inches) on medium-to-fine-textured, Wisconsinan till or lacustrine sediments
5	Moderately thick to thin loess or silty material (24-60+ inches) on medium-textured, Wisconsinan outwash
6	Thin loess (10-40 inches) on loam or sandy loam, Wisconsinan till
9	Loamy, silty, and clayey Wisconsinan lacustrine sediments
10	Thin loamy or silty materials on gravelly Wisconsinan outwash
12	Thick, sandy Wisconsinan outwash and Aeolian materials
15	Sandy to clayey alluvial sediments on bottomlands
98	Water

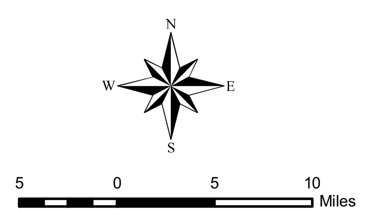
Soil Parent Material #	Acres	Percent
1	4,729	0.30%
2	669,436	42.97%
4	381,087	24.46%
5	91,244	5.86%
6	126,392	8.11%
9	66,145	4.25%
10	19,954	1.28%
12	21,285	1.37%
15	177,380	11.38%
98	368	0.02%

Legend

Urban Area
Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed & Subwatersheds

Soil Parent Material #

1, 2, 4, 5, 6, 9, 10, 12, 15, 98



and described as depositional plains of low relief underlain by thick till and modified only slightly by post glacial stream erosion. The plains are nearly flat to gently rolling and are crossed by several low and poorly developed end moraines. The flatness of the plains is broken by low eskers, esker troughs, and melt water drainage ways that trend southeast.

The central portion of the basin is within the Springfield Plain and extends approximately from the Cumberland -Coles County line on the north to the Richland -Jasper County line. The glacial material in this area is Illinoian in age and was not subjected to the more recent Wisconsinan glacial activity. It is underlain by lacustrine, outwash, and alluvial sediments and till and is characterized by extensively aggraded valleys. The lowlands are broad plains with low rolling hills. The northern part of the plain has less relief than the southern end.

Downstream from the Richland -Jasper County line the basin is within the Mt. Vernon Hill Country which has gently rolling topographic features that are controlled chiefly by the underlying bedrock. The uplands are well dissected, and the lowlands are broad and have low-gradient alluvial river plains.

Elevation varies from 715 feet Mean Sea Level at its source near Urbana to 405 feet Mean Sea Level at its confluence with the Wabash River, a total fall of 310 feet. With a total river distance of approximately 190 stream miles, this results in an average slope of 1.6 feet per mile. Headwater slopes of the main stem are relatively steep with a value of approximately 4.4 feet per mile, while the middle reaches an average 1.6 feet per mile. Finally, the outlet reach between the Wabash River and the USGS stream gauge at St. Marie averages only 1.2 feet per mile.

Geology

The surficial geology of the Embarras River drainage basin consists of a mantle of weakly consolidated to unconsolidated sediments of Pleistocene and recent age overlying Pennsylvanian-age bedrock. Bedrock exposures are relatively few in number and of limited areal extent. The near-surface Pleistocene glacial deposits of the drainage basin include: (1) Illinois-age Glasford Formation in the southern part, and (2) Late Wisconsin-age Wedron Group in the northern part. The mapped boundary between these two subdivisions is along the southern margin of the Shelbyville and Westfield terminal moraines, which were formed about 18,000 years ago (Exhibit 6).

The Glasford Formation is dominantly composed of glacial till and outwash sand and gravel deposits. In a few areas, Illinois-age eskers, kames and crevasse-filling deposits occur above the Glasford. Late Wisconsin-age deposits in the basin are composed of glacial tills, lacustrine silts and clays, outwash sand and gravels, and loess. Glacial till, which is mostly poorly sorted clay, silt, sand, and gravel, is thickest in moraines.

The location and form of Wedron Group deposits influences the configuration of the northern part of the drainage basin. Drainage divides generally occur along moraines. The headwater area of the Embarras River is on the southwest side of the Champaign moraine. The basin's western divide, from north to south, obliquely crosses the Pesotum and West Ridge moraines and parallels the Arcola and Cerro Gordo moraines before cutting across the Paris and Shelbyville moraines, cuts across the West Ridge moraine, and over flat landscapes underlain by lacustrine deposits to the Arcola moraine. After following a portion of the Arcola moraine, the divide cuts across the Paris, Nevins, and Westfield moraines. Like the Glasford, the Wedron is dominantly composed of glacial till and outwash sand and gravel deposits.

In south-central Champaign and eastern Douglas Counties, clayey lacustrine deposits of the late Wisconsin-age Equality Formation were deposited in lakes ponded behind the West Ridge and Arcola moraines. At the southernmost part of the basin, slackwater lacustrine deposits, also mapped as Equality Formation, overlie the Glasford within the Embarras River valley.

Sand and gravel outwash deposits of late Wisconsin-age (Henry Formation) generally occur along the outer margins of the moraines where glacial ice stagnated during gradual retreat northward. Outwash deposits are significantly larger just south of the Wisconsin terminal moraines and where glacial meltwater eroded channels through moraines. Wisconsin-age outwash also is abundant at the southern end of the basin, occurring as terrace deposits along the Wabash River.

Late Wisconsin-age silt-size loess, deposited by the wind, blankets most of the Wisconsin and older sediments. Windblown sand deposits (Parkland Sand) occur sporadically along the main branches of the Embarras River on the east side of the channel and south of the terminal Wisconsin-age moraine. Late Wisconsin-age and recent Cahokia Alluvium occurs throughout the drainage basin along streams and floodplains. The alluvium ranges from well to poorly sorted and consists of variable amounts of clay, silt, sand, and gravel derived from the loess, glacial till, and outwash sediments.

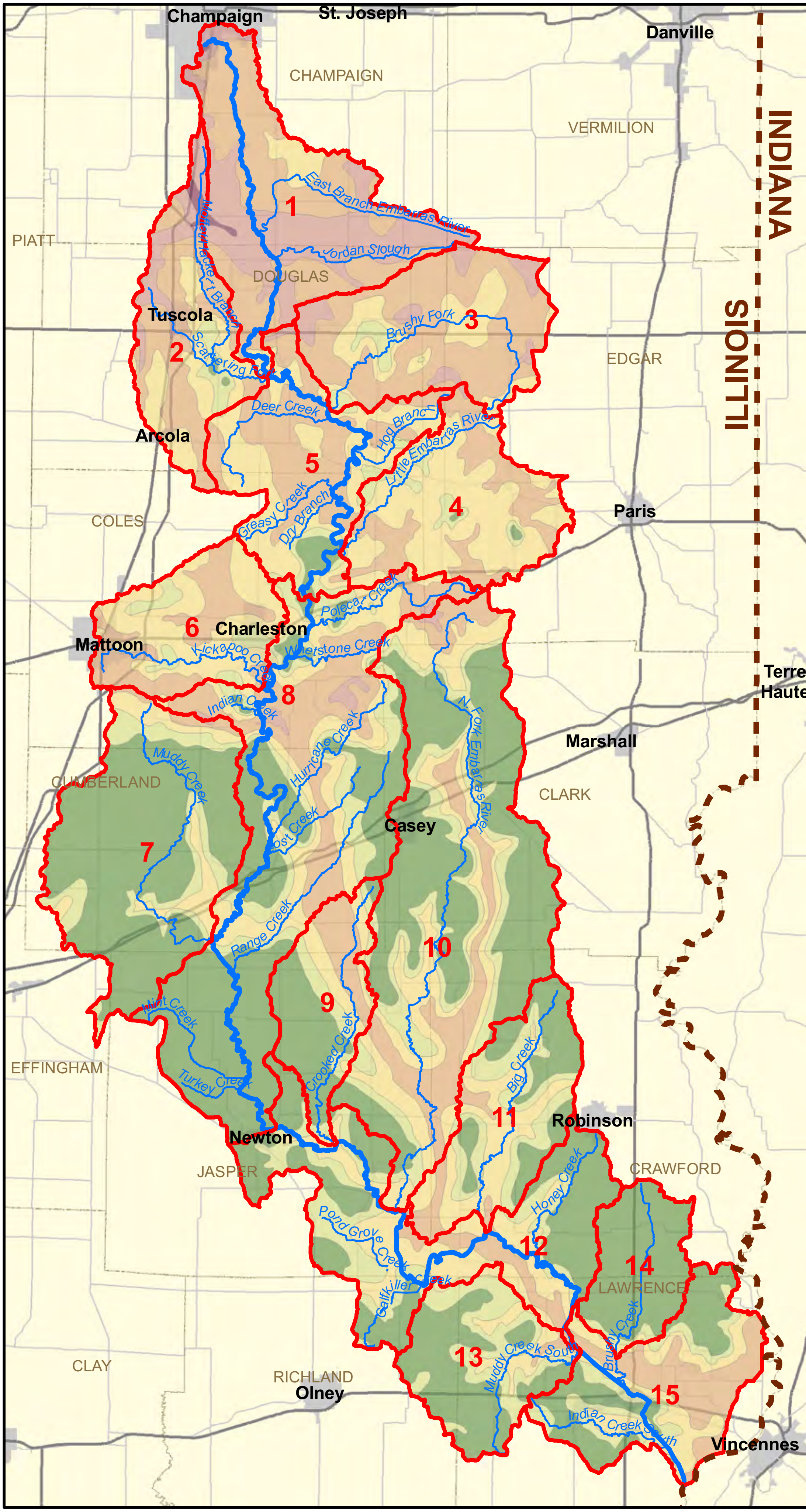
Exhibit 7 illustrates the surficial geology of the watershed and Exhibit 8 illustrates the thickness of unconsolidated materials that lie above bedrock throughout.

Soil Characteristics

Soil Associations

Soil associations are groups of soil types that generally share one or more common characteristics, such as parent material or drainage capability. These soil associations provide general characteristics for the specific soil association but should not be used at the decision-making level. There are 19 soil associations within the Embarras River Watershed (Table 3-15 and Exhibit 9). Approximately 55% of the basin area is composed of three, with the remaining 16 each comprising 0.0-6.6% of the watershed. The Catlin-Flanagan-Drummer series is prevalent in the northern portion of the watershed, while the Hoyleton-Cisne-Huey and Ava-Bluford-Wynoose series are predominantly found in the southern portion of the watershed.

Exhibit 8



Embarras River Watershed

Drift Thickness Above Bedrock Map

Range (feet)	Acres	Percent
< 25	519,503	33.34%
25 - 50	211,152	13.55%
50 - 100	366,140	23.50%
100 - 200	381,148	24.46%
200 - 300	77,826	5.00%
300 - 400	2,293	0.15%

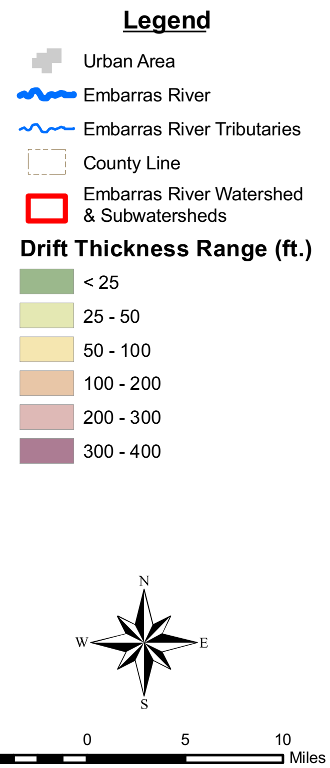
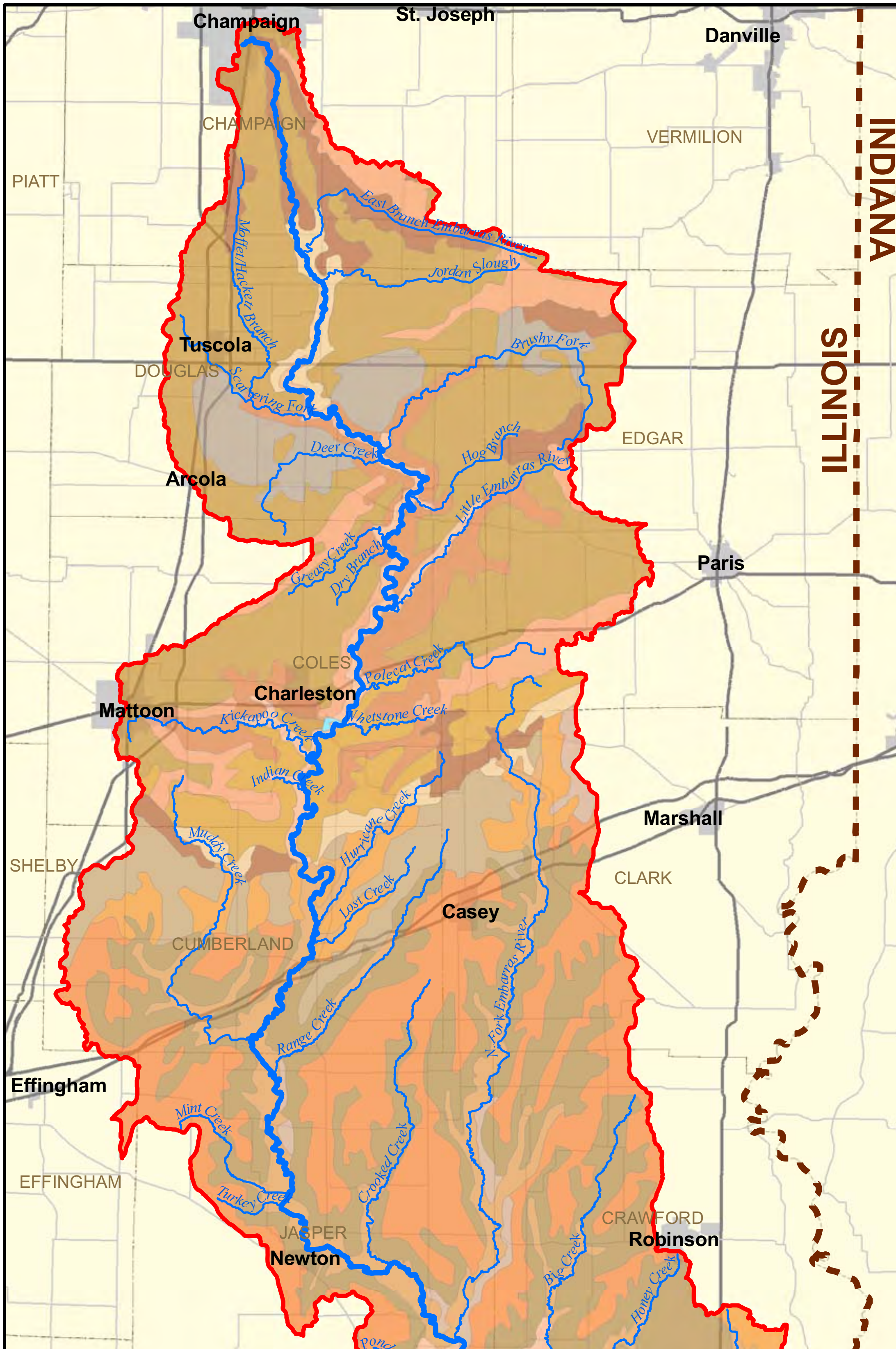


Exhibit 9

Embarras River Watershed

Soils Map



#	Soil association	#	Soil association
1	Port Byron-Joy	32	Fayette-Rozetta-Stronghur
2	Tama-Muscatine-Sable	33	Alford-Muren-Iva
3	Tama-Ipava-Sable	34	Clinton-Keomah-Rushville
4	Herrick-Virden-Piasa	35	Hosmer-Stoy-Weir
5	Oconee-Cowden-Piasa	36	Ava-Bluford-Wynoose
6	Hoyleton-Cisne-Huey	37	Westville-Pecatonica-Flagg
7	Winnebago-Durand-Ogle	38	Middletown-Tell-Thebes
8	Broadwell-Waukegan-Pillot	39	Birkbeck-Sabina-Sunbury
9	Catlin-Flanagan-Drummer	40	St. Charles-Camden-Drury
10	Wenona-Rutland-Streator	42	Dodge-Russell-Miami
11	Plano-Proctor-Worthen	43	Kidder-McHenry
12	Saybrook-Dana-Drummer	44	Morley-Blount-Beecher
13	Griswold-Ringwood	45	St. Clair-Nappanee-Frank
14	Varna-Elliott-Ashkum	46	Markland-Colp-Del Rey
15	Symerton-Andres-Reddick	48	Casco-Fox-Ockley
16	Swygert-Bryce-Mokena	49	Martinsville-Sciotoville
17	Clarence-Rowe	50	Oakville-Lamont-Alvin
18	Harco-Patton-Montgomery	51	Ritchey-New Glarus-Palsgrove
19	Martinton-Milford	52	Alford-Goss Baxter
20	Lorenzo-Warsaw-Wea	53	Alford-Wellston
21	Jasper-LaHogue-Selma	54	Hosmer-Zanesville-Berks
22	Sparta-Dickinson-Onarga	55	Grantsburg-Zansville-Wellston
23	Channahon-Dodgeville-Ashdale	56	Derinda-Schapville-Elroy
24	Lawson-Sawmill-Darwin	57	Haymond-Petrolia-Karnak
25	Houghton-Palms-Muskego	98	Water
31	Seaton-Timula		

Soil Association #	Acres	Percent
5	58,926	3.78%
6	241,942	15.53%
9	310,552	19.93%
11	57,319	3.68%
12	69,519	4.46%
18	11,832	0.76%
19	48,686	3.12%
20	19,954	1.28%
24	74,367	4.77%
33	4,729	0.30%
35	56,126	3.60%
36	307,265	19.72%
39	70,535	4.53%
41	33,925	2.18%
42	56,873	3.65%
46	5,628	0.36%
50	26,463	1.70%
57	103,013	6.61%
98	368	0.02%

Table 3-15: Soil Associations		
Association	**Acres**	**Percentage**
Oconee-Cowden-Piasa	58,926	3.8%
Hoyleton-Cisne-Huey	241,942	15.5%
Catlin-Flanagan-Drummer	310,552	19.9%
Plano-Proctor-Worthen	57,319	3.7%
Saybrook-Dana-Drummer	69,519	4.5%
Harco-Patton-Montgomery	11,832	0.8%
Martinton-Milford	48,686	3.1%
Lorenzo-Warsaw-Wea	19,954	1.3%
Lawson-Sawmill-Darwin	74,367	4.8%
Alford-Muren-Iva	4,729	0.3%
Hosmer-Stoy-Weir	56,126	3.6%
Ava-Bluford-Wynoose	307,265	19.7%
Birkbeck-Sabina-Sunbury	70,535	4.5%
St. Charles-Camden-Drury	33,925	2.2%
Sodge-Russell-Miami	56,873	3.6%
Markland-Colp-Del Ray	5,628	0.4%
Oakville-Lamont-Alvin	26,463	1.7%
Haymond-Petrolia-Karnak	103,013	6.6%
Water	368	0%

The Catlin-Flanagan-Drummer association consists of nearly level to gently sloping silty soils formed in loess and the underlying glacial till or outwash on till plains of Wisconsinan age. Flanagan soils are somewhat poorly drained, Drummer soils are poorly drained, and Catlin soils are moderately well drained. They formed under prairie vegetation and are characterized by a thick, black or very dark grayish brown surface layer that is high in organic matter. Most of this association is used for cultivated crops. The soils are well suited to all of the crops commonly grown in the basin.

The Ava-Bluford-Wynoose association consists of nearly level to very steep silty and loamy soils formed in loess and the underlying glacial till or entirely in glacial till on till plains of Illinoian age. This association occurs in sloping upland areas adjacent to the Embarras River and its tributaries. Bluford soils are somewhat poorly drained, Ava soils are moderately well drained, and Wynoose soils are poorly drained. They formed under forest vegetation. Most of the nearly level to moderately sloping areas are used for cultivated crops. The soils in these areas are well suited or moderately suited to cultivated crops depending on the amount of slope. Steeper areas are mostly used for pasture, hay, and woodland. The soils are well suited or moderately suited to these uses.

The Hoyleton-Cisne-Huey association consists of nearly level to gently sloping silty soils formed in loess and the underlying glacial till on till plains of Illinoian age. They formed mostly under prairie vegetation but have been influenced by forest vegetation at some time during their development. Hoyleton soils are somewhat poorly drained, Cisne soils are poorly drained, and Huey soils are poorly drained. Most of this association is used for cultivated crops. The soils are moderately suited or well suited to all of the crops commonly grown in the basin.

Hydrologic Soil Groups

Soils are classified into hydrologic soil groups to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The groups are designated as A, B, C, and D.

Group A soils have low runoff potential and high infiltration rates when thoroughly wetted and consist mainly of well to excessively drained soils. Group B soils have moderate infiltration rates and consist mainly of moderately well to well drained soils. Group C soils have low infiltration rates, and group D soils have high runoff potential.

Within the Embarras River Watershed, all soil groups can be found, however, the majority of the soils fall within hydrologic soil group B (45.2%). Table 3-16 and Exhibit 10 summarize the hydrologic soil group information for the watershed.

Table 3-16: Hydrologic Soil Groups Within the Watershed		
Soil Group	**Acres**	**Percentage**
A	2,575	0.2%
B	703,519	45.2%
C	541,493	34.8%
D	310,475	19.9%

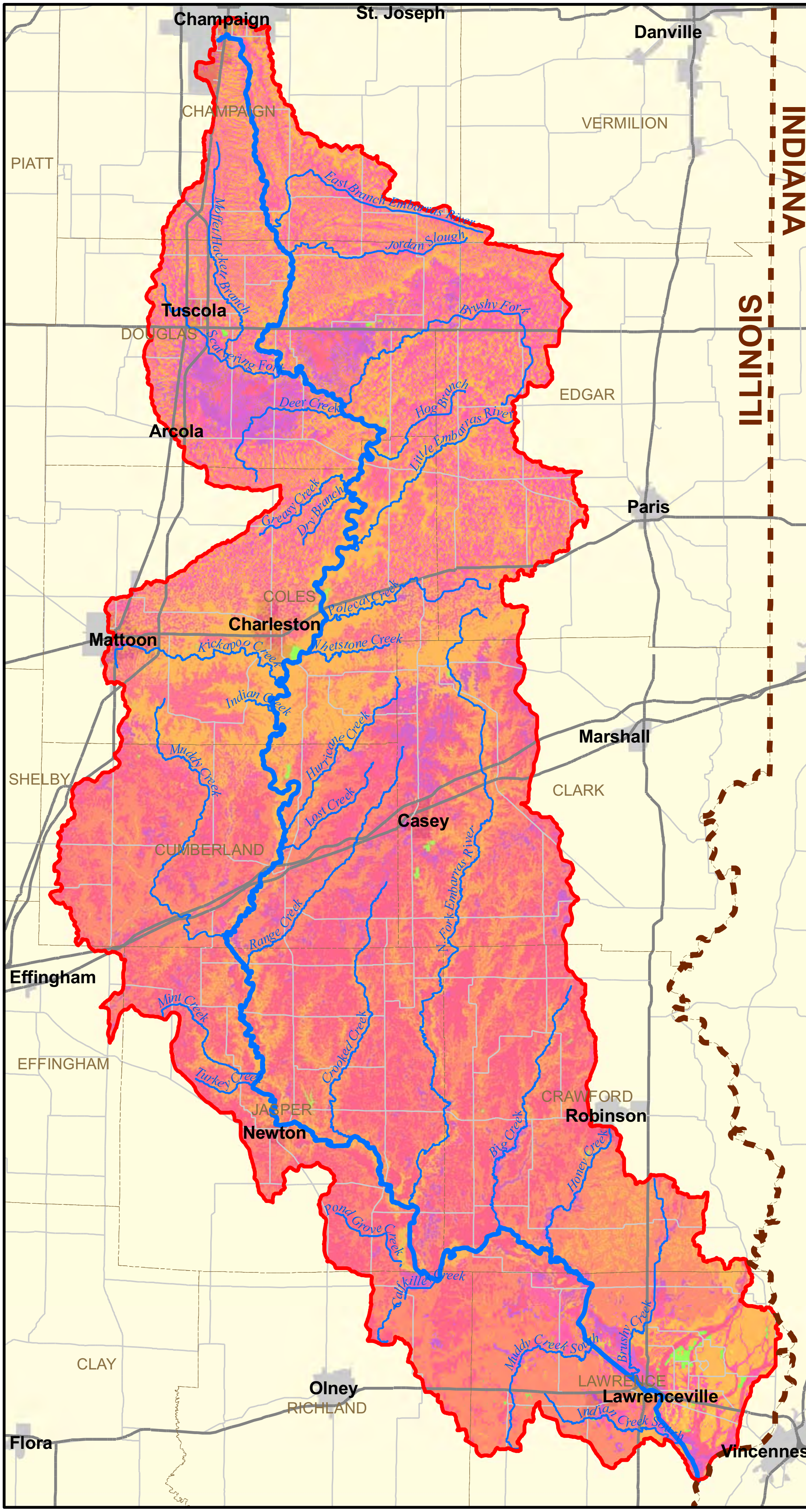
Highly Erodible Land (HEL)

Erosion is a natural process within stream ecosystems; however, excessive erosion negatively impacts the health of the watershed. Erosion throughout the watershed increases sedimentation of the streambeds which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. Highly erodible soils and potentially HEL soils are mapped in Exhibit 11. The data used to create this exhibit was extracted from the Soil Survey Geographic (SSURGO) Database. It was assumed that soils with K-factors greater than or equal to 0.4 and slope gradients greater than or equal to 6 were HEL. A total of approximately 78,822 acres, or 5.1% of the watershed, is considered HEL or potentially HEL.

These soils are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive topsoil from one place and depositing it in another. Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

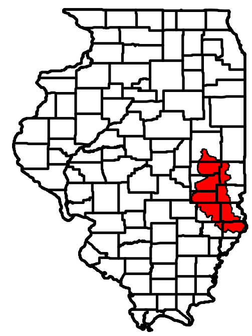
In areas with HEL soils, special care must be taken to ensure that land use practices do not result in severe wind or water erosion. Although natural erosion cannot be prevented, the effects of runoff can be moderated so that it does not diminish the health of the watershed. Exhibit 11 illustrates HEL throughout the watershed. In addition, the map illustrates those that are currently under agriculture or pasture land use.

Exhibit 10



Embarras River Watershed

Hydrologic Soil Groups



Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds

Hydrologic Soil Groups

- A - High Infiltration Rate
- B - Moderate Infiltration Rate
- C - Slow Infiltration Rate
- D - Very Slow Infiltration Rate
- B/D*
- C/D*
- Unclassified

*If a soil is assigned to a dual hydrologic group, the first letter is for drained areas and the second is for undrained areas

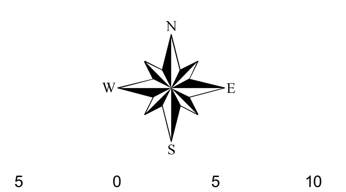
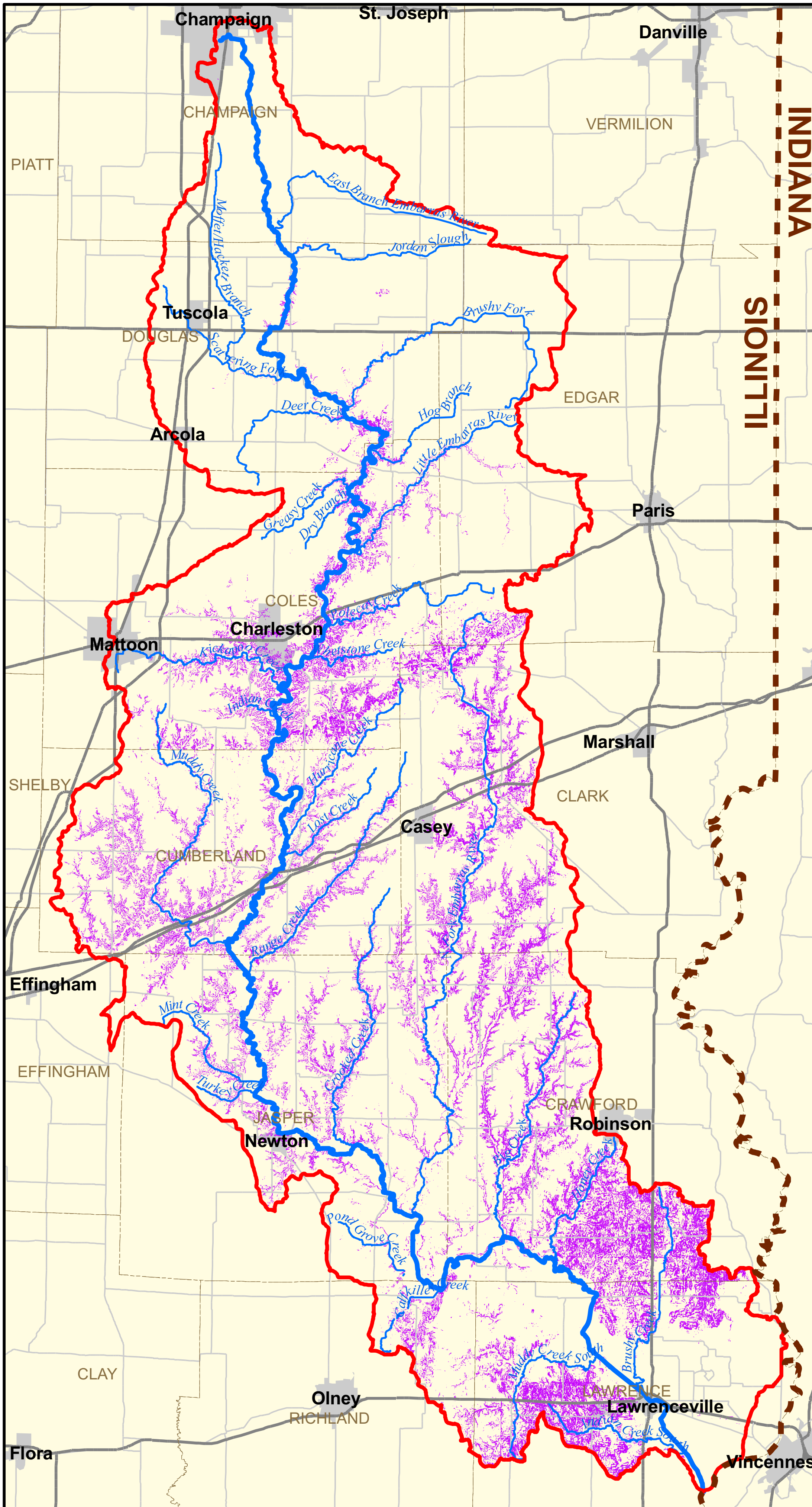
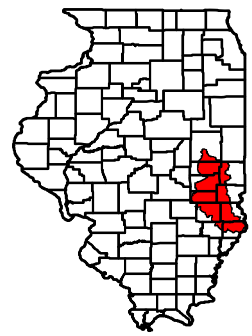


Exhibit 11



Embarras River Watershed

Highly Erodible Land Areas Map



Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds
- Highly Erodible Land Areas

N
W E
S

5 0 5 10
Miles

Hydric Soils

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Approximately 664,713 acres or 42.7% of the soils in the Watershed are considered hydric (Exhibit 12). However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils can be used to consider possible locations of wetland creation or enhancement. Wetland creation involves many components in addition to soil type that must be considered before moving forward with wetland design and creation.

Exhibit 12 shows the areas within the watershed that are classified as hydric soils that are currently under agricultural production. These areas should be given high priority for restoration as they would reduce flooding impacts, pollutant loading and create ecological habitat.

Hydrology

Stream Flow Characteristics

The USGS maintains four active stream gages within the watershed which are shown along with other hydrologic details in exhibit 13. These gages provide real-time data on gage height and discharge, as well as historical daily, monthly and annual statistics. Table 3-17 shows the stream flow characteristics at these gaging stations.

Table 3-17: USGS Stream Flow Characteristics

Gage	Drainage Area (sq mi)	Average Daily Flow (cfs)	Peak Flow (cfs)	Period of Records
3343400 Embarras River near Camargo	186	167	8,040 (4/12/94)	1961-2021
3345500 Embarras River at Ste. Marie	1,516	1,255	60,400 (6/7/08)	1909-2021
3346000 North Fork Embarras River near Oblong	318	272	46,200 (6/7/08)	1940-2021
3346500 Embarras River at Lawrenceville	2,333	1,890	47,500 (6/10/08)	2002-2021
0334500 Embarras River at Newton	1,390	971	31,900 (5/20/43)	1939-1945

The Federal Emergency Management Agency (FEMA) also provides a source for stream flow information. Flood Insurance Studies (FIS) are produced for each county. Peak discharges at specific locations along a river are determined as part of the FIS process. Table 3-18 includes the peak discharges for two locations along the Embarras River based on FIS information.

Exhibit 12

Embarras River Watershed

Hydric Soils Map

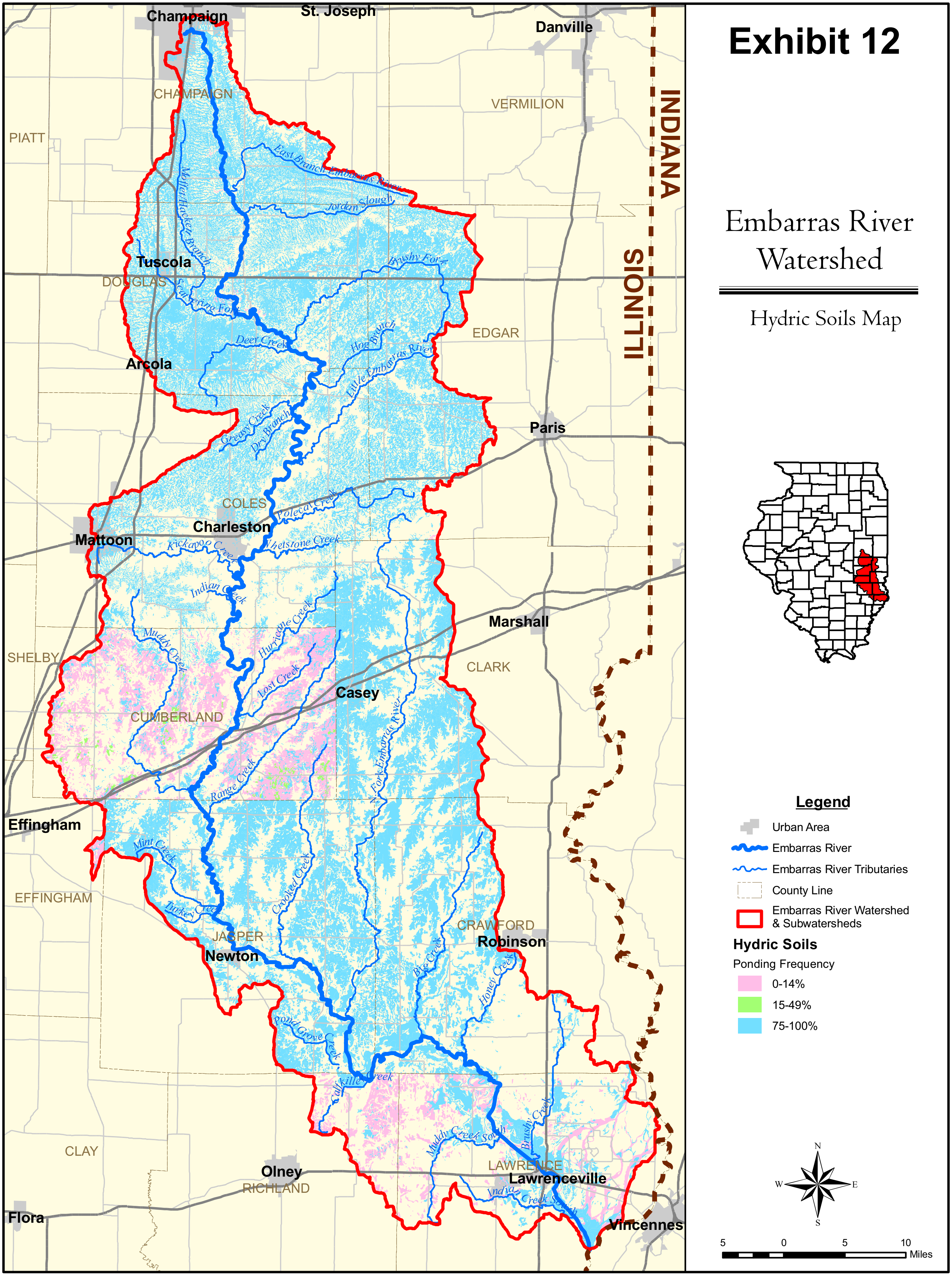
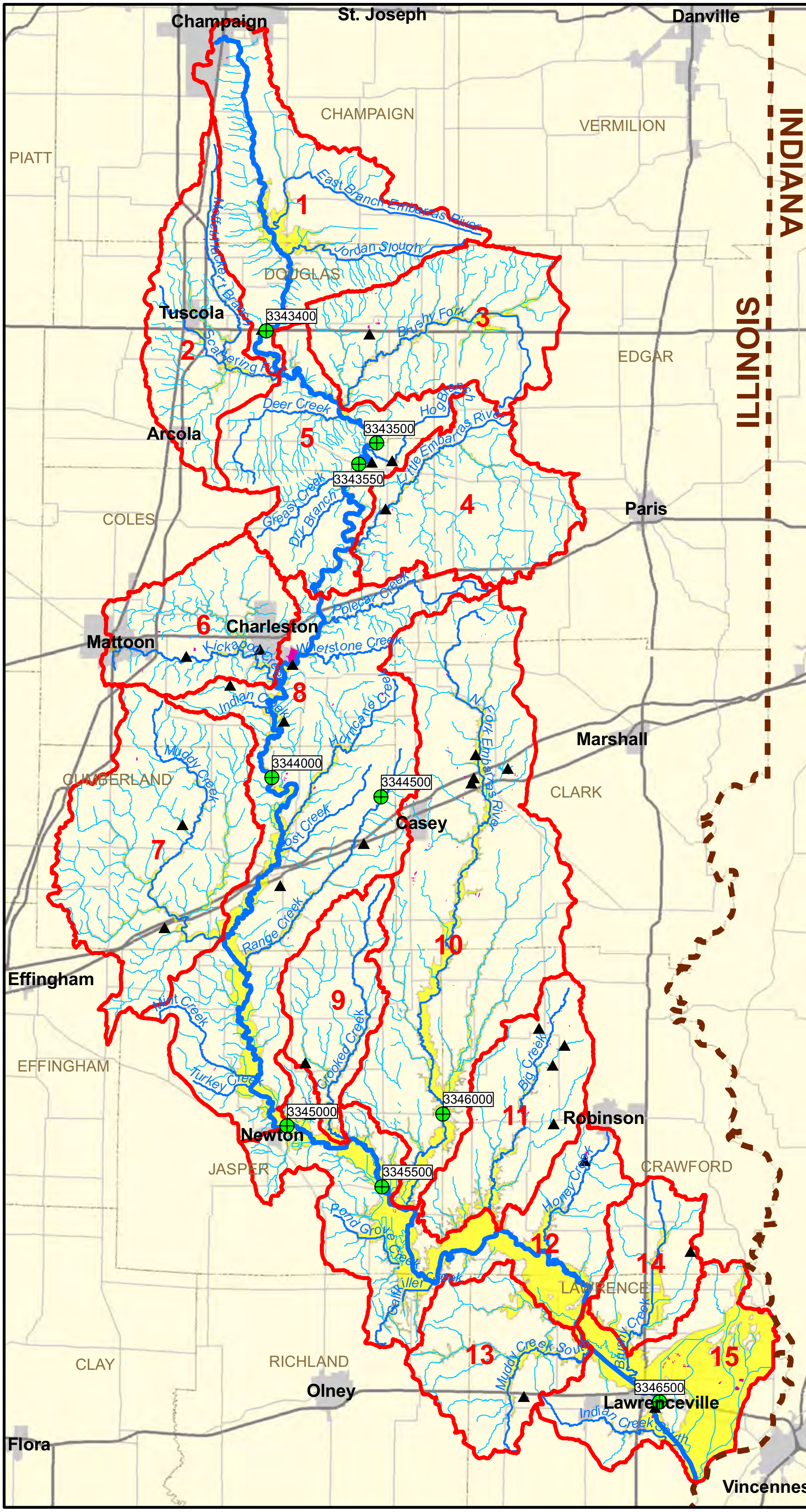


Exhibit 13



Embarras River Watershed

Hydrologic Map

Legend

- Dams
- USGS Streamflow Stations
- Lakes
- Urban Area
- Embarras River
- Embarras River Tributaries
- Streams
- County Line
- Embarras River Watershed & Subwatersheds

Floodzones

- 100 Year
- 500 Year

Table 3-18: FEMA FIS Stream Flow Characteristics				
Location	**Drainage Area (sq mi)**	**10-year Peak Flow (cfs)**	**100-year Peak Flow (cfs)**	**Source**
U/S of confluence with Jordan Slough	122	4,486	7,183	Effective Douglas County FIS, 5/24/2011
At mouth	2,440	48,000	69,000	Effective Lawrence County FIS, 7/18/2011

Regulatory Floodplain

The Federal Emergency Management Agency has developed Flood Insurance Rate Maps (FIRMs) for many parts of the country for individuals and governments to assess the risk of flooding in specific areas. These maps also indicate what insurance rates property owners may need to pay to develop property in these areas.

Illinois is still in the process of updating all of the FIRM panels for the state as part of the Map Modernization Project (MapMod). Some of Illinois' floodplain maps are outdated, some as much as 20 years. MapMod was undertaken to update and develop fully digital floodplain maps statewide. All but three counties (Effingham, Jasper, and Richland) within the Embarras River Watershed have completed the update with the updated maps being effective. Table 3-19 summarizes the status of the FIRM panels within the watershed.

Table 3-19: FEMA FIRM Status		
County	**Current Effective Date**	**MapMod Status**
Champaign	October 2, 2013	Effective
Clark	August 2, 2007	Effective
Coles	July 18, 2011	Effective
Crawford	June 2, 2011	Effective
Cumberland	February 4, 2011	Effective
Douglas	May 24, 2011	Effective
Edgar	January 19, 2011	Effective
Effingham	December 23, 1977	Preliminary in Progress
Jasper	January 17, 1985	Preliminary in Progress
Lawrence	July 18, 2011	Effective
Richland	November 1, 1984	Preliminary in Progress
Vermilion	May 16, 2012	Effective

The floodplain boundaries based on the current effective FIRMs are shown on Exhibit 13. The 100-year floodplain, which is defined as an area inundated by 100-year flooding, comprises 187,849 acres (12.1% of the watershed). In this zone, there is a 1% chance of annual flooding, and a 26% chance that the area will be inundated at some time during the life of a 30-year mortgage.

The 500-year floodplain (0.2% chance of annual flooding) comprises only 235 acres (0.02% of the watershed). These areas are considered to have a moderate or minimal risk of flooding, and the purchase of flood insurance is available but not required.

Wetlands

Wetland classifications are based on attributes which can be measured and, when combined, help to define the nature of a specific wetland and distinguish it from others. The National Wetland Inventory (NWI) classified wetlands into five major groups or systems. The three wetland classifications identified within the watershed include lacustrine, palustrine, and riverine.

