***DRAFT***

# PIGEON CREEK FLOOD DAMAGE REDUCTION AND DRAINAGE WORK PLAN

VANDERBURGH, WARRICK, AND GIBSON COUNTY

OCTOBER 2026

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# TABLE OF CONTENTS

**TABLE OF CONTENTS** ..... **i**

Executive Summary ..... v

**CHAPTER 1: PROJECT GOALS AND PURPOSE** ..... **1**

1.1 Introduction ..... 1

1.2 Pigeon Creek History ..... 1

1.3 Project Background ..... 2

1.4 Project Assessment ..... 3

**CHAPTER 2: PREVIOUS STUDIES AND DATA ANALYZED** ..... **4**

2.1 Previous Studies ..... 4

2.2 Stakeholder Survey ..... 5

2.3 Float Trip - Pigeon Creek Vanderburgh County ..... 10

2.4 Public Meeting Input ..... 12

2.5 Site Observation Summary ..... 12

**CHAPTER 3: KEY FINDINGS** ..... **15**

3.1 River Morphology ..... 15

3.2 Pigeon Creek Morphology and Soil ..... 16

3.2.1 Vanderburgh County ..... 16

3.2.2 Warrick County ..... 17

3.2.3 Gibson County ..... 17

3.3 Watershed Land Use ..... 17

3.3.1 Development ..... 17

3.3.2 Stormwater Planning ..... 19

3.3.3 Agricultural Areas ..... 19

3.4 Wood and Debris Accumulation ..... 21
3.5 Ohio River Effects ..... 22
3.6 Rainfall Analysis ..... 23
3.7 Stream Flow Data and Stream Gage Data ..... 24
3.8 Channel Access and Maintenance ..... 26
3.9 Bridges ..... 26
3.10 Watershed Hydrology/ Pigeon Creek Hydraulic Model ..... 26
3.11 Other Contributing Factors ..... 26
**CHAPTER 4: ALTERNATIVE ANALYSIS ..... 27**
4.1 Active Management Alternatives ..... 27
4.2 Passive Management Alternatives ..... 27
4.3 Active Management Strategies Not Recommended ..... 27
4.3.1 Dredging of Pigeon Creek Channel ..... 28
4.3.2 Channel Straightening or Realignment ..... 29
4.3.3 Clearing Trees from Channel Banks ..... 29
4.3.4 Floodgate Across Pigeon Creek Near Ohio River ..... 30
4.3.5 Increased Tile Drainage to Reduce Surface Flooding ..... 31
4.3.6 Construction or Improvement of Drainage Ditches ..... 32
4.4 Integrated Approach ..... 32
**CHAPTER 5: WATERSHED RECOMMENDATIONS ..... 33**
5.1 Active Management recommendations ..... 33
5.1.1 Selective Permanent Access for Debris Removal ..... 33
5.1.2 Wood and Debris Removal in Channel – Lower Stream Reaches ..... 35
5.1.3 Large Wood Removal at the Warrick County Line ..... 37
5.1.4 Construct Storage Areas along Laterals ..... 37
5.1.5 Bridge Analysis and Replacement ..... 40
5.1.6 Retrofit Existing Developed Areas with Detention ..... 41
5.2 Passive Management Recommendations ..... 42
5.2.1 UAV Flights ..... 42
5.2.2 Stream gages ..... 42
5.2.3 Develop Flood Response Plans ..... 43
5.2.4 Develop Flood Resilience Strategies ..... 43
5.2.5 Ordinance/Technical Standards Review and Update ..... 45
5.2.6 Mitigate Agricultural & County Drainage Project Impacts ..... 46
5.2.7 Incentivize Soil Health Practices ..... 46
5.2.8 Public Input and Inter-County Coordination ..... 47

5.2.9 Watershed-wide Hydrologic and Hydraulic Study ..... 48
**CHAPTER 6: IMPLEMENTATION SUMMARY ..... 49**
**REFERENCES 52**

## LIST OF FIGURES

Figure 1: Pigeon Creek Upstream of Franklin Street Bridge ..... 1
Figure 2: Survey Response Locations ..... 7
Figure 3: Float Trip Extents ..... 10
Figure 4: Debris blocking channel upstream of Lloyd Expressway bridge - May 30, 2025 ..... 11
Figure 5: Debris in channel along banks upstream of Lloyd Expressway Bridge – October 24, 2025 ..... 12
Figure 6: Lane's Balance ..... 15
Figure 7: Natural Channel Cross-section ..... 16
Figure 8: Waterline Profile Along Pigeon Creek ..... 17
Figure 9: Percentage of Developed Area in 1985 and 2024 ..... 18
Figure 10: Pigeon Creek North of State Road 57 Bridge ..... 20
Figure 11: Pigeon Creek North Side of E County Road 750 S, Gibson County ..... 20
Figure 12: UAV Photo from March 2026 Capturing Accumulation Zones and Erosion ..... 22
Figure 13: Annual Rainfall Depths for West Central Indiana ..... 23
Figure 14: Number of Days with Extreme Precipitation ..... 24
Figure 15: Debris Against Stringtown Bridge October 2025 (left) and July 2026 (right) ..... 34
Figure 16: Access View at Stringtown Bridge ..... 34
Figure 17: Debris approximately 200-ft south of Morgan Avenue Bridge – October 2025 ..... 35
Figure 18: Debris at 1st Avenue Culvert – October 2025 ..... 36
Figure 19: Blockage West of Evansville Day School – October 2025 ..... 36
Figure 20: Cover Crop Growing in Harvested Corn Field ..... 47
Figure 21: Implementation Timeline ..... 51

## LIST OF TABLES

Table 1: Survey Recipients for Stakeholder Survey ..... 5
Table 2: GIS Online Survey Responses ..... 8
Table 3: Site Observations ..... 12
Table 4: Source of Gage Data in Pigeon Creek Watershed ..... 25
Table 5: Gage Data Findings ..... 25
Table 6: Work Plan Recommended Actions ..... 49

## LIST OF EXHIBITS

Exhibit 1: Pigeon Creek Watershed
Exhibit 2: Elevation Map of County Line "S" Curve
Exhibit 3: Map of 100-Year Ohio River Backwater
Exhibit 4: Wesselman Woods Enhancement
Exhibit 5: Chandler Detention Basin Expansion
Exhibit 6: Centerpoint Energy Storage Expansion
Exhibit 7: Timber Road Storage
Exhibit 8: Evansville Day School Retrofit
Exhibit 9: Flood Resilience Planning Map (2023 study)

## APPENDICES

Appendix 1: MRLC Summaries
Appendix 2: Typical County Stormwater Management Requirements
Appendix 3: FEMA Flood Insurance Study
Appendix 4: Wesselman Woods Photographs
Appendix 5: Chandler Detention Basin Photographs
Appendix 6: Timber Park Photographs
Appendix 7: Evansville Day School Photographs

# EXECUTIVE SUMMARY

The Pigeon Creek Flood Damage Reduction and Drainage Work Plan was developed to support coordinated, watershed-scale management of flooding, drainage inefficiencies, and channel stability issues affecting communities in Gibson, Warrick, and Vanderburgh counties. The watershed has experienced increased flood risk due to changing precipitation patterns, land use intensification, historic channel modifications, and Ohio River backwater effects.

This Work Plan synthesizes previous studies, stakeholder input, public outreach, field observations, and planning-level hydraulic analyses to identify key issues and evaluate feasible short-term and long-term actions. The result is a set of 14 recommended actions – six active management measures and eight passive management measures – that together balance targeted physical improvements, such as large wood and debris removal and detention retrofits, with policy, monitoring, and land use strategies including coordinated stormwater standards, floodplain preservation, and agricultural soil health practices.

The Pigeon Creek Watershed Development Commission (PCWDC) was established by the Indiana Natural Resources Commission on September 17, 2024, under Indiana Code §14-30.5 to address longstanding flooding and drainage problems within the three-county Pigeon Creek watershed. This Work Plan fulfills PCWDC's first statutory responsibility: development of a comprehensive flood damage reduction and drainage plan. It was prepared by Christopher B. Burke Engineering, LLC, with assistance from Robert Barr, fluvial geomorphologist at Indiana University–Indianapolis, and Butler, Fairman and Seufert, Inc. The plan draws on previous studies, a stakeholder survey, a May 2025 float trip, a public meeting, and site observations conducted across all three counties in October 2025.

Pigeon Creek drains 370 square miles from its Gibson County headwaters near Princeton, through Warrick County past Chandler, and across Vanderburgh County through Evansville to the Ohio River. Approximately 58% of the combined watershed is in agricultural use; cultivated cropland alone covers 49%. Vanderburgh County is the most developed, with 37% of its area classified as developed and impervious surfaces exceeding 13%.

Assessment of Pigeon Creek identified six interconnected drivers of increasing flood damage:

- **Increasing precipitation intensity.** Annual rainfall in southwest Indiana has risen since 1960. More problematic is the additional days with extreme precipitation which disproportionately drives bank erosion, sediment transport, and channel-forming flows. Historical design assumptions increasingly underestimate actual flood risk.

- **Land use intensification.** Development expanded approximately 46.5 square miles across the three-county watershed between 1985 and 2024, shrinking forest and wetland cover. Gibson County's dense agricultural tile drainage network shortens runoff response time. The historical United States Geological Survey (USGS) gage record at Evansville confirms that annual mean discharge increased 44% over the 1961–1984 period of record, a statistically significant trend consistent with drainage intensification and surface runoff changes.

- **Legacy channel modifications and active sediment production.** Historic dredging and straightening in Gibson and Warrick counties steepened channel slopes and increased peak flows in all three counties. Erodible (sandy and loamy) riverbank soil and the lack of trees and vegetation along the banks in the upper part of the watershed cause the banks to erode easily. Sediment washes downstream and settles in Vanderburgh County, where it builds up, leaving less capacity in the stream.

- **Wood and debris accumulation.** Large wood collects at multiple locations in Vanderburgh County, most significantly at the Warrick/Vanderburgh County line (three distinct accumulations as of spring 2026 aerial imagery, with at least one accumulation zone actively eroding the adjacent banks) and at the center pier of Stringtown Road bridge.

- **Ohio River backwater effects.** Flooding in lower Vanderburgh County is strongly influenced by Ohio River stage. The historical gage record includes documented reversed flow. Because Ohio River stages reflect the larger Ohio River basin conditions, local channel modifications cannot significantly reduce this component of flood risk.

- **Stream gage gap.** The US 41 gage in Evansville was discontinued in the 1980's. Its frequency analysis yields a 100-year instantaneous peak of approximately 16,100 cfs (consistent with the FEMA FIS value of 16,000 cfs), but the record predates the steepest precipitation increases and likely understates current flood risk. No continuous-record gage exists in Vanderburgh County today.

Flooding in Pigeon Creek cannot be eliminated, but it can be managed. No single project addresses all six drivers simultaneously, and no structural measure can overcome the combined effects of a changing climate, four decades of drainage intensification, and Ohio River backwater. The following strategies were evaluated and rejected as technically counterproductive, financially infeasible, or ineffective against the root causes of flooding:

- Channel dredging
- Channel straightening at the Warrick/Vanderburgh County line
- Whole-bank tree clearing
- Floodgate for Pigeon Creek at the Ohio River
- Expanding tile drainage or tributary ditch conveyance

Recommended actions were identified as six active management measures (physical projects) and eight passive management measures (policy, monitoring, and land use change), summarized in the table below and described in detail within the report. Near-term priorities are identified within both categories and can be initiated within the Commission's first two years. A phased implementation timeline spanning 2026 through 2038, sequencing near-term, mid-term, ongoing, and long-term actions was also developed as part of this work plan. Mid-term and long-term measures will unfold through 2038 as funding is secured through grants, partnerships, and agricultural cost-share programs. The early data collection and access efforts, such as the new Vanderburgh County stream gage and the Unmanned Aerial Vehicle (UAV) monitoring program, build the foundation needed for later capital projects, including the watershed-wide hydrologic and hydraulic study.

**Summary of Recommended Actions**

| Number | Recommendation | Priority | Cost Factor |
|---|---|---|---|
| ***ACTIVE MEASURES*** | | | |
| 1. | Secure access at common debris-collection areas such as Stringtown Road bridge. | 2-yr Goal | Low |
| 2. | Evaluate debris at Warrick/Vanderburgh County line. | 2-yr Goal | Medium |
| 3. | Remove channel-blocking debris in Vanderburgh County. | Ongoing | Medium |
| 4. | Evaluate and construct storage in watershed. | 5-yr Goal | High |
| 5. | Bridge hydraulic analysis | 5-yr Goal | High |
| 6. | Retrofit existing developed areas with stormwater detention. | 5-yr Goal | High |
| ***PASSIVE MEASURES*** | | | |
| 7. | Establish Vanderburgh County USGS stream gage. | 2-yr Goal | Medium |
| 8. | Regular UAV monitoring program. | Ongoing | Low |
| 9. | Develop flood response and resilience plans. | 5-yr Goal | Medium |
| 10. | Update and coordinate 3-county stormwater ordinances. | 5-yr Goal | Medium |
| 11. | Require mitigation for agricultural drainage improvements. | Ongoing | Low |
| 12. | Incentivize soil health practices. | Ongoing | Medium |
| 13. | Public input and inter-county coordination. | Ongoing | Low |
| 14. | Watershed-wide hydrologic and hydraulic study. | 10-yr Goal | High |

# CHAPTER 1: PROJECT GOALS AND PURPOSE

## 1.1 INTRODUCTION

This report presents the results of an evaluation conducted for the Pigeon Creek Watershed Development Commission (PCWDC) by Christopher B. Burke Engineering, LLC (Burke) to develop a Flood Damage Reduction and Drainage Work Plan for reduction of flooding and improvement of drainage in the Pigeon Creek watershed. Robert Barr, a fluvial geomorphologist with Indiana University-Indianapolis, assisted Burke in this effort, along with Butler, Fairman and Seufert, Inc. in Evansville. The Work Plan encompasses proposed activities within the watershed, from its headwaters in Gibson County, Indiana to the outlet at the Ohio River in Evansville, Indiana (Vanderburgh County).

## 1.2 PIGEON CREEK HISTORY

Pigeon Creek has a drainage area of approximately 370 square miles its confluence with the Ohio River. Pigeon Creek flows southeast through Gibson County, then south through Warrick County before turning west and flowing through Vanderburgh County to the Ohio River. The stream begins near Princeton, passes by Chandler, and flows through the heart of Evansville. Other towns in the watershed include Fort Branch, Haubstadt, Lynnville, and Elberfeld. Large tributaries include West Fork Pigeon Creek, Big Creek, and Bluegrass Creek. The predominant land use in the overall watershed is agricultural (approximately 58% based on 2024 MRLC data). **Figure 1** shows a typical section of Pigeon Creek flowing through the Evansville area.

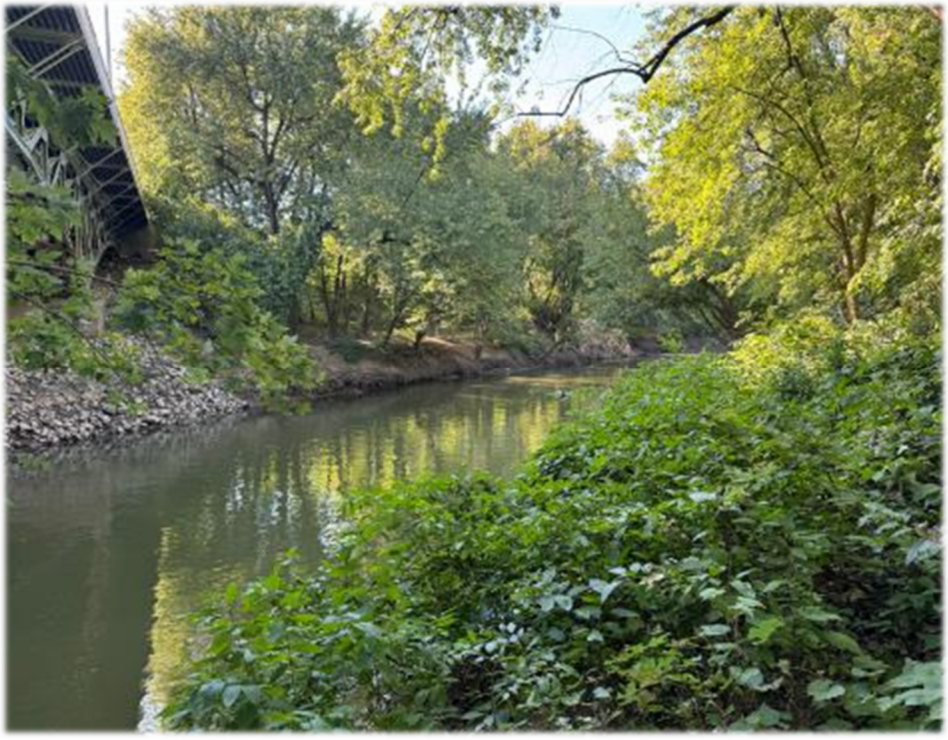


**Figure 1: Pigeon Creek Upstream of Franklin Street Bridge**

The watershed suffers from flood damage and poor drainage, as well as other stormwater management challenges. Many variables contribute to these challenges, such as precipitation, land use, each county's unique surficial geology and soils, floodplain connectivity, wooded corridors, and creek management issues. See **Exhibit 1** for the Pigeon Creek watershed map.

As discussed in detail in Burke's 2023 report titled *Pigeon Creek Corridor Flood Risk Management Plan*, peak Pigeon Creek flows appear to have increased over the last 40 years, as evidenced by nearby United States Geological Survey (USGS) gage data. The report also suggests a consistent trend in the increase in average annual precipitation in southwest Indiana over the last 50 years. This increase in precipitation and increases in agricultural drainage efficiency may have led to the increase in peak flows in Pigeon Creek. Regardless of the causes, higher rainfall amounts and land use intensification combine to increase the risk of flooding and channel instability as stream systems adapt to changing hydrologic conditions. Seasonal precipitation patterns have shifted over the period of record, altering the timing and volume of runoff delivered to Pigeon Creek throughout the year.

Pigeon Creek channel modifications through the years in Gibson and Warrick counties due to dredging, straightening, and relocating also contribute to challenges within the watershed. These modifications have led to increases in channel slope and stream power as well as decreases in the travel time of flood waters through the system, resulting in an increase in peak flows in Gibson, Warrick and Vanderburgh counties. According to Burke's 2023 report, the soils along Pigeon Creek in Gibson and Warrick counties are largely classified as alluvium, or floodplain soils. Composed of gravel, sand, silt, and a smaller amount of clay, these soils are generally poorly consolidated and easily eroded. While some erosion is typically expected, these issues can lead to increased channel instabilities and failed stream banks in Gibson and Warrick counties and the increased transport of sediment downstream to Vanderburgh County.

Vanderburgh County is the recipient of additional flow and sediment from the upper two-thirds of the watershed. Pigeon Creek in Vanderburgh County is not a regulated drain and has not been modified over the years. This leads to a natural stream with sinuosity and a flat channel slope, which is also subject to backwater from the Ohio River. The county is heavily influenced by the increased peak discharges and increased sediment loads due to increased precipitation, increased agricultural drainage efficiency, upstream creek soils, and upstream channel modifications. Large accumulations of woody debris, especially in the east portion of the county near the Warrick County line, are formed from large, felled trees and small debris generated in the county as well as carried from the upstream watershed.

## 1.3 PROJECT BACKGROUND

The PCWDC was established September 17, 2024, at the Natural Resources Commission meeting to address water management issues along Pigeon Creek. One of the first tasks of the PCWDC is to develop a plan for flood damage reduction and drainage as outlined in Indiana Code 14-30.5.

The formation of the PCWDC allows the counties within the watershed to address stormwater problems along the creek comprehensively. At the time of this report, only Vanderburgh County is legally a part of the PCWDC. The other counties within the watershed have opportunity to join through processes outlined in the statute. Development of a detailed flood damage reduction and drainage work plan with priority projects, schedule, and budgets will contribute to PCWDC's overall success over the years. This Work Plan will provide the basis for PCWDC to make decisions related to funding and support of practices within the watershed.

## 1.4 PROJECT ASSESSMENT

The development of the Work Plan was undertaken to address several issues along the Pigeon Creek corridor. These include:

- Localized flooding
- Wood and debris in channels impacting upstream water elevations
- Trash and/or wood against bridges or other structural/flow capacity areas
- Bank and channel stability and sedimentation downstream
- Lack of floodplain connectivity, wetlands, and stormwater storage
- Increased runoff peaks and volumes through development, agricultural drainage efficiency and increased precipitation intensity
- Inability to critically evaluate stream flooding dynamics due to lack of flow information
- Segments of creek corridor lacking management (buffer or control)

To address these issues, the following assessments were completed:

- Review of prior studies, reports, and evaluations of Pigeon Creek and the watershed.
- Review of Pigeon Creek floodplain connectivity mapping (Burke 2023).
- A survey of stakeholders in Vanderburgh, Warrick and Gibson counties to collect observations and concerns of local professionals working in and along Pigeon Creek.
- Collection of public comments through public meetings.
- Site visits throughout the watershed to evaluate specific areas identified from prior studies, surveys, or as determined from review of mapping and discussion with the project team.
- GIS watershed inventory of land use, soils, hydrology, development hotspots, and watershed hot spots. The watershed hotspots include the stressors identified in previous assessments.

# CHAPTER 2: PREVIOUS STUDIES AND DATA ANALYZED

## 2.1 PREVIOUS STUDIES

The review of previous studies for the project was limited to a small number of reports of significance to fluvial stability and flooding considerations and a float of a section of the creek within Vanderburgh County.

**Pigeon Creek Corridor Flood Risk Management Plan (Burke, 2023)**




This plan evaluates corridor flood risks for Pigeon Creek in Vanderburgh County to develop conceptual mitigation solutions. The study reach was approximately 15.9 miles in length and extended from the confluence with the Ohio River to the upstream-most crossing of the Vanderburgh-Warrick County Line.



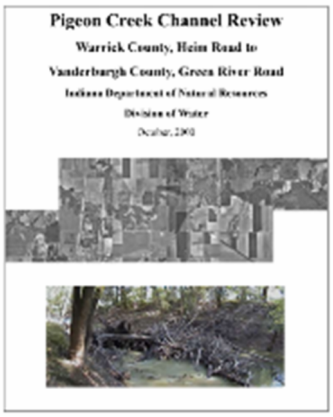
**Upper Pigeon Creek Watershed Master Plan (Burke, 2014)**

This watershed master plan provided a road map for management of stormwater in the Upper Pigeon Creek watershed and was developed for the Gibson County Drainage Board. Its purpose was to address specific drainage concerns and ditch maintenance issues in the watershed and evaluate the existing capacity for selected channel reaches, identify and provide improvement alternatives for restrictive channel segments, bridges, and culverts, provide recommendations for channel maintenance to maximize the effectiveness of the drainage system, and to develop a "Rule-of-Thumb" methodology for sizing drainage ditches given the ditch's location in the watershed.

**Lower Pigeon Creek Watershed Management Plan (Sara Peel, 2023)**



This report focuses on water quality in Vanderburgh County. Public input and assessment of the watershed provided a plan to address water quality. Some areas of erosion were evaluated providing insight into potential sediment sources.




**Pigeon Creek Channel Review – Warrick County, Heim Road to Vanderburgh County, Green River Road (Indiana DNR, 2000)**

This float trip report provides a historical perspective on the status of Pigeon Creek. In 2000, an estimated 300-foot-long wood and debris section was noted near the Warrick-Vanderburgh County line. Descriptions of the bank slopes and soils at this time can be compared to the current status.

The previous studies of Pigeon Creek, while varying in scope, methodology, and geographic focus, reach consistent conclusions about the causes and character of flooding across the watershed. Gibson County's reach is defined by legacy channelization, with a straightened and ditched channel maintained primarily for agricultural drainage, producing higher channel gradients and more rapid delivery of runoff to downstream reaches than would occur under natural conditions. Warrick County's reach exhibits a transitional character, with segments retaining more natural sinuosity alongside areas subject to active bank erosion, woody debris accumulation, and periodic maintenance. Vanderburgh County's reach is largely unmodified and meandering through an urban corridor, where flat channel gradients prolong flood stage duration and periodic Ohio River backwater extends inundation upstream independent of local watershed conditions.

Across all three counties, the previous studies consistently identify that drainage intensification, increasing precipitation intensity, and incremental development have progressively shortened runoff travel time and increased peak discharge at downstream communities. The recommendations in the following chapters build on the consistent findings of these prior studies and translate them into a coordinated program of active and passive management actions working toward reduced flooding.

## 2.2 STAKEHOLDER SURVEY

Initial steps of the Work Plan included a survey of identified stakeholders within the watershed. Stakeholder engagement in this study targeted local officials, professionals, and groups working within the watershed with management, oversight, regulation, or technical input into the condition of Pigeon Creek. The list of stakeholders is provided as **Table 1**.

**Table 1: Survey Recipients for Stakeholder Survey**

| **Entity (Title)** |
|---|
| Vanderburgh County Surveyor, PCWDC |
| City of Evansville, MS4CECI, PCWDC |
| Former Vanderburgh County Commissioner, PCWDC |
| DNR, Division of Water, PCWDC |
| Gibson County Surveyor |
| Warrick County Surveyor |
| Pike County Surveyor |
| Vanderburgh County Engineer, MS4 Director |
| Warrick County Engineer |
| Gibson County Engineer |

| |
|---|
| Vanderburgh County SWCD |
| Warrick County SWCD |
| Gibson County SWCD |
| Pike County SWCD |
| City of Evansville Engineer |
| City of Evansville Assistant Engineer |
| Town of Chandler Planning, Zoning, & Stormwater Director |
| University of Southern Indiana, Environmental Health & Safety Mgr., MS4 |
| University of Evansville, Environmental Health & Safety Mgr., MS4 |
| Vanderburgh County Purdue Extension Director |
| Warrick County Purdue Extension Director |
| Gibson County Purdue Extension Director |
| Pike County Purdue Extension Director |
| Vanderburgh County Commissioners |
| Warrick County Commissioners |
| Gibson County Commissioners |
| Pike County Commissioners |
| City of Evansville Parks & Recreation, Executive Director |
| Wesselman Woods |
| Evansville Levee Authority |
| City of Evansville/Vanderburgh County Emergency Management Agency |
| U.S. Army Corps of Engineers, Chief MCE Branch, Louisville District |
| Indiana State Department of Agriculture, Southwest RS Team Leader |
| Natural Resources Conservation Service, Evansville Service Center |
| Natural Resources Conservation Service, Boonville Service Center |
| Natural Resources Conservation Service, Princeton Service Center |
| Natural Resources Conservation Service, Petersburg Service Center |
| The Nature Conservancy |
| Centerpoint Energy |
| Evansville Water & Sewer |
| Ohio River Valley Water Sanitation Commission |
| Indiana Department of Environmental Management, Watershed Planning |
| Conservation Cropping Systems Initiative |
| Indiana Watershed Leadership Academy, Lower Pigeon Creek Watershed Steering Committee |
| Indiana Department of Natural Resources, Division of Water, Compliance & Enforcement Inspector |
| University of Southern Indiana, Professor of Geology |
| University of Evansville, Professor, Director of Environmental Studies |
| Former Vanderburgh County Surveyor, Board Member Pigeon Creek Greenway Passage |
| Former Vanderburgh County Surveyor |
| Pigeon Creek Greenway Passage, Chairperson |
| Vanderburgh County Health Department, Administrator |
| Warrick County Health Department, Health Officer |
| Gibson County Health Department, Health Officer |
| Sycamore Land Trust |

The input was obtained via an online survey embedded in a map of the watershed. A survey was distributed via email link to 63 recipients and remained open from September 2 to September 16, 2025. The survey yielded 15 points from 13 individuals, supplemented by 2 additional email responses. Response locations are shown in **Figure 2,** and list of the responses is provided in **Table 2**. Respondents identified several areas of concern, including wood and debris accumulation in the channel, erosion, sedimentation, opportunities for flood storage, and concerns in areas away from the main channel.