Lacustrine wetlands are associated with lakes and are characterized by a lack of trees and a dominance of emergent and submersed aquatic vegetation. Lacustrine wetlands typically extend from the shoreline to depths of 6.5 feet or until emergent vegetation no longer persists. Lacustrine wetlands are important in removing sediment and nutrients, as well as providing habitat for fish and macroinvertebrates which are a vital food source within a lake ecosystem. Palustrine wetlands are related to marshes, swamps and bogs. Palustrine habitats are wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. Palustrine habitats have structural features that provide feeding, breeding, nesting, over wintering and migration habitat for wildlife in addition to their natural filtration properties. Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Riverine wetlands are directly affected by streamflow, including overbank and backwater conditions. Riverine wetlands are very important in sediment retention, as well as pollutant removal.

There are 41,252 acres (2.6% of the watershed) of wetlands scattered throughout. Among the three wetland classifications, 1,322 acres are considered lacustrine, 37,647 acres are palustrine, and 2,283 acres are riverine. Exhibit 5 and Table 3-20 show the distribution of the three classifications and the habitats found within each system.

Table 3-20: NWI Wetland Classifications

System	Habitat	Acres	Percentage
Lacustrine	Deep Water Lake	1,319	3.2%
	Lake Shore	3	0.0%
Palustrine	Open Water Wetlands	4,243	10.3%
	Shallow Marsh/Wet Meadow	2,222	5.4%
	Deep Marsh	327	0.8%
	Bottomland Forest	30,005	72.7%
	Swamp	194	0.5%
	Shrub-Scrub Wetlands	656	1.6%
Riverine	Perennial Deep Water River	2,194	5.3%
	Perennial Riverine	89	0.2%
Total		**41,252**	**100%**

Aquatic Resources and Wildlife

Threatened or Endangered Species and Biologically Significant Streams

The IDNR was contacted to provide any Natural Heritage Data or related records for all listed threatened, endangered or rare species, high quality natural communities or natural areas documented within the Embarras River Watershed. Their response indicated that the watershed is home to several Threatened or Endangered Species as shown in Table 3-21.

Table 3-21: Threatened or Endangered Species			
Subwatershed Name	**Scientific Name**	**Common Name**	**Number of Occurrences**
East Branch Embarras River	*Clonophis kirtlandi*	Kirtland’s Snake	2
	Lanius ludovicianus	Loggerhead Shrike	1
	Bartramia longicauda	Upland Sandpiper	2
	Poliocitellus franklinii	Franklin's Ground Squirrel	3
	Necturus maculosus	Mudpuppy	1
	Haliaeetus leucocephalus	Bald Eagle	1
Scattering Fork	*None Identified*		-
Brushy Fork	*Lampsilis fasciola*	Wavy-rayed Lampmussel	2
	Myotis septentrionalis	Northern Long-eared Myotis	1
	Ptychobranchus fasciolaris	Kidneyshell	2
	Toxolasma lividum	Purple Lilliput	4
Little Embarras River	*Notropis boops*	Bigeye Shiner	1
Deer Creek-Embarras River	*Carex arkansana*	Arkansas Sedge	1
	Ptychobranchus fasciolaris	Kidneyshell	10
	Clonophis kirtlandi	Kirtland's Snake	1
	Quadrula metanevra	Monkeyface	4
	Epioblasma triquetra	Snuffbox	9
Kickapoo Creek	*Ammocrypta pellucidum*	Eastern Sand Darter	2
	Clonophis kirtlandi	Kirtland's Snake	1
	Bartramia longicauda	Upland Sandpiper	1
Muddy Creek	*Emydoidea blandingii*	Blanding's Turtle	1
	Ammocrypta pellucidum	Eastern Sand Darter	2
	Lanius ludovicianus	Loggerhead Shrike	1
Range Creek-Embarras River	*Quadrula metanevra*	Monkeyface	6
	Hybopsis amblops	Bigeye Chub	4
	Lethenteron appendix	American Brook Lamprey	18
	Orobanche ludoviciana	Broomrape	4
	Apalone mutica	Smooth Softshell	10
	Epioblasma triquetra	Snuffbox	1
	Ammocrypta pellucidum	Eastern Sand Darter	41
	Notropis anogenus	Pugnose Shiner	4
	Monarda clinopodia	White Bergamot	9
	Myotis sodalis	Indiana Bat	5
	Setophaga cerulea	Cerulean Warbler	11
	Etheostoma histrio	Harlequin Darter	17
	Clonophis kirtlandi	Kirtland's Snake	14
	Ixobrychus exilis	Least Bittern	1
	Lanius ludovicianus	Loggerhead Shrike	1
	Calephelis muticum	Swamp Metalmark	1
	Haliaeetus leucocephalus	Bald Eagle	1
	Festuca paradoxa	Cluster Fescue	1

East Crooked Creek	*Lanius ludovicianus*	Loggerhead Shrike	1
	Haliaeetus leucocephalus	Bald Eagle	1
North Fork Embarras River	*Ammocrypta pellucidum*	Eastern Sand Darter	2
	Polygonum arifolium	Halbred-leaved Tearthumb	1
	Necturus maculosus	Mudpuppy	1
Big Creek	*Thamnophis sauritus*	Eastern Ribbon Snake	1
	Styrax americana	Storax	1
Honey Creek-Embarras River	*Botaurus lentiginosus*	American Bittern	3
	Dendroica cerulea	Cerulean Warbler	18
	Thamnophis sauritus	Eastern Ribbon Snake	5
	Ammocrypta pellucidum	Eastern Sand Darter	9
	Apalone mutica	Smooth Softshell	5
	Tympanuchus cupido	Greater Prairie-Chicken	28
	Lanius ludovicianus	Loggerhead Shrike	18
	Circus cyaneus	Northern Harrier	1
	Haliaeetus leucocephalus	Bald Eagle	6
	Coccyzus erythropthalmus	Black-billed Cuckoo	9
	Clematis viorna	Leatherflower	2
	Apalone mutica	Smooth Softshell	5
	Haliaeetus leucocephalus	Bald Eagle	1
	Papaipema eryngii	Eryngium Stem Borer	4
	Ixobrychus exilis	Least Bittern	6
	Penstemon tubaeflorus	Tube Beard Tongue	3
	Spiranthes vernalis	Spring Ladies' Tresses	4
	Terrapene ornata	Ornate Box Turtle	16
	Sabatia campestris	Prairie Rose Gentian	3
	Silene regia	Royal Catchfly	7
	Bartramia longicauda	Upland Sandpiper	23
Paul Creek-Muddy River	*Dendroica cerulea*	Cerulean Warbler	2
	Carex bromoides	Sedge	7
	Carex gigantea	Large Sedge	1
	Carex prasina	Drooping Sedge	5
	Hemidactylium scutatum	Four-toed Salamander	7
	Polygonum arifolium	Halbred-leaved Tearthumb	8
	Terrapene ornata	Ornate Box Turtle	1
	Lycopodium clavatum	Running Pine	1
	Haliaeetus leucocephalus	Bald Eagle	1
	Styrax americana	Storax	1
Brushy Creek	*Styrax americana*	Storax	1
	Myotis septentrionalis	Northern Long-eared Myotis	1
Indian Creek-Embarras River	*Myotis sodalis*	Indiana Bat	1
	Stenanthium gramineum	Grass-leaved Lily	1
	Thamnophis sauritus	Eastern Ribbon Snake	4
	Ixobrychus exilis	Least Bittern	2
	Clematis viorna	Leatherflower	2
	Silene regia	Royal Catchfly	4

	Lithasia obovata	Shawnee Rocksnail	4
	Penstemon tubaeflorus	Tube Beard Tongue	4
	Bartramia longicauda	Upland Sandpiper	1
	Nyctanassa violacea	Yellow-crowned Night-Heron	2
	Nycticorax nycticorax	Black-crowned Night-Heron	1
	Ammocrypta pellucida	Eastern Sand Darter	4
	Apalone mutica	Smooth Softshell	2
	Lepomis miniatus	Redspotted Sunfish	1
	Carex alata	Winged Sedge	2
	Carex arkansana	Arkansas Sedge	4
	Carex bromoides	Sedge	1
	Salvia azurea	Blue Sage	2
	Gallinula galeata	Common Gallinule	2
	Haliaeetus leucocephalus	Bald Eagle	1
	Phalaropus tricolor	Wilson's Phalarope	1

In 1984, a Biological Stream Characterization (BSC) Work Group convened to develop a multi-tiered classification of streams based primarily on fish communities. The use of letter grades "A" through "E" for evaluated reaches established a means of communicating levels of biotic integrity to diverse stakeholders. In 1992, the Illinois Natural History Survey (INHS) published a list of biologically significant streams (BSS) for the purpose of conserving biodiversity across the state. The BSS process expanded on BSC "A" rated streams by adding additional information on endangered and threatened species and mussel diversity. The IL Department of Natural Resources - Office of Resource Conservation, in partnership with INHS, initiated a project to combine, update, and enhance the two previous approaches for rating Illinois streams. This revised process incorporates biological data from 1997 through 2007. (IDNR, 2021).

The Embarras contains 141.4 miles of rated streams. Of this, approximately 68 miles are considered biologically significant and another 141 miles have been ranked for integrity (Table 3-22). The BSS segments include the Little Embarras River, North Fork Embarras River, McNary Branch, the Embarras River north and south of Greenup, Range Creek, and Hurricane Creek. Ratings of D and E for integrity have been assigned to Hackett Branch near Tuscola, and Indian Creek and the Embarras River near Lawrenceville.

Table 3-22: Biological Stream Ratings

Subwatershed	BSS stream length (mi)	A rating (mi)	B Rating (mi	C Rating (mi)	D Rating (mi)	E Rating (mi)
East Branch Embarras River	0	0	2.3	8.2	0	0
Scattering Fork	0	0	0	3.1	0	4.2
Brushy Fork	0	0	2.0	0	0	0
Little Embarras River	9.1	14.7	0	3.4	0	0
Deer Creek- Embarras River	0	2.9	3.9	8.9	0	0
Kickapoo Creek	0	0	3.7	5.1	0	0

Muddy Creek	0	3.3	2.2	3.9	0	0
Range Creek- Embarras River	44.9	1.2	11.3	12.9	0	3.9
East Crooked Creek	0	0	0	0	0	0
North Fork Embarras River	14.0	0	5.7	9.6	0	0
Big Creek	0	0	0	3.7	0	0
Honey Creek- Embarras River	0	0	6.3	0	0	0
Paul Creek- Muddy River	0	0	0	0	0	0
Brushy Creek	0	0	0	0	0	0
Indian Creek-Embarras River	0	0	0	5.0	5.8	4.0
Total	**68**	**22**	**37**	**64**	**6**	**12**

Freshwater Mussels

In 2009, a mussel survey was undertaken by the INHS and IDNR for the Embarras and Wabash River watersheds. A total of 39 tributaries were assessed in the Embarras. Thirty-one species were found with the greatest diversity located in the middle part of the basin. The study identified several species that may be extirpated in the Embarras River basin. Live or dead occurrences for the salamander mussel, sheepnose, clubshell, rabbitsfoot, fanshell, butterfly, black sandshell, round hickorynut, and rayed bean were not located or recent past surveys. A relict shell of the round hickorynut was found in the Embarras mainstem below Lake Charleston Dam. Mainstem sites displayed moderate to high recruitment with the exception of the furthest upstream and two furthest downstream sites. Recruitment was also moderate to high in nearly 50% of the North Fork Embarras River sites and the minor Wabash tributaries. These findings suggest that the mussel communities of the mainstem Embarras are viable and self-maintaining. Although many threatened, endangered, and rare species have been lost from this basin, unique mussel communities still persist in many locations (Shasteen, D.K., S.A. Bales, and A.L. Price, 2021).

Existing Conservation Practices

The watershed contains approximately 47,500 acres of ground enrolled in the Conservation Reserve Program (CRP) administered by the federal Farm Service Agency, or FSA. In this land conservation program, farmers enroll and agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental quality. In exchange, those enrolled in the program receive an annual rental payment for the 10-15-year contract period (contract duration is practice dependent). The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. Typical practices that fall under CRP include grass waterways, filter strips, field borders and native prairie.

Another 6,200 acres and 164 individual practices have been implemented by county SWCDs through the State's Partners for Conservation (PFC) program since 2017. Under PFC, cover crops, terraces, and water and sediment control basins are common. As shown in Table 3-23, the Range Creek- Embarras River subwatershed contains the most acres enrolled in CRP (12,617) followed by the North Fork Embarras River. The fewest acres have been enrolled in Scattering Fork, or 576. Participation in the PFC program is greatest in the East Branch of the Embarras River in terms of acres and Brushy Creek in terms of number of practices. No PFC-funded projects are located in Indian Creek – Embarras River and only one in East Crooked Creek.

Table 3-23: Existing CRP and PFC

Subwatershed	Acres CRP	Acres PFC	Number of PFC Practices
East Branch Embarras River	1,476	1,660	4
Scattering Fork	576	761	2
Brushy Fork	1,047	88	1
Little Embarras River	1,050	400	2
Deer Creek- Embarras River	1,898	300	2
Kickapoo Creek	921	110	10
Muddy Creek	6,085	517	19
Range Creek- Embarras River	12,617	271	7
East Crooked Creek	1,714	0	1
North Fork Embarras River	9,481	1,221	5
Big Creek	1,884	281	12
Honey Creek- Embarras River	5,496	401	28
Paul Creek- Muddy River	1,236	104	14
Brushy Creek	1,478	150	57
Indian Creek-Embarras River	626	0	0
Total	**47,583**	**6,265**	**164**

Water Quality

Water Quality Standards

Water quality standards are laws or regulations established to enhance water quality and protect public health and welfare. Standards consist of 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 (CWA) 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

Water quality standards relevant to this plan are nitrogen, phosphorus, Total Suspended Solids (TSS) and Volatile Suspended Solids (VSS), Fecal Coliform (FC), Dissolved Oxygen (DO), and biological indices. The INLRS calls for a 15% interim goal or reduction in nitrogen by 2025, while the Gulf Hypoxia Action Plan (2008, updated in 2015) calls for a 20% reduction by 2025 to address and reduce the hypoxic zone and achieve plan goals. Similarly, the INLRS calls for a 25% interim goal or reduction in phosphorus loadings by 2025, while the Gulf Hypoxia Action Plan calls for a 20% reduction to achieve plan goals by 2025. Both the INLRS and the Gulf Hypoxia Action Plan have a long-term goal of 45% reduction for both nitrogen and phosphorus. Phosphorus loading is also linked to sediment yields in agricultural watersheds. Other impairments, such as mercury, manganese, and iron, and physicochemical parameters including pH and water temperature, are outside this plan's scope. Each relevant parameter and associated standards are discussed below.

Nitrogen The various forms of nitrogen differ in respect to stream and 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 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 natural or unimpacted surface water systems 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 and will be used as a benchmark for assessing data presented in this section.
- **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 for the purposes of this report. Illinois Nutrient Science Advisory Committee (INSAC) recommends 3.8 mg/L as the TN guideline for wadable streams in the northern ecoregion (INSAC, 2018). The Embarras watershed falls mostly in the northern ecoregion.

Phosphorus is a major cellular component of organisms. It can be found in dissolved and sediment-bound forms but is often "locked up" as components in aquatic biota, primarily algae. Major sources in the watershed likely include fertilizers and, to a lesser extent, human and animal waste. In freshwater systems, phosphorus 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 are:

- **Soluble reactive phosphorus (SRP)** – dissolved phosphorus (DP) readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the nutrient is tied up in the algae and cycled very rapidly. Sources include fertilizers, animal wastes, and septic systems.
- **Total phosphorus (TP)** – includes dissolved and particulate forms. 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 guideline for non-wadable rivers and 0.113 mg/L for wadable streams for the northern ecoregion of Illinois (INSAC, 2018). The Embarras watershed falls mostly in the northern ecoregion. Data presented in this section will be compared to the standard for lake and the guideline for streams.

Total Suspended Solids (TSS) refers to the portion of total solids suspended in water as retained by a filter. It varies temporally in both rivers and lakes, typically increasing from erosion during runoff events, lake turnover, biological processes, and human disturbances. Total Suspended Solids can be differentiated between volatile suspended solids (VSS), organic materials such as algae and decomposing organic matter, and nonvolatile suspended solids (NVSS), which includes non-organic "mineral" substances (Illinois EPA, 1998).

As there is no regulatory standard for TSS in streams, a guideline of 116 mg/L has been applied in the past as an indicator of conditions to support aquatic life use (ALUS). The following analysis will also compare VSS to the 116 mg/L guideline as a proxy for both streams and lakes.

In lakes, the Aesthetic Quality Index (AQI) is a point system used to rank the lake quality based on physical and chemical water quality indicators. Three evaluation factors are used in establishing the number of AQI points; the higher AQI scores indicate increased impairment (Illinois EPA, 1998):

1. Median Trophic State Index (TSI): May–October and calculated from water quality data (total phosphorus, 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. Although NVSS is only one of three evaluation criteria for determining the AQI score, NVSS concentrations are heavily weighted as the highest score is achieved when NVSS concentrations are greater than or equal to 15 mg/L. The previous Illinois EPA guideline for listing TSS for aquatic life in lakes is an NVSS greater than 12 mg/L. Given the gaps in NVSS data for lakes, TSS was evaluated using the 15 mg/L threshold for lakes.

Fecal Coliform (FC) bacteria are used as indicators of possible sewage contamination due to the fact they are commonly found in both human and animal feces. These bacteria are not necessarily harmful to humans who contact them but instead are used as an indicator that other pathogenic bacteria may be present due to a source of human or animal feces. This analysis, therefore, is used as an indicator that swimming may be a health risk. Fecal coliform is reported as Coliform Forming Units, or CFU. The General Use Water Quality Standard specifies that during the months of May through October, based on a minimum of five samples taken over not more than a 30-day period, FC bacteria counts shall not exceed a geometric mean of 200 CFU/100 mL, nor shall more than 10% of the samples during any 30-day period exceed 400 CFU/100 ml (35 Ill. Adm. Code 302.209). For the purpose of this report, data will be compared to both the 200 CFU/100 mL sample standard and 400 from individual samples and not the temporal period associated with the standard.

Dissolved Oxygen (DO) is the amount of oxygen present in water and is imperative for aquatic life. It is influenced primarily by temperature, stagnation of water, and bacterial decay of organic matter, which may be a result of the increased presence of phosphorus as a limiting nutrient, which enables algal blooms. Illinois has a water quality standard of 5 mg/L during the period of March through July for both streams and lakes at any time, which was used to compare DO levels in this report (Illinois Pollution Control Board Title 35 2021).

Biological indices include the fish Index of Biotic Integrity (fIBI; Karr et al. 1986; Smoger 2000, 2005), the macroinvertebrate Index of Biotic Integrity (mIBI; Tetra Tech, Inc. 2004), and the Macroinvertebrate Biotic Index (MBI; Illinois EPA 1994). These indices are used in conjunction with water quality physiochemical data and constituent data to assess streams and the potential impairment. The 2018 Illinois 303(d) List report is summarized in Table 3-24.

- The fIBI in three indicator levels including greater than or equal to 41 as no impairment and fully supporting aquatic life, in between 41 and 20 as moderate impairment and not supporting aquatic life, and severe impairment and not supporting aquatic life are indices below or equal to 20. The fIBI data were compared at the two levels of below 41 and below 20.
- Similarly, mIBI in three indicator levels, including greater than or equal to 41.8 as no impairment and fully supporting aquatic life, in between 41.8 and 20.9 as moderate impairment and not supporting aquatic life, and severe impairment and not supporting aquatic life are indices below or equal to 20.9. The mIBI data were compared at the two levels of below 41.8 and below 20.9.

Impairments

Current impairments on the 2018 303(d) list are shown in Table 3-24; Exhibit 14. There are approximately 245 miles of impaired streams compared to 240 in 2008. The Embarras River and its tributary streams, as well as Sam Parr Lake, Red Hills State Park Lake, and Walnut Point Lake (279 combined lake acres) make the 303(d) list and are impaired for TP, DP, TSS, FC, iron, mercury, manganese, DO, pH, and temperature. It should be noted that if a stream is not listed on the 303(d) list, it may be impaired, however, the data (or lack thereof) does not indicate the impairment at the time of publication.

Impairments have persisted through time as shown in Table 3-25. Water quality impairments documented in the watershed date back to at least the early 1990s.

Table 3-24: 2018 303(d) Impaired Waterbodies					
Assessment ID	**HUC 10**	**Waterbody**	**Size (ac or mi)**	**Designated Use**	**Cause**
BE-01 (EMB, 3346550)	512011215	Embarras River	29.06	Aquatic Life, Primary Contact Recreation	Dissolved Oxygen, Fecal Coliform
BE-07 (EMS, 3345500)	512011212	Embarras River	23.7	Primary Contact Recreation	Fecal Coliform
BE-09 (EMD, 3344000)	512011208	Embarras River	39.14	Fish Consumption, Primary Contact Recreation	Fecal Coliform, Mercury
BE-14 (3343395)	512011201	Embarras River	20.89	Fish Consumption, Primary Contact Recreation	Fecal Coliform, Mercury
BEB-01	512011214	Brushy Creek	8.15	Aquatic Life	Dissolved Oxygen
BEDB-01	512011211	Dogwood	15.22	Aquatic Life	Total Phosphorus, Dissolved Phosphorus, Manganese
BEF-05 (NFO)	512011210	North Fork Embarras River	29.96	Aquatic Life, Primary Contact Recreation	Fecal Coliform, pH
BEH	512011208	Mint Creek	12.29	Aquatic Life	Dissolved Oxygen
BENA-01	512011206	Riley Creek	1.38	Aquatic Life	Dissolved Oxygen
BEPC	512011204	Donica Creek	3.08	Aquatic Life	Dissolved Oxygen
BEPD-01	512011204	Catfish Creek	11.26	Aquatic Life	Dissolved Oxygen
BERB-TO-C1	512011202	Hackett Branch	6.61	Aquatic Life	Total Phosphorus, Dissolved Oxygen
BERB-TO-C1A	512011202	Hackett Branch	0.57	Aquatic Life	Total Phosphorus, Dissolved Oxygen
BEZB-07	512011215	Indian Creek	15.08	Aquatic Life	Dissolved Oxygen
BEZF-01	512011215	Allison Ditch	18.71	Aquatic Life	Dissolved Oxygen
BEZY	512011205	Deer Creek	14.34	Aquatic Life	Dissolved Oxygen, Water Temperature, Iron
RBA	512011212	Sam Parr Lake	180	Aesthetic Quality, Fish Consumption	Total Phosphorus, Total Suspended Solids, Mercury
RBB	512011213	Red Hills State Park Lake	40	Fish Consumption	Mercury
RBK	512011205	Walnut Point Lake	58.7	Aesthetic Quality	Total Suspended Solids

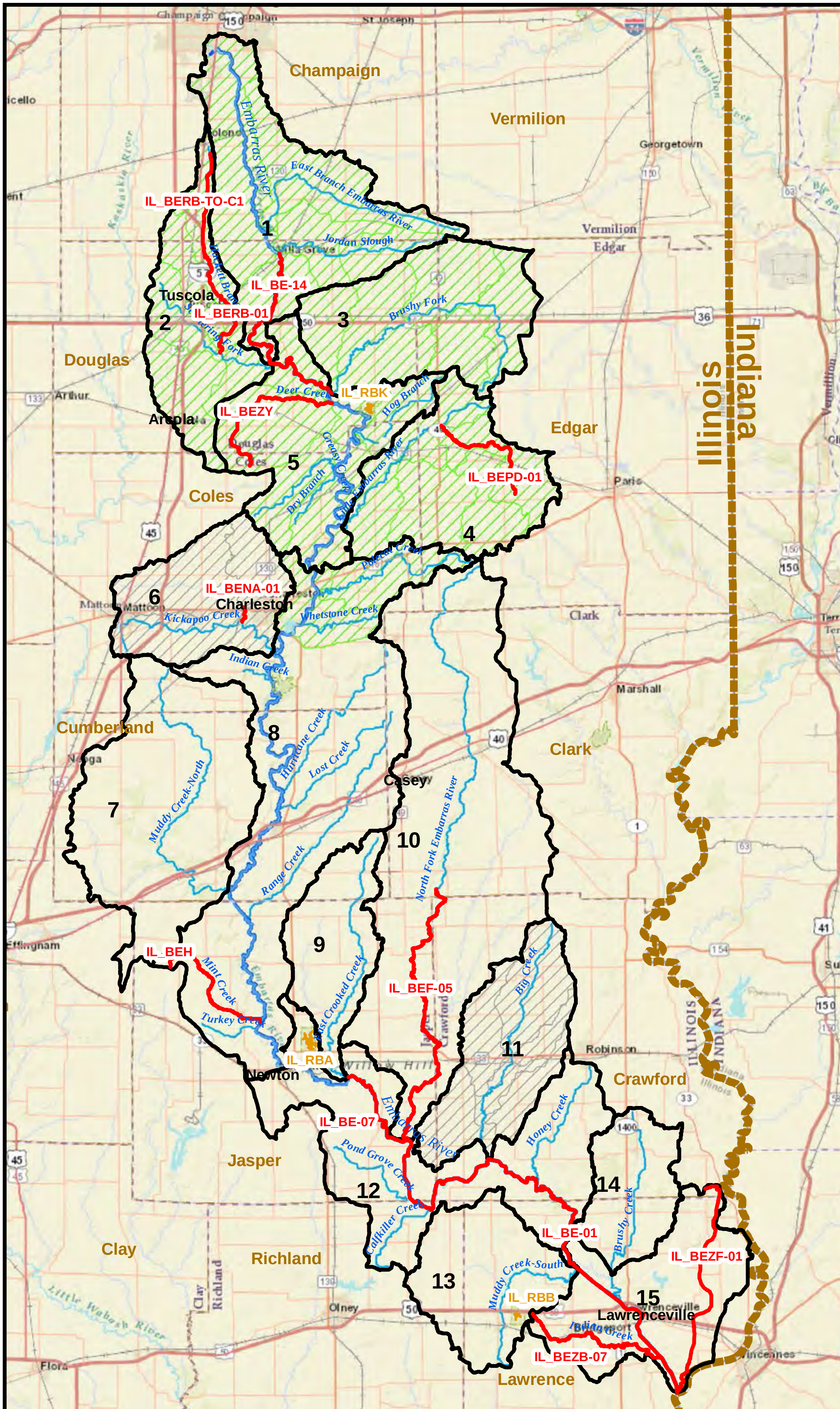
Table 3-25: Historical Impairments – 2004-2016 Illinois EPA 303(d) List		
Assessment ID	**Waterbody**	**Impairment/ Impairment Cause**
2004		
RBP	Oakland	Total Phosphorus, Sedimentation, Total Suspended Solids, Excess Algal Growth, Manganese
RBK	Walnut Point Lake	Nitrate Nitrogen, Unspecified Nutrient, Total Phosphorus, Sedimentation, Dissolved Oxygen, Total Suspended Solids, Aquatic Plants - Native, Excess Algal Growth
BE-14	Embarras River	Total Nitrogen, Total Phosphorus, Total Suspended Solids, Ph, Sedimentation, Dissolved Oxygen, Fecal Coliform
2006		
BE-14	Embarras River	Total Nitrogen, Total Phosphorus, Total Suspended Solids, Sedimentation, Fecal Coliform, Dissolved Oxygen, Ph
RBK	Walnut Point Lake	Total Phosphorus, Total Suspended Solids
BER-01	Scattering Fork	Total Phosphorus, Total Nitrogen
BERB-TO-C1	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BERB-TO-C1A	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BEN-01	Kickapoo Creek	Total Phosphorus, Total Nitrogen
BENA-01	Riley Creek	Total Nitrogen, Ph
BENA-02	Riley Creek	Total Nitrogen
BE-09	Embarras River	Fecal Coliform
BEI-01	Range Creek	Unknown
RBC	Charleston Side Channel	Manganese
BE-07	Embarras River	Fecal Coliform
RBA	Sam Parr Lake	Total Phosphorus, Total Suspended Solids
BE-01	Embarras River	Fecal Coliform
BEZB-07	Indian Creek	Dissolved Oxygen, Manganese
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Total Phosphorus, Total Suspended Solids
2008		
BE-14	Embarras River	Total Phosphorus, Sedimentation/Siltation, Total Suspended Solids, Fecal Coliform, Ph
BEN-01	Kickapoo Creek	Total Phosphorus
BENA-01	Riley Creek	Ph
BENA-02	Riley Creek	Unknown

BENC-01	Cassel Creek	Unknown
BE-07	Embarras River	Fecal Coliform
RBA	Sam Parr Lake	Total Phosphorus, Total Suspended Solids, Mercury
BER-01	Scattering Fork	Total Phosphorus
BERB-TO-C1	Hackett Branch	Total Phosphorus
BERB_TO_C1A	Hackett Branch	Total Phosphorus
BE-09	Embarras River	Fecal Coliform
BEI-09	Range Creek	Unknown
BE-01	Embarras River	Fecal Coliform
BEZB-07	Indian Creek	Manganese
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Total Phosphorus, Total Suspended Solids
RBK	Walnut Point Lake	Total Suspended Solids
2010		
BEB-01	Brushy Creek	Manganese
BEDB-01	Dogwood Creek	Total Phosphorus, Manganese
BE-01	Embarras River	Fecal Coliform
BE-07	Embarras River	Fecal Coliform
BE-09	Embarras River	Fecal Coliform
BE-14	Embarras River	Fecal Coliform
BERB-TO-C1	Hackett Branch	Total Phosphorus
BERB-TO-C1A	Hackett Branch	Total Phosphorus
BEZB-07	Indian Creek	Unknown
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Total Phosphorus, Totals Suspended Solids, Mercury
RBA	Sam Parr Lake	Total Phosphorus, Totals Suspended Solids, Mercury
2012		
BEB-01	Brushy Creek	Manganese
BEDB-01	Dogwood Creek	Total Phosphorus, Dissolved Oxygen, Manganese
BE-01	Embarras River	Fecal Coliform
BE-07	Embarras River	Fecal Coliform
BE-09	Embarras River	Fecal Coliform
BE-14	Embarras River	Fecal Coliform
BERB-TO-C1	Hackett Branch	Total Phosphorus, Dissolved Oxygen

BERB-TO-C1A	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BEZB-07	Indian Creek	Dissolved Oxygen
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Total Phosphorus, Totals Suspended Solids, Mercury
RBA	Sam Parr Lake	Total Phosphorus, Totals Suspended Solids, Mercury
2014		
BEB-01	Brushy Creek	Dissolved Oxygen
BEPD-01	Catfish Creek	Dissolved Oxygen
BEZY	Deer Creek	Dissolved Oxygen, Iron, Water Temperature
BEDB-01	Dogwood Creek	Total Phosphorus, Dissolved Oxygen, Manganese
BEPC	Donica Creek	Dissolved Oxygen
BE-01	Embarras River	Dissolved Oxygen, Iron, Fecal Coliform
BE-07	Embarras River	Fecal Coliform
BE-09	Embarras River	Fecal Coliform
BE-14	Embarras River	Fecal Coliform
BERB-TO-C1	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BERB-TO-C1A	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BEZB-07	Indian Creek	Dissolved Oxygen
BEH	Mint Creek	Dissolved Oxygen
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Mercury
BENA-01	Riley Creek	Dissolved Oxygen
RBA	Sam Parr Lake	Total Phosphorus, Totals Suspended Solids, Mercury
2016		
BEZF-01	Allison Ditch	Dissolved Oxygen
BEB-01	Brushy Creek	Dissolved Oxygen
BEPD-01	Catfish Creek	Dissolved Oxygen
BEZY	Deer Creek	Dissolved Oxygen, Iron, Water Temperature
BEDB-01	Dogwood Creek	Total Phosphorus, Dissolved Oxygen, Manganese
BEPC	Donica Creek	Dissolved Oxygen
BE-01	Embarras River	Dissolved Oxygen, Iron, Fecal Coliform
BE-07	Embarras River	Fecal Coliform
BE-09	Embarras River	Fecal Coliform
BE-14	Embarras River	Fecal Coliform
BERB-TO-C1	Hackett Branch	Total Phosphorus, Dissolved Oxygen

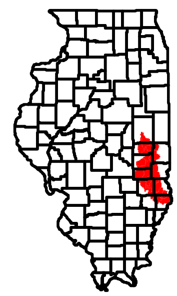
BERB-TO-C1A	Hackett Branch	Total Phosphorus, Dissolved Oxygen
BEZB-07	Indian Creek	Dissolved Oxygen
BEH	Mint Creek	Dissolved Oxygen
BEF-05	North Fork Embarras River	Fecal Coliform
RBB	Red Hills State Park Lake	Mercury
BENA-01	Riley Creek	Dissolved Oxygen
RBA	Sam Parr Lake	Total Phosphorus, Totals Suspended Solids, Mercury

Exhibit 14



Embarras River Watershed

2018 Impairments & TMDL Status



Legend

- 2018 Impaired Streams
- 2018 Impaired Lakes

TMDL Status

- Complete
- Underway
- Embarras River
- Embarras River Tributaries
- Embarras River Watershed & Subwatersheds
- Counties

N
W E
S

0 5 10 Miles

Water Quality

As described in the previous section, waterbodies in the Embarras River Watershed have had a wide range of impairments, including TP, DP, TSS, FC, iron, mercury, manganese, DO, pH, and temperature.

Data were retrieved from the National Water Quality Monitoring Council water quality data portal from a period up to 2021. Multiple sources were used, including the USGS, Illinois EPA, and independent studies. Biological data (i.e., fish or fIBI and macroinvertebrates or mIBI) were obtained directly from the Illinois EPA. Additionally, data from other non-governmental organization efforts, including the Farm Bureau, were used, if available. All data were included in the presentation and analysis; however, some were reported in units incomparable and, therefore, omitted.

Stations were synthesized to support cohesive analysis and nomenclature following USGS station codes. If no code was applicable, then Illinois EPA station codes are presented. For example, USGS station code number 3343395 is the same sampling location as Illinois EPA site BE-14; therefore, 3343395 is used. Details of the water quality stations and locations are included in Table 3-26. Figure 3-A depicts monitoring locations.

Table 3-26: Primary Water Quality Stations

Station Code	Latitude (dd)	Longitude (dd)	Waterbody	Range of Data	Parameters & Other Notes
3343395; BE-14	39.7997222	-88.1702777	East Branch Embarras River	July 2001-August 2016 (Bi-weekly)	NO3, TP, TSS, VSS, Fecal Coliform, DO, fIBI, mIBI
3344000; BE-09; EMD	39.3444444	-88.1708333	Range Creek-Embarras River	October 1963-September 2020 (Monthly)	NO3, TP, TSS, VSS, Fecal Coliform, DO, fIBI, mIBI
3345500; BE-07; EMS	38.9363888	-88.0225	Honey Creek-Embarras River	October 1963-September 2020 (Monthly)	NO3, TP, TSS, VSS, Fecal Coliform, DO, fIBI, mIBI
3346000; BEF-03	39.01023	-87.9466	North Fork Embarras River	December 1978-May 2021 (Bi-monthly)	NO3, TP, TSS, VSS, Fecal Coliform, DO, fIBI, mIBI
3346500; BE-33	38.724167	-87.6652778	Indian Creek-Embarras River	January 2013-November 2020 (Bi-weekly)	NO3, TP, TSS, VSS, fIBI, mIBI
3346550; EMB	38.665	-87.6263888	Indian Creek-Embarras River	October 1977-May 2021 (Monthly)	NO3, TP, TSS, VSS, Fecal Coliform, DO, fIBI, mIBI
BE-96; EMLC	39.45714	-88.14699	Range Creek-Embarras River	July 2001-December 2019 (Bi-weekly)	TP

BEF-05	39.00017	-87.9448	North Fork Embarras River	January 1999-December 2019 (Monthly)	NO3, TP, TSS, VSS, DO, fIBI, mIBI
BEN-01	39.46252	-88.19315	Kickapoo Creek	June 2001-August 2016 (Monthly)	NO3, TP, TSS, VSS, DO, fIBI
BEN-03	39.46252	-88.19315	Kickapoo Creek	September 2011-October 2015 (Monthly)	NO3, TP, fIBI
BEN-04	39.46252	-88.19315	Kickapoo Creek	May 2013-October 2015 (Monthly)	NO3, TP
BEN-05	39.46252	-88.19315	Kickapoo Creek	May 2013-October 2016 (Monthly)	NO3, TP
Lake Charleston Side Channel (RBC 1-3)	39.46249	-88.14194	Range Creek-Embarras River	May 2001-October 2013 (Monthly)	NO3, TP, TSS, VSS, DO
Red Hills Lake (RBB 1-3)	38.72398	38.72398	Paul Creek-Muddy River	May 2011-October 2011 (Monthly)	NO3, TP, TSS, VSS, DO
Sam Parr Lake (RBA 1-3)	39.01369	-88.11841	Honey Creek-Embarras River	May 2011-October 2011 (Monthly)	NO3, TP, TSS, VSS, DO
Walnut Point Lake (RBK 1-3)	39.69527	-88.03275	Deer Creek-Embarras River	April 2014-October 2014 (Monthly)	NO3, TP, TSS, VSS, DO

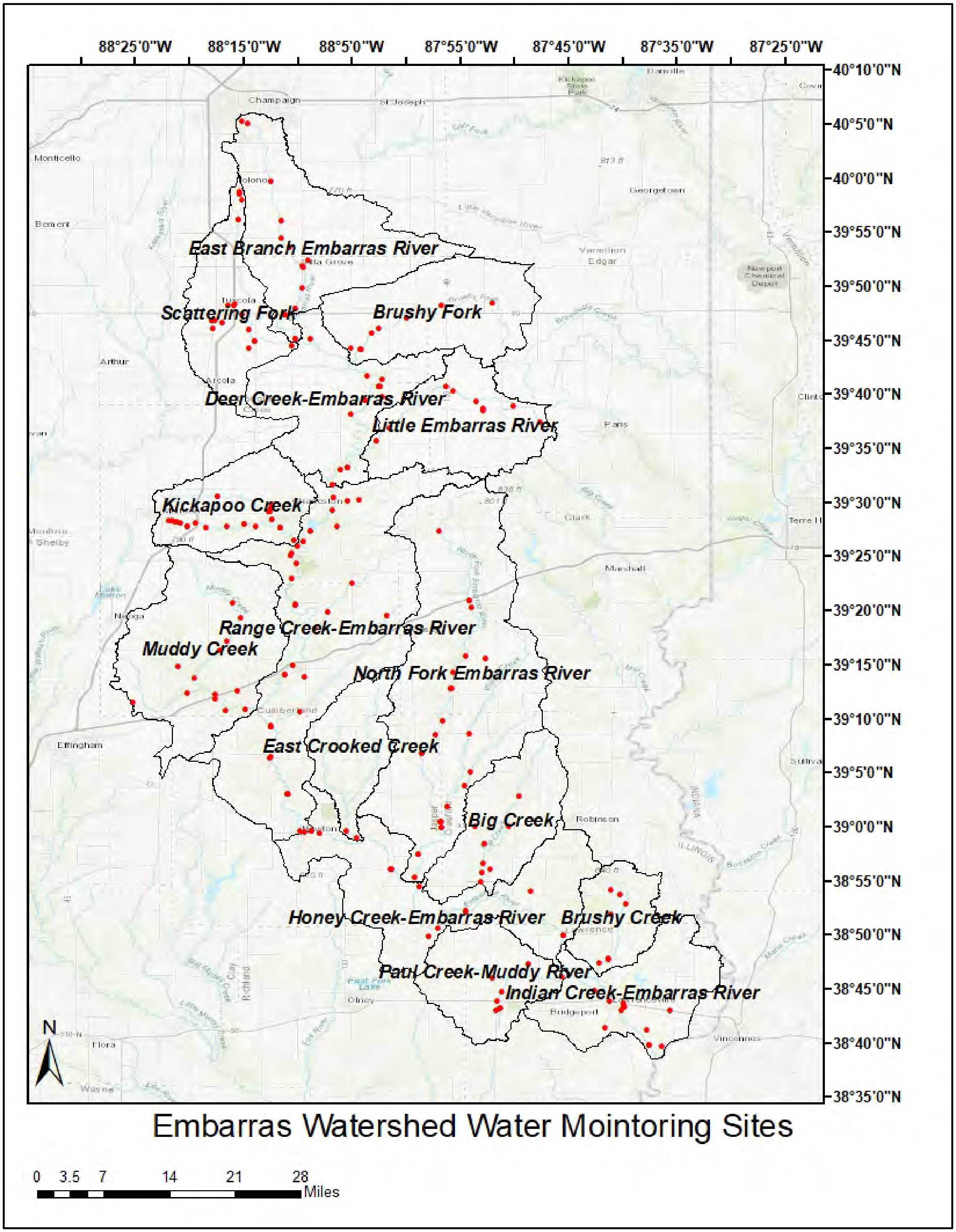


Figure 3-A – Monitoring locations in the Embarras

Nitrogen

Nitrate (NO3) is the primary form of nitrogen for which data is available, with over 3,000 samples from the Embarras River and its tributaries. The NO3 concentrations were compared against the 10 mg/L drinking water standard and the 3.98 mg/L INSAC TN guideline in Table 3-27 and 3-28. These data bring insights into the nitrogen loading dynamics in the watershed.

Most data available for the streams fall below lab detection limits, and there is limited data for TKN and NH4. The analysis assumes that NO3 is the primary component of TN when screening against the INSAC criteria.

Many of the samples exceeded the INSAC guideline of 3.98 mg/L most of the time (Table 3-27). Samples from the 1970s to 2020 show frequent exceedances of 3.98 mg/L. The drinking water quality standard of 10 mg/L was rarely exceeded.

Nitrate data organized by HUC 10 subwatershed (Table 3-28) can inform priorities and management efforts. Kickapoo Creek appears to have the highest concentrations with 91% and 50% of the samples exceeding the guideline and drinking water standard, respectively. It should be noted that most samples in the Kickapoo were taken around the 2013-2015 timeframe. Considering precipitation is a primary driver of NO3 loss, wetter periods tend to correspond to greater loadings. The years of 2014 and 2015 exhibited the third wettest and the wettest June, as well as the third wettest July on record between 1970 and 2020 (Figure 3-B). Additionally, four of the top 20 historical river crests at Lawrenceville occurred between 2013 and 2015. Therefore, in the Kickapoo, more samples may have been taken during years that exhibited more NO3 runoff. Other watersheds with high NO3 concentrations include the Deer Creek-Embarras River, East Branch Embarras River, and the Little Embarras River. Limited lake sampling indicates NO3 concentrations rarely exceed 10 mg/L, with only the Lake Charleston Side Channel reservoir exceeding 3% of the time.

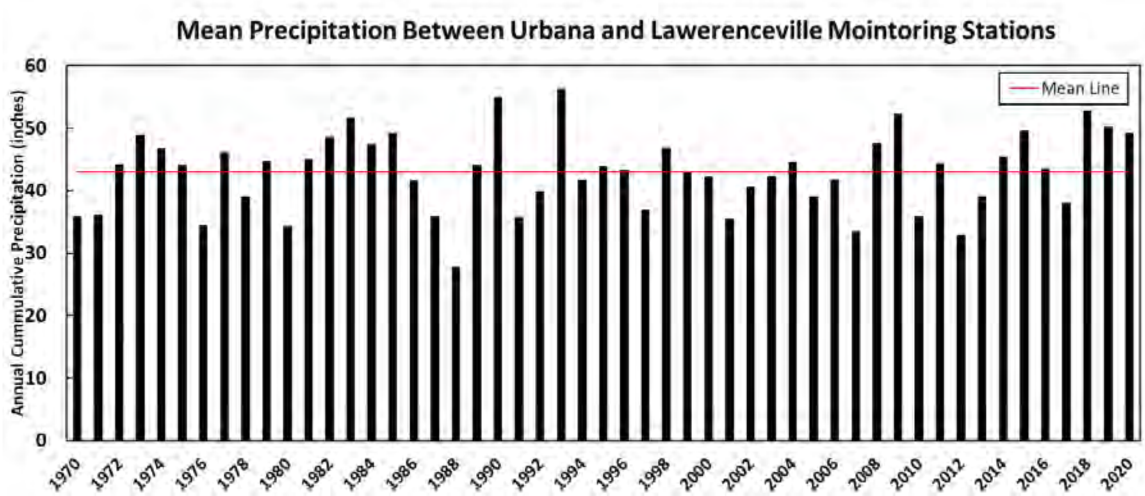


Figure 3-B - National Weather Service Precipitation Data, Mean between Urbana and Lawrenceville Monitoring Stations

Figure 3-C plots NO3 in three HUC 10s and locations are organized from the northern-most site at Camargo to Lawrenceville, or the outflow of the Embarras River. Based on measured concentrations, NO3 decreases moving downstream. This could be a result of dilution or less tile drainage along the lower reaches of the Embarras, or more denitrification or assimilation

as the water moves through the watershed. The year 2013 provides an example where exceptionally high runoff show concentrations above 10 mg/L in multiple locations. This was a statistically high year of flow and precipitation preceded by a year of lower rainfall. High concentrations are observed during the spring period when agricultural practices are commencing. Low concentrations occur during lower flows, typically from late summer through winter.

Overall, trends in the Embarras over time cannot be discerned from Figure 3-C plots. However, Hodson and Terrio (2020) analyzed data from 1978-2017 and described several trends in TN and NO3 where from 1978-2017, the Embarras saw a decrease in TN, an increase in NO3, and a decrease in TKN (Hodson and Terrio, 2020). When analyzing the more recent data from 2008-2017 TN, NO3, and TKN all showed increases in yields from the Embarras River at the USGS station 03345500 or BE-07 (Hodson and Terrio, 2020). Hodson and Terrio (2020) noted a yield change decrease in flow-normalized TN of 3.9 kg/ha/yr between 1978 and 2017, while an increase of 2.2 kg/ha/yr between 2008 and 2017. This increase was the largest of all Illinois watersheds investigated, as opposed to 1978-2017 where the Embarras had the largest decrease. Additionally, continuous monitoring data were analyzed by the USGS for the period of 2015-2019 at the same site at Lawrenceville. This showed that annual NO3 loading ranged between 8 and 12.3 lbs/ac with a mean of 10.2, with the largest being 2019 (USGS, 2020).

Another study analyzed data from 1992 to 2012 from five sampling stations, including Jordan Slough, Long Point Slough, Black Slough, East Branch, and at USGS station 3393395 near Camargo (3393395 concentrations presented in Exhibit 17; Gentry et al., 2014). During the two decades of monitoring, the yields from the East Branch Embarras River watershed (3393395 site) varied largely between less than 10 kg-N/ha/yr in 2003 and 2012 to over 50 kg-N/ha/yr in 1993 and 2002 (Gentry et al., 2014). The years 2003 and 2012 were both two of the driest for the watershed. Additionally, Gentry et al. (2014) observed a seasonal trend in the data with low concentrations in the fall and increasing throughout the winter with a peak in late spring followed by a decrease in the summer. Gentry et al. (2014) attributed the fluctuation to agricultural tile flow along with David et al. (1997).

These data indicate that management of nitrogen could be prioritized to the northern portion of the basin.

Table 3-27: NO3-N Concentrations

Station Code	Waterbody	Temporal Range of Data	Count	Mean (mg/L)	Median (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed INSAC		Exceed WQ std.	
								#	%	#	%
3343395; BE-14	East Branch Embarras River	1978-2020	368	7.48	8.35	14	19	269	73	122	33
3346000; BEF-03	North Fork Embarras River	1978-2020	173	1.24	1.1	2.84	6.7	1	1	0	0
3346500; BE-33	Indian Creek-Embarras River	2015-2020	69	2.25	2.44	4.36	9.14	6	9	0	0

3344000; BE-09; EMD	Range Creek-Embarras River	1970-2020	698	5.94	6.23	11.28	16.2	478	68	91	13
3345500; BE-07; EMS	Honey Creek-Embarras River	1977-2020	567	4.06	3.9	9.57	13	277	49	18	3
3346550; EMB	Indian Creek-Embarras River	1977-2020	370	2.96	2.76	6.99	10.4	123	33	2	1
BEF-05	North Fork Embarras River	1999-2019	186	0.91	0.63	2.88	4	1	1	0	0
BEN-01	Kickapoo Creek	2001-2016	59	10.31	8.43	22.65	33.3	57	97	23	39
BEN-03	Kickapoo Creek	2013-2015	42	13.06	9.01	29.54	37.6	40	95	19	45
BEN-04	Kickapoo Creek	2013-2015	39	13.83	12.1	26.34	32.7	37	95	23	59
BEN-05	Kickapoo Creek	2013-2015	37	14.03	11.6	28.7	31.8	35	95	23	62
Lake Charleston Side Channel (RBC 1-3)	Range Creek-Embarras River	2001-2013	94	0.25	0.01	0.41	4.9	4	4.3	0	0
All other samples*	Entire Embarras River Basin	2000-2019	548	3.47	1.18	12.07	25.1	168	30.7	73	13
All Data	**Entire Embarras River Basin**	**2000-2019**	**3,321**	**4.5**	**3.28**	**12**	**37.6**	**1,523**	**45.1**	**395**	**12**

The INSAC guideline is for total nitrogen; this table is based on nitrate concentrations and should be considered conservative in that regard, as TKN and ammonia are not accounted for.
*For data reported as nitrate + nitrite, it was assumed that nitrite was negligible; this allowed for a more complete temporal plot to be developed. *remaining sites which did not have samples in more than one year or more than 20 samples collected*

Table 3-28: HUC10 NO3-N Concentrations										
HUC10	**Temporal Range of Data**	**Count**	**Mean (mg/L)**	**Median (mg/L)**	**95th Percentile (mg/L)**	**Max (mg/L)**	**Exceed INSAC**		**Exceed WQ std.**	
							#	**%**	**#**	**%**
Big Creek	2001-2016	23	0.55	0.5	1.32	1.93	0	0	0	0
Brushy Creek	2006-2011	9	0.5	0.18	1.4	1.63	0	0	0	0
Brushy Fork	2001-2016	18	3.63	0.07	13	16.4	6	33	3	17
Deer Creek-Embarras River	2001-2014	35	5.66	4.9	11.79	16.1	20	57	8	23
East Branch Embarras River	1978-2019	412	7.57	8.27	14.14	51	292	71	139	34
East Crooked Creek	2016	5	0.79	0.31	1.78	1.87	0	0	0	0

Honey Creek-Embarras River	1977-2019	742	4.8	3.4	14.42	53	334	45	59	8
Indian Creek-Embarras River	1977-2020	489	2.72	2.44	6.8	10.4	137	28	2	0
Kickapoo Creek	2001-2016	224	11.83	10	26.6	37.6	204	91	113	50
Little Embarras River	2001-2016	27	6.16	5.94	13.52	14.9	15	56	8	30
Muddy Creek	2001-2016	18	0.58	0.11	3	3.23	0	0	0	0
North Fork Embarras River	1978-2020	404	1.04	0.8	2.9	6.70	5	1	0	0
Paul Creek-Muddy River	2006-2016	9	1.57	1.09	3.5	3.80	0	0	0	0
Range Creek-Embarras River	1970-2016	774	13.25	7.8	45	66	562	73	296	38
Scattering Fork	2000-2016	22	6.12	3.55	13.77	17.3	10	45	8	36
Red Hills Lake (RBB 1-3)	2011	20	0.13	0.06	0.34	0.44	0	0	0	0
Sam Parr Lake (RBA 1-3)	2011	20	0.12	0.09	0.33	0.33	0	0	0	0
Walnut Point Lake (RBK 1-3)	2014	16	1.1	0.85	2.8	2.94	0	0	0	0
Lake Charleston (RBH 1-3)	2003	18	4.42	3.83	9.46	9.47	9	50	0	0
Lake Charleston Side Channel (RBC 1-3)	2001-2013	94	0.25	0.01	0.41	4.9	4	4	0	0
Oakland Lake (RBP 1-3)	2001	18	1.09	0.78	3.18	3.6	0	0	0	0

The INSAC guideline is for total nitrogen; this table is based on nitrate concentrations and should be considered conservative in that regard, as TKN and ammonia are not accounted for.
For data reported as nitrate + nitrite, it was assumed that nitrite was negligible; this allowed for a more complete temporal plot to be developed.

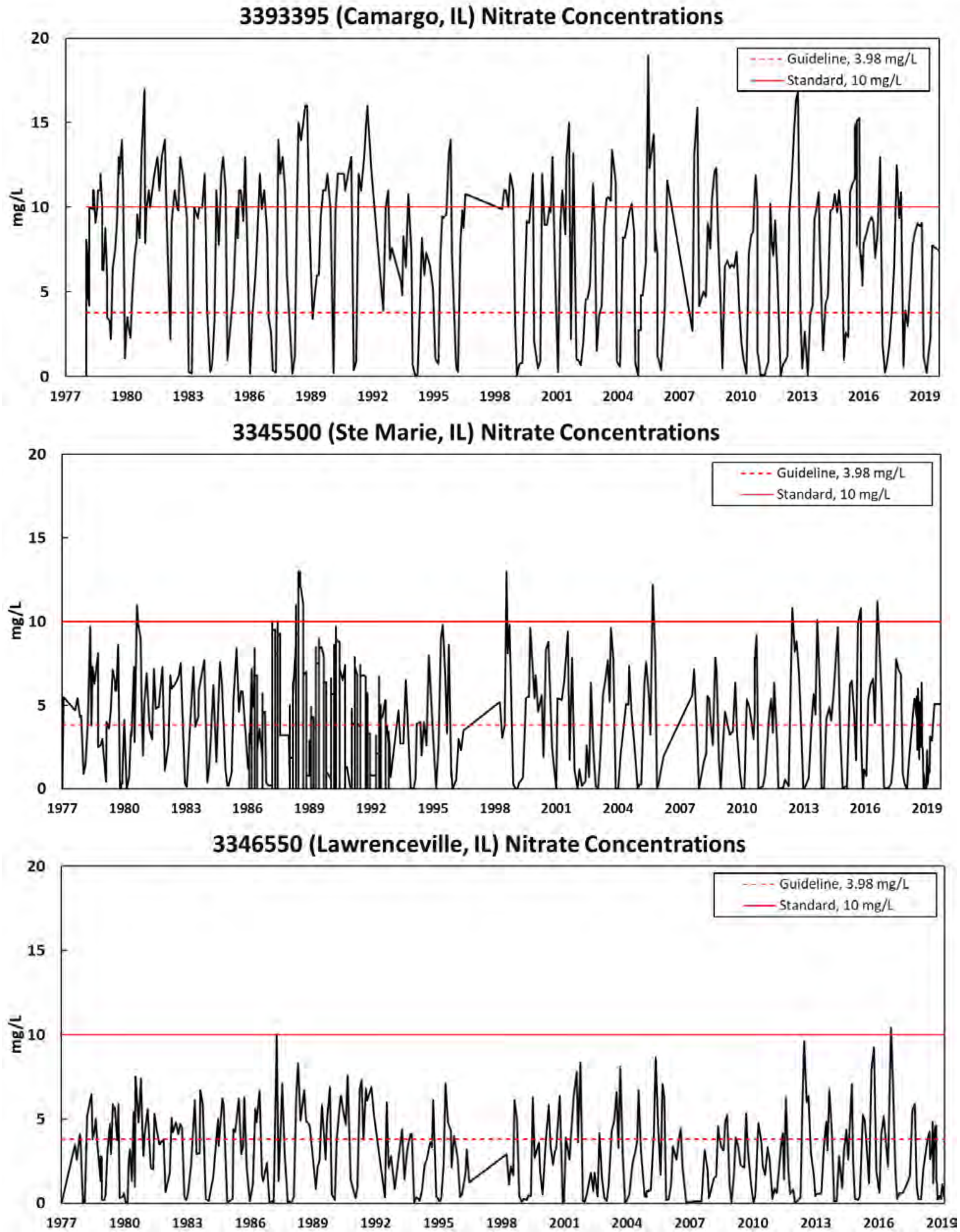


Figure 3-C – Nitrate Concentrations at Camargo, Ste Marie, and Lawrenceville Monitoring Stations

Total Phosphorus

Over 4,700 TP samples have been collected regularly exceeding the INSAC guideline of 0.113 mg/L and the 0.05 mg/L standard used for lakes 20 acres or greater. Based on data presented in Table 3-29, 32-99% and 62-100% of samples exceeded the guideline and standard, respectively. All sampling locations' means were above 0.1 mg/L with the exception of the Lake Charleston Side Channel reservoir. Almost all locations have median values equal to or above the standard. These consistently high concentrations demonstrate the challenges associated with meeting the low 0.05 mg/L threshold in lakes.

The HUC10 subwatersheds with the highest values include Big Creek, Honey Creek-Embarras River, Indian Creek-Embarras River, Kickapoo Creek, and Paul Creek-Muddy River (Table 3-30). Kickapoo Creek, with over 400 samples, shows an average of 1.32 mg/L, with 90% and 94% of samples exceeding the guideline and standard, respectively. Agriculture and the permitted point sources from Charleston and Mattoon are likely sources in this subwatershed. Almost all samples were taken between 2013 and 2015 when significant amounts of precipitation led to unusually large amounts of runoff and possibly higher TP.

Lakes have limited sample records and usually from just one year. Sam Parr Lake in 2011 had 40 samples collected at three sites with an average of 1.37 mg/L. It should be noted that 2011 had the second wettest April on record between 1970 and 2020, which coincides with spring agricultural activities. A large majority of this lake's watershed is in agricultural production.

Concentrations for three stream sites are presented in Figure 3-D and show that TP is less seasonal than NO3 and more responsive to precipitation events. This is expected due to higher losses associated with soil erosion and larger volume of runoff. Figure 3-D indicates that phosphorus follows an opposite trend to nitrogen and increases moving downstream. This may be a result of higher concentrations in downstream tributaries, additional wastewater treatment facility effluent (greater population), septic systems, and potentially more severe stream bank erosion.

Soil erosion was noted as a factor influencing phosphorus, TSS, and TKN, evident by streamflow trends from 2008-2017 (Hodson and Terrio, 2020). Overall, Hodson and Terrio (2020) reported a yield increase in the Embarras for both analysis time periods, including 1978-2017 and 2008-2017, with a change of 0.1 kg/ha/yr and 0.7 kg/ha/yr, respectively. Additionally, USGS (2020) reported annual yields of 1.46-2.24 kg/ha between 2016 and 2019 from continuous monitoring studies at the Lawrenceville station. Data suggests that phosphorus is heavily influenced by erosion, especially during precipitation events. Although a decreasing trend was observed from 1978 to 2017, more recent data from 2008 through 2017 show an increase suggesting less municipal effluent and more from agricultural sources (Hodson and Terrio, 2020). Gentry et al. (2007) analyzed phosphorus from samples collected at the USGS station 3343400 and described that TP loadings were disproportionate to wet conditions suggesting that loads were not directly proportional to amounts of precipitation and that wetter years could experience much more export. At this station, annual loadings were 0.75 kg/ha/yr and responded to precipitation events with larger events contributing a disproportionately large amount of TP to streams (Gentry et al., 2007). During the ten years of monitoring from 1994 to 2003, Gentry et al. (2007) observed the greatest flow-weight concentration during 2002 at 0.356 mg/L and the least during 2000 at 0.147 mg/L.

Table 3-29: TP Concentrations by Station									
Station Code	Waterbody	Temporal Range of Data	Count	Mean (mg/L)	Median, (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed INSAC[A]	
								#	%
3343395; BE-14	East Branch Embarras River	1984-2020	592	0.1	0.07	0.26	1.22	175	30
3344000; BE-09; EMD	Range Creek-Embarras River	1973-2020	723	0.2	0.14	0.54	2	488	67
3345500; BE-07; EMS	Honey Creek-Embarras River	1977-2020	717	0.16	0.12	0.44	3.2	408	57
3346000; BEF-03	North Fork Embarras River	1984-2020	264	0.14	0.11	0.44	0.89	134	51
3346500; BE-33	Indian Creek-Embarras River	2015-2020	73	1.95	2.13	4.33	6.71	72	99
3346550; EMB	Indian Creek-Embarras River	1977-2020	598	0.18	0.13	0.48	2.5	371	62
BE-96; EMLC	Range Creek-Embarras River	2001-2019	36	0.12	0.1	0.26	0.59	14	39
BEF-05	North Fork Embarras River	1999-2019	343	0.15	0.11	0.43	1.32	172	50
BEN-01	Kickapoo Creek	2001-2016	110	1.11	0.96	2.68	3.82	108	98
BEN-03	Kickapoo Creek	2013-2015	82	1.15	0.8	3.62	4.04	71	87
BEN-04	Kickapoo Creek	2013-2015	76	1.76	1.35	4.64	5.21	74	97
BEN-05	Kickapoo Creek	2013-2015	72	1.93	1.78	4.86	5.16	70	97
Lake Charleston Side Channel (RBC 1-3)	Range Creek-Embarras River	2001-2013	162	0.08	0.08	0.16	0.24	100	62
All other samples*	Entire Embarras River Basin	2000-2019	855	0.29	0.1	0.93	13.1	403	47
All Data	**Entire Embarras River Basin**	**1973-2020**	**4,703**	**0.3**	**0.12**	**1.14**	**13.1**	**2,609**	**56**

**remaining sites which did not have samples in more than one year or more than 20 samples collected*

[A] Lake Charleston Side Channel data compared to lake standard of 0.05 mg/L. All other samples and all data percentages were calculated using 0.1 mg/L guideline

Table 3-30: HUC10 TP Concentrations								
HUC10	**Temporal Range of Data**	**Count**	**Mean (mg/L)**	**Median (mg/L)**	**95th Percentile (mg/L)**	**Max (mg/L)**	**Exceed INSAC***	
							#	**%**
Big Creek	2001-2016	39	0.33	0.20	0.92	1.44	27	69
Brushy Creek	2006-2011	15	0.07	0.07	0.12	0.14	1	7
Brushy Fork	2001-2016	22	0.07	0.06	0.17	0.24	3	14
Deer Creek-Embarras River	2001-2011	47	0.11	0.11	0.23	0.31	20	43
East Branch Embarras River	1991-2020	643	0.1	0.07	0.26	1.22	189	29
East Crooked Creek	2016	8	0.19	0.16	0.36	0.36	5	63
Honey Creek-Embarras River	1977-2020	764	0.17	0.13	0.46	3.2	446	58
Indian Creek-Embarras River	1977-2020	732	0.35	0.15	2.13	6.71	484	66
Kickapoo Creek	2001-2016	425	1.32	0.87	3.81	5.21	381	90
Little Embarras River	2001-2016	45	0.09	0.07	0.16	0.65	12	27
Muddy Creek	2001-2016	21	0.13	0.11	0.3	0.58	11	52
North Fork Embarras River	1984-2020	651	0.14	0.1	0.43	1.32	319	49
Paul Creek-Muddy River	2006-2016	15	0.31	0.25	0.71	1.26	14	93
Range Creek-Embarras River	1973-2016	381	0.22	0.15	0.69	2	254	67
Scattering Fork	2000-2016	35	0.51	0.2	2.5	3.8	22	63
Red Hills Lake (RBB 1-3)	2011	40	0.2	0.03	0.98	1.76	n/a	n/a
Sam Parr Lake (RBA 1-3)	2011	40	1.37	0.13	12.01	13.1	n/a	n/a
Walnut Point Lake (RBK 1-3)	2014	32	0.26	0.09	1.16	1.8	n/a	n/a
Lake Charleston (RBH 1-3)	2003	36	0.08	0.08	0.13	0.28	n/a	n/a
Lake Charleston Side Channel (RBC 1-3)	2001-2013	162	0.08	0.08	0.16	0.24	n/a	n/a
Oakland Lake (RBP 1-3)	2001	30	0.18	0.17	0.43	0.46	n/a	n/a

**Lake data compared to lake standard of 0.05 mg/L*

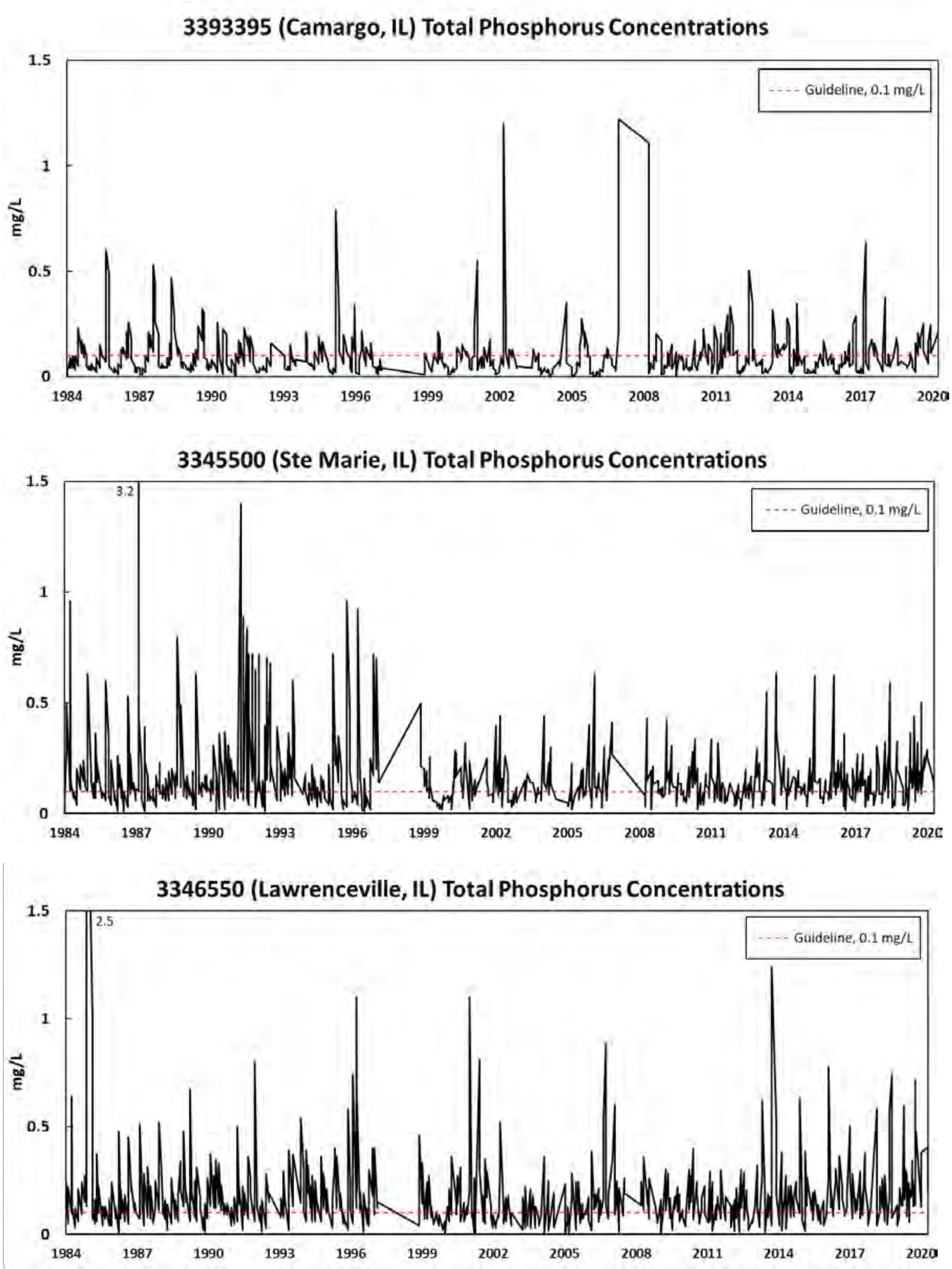


Figure 3-D – Total Phosphorus Concentrations at Camargo, Ste Marie, and Lawrenceville Monitoring Stations

Total Suspended Solids and Volatile Suspended Solids

Over 2,400 samples were analyzed for TSS, and there is a wide range of concentrations directly correlated to flow. Results indicate that large portions of the load occur from a few events each year. Monitoring locations regularly exceeded the streams guideline of 116 mg/L and the 15 mg/L proxy guideline for lakes. Based on analysis of the data presented in Table 3-31, the overall average for all samples was 75 mg/L. Only 16% of the samples exceeded the 116 mg/L guideline, while 70% exceeded 15 mg/L. Almost all locations have median values that fall in between the guidelines.

The HUC10 watersheds with the greatest measured TSS are similar to those with the highest phosphorus, including Honey Creek-Embarras River, Indian Creek-Embarras River, and Paul Creek-Muddy River (Table 3-32). Lakes had limited sampling and usually from only one year. Sam Parr Lake and Lake Charleston Side Channel reservoir exhibited the highest concentrations.

Total Suspended Solids concentrations for three sites are presented in Figure 3-E and, like phosphorus, TSS is responsive to precipitation events. Also, like TP, TSS appears to increase moving downstream. Hodson and Terrio (2020) showed increasing trends in yields from both 1978-2017 and 2008-2017 at the Lawrenceville station. This station experienced the most significant increase in both temporal analyses, with an increase of 800 kg/ha/yr for both periods (Hodson and Terrio 2020). Additionally, in-situ measurements in the Embarras River at Lawrenceville from 2015-2019 showed a 0.46-0.74 ton/ac yield, with the highest in 2019 and the least in 2018, similar to TP (USGS, 2020).

Table 3-31: TSS Concentrations by Station

Station Code	Waterbody	Temporal Range of Data	Count	Mean (mg/L)	Median (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed Guideline	
								#	%
3343395; BE-14	East Branch Embarras River	1978-2020	357	38	25	110	744	16	4
3346000; BEF-03	North Fork Embarras River	1978-2020	194	79	39	287	865	40	21
3346500; BE-33	Indian Creek-Embarras River	2013-2020	66	120	3	450	2,280	13	20
BEF-05	North Fork Embarras River	1999-2018	158	64	29	263	858	20	13
3344000; BE-09; EMD	Range Creek-Embarras River	1978-2020	352	63	30	268	725	45	13
3345500; BE-07; EMS	Honey Creek-Embarras River	1978-2020	397	116	63	415	994	120	30
3346550; EMB	Indian Creek-Embarras River	1978-2020	350	131	63	399	6,920	111	32

Lake Charleston Side Channel (RBC 1-3)	Range Creek-Embarras River	2001-2013	100	24	23	38	54	0	0
All other samples*	Entire Embarras River Basin	1979-2016	476	41	16	110	1,740	23	5
All Data	**Entire Embarras River Basin**	**1978-2020**	**2,438**	**75**	**32**	**282**	**6,920**	**388**	**16**

**remaining sites which did not have samples in more than one year or more than 20 samples collected*

Table 3-32: HUC10 TSS Concentrations

HUC10	Temporal Range of Data	Count	Mean (mg/L)	Median (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed Guideline	
							#	%
Big Creek	2001-2016	21	27	21	73	145	1	5
Brushy Creek	2006-2011	9	18	13	53	66	0	0
Brushy Fork	1979-2016	14	28	17	81	120	1	7
Deer Creek-Embarras River	2001-2011	34	185	70	625	1,740	11	32
East Branch Embarras River	1978-2020	375	37	25	108	744	16	4
East Crooked Creek	2016	5	23	16	61	71	0	0
Honey Creek-Embarras River	1978-2020	402	115	63	411	994	120	30
Indian Creek-Embarras River	1978-2020	452	123	53	400	6,920	125	28
Kickapoo Creek	2001-2016	69	18	10	33	372	1	1
Little Embarras River	2001-2016	27	34	17	51	432	1	4
Muddy Creek	2001-2016	11	29	14	100	167	1	9
North Fork Embarras River	1978-2020	375	69	32	270	865	61	16
Paul Creek-Muddy River	2006-2016	9	148	16	723	1,170	1	11
Range Creek-Embarras River	1978-2016	426	59	26	258	725	48	11
Scattering Fork	2000-2016	22	24	11	96	134	1	5
Red Hills Lake (RBB 1-3)	2011	20	6	5	12	14	0	0
Sam Parr Lake (RBA 1-3)	2011	20	22	17	50	63	0	0
Walnut Point Lake (RBK 1-3)	2014	16	8	8	15	19	0	0
Lake Charleston (RBH 1-3)	2003	15	37	31	69	72	0	0

Lake Charleston Side Channel (RBC 1-3)	2001-2013	100	24	23	38	54	0	0
Oakland Lake (RBP 1-3)	2001	16	35	32	78	85	0	0

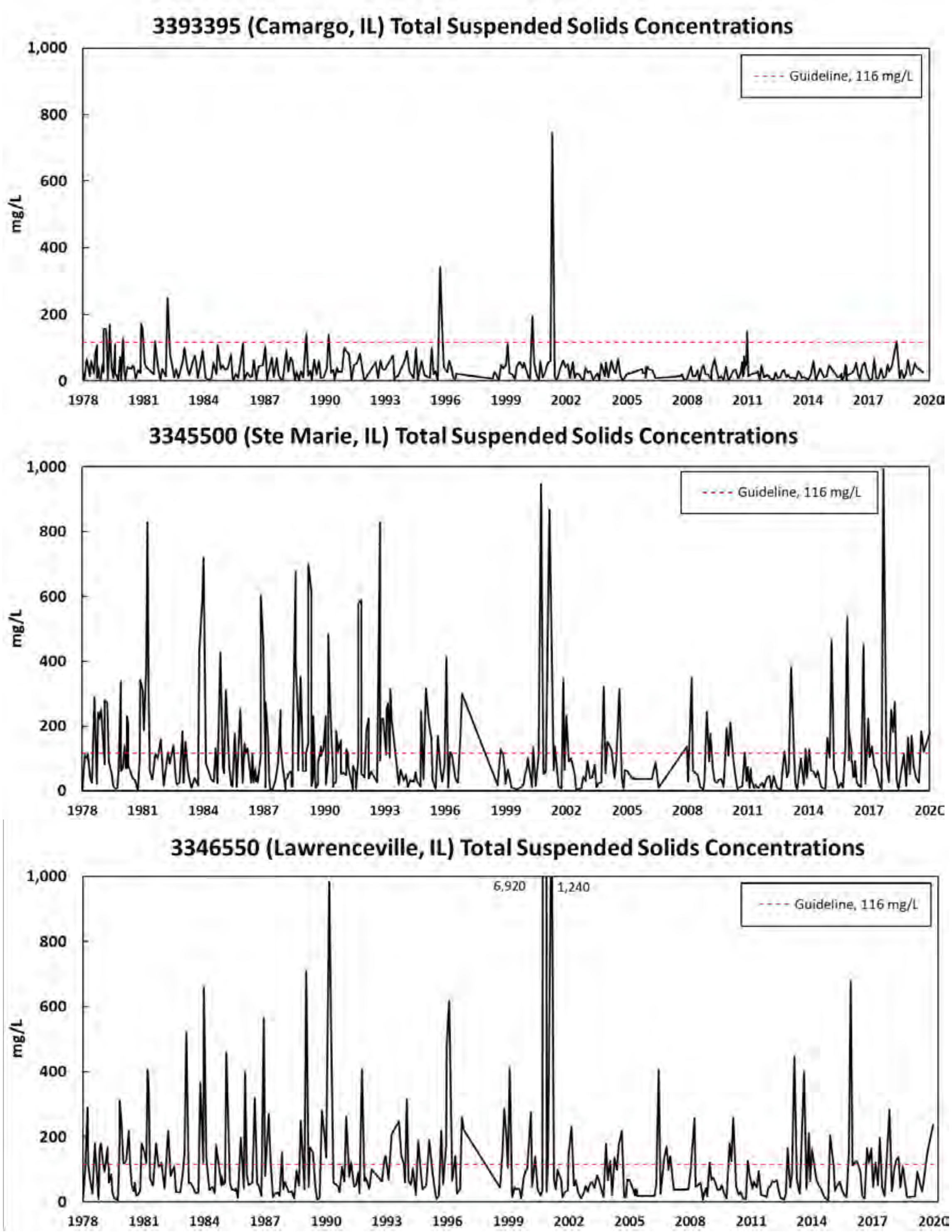


Figure 3-E – TSS Concentrations at Camargo, Ste Marie, and Lawrenceville Stations

Volatile Suspended Solids

Volatile suspended solids (VSS) data are presented in Tables 3-33 and 3-34. Since VSS is a fraction of TSS, it is expected that when compared to the same guidelines, it would be less. Over 2,200 samples show a mean of 11 mg/L with only three exceeding the 116 mg/L guideline. In lakes, the guideline is exceeded 0-26% of the time (Table 3-34). As with TSS, Honey Creek-Embarras River and Indian Creek-Embarras River experienced the highest concentrations. Considering these two subwatersheds are higher than others in terms of both phosphorus and sediment, efforts to address erosion may be more effective than elsewhere.

Table 3-33: VSS Concentrations by Station

Station Code	Waterbody	Temporal Range of Data	Count	Mean (mg/L)	Median (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed Guideline	
								#	%
3343395; BE-14	East Branch Embarras River	1978-2020	356	7	5	16	112	0	0
3346000; BEF-03	North Fork Embarras River	1978-2020	194	10	6	30	82	0	0
3346550; BE-33	Indian Creek-Embarras River	1978-2020	348	16	12	34	470	1	0.3
BEF-05	North Fork Embarras River	1999-2018	157	11	6	28	380	1	1
3344000; BE-09; EMD	Range Creek-Embarras River	1978-2020	350	8	6	27	56	0	0
3345500; BE-07; EMS	Honey Creek-Embarras River	1978-2020	355	14	10	40	108	0	0
3346550; EMB	Indian Creek-Embarras River	1978-2020	348	16	12	34	470	1	0
Lake Charleston Side Channel (RBC 1-3)	Range Creek-Embarras River	2007-2013	61	11	11	18	25	0	0
All other samples*	Entire Embarras River Basin	1979-2016	398	7	5	17	125	1	0
All Data	**Entire Embarras River Basin**	**1978-2020**	**2,567**	**10**	**7**	**30**	**470**	**3**	**0.1**

**remaining sites which did not have samples in more than one year or more than 20 samples collected*

Table 3-34: HUC10 VSS Concentrations								
HUC10	Temporal Range of Data	Count	Mean (mg/L)	Median (mg/L)	95th Percentile (mg/L)	Max (mg/L)	Exceed Guideline	
							#	%
Big Creek	2001-2016	21	9	8	17	26	0	0
Brushy Creek	2006-2011	9	6	6	11	11	0	0
Brushy Fork	2001-2016	11	3	2	6	8	0	0
Deer Creek-Embarras River	2001-2011	15	10	6	29	68	0	0
East Branch Embarras River	1978-2020	374	7	5	16	112	0	0
East Crooked Creek	2016	5	5	4	10	11	0	0
Honey Creek-Embarras River	1978-2020	360	14	10	40	108	0	0
Indian Creek-Embarras River	1978-2020	384	16	11	34	470	1	0
Kickapoo Creek	2001-2016	62	4	2	9	44	0	0
Little Embarras River	2001-2016	27	6	4	11	44	0	0
Muddy Creek	2001-2016	11	5	2	15	22	0	0
North Fork Embarras River	1978-2020	374	10	6	30	380	1	0
Paul Creek-Muddy River	2006-2016	9	17	2	78	125	1	11
Range Creek-Embarras River	1978-2016	423	8	6	26	59	0	0
Scattering Fork	2001-2016	17	5	2	16	21	0	0
Red Hills Lake (RBB 1-3)	2011	20	5	5	10	11	0	0
Sam Parr Lake (RBA 1-3)	2011	20	11	10	20	26	4	20
Walnut Point Lake (RBK 1-3)	2014	16	8	7	15	19	1	6
Lake Charleston Side Channel (RBC 1-3)	2007-2013	61	11	11	18	25	16	26

Fecal Coliform

Fecal Coliform, an indicator of both human and animal waste contamination, was monitored at five locations, in five different HUC10 subwatersheds. Concentrations shown in Table 3-35 were compared to standard values. Over 870 samples were collected with an average of 1,198 CFU, with 58% exceeding 200 and 40% exceeding 400 CFU. As waterbodies are organized from north to south in Table 3-34, FC appears to increase moving downstream. The sample location with the greatest mean concentration is within the Indian Creek-Embarras River HUC10 and the most downstream station. Population centers of Lawrenceville and Bridgeport are directly upstream from this sampling location and could be a localized source.

Table 3-35: Fecal Coliform Concentrations by Station											
Station Code	**Waterbody**	**Temporal Range of Data**	**Count**	**Mean (mg/L)**	**Median (mg/L)**	**95th Percentile (mg/L)**	**Max (CFU)**	**Exceed 200 CFU***		**Exceed 400 CFU***	
								#	**%**	**#**	**%**
3343395; BE-14	East Branch Embarras River	1978-2020	171	840	270	3,150	36,000	109	64	64	37
3344000; BE-09; EMD	Range Creek-Embarras River	1978-2020	176	583	125	1,825	22,000	66	38	37	21
3345500; BE-07; EMS	Honey Creek-Embarras River	1978-2020	212	1,098	220	5,500	22,000	118	56	88	42
3346000; BEF-03	North Fork Embarras River	1978-2021	132	1,113	225	5,755	24,000	74	56	44	33
3346550; EMB	Indian Creek-Embarras River	1977-2021	163	2,301	680	8,900	34,000	138	85	112	69
All Data	**Entire Embarras River Basin**	**1978-2021**	**854**	**1,172**	**270**	**5,700**	**36,000**	**505**	**60**	**345**	**40**

**30-day time periods were not evaluated in the summary analyses; therefore, data in columns is when concentrations exceeded those values, not the occurrence of the water quality standard being violated*

Dissolved Oxygen

Dissolved Oxygen is influenced by many different physicochemical and biological conditions, including temperature, water flow, as well as algal growth and decay which can be influenced by increased levels of nitrogen and phosphorus. The Illinois standard of 5 mg/L was used to analyze data. Anoxic conditions occur with a lack of oxygen and can cause the release of dissolved phosphorus from sediment. A summary of over 2,600 measurements is presented in Table 3-36. Average concentration is 8.7 mg/L, with 10% below the standard. All lake measurements reported numerous instances of 0 mg/L, likely from bottom or lakebed locations and likely indicating anoxic conditions. Since 1977, the HUC10 with the most occurrences was the East Branch Embarras River with 28 measurements less than 5 mg/L (Table 3-37). High corresponding phosphorus levels may indicate this location is experiencing the periodic release of dissolved phosphorus from bottom sediments.

Table 3-36: DO Concentrations by Station									
Station Code	**Waterbody**	**Temporal Range of Data**	**Count**	**Mean (mg/L)**	**Median (mg/L)**	**95th Percentile (mg/L)**	**Min (mg/L)**	**Exceeded WQ std.**	
								#	**%**
3343395; BE-14	East Branch Embarras River	1978-2020	354	8.71	8.2	13.1	2.2	28	8
3346000; BEF-03	North Fork Embarras River	1978-2019	178	9.22	8.9	13.55	1.6	5	3

Table 3-36: DO Concentrations by Station										
3344000; BE-09; EMD	Range Creek-Embarras River	1975-2020	366	10.17	10	13.88	3.92	3	1
3345500; BE-07; EMS	Honey Creek-Embarras River	1978-2020	474	10.1	10	13.99	4.9	2	0.4
3346550; EMB	Indian Creek-Embarras River	1977-2021	355	9.23	9.3	13.9	0.61	19	5
BEF-05	North Fork Embarras River	1999-2018	163	8.98	8.62	12.89	4.1	5	3
Lake Charleston Side Channel (RBC 1-3)	Range Creek-Embarras River	2009	156	8.54	8.5	11.5	0.1	11	7
Red Hills Lake (RBB 1-3)	Paul Creek-Muddy River	2011	101	5.22	7.48	9.91	0	42	42
Sam Parr Lake (RBA 1-3)	Honey Creek-Embarras River	2011	84	6.36	6.76	15.55	0	30	36
Walnut Point Lake (RBK 1-3)	Deer Creek-Embarras River	2014	131	4.87	1.27	15.09	0	76	58
All other samples*	Entire Embarras River Basin	1975-2016	283	7.20	7.1	10.97	0.3	41	14
All Data	**Entire Embarras River Basin**	**1975-2021**	**2,637**	**8.7**	**13.7**	**0**	**8.7**	**258**	**10**

**remaining sites which did not have samples in more than one year or more than 20 samples collected*

Table 3-37: HUC10 DO Concentrations								
HUC10	**Temporal Range of Data**	**Count**	**Mean (mg/L)**	**Median (mg/L)**	**95th Percentile (mg/L)**	**Min (mg/L)**	**Exceeded WQ std.**	
							#	**%**
Big Creek	1975-2016	20	5.79	5.8	9.16	0.3	7	35
Brushy Creek	2006-2011	6	6.77	6.65	9.05	4.6	1	17
Brushy Fork	1979-2016	14	7.64	7.15	9.82	5.7	0	0
Deer Creek-Embarras River	2001-2011	10	7.21	7.47	8.4	5.3	0	0
East Branch Embarras River	1978-2011	366	8.7	8.2	13.09	2.2	28	8
East Crooked Creek	2016	3	4.63	4.9	5.53	3.4	2	67
Honey Creek-Embarras River	1978-2020	477	10.07	10	13.99	4.6	3	1
Indian Creek-Embarras River	1977-2021	381	9.05	9.1	13.7	0.61	27	7
Kickapoo Creek	2001-2016	55	7.46	7.6	9.9	3.8	3	6

Little Embarras River	2001-2016	18	7.15	7.15	8.72	4.4	1	6
Muddy Creek	2001-2016	9	6.54	7	8.04	3.4	1	11
North Fork Embarras River	1978-2021	359	8.98	8.6	13.22	0.4	11	3
Paul Creek-Muddy River	2006-2016	7	6.41	6	8.31	4.7	2	29
Range Creek-Embarras River	1975-2016	182	9.34	9	13.69	3.1	9	2
Scattering Fork	2000-2016	17	9.48	10.6	15.72	2.3	4	24
Red Hills Lake (RBB 1-3)	2011	101	5.22	7.48	9.91	0	42	42
Sam Parr Lake (RBA 1-3)	2011	84	6.36	6.76	15.55	0	30	36
Walnut Point Lake (RBK 1-3)	2014	131	4.87	1.27	15.09	0	76	58
Lake Charleston Side Channel (RBC 1-3)	2009	156	8.54	8.50	11.5	0.1	11	7

Biological Indicators

Summaries of both fIBI and mIBI scores are organized by HUC10 in Tables 3-38 and 3-39. Several locations indicated an impairment, while only Big Creek and Indian Creek-Embarras River had severe impairments. Many of the HUC10 watersheds with biological impairments corresponded to higher NO3, TP, and TSS. Big Creek and Indian Creek both had severe impairments in indices, and both had some of the largest concentrations of NO3, TP, and TSS, as well as occurrences of low DO.