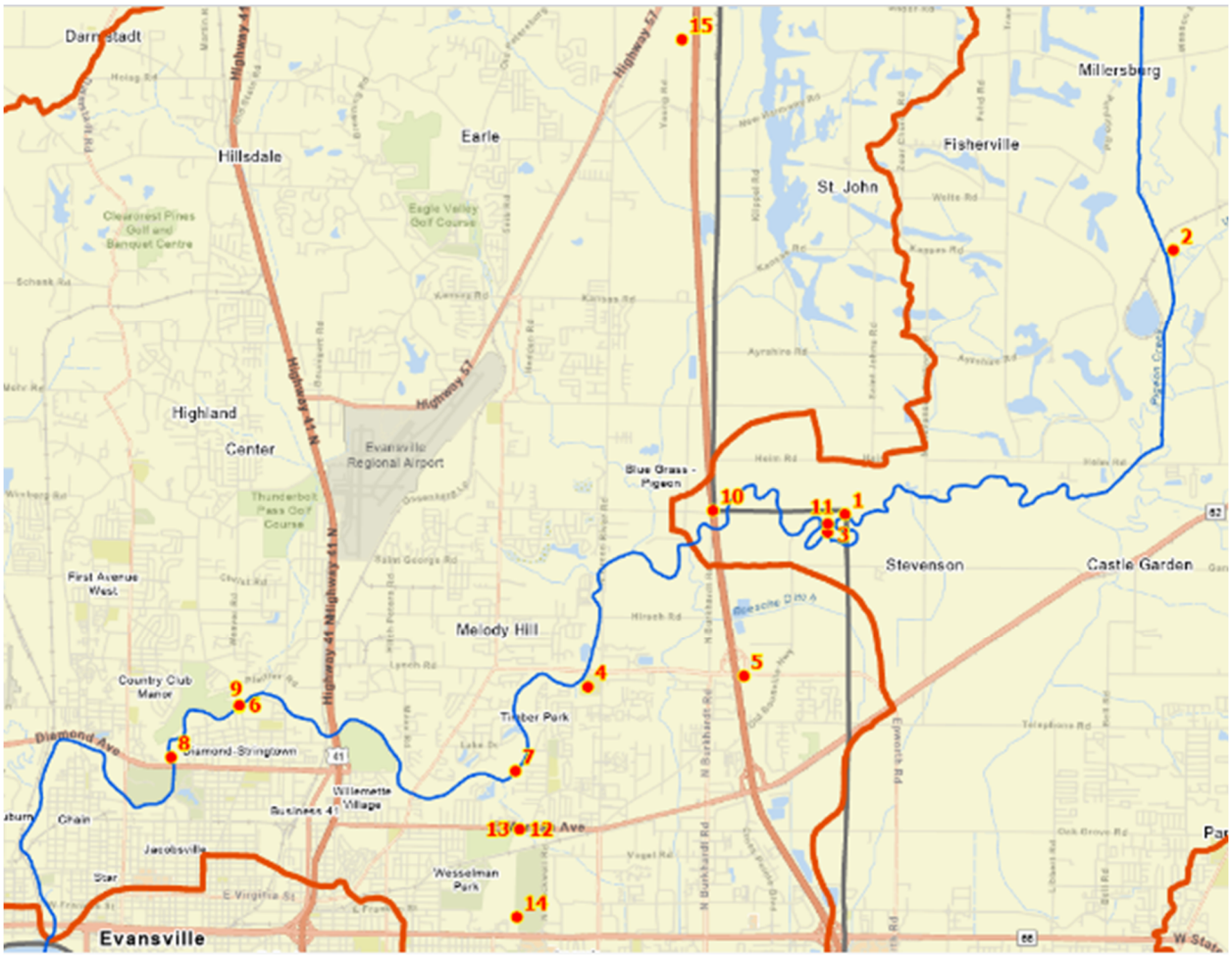



**Figure 2: Survey Response Locations**

**Table 2: September 2025 GIS Online Survey Responses**

| Point No. | Category | Stakeholder Comment |
|---|---|---|
| 1 | Logjam/wood or debris in channel collecting to cause an issue | Log jam |
| 2 | Flooding | During the rainy season we constantly have to watch for flooding on the northwest section of the town of Chandler (Warrick Co) due to Pigeon Creek not draining as well as it should. This is caused either by the Ohio River being flooded, debris and sediment build up along the creek bed of Pigeon Creek, or an excessive amount of rainfall within our area or further upstream not allowing enough time to properly drain. |
| 3 | Logjam/wood or debris in channel collecting to cause an issue | Several large log jams are causing flooding issues |
| 4 | Erosion | Flooding at the Evansville Day School Properties. Blockages and erosion may be impacting the drainage. |
| 5 | Logjam/wood or debris in channel collecting to cause an issue | Log jam backs 5 ft of water into Warrick County |
| 6 | Logjam/wood or debris in channel collecting to cause an issue | Logjams can routinely occur at the Stringtown Road bridge. |
| 7 | Opportunity area for flood storage or other creek drainage improvement | Flood storage anywhere upstream of the Pigeon Creek Bridge at Oak Hill Road would be valuable. Pigeon Creek cresting from spring storms rose higher than the roadway causing its temporary closure. |
| 8 | Logjam/wood or debris in channel collecting to cause an issue | Lot of logs causing build up in the creek. |
| 9 | Logjam/wood or debris in channel collecting to cause an issue | Logs are being collected by bridge supports. This is the only area I could provide current pictures for as of Saturday, September 13th. |
| 10 | Logjam/wood or debris in channel collecting to cause an issue | Warrick County Surveyor reported a large log jam just west of the Warrick/Vanderburgh County line in Pigeon Creek |
| 11 | Opportunity area for flood storage or other creek drainage improvement | To explore the possibility of stormwater storage in different locations. I think that maybe the location where large woody debris accumulates near the Warrick/Vanderburgh County line would be a good start. Maybe the area could also be utilized as a catch for the debris that seems to come into that location from upstream. |
| 12 | Logjam/wood or debris in channel collecting to cause an issue | Trash and debris collect along roadside and in Harper Ditch |
| 13 | Sediment accumulation | Sediment accumulates in Harper Ditch |

| | | |
|---|---|---|
| 14 | Opportunity area for flood storage or other creek drainage improvement | Wetland area is approximately 3 acres in Wesselman Woods South located along the Lloyd Expressway at the corner of Division and Stockwell Roads. We are looking to restore this conservation easement area by removing invasive phragmites and repopulating with native plants. This could potentially be a water catchment area. |
| 15 | Concerns away from channel impacting the creek | Traditional agriculture practices contribute to sediment and nutrients. The plan needs to incorporate infield practices such as no-till and cover crops and edge of field practices like buffers to decrease sediment and nutrients from entering the waterways. |

Two stakeholders sent email responses to the survey rather than submitting entries into the GIS survey map. Several comments were included in the emails that are captured directly below.

**Emails submitted from stakeholders as responses to survey:**

1. Straight channeling due west (replacing radical meanderings) from Creek Point of Entry to Vanderburgh County at Northeast Corner Knight Township and along Knight Township/Campbell Township line to I-69 Bridge, in order to remove the historic logjam collection points.
2. Construct a trash collection structure of some approvals and maintainable design (a controlled stilling/sediment impoundment and trash rack) at the northeast point of intake to gather fallen/cut timber and agricultural debris chronically generated by previous and continual poorly controlled activities in Warrick County.
3. Increase the available waterway opening at Lynch Road Pigeon Creek Crossing to sufficiently address the significantly undersized current structure's capacity that results in upstream flooding during events equal to 50-yr to 100-yr rainfall events. The Green River Road bridge reconstruction design included a significant primary waterway opening enlargement along with two auxiliary bridge structures to accommodate the designated regulatory high-water. The design for Green River Road bridge replacement clearly proves the requirement for an enormous increase in waterway opening(s) at the dramatically undersized Lynch Road crossing which when designed circa 1994 did not accommodate the 100-yr volume without exceeding the regulatory 0.10 foot elevation height of floodwaters at upstream face of structure compared to downstream discharge elevation. In order to keep vehicular traffic flow uninterrupted, auxiliary tunnel openings could be bored under existing roadbed. I personally observed and measured flood elevation following several 50-yr and near 100-yr events on several public roads and flooded residences upstream of Lynch Road and Green River Road both before and after the construction of the new Green River Road bridge while I was Chief Deputy and elected County Surveyor between 1984 and 2012, and I'm certain the Lynch Road bridge opening is a major obstruction.
4. …the worst of the radical meanders that have created logjams are those between the northeast corner of Knight Township where the Creek enters Vanderburgh County, thence west to the 1-69 bridge. From there, downstream to Green River Road, the Creek bends are not as problematic.
5. Clean up and remove debris from the creek. The debris is located between Heidelbach boat ramp and where Pigeon Creek dumps into the Ohio River.

**Other Input**

The Warrick County Surveyor brought attention to a potential hazardous situation along Pigeon Creek during a regular PCWDC Board meeting. He indicated to the Board that a large slurry storage pond in Warrick County, adjacent to Pigeon Creek, may be in danger of dam failure. The potential failure area was not evaluated for this report but was evaluated by state authorities. State authorities found the structure in fair condition with no imminent safety risk. This site should continue to be monitored to ensure there are no negative impacts to Pigeon Creek.

## 2.3 FLOAT TRIP - PIGEON CREEK VANDERBURGH COUNTY

Several stakeholders participated in a float trip on Pigeon Creek on May 30, 2025. The purpose of the trip was to see the creek and banks from the water and allow an opportunity for photography. The float trip started at Heidelbach Avenue and continued downstream approximately 4.3 creek miles to just north of the Lloyd Expressway bridge. **Figure 3** identifies the reach of Pigeon Creek that was floated.

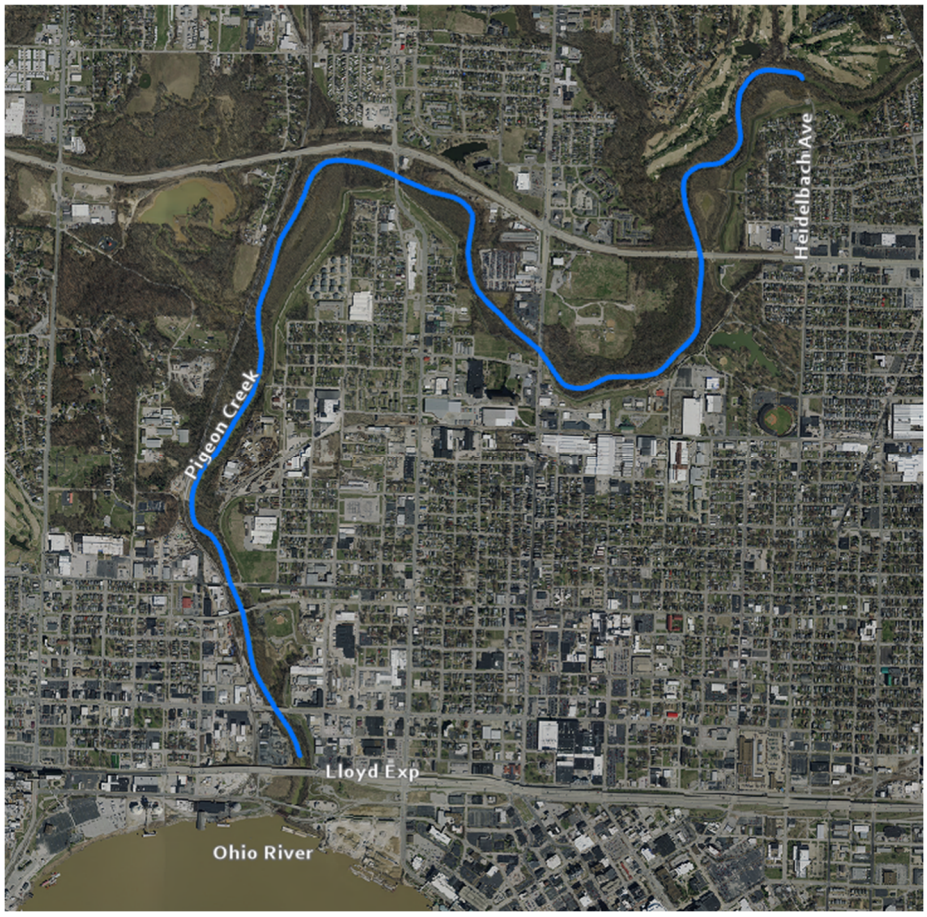



**Figure 3: Float Trip Extents**

Just upstream of the Lloyd Expressway bridge, debris blocked the channel surface across the entire width of the creek. This debris matches a description from an email respondent to the stakeholder survey. **Figure 4** shows the debris across Pigeon Creek that was in place during the float trip. **Figure 5** was taken nearly 5 months later in the same area showing the debris had cleared across most of the creek width.