Table 3-38: HUC10 fIBI Scores

HUC10	Temporal Range of Data	Count	Mean Score	Median Score	95th Percentile (score)	Min Score	Impairment Noted		Severe Impairment	
							#	%	#	%
Big Creek	2001-2011	4	36	39	51	15	2	50	1	25
Brushy Creek	2006-2011	2	40	40	40	39	2	100	0	0
Brushy Fork	2001-2006	2	44	44	46	42	0	0	0	0
Deer Creek-Embarras River	2001-2011	5	37	39	42	30	4	80	0	0
East Branch Embarras River	2001-2011	8	36	35	43	27	6	75	0	0
East Crooked Creek	No Data	-	-	-	-	-	-	-	-	-
Honey Creek-Embarras River	2001-2011	5	41	46	53	20	2	40	0	0
Indian Creek-Embarras River	2006-2011	5	38	39	41	34	4	80	0	0
Kickapoo Creek	2000-2011	10	36	36	43	31	9	90	0	0
Little Embarras River	2001-2011	5	40	38	50	28	3	60	0	0
Muddy Creek	2001-2006	2	50	50	55	44	0	0	0	0

North Fork Embarras River	2001-2011	7	50	52	57	36	1	14	0	0
Paul Creek-Muddy River	2006	1	52	52	52	52	0	0	0	0
Range Creek-Embarras River	2001-2011	16	45	46	55	29	4	25	0	0
Scattering Fork	2001-2011	3	38	41	42	32	1	33	0	0
All Data	**2001-2011**	**75**	**41**	**40**	**55**	**15**	**38**	**51**	**1**	**1**

Table 3-39: HUC10 mIBI Scores

HUC10	Temporal Range of Data	Count	Mean Score	Median Score	95th Percentile (score)	Min Score	Impairment Noted		Severe Impairment	
							#	%	#	%
Big Creek	2001-2016	5	38	34	64	20	3	60	1	20
Brushy Creek	2006-2011	2	64	64	68	59	0	0	0	0
Brushy Fork	2001-2016	3	75	72	80	71	0	0	0	0
Deer Creek-Embarras River	2001-2016	4	70	76	84	44	0	0	0	0
East Branch Embarras River	2001-2016	8	62	60	77	53	0	0	0	0
East Crooked Creek	No Samples	-	-	-	-	-	-	-	-	-
Honey Creek-Embarras River	2001-2016	5	46	51	60	22	2	40	0	0
Indian Creek-Embarras River	2001-2016	9	40	38	67	11	6	67	1	11
Kickapoo Creek	2001-2016	15	66	67	79	43	0	0	0	0
Little Embarras River	2001-2016	6	67	61	82	58	0	0	0	0
Muddy Creek	2001-2016	3	52	57	64	35	1	33	0	0
North Fork Embarras River	2001-2016	11	52	49	77	22	3	27	0	0
Paul Creek-Muddy River	2006-2016	2	48	48	50	45	0	0	0	0
Range Creek-Embarras River	2001-2016	20	66	71	81	26	1	5	0	0
Scattering Fork	2001-2016	4	50	49	57	43	0	0	0	0
All Data	**2001-2016**	**97**	**58**	**60**	**81**	**11**	**16**	**16**	**2**	**2**

Water Supply

A majority of the population within the watershed relies on groundwater for potable water supply. The City of Charleston is the largest urban area entirely within the watershed and this city relies on the Embarras River for its water supply.

The Charleston Side Channel Reservoir (CSCR), a water supply and recreational reservoir located in Coles County, is located three kilometers south of Charleston, and it is the sole drinking water source for the city's approximately 21,000 residents. Many residents and outsiders also use the CSCR for sport fishing and boating activities. The CSCR was created in 1981 when Lake Charleston, an impoundment on the Embarras River, was divided by the building of a dike. Water from the Embarras River is now pumped into the CSCR for eventual intake to the Charleston drinking WTP. The land that drains directly into the CSCR is only a few square kilometers in size, is steeply sloped, and is primarily forested. Since water from the Embarras River is also pumped directly to the reservoir, the entire contributing watershed of the Embarras River affects the water quality of the lake and is a significant resource concern to the City of Charleston and its residents.

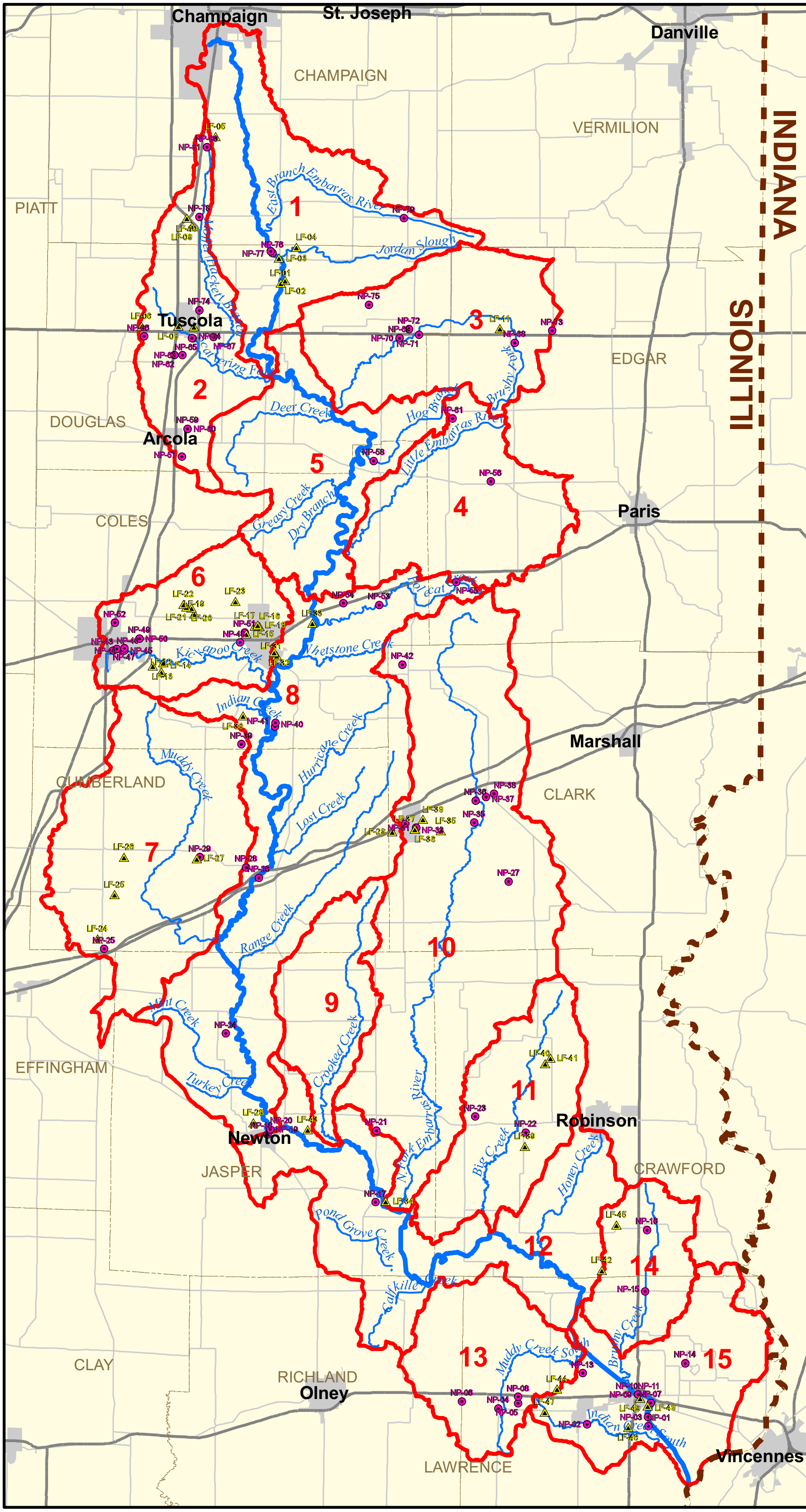
Almost two decades ago, as part of the Section 303(d) listing process, the Illinois EPA identified the CSCR as impaired water. The potential causes of impairment are phosphorus, nitrogen, total suspended solids (TSS), and excessive algal growth/chlorophyll a (Illinois EPA, 2001). These impairments resulted in partial support of its primary contact (swimming) and secondary contact (recreation) designated uses and in partial support of its aquatic life designated use.

In response, a 2003 TMDL report was developed by Tetra Tech to investigate the causes of impairments and make recommendations to improve water quality. Since completion of the TMDL, Charleston has secured grant funding to implement practices in the reservoir and it has remained off the 303(d) list. Practices have included shoreline and eroding bluff stabilization.

NPDES Permits and Landfills

The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. A total of 54 permit holders (95 discharge points) are located within the Embarras River Watershed (Exhibit 15 and Table 3-40). Compliance records for the facilities within the watershed were analyzed for 2020 using the United States Environmental Protection Agency (USEPA) Enforcement and Compliance History Online (ECHO) system. Although a formal violation may not have been noted, several facilities indicated effluent exceedances for water quality parameters. Effluent exceedances were noted based on the number of times in the past year the permit allowed discharge was exceeded. The water quality parameters screened in this analysis included Dissolved Oxygen (DO), Total Suspended Solids (TSS), Total Phosphorus (TP) Ammonia Nitrogen (N), pH, Iron, Biochemical Oxygen Demand (BOD), Chlorine and Fecal Coliform (FC).

Exhibit 15



Embarras River Watershed

Landfills and NPDES Permits Map

Legend

- Landfills
- NPDES Permits
- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds

N E S W

5 0 5 10 Miles

Table 3-40: NPDES Permits				
Subwatershed	**NPDES Permit Number**	**# of Outfalls**	**Facility Name**	**Effluent Exceedances**
East Branch Embarras River	IL0059005	4	City of Villa Grove STP	STP outfall, excess flow/bypass
	IL0051900	1	Village of Broadlands WTP	Iron filter backwash
	IL0064327 & ILG580132	1	Village of Ogden	STP outfall
	IL0059846 & ILG640006	2	Village of Longview WTP	Iron filter backwash
Scattering Fork	IL0027499	2	City of Arcola STP	STP outfall / emergency bypass
	IL0060119	1	Parkview MHP-STP	STP outfall
	IL0004375	4	Cabot Corporation	Combined treated wastewaters and sanitary / pump seal units / Treated lab drains
	IL0026107	2	City of Tuscola Southside STP	STP outfall / excess flow
	IL0004596 & ILG840095	2	Tuscola Stone Company	Pit pumpage and stormwater / quarry outfall
	IL0071617	2	City of Tuscola STP	STP outfall / emergency bypass
	IL0031453	2	Village of Tolono STP	STP outfall / excess flow
Brushy Fork	IL0042757	1	Shiloh School STP	STP outfall
	IL0036005 & ILG640204	2	Village of Hume WTP	Iron filter backwash
	IL0066974	1	Newman Rehab and Health Care Center	STP outfall
	IL0069159 & ILG640223	1	Newman WTP	Iron filter backwash
	IL0072222 & ILG640245	1	Metcalf WTP	Iron filter backwash
Little Embarras River	IL0047210 & ILG640251	1	Village of Brocton	TSS-3
Deer Creek-Embarras River	ILG580001	2	City of Oakland STP	STP outfall
Kickapoo Creek	IL0029831 & ILR006231	7	City of Mattoon STP	STP outfall, CSO outfalls
	ILR006025	1	GE Lighting – Mattoon Lamp Pit	Cooling water
	IL0021644	5	City of Charleston STP	STP outfall, CSO outfall, excess flow
	ILR005934 & ILR006676	1	Anamet Electrical	Cooling water, stormwater
Muddy Creek	IL0063096	1	Village of Montrose STP	STP outfall
	ILR006025	1	GE Lighting – Mattoon Lamp Pit	Stormwater runoff
	IL0031445 & ILG580158	2	Village of Toledo STP	STP outfall
	IL0049361	1	HPA-Lincoln Log Cabin Historical Site	STP outfall

Range Creek-Embarras River	IL0030121	2	City of Newton STP	STP outfall / emergency bypass
	IL0069574 & ILG640197	1	EJ Water Corporation PWS	Treated iron filter backwash
	IL0025534 & ILG580065	2	Village of Greenup STP	STP outfall
	IL0049212	1	Cumberland Comm Sch Dist 77	STP outfall
	IL0051250	1	IL DNR-Fox Ridge State Park STP	STP outfall
	IL0004537 & ILG640207	2	Ashmore WTP	Iron filter backwash
	IL0060585 & ILG670059	1	Marathon Pipeline Company	Hydrostatic test water
	IL0020991 & ILG640219	1	Village of Kansas WTP	Iron Filter Backwash
East Crooked Creek	No NPDES Permits			
North Fork Embarras River	IL0032697 & ILG580092	2	Village of Willow Hill STP	STP outfall
	IL0060585 & LIG670059	1	Marathon Pipeline Company	Hydrostatic test water
	IL0035084	4	City of Casey North STP	STP outfall, excess flow, CSO outfall, golf course irrigation
	IL0020435 & ILG40137	2	Mid Illinois Quarry - Casey	Pit pumpage, groundwater and stormwater
	IL0055417 & ILR007471	1	Rowe Foundry - Martinsville	Stormwater runoff
	IL0025011 & ILG580269	2	City of Martinsville STP	STP outfall
	IL0051462 & ILG40135	1	Village of Westfield WTP	Filter backwash
Big Creek	IL0060585 & ILG670059	1	Marathon Pipeline Company	Hydrostatic test water
	IL0033316 & ILG582017	2	Village of Oblong WWTP	STP outfall
Honey Creek-Embarras River	IL0049328 & ILG580058	2	Village of Saint Marie STP	STP outfall
Paul Creek-Muddy River	IL0031283 & ILG580118	1	City of Sumner STP	STP outfall
	IL0051829	1	IL DNR-Red Hills State Park Campground	STP outfall
	IL0073610	1	Lawrence Correctional Center	STP outfall
	IL0051837	1	IL DNR-Red Hills State Park Restrooms	STP outfall
Brushy Creek	IL0028802 & ILG580224	2	Village of Flatrock STP	STP outfall
Indian Creek-Embarras River	IL0032590 & ILG582001	1	City of Bridgeport STP	STP outfall
	IL0004219	1	Texaco Downstream Properties	Treated sanitary waste

	IL0029467, IL0060054 & ILG640282	5	City of Lawrenceville WWTP & WTP	STP outfall, CSO outfalls, excess flow, raw water reservoir overflow
	IL0055948 & ILG640277	1	City of Mount Carmel WTP	Filter backwash, clarifier and settling basin
	IL0051209	1	Lawrenceville-Vincennes Airport	STP outfall

Out of the 54 permits with available online records, 11 had reported exceedances of the water quality parameters screened. Of the water quality parameters, TSS was exceeded the most followed by BOD and DO. Phosphorus and FC were noted twice.

Landfill locations were also identified within the watershed. Landfills are often viewed as potential contamination sources. A total of 49 were identified (Table 3-41). Exhibit 15 shows the location of the landfills.

Of note are future improvements to the Charleston WWTP that treats wastewater from about 20,000 people and discharges approximately 3 Million Gallons per Day (MGD) to Cassel Creek and, eventually, the Embarras. Treatment plant upgrades will include Biological Nutrient Removal, or BNR, and attain a new phosphorus limit of 0.5 mg/L. It is estimated that by 2023, the new system will achieve an 85% reduction in phosphorus and a 56% reduction in nitrate. The City of Charleston is committed to removing nutrients from the discharge to the watershed and continuing the sustainability practices of beneficial reuse of stabilized sludge for land application on farm fields.

Although details are unknown at this time, it is likely Mattoon and Lawrenceville will also need to address lower permit levels for phosphorus and may need to consider plant upgrades.

Table 3-41: Landfills

Subwatershed	Facility ID Number	Location Identifier	Facility Name
East Branch Embarras River	0418030002	LF-01	Phipps, Harold
	0418030003	LF-02	Bade, Herman #1
	0418030004	LF-03	Bade, Herman #2
	0418030001	LF-04	Multi-County Landfill
	0198260001	LF-05	Tolono Municipal
Scattering Fork	0418080001	LF-06	Cabot Corp
	0410300001	LF-07	Tuscola Municipal
	0410300002	LF-08	Universal Asphalt Co Inc
	0198150001	LF-09	Illinois Central Gulf Railroad
	0198150002	LF-10	Harrel, Wally
Brushy Fork	0450150001	LF-11	Hume Municipal
Little Embarras River	No landfills		
Deer Creek- Embarras River	No landfills		
Kickapoo Creek	0298060002	LF-12	Alexander-Gilbert Inc
	0298050003	LF-13	Farrier, Francis L.
	0298050002	LF-14	Young
	0290100002	LF-15	Pearcy, Elmer

	0290100005	LF-16	Craig, Floyd
	0290100003	LF-17	Nielsen, Leif
	0290100001	LF-18	H & B Ready Mix Inc
	0298050007	LF-19	Coles County Landfill
	0298050001	LF-20	Service Disposal #1
	0298050005	LF-21	Service Disposal #2
	0298050006	LF-22	Western Lion LTD
	0290100004	LF-23	Midstate Foundry Co
Muddy Creek	0358040001	LF-24	Montrose Municipal
	0358040002	LF-25	Derrickson, Elza
	0418080002	LF-26	Quantum Chemical Company
	0358050001	LF-27	Toledo Municipal
Range Creek- Embarras River	0798090001	LF-28	Newton Sewage & Treatment Plant
	0230050001	LF-29	Casey Fertilizer Company
	0298100002	LF-30	Heath, William E#
	0298010002	LF-31	Farrier, James H#
	0298010001	LF-32	Woodyard
	0298000003	LF-33	Wright, Max
East Crooked Creek	No landfills		
North Fork Embarras River	0798060001	LF-34	St Marie Municipal
	0230050002	LF-35	Casey Municipal #2
	0238020001	LF-36	Casey Municipal
	0238020002	LF-37	Casey Municipal TBS
	0238020003	LF-38	Hickox
Big Creek	0330150001	LF-39	Curry, Frank
	0338080004	LF-40	Wilder #2
	0338080001	LF-41	Wilder #1
Honey Creek- Embarras River	0338000004	LF-42	Wilson
	0798090002	LF-43	Bergbower
Paul Creek- Muddy River	1018020001	LF-44	Dowty
Brushy Creek	0338000003	LF-45	Flat Rock Municipal
Indian Creek-Embarras River	1018040002	LF-46	Siddens #2
	1018020002	LF-47	Dowty
	1010150002	LF-48	Lawrenceville Municipal #3
	1010150001	LF-49	Siddens #1

Septic Density

In rural areas, households and businesses often depend on septic tank absorption fields. These waste treatment systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high-water tables, shallow compact till and coarse soils present limitations for septic systems. While system design can often overcome these limitations (i.e., perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system or maintenance practices (or lack thereof) contribute to a failing septic system. Failing septic systems are often linked to water quality issues.

According to the NRCS Soil Reports for the counties within the Embarras River watershed, approximately 98% of the soils are rated as very limited for septic systems. A rating of very limited indicates that the soil has at least one feature that is unfavorable for septic systems.

Possible locations of systems were identified by using well permit records. Well records typically are good indicators of septic systems because there is a water supply that requires treatment. Table 3-42 shows the estimated number of septic systems and density for each subwatershed. It should be noted that this analysis is not ideal in urban areas because often there is a wastewater treatment service even for areas that use private wells for water supply.

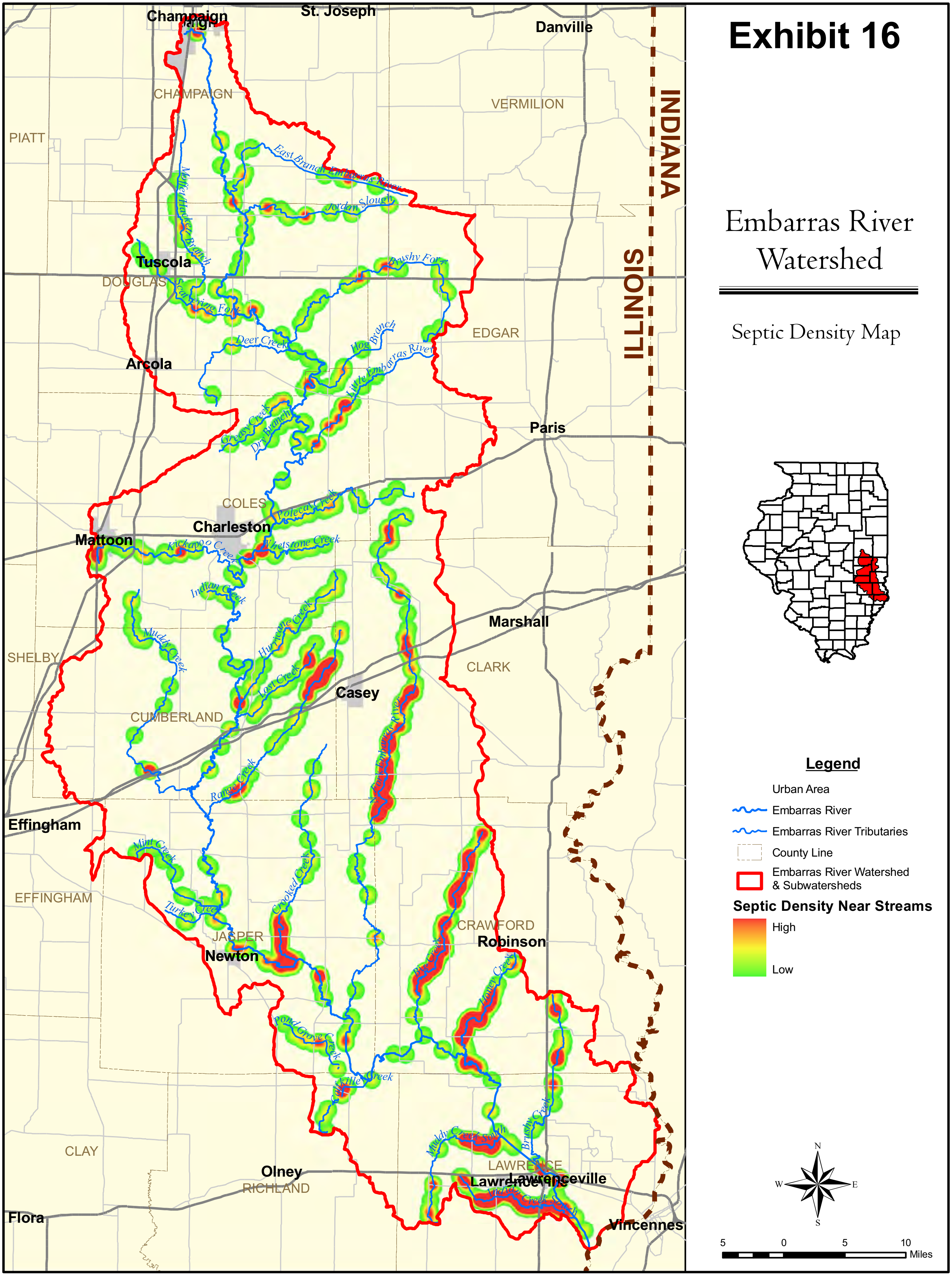
Exhibit 16 illustrates septic density analysis for within 800 feet of a perennial waterway; this analysis is valuable as it shows areas that varying ranges of probabilities of contributing to direct pollution to the streams. It is an important planning tool to help focus on priority areas to reduce fecal coliform bacteria loading.

Table 3-42: Possible Septic Locations		
Subwatershed	**Number of Possible Septic Systems**	**Density (#/sq mi)**
East Branch Embarras River	886	4.6
Scattering Fork	748	6.9
Brushy Fork	522	3.5
Little Embarras River	1,110	8.5
Deer Creek- Embarras River	524	3.6
Kickapoo Creek	922	9
Muddy Creek	981	4.6
Range Creek- Embarras River	6,318	18
East Crooked Creek	1,035	13
North Fork Embarras River	10,835	30
Big Creek	15,801	140
Honey Creek- Embarras River	7,058	35
Paul Creek- Muddy River	4,275	43
Brushy Creek	2,721	42
Indian Creek-Embarras River	6,907	53

Exhibit 16

Embarras River Watershed

Septic Density Map



Section 4 – Pollutant Load Analysis

Overview of Watershed Pollutant Loading

Pollutant loading within the watershed is the sum of point sources and NPSs. Due to the large size and rural nature of the Embarras River watershed, non-point source pollutants are the primary concern as it relates to addressing water quality at a watershed scale. Total nitrogen, TP, and TSS are priority pollutants addressed in the watershed plan to accomplish water quality improvement goals. These pollutants were identified based on land-use activities in the watershed and primary water quality impairments identified by the Illinois EPA.

As defined by USEPA, the pollution from NPSs originates from urban runoff, construction activities, manmade modification of hydrologic regime of a watercourse (e.g., retention, detention, channelization, etc.), silviculture, mining, agriculture, irrigation return flows, solid waste disposal, atmospheric deposition, stream bank erosion, and individual or zonal sewage disposal. Nonpoint source pollution originates in a wide spectrum of public and private activities and, when not known or properly controlled, affects, in a large percentage, the water quality in a certain area.

Since runoff from the rainfall flows over or through the land and collects pollutants and nutrients prior to entering waterways, the overall characteristics of the land use within a watershed greatly influences water quality. Land use types have diverse effects on water quality, by contributing different pollutants with varying amounts and concentrations. The cumulative effect of this pollution throughout the watershed represents the contribution of NPS pollution.

Point sources, or permitted facilities, are contributors to the overall watershed pollutant loading but, due to the size of the watershed, the primary focus of this plan is to address NPS pollutant loading. The premise of not focusing in detail on point source loading is that it is handled by existing regulatory processes and enforcement. The permitted point source facilities within the watershed include municipal WWTPs, mining operations, manufacturing facilities and private utility operations. All permitted facilities are subject to regulation through the Illinois EPA and annual discharge volume estimates and permitted pollutant concentration of the applicable constituents are publicly available.

Septic systems, although typically considered to be a NPS issue, exist and may be contributing to nutrient loading in certain areas. Failing septic systems can leach wastewater into groundwater and surrounding waterways.

Annual sediment and nutrient loading from permitted point sources and septic systems are summarized below.

Point Sources and Septic Systems

In addition to NPS loading, permitted point sources and potentially failing septic systems contribute nutrients and, to a lesser extent, sediment. Contributions from permitted point sources were calculated using data from the Illinois EPA and USEPA ECHO site. Loading from septic was estimated using the number of systems presented in the previous section and the Spreadsheet Tool for Estimation of Pollutant Load (STEPL). 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 (Table 4-1).

Table 4-1: Potential Septic System Loading

Subwatershed	Number of Possible Septic Systems	Number of potentially failing systems	Annual Nitrogen Load (lbs)	Annual Phosphorus Load (lbs)
East Branch Embarras River	886	133	4,132	1,618
Scattering Fork	748	112	3,488	1,366
Brushy Fork	522	78	2,434	953
Little Embarras River	1,110	167	5,176	2,027
Deer Creek- Embarras River	524	79	2,444	957
Kickapoo Creek	922	138	4,300	1,684
Muddy Creek	981	147	4,575	1,792
Range Creek- Embarras River	6,318	948	29,462	11,539
East Crooked Creek	1,035	155	4,826	1,890
North Fork Embarras River	10,835	1,625	50,526	19,789
Big Creek	15,801	2,370	73,684	28,859
Honey Creek- Embarras River	7,058	1,059	32,913	12,891
Paul Creek- Muddy River	4,275	641	19,935	7,808
Brushy Creek	2,721	408	12,689	4,970
Indian Creek-Embarras River	6,907	1,036	32,209	12,615
Total	**60,643**	**9,096**	**282,792**	**110,760**

Table 4-2 lists 2020 permitted point source loads by HUC10 watershed. It is estimated that 428,611 lbs of nitrogen, 89,503 lbs of phosphorus and 211 tons of sediment originates from point sources. Almost 99% of the nitrogen, 84% of the phosphorus and 74% of the sediment in 2020 originated from Kickapoo Creek and Indian Creek – Embarras River. The Charleston and Mattoon Sewage Treatment Plant in Kickapoo, and the Lawrenceville Sewage Treatment Plant in Indian Creek are the primary contributors and account for vast majority of the loading.

It should be noted that Charleston is undertaking major plan upgrades and, in the near future, will achieve a 56% reduction in nitrate and an 85% reduction in phosphorus loading.

Table 4-2: 2020 Estimated Permitted Point Source Loading			
Subwatershed	**Annual Nitrogen Load (lbs)**	**Annual Phosphorus Load (lbs)**	**Annual Sediment Load (tons)**
East Branch Embarras River	459	804	4.2
Scattering Fork	589	1,329	11.6
Brushy Fork	74	N/A	1.4
Little Embarras River	N/A	N/A	0.004
Deer Creek- Embarras River	979	N/A	2.8
Kickapoo Creek	389,530	50,343	105
Muddy Creek	113	N/A	9.1
Range Creek- Embarras River	396	11,844	3.9
East Crooked Creek	N/A	N/A	N/A
North Fork Embarras River	1,528	N/A	1.7
Big Creek	807	N/A	17.9
Honey Creek- Embarras River	34	N/A	0.7
Paul Creek- Muddy River	410	N/A	1.5
Brushy Creek	31	N/A	0.96
Indian Creek-Embarras River	33,661	25,183	50.4
Total	**428,611**	**89,503**	**211**

Nonpoint Source Pollution Load Model

Nonpoint source pollution management is highly dependent on hydrologic simulation models and the use of computer modeling is often the only viable means of providing useful input information for adopting the best management decisions. As previously mentioned, the NPSs are generated by activities that are spatially distributed on the analyzed watershed or study area. Due to this spatial distribution of nonpoint pollution sources, the computation models used to study pollutant transport and stream bank erosion require large amounts of data for analysis in even a small watershed.

For the Embarras watershed, a custom and simplified GIS-based model was used to calculate pollutant loads to assess the NPS pollution of the four identified pollutant parameters (TN, TP, Sediment, and Fecal Coliform) that have been identified as elements of concern by both the stakeholders and priorities listed under the INLRS. Fecal Coliform Bacteria was a concern in 2011 and continues to persist as an impairment today, however, it was not modeled for this plan update and, therefore, 2011 estimates were used.

The GIS-based model was executed for each HUC 10 subwatershed within the basin. It should be noted that all computation models have assumptions and limitations. Therefore, the provided analytical results may not represent the exact pollution loads due to calibration and model limitations. In these conditions, even if the results are relative, they still can provide very useful information for targeting and prioritizing subwatersheds for BMPs.

Methodology and Calibration

The GIS-based model was developed for the watershed, which was compiled using land-cover data and SSURGO soils data for the entire watershed. Using these layers and local climate data, average annual runoff volumes were estimated. Following the runoff calculations, event mean pollutant concentrations (EMCs) were applied based on each type of land use category. The EMCs were established based on literature sources, water quality studies and the previous plan.

For open and agricultural areas, the model incorporates a Universal Soil Loss Equation (USLE) with a delivery ratio based on the soil types and land practices. The USLE portion allows for more accurate sediment, nitrogen and phosphorus loading for individual land parcels based on soil types and topography.

Formulas and selected variables were derived from STEPL Version 3, Tetra Tech, 2004. For Fecal Coliform, Schueler's Simple Method (1987) was modified for calculating bacterial loads (refer to Appendix D for further citations and details). Fecal Coliform load estimates were not simulated or updated from the 2011 plan.

Model calibration was performed by matching predicted loads to measured values from published literature and monitoring stations throughout the watershed. Water quality was cross-referenced with existing Illinois EPA and USGS water quality data from the watershed as outlined in the watershed inventory.

Existing Pollutant Loading Conditions

Exhibits 17 through 20 and Tables 4-3 through 4-4 below illustrate the modeling results for the existing land use conditions of the watershed. Exhibits 17, 18, 19 and 20 illustrate the existing condition pollution loads for TN, TP, TSS and FC bacteria (respectively).

These maps are valuable planning and implementation tools to identify general locations and areas that are contributing significant loading to the watershed.

Table 4-3: Existing Conditions Annual Nonpoint Source Pollutant Loading *

Parameter	Total NPS Loading	Per Acre
Total Suspended Sediment – (ton/yr)	1,019,369	0.65
Total Nitrogen (lb/yr)	16,964,442	10.9
Total Phosphorus (lb/yr)	2,168,395	1.4
Fecal Coliform (CFU in billions/yr)	3,115,237	2.02
Total Annual Storm Runoff (AC-Feet)	2,009,771	1.3

*Total suspended sediment estimate includes delivered sheet/rill erosion and streambank and gully erosion.

Table 4-4: Existing Conditions Nonpoint Source Pollutant Loading*					
Land-Use Type	Acres	Total Suspended Sediment (tons/acre)	Total Nitrogen (lbs/acre)	Total Phosphorus (lbs/acre)	Fecal Coliform (billion-cfu/acre)
Cultivated Crops	1,142,782	0.88	14.4	1.8	2.2
Forest	215,342	0.02	0.6	0.19	0.3
Open Space/Grassland	69,168	0.01	1	0.19	0.4
Hay/Pasture	62,591	0.03	2	0.56	4.7
Developed	41,616	0.04	1.8	0.5	6.1
Wetlands	19,394	0.01	0.3	0.16	0.9
Open Water**	6,515	0.25	23.8	2.4	1.3
Barren	1,498	0.01	0.4	0.15	0.7

*this suspended sediment estimate does not include streambank erosion

**Very high nutrient yields for streams and, to a lesser extent, ponds and reservoirs are the result of legacy nutrients from the watershed already in the water column and, therefore, high measured event concentrations. When combined with high runoff rates and rapid delivery of water through the system, yield results exceed other landuse categories. This is a limitation of the model used for estimating surface runoff loading.

As illustrated in Exhibits 17 - 20; the highest sediment loading per land area occurs in the middle and southern portion of the watershed, and along streams. This is primarily due to the soils and land slopes that are more highly erodible. Phosphorus loading is greater throughout the southern extent of the basin. Nitrogen is the reverse where loading is the greatest from the north. Model results reflect measured data which indicate high nitrogen loading from heavily tiled and intensively cropped areas in the headwaters. Downstream of Charleston, nitrogen yield declines and phosphorus increases.

Nitrogen – Exhibit 17

Total nitrogen NPS loading is 16,964,442 lbs/year, averaging 10.9 lbs/acre per year for the entire watershed. The total loading is predominantly attributed to agricultural areas. The East Branch Embarras River (Subwatershed 1) is the largest contributor of nitrogen, primarily due to the subwatershed size and the agricultural land practices that dominate it. Table 4-6 also indicates that the top four loading subwatersheds per unit land area are:

East Branch Embarras River (Subwatershed 1)
East Crooked Creek (Subwatershed 9)
Muddy Creek (Subwatershed 7)
Brushy Fork (Subwatershed 3)

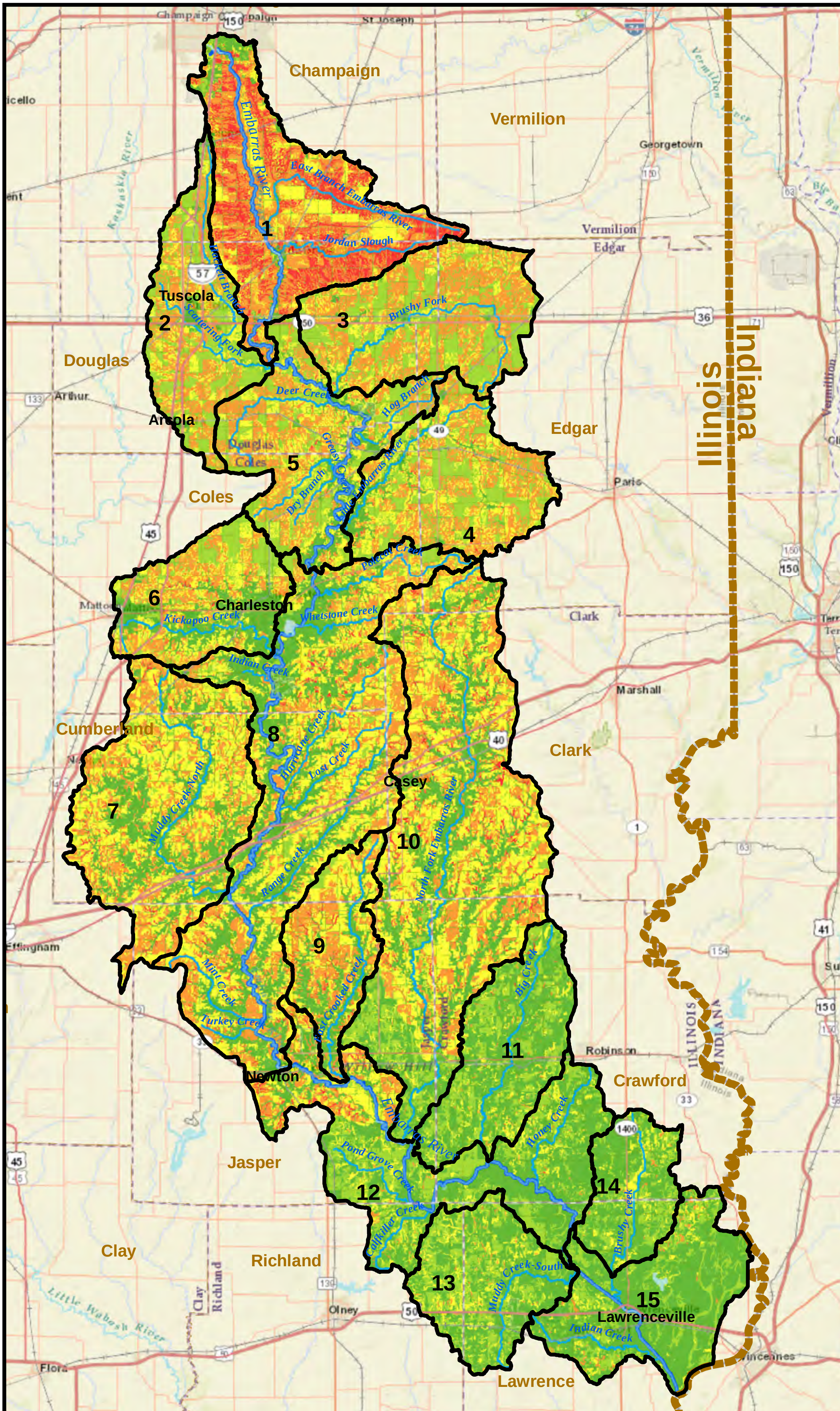


Exhibit 17

Illinois Extension

Embarras River Watershed

Nitrogen Non Point Source Pollutant Loading

ID	Name	Total Nitrogen (lbs/yr)	lbs/ ac
1	East Branch Embarras River	3,282,251	26.9
2	Scattering Fork	744,279	10.6
3	Brushy Fork	1,142,340	12.1
4	Little Embarras River	996,670	11.9
5	Deer Creek-Embarras River	1,016,029	10.8
6	Kickapoo Creek	636,057	9.7
7	Muddy Creek	1,649,090	12.2
8	Range Creek-Embarras River	2,409,978	10.8
9	East Crooked Creek	681,373	13.6
10	North Fork Embarras River	2,603,203	11.3
11	Big Creek	284,537	3.9
12	Honey Creek-Embarras River	843,726	6.5
13	Paul Creek-Muddy River	283,707	4.5
14	Brushy Creek	141,228	3.4
15	Indian Creek-Embarras River	249,974	3.0

Legend

Nitrogen (lbs/ac/yr)

- 0 - 4
- 4 - 8
- 8 - 16
- 16 - 35
- 35 - 94.8
- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver Tributaries
- Counties

N S E W

0 5 10 Miles

The primary NPSs of nitrogen loading in the watershed are related to agricultural production, fertilizer application and common septic/sanitary infrastructure issues in developed areas.

Phosphorus – Exhibit 18

Total phosphorus NPS loading is 2,168,395 lbs/year, averaging 1.4 lbs/acre per year over the entire watershed. The total NPS loading is dominated by the cropland, pasture, and urban land use categories. The Paul Creek-Muddy River subwatershed (Subwatershed 13) is the largest contributor of phosphorus per unit area, whilst the North Fork subwatershed (Subwatershed 10) is the largest overall contributor, but this is primarily due to its large size. Table 4-6 indicates the loading per subwatershed. The top four subwatersheds are:

Paul Creek – Muddy River (Subwatershed 13)
Big Creek (Subwatershed 11)
Honey Creek – Embarras River (Subwatershed 12)
East Crooked Creek (Subwatershed 9)

The dominant typical NPSs of phosphorus loading in the watershed are related to agricultural production, livestock, fertilizer application, common sanitary infrastructure issues, and potentially streambank erosion and legacy sediment.

Sediment – Exhibit 19

Total suspended sediment loading is 1,019,369 tons per year, average 0.65 tons/acre per year for the entire watershed. This overall loading is somewhat lower in comparison to other watersheds in the Midwest and Great Lakes areas primarily due to the fact that most of the Embarras watershed was not glaciated during the latest Wisconsin episode. As a result, this watershed is more mature in terms of recovering from the mass amount of sediment deposited during the Wisconsin event.