**Figure 4: Debris blocking channel upstream of Lloyd Expressway bridge - May 30, 2025**



**Figure 5: Debris in channel along banks upstream of Lloyd Expressway Bridge – October 24, 2025**

## 2.4 PUBLIC MEETING INPUT

A public meeting was held on October 27, 2025 at the Vanderburgh County Civic Center. The background of the PCWDC was provided along with the general findings of previous studies and results of the stakeholder study. A public handout was provided to attendees. In addition to the PCWDC board, attorney, and presenters, 15 public participants attended the meeting. There were four comments from the public that included:

- One Warrick County resident commented that the logjam at the Vanderburgh/Warrick County line should be removed.
- One person noted that he uses the canoe launch at Kleymeyer Park and that it should be better promoted so that others will know it is there.
- Two Evansville residents commented on the need for replacement/maintenance of inlets/culverts near their homes.

## 2.5 SITE OBSERVATION SUMMARY

Sites were visited in Vanderburgh, Warrick, and Gibson counties on October 16-17, 2025 to observe areas of concern and opportunities for improvement. The sites were selected from the stakeholder survey, previous study indications, and as noted during discussion with those in attendance. In addition to the Burke team, discussions and/or field visits were conducted with the Vanderburgh County Engineer, the Chandler Floodplain Manager, and three members of the PCWDC Board. **Table 3** below lists the sites that were visited and a brief description of what was observed.

**Table 3: Site Observations**

| Site No. | Location | Description of Site |
|---|---|---|
| 1 | Stringtown Road Bridge | Pier in center of bridge bisects the flow in Pigeon Creek and collects debris. The debris may cause concerns for the bridge structure or abutment banks if debris is large or held long enough to cause flow to deflect to banks. Apparent access to the bridge is currently private property. |
| 2 | Upstream of Diamond Road | This area is at the end of the Parkland Road extension. Individual trees have fallen into the creek, but there is no substantial erosion. |
| 3 | Upstream of Morgan Avenue | This bridge has riprap protection. An area of woody accumulation is approximately 200 feet upstream of the bridge. The woody accumulation is within the county regulated drain. |
| 4 | West of Timber Road Subdivision Area | Approximately 64 acres of wooded and formerly scraped (for borrow) area is along the inside bend of Pigeon Creek. One small area along the southeast border contains trees that were part of a mitigation plan. The floodwater level typically can reach the tree line near the yards of the homes adjacent to the east. A homeowner noted the flood line. This area may have potential for flood storage. |
| 5 | Warrick Co - Chandler Detention Pond | This detention area was apparently constructed to intercept stormwater runoff from surrounding development from the south and east and outlets through a small (8-12-inch diameter) pipe. There may be potential to increase detention storage volume. |
| 6 | Warrick Co - Northwest Chandler | The northwest end of Chandler (along Inderrieden Road) sees a lot of flooding both from the town of Chandler as well as from Pigeon Creek. Several houses flood more than once per year (according to the Chandler Floodplain Manager). |
| 7 | Dry Branch at First Avenue | At Woodbridge Avenue, a culvert headwall has vertical racks that catch trash and debris. It appears that sediment drops out upstream of this culvert and recent maintenance had cleaned some sediment from the channel. |
| 8 | Franklin Bridge | Metal bridge structure was clear and open. |
| 9 | Ohio Street Bridge | Three bridges were observed to include the Ohio Street bridge, the railroad bridge, and a walking bridge downstream closest to the Ohio River. No debris was seen under any of these bridges. |
| 10 | Wesselman Woods | The former park (ballfields) area has construction materials and equipment on the edges and was acquired by Wesselman Woods Nature Preserve. They would like to make it into a small wetland. A beehive grate in a swale has an approximately 8" diameter outlet toward the soccer field (north) only. |
| 11 | Evansville Day School | Multiple ravines run through the woods west to the creek, with one noted to be very narrow and deep. The school and parking lot do not appear to have adequate stormwater runoff control or detention. |
| 12 | Upstream of Lynch Road | This bridge is the planned location for the stream gage. A 2023 report indicates that there is erosion in the reach north of Lynch Road to northeast of Green River Road bridge, but no substantial erosion was seen in this reach. |
| 13 | Green River Canoe Launch | The launch area was viewed and no concerns were noted. |
| 14 | Gibson Co – SR 57 Road Bridge | Sediment appears to be flowing in the channel. |

| Site No. | Location | Description of Site |
|---|---|---|
| 15 | Gibson Co – I-69 Bridge | There is a wide floodplain area under the multiple piers of the I-69 bridge work. |
| 16 | Gibson Co – SR 168 Bridge | This bridge has stream gage/measurement apparatus in place. The banks of farmed areas upstream had been tilled to the top of the banks. |

# CHAPTER 3: KEY FINDINGS

Existing data and previous studies, where available, were used as supporting information for the system assessment to provide an initial understanding of the current processes along Pigeon Creek. Additional data and observations were collected to provide a more comprehensive understanding of the physical processes at work and the flooding risk within the river system. Synthesis of the data described in Chapter 2 enabled identification of issues affecting flooding and drainage along the Pigeon Creek. The key findings are presented in the following paragraphs.

## 3.1 RIVER MORPHOLOGY

The shape of a river channel and how it changes over time is referred to as the morphology of the river. The morphology of a river integrates changes in land use and precipitation and can be important to understanding the processes affecting the river and the overall stability of the channel and the river system. A standard definition of channel stability is "a river or stream's ability in the present climate to transport the stream-flows and sediment of its watershed over time in such a manner that the channel maintains its dimension, pattern, and profile without either aggrading or degrading" (Rosgen, 1996, 2001b). Lane's Balance, as shown in **Figure 6**, is a commonly used illustration of the general relationships involved in channel stability, which is also referred to as dynamic equilibrium.

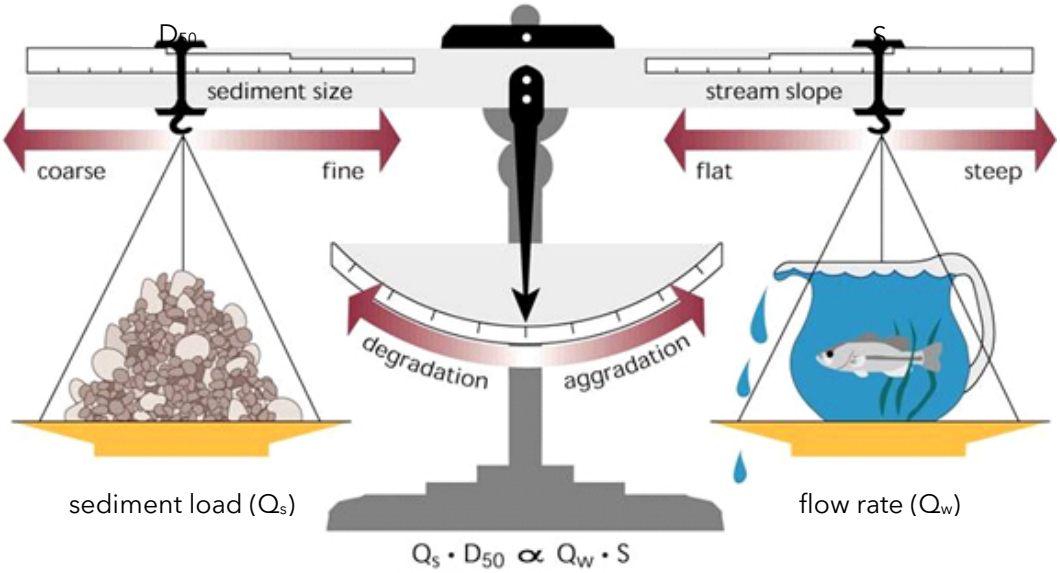



**Figure 6: Lane's Balance (after Rosgen 1996)**

Different scenarios can be illustrated by visually sliding the sediment load and flow rate on the balance beam, as well as changing the amount of sediment and water on the weighing platforms. When the supply of sediment is balanced with streamflow, the river can "over time" transport the sediment and water through the system. This illustration can be used to start exploring the current and future expected conditions of the Pigeon Creek system that may result from the improvements discussed in Chapter 5.

The ability of a river system to accommodate changes in the inputs of water and sediment without instability requires that the river have a shape that provides natural resilience. The cross-section of a natural channel shown in **Figure 7** demonstrates the components that must be present in a resilient channel. The most important component of a resilient channel is a floodplain that is connected/accessible at the bankfull stage. The connected floodplain provides the critical function of dissipating energy that would otherwise result in erosion, storage of floodwater which reduces flow

rates, and storage of mobilized sediment and debris after flooding events. Channels are typically stable where these features are intact. Where a stream has not been allowed to maintain a natural form, instabilities should be expected and can be observed most easily through an evaluation of the channel morphology.

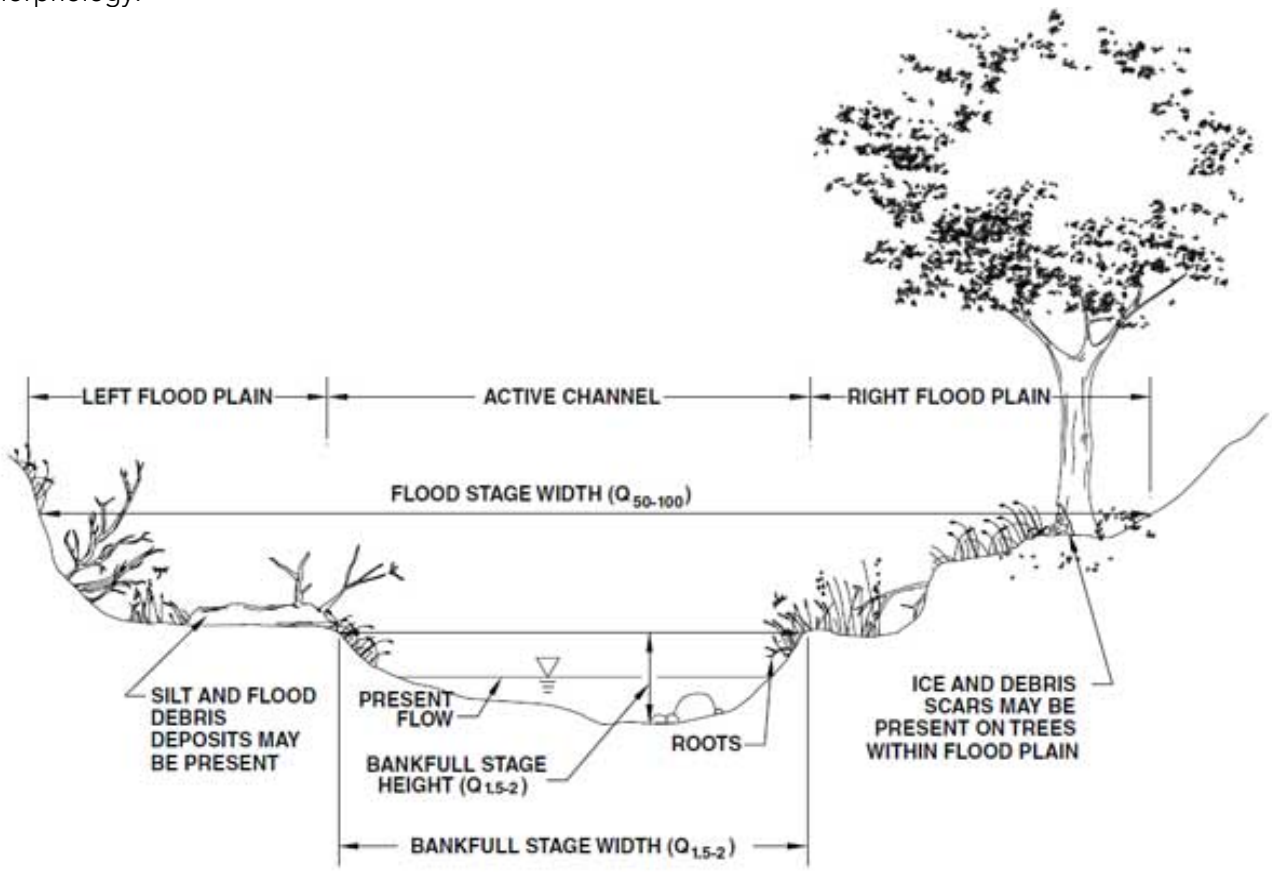



**Figure 7: Natural Channel Cross-section (USDA)**

The following section describes the morphology for the main stem of Pigeon Creek.

## 3.2 PIGEON CREEK MORPHOLOGY AND SOIL

Flow capacity and erosion potential in Pigeon Creek reflect slope and soil conditions that change distinctly from Gibson County downstream through Warrick County to Vanderburgh County. These longitudinal differences in morphology, slope, and soil type govern erosion potential, sediment transport, floodplain connectivity, and what kinds of practices will be most effective in each reach. The county-by-county descriptions below reflect these differences.

### 3.2.1 VANDERBURGH COUNTY

The channel slope is flat and soils have small particle sizes with enough clay content to make the soils mostly stable along steep bank sections. Banks tend to be steep but comparatively stable, and widespread bank erosion is not the dominant geomorphic issue. Instead, flooding dynamics are governed by limited channel capacity, extensive backwater effects from the Ohio River, potential bridge constrictions, and accumulation of large wood and debris. Channel modification is generally neither feasible nor desirable in this reach due to low slope, backwater influence, and proximity to urban limitations.

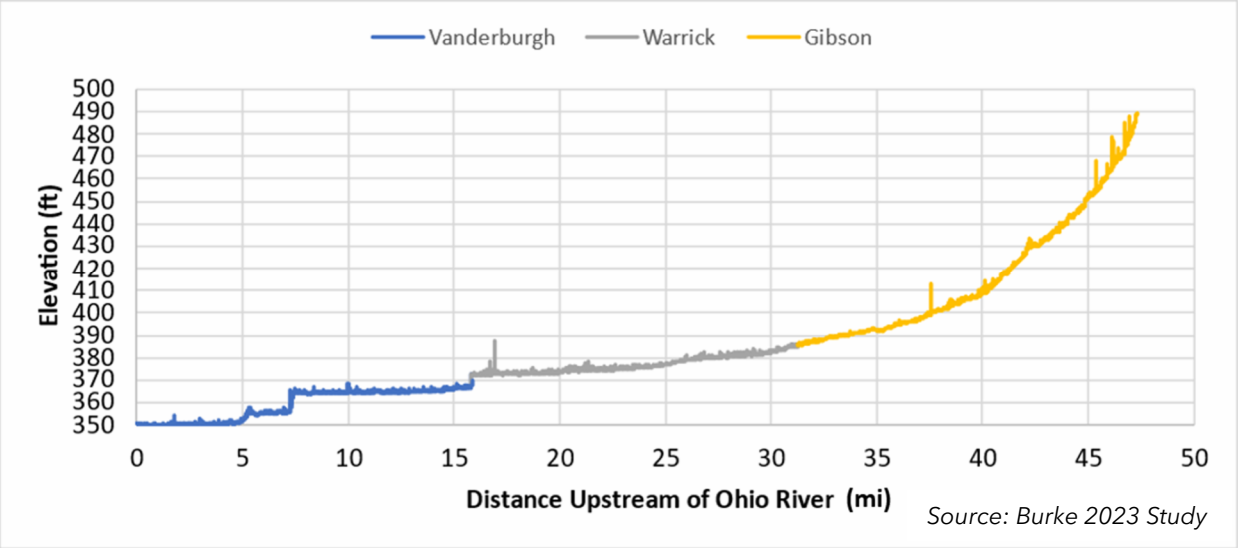
### 3.2.2 WARRICK COUNTY

The channel slope steepens slightly into Warrick County with a dredged channel routing through low, flat wooded wetlands that still contain areas for flood storage. Remnant oxbows, backchannels, and wooded floodplain areas remain hydraulically connected. These features provide localized storage of flood peaks and sediment deposition; however, the dredged geometry through most of the county promotes rapid conveyance during moderate events. The soils move out of the fine-grained lacustrine (clay/silt predominant) area of Vanderburgh County up into alluvial soil with more sand/gravel content placed by moving water.

### 3.2.3 GIBSON COUNTY

The channel slope steepens further, and the floodplain soils frequently have sand and gravel deposits with limited cohesion. These soils are highly erodible under elevated flow conditions. Observations and prior studies indicate active bank erosion, sediment recruitment from cropped fields to the channel edge, and limited riparian buffers in many reaches. As a result, the upper watershed is a primary contributor of sediment and elevated peak discharges to downstream reaches. Due to this, practices in Gibson County should address field runoff and bank erosion.

The longitudinal differences illustrated in **Figure 8** indicate that no single solution is appropriate throughout the watershed. Instead, targeted practices matched to geomorphic location are required.




*Source: Burke 2023 Study*

**Figure 8: Waterline Profile Along Pigeon Creek**

## 3.3 WATERSHED LAND USE

### 3.3.1 DEVELOPMENT

Urbanization and suburban development have increased the extent of impervious surfaces throughout the Pigeon Creek watershed over the past four decades. Analysis of Multi Resolution Land Characteristics Consortium (MRLC) data indicates measurable conversion of agricultural land to residential, commercial, and transportation uses in all three counties, with the most pronounced increases occurring in Vanderburgh and Warrick counties.

Impervious surfaces reduce infiltration, increase runoff volume and peak discharge, and shorten the time water takes to reach the creek. Without adequate detention or retention, development adds incrementally to flood stages downstream, particularly during the moderate, frequent storms that shape channel geometry. Older developed areas built before stormwater detention requirements were in place present an opportunity for retrofits that could meaningfully reduce cumulative impacts.

The increase in runoff in the general three-county area of Vanderburgh, Warrick and Gibson counties can be roughly estimated by the change in land use. According to the MRLC, there has been an overall increase of approximately 46.5 square miles of development from 1985 to 2024 across the three counties, representing approximately 4.2% of the combined three-county land area.

- An estimated 19.30 square miles of development and 8.36 square miles of impervious surfaces were gained between 1985 and 2024 in Vanderburgh County. The majority of those acres were lost cropped fields.
- In Warrick County, the estimate is 15.83 square miles of development and 4.77 square miles of impervious surface added between 1985 and 2024.
- Gibson County experienced approximately 11.44 square miles of development, adding 4.24 square miles of impervious surface during the same time frame.

Agricultural land dominates the watershed, covering approximately 58% of the combined three-county area, with cultivated cropland alone accounting for nearly 49%. While cropland acreage declined modestly in all three counties between 1985 and 2024, it remains the dominant land cover type and a primary driver of runoff volume and rate. Forest cover declined across all three counties (Gibson lost 3.88 sq. mi., Warrick 15.03 sq. mi., Vanderburgh 2.08 sq. mi.), reducing natural infiltration capacity. Wetlands also contracted in all three counties, further diminishing the watershed's natural flood buffering. See **Appendix 1** for MRLC summaries of each of the three counties. **Figure 9** graphically represents the increase of developed area in the three counties over nearly 40 years.

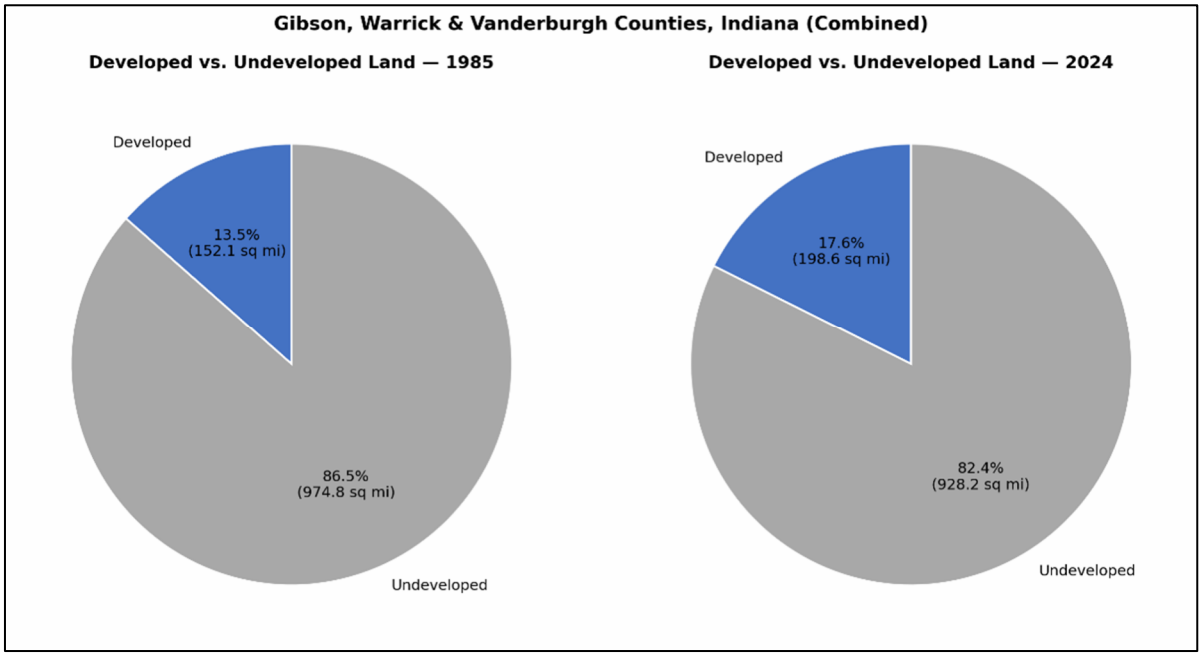



**Figure 9: Percentage of Developed Area in 1985 and 2024**

These land cover trends of growing impervious area, shrinking forest and wetland cover, and a high proportion of cultivated cropland reduce the watershed's ability to slow, store, and filter runoff, and have contributed to higher peak flows in Pigeon Creek over time.

### 3.3.2 STORMWATER PLANNING

**Current Standards and Ordinances**

Many Indiana counties and cities have stormwater rules that define how runoff and drainage must be controlled. These rules help to ensure shared drains are not overloaded and reduce the risk of flooding downstream of new developments. Stormwater rules typically take the form of stormwater ordinances and technical standards. Stormwater management within the Pigeon Creek watershed is governed independently by each county and municipality.

Updated stormwater standards incorporating retention, infiltration, and extended detention are necessary to stabilize watershed hydrology over time. Coordination of stormwater standards across county boundaries is particularly important given the longitudinal connectivity of Pigeon Creek. Up-to-date and progressive stormwater standards may address some of the contributing factors and help reduce further increases in peak flow rates caused by new development and redevelopment.

Stormwater detention/retention and compensatory storage requirements are not consistent throughout the watershed. In many cases, the current requirements lack up-to-date, no-adverse-impact measures. The current stormwater and floodplain regulations within all jurisdictions in the watershed should be updated. Each of the jurisdictions within the watershed should coordinate their stormwater standards with other jurisdictions in the Pigeon Creek watershed to the greatest extent practicable to promote more consistent stormwater management.

See **Appendix 2** for typical requirements utilized as a basis for county stormwater management.

**Historic Requirements**

Development areas within Evansville (and perhaps other communities within the watershed) were constructed prior to implementation of stormwater rules. These areas lack detention and add to the flooding through decreased permeability and shorter runoff times.

### 3.3.3 AGRICULTURAL AREAS

A large portion (approximately 58%) of the watershed remains in agricultural use. The upper watershed area remains the highest use of agriculture, with Gibson County above 70% in agricultural use. Site visits as part of this study and prior studies indicated that agriculture is a sediment source that may be reduced with in-field and edge of field management practices.

Field observation at Site 14 (Gibson Co. – SR 57 bridge, upstream of the SR 168 gage) noted sediment visibly moving in the channel during the October 2025 site visit. This indicates active bedload transport in the upper watershed. Agricultural fields upstream of SR 168 have been tilled to the top of channel banks with no riparian buffer, directly delivering surface runoff and eroded topsoil to the channel. This represents a significant and ongoing sediment source. **Figure 10** and **Figure 11** were taken October 17, 2025. The Lower Pigeon Creek Watershed Management Plan (Peel, 2023) and the 2023 Burke report both document sediment accumulation in Vanderburgh County, consistent with active sediment production in the upper watershed reaching and depositing in the lower gradient reach.



**Figure 10: Pigeon Creek North of State Road 57 Bridge**



**Figure 11: Pigeon Creek North Side of E County Road 750 S, Gibson County**

### Soil Health Practices

Soil health practices in cropped fields include no-till, cover crops and a system of nutrient management to encourage biotic organisms and root systems that create higher organic matter and an easily infiltrated soil with pore spaces. Research by the Natural Resources Conservation Service (NRCS), Purdue University, and other institutions consistently demonstrates that soil health practices, including no-till, cover cropping, diverse crop rotations, and nutrient management, can significantly increase soil organic matter. Even modest increases in organic matter substantially improve soil water-holding capacity, reducing runoff during moderate rainfall events that drive channel erosion and cumulative flooding impacts. The set of practices that the NRCS terms "soil health" appear to be the future of sustainable agriculture and have the potential to change water management in agricultural regions of the United States.

### Edge of Field Options

Edge-of-field practices such as grassed waterways, filter strips, and saturated buffers further reduce sediment and nutrient transport to receiving streams. Adoption of these practices at scale in Gibson and Warrick counties could reduce downstream maintenance needs and sediment accumulation in Vanderburgh County.

## 3.4 WOOD AND DEBRIS ACCUMULATION

Trees, branches, and trash are more likely to accumulate in forested stream corridors where flow intersects with piers, trees, or brush along the edge of the channel, where water rises and falls in backwater flooding situations, and where existing debris catches floating pieces. Pigeon Creek has all these conditions at different locations and at various rainfall amounts. Full-channel-width blockages can raise water levels upstream temporarily, or flow may go through or around enough to have a negligible effect on the water surface profile.