It is estimated that approximately 25% of total loading, or 254,842 tons of sediment delivery, are attributed to bank and gully erosion. Most of the bank erosion occurs in the lower portion of the watershed where there are higher stream flows and more highly erodible soils and slopes. The remainder of sediment is sourced from sheet/rill and gully erosion throughout. Agriculture and streambanks are the largest sources of sediment. The sediment loading per subwatershed is shown in Table 4-6; the top four contributing subwatersheds per land area are:

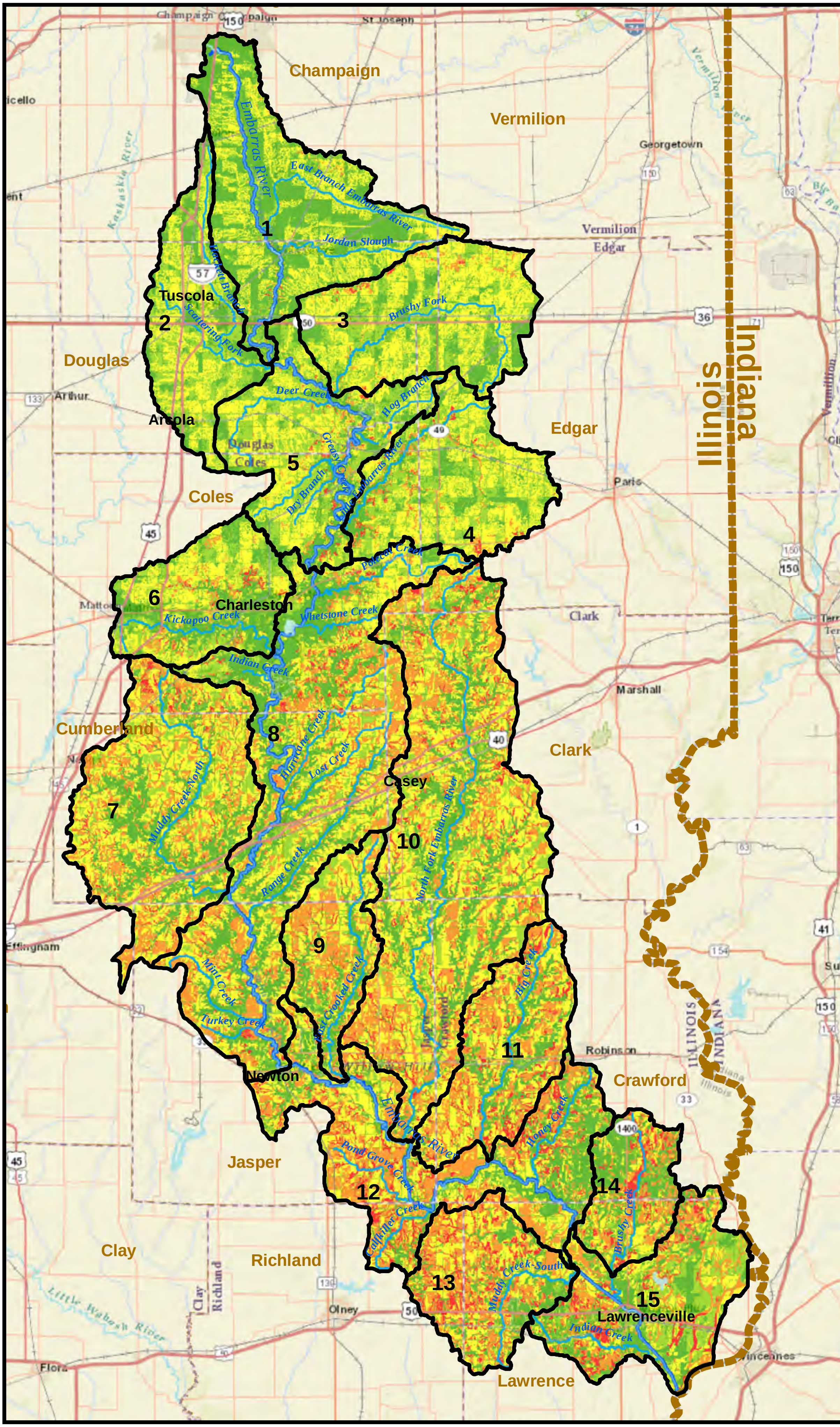
Paul Creek – Muddy River (Subwatershed 13)
Brushy Creek (Subwatershed 14)
Honey Creek – Embarras River (Subwatershed 12)
Little Embarras River (Subwatershed 4)

Table 4-5: Total Suspended Sediment Loading Breakdown *		
Parameter	Total Delivered Sediment	Per Acre
Sheet and Rill – (ton/yr)	764,527	0.5
Stream bank and Gully – (ton/yr)	254,842	0.15
Total	1,019,369	0.65

Fecal Coliform – Exhibit 20

Fecal Coliform bacteria NPS loading in the watershed is 3.115×10^9 coliform units per year. This averages 2.02×10^9 coliform units per acre/year. This loading is fairly low overall for the watershed when compared to areas in the northwest part of Illinois; however, there is a large dichotomy between areas with high and low loading. For example, there is a lot of forested land area in the watershed which has low fecal coliform loading which helps depress the overall loading for the watershed. Urban and pasture areas have the highest loading in the watershed reaching over 6×10^9 coliform units per year.

Exhibit 18



Embarras River Watershed

Phosphorus Non Point Source Pollutant Loading

ID	Name	Total Phosphorus (lbs/yr)	lbs/ ac
1	East Branch Embarras River	75,622	0.62
2	Scattering Fork	63,618	0.91
3	Brushy Fork	101,287	1.07
4	Little Embarras River	95,137	1.14
5	Deer Creek-Embarras River	97,094	1.03
6	Kickapoo Creek	65,390	1.00
7	Muddy Creek	205,625	1.52
8	Range Creek-Embarras River	293,053	1.32
9	East Crooked Creek	82,991	1.66
10	North Fork Embarras River	369,881	1.61
11	Big Creek	143,855	1.99
12	Honey Creek-Embarras River	246,504	1.89
13	Paul Creek-Muddy River	135,134	2.13
14	Brushy Creek	67,712	1.63
15	Indian Creek-Embarras River	125,493	1.51

Legend

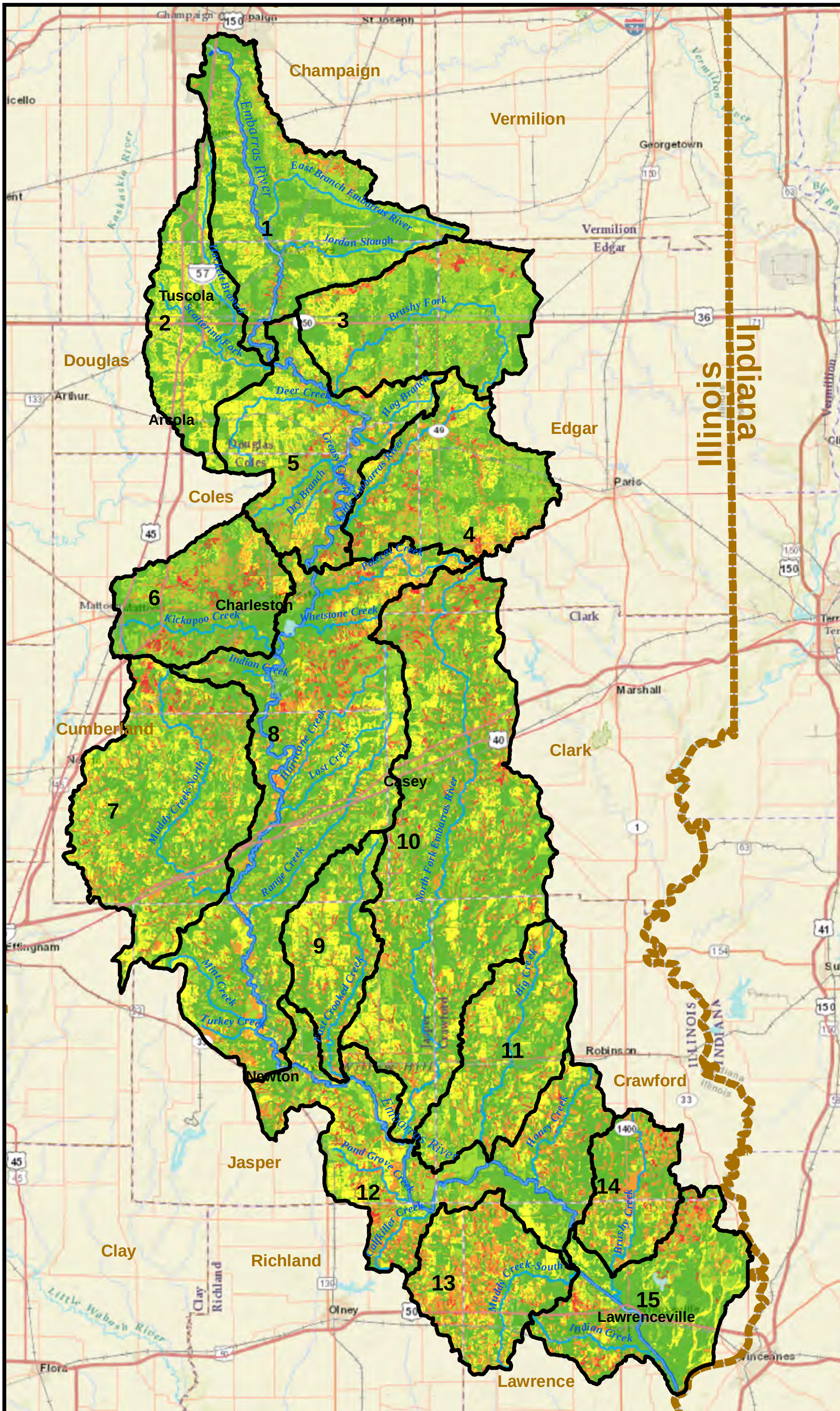
Phosphorus (lbs/ac/yr)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 4
- 4 - 21.4
- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver Tributaries
- Counties

N S W E

0 5 10 Miles

Exhibit 19



Embarras River Watershed

Sediment Non Point Source Pollutant Loading

ID	Name	Total Suspended Sediment (tons/yr)	tons/ ac
1	East Branch Embarras River	54,017	0.44
2	Scattering Fork	26,735	0.38
3	Brushy Fork	49,739	0.53
4	Little Embarras River	62,480	0.75
5	Deer Creek-Embarras River	65,490	0.70
6	Kickapoo Creek	43,576	0.67
7	Muddy Creek	90,844	0.67
8	Range Creek-Embarras River	148,553	0.67
9	East Crooked Creek	32,989	0.66
10	North Fork Embarras River	162,976	0.71
11	Big Creek	45,724	0.63
12	Honey Creek-Embarras River	99,433	0.76
13	Paul Creek-Muddy River	58,163	0.92
14	Brushy Creek	32,391	0.78
15	Indian Creek-Embarras River	46,258	0.56

Legend

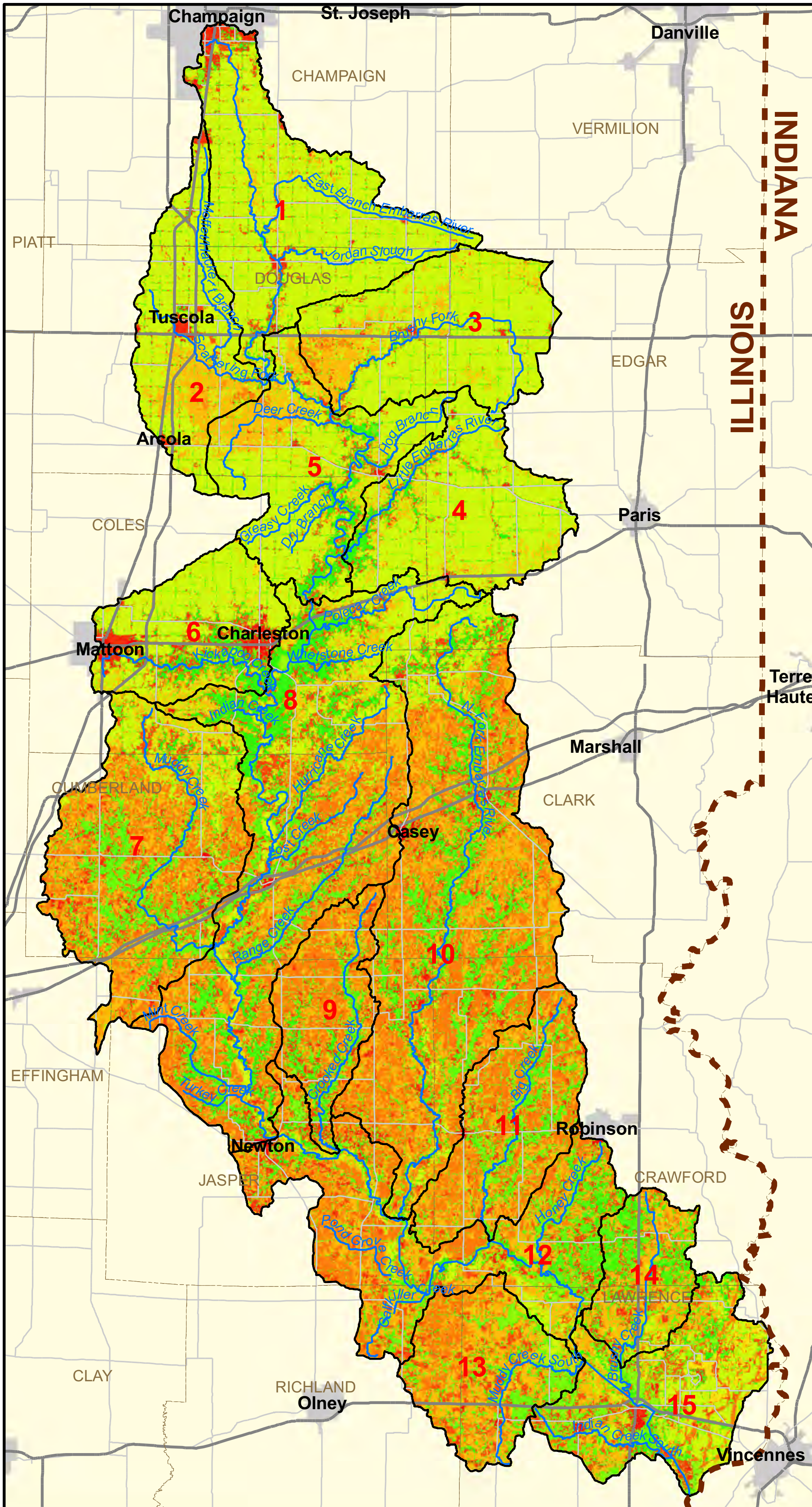
Sediment (tons/ac/yr)

- 0 - 0.3
- 0.3 - 0.6
- 0.6- 1
- 1 - 4
- 4- 36.5
- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver Tributaries
- Counties

N W E S

0 5 10 Miles

Exhibit 20



Embarras River Watershed

Fecal Coliform
Non Point Source
Pollutant Loading

ID	Name	Fecal Coliform (cfu in billions)	
		Total	per acre
1	**East Branch Embarras River**	226,427	1.87
2	**Scattering Fork**	143,017	2.07
3	Brushy Fork	169,805	1.82
4	Little Embarras River	141,147	1.70
5	**Deer Creek-Embarras River**	163,654	1.76
6	**Kickapoo Creek**	138,215	2.13
7	Muddy Creek	290,251	2.16
8	Range Creek-Embarras River	432,019	1.96
9	East Crooked Creek	111,957	2.26
10	North Fork Embarras River	492,290	2.17
11	**Big Creek**	154,228	2.16
12	**Honey Creek-Embarras River**	279,956	2.17
13	**Paul Creek-Muddy River**	137,117	2.18
14	Brushy Creek	77,062	1.88
15	Indian Creek-Embarras River	158,093	1.92

Legend

Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed & Subwatersheds

Fecal Loading (bill fcu/ac/yr)

High : 8.2
Low : 0.074

N
W E
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5 0 5 10
Miles

Table 4-6: Existing Conditions Nonpoint Source Loading by Subwatershed*									
ID	**Name**	**Total Suspended Sediment (tons)**		**Total Nitrogen (lbs)**		**Total Phosphorus (lbs)**		**Fecal Coliform (cfu in billions)**	
		Total	tons/acre	Total	lbs/acre	Total	lbs/acre	Total	per acre
1	**East Branch Embarras River**	54,017	0.44	3,282,251	26.85	75,622	0.62	226,427	1.87
2	**Scattering Fork**	26,735	0.38	744,279	10.65	63,618	0.91	143,017	2.07
3	Brushy Fork	49,739	0.53	1,142,340	12.09	101,287	1.07	169,805	1.82
4	Little Embarras River	62,480	0.75	996,670	11.89	95,137	1.14	141,147	1.70
5	**Deer Creek-Embarras River**	65,490	0.70	1,016,029	10.80	97,094	1.03	163,654	1.76
6	**Kickapoo Creek**	43,576	0.67	636,057	9.71	65,390	1.00	138,215	2.13
7	Muddy Creek	90,844	0.67	1,649,090	12.16	205,625	1.52	290,251	2.16
8	**Range Creek-Embarras River**	148,553	0.67	2,409,978	10.83	293,053	1.32	432,019	1.96
9	East Crooked Creek	32,989	0.66	681,373	13.63	82,991	1.66	111,957	2.26
10	North Fork Embarras River	162,976	0.71	2,603,203	11.33	369,881	1.61	492,290	2.17
11	**Big Creek**	45,724	0.63	284,537	3.94	143,854	1.99	154,228	2.16
12	**Honey Creek-Embarras River**	99,433	0.76	843,726	6.46	246,504	1.89	279,956	2.17
13	**Paul Creek-Muddy River**	58,163	0.92	283,707	4.47	135,134	2.13	137,117	2.18
14	Brushy Creek	32,391	0.78	141,228	3.40	67,712	1.63	77,062	1.88
15	Indian Creek-Embarras River	46,259	0.56	249,974	3.01	125,493	1.51	158,092	1.92
	Total	1,019,369	0.66 (avg)	16,964,442	10.1 (avg)	2,168,395	1.4 (avg)	3,115,237	2.0 (avg)

*bold = 2011 priority subwatershed

Section 5 – Identification of Watershed Impairments and Problems

Group Concerns

As discussed in Section 2, stakeholder concerns were gathered during the planning process. The Watershed Inventory provided a means of verifying these concerns or, in some cases, developing additional ones. The results of the Watershed Inventory and analysis of the stakeholder concerns indicate that the group concerns can be described in four primary areas: soil, water, wildlife, and human factors.

Table 5-1 lists the concerns that were identified during the work group meetings and the problem category associated with each concern. Some are listed in several problem groups as they cover a wide variety of issues.

Table 5-1: Concerns and Associated Problems

Concern	Problem Category
- Ephemeral, gully, and sheet & rill erosion - Streambank erosion and funding for streambank stabilization projects - Siltation and sediment accumulation - Soil Compaction - Excessive use of and reliance on tillage - Nutrient management - Funding for soil testing - Funding for maintenance of existing conservation practices - Research on legacy nutrients - Research on cover crops	Soil
- Nutrient management – e.g., application of proper rates - Maintenance of conservation practices - Flooding - Siltation and sediment accumulation contributing to nutrient levels - Urban water management (stormwater and retention ponds, parking lots with oil and salt runoff) - Proper management of tile drainage and terraces - Water surges and flash floods - Lack of maintenance on road ditches and culverts - Over-fertilization of lawns - Funding for construction and maintenance of ponds - Funding for water testing - Wastewater concerns - Research on cover crops	Water
- Log jam removal - Develop and maintain proper habitat - Nuisance wildlife - Lack of quality wildlife for recreation (birding, fishing, hunting, etc.) - Changing course of river, e.g., large gullies through fields - Maintenance of recreation areas along river - Lack of public access for recreation	Wildlife and Natural Character

- Nutrient management education - Lack of funding for long-term conservation programs leading to land being converted back to crop production - Education on wildlife habitat and management of wildlife - Outreach and education on availability of USDA programs - Abandoned wells and associated safety concerns - Land ownership trends (including land exchanges) - Equipment costs - Lack of funding for infrastructure projects (e.g., improving bridges) - Lack of education and outreach for general public (e.g., watershed plan updates, point source/non-point source pollution, agricultural conservation, etc.) - Perceived lack of local control - Lack of farmer-led education - Lack of technical assistance and staffing fluctuations - Lack of contractors to design and construct practices	Human Factors

Priority Resource Concerns

The priority resource concerns that were identified during the public meetings were prioritized by the working group. Seventeen of the concerns were identified as priority resource concerns and are included as part of this WMP. These concerns were listed into four categories to aid understanding of the issues: soil, water, wildlife and natural character, and human factors. An explanation of each priority resource concern is listed below.

Soil

Erosion

Soil erosion is a problem in almost all Illinois watersheds. Erosion is a natural process, but it has been increased dramatically by human land use. Excessive rates can cause serious problems, such as receiving water sedimentation, ecosystem damage, and loss of productive topsoil. Streambank erosion is a primary area of concern, often contributing to property damage, sediment build-up in-stream, and raising concerns about legacy nutrients being lost to water bodies.

Sedimentation

Sedimentation is an on-going, natural process that occurs in all watersheds. Sediment deposition occurs throughout the watershed in low spots and depressions, along field borders, on flood plains, in stream channels, and wherever slight variations in the velocity of silt-laden water takes place. Sedimentation is the result of stream channel dynamics and "bed load" conditions. As the river meanders, sediment bars are deposited on the inside of meander curves where the velocity of water flow is lower. Sedimentation in the watershed has been accelerated by man-made changes in land use.

Water

Water Quality

Water quality is the measure of the condition of water relative to the requirements of the biotic species or to any human need or purpose. Water quality can impact many aspects of the river system from aquatic habitats to recreational opportunities. The INLRS identified the Embarras River watershed as a priority for phosphorus reduction, meaning it is among those with the greatest capacity to reduce high volumes of nutrient loss annually.

Flooding
A flood is an overflow of an expanse of water that submerges land. Floods occur in rivers when flow exceeds the capacity of the river channel, particularly at bends or meanders. Floods often cause damage to homes and agricultural fields that are placed in natural flood plains of rivers. Floods can also damage infrastructure, including roads and bridges.

Drainage
Drainage has been, and will continue to be, a major requirement for agricultural production in the watershed. Surface and subsurface drains have been installed by individual landowners since 1850 and by mutual or organized groups of landowners beginning in 1895. Maintenance and replacement of the drainage improvements, such as installation of drainage water management structures, are continuing at the present time and will be important economic and environmental action items in the future.

Wildlife and Natural Character

Beaver-related problems
The planning committee identified beaver as a wildlife species causing some problems with landowners in the watershed. Flooding of crops caused by beaver dams on tributaries and erosion of streambanks have been cited by some landowners.

Log jams
Log jams cause problems when they force changes to the normal channel flow. Small log jams form restrictions in the stream channel and can lead to bank erosion, which widens the channel. Larger log jams divert water flow onto adjacent land, change the direction of the normal channel flow, and are potential safety hazards to private and public resources.

Wildlife, Recreation Opportunities & Impacts
Many segments of the Embarras River are in areas with extensive wildlife habitat which are frequently used for canoeing, fishing, hunting and other recreational activities. The recreational value of this basin contributes significantly to the economic resources of the area. Landowners in the watershed recognize these values of the watershed, including the intrinsic, biological, and physical importance for threatened and endangered species. However, trespassing recreationalists continue to be a concern. Additionally, absentee landlords who rent land for recreation may neglect maintenance of streambanks and invasive species which can have negative impacts on neighboring and downstream tracts. Damage to the river channel and natural flood plain area reduce its scenic beauty and affect landowners and recreationalists.

Natural Character of River
As the Embarras River flows through the basin, it tends to meander, creating numerous bends. In the lower half the grade flattens out, and the meandering of the river increases which is typical of a river this size. The bends move back and forth over time across the floodplain. Landowners and operators farming along the river report losses of up to 10 rows of crop (25 feet) as the river bend advances. Eventually, the river jumps across the neck of the bend leaving isolated sloughs or oxbows. Activities of people and their structures in the

floodplain come into conflict with the river as it moves. It is estimated that 57 miles of streambanks along the Embarras mainstem are actively eroding enough to need treatment.

Wetlands

For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetland functions include water quality improvement, floodwater storage, fish and wildlife habitat, aesthetics, and biological productivity. Restoring wetlands will slow stormwater runoff, filter excess nutrients from the runoff, recharge groundwater supplies, decrease flooding, and increase habitat for threatened and endangered species.

Human Factors

Infrastructure and Bridges

The working group identified concerns including maintenance of infrastructure, including bridges. Small bridge outlets can create restrictions for flow if not sized properly and can aid in the accumulation of debris around the bridge openings. Improperly maintained culverts and ditches can also contribute to flooding over roadways and small bridges, interrupting transportation, and interfering with neighboring croplands.

Communication

Communication and coordination need to be continuously pursued to strengthen and maintain the cooperative relationship among the working group and other stakeholders involved in the watershed. In addition, communication among private, state, and federal agencies that can provide financial and technical assistance needs to be facilitated so planning and implementation efforts will not be duplicated.

Private Property Rights

Landowners throughout the Embarras River basin have apprehension about any plan that affects freedom to use their land, as well as any potential liability. Landowners may view any resource problem solution that restricts the land use as an infringement on private property rights. In the same manner, solutions to resource problems involving actual or perceived public access to private property raise unresolved questions about liability in cases of accidental injury. Solutions to resource problems require adequate communication and education to make landowners aware of their rights as private property owners.

Economic Costs (Funding Solutions)

Landowners are concerned about the cost of implementing practices to address resource concerns such as flooding, soil erosion and water quality. Without financial assistance, many practices are not economical for the individual landowner to implement. Offsite benefits should be considered for overall economic justification.

Water Usage and Supply

The Embarras River is a source of water supply. Protecting the quality and quantity are important to the communities along it. Charleston draws one half of its water from the river through a side channel reservoir. Other towns and villages draw water from shallow and deep wells in the river bottom floodplain.

Land Use and Ownership Changes

Although land use within the watershed has remained virtually unchanged, the growth of absentee landlords and other ownership changes may affect land use in the future. The way in which growth takes place affects its impact on water quality. With careful planning and a commitment to protect streams, rivers, and ground water, watershed efforts can be communicated with absentee landowners and tenants and land use practices can be implemented that balance the need for jobs and economic development with protection of the natural environment.

Lack of Education

Lack of education about the river basin and stream channel dynamics were suggested as the reason that citizens take actions that were detrimental to the basin in general.

Problem Statements

Problem statements were developed during the planning process to link the watershed concerns with existing and historical water quality data and the four major concern categories.

Flooding

Excessive flow rates and volumes of water are causing damage and loss within the Embarras River watershed.

Erosion/Water Quality

Soil erosion and sedimentation within the watershed is degrading the water quality/quantity and limiting the aesthetics, wildlife habitat, and aquatic health of streams. Agriculture and typical urban area practices within the watershed contribute a significant amount of pollutants, thereby contributing to the frequent exceedances of water quality targets.

Wetland, Wildlife and Natural Character

Impacts to the natural resources of the watershed are degrading the quality and number of wetlands, reducing wildlife habitat, and limiting recreational opportunities.

Information and Public Communication

Stakeholders are not knowledgeable about their daily impact on the watershed and its water quality.

Section 6 – Identification of Sources and Priority Areas

Potential Sources

A source is an activity, material or structure that results in NPS pollution. Potential sources were identified for each problem statement based on the information analyzed in the Watershed Inventory in Section 3. Table 6-1 lists the potential sources for each problem. For sources that did not have collected data as backup, the information was retained from the 2011 plan which was compiled during work group meetings.

Table 6-1: Potential Causes and Sources

Problem Statement	Potential Sources
Excessive flow rates and volumes of water are causing damage and loss within the Embarras River Watershed.	-Alterations to flood storage and flow conveyance through the impacts of log jams and beaver activities or improperly sized crossings -Urban encroachment on the floodplains -Loss of wetlands -Land use changes
Soil erosion and sedimentation within the watershed is degrading the water quality/quantity and limiting the aesthetics, wildlife habitat, and aquatic health of the streams within the watershed. Agriculture and typical urban area practices within the watershed contribute a significant amount of pollutants, thereby contributing to the frequent exceedances of water quality targets.	-Conventionally tilled agricultural fields that drain directly to ditches/streams with no or inadequate buffers -Bank erosion due to changes in hydrology -Areas where livestock have direct access to streams -Areas with inadequate buffers -Combined Sewers and Overflows into ditches/streams -Communities with no sewer systems and direct discharges to ditches/streams -Discharge from WWTPs -Legacy phosphorus in streambed sediments -Over application of fertilizers for its specific use -Timing of application of fertilizers -Lack of septic maintenance -Lack of manure management
Impacts to the natural resources of the watershed are degrading the quality and amount of wetlands, wildlife habitat and recreational opportunities.	-Areas with inadequate buffers -Loss of wetlands -Urban encroachment on the floodplains -Water quality degradation
Stakeholders in the Embarras River Watershed are not knowledgeable about their daily impact on the watershed and its water quality.	-Lack of public awareness -Lack of unified approach -Lack of perceived benefits/ impacts -Lack of interest -Lack of time and commitment -Lack of media coverage/ educational material

Priority Areas and Priority Subwatersheds

Priority areas include those where project implementation focuses on remediating the most severe areas with a goal to reduce the impact of future impairments. The priority areas within the Embarras River watershed were identified based on:

1. The 2011 WMP that utilized the watershed Inventory, the identified problems and goals, GIS analysis, and stakeholder input. Priority areas throughout the entire watershed were mapped using GIS spatial and statistical analyses; Table 6-2 below illustrates the exhibits that identify the priority areas within the watershed. Table 6-2 also illustrates the exhibits that display mapping analysis that can be used to prioritize areas for the most effective implementation.
2. An updated prioritization process to identify smaller HUC-12 subwatersheds for detailed planning. Polecat Creek (051201120801) and The Slough (HUC 051201121302) were selected using a combination of data-driven and stakeholder criteria.
3. West Branch of Hurricane Creek Agricultural Conservation Planning Framework (ACPF) modeling and practice recommendations. The Nature Conservancy and Environmental Solutions AQ conducted an analysis of the watershed to identify runoff risk areas and conservation opportunities. Detailed results are presented in Appendix E.

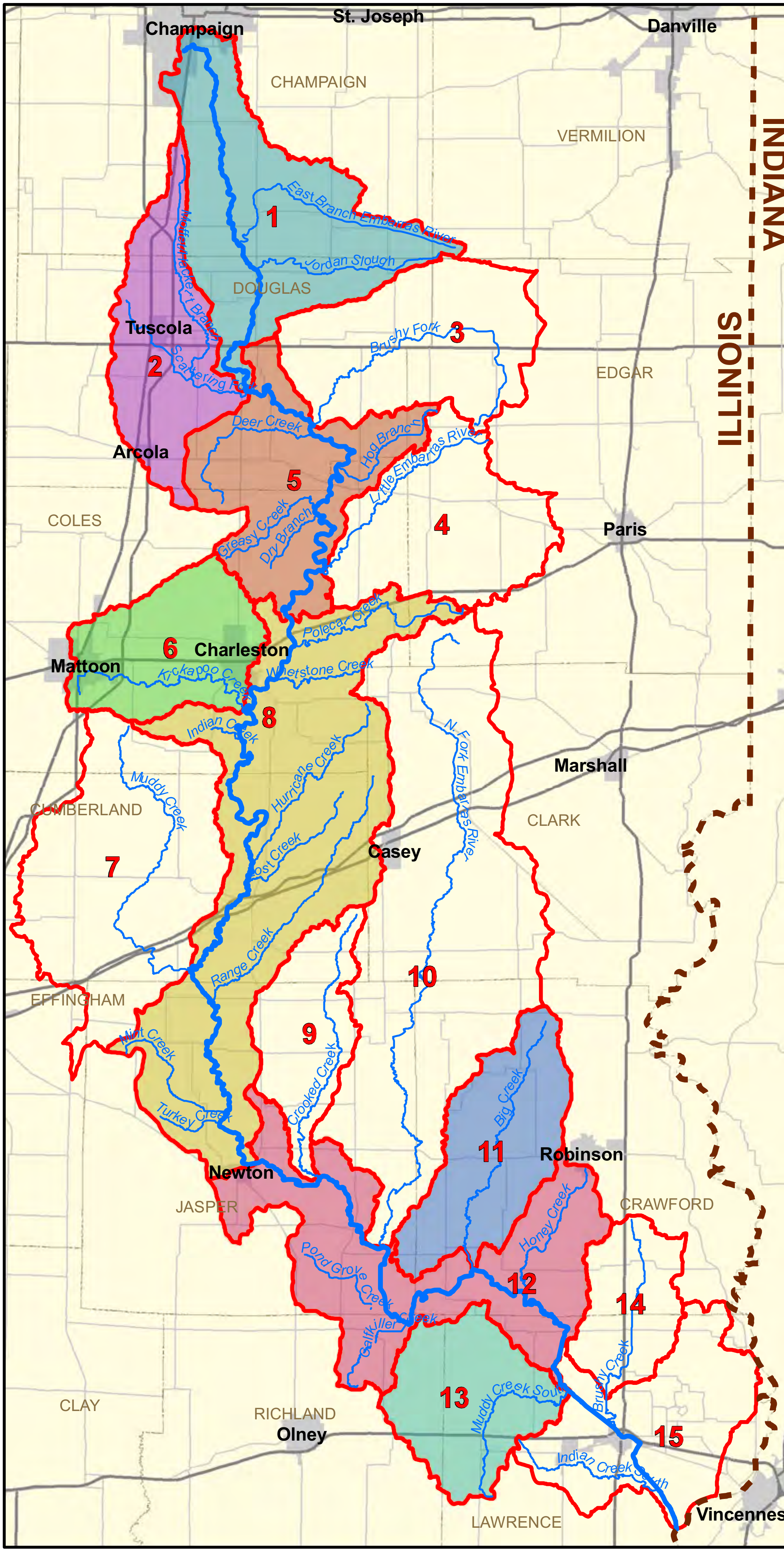
2011 Embarras River Watershed Management Plan Priority Areas

In 2011, understanding the size and scale of such a large watershed, the stakeholders selected 8 priority HUC-10 subwatersheds based on a range of criteria identified above to focus on for identifying specific priority areas and projects for implementation. In addition to the modeling results and regulatory water quality impairments, stakeholder participation and interest was weighed heavily. These subwatersheds are further detailed and inventoried in Appendix D. The previously selected strategic subwatersheds are shown in Exhibit 21.

2011 Priority Area Mapping and Project Identification

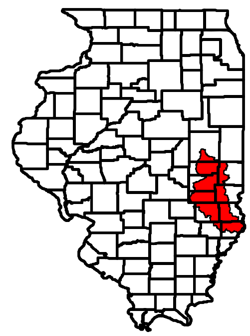
Mapping, modeling, stakeholder input and analysis were performed to identify project implementation priority areas that address the resource concerns. The exhibits created were intended to be tools that the stakeholders can use to identify areas and sites within the watershed that are contributing to impairments and where significant watershed improvements can be applied. The following exhibits listed in Table 6-2 were designed to be utilized as tools for project prioritization and many of the exhibits are provided in Appendix D to show greater detail for the 8 selected priority subwatersheds.

Exhibit 21



Embarras River Watershed

Priority Subwatersheds Map



Sub-watershed #	HUC Code	Subwatershed Name	Acres
1	0512011201	East Branch Embarras River	122,219
2	0512011202	Scattering Fork	69,875
5	0512011205	Deer Creek-Embarras River	94,017
6	0512011206	Kickapoo Creek	65,461
8	0512011208	Range Creek-Embarras River	222,342
11	0512011211	Big Creek	72,143
12	0512011212	Honey Creek-Embarras River	130,554
13	0512011213	Paul Creek-Muddy River	63,468

Legend

Urban Area
Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed & Subwatersheds

Priority Subwatershed Basins

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6
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Miles

Table 6-2: 2011 Watershed-Wide Maps Designed for Prioritizing Project Areas and Locations		
Exhibit	**Name**	**Details**
28	Pasture Land Near Streams	Illustrates areas that have pasture land adjacent to streams where Environmental Quality Incentive Program (EQIP) projects can be prioritized.
27	Highly Erodible Lands	Illustrates highly erodible lands that are under agriculture or pasture/grazing land usage. These areas are high priority for reducing sediment and nutrient loads.
26	Hydric Soils	Illustrates hydric soils that are under agricultural production. These areas are great candidate sites to reduce nutrient loading, provide flood mitigation and enhance habitat.
14	303 (d) List	Illustrates impaired stream segments. Projects should prioritize improving the contributing watersheds to these stream segments as much as possible.
16	Septic Density	Illustrates potential septic density hotspots near streams and waterways throughout the watershed.
17	Nitrogen NPS Loading	Custom GIS model identifies ranges of nitrogen loading and hotspots throughout the watershed.
18	Phosphorus NPS Loading	Custom model identifies ranges of phosphorus loading and hotspots throughout the watershed.
19	Sediment NPS Loading	Custom model identifies ranges of sediment loading and hotspots throughout the watershed.
20	Fecal Coliform NPS Loading	Custom model identifies ranges of fecal coliform loading and hotspots throughout the watershed.
22	Stakeholder Identified Project Locations	Shows 68 specific implementation projects identified by stakeholders during the plan development
23	Priority Areas Based on NPS Loading (updated with 2022 loading estimates)	A spatial analysis to identify hotspots that contribute significant nitrogen, phosphorus and sediment loading using an updated NPS model
24	Priority Areas Based on Wetland Restoration and Flood Mitigation Potential	An analysis performed by Eastern Illinois University to identify potential implementation locations throughout the watershed.
25	Priority Areas Based on Fecal Coliform Loading and Septic Density	A spatial analysis that identified hotspots that likely contribute to bacteria loading in the watershed.

2011 Stakeholder Identified Project Priority Locations

A series of one-on-one meetings were held with selected stakeholders in December of 2009. A total of 68 specific projects were identified. The meetings were held with selected counties and municipalities within the 8 strategic subwatersheds chosen by the planning committee. Projects were intended to be implemented first, because the projects were identified and supported by stakeholders. Table 6-3 below summarizes the projects and Exhibit 22 illustrates their locations on a map. These projects are further detailed in Appendix D. The only 2 projects known to have been implemented since 2011 are shoreline stabilization in the Charleston Side Channel Reservoir and a two-stage ditch in Tuscola to treat urban runoff.

Exhibit 22

Embarras River Watershed

Stakeholder Identified Prioirty Projects Map

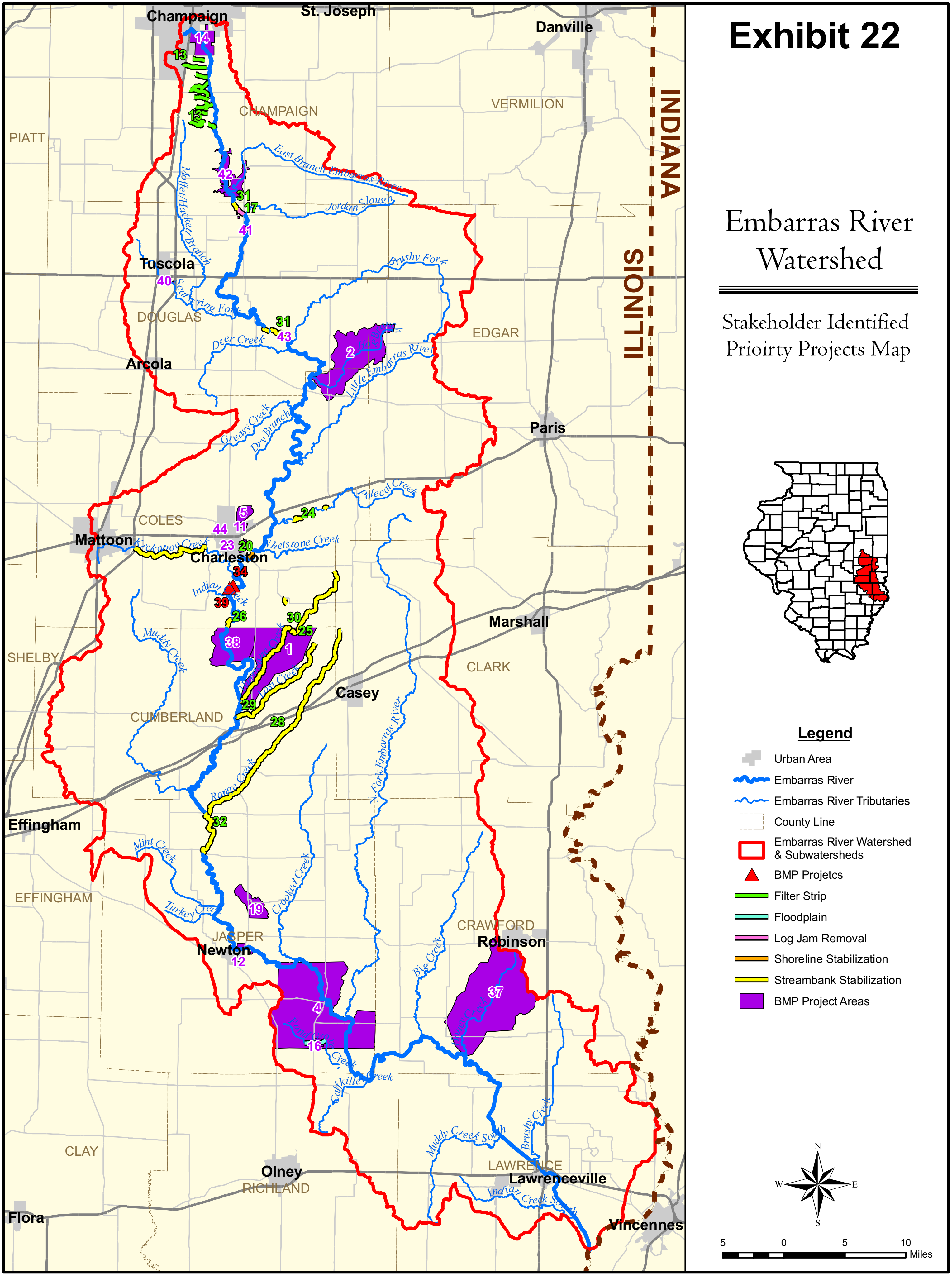


Table 6-3: 2011 Project Identification Workshops		
Entity	**# Projects Identified**	**Project Types**
Champaign County SWCD/NRCS	16	Runoff control at dairy farm; wetland restoration; filter strips
Coles County SWCD/NRCS	8	Terrace, grassed waterway, streambank stabilization
Douglas County SWCD/NRCS	5	Agricultural BMPs, wetland restoration, streambank stabilization
Jasper County SWCD/NRCS	5	Floodplain easements, streambank stabilization, waste management and runoff BMPs from livestock operations
City of Charleston	8	Shoreline stabilization, runoff control BMPs, wetland restoration
City of Newton	6	Urban runoff BMPs, streambank stabilization, wetland restoration (acquisition)
City of Tuscola	6	Urban runoff control, stream restoration to improve flood issues, flood mitigation
City of Villa Grove	7	Urban runoff control, wetland restoration, stream maintenance to prevent flooding
Crawford County SWCD/NRCS	2	WASCB/Waterway, boat access to reduce erosion
Cumberland County SWCD/NRCS	5	WASCB, grassed waterway, agricultural BMPs, streambank stabilization
Total	**68**	

2022 Priority Areas based on Pollutant Load Analysis

Exhibits 17 – 20 illustrate the pollutant load analysis for the entire watershed which replaces results from the 2011 plan. These maps are created in a way to identify specific areas and land parcels that contribute high loads of nitrogen, phosphorus, sediment and Fecal Coliform. They provide guidance to identify project opportunities and prioritize locations throughout the entire watershed.

This analysis was taken one step further and a statistical analysis was applied to identify areas within the watershed that contributed the highest combined load of nitrogen, phosphorus and sediment, collectively. These areas are illustrated on Exhibit 23. Priority areas from 2011 are further detailed in Appendix D.

2011 Priority Areas based on Wetland Restoration Potential

Eastern Illinois University (EIU) performed a detailed soils analysis for the entire watershed to identify ideal locations for wetland and bottomland restoration. Implementation in these priority areas would lead to flood mitigation, creation of habitat and significant reductions in pollutant loading. Exhibit 24 details these areas for the entire watershed and Appendix D further details them for each strategic subwatershed.

2011 Priority Areas based on Fecal Coliform Loading and Septic Density

Exhibit 25 shows the non-point source pollutant load analysis for Fecal Coliform and septic density near waterways. This analysis was taken one step further to identify potential project areas to address loading. A statistical analysis was applied to identify the highest statistically significant areas in the watershed, and are further detailed by subwatershed in Appendix D.

2011 Priority Areas based on Hydric Soils under Agricultural Land Cover

Hydric soils that are currently under agricultural land cover were identified. These areas are important locations for wetland restoration that will reduce flooding problems and pollutant loading. Implementation of projects in these areas will also reduce damage to crops and improve ecological habitat. Exhibit 26 illustrates these areas of the watershed.