Wood and debris that collects to block the entire width of a channel where the channel/creek is not connected to the floodplain can raise the water levels, preventing upstream water from draining efficiently. In areas where the floodplain is connected and water can spread out beyond the banks into flat topography, large wood slows the flow of water but generally does not affect the upstream drainage because the cross-sectional flow is wide across the floodplain. If the blockage remains for a long period of time, perhaps months, the banks may erode around the blockage. Careful consideration is needed to determine whether removal is warranted. Short-term debris accumulations may resolve on their own, while long-term, large debris sections should be monitored for erosion and potentially removed to lessen downstream sediment deposition.

The large wood and debris in Pigeon Creek near the Warrick/Vanderburgh County line has been observed in various locations along the "S" curve that winds back and forth between the counties. Aerial imagery from nonconsecutive years of 2005 through 2024 indicates presence of accumulations at various locations instead of one consistent location. **Figure 12**, the most recent aerial imagery from March 2026 collected by unmanned aerial vehicle (UAV), shows three distinct wood and debris accumulations near the county line (at red arrows). At least one of the debris areas appears to be eroding the banks significantly around the debris pile.

**Exhibit 2** provides the elevation map of the "S" curve area. This indicates that the general area is low and floodwaters can spread over the floodplain. Exhibit 2 clearly indicates the ability of a log jam to hold back floodwater temporarily in the floodplain. At the time the Light Detection and Ranging (LiDAR) data depicted in Exhibit 2 was collected, the elevation above one log jam was 6 feet higher than just below the debris. This scenario benefits downstream properties while holding water in the adjacent floodplain for a longer period. As long as the area behind a log jam is in natural wetland or floodplain areas and

the impact of the higher elevation is localized and does not cause flooding to homes, farms or infrastructure, the impounding of water is generally an overall ecological benefit and a desired condition.

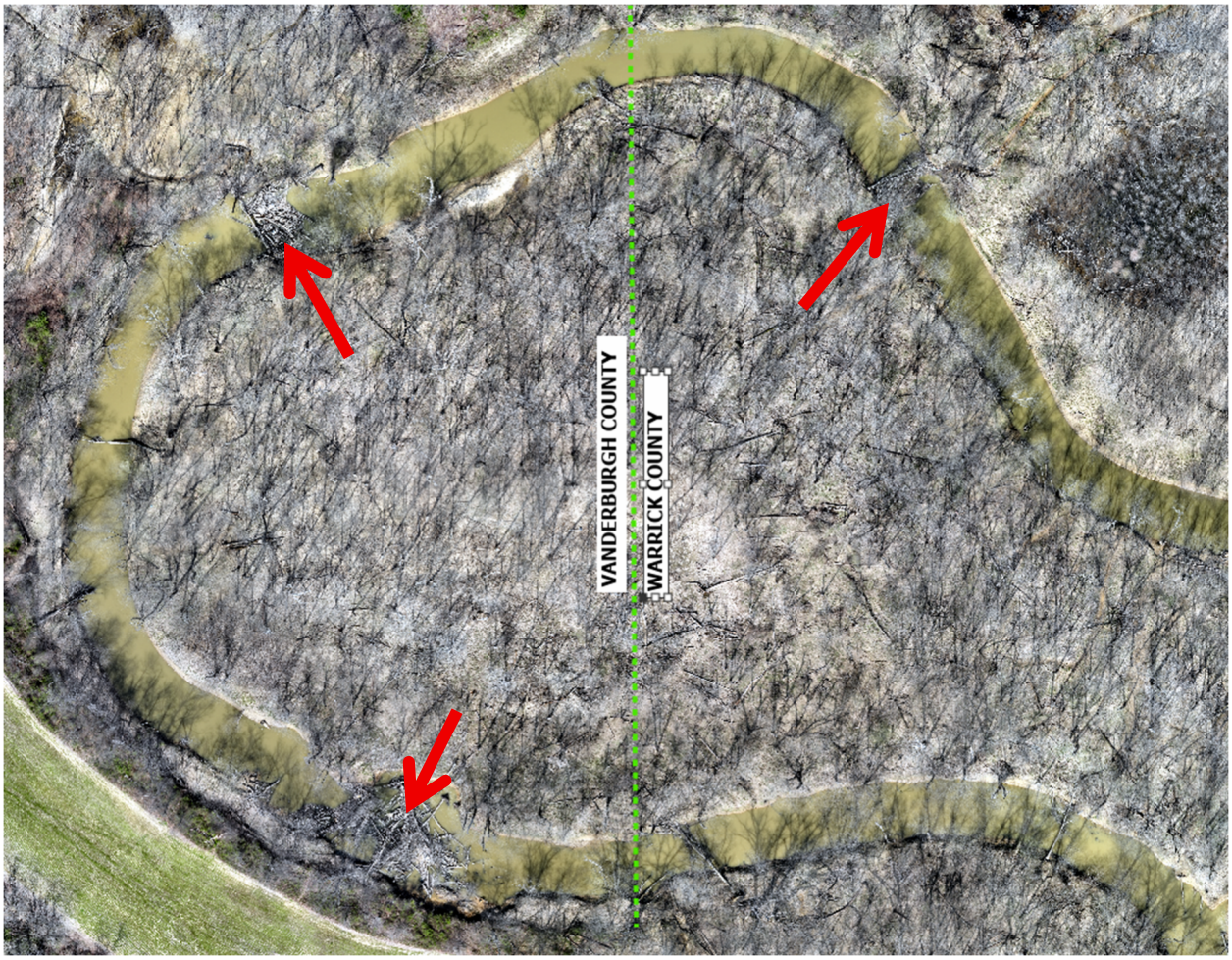



**Figure 12: UAV Photo from March 2026 Capturing Accumulation Zones and Erosion**

## 3.5 OHIO RIVER EFFECTS

Flooding in the lower reaches of Pigeon Creek is strongly influenced by backwater conditions from the Ohio River. During elevated Ohio River stages, Pigeon Creek experiences reduced conveyance capacity, backwater flow from the Ohio River north into Pigeon Creek, and prolonged high water levels even in the absence of significant local rainfall.

Hydraulic interactions between the Ohio River and Pigeon Creek are well documented in Federal Emergency Management Agency (FEMA) Flood Insurance Studies and USGS analyses. Backwater effects can extend several miles upstream, submerging bridges, and altering the location and persistence of wood and debris accumulations. The FIS profile along Pigeon Creek is provided in **Appendix 3**. The extent of the 100-year flood backwater is mapped in **Exhibit 3**. The 100-year backwater flooding of the Ohio River into Pigeon Creek is substantial and extends to approximately the county line where Pigeon Creek reaches Warrick County. The map outlines elevation 377.7 feet (NAVD 88), which is the elevation of the Ohio River without the addition of Pigeon Creek water flowing. Ohio River backwater can create

a slow-flow or stagnant area in sections along Pigeon Creek where blockages or accumulations are more likely to happen.

Because Ohio River stages are controlled by basin-scale precipitation, local channel modifications alone cannot eliminate flood risk in lower Vanderburgh County. Effective flood damage reduction should therefore incorporate the following:

- Emergency response planning.
- Early warning systems using coordinated river gage data.
- Strategic floodplain management rather than channel enlargement.

## 3.6 RAINFALL ANALYSIS

The average annual precipitation in southwest Indiana is approximately 40 inches. The annual precipitation has an increasing trend over the last 123 years, increasing by approximately 6 inches, approximately one-half inch per decade, as shown in **Figure 13**. Evaluating the trend using only the post-1960 rainfall data shows a much steeper increase in precipitation. The post-1960 trend shows an increase from 37 to 45 inches. This equates to 8 inches in 58 years, an increase of approximately 1 inch every 7 years.

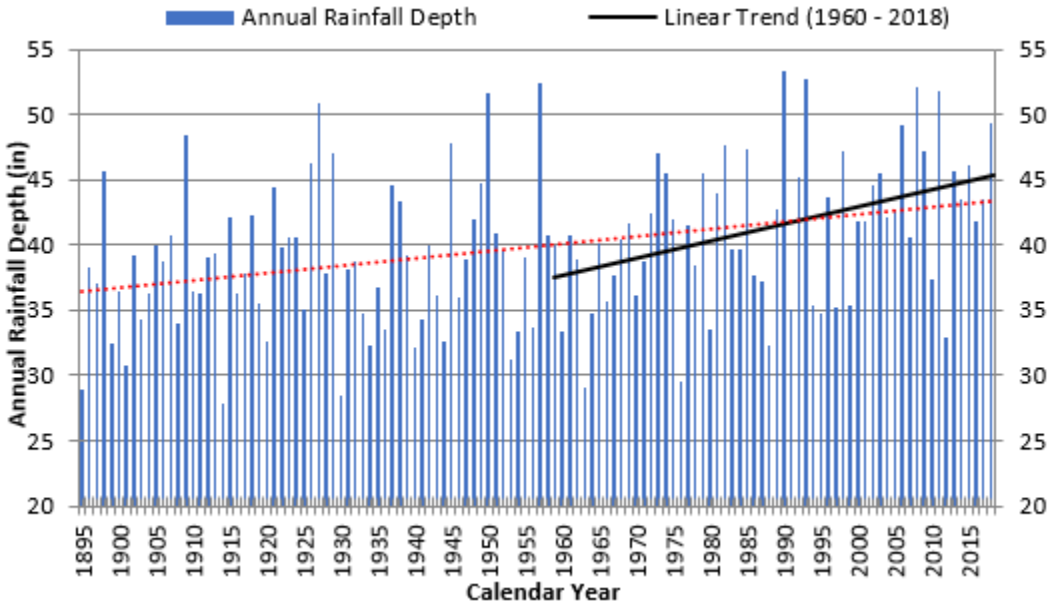



**Figure 13: Annual Rainfall Depths for West Central Indiana**
(Source: NOAA Climate at a Glance Database)

More relevant to erosion potential than annual average precipitation is the frequency of heavy rainfall events. **Figure 14** shows the number of days each year with precipitation events exceeding the 1900 to 2016 period's 99$^{th}$ percentile rainfall depth. The black line shows the increasing trend from 1 day per year to over 3 days per year. More frequent extreme events result in a larger number of erosive events. These high-intensity events disproportionately drive channel-modifying flows, bank and bed erosion, sediment transport, and floodplain activation. These trends suggest that historical design assumptions based on stationary climate conditions may underrepresent future flood and erosion risk.

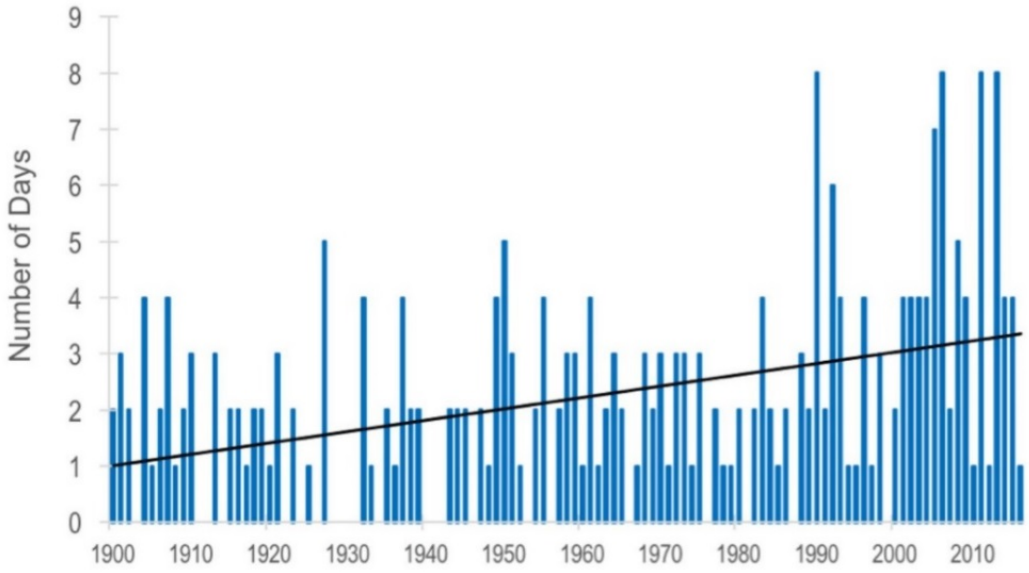



**Figure 14: Number of Days with Extreme Precipitation**
**(Events Exceeding the 1900–2016 period's 99th Percentile for Indiana)**
(Source: Indiana's Past & Future Climate: A Report from the Indiana Climate Change Impacts Assessment. Purdue Climate Change Research Center, March 2018.)

## 3.7 STREAM FLOW DATA AND STREAM GAGE DATA

### Monitoring

Pigeon Creek is prone to flooding and wood and debris collection. Flooding can occur from local Pigeon Creek watershed rainfall events and/or backwater from larger Ohio River rainfall events. Maintenance of the creek is difficult because debris and flooding can occur at various locations depending on flow dynamics. More can be understood and monitored along the creek with regular photography and video by use of a UAV.

### Data measurement

The only stream gage currently providing Pigeon Creek data is in Gibson County near SR 168 (USGS Gage 03322011) . Creek flow elevation and other parameters are a key component to assessing areas of concern, flow patterns, and matching of channel capacity to rainfall measurements. This information allows for adjustments in stream capacity and practices based on actual channel flow. It is particularly critical in Pigeon Creek to capture flow and elevation data because of the backflow from the Ohio River and the flows coming from the Pigeon Creek watershed intermingling. It is difficult to model flow in two directions and with different watershed sizes.

In addition to calibration of flooding for modeling, a stream gage can help provide early warning for emergency management. The gage elevation can alert emergency professionals to road closures needed before they flood. Emergency action plans utilize stream gages for forecasting and warning to potentially save lives.

### Historic Gage Data

A desktop analysis of two USGS gages within the watershed correlates with other findings of increased peak flows over time. The available gage data is from gages listed in **Table 4**.

**Table 4: Source of Gage Data in Pigeon Creek Watershed**

| | |
|---|---|
| **US 41 Gage** | **Station:** USGS 03322100 (discontinued), Pigeon Creek at Evansville, Indiana |
| | **Location:** US 41 bridge, Vanderburgh County; Lat 37°58'35" N, Long 87°35'22" W |
| | **Period of Record:** Water years 1961–1988 (of which, 24 years of systematic record); discontinued September 1989 |
| **SR 168 Gage** | **Station:** USGS Gage 03322100, Pigeon Creek at Gibson County, Indiana |
| | **Location:** State Road 168 bridge, Gibson County |
| | **Period of Record:** Lack of continuous long-term record |

The findings shown in **Table 5** are from gage data from these two locations and are directly applicable to the Pigeon Creek Flood Damage Reduction and Drainage Work Plan.

**Table 5: Gage Data Findings**

| Gage | Finding | Implication for Work Plan |
|---|---|---|
| US 41 Historic | 1% AEP peak discharge at US 41 gage: ~16,100 cfs (B17C, 1961–1988 record) | Consistent with FEMA FIS coordinated discharge of 16,000 cfs. Provides baseline for bridge sizing analysis and confirmation that FEMA mapping hydrology is grounded in observed data. |
| US 41 Historic | Peak flows at US 41 gage increased at a statistically significant rate over 1961–1988. | Supports that flooding is worsening over time. The increasing trend continued after gage closure in 1989. Current 1% AEP discharge is likely higher than 16,000 cfs; the proposed new Vanderburgh County gage is essential to quantify the current flood frequency. |
| US 41 Historic | Later period (1973–1988) mean annual peak is higher than earlier period (1961–1972). | The acceleration of the trend in the second half of the record parallels the steepening precipitation trend identified by NOAA and Purdue. Continued increases in peak discharges should be expected. |
| US 41 Historic | Gage results are based on a discontinued, pre-1989 record and should not be used for current regulatory or design purposes. | Design flood magnitudes will need to be updated once the proposed new Vanderburgh County gage accumulates sufficient recorded data. |
| SR 168 Gibson County | SR 168 site has measurement apparatus but no continuous long-term record for specific gage analysis. | Making SR 168 a cooperative USGS gage location would allow analysis of continuous stage-discharge records. Field evidence is qualitatively consistent with active sediment supply. |

## 3.8 CHANNEL ACCESS AND MAINTENANCE

Access is important for legal, financial, and physical management of the channel. Access must be assessed for each location where work is to be proposed along the channel. In some instances, physical access does not exist. Access may only be necessary for a one-time effort or may be beneficial for recurrent work along the creek.

An example of recurring debris is at the bridge at Stringtown Road. It has a center pier that collects woody and other debris. This may be the only bridge with a center pier along Pigeon Creek and is a point of accumulation of debris on a regular basis. The adjacent land to the south and east of the bridge is privately owned and is suitable to provide direct access to the creek.

After UAV imagery provides identification and tracking of debris collection areas, it may reveal other areas along the channel that are prone to debris. These areas can be identified and targeted for planning of access for removal of debris on a regular basis.

## 3.9 BRIDGES

Bridge openings were generally designed for the regulatory and hydraulic needs at the time of design. After construction and over time, the changes in watershed development, channel evolution, and rainfall patterns can decrease the storm frequency capacity of a bridge. This study did not evaluate bridge openings, but one survey responder opinion noted that the Lynch Road bridge may be undersized. Bridge openings can be analyzed with measurement and modeling and are best correlated to stream flow from nearby gages.

## 3.10 WATERSHED HYDROLOGY/ PIGEON CREEK HYDRAULIC MODEL

Current baseline information includes the FEMA Flood Insurance Study (FIS) which establishes flood profiles for Pigeon Creek for all three counties and the 2023 Burke study that mapped the FIS elevations for reference. The 2014 Burke study evaluated parts of Gibson County with hydrology and hydraulic modeling of select sections.

An updated baseline model of Pigeon Creek completed in detail for the full length through Vanderburgh, Warrick and Gibson counties would provide flood elevations for project comparisons. Projects to provide flood storage, repair, outlet structures, or any work along the channel that may affect the floodway will require a hydraulic model of the channel section for “before” and “after” flooding analysis. Physical practices should typically result in no increases in water surface elevation to meet regulatory requirements and avoid the need for costly and time-consuming map revision processes. While hydraulic modeling of the entire creek at once is not feasible or recommended, select sections of Pigeon Creek could be modeled for planning. The anticipated sections of the channel would be ready for an “after” condition evaluation for any practice considered.

## 3.11 OTHER CONTRIBUTING FACTORS

Additional contributing factors include legacy channelization, undersized crossings at select locations, aging urban drainage infrastructure, and limited floodplain storage within developed corridors. Because these factors compound one another rather than acting independently, addressing flooding in Pigeon Creek requires a coordinated, watershed-scale approach across all three counties.

# CHAPTER 4: ALTERNATIVE ANALYSIS

Flood damage reduction and drainage improvement alternatives were evaluated using a combination of **active** and **passive** management strategies.

## 4.1 ACTIVE MANAGEMENT ALTERNATIVES

Active strategies involve direct physical intervention to improve conveyance, storage, or protection of assets. Many active management alternatives were suggested and evaluated by the team. Several of these were determined not recommended and are discussed in Section 4.3. Examples of recommended alternatives include:

- Selective permanent access areas for common debris accumulation areas
- Selective wood and debris removal
- Detention basin retrofits and expansion
- Wetland restoration projects that serve as detention
- Bridge opening enlargement over time
- Targeted bank improvements upstream where excessive sediment loss is occurring
- Retrofit existing developed areas with stormwater detention features

Active alternatives provide localized, measurable benefits but require sustained funding and maintenance. These alternatives are further evaluated along with recommendations in Chapter 5.

## 4.2 PASSIVE MANAGEMENT ALTERNATIVES

Passive strategies focus on land use controls, policy updates, monitoring, and natural process accommodation. These alternatives generally have lower capital costs and long-term benefits but produce gradual results.

Passive alternatives evaluated and recommended include:

- UAV aerial photography of Pigeon Creek
- Expanded monitoring and data collection
- Flood response planning
- Flood resiliency planning
- Watershed-wide stormwater ordinance updates
- Agricultural soil health and nutrient management incentives
- Public outreach and inter-county coordination
- Hydrology/hydraulic modeling of watershed/Pigeon Creek

These alternatives are particularly effective for addressing future risk and reducing cumulative impacts. These alternatives are further evaluated along with recommendations in Chapter 5.

## 4.3 ACTIVE MANAGEMENT STRATEGIES NOT RECOMMENDED

The following active management strategies were evaluated but are not recommended for implementation. Each was assessed against the goals of this Work Plan – reducing flood damage, improving drainage, promoting long-term channel stability, and protecting public and private assets across the three-county watershed. The strategies described below were found to be either technically counterproductive, financially infeasible, insufficient to address the root causes of flooding, or likely to produce significant negative consequences that outweigh the anticipated benefit. Documentation of

these evaluations is provided to inform the PCWDC and the public and to pre-empt proposals that may be raised in future discussions.

### 4.3.1 DREDGING OF PIGEON CREEK CHANNEL

Channel dredging — the mechanical excavation and removal of bed material to deepen or widen the channel — is among the most frequently proposed interventions for flood-prone streams and is often suggested by agricultural landowners, drainage boards, and local officials in southwestern Indiana. Dredging in portions of Pigeon Creek in Gibson and Warrick counties has occurred in the past as part of regulated drain maintenance. While this history reflects genuine concern over drainage capacity, dredging as a flood damage reduction strategy for the Pigeon Creek system is not recommended for the following reasons.

**Benefit is localized and short-lived.** Dredging a reach of Pigeon Creek increases the channel's cross-sectional area and temporarily improves conveyance at that location. However, the effect is limited to the dredged reach and does not reduce flood peaks generated upstream or address the Ohio River backwater effects that dominate flooding in lower Vanderburgh County. Sediment supplied from actively eroding banks and agricultural fields in Gibson and Warrick counties will begin refilling the dredged area during the next significant runoff event. In comparable sand-bed and silt-bed streams in Indiana, dredged sections have been observed to return to pre-dredging dimensions within several years, requiring repeated expenditure for diminishing return.

**Dredging increases slope, velocity, and upstream erosion.** Removing bed material from a reach steepens the channel gradient immediately upstream of the dredged section. This accelerates flow velocities and bed scour upstream, destabilizing banks that were previously in equilibrium. In a system where alluvial, water-deposited soils are already susceptible to erosion — particularly in Gibson and Warrick counties — dredging can trigger a progressive cycle of upstream bank failures and sediment loading that worsens conditions downstream in Vanderburgh County. The 2023 Burke report titled *Pigeon Creek Corridor Flood Risk Management Plan* notes that the soils along Pigeon Creek in Gibson and Warrick counties are largely classified as poorly consolidated deposited layers. Dredging in these reaches poses a risk of triggering this cycle.

**Dredging in Vanderburgh County is neither feasible nor beneficial.** Pigeon Creek in Vanderburgh County has not been modified over the years and exhibits the natural sinuosity and flat slope of an unmodified alluvial stream. The channel slope in Vanderburgh County is already minimal, and the dominant flooding driver in the lower reaches is Ohio River backwater, not insufficient channel capacity. Dredging a flat, backwater-influenced reach would increase channel cross-sectional area without meaningfully changing flood stage since the hydraulic gradient, controlled by the Ohio River, would not change. Excavated material would need to be hauled significant distances, as no suitable disposal site exists adjacent to the channel in the urban corridor, adding substantially to project cost.

**Environmental permitting is a significant constraint.** Pigeon Creek is a navigable waterway under Indiana and federal law and in-channel dredging typically requires authorization under Section 404 of the Clean Water Act (U.S. Army Corps of Engineers) and Section 10 of the Rivers and Harbors Act, in addition to Indiana DNR waterway permits. The Indiana DNR navigable waterways program applies to the entire mainstem of Pigeon Creek. Obtaining these permits for routine maintenance dredging is not guaranteed, and the mitigation requirements for impacts to wetlands, riparian habitat, and aquatic resources can exceed the cost of the dredging.

Strategies focused on reducing the sources of sediment and runoff — through bank bioengineering in Gibson and Warrick counties, agricultural soil health practices, and floodplain reconnection — are expected to produce more durable flood damage reduction benefits than in-channel dredging, at

lower cost and without the risk of induced instability. Dredging is therefore not recommended as a flood damage reduction strategy for Pigeon Creek.

### 4.3.2 CHANNEL STRAIGHTENING OR REALIGNMENT

Channel straightening, the elimination of meanders to shorten the channel and increase its gradient, has been proposed by at least one stakeholder for the sinuous reach of Pigeon Creek near the Warrick/Vanderburgh County line, the area locally referred to as the "S" curve. The proposal cites the accumulation of large wood and debris in this reach as justification, on the theory that a straighter channel would reduce the number of debris collection points. Channel straightening is not recommended for this or any other reach of Pigeon Creek for the following reasons.

**Straightening accelerates flow and worsens downstream flooding.** The sinuosity of a natural channel is the primary mechanism by which energy is dissipated as water flows downstream. Eliminating meanders shortens the channel, increases the bed slope, and raises velocities during flood events. The result is that flood peaks arrive sooner and at higher magnitude at downstream communities. A reach of Pigeon Creek through Evansville that is already stressed by Ohio River backwater and limited channel capacity would receive accelerated upstream flows, worsening the problem the straightening was intended to address. The original channelization of Pigeon Creek in Gibson and Warrick counties in prior decades produced steeper slopes, higher peak flows, and increased sediment delivery to Vanderburgh County, as documented in the 2023 Burke report.

**Straightening does not eliminate the debris source.** The accumulation of large woody debris at the Warrick/Vanderburgh County line results from the combination of trees falling from actively eroding and forested banks throughout the upstream watershed and from backwater ponding during Ohio River flooding events that captures and holds floating material. Straightening the "S" curve would change the geometry of the accumulation locations but would not reduce the volume of wood entering the system from the upper watershed. New debris collection points would form at bends downstream in Vanderburgh County. The appropriate response to the debris problem is source control, not realignment.

**Straightening in Vanderburgh County is likely not permissible.** Pigeon Creek in Vanderburgh County is a navigable waterway that has not been modified over the years. Any structural realignment of the channel would require federal and state regulatory authorization that is extremely unlikely to be granted for a natural, meandering stream in an urban setting, particularly given the presence of the Wesselman Woods Nature Preserve and adjacent wetland and riparian resources. Channel straightening is therefore not recommended for any reach of Pigeon Creek.

### 4.3.3 CLEARING TREES FROM CHANNEL BANKS

Clearing trees from the banks of Pigeon Creek as a channel maintenance strategy to prevent fallen trees from becoming instream debris and to improve conveyance is not recommended. This approach is occasionally proposed by landowners and drainage personnel and is sometimes implemented on regulated drains. However, its application to the main channel of Pigeon Creek is counterproductive.