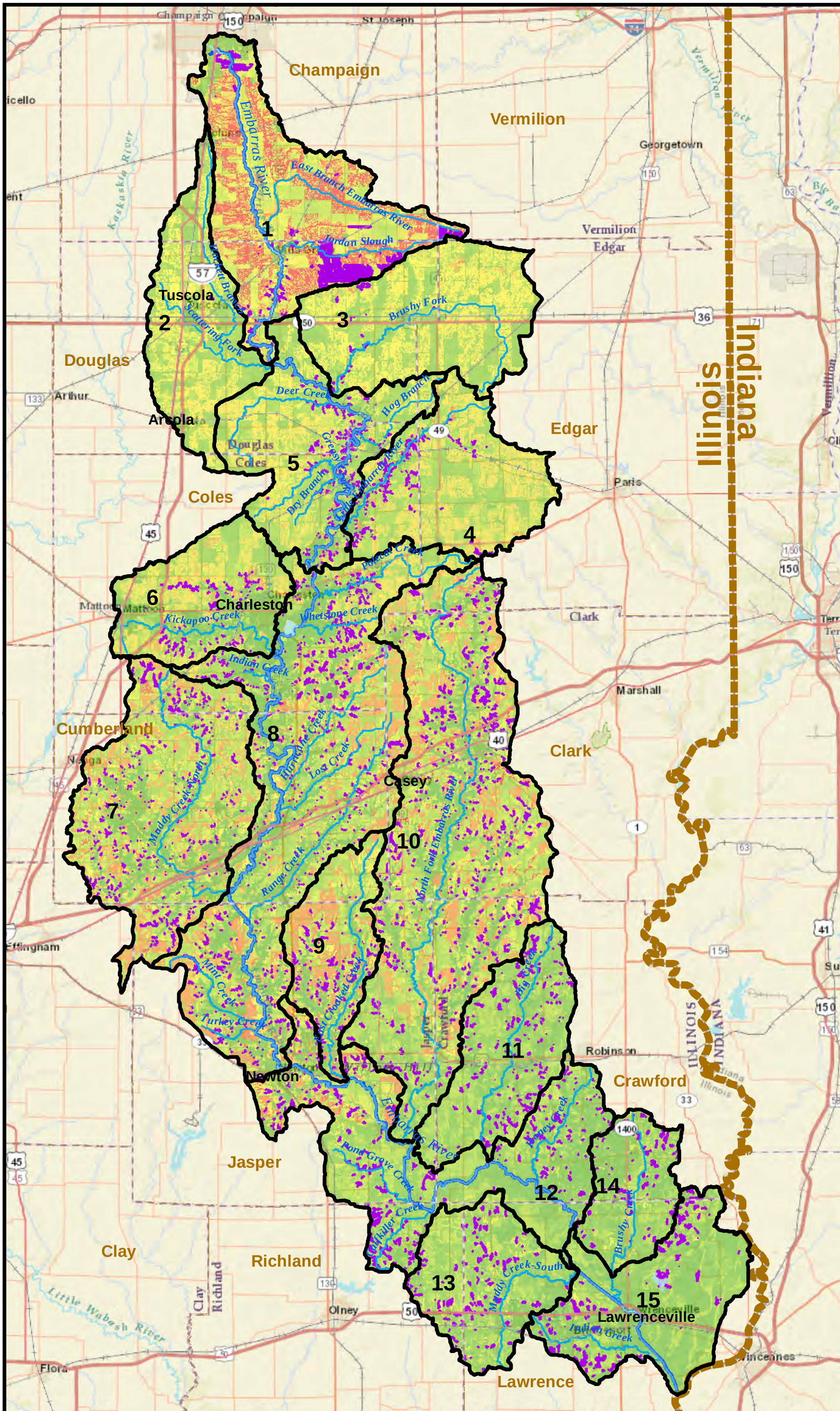
2011 Priority Areas based on HEL Soils under Agricultural or Pasture Land Cover

Priority areas based on agricultural and pasture land uses on HEL soils were identified. These areas are important focus areas because project implementation will have the greatest bang for the buck and contribute significant load reductions. Exhibit 27 illustrates all of the areas that met the criteria.

2011 Pasture Land Near Streams

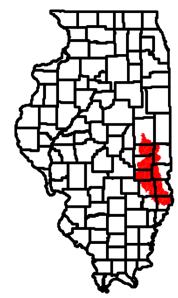
All pasture land areas near streams in the watershed were identified. These areas can be evaluated for project implementation through USDA-NRCS programs that would significantly reduce nutrient and bacteria loading. Exhibit 28 illustrates these areas.

Exhibit 23



Embarras River Watershed

Pollutant Load Priority Areas Map



Legend

- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver Tributaries
- Counties
- Areas With High Nitrogen, Phosphorus, and Sediment Loading

Nutrient Loading Scale

Value

High

Low

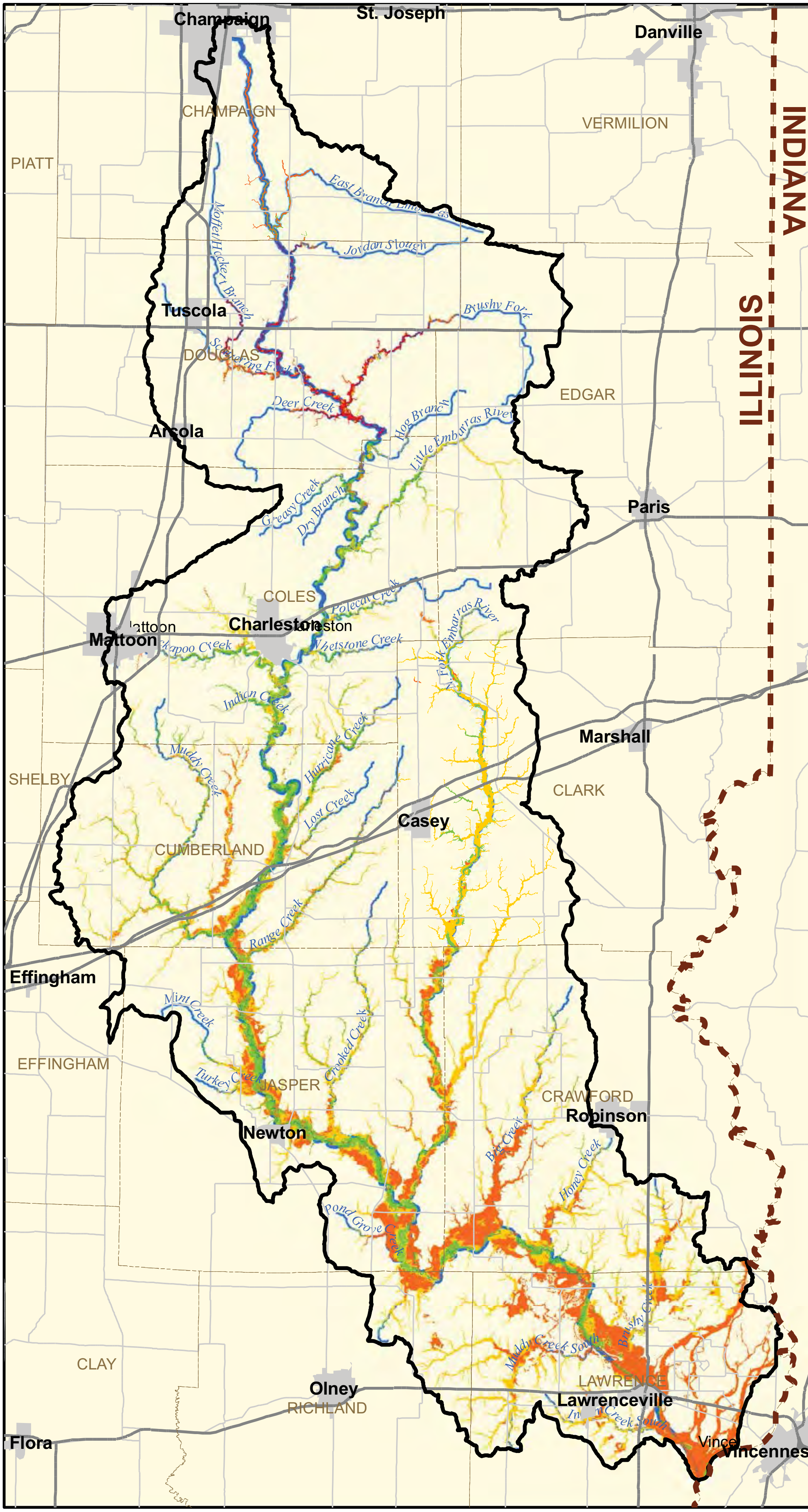
N S E W

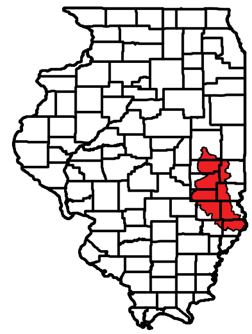
0 5 10 Miles

Exhibit 24

Embarras River Watershed

Wetland Restoration and Flood Mitigation Potential





Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds

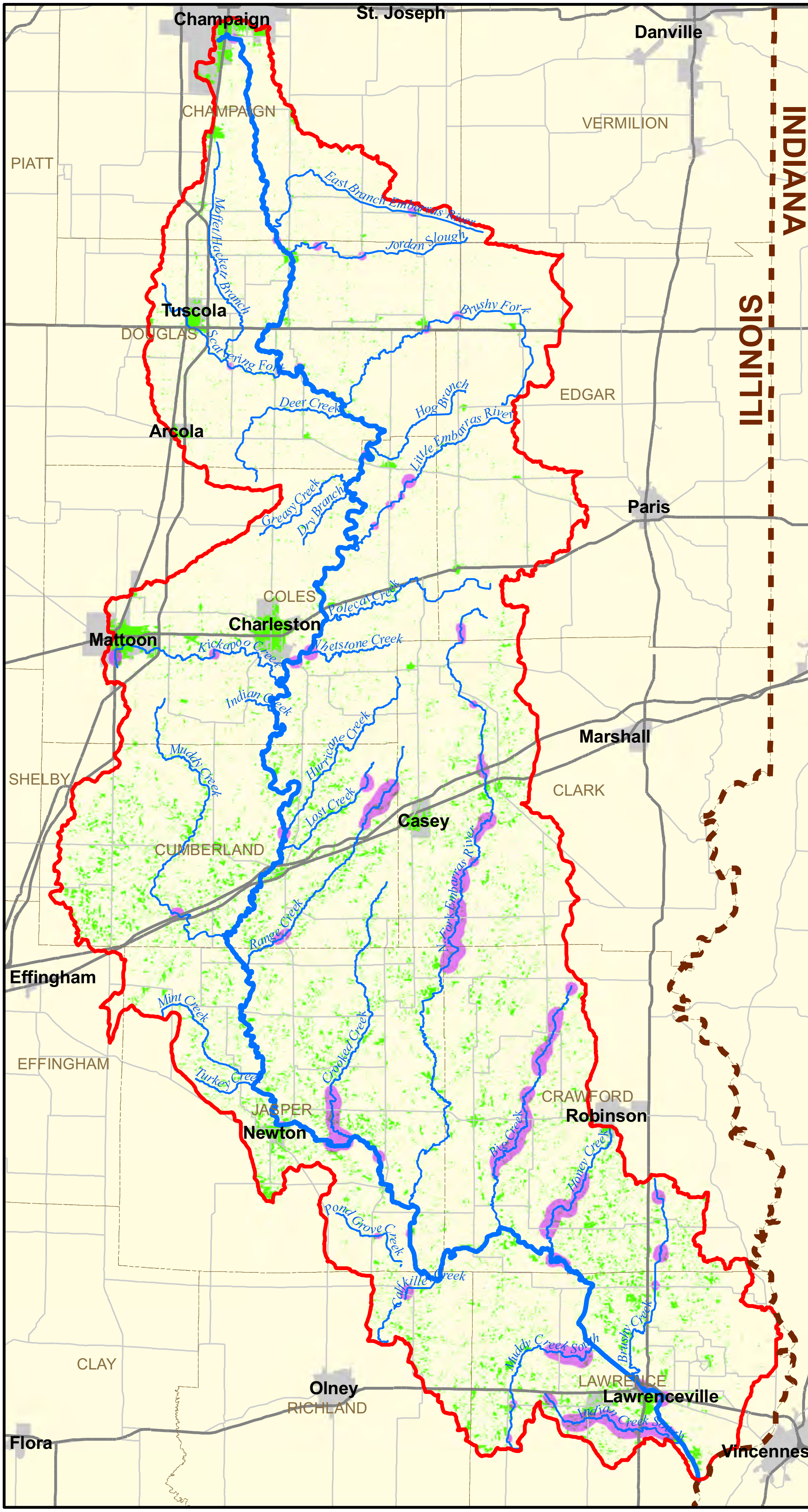
Project Potential:

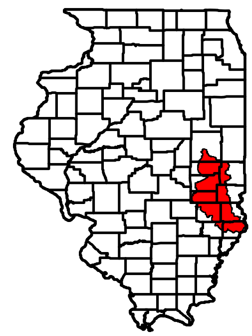
Moderate — High

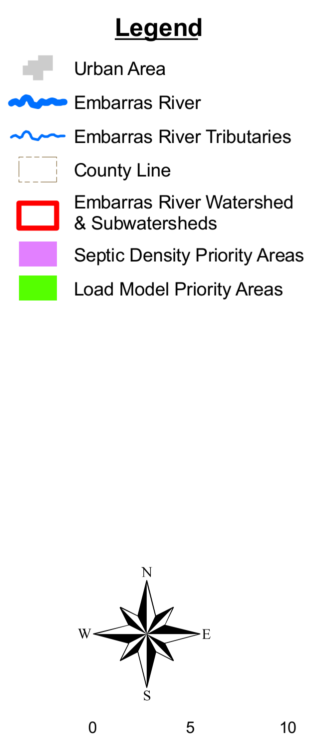
Exhibit 25

Embarras River Watershed

Septic and Fecal Coliform Priority Areas







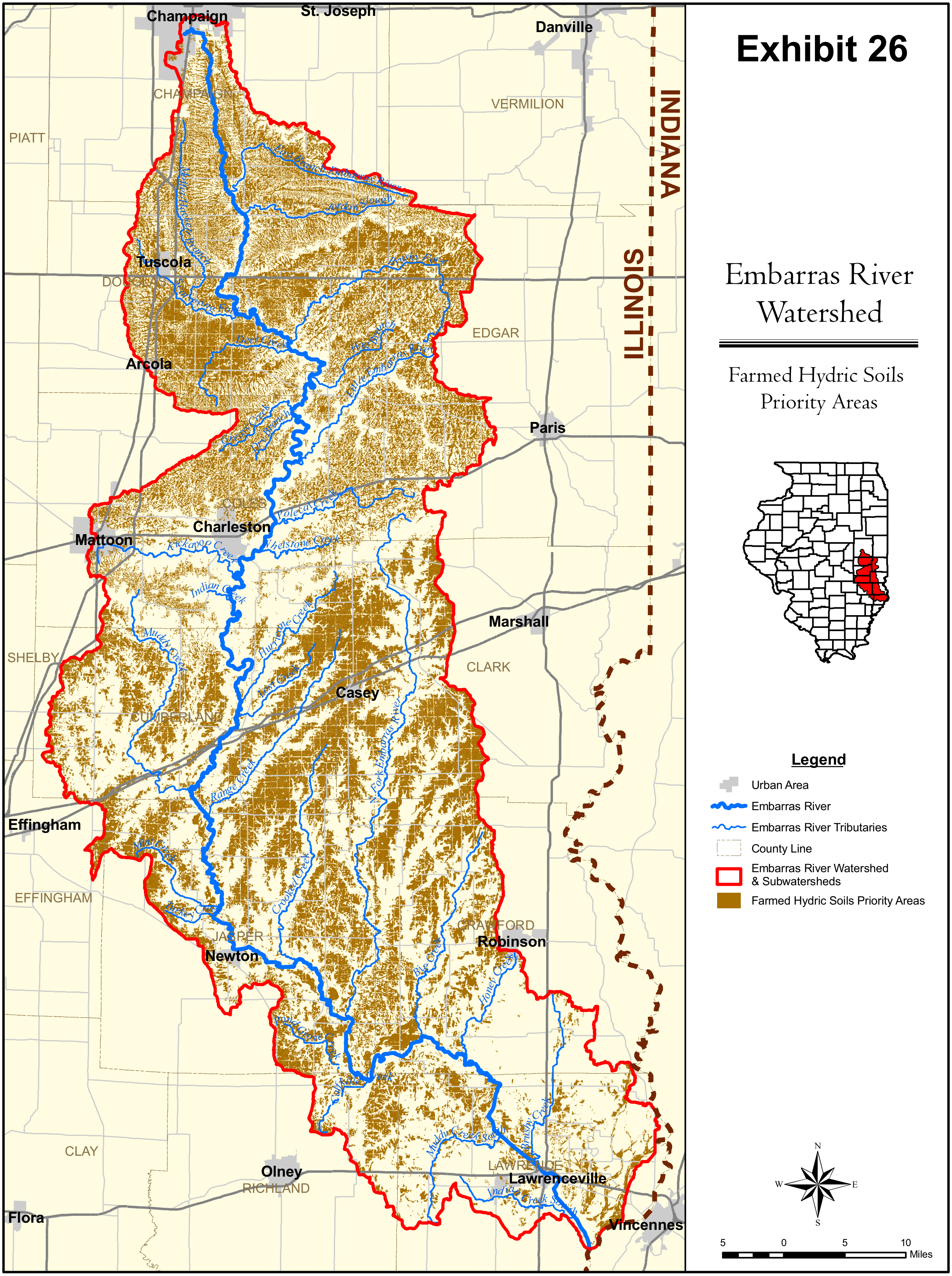
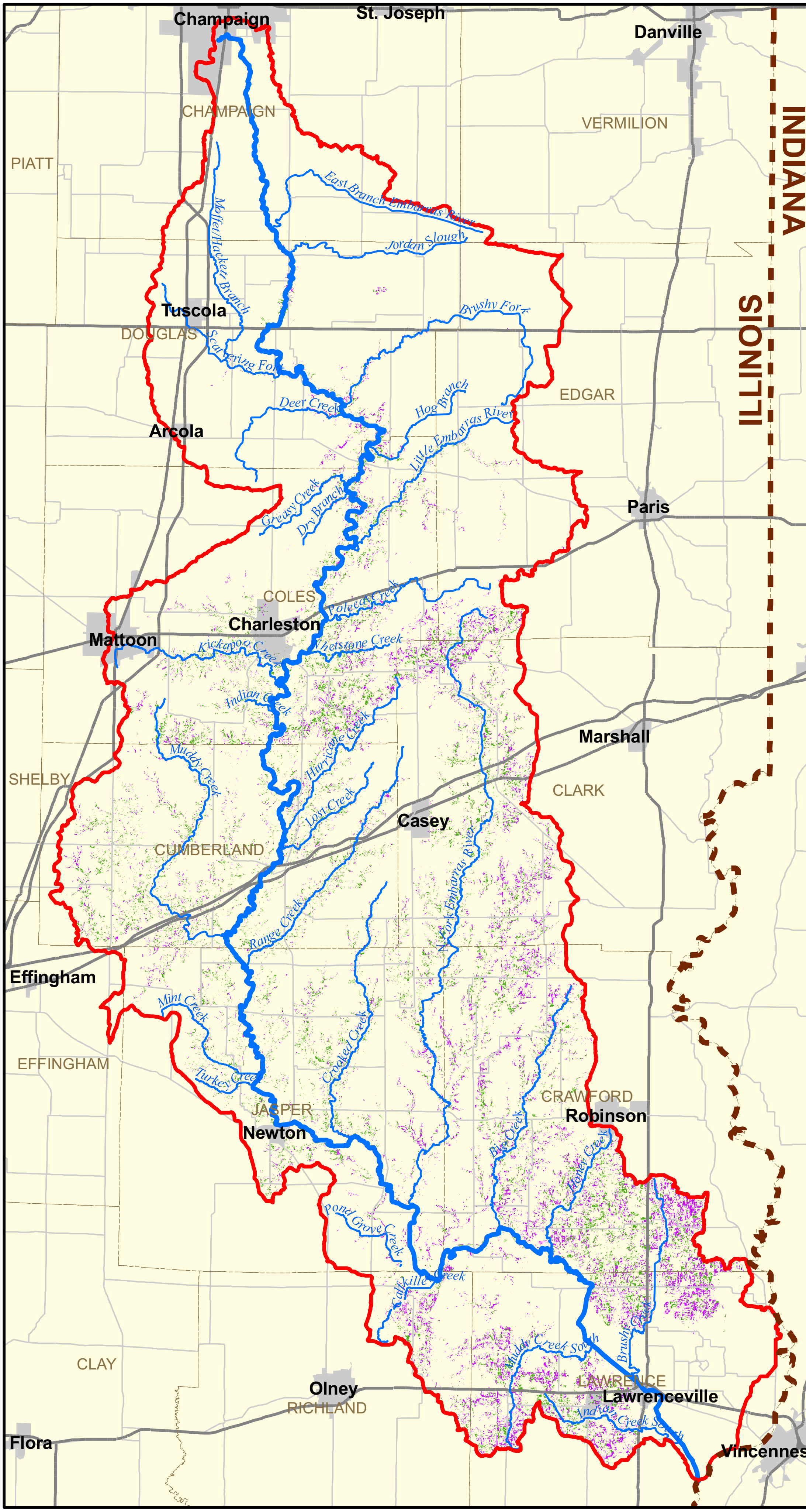


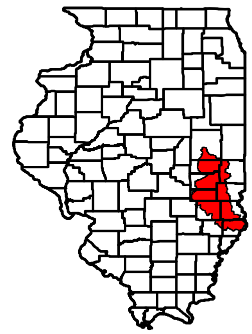
Exhibit 26
Embarras River Watershed
Farmed Hydric Soils Priority Areas
Legend
Urban Area
Embarras River
Embarras River Tributaries
County Line
Embarras River Watershed & Subwatersheds
Farmed Hydric Soils Priority Areas
Champaign
St. Joseph
Danville
CHAMPAIGN
VERMILION
PIATT
INDIANA
ILLINOIS
Tuscola
Arcola
EDGAR
Paris
Charleston
Mattoon
Marshall
SHELBY
CLARK
Casey
CUMBERLAND
Effingham
EFFINGHAM
JASPER
Newton
CRAWFORD
Robinson
CLAY
Olney
RICHLAND
LAWRENCE
Lawrenceville
Vincennes
Flora
East Branch Embarras River
Jordan Slough
Brushy Fork
Deer Creek
Little Embarras River
Polecat Creek
Kickapoo Creek
Whetstone Creek
Indian Creek
Muddy Creek
Hurricane Creek
Range Creek
Crooked Creek
North Fork Embarras River
Big Creek
Honey Creek
Brushy Creek
Muddy Creek South
Indian Creek South
5 0 5 10
Miles
N
S
E
W

Exhibit 27

Embarras River Watershed

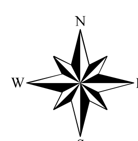
Agriculture and Pasture Land Use on Highly Erodible Land Priority Areas





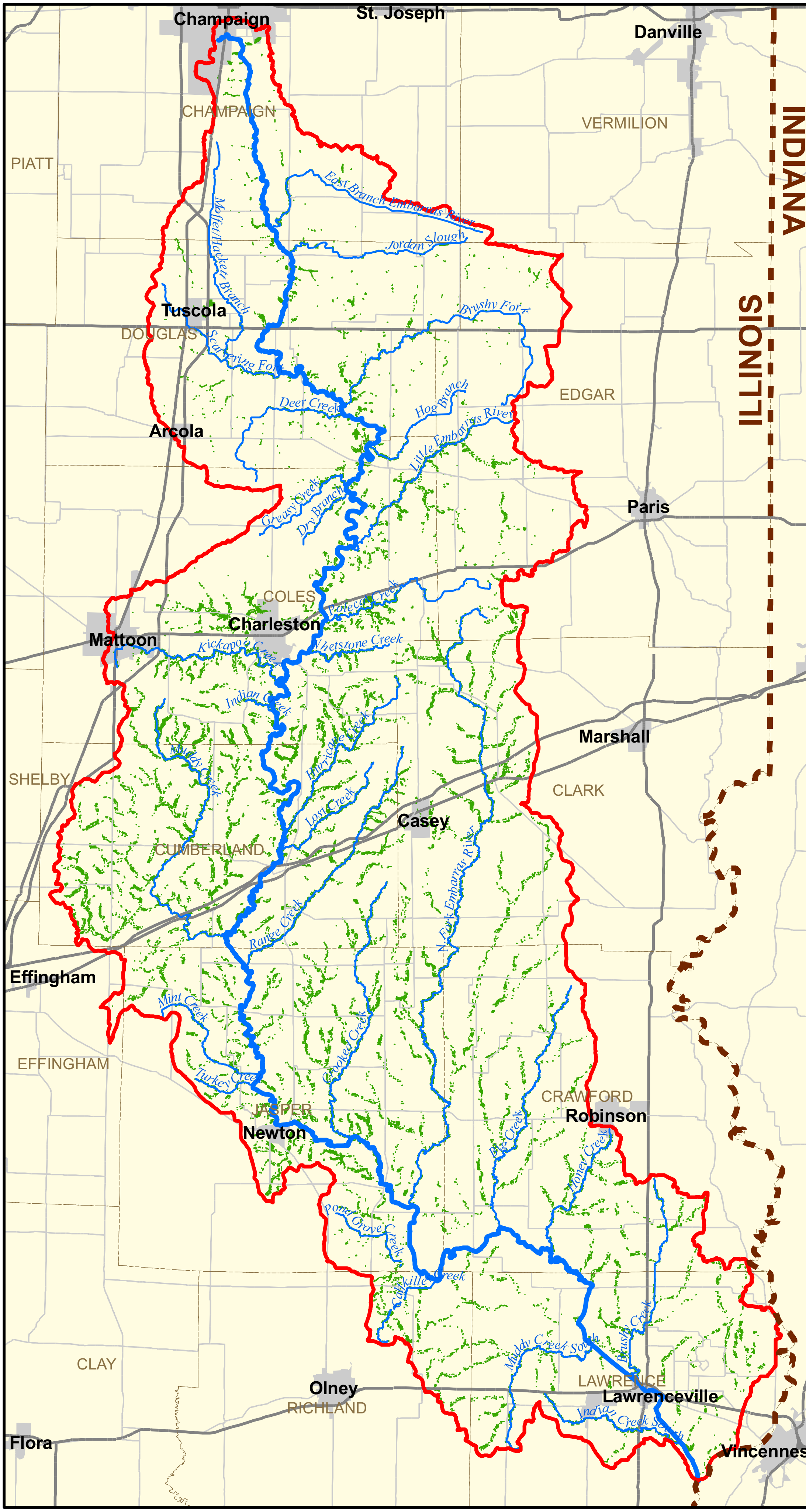
Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds
- Highly Erodible Land and Agriculture
- Highly Erodible Land and Pasture



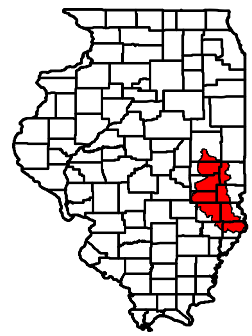
5 0 5 10 Miles

Exhibit 28



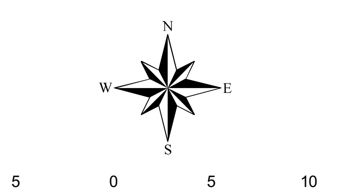
Embarras River Watershed

Pasture Land Near Streams Priority Areas



Legend

- Urban Area
- Embarras River
- Embarras River Tributaries
- County Line
- Embarras River Watershed & Subwatersheds
- Pasture Land Near Streams Priority Areas



2022 Embarras River Watershed Management Plan Priority Subwatersheds

A revised prioritization process was used to identify two smaller HUC-12 subwatersheds for detailed planning (Exhibit 29). The process is further detailed in Section 9. Polecat Creek and The Slough were selected. The Polecat watershed is 18,880 acres in size and located predominately in Coles County, with a portion in Edgar. It flows directly to the Embarras River, East of Charleston. The Slough is 18,201 acres and located mostly in Lawrence County with portions in Crawford and Richland. The Slough flows into Muddy Creek before entering the Embarras River Northwest of Lawrenceville.

Each plan includes a watershed inventory and characterization, estimates of nutrient and sediment loading and sources, BMPs and expected load reductions, costs, critical areas, water quality targets, technical and financial resources, milestones, and a monitoring strategy. Implementation in the Embarras is expected to commence in these two subwatersheds. Partners intend to continue planning based on priority rankings described in Section 9.

West Branch Hurricane Creek ACPF Modeling and Analysis

Modeling for the 17,765-acre watershed was conducted in November 2021 by Environmental Solutions AQ (ENSOAQ) with support from the Nature Conservancy (Exhibit 29). West Branch of Hurricane Creek is located mostly in Coles County with a small portion in Clark. A total of 649 fields were evaluated, 299 in crop, 21 in pasture, and 329 non-agricultural. The analysis reported 3,575 acres with high and very high runoff risk, or 20% of the watershed. Potential practices include:

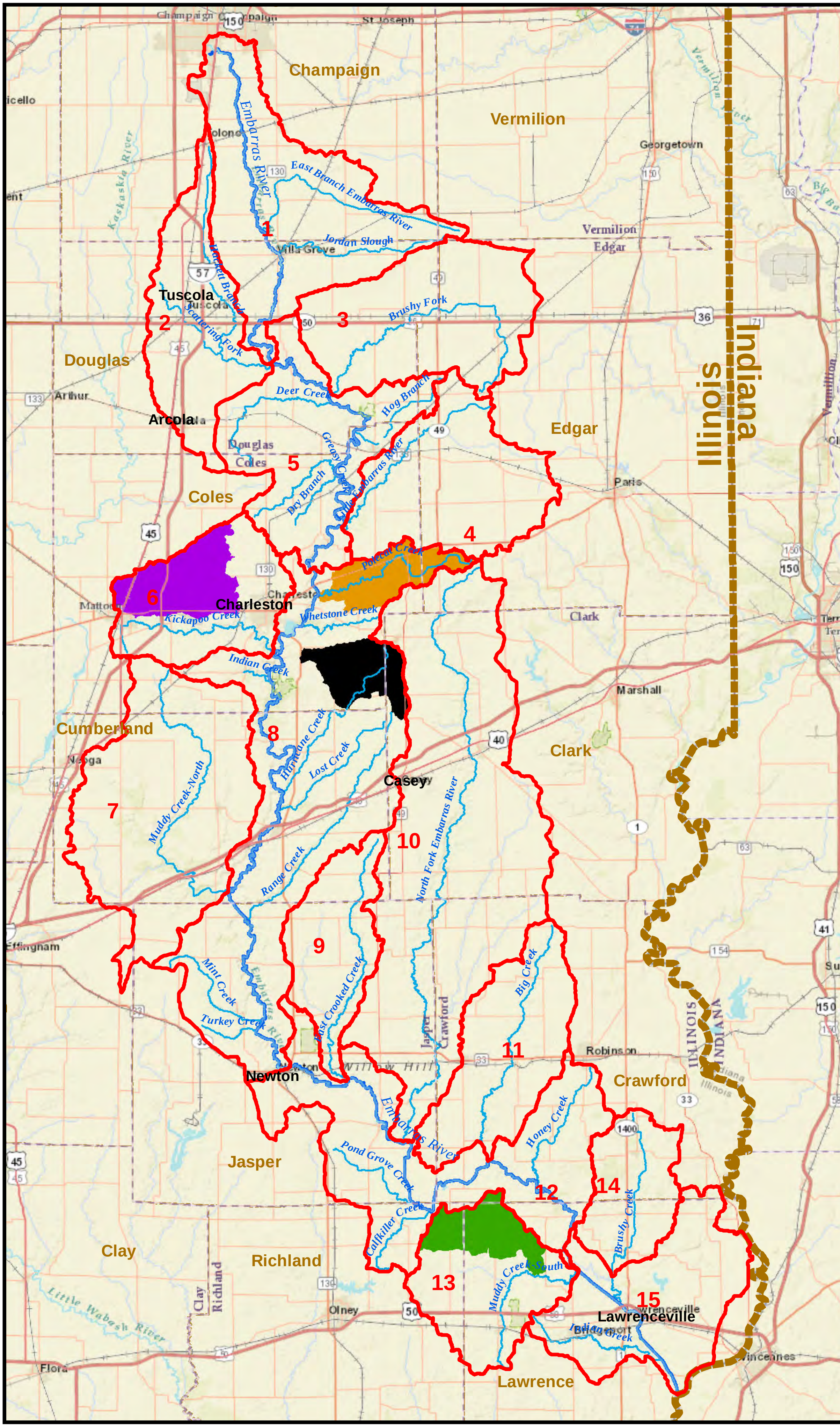
1. Grassed waterways - 263 acres
2. Contoured buffer strips - 26 acres
3. Drainage Water Management - 42 acres
4. Wetlands - 3,201 acres
5. Water and Sediment Control Basins - 66 sites
6. Bioreactors – 54
7. Ponds – 36
8. Riparian buffers - 42 miles
9. Streambank Stabilization - 52 miles

Riley Creek ACPF Modeling and Analysis

Modeling for the 25,945-acre watershed was conducted in 2020 by the Wetlands Initiative (Exhibit 29). Riley Creek is entirely in Coles County and drains a portion of the City of Mattoon. A TMDL is currently being developed for the Kickapoo Creek, the receiving stream for Riley. The TMDL addresses a DO impairment for a segment of the creek. The Wetlands Initiative evaluated the entire watershed for project opportunities. Potential practices identified include:

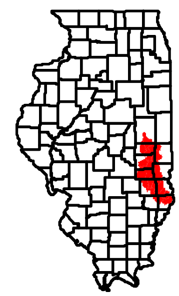
1. Grassed Waterways – 307 locations, 241,021 feet
2. Water and Sediment Control Basins – 3 sites, 980 feet
3. Bioreactor – 35
4. Contoured buffer strips – 1.9 acres
5. Cover crop – 674 acres
6. Drainage Water Management – 2,886 acres
7. Saturated buffer – 117 sites
8. Wetlands – 2.6 acres

Exhibit 29



Embarras River Watershed

2022 Priority Subwatershed Planning and West Branch Hurricane Creek & Riley Creek ACPF



Legend

- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver
- The Slough
- Polecat Creek
- West Branch Hurricane Creek
- Riley Creek
- Counties

0 5 10 Miles

Section 7 – Set Goals and Load Reductions

Overview of Load Reduction Goals and Targets

Due to the hypoxic zone in the Gulf of Mexico, states that drain into the Mississippi/Atchafalaya River Basin were tasked to create a nutrient reduction strategy. Illinois created a Nutrient Loss Reduction Strategy in 2015 that works to improve water quality throughout the state and minimize the hypoxic zone. The current focus of the strategy is to reduce nitrate-nitrogen loss by 15% and total phosphorus by 25% by the year 2025, so that the overall goal of reducing total nitrogen and phosphorus loss by 45% is reached. The INLRS focuses on education and outreach programs that encourage the use of best management practices for nutrient management. These efforts are led by Illinois EPA, Illinois Department of Agriculture (IDOA), and University of Illinois Extension.

One approach to nutrient management is identifying priority watersheds and then creating watershed-based plans. Priority watersheds are designated based on certain criteria that highlight the ones that need more immediate work. The main characteristic of the watershed that is assessed is their TMDL. Watersheds that have high daily nutrient loads and have the ability to make significant changes are deemed the highest priority. When priority watersheds are determined, there also must be a distinction for whether it is a nitrogen or a phosphorus priority for nutrient reduction. The Embarras River watershed is designated as a phosphorus priority.

Load reduction goals are utilized in the watershed planning process to provide a numeric reference goal so that the plan works towards achieving water quality regulatory standards or other water quality standards through the diverse range of flows over the course of a year. Targets can be set in several ways, including reduction of current loads by a defined percentage, or basing the reduction on known water quality guidelines. For the Embarras, reduction percentages for sediment and nutrients were identified based on the INLRS. The Fecal Coliform target, which is based on the water quality standard, was retained from the 2011 plan for reference and has not been updated.

Table 7-1 indicates the water quality targets identified and the source of the target concentration. The sediment target was set to match phosphorus as eroded sediment is largely associated with phosphorus loading.

Table 7-1: Water Quality Targets

Parameter	Target	Source
Sediment	45% Reduction	Long-term INLRS target for phosphorus
Nitrogen	45% Reduction	Long-term INLRS target for nitrogen
Phosphorus	45% Reduction	Long-term INLRS target for phosphorus
Fecal Coliform	200 CFU/100mL	50% of the Illinois Water Quality Standards, Title 35: Environmental Protection (400 CFU/100mL)

Pollutant Load Reductions

Target Load Reductions

Table 7-2 below shows the target loads that were calculated and the required reductions to meet these goals. Total current loading includes both point and NPSs. Point sources are responsible for 3.7% of the annual phosphorus and 2.4% of the nitrogen load. Given that major municipal dischargers will eventually be required to meet phosphorus concentration limits of 0.5 mg/L, the percentage of loading could be reduced by more than half.

Table 7-2: Target Load Reductions

Parameter	Total Current Loading	Target Load	Reduction
Sediment (ton/yr)	1,019,580	560,769	458,811 (45%)
Nitrogen (lb/yr)	17,675,845	9,721,715	7,954,130 (45%)
Phosphorus (lb/yr)	2,368,658	361,253	1,065,896 (45%)
Fecal Coliform (CFU in billions/yr)	3,115,237	2,780,000	335,237 (11%)

Interim Load Reduction Goals

Since the overall reduction goals are significant, interim goals are also noted in the INLRS and will aid in the progress measurement of plan implementation. The overall reduction represents a long-term target; therefore, interim goals were identified for a 3-year timeframe. Interim targets are 25% for phosphorus and sediment, 15% for nitrogen, and 10% for Fecal Coliform (retained from 2011 plan). Table 7-3 identifies the interim load reduction goals.

Table 7-3: Interim 2025 Target Load Reductions

Parameter	Total Current Loading	3-Year Target Load	Reduction
Sediment (ton/yr)	1,019,580	764,685	254,895 (25%)
Nitrogen (lb/yr)	17,675,845	15,024,468	2,651,377 (15%)
Phosphorus (lb/yr)	2,368,658	1,776,493	592,165 (25%)
Fecal Coliform (CFU in billions/yr)	3,115,237	2,803,713	311,524 (10%)

Goal Statements

Based on the identified concerns and pollutant loading analysis, goal statements were developed for each problem statement. Implementation of policies and programs to meet these goal statements will improve watershed management. The statements indicate the ultimate goal for a specific project. In some cases, they may not be attainable in the short term; therefore, there is also a list of objectives included with each. The statements themselves are typically the overall long-term goal. It should be noted that some objectives may relate to several goal statements, they are listed in each applicable category.

Flooding

Problem Statement: Excessive flow rates and volumes of water are causing damage and loss within the Embarras River Watershed.

Goal Statement: Reduce flood damage in the Embarras River watershed.

Objectives:

- Protect and restore floodplain function.
- Maintain and manage the river corridor and other drainage ways to preserve conveyance of stormwater.
- Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development.
- Mitigate flood damages using both remedial and preventative measures.
- Implement drainage water management and water control practices that slow water flow and capture excess overflow.

Erosion/Sedimentation

Problem Statement: Soil erosion and sedimentation within the watershed is resulting in conditions which can degrade water quality (i.e., through nutrients bound to sediment) and water quantity (i.e., sediment deposits rerouting portions of the river). Sediment deposit build-up can also lead to conditions which alter the flow of streams and affect the overall aesthetics, wildlife habitat, and aquatic health within the watershed.

Goal Statement: Protect soil and improve erosion in the Embarras River watershed.

Objectives:

- Reduce streambank and landscape erosion.
- Protect and restore grassed waterways and buffers along water resources.
- Educate the stakeholders on the importance of reduced tillage passes and other practices which reduce erosion.
- Promote and implement BMPs that will reduce erosion and sedimentation in the watershed (e.g., conservation tillage, grassed waterways, buffer strips, streambank stabilization projects, water and sediment control basins, cover crops, etc.).
- Establish a monitoring program to identify high-priority streambank repair projects.

Water Quality

Problem Statement: Agriculture and typical urban area practices within the watershed contribute a significant amount of pollutants, thereby contributing to the frequent exceedances of water quality targets.

Goal Statement: Protect and improve water quality in the Embarras River watershed.

Objectives:

- Reduce nonpoint pollutant loadings from runoff to meet load reduction targets.
- Protect and restore riparian buffers and grassed filter strips along water resources.
- Educate stakeholders on the importance of reduced application and correct timing of fertilizer use (i.e., the 4Rs of nutrient management).

- Promote and implement agricultural practices that will reduce nutrient levels in the watershed (e.g., alternative watering systems, buffer/filter strips, exclusionary fencing, drainage water management, reforestation, stream restoration, wetland restoration, cover crops, etc.).
- Promote and implement urban practices that will reduce nutrient levels in the watershed (e.g., filtration basins, pervious pavement, bioretention practices, etc.).
- Work with point-source discharges (i.e., NPDES permitted facilities, etc.) to reduce their nutrient loads.
- Establish a monitoring program or group to collect samples.

Wildlife and Natural Resources

Problem Statement: Impacts to the natural resources of the watershed have the potential to severely degrade the quality and amount of wildlife habitat and recreational opportunities within the watershed.

Goal Statement: Protect and enhance natural resources and support associated recreational opportunities.

Objectives:

- Educate stakeholders on the importance of maintaining and properly managing natural resources in the watershed.
- Protect and restore streams and streambanks to improve water quality and wildlife habitat.
- Identify potential wetland restoration areas.
- Protect and restore riparian greenways and buffers along water resources.
- Identify and develop potential areas for river-based recreational opportunities such as hiking, canoeing, fishing, running, biking, etc.

Human Factors

Problem Statement: Stakeholders exhibit widely varying degrees of knowledge about their daily impact on the watershed and its water quality.

Goal Statement: Develop and implement education and outreach strategies.

Objectives:

- Effectively share and communicate past, current, and future activities within the watershed.
- Educate stakeholders on the function of a watershed and their individual and collective impacts on water quality.
- Educate stakeholders on the different sources of pollution (i.e., point source and non-point source) and erosion, as well as practices that can help mitigate those concerns.
- Coordinate efforts with local outreach groups and any other education and outreach efforts being conducted within the watershed.
- Utilize examples or pilot programs/demonstration projects for educational purposes.

Section 8 – Watershed Wide Implementation

Although priority subwatersheds were identified in 2011 and in 2022, the large scale of the watershed necessitates implementation for the entire Embarras basin. This section details some of the implementation and project recommendations that can be applied to the diverse character of the watershed.

This WMP provides many tools and identified priority areas that can be used by stakeholders to identify potential project locations and priority areas. Section 6 identifies many of the exhibits and spatial analysis that have been performed to assist in implementing practices.

Recommended Best Management Practice Types

Due to the significance of both point and NPSs, separate implementation strategies need to be developed to address both sources of pollutants. This section addresses NPSs through the application of watershed BMPs. Strategies to reduce point source pollutant loads are outside the scope of this plan as a regulatory framework exists to address them.

The watershed restoration and management techniques described, when applied to the Embarras, can help achieve the goals and objectives to decrease the concentrations of sediment, nutrient and bacteria loads identified in this plan. The selected measures and BMPs for improvement are categorized as agricultural/rural and urban BMPs, as well as preventative measures. While not all are being recommended at this point in the plan preparation, these BMPs may become important as the plan is updated and for future implementation opportunities.

The following summaries are typical BMPs and are provided as a reference. They generally describe each measure and its design components and are not meant to be an all-inclusive list but only a guide. To choose an appropriate BMP, it is essential to determine in advance the objectives to be met and to calculate the cost and related effectiveness of alternatives. Once a BMP has been selected, expertise is needed to ensure that it is properly installed, monitored, and maintained over time.

Agricultural/Rural BMPs

Agricultural/rural BMPs are implemented on agricultural lands for the purpose of protecting water resources, protecting aquatic wildlife habitat, and protecting the land resource from degradation. These practices control the delivery of NPS pollutants to receiving water resources by first minimizing the pollutants available.

Agricultural/Rural BMPs include:

- Alternative Watering System
- Buffer/Filter Strips
- Cover Crops
- Saturated Buffers
- Bioreactors
- Drainage Water Management
- Grassed Waterways
- Water and Sediment Control Basin

- Infiltration Trenches
- No-Till/Reduced Till (Conservation Tillage)
- Nutrient/Waste Management
- Rotational Grazing/Exclusionary Fencing
- Two Stage Ditches
- Pond/Sediment Basin
- Stream Restoration
- Wetland Restoration
- Reforestation

Alternative Watering System

Alternative watering systems (e.g., nose pumps or gravity flow systems) protect surface water by eliminating livestock's direct access to the stream. Providing an alternative watering source reduces soil erosion and sedimentation and improves surface water quality by reducing *E. coli* concentrations and nutrient loading. Alternative watering systems help to provide additional bank stabilization and assist in the preservation of riparian buffers through a reduction in compaction.

Buffer/Filter Strips

Creating and maintaining buffers along stream and river channels and lakeshores increases open space and can reduce some of the water quality and habitat degradation effects associated with increased imperviousness and runoff. Buffers provide hydrologic, recreational, and aesthetic benefits, as well as water quality functions, and wildlife habitat. Sediment, phosphorus, and nitrogen are at least partly removed from water passing through a naturally vegetated buffer. Bacteria are also reduced with buffers. The percentage of pollutants removed depends on the load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width. Buffers need to be a minimum of 30 feet wide to be eligible for most USDA programs. The greater the width, the greater the pollutant removal efficiency. Education is important in teaching farmers what options they have for funding. Several state and federal programs exist to provide incentives for maintaining riparian buffers.

A filter strip is an area of permanent herbaceous vegetation situated between environmentally sensitive areas and cropland, grazing land, or otherwise disturbed land. Filter strips reduce sediment, particulate organic matter, sediment adsorbed contaminants, and dissolved contaminant loadings in runoff to improve water quality. Filter strips also restore or maintain sheet flow in support of a riparian forest buffer, and restore, create, and enhance herbaceous habitat for wildlife and beneficial insects.

Filter strips should be permanently designated plantings to treat runoff and should not be part of the adjacent cropland's rotation. Overland flow entering the filter strip should be primarily sheet flow. If there is concentrated flow, it should be dispersed so that it creates sheet flow. Filter strips cannot be installed on unstable channel banks that are eroding due to undercutting of the toe bank. Permanent herbaceous vegetation should consist of a single species or a mixture of grasses, legumes and/or other forbs (an herbaceous plant other than a grass) adapted to the soil, climate, and farm chemicals used in adjacent cropland. Filter strips must be properly maintained so that they function properly.

Filter strips should be located to reduce runoff and increase infiltration and groundwater recharge throughout the watershed. They should also be strategically placed to intercept contaminants, thereby enhancing the water quality in the watershed. Filter strip sizes should be adjusted to accommodate planting, harvesting, and maintenance equipment. Widths greater than that needed to achieve a 30-minute flow-through time at ½-inch depth will not likely improve the effectiveness of the strip in addressing water quality concerns created by TSS, particulate organics, and sediment adsorbed contaminants. Like buffers, filter strips decrease TSS and nutrient loading, reduce bacteria concentrations, and increase open space. Education will help to teach farmers where these practices should be applied and sources of possible funding.

Cover Crops

Cover crops can be legumes or grasses, including cereals established prior to or following a harvested crop primarily for seasonal soil protection and nutrient recovery. Cover crops protect soil from erosion, decreasing sediment concentrations in the watercourse and recover/recycle phosphorus and nitrogen in the root zone. They are grown seasonally and are especially effective at reducing nitrogen loss from tiled fields.

Cover crops are established during the non-crop period, usually after harvest, but can be interseeded into a crop before harvest by aerial application or cultivation. Cover crops reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops. The soil tilth also benefits from the increase of organic material added to the surface. Growing vegetation promotes infiltration, and roots enhance percolation of water supplied to the soil. This reduces surface runoff. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field.

Saturated Buffers

A saturated buffer is a BMP in which drainage water is diverted as shallow groundwater flow through a grass buffer specifically for nitrate removal. A saturated buffer system can treat approximately 40 acres and consists of a control structure for diversion of drainage water from the outlet to lateral distribution lines that runs parallel to the buffer. Areas adjacent to a stable stream segment or existing grass buffer where adequate slope and ideal soil characteristics are likely to exist were chosen; in several cases, planting of stream buffers is needed.

Denitrifying Bioreactor

A denitrifying bioreactor is a structure containing a carbon source such as woodchips, installed to reduce the concentration of nitrate nitrogen in subsurface agricultural drainage flow via enhanced denitrification. One bioreactor system will treat approximately 50 acres.

Drainage Water Management

Drainage water management (DWM), also known as controlled drainage, is the practice of managing water table depths in such a way that nutrient transport from agricultural tile drains is reduced during the fallow season and plant water availability is maintained during the growing season.

Grassed Waterways

Grassed waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate channel dimensions and proper vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels. This BMP can reduce sediment concentrations of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality due to its nutrient removal through plant uptake and absorption by soil. The waterways can also provide wildlife corridors and allows more land to be natural areas.

Water and Sediment Control Basin

A Water and Sediment Control Basin (WASCB) is an earth embankment and/or channel constructed across a slope to intercept runoff water and trap soil. They are often constructed to mitigate gully erosion where concentrated flow is occurring and where drainage areas are relatively small. Multiple basins are often placed along a flow line or at each site depending on drainage area and cropping systems. Locations to apply these practices are likely widespread in the watershed on sloping ground and are very efficient at reducing sediment and phosphorus loading.

Infiltration Trenches

Infiltration trenches are excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil. Phosphorus from agricultural areas is primarily from animal manure either directly washing into streams and rivers or washing off from farm fields. Soil infiltration trenches can be especially beneficial as concrete feed-lots, barns, confined livestock areas, Confined Feeding Operations (CFOs), and other agricultural areas can carry excess food and waste materials towards the adjacent stream through stormwater runoff. Installing soil infiltration trenches where runoff is concentrated will maximize the benefit of contaminant removal.

No-till/Reduced Till Conservation Practices

This practice manages the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round. The purpose is to reduce sheet and rill erosion, thereby promoting improved water quality by reducing sediment and nutrient loading in the waterways. Additional benefits of this practice are to reduce wind erosion, to maintain or improve soil organic matter content and tilth, to conserve soil moisture, to manage snow, to increase plant available moisture or reduce plant damage from freezing or desiccation, and to provide food and escape cover for wildlife. This technique includes tillage and planting methods commonly referred to as no-till, zero till, slot plant, row till, direct seeding, or strip till.

Residue management is when loose residues are left on the field, and then uniformly distributed on the soil surface to minimize variability in planting depth, seed germination, and emergence of subsequently planted crops. When combines or similar machines are used for harvesting, they are equipped with spreaders capable of distributing residue over at least 80% of the working width. No-till or strip-till may be practiced continuously throughout the crop sequence, or may be managed as part of a system which includes other tillage and planting methods such as mulch till. Production of adequate amounts of crop residues is necessary for the proper functioning of this conservation practice and can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

Maintaining a continuous no-till system will maximize the improvement of soil organic matter content. Also, when no-till is practiced continuously, soil reconsolidation provides additional resistance to sheet and rill erosion. The effectiveness of stubble to trap snow or reduce plant damage from freezing or desiccation increases with stubble height. Variable height stubble patterns may be created to further increase snow storage.

Nutrient/Waste Management

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil.

A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater.

To protect the health of aquatic ecosystems and meet water quality targets, manure must be safely managed. Good management of manure keeps livestock healthy, returns nutrients to the soil, improves pastures and gardens, and protects the environment, specifically, water quality. Poor manure management may lead to sick livestock, unsanitary and unhealthy conditions for humans and other organisms, and increased insect and parasite populations. Proper management of animal waste can be done by implementing BMPs, through safe storage, by application as a fertilizer, and through composting. Proper manure management can effectively reduce bacteria concentrations, nutrient levels and sedimentation. Manure management can also be addressed in education and outreach to encourage farmers to participate.

Rotational Grazing, Perennial Cover and Exclusionary Fencing

Rotational grazing management is the division of pastures into multiple cells that receive a short but intensive grazing period followed by a period of recovery of the vegetative cover. Pasture management practices that include the use of rotational grazing systems are beneficial for water and soil quality. Systems that include the riparian area as a separate pasture are beneficial because livestock access to these areas is controlled to limit the impact on the riparian plant communities.

The impacts of livestock grazing within riparian areas include manure and urine deposited directly into or near surface waters where leaching and runoff can transport nutrients and pathogens into the water. Unmanaged grazing may accelerate erosion and sedimentation into surface water, change stream flow, and destroy aquatic habitats. Improper grazing can reduce the capacity of riparian areas to filter contaminates, shade aquatic habitats, and stabilize stream banks.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc.) installed to exclude livestock from streams and areas not intended for grazing. This will reduce erosion, sediment, and nutrient loading, and improve the quality of surface water. Education and outreach programs focusing on rotational grazing and exclusionary fencing are important in the success of this BMP.

Grazing well-managed perennial grasslands is a strategy that sinks atmospheric C in soils significantly and permanently. Perennial grasses build soils rather than deplete them and integrating livestock is a way to maintain landscapes in active agricultural production while significantly reducing phosphorus runoff and nitrate leaching into waterways. Increasing perennial grasses also serve as an opportunity to provide habitat for grassland birds and other forms of wildlife that simply cannot be supported by a monoculture row crop system.

Two-Stage Ditches

Water, when confined to a channel such as a stream or ditch, has the potential to cause great destruction. If there is too much water moving through an undersized area of land, then there is nowhere for it to go but to rush out of its barriers. Bank erosion, scouring, and flooding are good indicators that there is a problem with how the water is drained from the soil. Researchers have been working on a type of in-stream restoration called the two-stage ditch that has proven to help solve these problems.

The design of a two-stage ditch incorporates a floodplain zone, called benches, into the ditch by removing the ditch banks roughly 2-3 feet about the bottom for a width of about 10 feet on each side. This allows the water to have more area to spread out on and decreases the velocity of the water. This not only improves the water quality, but also improves the biological conditions of the ditches where this is located.

The benefits of a two-stage ditch over the typical agricultural ditch include both improved drainage function and ecological function. The design improves ditch stability by reducing water flow and the need for maintenance, saving both labor and money. It also has the potential to create and maintain better habitat conditions. Better habitats for both terrestrial and marine species are a great plus when it comes to the two-stage ditch design. The transportation of sediment and nutrients is decreased considerably because the design allows the sorting of sediment, with finer silt depositing on the benches and courser material forming the bed.

Pond/Sediment Basin

A pond is a water impoundment made by constructing an earthen dam. A sediment basin is similar but designed to trap sediment and only hold water for a limited period of time. Similar to a WASCB, a sediment basin will treat a large drainage area. These structures will trap sediment and nutrients from runoff and will control gully erosion in steep forested draws.

Stream Restoration

Stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. For urban stream reaches, restoration to natural conditions may not be possible or feasible. For instance, physical constraints due to adjacent development may limit the ability to re-meander a stream. In addition, the natural stream conditions may not be able to accommodate the increased volume of flow from the developed watershed.

Even in cases where restoring the stream to its natural condition is not possible, the stream can still be naturalized and improved by reestablishing riparian buffers, performing stream channel maintenance, stabilizing streambanks using bioengineering techniques and, where appropriate, by removing manmade dams and installing pool/riffle complexes. Stream restoration projects may be one component of floodplain restoration projects, and can be supplemented with trails and interpretive signs, providing recreational and educational benefits to the community.

Wetland Restoration

Because agriculture and urbanization have degraded many of the wetlands in the Embarras River watershed, wetland enhancement projects are necessary to improve the diversity and function of these degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland/field sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benefits. Wetland restoration is the process of establishing a wetland on a site that is not currently a wetland, but once was prior to conversion. Wetlands can reduce bacteria concentrations, nutrient loading, TSS concentrations, and flood damage. They can be used to teach landowners about their importance with respect to plants and animals and also increases the amount of open space in the watershed.

Wetland functional values vary substantially from wetland to wetland; they receive special consideration because of the many roles they play. Because of the wetland protection laws currently in place, the greatest impact from future development will likely be a shift in the types of wetlands. Often in mitigation projects, various types of marshes, wet prairies, and other wetlands are filled and replaced elsewhere, usually with existing open water wetlands. This replacement may lead to a shift in the values served by the wetland communities due to a lack of diversity of types. The wetland restorations that are proposed should include a variety of different types to increase the diversity. Restoration can decrease flood damage by providing new stormwater storage areas, will improve water quality by treating stormwater and tile water runoff, and will create new plant and wildlife habitat. In addition to these values, wetlands can be part of regional greenways or trail networks. They can be constructed with trails to allow the public to explore them more easily, and they can be used to educate the public through signs, organized tours, and other techniques. Restoration is an exceptional way to meet multiple objectives within a single project.

Reforestation

Reforestation is the restocking of existing forests and woodlands which have been depleted. Reforestation can be used to improve the quality of human life by soaking up pollution and dust from the air and rebuild natural habitats and ecosystems.

Urban BMPs

For the past two decades, the rate of land development across the country has been more than two times greater than the rate of population growth. The increased impervious surface associated with this development will increase stormwater volume and degrade water quality, which will harm the overall watershed.

The best way to mitigate stormwater impacts from new developments is to use urban BMPs to treat, store, and infiltrate runoff onsite before it can affect water bodies downstream. Innovative site designs that reduce imperviousness and smaller-scale low-impact development practices dispersed throughout a site are excellent ways to achieve the goals of reducing flows and improving water quality.

The Urban BMPs include:

- Bioretention Practices
- Filtration Basin
- Naturalized Detention Basin
- Naturalized Stream Buffer
- Pervious Pavement
- Rain Barrels/Gardens
- Infiltration Trench
- Stream Restoration

Bioretention Practices

Bioretention practices (including bioinfiltration or biofiltration) are primarily used to filter runoff stored in shallow depressions by utilizing plant uptake and soil permeability. This practice utilizes combinations of flow regulation structures, a pretreatment grass channel or other filter strip, a sand bed, a pea gravel overflow treatment drain, a shallow ponding area, a surface organic mulch layer, a planting soil bed, plant material, a gravel underdrain system, and an overflow system to promote infiltration. Bioinfilitration systems such as swales are used to treat stormwater runoff from small sites such as driveways, parking lots, and roadways. They provide a place for stormwater to settle and infiltrate into the ground. Biofiltration swales are a relatively low-cost means of treating stormwater runoff for small sites typifying much of the urban environment, such as parking, roadways, driveways, and similar impervious features. They provide areas for stormwater to slow down and pollutants to be filtered out. Careful attention to location and alignment of swales can lend a pleasing aesthetic quality to sites containing them.

In general, bioretention practices are highly applicable to residential uses in community open space or private lots. The bioretention system is very appropriate for treatment of parking lot runoff, roadways where sufficient space accommodates off-line implementation, and pervious areas such as golf courses. This BMP is not recommended for highly urbanized settings where impervious surfaces comprise 95% or more of the area due to high flow events and limited storage potential. This BMP can address most of the WMP goals, including reducing concentration of sediments and nutrients. Bioretention practices can also decrease flooding by storing stormwater and increase open space.

Filtration Basin

Filtration basins provide pollutant removal (including TSS, nutrients, and bacteria) and reduce volume of stormwater released from the basin. These basins utilize sand filters or engineered soils to filter stormwater runoff through a sand or engineered soil layer within an underdrain system that conveys the treated runoff to a detention facility or to the ultimate point of discharge. The filtration system consists of an inlet structure, sedimentation chamber, sand/engineered soil layer, underdrain piping, and liner to protect against infiltration.

Naturalized Detention Basins

Naturalized wet-bottom detention basins are used to temporarily store runoff and release it at a reduced rate. Naturalized wet-bottom detention basins are better than traditional detention basins because they encourage water infiltration, and thereby recharge groundwater tables. Native wetland and prairie vegetation also help to improve water quality by trapping sediment and other pollutants found in runoff and are aesthetically pleasing. Naturalized wet-bottom detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes.

Naturalized Stream Buffer

Creating and maintaining buffers along stream and river channels and lakeshores increases open space and can reduce some of the water quality and habitat degradation effects associated with increased imperviousness and runoff in the watershed. Buffers provide hydrologic, recreational, and aesthetic benefits, as well as water quality functions and wildlife habitat. Sediment, phosphorus, and nitrogen are at least partly removed from water passing through a naturally vegetated buffer. The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width. Buffers need to be a minimum of 30 feet wide to be eligible for most USDA programs. Other specific requirements for regulated drains should be determined during the feasibility stages of utilizing this practice.

Pervious Pavement

Pervious pavement has the approximate strength characteristics of traditional pavement but allows rainfall and runoff to percolate through it. This decreases sediment concentrations and flood damage in the watershed by slowing the water from entering the streams. The key to the design of these pavements is the elimination of most of the fine aggregate found in conventional paving materials. Pervious pavement options include porous asphalt and pervious concrete. Porous asphalt has coarse aggregate held together in the asphalt with sufficient interconnected voids to yield high permeability. Pervious concrete, in contrast, is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that also yields interconnected voids for the passage of air and water. Underlying the pervious pavement is a filter layer, a stone reservoir, and filter fabric. Stored runoff gradually drains out of the stone reservoir into the subsoil.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod, interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area.

Rain Barrels/Gardens

A rain barrel is a container that collects and stores rainwater from your rooftop (via disconnected downspouts) for later use on lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems.

Rain gardens are small-scale bioretention systems that can be used as landscape features and small-scale stormwater management systems for single-family homes, townhouse units, and some small commercial development. These units not only provide a landscape feature for the site and reduce the need for irrigation but can also be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event. In addition, these features can be designed to provide a significant improvement in the quality of the stormwater runoff. These units can also be integrated into the design of parking lots and other large, paved areas, in which case they are referred to as bioretention areas.

Infiltration Trenches

Infiltration trenches are excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil. Infiltration trenches remove fine sediment and the pollutants associated with them. Soil infiltration trenches can be effective at reducing sediment concentrations and nutrient loading. Soluble pollutants can be effectively removed, if detention time is maximized. The degree to which soluble pollutants are removed is dependent primarily on holding time, the degree of bacterial activity, and chemical bonding with the soil. The efficiency of the trench to remove pollutants can be increased by increasing the surface area of the trench bottom. Infiltration trenches can provide full control of peak discharges for small sites. They provide groundwater recharge and may augment base stream flow.

Stream Restoration

Stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. For urban stream reaches, restoration to natural conditions may not be possible or feasible. For instance, physical constraints due to adjacent development may limit the ability to re-meander a stream. In addition, the natural stream conditions may not be able to accommodate the increased volume of flow from the developed watershed.

Even in cases where restoring the stream to its natural condition is not possible, the stream can still be naturalized and improved by reestablishing riparian buffers, performing stream channel maintenance, stabilizing streambanks using bioengineering techniques and, where appropriate, by removing manmade dams and installing pool/riffle complexes. Stream restoration projects may be one component of floodplain restoration projects and can be supplemented with trails and interpretive signs, providing recreational and educational benefits to the community.

Preventative Measures

The preventative measures section is provided as potential recommendations for education and outreach focused implementation. These practices encourage planning to reduce water quality impacts prior to the start of a project and ongoing maintenance/practices to reduce water quality impacts from municipal operations.

Conservation Design Developments

The goal of conservation design development is to protect open space and natural resources for people and wildlife, while at the same time allowing development to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space. They are density neutral, allowing the same density as in conventional developments, but that density is realized on smaller areas of land by clustering buildings and infrastructure. In addition to clustering, conservation design developments incorporate natural riparian buffers and setbacks for streams, wetlands, other waterbodies, and adjacent agricultural.

The first and most important step in designing a conservation development is to identify the most essential lands to preserve in conservation areas. This will require coordination with local officials and the community as this practice is commonly added into ordinances and future planning efforts. Natural features including streams, wetlands, lakes, steep slopes, mature woodlands, native prairie, and meadow (as well as significant historical and cultural features) are included in conservation areas. Clustering is a method for preserving these areas. Clustered developments allow for increased densities on less sensitive portions of a site, while preserving the remainder of the site in open space for conservation and recreational uses (such as trails, soccer or ball fields).

Clustering can be achieved in a planned unit development (PUD) or planned residential development (PRD). PUDs contain a mix of zoning classifications that may include commercial, residential, and light industrial uses, all of which are blended together. Well-designed PUDs usually locate residences and offices within walking distance of each other to reduce traffic. Planned residential developments (PRDs) apply similar concepts to residential developments.

Greenways and Trails

Greenways can provide a number of functions and benefits to nature and the public. For plants and animals, greenways provide habitat, a buffer from development, and a corridor for migration. Greenways located along streams include riparian buffers that protect water quality by filtering sediments and nutrients from surface runoff and stabilizing streambanks. By buffering the stream from adjacent developed land use, riparian greenways offset some of the impacts associated with increased impervious surface in a watershed. Maintaining a good riparian buffer can mitigate the negative impacts of approximately 5% additional impervious surface in the watershed.

Greenways also provide long, linear corridors with options for recreational trails. Trails along the river provide watershed stakeholders with an opportunity to exercise and enjoy the outdoors. Trails allow users to see and access the river, thereby connecting people to their river and the overall watershed. Trails can also be used to connect natural areas, cultural and historic sites and communities, and serve as a safe transportation corridor between work, school, and shopping destinations.

Techniques for establishing greenways and trails involve the development of a plan that proposes general locations for greenways and trails. In the case of trails, the plan also identifies who the users will be and provides direction on trail standards. Plans can be developed at the community and/or county level, as well as regionally, statewide, and in a few cases, at the national level. Public and stakeholder input are crucial for developing successful greenway and trail plans.

Several techniques can be used for establishing greenways and trails. Greenways can remain in private ownership, they can be purchased, or easements can be acquired for public use. If the lands remain in private ownership, greenway standards can be developed, adopted, and implemented at the local level through land use planning and regulation. Development rights for the greenway can be purchased from private landowners where regulations are unpopular or not feasible.

If the greenways will include trails for public use, the land for trails is usually purchased and held by a public agency such as a forest preserve district or local park system. In some cases, easements will be purchased rather than purchasing the land itself. Usually, longer trail systems are built in segments, and completing connections between communities depends heavily on the level of public interest in those communities.

In new developing areas, the local planning authority can require trails. Either the developer or the community can build the trails. In some cases, the developer will voluntarily plan and build a trail connection through the development and use this as a marketing tool to future homebuyers. In other cases, the local planning authority may require the developer to donate an easement for the trail. To install trails through already developed areas, land can be purchased by a community agency with a combination of local, state, and federal funds.

Impediments to land purchase can significantly slow up trail connections in already established areas.

Protected Ownership

There are several options for land transfer ranging from donation to fee simple land purchase. Donations can be solicited and encouraged through incentive programs. Unfortunately, while preferred by money-strapped conservation programs, land donations are often not adequate to protect high priority sites. A second option is outright purchase (or fee simple land purchase). Outright purchase is frequently the least complicated and most permanent protection technique but is also the costliest. A conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Protecting Open Space and Natural Areas

Several techniques can be used for protecting natural areas and open space in both public and private ownership. The first step in the process is to identify and prioritize properties for protection. The highest priority natural areas should be permanently protected by the ownership or under the management of public agencies or private organizations dedicated to land conservation. Other open space can be protected using conservation design development techniques and is more likely to be managed by homeowner associations.

Septic Tank Maintenance and Repair

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment in the unincorporated parts of the Watershed. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-$15,000 per unit based on industry standards.

Property owners are responsible for their septic systems. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources, provide conditions favorable to insect vectors such as flies and mosquitoes, and contribute significant amounts of nitrogen and phosphorus to the watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up or will not drain, the system is failing. Funding for this practice is limited.

Threatened and Endangered Species Protection

Threatened and endangered species are those plant and animal species whose survival is in peril. Both the federal government and the state of Illinois maintain lists of species that meet threatened or endangered criteria within their respective jurisdictions. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Illinois.

Considerations in protecting endangered species include making sure there is sufficient habitat available - food, water, and “living sites” (For animals, this means areas for making nests and dens and evading predators. For plants, it refers to availability of preferred substrate and other desirable growing conditions.); providing corridors for those species that need to move between sites; and protecting species from impacts due to urbanization.

Several techniques can be used to protect species. One technique is to acquire sites where they occur. Purchase and protection of the site where the species is located (with adequate surrounding buffer) may be sufficient to protect that population. In some instances, it is not feasible or possible to buy the needed land. Where the site and buffer area are not available for purchase, where an animal’s range is too large of an area (or migrates between sites), or where changes in hydrology or pollution from outside the site affect the species, other techniques must be used to protect the T&E species.

Developing a resource conservation or management plan for the species and habitat of concern is the next step. Resource plans consider the need for buffer areas and habitat corridors, and consider watershed impacts from hydrology changes or pollutant loadings. The conservation plan will include recommendations for management specific to the species and its habitat, whether located on private or public lands. The conservation plan will guide both the property owner and the local unit of government that plans and permits adjacent land uses and how to manage habitat to sustain the species.

Wetland Enhancement and Protection
Wetlands provide a multitude of benefits and functions. Wetlands improve water quality by removing suspended sediment and dissolved nutrients from runoff. They control the rate of runoff discharged from the watershed and reduce flooding by storing rainfall during storm events. Wetlands also provide habitat for plants and animals, including many of those that are threatened and endangered.

Because agriculture and urbanization have degraded many of the remaining wetlands in the Watershed, wetland enhancement projects are necessary to improve the diversity and function of these degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland/field sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benefits. Wetland restoration is the process of establishing a wetland on a site that is not currently a wetland, but once was prior to conversion. Wetlands can reduce nutrient loading, sediment concentrations, and flood damage. Wetlands can be used to teach landowners about their importance with respect to plants and animals and also increases the amount of open space in the watershed.

Best Management Practices Load Reductions

Load reduction calculations were estimated for nitrogen, phosphorus, sediment, and bacteria based on the potential BMPs to be implemented. Percent reductions for each were based on literature, studies, and other watershed plans. References are included in Appendix B.

Those listed are provided as a reference. It is not meant to be an all-inclusive list but only a guide. The reductions only apply to the drainage area that is directly tributary to the BMP implemented. Meaning, a practice is only effective for the drainage area tributary to it and not the areas of the entire subwatershed. Therefore, when trying to evaluate BMPs and their effectiveness for pollutant removal, the tributary drainage area needs to be evaluated as well.

The actual efficiency of each is based on several variables making it difficult to accurately determine the number required to equal the reduction goals (e.g., the location in the watershed, tributary area, soils, etc.), therefore, specific locations and types should be carefully planned out in coordination with the landowners and applicable local, state and federal agencies, and with the load reduction needs of the subwatershed in mind. Table 8-1 shows the expected load reductions and associated costs for each BMP.

The reductions shown in Table 8-1 are based on the tributary drainage area to the BMP. For example, if you have a tributary drainage area that is 1 acre and you install a buffer/filter strip that is 5 acres, you will reduce the loads for that 1-acre tributary drainage area by 60%, 30% and 10% for TSS, P and N, respectively. And the approximate cost for the buffer/filter strip will be $1,925 (5 acres * $385/acre). Many of the practices, reduction percentages and costs have been retained from the 2011 plan. Costs from the previous plan have not been updated with an inflation factor, however, they were overestimated and generally represent current costs. Additional BMPs have been added and/or updated and are reflected in bold.

Table 8-1: Best Management Practice Load Reduction Summary					
Agricultural/Rural Best Management Practices					
	Estimated Load Reductions				
BMP/Measure	**Sediment**	**Phosphorus**	**Nitrogen**	***Bact***	**Cost**
Alternative Watering System	80%	78%	75%	N/A	$5,000/EA
Buffer/Filter Strips	**60%**	**30%**	**10%**	**N/A**	**$385/AC**
Cover Crops	**40%**	**30%**	**30%**	**N/A**	**$63.74/AC**
Exclusionary Fencing	70%	60%	65%	90%	$50/Ft
Grassed Waterways	**40%**	**25%**	**20%**	**N/A**	**$10,000/AC**
Waste Management	60%	90%	80%	85%	$5 - $30/AC
Nutrient Management - Nitrogen	**0%**	**0%**	**20%**	**N/A**	**$18.40/AC**
Nutrient Management - Phosphorus	**0%**	**20%**	**0%**	**N/A**	**$62.76**
Drainage Water Management (only for tile water)	**0%**	**10%**	**40%**	**N/A**	**$185.80/AC**
Bioreactor (only for tile water)	**0%**	**5%**	**40%**	**N/A**	**$9,500/EA**
Saturated Buffer (only for tile water)	**0%**	**25%**	**55%**	**N/A**	**$7.60/Ft**
Infiltration Trench	100%	45%	45%	N/A	$10,000-$20,000/AC
No-Till/Strip-Till	**70%**	**50%**	**10%**	**N/A**	**$16.41/AC**
Reforestation	80%	42%	68%	N/A	$750/AC
Rotational Grazing	40%	20%	20%	N/A	N/A
Stream Restoration	75%	75%	75%	N/A	$100-$250/Ft
Two-Stage Ditches	38%	33%	17%	N/A	$15-$20/Ft
Wetland Restoration / Creation	80%	55%	45%	80%	**$23,000/AC**
Water and Sediment Control Basin / Terrace	**70%**	**60%**	**20%**	**N/A**	**$2,884/EA**
Pond	**70%**	**60%**	**35%**	**N/A**	**$50,000/EA**
Urban Best Management Practices					
	Estimated Load Reductions				
BMP/Measure	**Sediment**	**Phosphorus**	**Nitrogen**	***Bact***	**Cost**
Bioretention Practices	40%	80%	65%	N/A	$10,000-$20,000/AC
Filtration Basin	75%	65%	60%	N/A	$10,000-$20,000/AC
Naturalized Detention Basin	80%	55%	35%	N/A	$10,000-$20,000/AC
Naturalized Stream Buffer	75%	45%	40%	N/A	$5,000-$20,000/AC
Pervious Pavement	95%	85%	85%	N/A	$2 - $7/Sq. Ft
Rain Barrels	N/A	N/A	N/A	N/A	$75-$300/Each
Rain Garden	80%	20%	20%	N/A	$10,000-$20,000/AC
Stream Restoration	75%	75%	75%	N/A	$100-$250/Ft
Infiltration Trench	100%	45%	45%	N/A	$10,000-$20,000/AC

Watershed-Wide Implementation Goals

To support the 2011 plan, the NRCS and SWCDs from most counties in the watershed held special focused meetings to identify priority resource concerns. These meetings identified and ranked key priority concerns and some counties identified specific project opportunities to address issues. The details of these meetings and highest ranked concerns and project recommendations can be found in the previous plan. Table 8-2a includes an implementation strategy and Table 8-2b summarizes the 2011 watershed-wide implementation goals, all of which are still relevant today. Table 8.2b has been updated to reflect a broader application of BMPs, revised load reductions, new cost estimates, and a selection of BMPs not included in the previous plan or those needed to achieve water quality targets. Bolded areas represent additions or changes to the 2011 table.

Table 8-2a: Stakeholder Led Watershed-Wide Implementation Strategy (2011)

Parameter	Applications to Achieve Goals	Notes
Sheet/Rill Erosion	Conservation Tillage; Filter Strips; Terraces	Focus on highly erodible land, filter strips along water courses to filter sediment and pollutants
Gully Erosion	Grassed Waterways; Conservation Tillage; Check Dam Structures; WASCBs	Focus on highly erodible lands; pasture and agricultural land use
Livestock Management	Exclusionary fencing, alternate watering systems, waste/nutrient management	Priority should be given to CAFOs near streams and on highly erodible lands
Streambank Erosion	Standard stabilization practices and riparian restoration: Study required to develop prioritized implementation plan	Stakeholders have identified hundreds of miles of streams to be restored; a focused study is required to prioritize streambank erosion projects and develop an implementation plan
Crop Nutrient Management	Nutrient management plans	Approximately 20% of the agricultural land in the watershed targeted
Flood Mitigation and Wetland Restoration	Flood easements, wetland restoration	Measures that address taking cropland out of production to improve flood areas. Prioritize hydric soils and poorly drained areas.
Urban stormwater detention/reten-tion	Detention/retention basins, WASCBs, urban stormwater BMPs	Goal to improve urban stormwater management from 5 – 10% of the urban area in the watershed and encourage these practices for future urban development
Invasive Species	Woodland management	Reduce undergrowth in forests
Public Participation and Outreach	Meetings, events, websites, emails, workshops	Meetings/events to promote watershed implementation projects and efforts. Focus on urban areas and urban BMPs
CRP Enrollment	Conservation Reserve Program Enrollment	Increase CRP awareness and enrollment; push for Conservation Reserve and Enhancement Program (CREP) in the watershed
Water Supply	Shoreline stabilization, ravine stabilization, invasive species control, well abandonment	Intent to improve water quality of Charleston Side Channel Reservoir, which is an important water supply and recreational asset.

Table 8-2b: Watershed-Wide Implementation Goals									
					Estimated Load Reductions				
Category	Bmp	Amount	Unit	Estimated Costs	Sediment (tons/yr)	Phosphorus (lbs/yr)	Nitrogen (lbs/yr)	Fecal Coliform (CFU in billions/yr)	Priority
AG	**No-Till / Strip-Till[1]**	**789,538**	**acre**	**12,956,319**	**483,046**	**620,207**	**1,312,857**	**359,240**	**High**
AG	**Cover Crops[1]**	**1,124,587**	**acre**	**71,681,175**	**400,285**	**601,076**	**4,868,466**	**511,687**	**High**
AG	**Filter Strip[1]**	**5,359**	**acre**	**2,063,215**	**32,721**	**48,463**	**119,964**	**5,816**	**Med**
AG	**Grassed Waterway**	**5,406**	**acre**	**54,060,000**	**180,334**	**102,416**	**418,963**	**21,786**	**Med**
AG	**Nutrient Management – Nitrogen[1]**	**403,027**	**acre**	**7,415,697**	**0**	**0**	**2,095,324**	**N/A**	**High**
AG	**Nutrient Management – Phosphorus[1]**	**307,498**	**acre**	**19,298,574**	**0**	**218,018**	**0**	**N/A**	**High**
AG	**Drainage Water Management[1]**	**293,897**	**acre**	**54,606,063**	**0**	**3,038**	**1,151,247**	**N/A**	**Med**
AG	**Bioreactor[1]**	**11,294**	**#**	**107,293,380**	**0**	**3,804**	**1,868,239**	**N/A**	**Med**
AG	**Saturated Buffer[1]**	**2,334,203**	**feet**	**17,739,943**	**0**	**33,711**	**808,609**	**N/A**	**Med**
AG	**Water and Sediment Control Basin / Terrace**	**16,217**	**#**	**46,769,251**	**189,350**	**147,479**	**251,378**	**N/A**	**High**
AG	Two-Stage Ditch	5,280	feet	105,600	1,584	1,901	4,752	1,236	High
HYDRO	Stream Channel Stabilization	300,000	feet	25,500,000	96,000	108,000	270,000	70,200	Med
HYDRO	Streambank and Shoreline Protection	16,000	feet	352,000	3,200	4,800	13,280	3,120	Med
HYDRO	**Wetland Restoration / Creation**	**3,600**	**acre**	**82,800,000**	**12,960**	**115,200**	**396,000**	**37,440**	**High**
HYDRO	**Pond[1]**	**346**	**#**	**17,300,000**	**65,369**	**86,143**	**313,868**	**N/A**	**High**
LIVESTOCK	Fencing	18,000	feet	900,000	900	7,200	19,800	4,680	High
LIVESTOCK	Planned Grazing Systems	800	acre	16,000	8	480	880	312	Med
LIVESTOCK	Runoff Management System	12	#	60,000	90	360	1,260	234	Low
LIVESTOCK	Trough or Tank	12	#	18,000	0	0	0	0	Med
LIVESTOCK	Waste Management System	12	#	300,000	0	1,320	6,720	858	High
OTHER	Septic System upgrade	100	#	150,000	0	1,600	5,600	1,040	Med
OTHER	Buffer Zone Enhancement / Installation	25	acre	125,000	0	38	125	24	Low

OTHER	Woodland Improvement	2,500	acre	1,875,000	75	6	13	4	Low
URBAN	Bio-retention Facility	12	acre	120,000	120	300	840	195	Med
URBAN	Porous Pavement	8	acre	696,000	0	20	48	13	Low
URBAN	Rain Garden	12	acre	115,200	0	150	360	98	Low
URBAN	Urban Stormwater Wetlands	5	acre	57,500	4	80	200	52	High
URBAN	Infiltration Trench	4	acre	40,800	5	64	160	42	Med

1 – Represents all potential acreage in the watershed

Filter strips were evaluated in greater detail due to a higher relative confidence in the analysis and underlying datasets. Locations were selected using a combination of a national stream layer and landcover dataset. All cultivated land within 50 feet either side of a perennial stream or ditch was selected as a potential site. Given scale and accuracy limitations with the two datasets results are more reflective of average conditions at the subwatershed scale.

It is estimated that approximately 5,359 acres of filter strips could be implemented. This translates to over 4.5 million feet along 221 miles of stream. The greatest potential exists in the Brushy Fork, East Branch Embarras River, and Scattering Fork, or the upper reaches of the basin (Table 8-3). Lower reaches of the watershed where streams are well buffered offer less opportunity. These subwatersheds include East Crooked Creek, Brushy Creek, and Big Creek

Table 8-3: Potential Filter Strip Extent

Subwatershed	Filter Strip Area (acres)	Filter Strip Length (feet – both banks)	Stream Miles
East Branch Embarras River	761	663,179	31.4
Scattering Fork	629	548,118	26
Brushy Fork	825	718,607	34
Little Embarras River	396	344,859	16.3
Deer Creek- Embarras River	580	505,449	23.9
Kickapoo Creek	206	179,461	8.5
Muddy Creek	393	342,794	16.2
Range Creek- Embarras River	329	286,870	13.6
East Crooked Creek	18	15,334	0.7
North Fork Embarras River	311	271,190	12.8
Big Creek	82	71,480	3.4
Honey Creek- Embarras River	216	187,984	8.9
Paul Creek- Muddy River	95	82,494	3.9
Brushy Creek	26	22,351	1.1
Indian Creek-Embarras River	492	428,235	20.3
Grand Total	**5,359**	**4,668,405**	**221**

To calculate expected load reductions (Table 8-4), each stream segment was buffered by 600 feet to approximate drainage areas. These drainage areas were then run through the watershed nutrient and sediment loading model to estimate reductions by HUC-10 subwatershed. Adding filter strips has the potential to reduce loading in the Embarras River watershed by 0.7% for nitrogen, 2.2% for phosphorus, and 2.1% for sediment. The greatest nitrogen reductions are likely achieved in Indian Creek, Brushy Fork and Scattering Fork. The greatest phosphorus reductions are likely achieved in Scattering Fork, Brushy Fork, and Indian Creek. Sediment reductions are greatest in the Little Embarras River, Deer Creek, and Scattering Fork. Very little potential for sediment and nutrient reductions are expected in Brushy Creek and East Crooked Creek.

Table 8-4: Potential Filter Strip Load Reductions

Subwatershed	Nitrogen Reduction (lbs/yr)	Phosphorus Reduction (lbs/yr)	Sediment Reduction (tons/yr)	% Total Nitrogen Load	% Total Phosphorus Load	% Total Sediment Load
East Branch Embarras River	35,881	3,459	3,415	1.1%	4.6%	2.8%
Scattering Fork	11,309	3,913	2,328	1.5%	6.2%	3.3%
Brushy Fork	16,119	5,470	2,766	1.4%	5.4%	2.9%
Little Embarras River	8,428	3,464	3,386	0.85%	3.6%	4%
Deer Creek-Embarras River	11,348	4,222	3,370	1.1%	4.4%	3.6%
Kickapoo Creek	4,558	1,950	2,104	0.72%	3%	3.2%
Muddy Creek	9,526	5,047	4,097	0.58%	2.5%	3%
Range Creek-Embarras River	7,614	3,682	2,883	0.32%	1.3%	1.3%
East Crooked Creek	522	278	237	0.08%	0.33%	0.47%
North Fork Embarras River	7,464	4,203	2,840	0.29%	1.14%	1.2%
Big Creek	725	1,339	799	0.25%	0.93%	1.1%
Honey Creek-Embarras River	2,302	3,200	1,431	0.27%	1.3%	1.1%
Paul Creek-Muddy River	779	1,439	839	0.27%	1.1%	1.3%
Brushy Creek	223	429	201	0.16%	0.63%	0.48%
Indian Creek-Embarras River	3,167	6,368	2,026	1.3%	5.1%	2.4%
Grand Total	**119,964**	**48,463**	**32,721**	**0.71%**	**2.2%**	**2.1%**

2011 Specific Implementation Projects Identified by Stakeholders

Table 8-5 below summarizes 54 site-specific projects from 2011 within the priority subwatersheds identified by stakeholders during this planning process. Totals have been updated to reflect implementation since the last plan of 2,200 feet of shoreline stabilization in Lake Charleston and a section of two-stage ditch in Tuscola. Table 8-6 includes additional site-specific practices identified by stakeholders under the most recent planning process.

Table 8-5: Specific Implementation Projects Identified by Stakeholders (2011)

Project Type	Unit of Measure	Stakeholders	Total
Floodplain Easement	Acre	Jasper County SWCD/NRCS	299
Log Jam Removal	Feet	City of Villa Grove	4,798
Runoff Control	Acre	Champaign County SWCD/NRCS	81
Sediment Control; Retention	Acre	Jasper County SWCD/NRCS	2,219
Shoreline Stabilization	Feet	City of Charleston	1,497
Stabilization/Detention	Acre	City of Charleston	275
Streambank Stabilization	Feet	Jasper, Cumberland, Douglas and Coles SWCD/NRCS	445,897
Streambank Stabilization/retention	Acre	City of Newton	42
Two-Stage Drainage Ditch	Acre	City of Tuscola	18
WASCB/Retention	Acre	Crawford County SWCD/NRCS	23,696
WASCB/Waterway	Acre	Cumberland County SWCD	5,939
Wetland Creation	Acre	City of Tuscola; City of Villa Grove	61
Wetland Restoration	Acre	Douglas and Champaign Counties SWCD/NRCS	3,370
Wetland/Floodplain Restoration	Acre	City of Charleston	46

2022 Specific Implementation Projects Identified by Stakeholders

Table 8-6 below summarizes 53 site-specific projects documented under the current plan. Practices were provided by individual landowners and from the Lawrence County SWCD and have been verified as appropriate for each location to address NPS pollution. Field visits were completed in 2021 with landowners that expressed an interest during the 2020 planning meetings. Practices include terraces and WASCBs, grass waterways, a pond, streambank stabilization, and cover crops. All practices are in Lawrence, Crawford, Coles, and Richland Counties. Load reductions and estimated costs are also presented in Table 8-6.

Table 8-6: Specific Implementation Projects Identified by Stakeholders (2022)							
Project Type	**Quantity**	**BMP #**	**Estimated Sediment Reduction (tons/yr)**	**Estimated Phosphorus Reduction (lbs/yr)**	**Estimated Nitrogen Reduction (lbs/yr)**	**Cost**	**Notes**
Cover Crop	202 (acres)	39, 51, 52, 77, 80, 84	219	295	656	$12,875	7 fields, Lawrence Co.
Pond	1 (#)	75	31	68	83	$50,000	Crawford Co.
Terrace	23,800 (Feet)	2, 3, 6, 10, 12, 14, 17, 18, 19, 25, 28, 29, 30, 34, 35, 36, 38, 40, 58, 69, 82, 86	889	939	963	$113,050	22 locations, Lawrence and Crawford Co.
WASCB	49 (#)	16, 41, 54, 59, 62, 63, 64, 65, 66, 67, 68, 71, 72, 78, 83, 91	1,000	937	1,656	$141,316	16 locations, Lawrence, Richland, and Crawford Co.
Grassed Waterway	8.8 (acres)	1, 20, 21, 23, 24, 53, 60, 79	390	383	1,035	$88,000	8 locations, Lawrence, Richland, and Crawford Co.
Stream bank Stabilization	2,000 (Feet)	92	60	75	110	$240,000	City of Charleston, Town Branch, Coles Co.
	Total		**2,589**	**2,697**	**4,503**	**$645,241**	

Section 9 – Subwatershed Based Implementation Plan

Two priority HUC-12 subwatersheds were prioritized for more detailed planning; Polecat Creek and The Slough. The prioritization process was accomplished using two tiers of criteria:

1. Tier 1 – data driven analysis and scoring based on watershed characteristics.
2. Tier 2 – Stakeholder input and staff capacity.

Each criterion was organized by HUC-12. Data was summed, re-normalized and "scored" from highest to lowest. The highest scoring subwatersheds were reviewed by the planning team and considered against stakeholder interest and agency capacity. The #8 (Slough) and #11 (Polecat) Tier 1 ranked subwatersheds were selected. Criteria are summarized below.

Tier 1

1. Pollutant yield - total nitrogen, total phosphorus and sediment. A normalized pollutant loading score was generated using the following criteria:
    a. HUC-12 subwatershed annual per-acre nitrogen, phosphorus, and sediment loading. Greatest loading received a higher score.
2. Existing or ongoing TMDLs:
    a. HUC -12 subwatersheds with current and historical sediment, phosphorus, and nitrogen impairments. Greatest number received a higher score.
3. Data availability – water quality:
    a. HUC-12 subwatersheds with available/historic water quality data. Greatest number received a higher score.
4. Subwatershed size and location:
    a. Number of counties intersected by single HUC-12 or those that cross jurisdictional boundaries and address a broad geographic range of stakeholder involvement. The greater number of counties received a higher score.
    b. HUC-12s size. Those with a smaller than average size received a higher score.
    c. Subwatersheds' location. Those that do not encompass the main stem of the Embarras River received a higher score.
5. Percent of HUC-12 in row crops. A higher percentage received a higher score.
6. Soil erodibility "K" factor and tillage transect data. The K factor is used in USLE and represents both susceptibility of soil to erosion and rate of runoff, as measured under the standard unit plot condition. Soil units were intersected with tillage transect points representing conventional tillage. Greater K values that overlapped with conventional tillage transect points received higher scores.
7. Percent area of cropped hydric soils. Higher percentage was assigned a higher score.
8. Existing conservation practices. Aggregated CRP acreage data and current SWCD cost-share practices, commonly known as PFC locations, were combined and ranked. Subwatersheds with the lower per-acre CRP and number of PFC practices received higher scores.

Tier 2

Tier 1 rankings were then compared against the following Tier 2 criteria to make final selections:

1. Stakeholder support gathered by county SWCDs and Farm Bureau. Interest from

meetings held in 2020 and agency input on landowner willingness to determine what subwatersheds would receive the most support for detailed planning and implementation. Subwatersheds with highest level of anticipated support received a higher score.

2. Conservation agency staff capacity by county. The potential for implementation by key agency staff, primarily county SWCDs, was assessed to determine where perceived future support is the greatest. Subwatersheds within counties that maintain the greatest amount of staff capacity future support received a higher score.

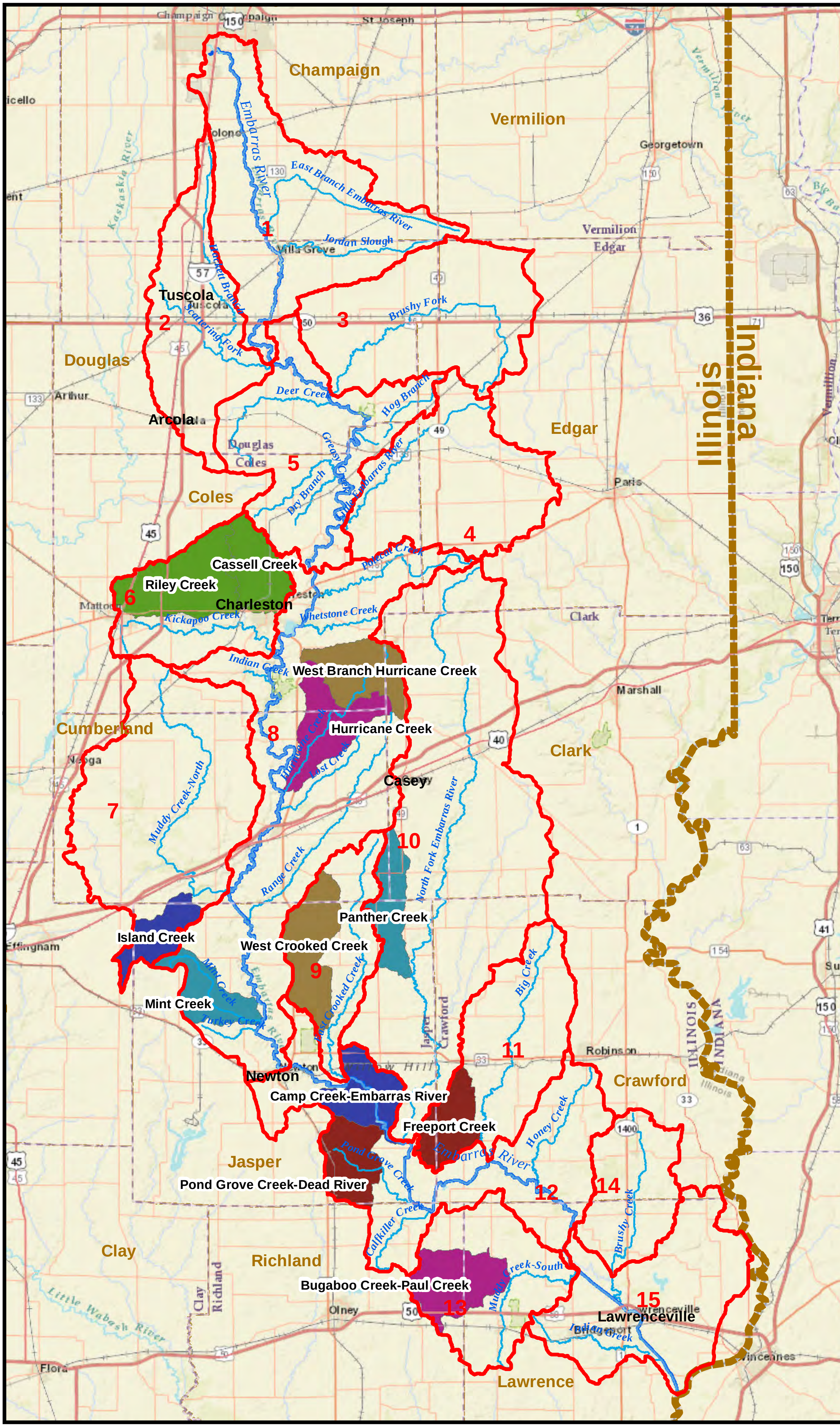
Following Polecat Creek and The Slough, it is recommended that additional plan development proceed in accordance with the ranking system described above over a 10-year horizon. A chronogram is provided in Table 9-1. Exhibit 30 shows locations.

Table 9-1: HUC-12 Subwatershed Planning Schedule and Priority

Subwatershed & Acres	Priority Rank	Counties	Planning year	Notes
West Crooked Creek - HUC 051201120901, 20,690 acres	3	Cumberland, Jasper	2023	Third ranked subwatershed, ranked 12th highest for pollution loading
West Branch Hurricane Creek – HUC 051201120803, 17,765 acres	8	Coles, Clark	2023	Recently completed ACPF model and identified BMPs warrants additional planning. Ranked 8th highest for pollution loading
Riley Creek – HUC 051201120602, 25,944 acres	23	Coles	2025	Lower ranked subwatershed, however, existing TMDL and ACPF model run will support planning
Cassell Creek – HUC 051201120602, 14,944	20	Coles	2025	Lower ranked subwatershed, however, existing TMDL and potential support from City of Charleston
Island Creek – HUC 051201120705, 11,243 acres	5	Jasper, Effingham, Cumberland	2027	Ranked 6th highest for pollution loading
Camp Creek – Embarras River – HUC 051201121202	7	Jasper	2027	Ranked 9th highest for pollution loading, substantial existing water quality data
Freeport Creek – HUC 051201121104, 13,795 acres	4	Crawford, Jasper	2029	In TMDL watershed
Pond Grove Creek – Dead River – HUC 051201121203, 14,862 acres	6	Jasper, Richland	2029	Ranked 2nd highest for pollution loading
Panther Creek – HUC 051201121006, 13,581 acres	9	Clark, Cumberland, Jasper	2031	Spans 3 counties, relatively low existing conservation practice participation

Mint Creek – HUC 051201120810, 13,191 acres	10	Jasper	2031	Relatively low existing conservation practice participation
Hurricane Creek – HUC 051201120804, 18,922 acres	11	Coles, Cumberland, Jasper	2033	Spans 3 counties, ranked 13th for pollution loading
Bugaboo Creek – Paul Creek – HUC 051201121301, 18,885 acres	18	Lawrence, Richland	2033	Ranked #1 for pollution loading

Exhibit 29



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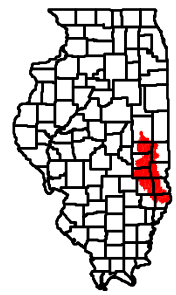
Embarras River Watershed

Subwatershed Planning Schedule & Priority



Legend

- Embarras River Watershed & Subwatersheds
- Embarras River
- Embarras RIver Tributaries

Planning Year

- 2023
- 2025
- 2027
- 2029
- 2031
- 2033
- Counties

Section 10 – Implementation Costs and Schedule

Estimated Costs of BMPs to Achieve Load Reduction Targets

Cost Estimate Methodology

Tables 10-1 through 10-4 below portray the pollutant load reductions and approximate BMP costs to achieve the reductions for the Embarras River watershed. The reductions were calculated by applying the urban and agricultural practices to the watershed. Using the same methodology from the 2011 plan, an average BMP reduction value was derived for each pollutant parameter. Cost within each of the critical areas to accomplish the targets are $400/acre for urban and $15/acre for cropland. These values were then averaged relative to the proportion of each landuse within the watershed. Based on this analysis, the average cost per acre for BMP implementation was determined to be approximately $67.50. The costs and reductions were also calculated assuming that the applied practices benefit an upland drainage area.

Estimates are generalized for watershed-scale planning purposes and should not be used to estimate costs for individual projects, as costs will range significantly. They also do not account for load reductions from education and outreach and policy/regulation since direct impacts are not easily determined. Therefore, these costs could vary significantly if extensive education and policy changes are implemented.

To determine the total cost required to meet the 2025 target, the 2011 methodology was used. The target load reduction for each parameter was divided by the average BMP removal efficiency and the per-acre load to determine an estimated treatment area in acres. The acreage total was then multiplied by an average cost of $67.50/ac to get a total. For example, the average BMP efficiency for phosphorus is 46% and the total cost to meet the 3-year target would be approximately $62,066,984. Bacteria targets and costs were not updated from the 2011 plan.

It should be noted that costs provided below are cumulative between the goals. For example, the total to remove phosphorus to meet the interim INLRS 25% target would be approximately $62,066,984. Assuming that the interim targets had been met, the additional cost to meet the long-term 45% reduction target would only be $49,653,481.

3-Year Interim Target Loading Estimated Costs

Table 10-1: Estimated Costs to Meet 3-Year Target Load Reductions

Parameter	Total Current Loading	3-Year Target Load Reduction	BMP Average Efficiency	Average Loading (per acre)	Treatment Acres Required	Total Cost ($67.50/ac)
Sediment (ton/yr)	1,019,580	254,895	57%	0.65	687,976	$46,438,360
Nitrogen (lb/yr)	17,675,845	2,651,377	43%	10.9	565,687	$38,183,902
Phosphorus (lb/yr)	2,368,658	592,165	46%	1.4	919,511	$62,066,984
Fecal Coliform (CFU in billions/yr)	3,115,237	33,524	50%	2.0	33,524	$2,262,870

Long-Term INLRS Target Loading Estimated Costs

Table 10-2: Estimated Costs to Meet INLRS Long-Term Target Load Reductions						
Parameter	**Total Current Loading**	**Long-Term Target Load Reduction**	**BMP Average Efficiency**	**Average Loading (per acre)**	**Treatment Acres Required**	**Total Cost ($67.50/ac)**
Sediment (ton/yr)	1,019,580	458,811	57%	0.65	1,238,356	$37,150,670
Nitrogen (lb/yr)	17,675,845	7,954,130	43%	10.9	1,697,062	$76,367,783
Phosphorus (lb/yr)	2,368,658	1,065,896	46%	1.4	1,655,118	$49,653,481
Fecal Coliform (CFU in billions/yr)	3,115,237	335,237	50%	2.0	335,237	$22,627,498

2011 Specific Stakeholder Identified Project Cost Estimates

Table 10-3: Load Reduction Estimates For 2011 Stakeholder Identified Implementation Projects				
Subwatershed	**Nitrogen (lbs)**	**Phosphorus (lbs)**	**Sediment (tons)**	**Fecal Coliform (b-cfu/yr)**
Big Creek	5,713	1,766	312	5,194
Deer Creek-Embarras River	32,194	9,931	1,961	29,111
East Branch Embarras	17,357	5,288	1,753	14,651
Honey Creek – Embarras River	83,417	18,604	4,282	59,092
Kickapoo Creek	5,074	1,339	2,688	2,783
Range Creek/Embarras River	71,605	19,949	26,833	29,325
Scattering Fork	1,119	346	47	615
Total Estimates	216,479	57,223	37,876	140,771
Estimated Implementation Cost	$25,000,000 - $55,000,000			

2022 Specific Stakeholder Identified Project Cost Estimates

Table 10-4: Load Reduction Estimates For 2022 Stakeholder Identified Implementation Projects			
Subwatershed	**Nitrogen (lbs)**	**Phosphorus (lbs)**	**Sediment (tons)**
Big Creek	1,517	679	686
Brushy Creek	138	135	116
Indian Creek – Embarras River	555	502	542
Kickapoo Creek	110	75	60
Paul Creek – Muddy River	2,183	1,306	1,185
Total Estimates	4,503	2,697	2,589
Estimated Implementation Cost	$645,241		

Implementation Schedule

Table 10-5: Implementation Schedule										
Task	**YR 1**	**YR 2**	**YR 3**	**YR 4**	**YR 5**	**YR 6**	**YR 7**	**YR 8**	**YR 9**	**YR 10**
Seek funding and technical assistance	X	X								
Submit grant applications	X	X	X	X	X	X	X			
Coordinate available programs	X	X	X	X	X	X	X	X	X	
Secure funding through participation in existing programs and other mechanisms, such as market-based conservation (i.e., conservation credits)	X	X	X	X	X	X	X	X	X	X
Project planning, site surveys and project design		X	X	X	X	X	X	X	X	
Implementation and construction			X	X	X	X	X	X	X	X
Report and monitor progress	X	X	X	X	X	X	X	X	X	X
Communicate success stories		X	X	X	X	X	X	X	X	X
Evaluate accomplishments			X			X				X

Section 11 –Measuring Success

Indicators of Success

The success of a WMP can be measured by how readily it is used by its intended audience and how well it is implemented. The Embarras River WMP is very ambitious and continued implementation will require an even greater degree of cooperation and coordination among partners and funding for projects.

Indicators are measurable parameters or criteria which can used to determine the progress being made toward achieving a goal. Indicators were developed for each goal and objective. Some indicators may be appropriate for several categories and are listed for each applicable goal. As the WMP is being implemented, it is anticipated that additional indicators will be identified; therefore, this list is not intended to be comprehensive. Table 11-1 lists the indicators and the goals to which they are linked.

Table 11-1: Goals and Indicators	
Goal	**Indicators**
Reduce flood damage in the Embarras River Watershed	-Number of practices installed to improve water flow and flooding conditions (e.g., ponds, retention basins, etc.) -Maintenance and management of drainage ways (debris/log jam removal) -Amount of property, infrastructure, and crop damage tracked over time, including incorporating yearly weather patterns -Trends in water levels, volume, and duration of flooding events
Protect soil and improve erosion in the Embarras River Watershed	-Observed sediment deposit build-up and quality of topsoil -Number of agricultural fields utilizing conservation tillage, cover crops, or other practices associated with erosion reduction -Miles of stabilized streambanks and associated load reductions
Protect and improve water quality in the Embarras River Watershed	-Observed Total Nitrogen, Total Phosphorus, Total Suspended Solids and Fecal coliform concentrations -Number of agricultural fields utilizing conservation tillage, cover crops or other practices associated with nutrient load reductions -Miles of improved/created buffers along water resources and associated load reductions -Number of direct animal access points eliminated and associated load reductions -Nutrient loadings from point source dischargers
Protect and enhance natural resources and support associated recreational opportunities	-Inventory of lands held within preservation and open space uses -Total acreage of restored uplands, wetlands, shoreline, and stream channels -Number of identified recreational areas -Total acreage of sites managed for invasive species

	-Number of threatened or endangered species within the watershed
Develop and implement education and outreach strategies within the watershed	-Number of brochures/educational materials distributed or field days organized -Number of programs and ideas utilized from the Education/Outreach Menu -Number of attendees at in-person and virtual programs -Public involvement in volunteer programs

Evaluating Plan Performance

This plan is meant to be a flexible tool to achieve water quality improvements within the Embarras River watershed. It will be evaluated by assessing the progress made on each of the six goals.

The plan should be evaluated every 5 years to assess the progress made, as well as to revise the plan, if appropriate, based on the progress achieved. A comprehensive review will be needed every 10 years. Amendments and changes may be made more frequently as laws change or new information becomes available that will assist in providing a better outlook for the watershed. As goals are accomplished and additional information is gathered, efforts may need to be shifted to issues of higher priority.

In addition to the official 10-year update, the planning committee will have a key role in evaluating implementation progress on an annual basis. They will review the status of actions recommended in the WMP, based on the indicators for success, at least once per year and then identify the top priority concerns and actions for the following years' focus. They should identify how it will implement the plan (subcommittees, reporting structure, meeting schedule, etc.). Other opportunities for evaluating the status of plan implementation include the completion of quarterly project reports or meeting minutes. Since this plan is a flexible tool, tracking changes/modifications are anticipated based on usability and changes in priority throughout the implementation of the WMP.

Recommendations for Measuring Success and Evaluating Plan Performance

This plan is meant to be a flexible tool to achieve water quality improvements within the Embarras River watershed. These recommendations are included below in Table 11-2 to help track success and achieve the goals of the plan.

Table 11-2: Recommended Actions For Increasing Public Participation, Measuring Success and Evaluating Performance		
Recommendation	**Estimated Cost**	**Description**
Online BMP Tracking GIS System	$120,000: $10,000/year	Open on-line and administrative system for projects to be entered online and tracked in a database.
Water Quality Monitoring	$40,000	Within the watershed, water samples will be regularly taken to provide the opportunity to track the water quality and to be aware if any area requires particular attention.
Full-Time Watershed Coordinator/Administrator	$55,000/yr	Position to implement plan, administer online BMP tracking GIS system, certification program and quarterly outreach events.
Quarterly Outreach Events	$20,000/yr	Public events

Annual Update Report

To further measure progress and success, the planning committee will ask each county in the watershed to provide a brief annual update on project implementation. The annual update will include the following information on a subwatershed basis:

County Level NRCS/SWCD Updates

- Type and number of soil erosion control measures for upland treatment applied and acres benefitted.
- Soil loss reductions and nutrient loading reductions credited to the above conservation measures.
- Number of conservation tillage acres applied.
- Number of lineal feet of streambanks protected by structural measures and the corresponding nutrient load reductions.
- Number and acres of nutrient management plans developed and implemented and corresponding nutrient load reductions.
- Number and acres of pasture planning, prescribed grazing systems planned and applied.
- Number of use exclusions (cattle crossings and associated fencing) and livestock watering systems planned and applied.
- Status on the inventory of confined livestock operations in the watershed.
- Acres of filter/buffer strips planned and applied.
- A list of activities (workshops, tours, news articles, interviews, brochures) relating to resource concerns in the watershed plan.

Illinois Department of Natural Resources Updates

- Number and acres of forest management plans developed (Division of Forest Resources).
- Number and acres of timber stand improvement planned and applied (Division of Forest Resources).
- Number and acres of tree plantings (Division of Forest Resources).
- Acres of grassland/prairie planting/restoration planned/planted – State parks and State-owned land.
- Acres of bottomland forest restoration, wetland restoration planned and completed - – State parks and State-owned land.

County Health Department Updates

- Number of septic inspections for existing, upgraded, and new systems resulting from property transfers or other situations.
- List of activities relating to public information on septic system construction, operation, and maintenance.

Communities within the Watershed Updates

- Results from any new runoff and hydrology studies.
- Number of retention basins and/or other stormwater management practices planned and installed.

Section 12 – Financing Resources

There are a number of financing resources to implement BMP projects. Fund sources for practice implementation, habitat protection and restoration, as well as technical assistance, are available from a variety of publicly accessible programs at the local, regional, state, and federal levels of government, including Illinois EPA Section 319 grants.

U.S. Army Corps of Engineers (USACE) Continuing Authorities Program

At the Federal level, the USACE Continuing Authorities Program (CAP) provides the U.S. Army Corps of Engineers with the authority to solve water-resource, flood-risk mitigation, and environmental restoration problems in partnership with local sponsors without the need to obtain specific Congressional authorization.

Projects include Section 14 Emergency Streambank and Shoreline Protection, Section 205 Flood Risk Management, Section 206 Aquatic Ecosystem Restoration, and others. The objectives, purposes, and cost-share division of each section of funding varies, however, each project should be economically feasible and environmentally acceptable. The feasibility phase of all projects are initially federally funded up to $100,000, with any remaining costs being shared 50/50 with the non-federal sponsor. The USACE and the non-federal sponsor sign a project partnership agreement near the beginning of the implementation phase. The non-federal sponsor cost share can generally entail a contribution mix of cash, lands, easements, rights-of-way, relocations, and disposal areas and/or work-in-kind.

Requests for assistance should be in the form of a letter describing the location and nature of the problem and requesting assistance under the program. Upon receipt of a letter, the USACE will determine if the project fits the program and can then request funding to initiate a planning process to determine federal interest in proceeding with the project.

U.S Environmental Protection Agency (USEPA) Section 319 Grants

Section 319 of the Clean Water Act provides funding for projects that work to reduce NPS water pollution. Illinois EPA administers funds from the Section 319 program which are used to create watershed management plans, demonstrate new technology, provide education and outreach on pollution prevention, conduct assessments, develop and implement TMDLs, provide cost-share dollars for BMP implementation and provide technical assistance. Organizations that are eligible for funding include nonprofit organizations, universities, and local, State or Federal government agencies. A minimum of 40% in-kind or cash match of the total project cost must be provided. Section 319 is a reimbursement program.

Farm Service Agency (FSA) Programs

Illinois Farm Service Agency (FSA) supports farmers through a variety of Credit and Commodity Programs designed to stabilize and enhance rural landscape. The FSA administers and manages farm commodity, credit, disaster and loan programs, and conservation as laid out by Congress through a network of federal, state and county offices. Programs are designed to improve the economic stability of the agricultural industry and to help farmers adjust production to meet demand. Economically, the desired result of these programs is a steady price range for agricultural commodities for both farmers and consumers.

Conservation Reserve Program (CRP)
The CRP is a voluntary program which provides technical and financial assistance to eligible farmers and ranchers for long-term conservation of soils, water, and wildlife resources. The program is funded through the Commodity Credit Corporation. The CRP is the USDA's single largest environmental improvement program and is administered through the FSA with 10 to 15-year contracts. The goal of the program is to give incentives to landowners who take frequently flooded and environmentally sensitive land out of crop production and plant specific types of vegetation that improve environmental health and quality in exchange for annual rental payments and signup incentives. This program offers up to 90% cost-share for continuous signup. Additional incentives can be accessed through adding additional practices, such as filter strips (CP-21), riparian buffers (CP-22), wetland restoration (CP-23), or others.

Conservation Stewardship Program (CSP)
The Conservation Stewardship Program (CSP) is a voluntary program that was designed to compensate agricultural and forest producers who agree to increase their level of conservation by adopting additional conservation activities and maintaining their baseline level of conservation. The NRCS administers this program and provides financial and technical assistance to eligible producers. The program is available on Tribal and private agricultural lands and non-industrial private forestland on a continuous application basis. Contracts last for 5 years, with the potential to renew for another 5 if the renewal application ranks high enough.

The program offers financial assistance to eligible participants through three possible types of payments:

- Annual payment for installing and adopting additional activities; and improving, maintaining, and managing existing activities,
- Supplemental payment for the adoption of resource-conserving crop rotations, improving an existing resource-conserving crop rotation, or implementing advanced grazing management, and
- Minimum contract payments for most contracts.
- Through CSP, the Grassland Conservation Initiative (GCI) is also available to aid eligible producers with protecting grazing lands, conserving and improving soil, water, and wildlife resources, and achieving related conservation values. Eligibility is limited to those with recorded grass on their FSA acreage report from 2009 through 2017.

Environmental Quality Incentives Program (EQIP)
The EQIP provides technical and financial assistance to producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion and sedimentation, and others. Typically, monies will fund up to 75% of land improvements and installation of conservation practices such as grade stabilization structures, grassed waterways, and filter strips adjacent to water resources (including wetlands).

Conservation Reserve Enhancement Program (CREP)
This federal-state natural resources conservation program that addresses agricultural-related environmental concerns at the state and national levels. Participants receive financial incentives to voluntarily enroll in CRP in contracts of 14 to 15 years. Participants remove

cropland from agricultural production and convert the land to native grasses, trees and other vegetation.

The program will improve water quality by creating buffers and wetlands that will reduce agricultural runoff into the targeted watersheds. Installing buffer practices and wetlands will enhance habitat for wildlife, including State and Federally listed threatened and endangered species. The program will also reduce NPS nutrient losses.

Landowners may enroll any amount of eligible cropland in the federal program and voluntary state 14–15-year contract extensions. State permanent easements allow producers to offer non-cropped acreage when they enroll cropland. Installation of conservation practices must be completed within 12 months of the federal CREP contract effective date. Once enrolled in, the land cannot be developed (i.e., no permanent structures or roads may be built). Existing abandoned structures and roads may remain if approved by IDNR. Landowners must follow the Conservation Plan of Operation, and land cannot go back into row crops or agricultural uses. The landowners retain the right to recreational use of their property, providing it does not negatively impact the practices or cover established. The state CREP contract is attached to the land deed; thus, a producer who purchases land enrolled in an active state CREP contract is required to participate in the program or refund state money paid to date and incur other penalties.

Agricultural Conservation Easement Program (ACEP)

In 2015, NRCS published an interim rule (which became effective on October 18, 2016) to implement the Agricultural Conservation Easement Program (ACEP), which consolidated the Wetlands Reserve Program (WRP), Farm and Ranch Lands Protection Program, and Grassland Reserve Program into one program. It is a voluntary program to help farmers and ranchers preserve their agricultural land and restore, protect, and enhance wetlands on eligible lands. The program has two easement enrollment components: (1) Agricultural land easements; and (2) wetland reserve easements. Landowners who enroll in ACEP retain private ownership of their land but must follow certain land use requirements. Under the Agricultural Land Easements component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Through the wetland reserve enrollment options, NRCS may enroll eligible land through permanent easements or 30-year easements.

Regional Conservation Partners Program (RCPP)

The RCPP promotes coordination of NRCS conservation activities with partners that offer value-added contributions to expand our collective ability to address on-farm, watershed, and regional natural resource concerns. Through RCPP, partners apply for project awards and, if awarded, enter into producer contracts and supplemental agreements with NRCS to carry out agreed-to conservation activities. Projects may include any combination of authorized, on-the-ground conservation activities implemented by farmers, ranchers, and forest landowners, including land management or land improvement practices, entity-held easements, public works or watersheds, and others.

Partners for Conservation Program (PFC)

The PFC program, formerly known as CPP, is a long-term, state-supported initiative to protect natural resources and enhance outdoor recreational opportunities in Illinois. Through this program, several state agencies share responsibility for administering the funds, with the

Illinois Department of Agriculture overseeing the program's agriculture-related components. The program promotes the construction or adoption of practices that conserve soil and protect water quality. The PFC program provides funding for the following agriculture-related programs: the sustainable agriculture grant program, the conservation practices cost-share program, the stream bank stabilization and restoration program, and the SWCD grants program. Through these programs, cost-share assistance may be available for practices such as waterways, cover crops, and sealing of abandoned wells.

Stream Bank Stabilization and Restoration Program (SSRP)

The SSRP program, one of the funding opportunities available through the PFC, is designed to implement effective, inexpensive vegetative and bio-engineering techniques for limiting stream bank erosion. Program monies fund demonstration projects at suitable locations statewide and provide cost-share assistance to landowners with severely eroding stream banks. The program specifically targets stabilizing and restoring high priority streambanks that are severely eroding. Cost-share assistance may be available for practices such as bendway weirs, rock riffles, stream barbs or rock vanes, gabion baskets, and stone toe protection.

Private Sector Opportunities

Environmental stewardship and mitigation remain common and critical issues that most private businesses deal with. Numerous opportunities exist to encourage private enterprise to become involved with watershed initiatives and assist in achieving the goals of this plan. Businesses identified in the table below have permits that affect water quality and, therefore, are stakeholders as well. Stakeholders in the watershed should attempt to develop partnerships with some of these entities and at least make them aware of this watershed plan and the partnership opportunities that are available.

Table 12-1: Stakeholder Opportunities for Partnerships

Subwatershed	Facility Name
East Branch Embarras River	City of Villa Grove Sewage Treatment Plant (STP)
	Village of Broadlands Water Treatment Plant (WTP)
Scattering Fork	City of Arcola STP
	Parkview Mobile Home Park STP
	Cabot Corporation
	City of Tuscola Southside STP
	Tuscola Stone
	City of Tuscola STP
	Village of Pesotum WTP
	Village of Tolono STP
Brushy Fork	Shiloh School STP
	Hydromet Environmental (USA)
	Newman Rehabilitation & Health Care Center
	Newman WTP
	Metcalf WTP
	Veolia ES Valley View Landfill
Little Embarras River	Redman Waterworks, Inc. WTP
	Village of Brocton

Deer Creek-Embarras River	City of Oakland STP
Kickapoo Creek	City of Mattoon STP
	City of Charleston STP
	Anamet Electrical
Muddy Creek	Village of Montrose STP
	Village of Toledo STP
	HPA-Lincoln Log Cabin Historical Site
Range Creek-Embarras River	City of Newton STP
	EJ Water Corporation Treat Plant
	City of Charleston STP
	Village of Greenup STP
	Cumberland Comm School District 77
	IL DNR-Fox Ridge State Park
	IL DNR-Fox Ridge State Park STP
	Ashmore WTP
	Marathon Pipeline Company
	Kansas WTP
North Fork Embarras River	Village of Willow Hill STP
	Marathon Pipeline Company
	City of Casey North STP
	Vulcan Materials Casey North
	City of Casey WTP
	E. Rowe Foundry
	City of Martinsville STP
	Village of Westfield WTP
Big Creek	Marathon Pipeline Company
	Village of Oblong WWTP
Honey Creek-Embarras River	Village of Saint Marie STP
	Newton WTP
Paul Creek-Muddy River	City of Sumner STP
	IL DNR-Red Hills State Park
	Lawrence Correctional Center
Brushy Creek	Birds-Pinkstaff WTP
	Village of Flatrock STP
Indian Creek-Embarras River	City of Bridgeport STP
	AWR Liquidating Trust
	City of Lawrenceville WWTP
	City of Mount Carmel WTP
	Lawrenceville-Vincennes Airport

Section 13 – Education and Outreach Strategy

The purpose of this Education and Outreach Strategy is to foster stakeholder involvement in the implementation of the comprehensive and actionable watershed plan that further identifies strategies to improve water quality and protect and enhance natural resources. Additionally, this strategy will be used to develop education and outreach opportunities for stakeholders, focused on watershed issues, as well as the ongoing and future planning and implementation process. These efforts will also help to initiate gathering valuable feedback which can be used to establish stakeholder-driven priorities, goals, and objectives for future watershed planning efforts.

In preparation of updating the WMP, several education and outreach activities were held to help educate stakeholders on progress of the expiring 2011 plan, as well as to gather updated input on their primary concerns and other feedback. These education and outreach events - which included watershed-wide planning meetings, Nutrient Stewardship Field Days, and subwatershed meetings - primarily targeted to farmers and landowners. Municipalities, local politicians, and agencies were also invited to these stakeholder events. These education and outreach opportunities allowed for two-way communication between the planning group and watershed stakeholders, allowing many opportunities for updates to be shared with stakeholders and for their feedback and ideas to be collected and incorporated into the plan.

Watershed Planning Meetings

In January 2020, University of Illinois Extension, ten CFBs, IFB, and ten SWCDs hosted a series of 9 planning meetings across the watershed with funding from an IFB Nutrient Stewardship Grant and support from the Illinois EPA. These meetings gave farmers and landowners the opportunity to share their concerns and interests across the entire watershed, as well as what tools they desired to help address those concerns. The feedback received has been incorporated in the plan. A summary report of the findings from the January 2020 meetings was published on the Coles County SWCD website and publicized through press releases and social media. It is available in Appendix C.

Nutrient Stewardship Field Days

In partnership with the IFB, two nutrient stewardship field days were held in 2021. In April, IFB worked alongside partners from Richland and Lawrence County Farm Bureaus, University of Illinois Extension, Northwater Consulting, Lawrence and Richland County SWCDs, and NRCS to host a field near Bridgeport, Illinois. Information was shared about the progress on updating the plan, and additional topics included information about the INLRS and improving soil health. Four farmers from Richland and Lawrence counties also participated in a panel discussion, sharing their experiences with cover crops.

In July, Coles CFB partnered with Coles County SWCD, University of Illinois Extension, Northwater Consulting, and Donahue & Associates, Inc. to host a Nutrient Stewardship Field Day near Charleston, Illinois. Topics covered included a focus on supporting education and outreach in the watershed, discussing its history, Illinois EPA 319 grant and plan updates, and local urban water use. The program concluded with a panel of farmers who shared their experiences with various conservation practices in the watershed.

Subwatershed Field Days: Polecat Creek and Slough

While the target audience for plan outreach and education is the entire Embarras River watershed, more direct engagement occurred in the two priority HUC-12 subwatersheds. Two field days were hosted in early 2022, one in the Polecat Creek subwatershed in January and one in The Slough in February.

At each event, attendees were presented with updates on the watershed planning process, a summary of the resource inventory report, informed about recommended agricultural conservation practices such as reduced tillage, cover crops, water and sediment control basins, edge-of-field practices, and others, as well as provided information about potential funding sources. Large format maps of the subwatersheds were also presented, and landowners were invited to mark locations where they had existing resource concerns or where they were interested in implementing practices. This feedback, along with feedback from one-on-one meetings with landowners, was incorporated into the watershed plan(s).

Future Education and Outreach

To improve the water quality of the Embarras River and its tributaries, stakeholders and the general public must be informed about this new WBP and engaged in implementing its recommended practices. Implementation of the plan will require a multi-practice, multi-partner approach with on-the-ground, local outreach as a key component.

The strategy will utilize partnerships to ensure that all landowners and producers receive consistent and coordinated information from trusted messengers, and highlight multiple benefits (environmental, economic, social, etc.) of increased conservation in all parts of the watershed. It is expected that increased public understanding of improved water quality will encourage landowner participation, inspire beneficial policy actions, and motivate future involvement in watershed improvement efforts.

Audiences targeted for education and outreach activities are:

1. Local government offices/agencies.
2. Farmers and landowners.
3. Local businesses or agencies with interest in watershed.
4. Community residents, professionals, and partners.

The schedule of activities is summarized Table 13-1.

Table 13-1: Watershed Planning Education and Outreach Activities			
Timeframe	**Activities**	**Target Audiences**	**Lead Organization(s)**
Short-term	• Develop and distribute factsheet • Develop and distribute executive summary • Distribute watershed plan	• Local government offices/agencies • Farmers and landowners • Local businesses or agencies with interest in watershed • Community residents, professionals, and partners	• SWCD

Medium-term	• Professional development • Field days	• Farmers and landowners • Community residents, professionals, and partners Volunteers/ non-profit groups • Local businesses or agencies with interest in watershed	• Illinois/County Farm Bureau • SWCD
Long-term	• Watershed planning meetings	• All stakeholders	• SWCD • Illinois/County Farm Bureau
Ongoing	• Watershed protection awareness days • Community outreach • Public Event Booths • Subwatershed Planning	• Community residents, professionals, and partners Students/ Parents • Teachers/ administrator • Farmers and landowners	• SWCD • Illinois/County Farm Bureau • Municipalities

Short-term Education and Outreach Activities: *Watershed Plan Outreach*

Short-term education and outreach in years 1-3 of the watershed plan will focus on "watershed plan outreach" and will be directed towards the following target audiences:

1. Local government offices/agencies.
2. Farmers and landowners.
3. Local businesses or agencies with interest in watershed.
4. Community residents, professionals, and partners.

Develop and Distribute Factsheet

Strategies:

1. Produce an updated watershed fact sheet that provides information on watershed planning history, watershed plan progress, 319 grants and other funding opportunities, the INLRS, and efforts that have been made on the watershed plan.
2. Distribute the fact sheet to landowners and stakeholders through many avenues, such as Illinois Farm Bureau as a FarmWeek excerpt, through the Coles County SWCD website, and through social media channels.

Desired Outcomes

1. Watershed stakeholders and public are knowledgeable about planning efforts and 319 grants.
2. Stakeholders are aware of next steps to move forward with planning and implementation.

Develop and Distribute Executive Summary & Watershed Plan

Strategies:

1. Create a high-quality executive summary of the Embarras River WBP, in addition to what is presented in this document.
2. Distribute executive summary to stakeholders through mail, e-mail, social media, and other channels.
3. Make full plan accessible online with continual progress updates and information about future planning meetings or activities.

Desired Outcomes

1. Watershed residents gain an understanding of the current watershed conditions.
2. All stakeholders learn about possible watershed improvements and access key contacts to get involved in the implementation of best management practices.

Medium-Term Education and Outreach Activities

Medium-term education and outreach strategies will focus on years 4-6 of the watershed plan. These activities will be directed towards the following stakeholder groups:

1. Farmers and landowners.
2. Community residents, professionals, and partners.
3. Volunteers/non-profit groups.
4. Local businesses or agencies with interest in watershed.

Professional Development

Strategies:

1. Coordinate with stakeholders to host professional development opportunities.
2. Host workshops to provide information on and demonstrate recommended practices.
3. Distribute information about various available funding options for practice implementation.

Desired Outcomes

1. Farmers and landowners learn how to implement recommended practices and learn about different funding support options.
2. Professionals receive continuing education on recommended practices to support stakeholders with implementation.

Field Days

Strategies:

1. Host demonstrations and tours of recommended practice projects within the watershed
2. Presentations from a variety of agriculture, urban, and conservation professionals on recommended practice implementation recommendations.

Desired Outcomes

1. Landowners and farmers learn about recommended agricultural practices and can visualize implementing them on their land.
2. Watershed residents gain an understanding of recommended urban practices such as stormwater management, raingardens, etc.
3. Landowners and farmers make connections with municipalities and developers who can support implementation of recommended practices via technical and financial resources.

Long-term Education and Outreach Strategies

The long-term education and outreach strategies will focus on years 7-10 of the watershed plan. These activities will be focused on reaching all stakeholders within the watershed.

Watershed Planning Meetings

Strategies:

1. Host landowner watershed planning meetings throughout the watershed to inform landowners and farmers about recommended agricultural conservation practices that have been implemented such as reduced tillage, cover crops, water and sediment control basins, edge of field practices, etc. These meetings will be targeted toward landowner and farmers within the watershed.
2. Present updates on Watershed-Based plan implementation progress within the watershed, along with other relevant information that would be beneficial to the landowners.
3. Provide the opportunity for landowners to discuss their resource and implementation concerns, along with sharing what their hopes would be for the next plan update.

Desired Outcomes:

1. Producers and landowners learn about different conservation practices, as well as how to access funding and program support.
2. Landowners and other stakeholders can visualize conservation practices on their property, leading to increased implementation of them.
3. Public is knowledgeable on plan implementation and future planning efforts and understand the importance of a healthy watershed.
4. Input is incorporated into the new plan update.

Watershed stakeholders can seek funding for future implementation projects from local partners and professionals.

Ongoing Education and Outreach Activities

The ongoing education and outreach activities are activities that happen throughout the entirety of the ten years that this plan is viable. Activities will be focused on residents, students, parents, teachers, and administrators.

Community Outreach Days

Strategies:

1. Host various events throughout the watershed that encourage community involvement with conservation efforts (e.g., stream clean up, trash clean up, etc.).

Desired Outcomes:

1. Watershed residents develop interest in watershed conservation and knowledge of ongoing watershed planning and improvement efforts.
2. Water quality of streams across the watershed is improved.

Watershed Protection Awareness

Strategies:

1. Post informational signs along the boundary of the watershed, including information about a wide range of watershed conservation and improvement efforts.
2. Host educational booths with information about the watershed plan, water quality, stormwater management, flooding, recommended practices, etc. at various events throughout the year including, but not limited to, County Fairs, environmental festivals, and local markets.

3. Provide teacher training focused on how to include watershed conservation in curriculums.

Desired Outcomes:

1. Residents understand the important of a healthy watershed.
2. Stakeholders gain an understanding of what a watershed is and what the importance is for maintaining and monitoring the water quality.
3. Teachers and administrators implement watershed education in standard curriculums.

Section 14 – Appendices

Appendix A – Acronyms and Abbreviations

Appendix B – References

Appendix C – Public Participation and Stakeholder Meeting Details

Appendix D – 2011 Subwatershed Based Implementation Plan

Appendix E – West Branch Hurricane Creek ACPF Results