**Riparian trees stabilize banks and reduce sediment loading.** The root systems of bank trees are a primary mechanism of bank stabilization on alluvial streams. In Gibson and Warrick counties, where bank soils are highly erodible, the removal of riparian trees eliminates the root reinforcement that prevents mass bank failures. Removal of trees and disturbance of the root zone during clearing operations directly opens the exposed bank to erosion from rainfall impact and high-velocity flow. The result is increased bank erosion rates and accelerated sediment delivery downstream.

**Tree clearing increases rather than decreases the debris supply.** Cutting trees along the bank and leaving branches, tops, and trunk segments in place or near the channel edge dramatically increases the near-term supply of woody material available to enter the channel during the next flood event. Even when cut material is removed from the site, grubbing operations disturb the root ball and destabilize the bank, increasing the likelihood of the remaining bank material slumping into the channel. The net effect of a clearing program is typically an increase in both in-channel debris and bank-derived sediment load.

**In Vanderburgh County, instream wood provides ecological and hydraulic benefits.** In the flat, low-gradient reach through urban Evansville, large wood in areas where the floodplain is connected and accessible does not cause meaningful flood stage increases because floodwater spreads laterally before the debris becomes a hydraulic control. In these reaches, instream wood provides habitat complexity, bank protection through flow deflection, and sediment trapping that reduces the downstream transport of fine material. Indiscriminate removal of instream wood from floodplain-connected reaches is ecologically harmful and hydraulically unnecessary.

Selective removal of individual trees that have already fallen and are blocking the full channel width at bridge crossings or in disconnected-floodplain reaches is warranted and is addressed in the active management recommendations of this Work Plan. Whole-bank clearing projects are not recommended on any reach of Pigeon Creek. Where standing trees lean at an acute angle over the channel and pose a near-term risk of falling onto a bridge or critical structure, individual tree removal should be considered on a case-by-case basis with the root ball left in place where possible.

### 4.3.4 FLOODGATE ACROSS PIGEON CREEK NEAR OHIO RIVER

The City of Evansville is protected from Ohio River flooding by a certified federal flood control levee system managed by the Evansville-Vanderburgh Levee Authority District. The existing levee system protects the downtown core and established urban areas along the Ohio River but does not enclose the lower reach of Pigeon Creek. During major Ohio River flood events, water backs up into Pigeon Creek from the confluence, inundating residential and commercial areas several miles upstream. The alternative to extend the levee system to close the Pigeon Creek corridor may eliminate this backwater flooding but is not recommended for the following reasons.

**A levee closure structure at the confluence would be required.** Any levee extension enclosing the Pigeon Creek corridor must include a closure structure or floodgate at the creek's confluence with the Ohio River that can be closed when the Ohio River rises above a design stage. Such a structure would require USACE authorization as a major modification to the existing federal levee system, which could be a multi-year process with no guarantee of approval. More critically, when the gate is closed during an Ohio River flood, all local runoff from the Pigeon Creek watershed is trapped inside the protected area. A pump station of very substantial capacity would be required to discharge accumulated local runoff over the levee during closure periods, at significant capital and operating cost.

**The cost and footprint are prohibitive.** A levee extension along both sides of Pigeon Creek through the urban east side of Evansville would require acquisition of right-of-way through a densely developed corridor, displacement of structures, and construction of miles of levee and associated drainage infrastructure in an area with significant utility conflicts. The PCWDC does not have the funding authority or scale to develop a project of this type independently, and the federal cost-sharing programs that fund such projects (such as FEMA BRIC) are highly competitive and require local cost-share commitments that would likely exceed the commission's assessment revenue for decades.

**A levee does not address the only flooding driver**. Flood damage events along Pigeon Creek in Vanderburgh County result from local watershed rainfall events in addition to Ohio River backwater alone. A levee system enclosing the Pigeon Creek corridor would provide no protection against flooding driven by runoff from within the watershed during events unaccompanied by significant Ohio River flooding. The investigations, debris management, stormwater management, and detention improvements recommended in this Work Plan address both flooding drivers and provide benefit across a broader range of events than a levee would.

While extension of the Ohio River levee system to enclose Pigeon Creek is not recommended as a PCWDC initiative, the commission should monitor and participate in any future feasibility studies conducted by the City of Evansville, Vanderburgh County, or the USACE that evaluate this option. If such a study proceeds, the PCWDC should ensure that interactions with the Pigeon Creek watershed drainage system are fully evaluated as part of the hydraulic analysis.

### 4.3.5 INCREASED TILE DRAINAGE TO REDUCE SURFACE FLOODING

Expanding subsurface tile drainage networks in agricultural areas is occasionally proposed as a means of reducing surface flooding on farm fields by rapidly moving water off the land and into drainage ditches. While tile drainage is an essential and well-established tool for agricultural production in southwestern Indiana, expanding tile drainage systems as a strategy for reducing downstream flood peaks in Pigeon Creek is not recommended.

**Tile drainage increases runoff volume and peak flows in receiving streams.** Agricultural tile drainage systems intercept infiltrating water and route it rapidly to drainage ditches and receiving streams, reducing the time water spends in the soil profile and the associated natural attenuation of runoff. Expanding or upgrading tile drainage increases the total volume of runoff reaching Pigeon Creek and its tributaries during storm events and reduces the lag time between rainfall and peak stream discharge. While field-level flooding is reduced locally, the result at the watershed scale is higher and earlier peak flows at downstream communities, worsening the flooding downstream.

**Agricultural drainage in the watershed is already highly developed**. According to the 2022 Census of Agriculture, approximately 119,000 acres of Gibson County farmland are artificially drained by subsurface tile or open ditches. The county's 48,000 acres of ditch-drained land reflects one of the most extensive regulated drain networks in southwestern Indiana. Combined tile and ditch drainage in Gibson County increased by more than 20% between 2017 and 2022, accelerating the rate at which agricultural runoff is delivered to Pigeon Creek and its tributaries. The existing drainage network density in the Pigeon Creek watershed reflects decades of tile and ditch investment. The increase in peak flows documented in Pigeon Creek over the past four decades is attributable in part to the cumulative intensification of this drainage infrastructure. Expanding the system further would accelerate this trend rather than reverse it.

Tile drainage expansion is a private land management decision outside the PCWDC's authority, but it should not be promoted or funded as a flood damage reduction strategy. Where new tile drainage or ditch improvement projects are implemented by individual landowners or county drainage boards, the PCWDC should encourage accompanying detention or drainage management structures (e.g., controlled drainage outlets, constructed wetlands) to compensate for increased runoff, consistent with the passive management recommendations in Section 5.2. This is discussed further in the recommendation to mitigate agricultural and county drainage project impacts.

### 4.3.6 CONSTRUCTION OR IMPROVEMENT OF DRAINAGE DITCHES

County drainage boards in Gibson, Warrick, and Vanderburgh counties periodically undertake improvement projects on regulated drains that are tributaries to Pigeon Creek. These projects typically involve cleaning, regrading, or enlarging ditch cross-sections to increase drainage conveyance from agricultural fields. While such projects serve a legitimate local drainage function, undertaking them at scale as a flood conveyance improvement strategy for the Pigeon Creek system is not recommended.

**Conveyance improvements transfer flooding downstream without reducing it.** Enlarging a tributary ditch allows water to reach Pigeon Creek faster and in greater volume during storm events. At the scale of an individual property or farm, this reduces local flooding. At the scale of the watershed, it transfers the flooding problem downstream, increasing peak flows in Pigeon Creek at the expense of communities downstream. Because Pigeon Creek's flooding problems are already driven in large part by the cumulative effect of upstream drainage intensification, further conveyance improvements at the tributary level will worsen conditions in the main channel without providing net benefit to the watershed.

Flood-conveyance improvements on drainage ditches that contribute to Pigeon Creek should be avoided unless the flooding directly threatens critical infrastructure or human life. Where improvement projects are deemed necessary by county drainage boards, runoff detention should be required as a compensating measure, consistent with the recommendations in Section 5.2. The PCWDC should pursue coordination with Gibson, Warrick, and Vanderburgh county drainage boards to ensure that future drain improvement projects do not increase downstream flooding in Pigeon Creek without adequate mitigation.

## 4.4 INTEGRATED APPROACH

Neither active nor passive strategies alone are sufficient to address flooding in Pigeon Creek. The recommended approach combines near-term active measures like debris removal, targeted detention, and access improvements with longer-term passive management through updated stormwater standards, floodplain preservation, and agricultural practices. This combined approach produces the most durable reduction in flood risk given the commission's available resources and the pace at which watershed-scale changes take effect.

# CHAPTER 5: WATERSHED RECOMMENDATIONS

The preliminary findings and discussions provided in previous chapters provide the background information for making prudent decisions regarding improvements within the Pigeon Creek watershed and river corridor. Recognizing the extent of the existing risks and the likely future vulnerabilities in the face of a changing climate, addressing the flooding and sedimentation issues within the Pigeon Creek watershed will require both adaptation and mitigation. Adaptation and learning how to live with floods is necessary because there are no feasible structural solutions to eliminate the vulnerability to flooding along Pigeon Creek, especially given the increasing trends in peak flows and volumes.

The following recommendations focus on providing sustainable, cost-efficient strategies for reducing the flooding and sediment-related issues present in the system. The recommendations are divided into active management recommendations (i.e., projects that include physical changes within the river corridor) and passive management recommendations (i.e., regulatory changes and watershed-based improvements).

## 5.1 ACTIVE MANAGEMENT RECOMMENDATIONS

### 5.1.1 SELECTIVE PERMANENT ACCESS FOR DEBRIS REMOVAL

Large wood and debris accumulation at select bridges and locations identified by yearly UAV photography may be a maintenance concern. As a result, improvements at select locations should be made to promote better and more permanent access for logjam removal. A specific example of this is at the Stringtown Road bridge.

**Stringtown Bridge – Access Easement or Purchase for Debris Removal**

The bridge at Stringtown Road has a center pier that collects wood and debris. This may be the only bridge with a center pier along Pigeon Creek and is a point of accumulation of debris on a regular basis. The adjacent land to the south and east of the bridge is privately owned and is suitable to provide direct access to the creek.

It is recommended that the PCWDC pursue access to the east side of the Stringtown Road bridge to maintain a clear channel at this location. Permanent access through purchase of the property or perpetual easement would provide important maintenance access for protection of the bridge and reduction of flooding risk due to accumulation against the pier. Two large leaning trees directly upstream are in danger of falling in to block against the pier and should be evaluated. **Figure 15** and **Figure 16** below show the Stringtown Road bridge area.



**Figure 15: Debris Against Stringtown Bridge October 2025 (left) and July 2026 (right)**



**Figure 16: Access View at Stringtown Bridge**

### 5.1.2 WOOD AND DEBRIS REMOVAL IN CHANNEL – LOWER STREAM REACHES

Trees, branches, and trash are more likely to accumulate in forested riparian corridors where stream flow interacts with piers, trees, or brush along the edge of the channel, where water rises and falls in backwater flooding situations, and where existing debris catches floating pieces. Pigeon Creek has all of these circumstances at different locations and at various rainfall amounts.

Wood and debris that collects to block the entire width of a channel where the channel/creek is not connected to the floodplain can raise the water levels preventing upstream water from draining efficiently. In areas where the floodplain is connected and water can spread out beyond the banks, instream wood and debris slows the flow of water and can promote bank stability but generally does not affect upstream drainage because the cross-sectional flow is wide across the floodplain. Because there are potential positive and negative aspects of instream wood, a careful evaluation is warranted before any removal is undertaken, particularly in a connected floodplain area.

In addition to the debris against the Stringtown Road bridge, three other wood and debris/trash collection areas were observed in channel sections within Vanderburgh County. It is recommended that wood and debris in areas of complete channel blockage or areas of blockage next to a bridge or culvert be removed as maintenance to improve drainage and recreational opportunities. The observed areas were near Morgan Avenue, the 1st Avenue bridge, and just west of the Evansville Day School as shown on **Figures 17-19**, respectively.

The UAV aerial imagery will also indicate channel debris accumulation that should be removed where causing flooding or erosive bank conditions.



**Figure 17: Debris approximately 200-ft south of Morgan Avenue Bridge – October 2025**



**Figure 18: Debris at 1st Avenue Culvert – October 2025**



**Figure 19: Blockage West of Evansville Day School – October 2025**

### 5.1.3 LARGE WOOD REMOVAL AT THE WARRICK COUNTY LINE

In response to concerns about logjams in Pigeon Creek, PCWDC requested a public presentation on management of large wood (LW) in streams. Robert Barr, a fluvial geomorphologist from the Center for Earth and Environmental Science at Indiana University – Indianapolis, briefed the commission July 28, 2025, on the complexities of LW management. Barr explained the role of LW in streams and discussed how wood in the stream was critical for channel stability and habitat and how removing too much LW from a stream can be detrimental. He also explained that the amount of large wood in a stream can be temporarily out of balance because of significant inputs of cut wood and from areas of channel instability.

Management options can range from not removing any LW to removing all LW in the channel. One aspect of management that was discussed at length was that most perceived "logjams" are not locked in place; rather they are accumulations of large wood left behind as the river level drops after a high flow event. That event could be a true flood, or it can simply be increased flow in the channel. The significant aspect is that higher flows move more water, sediment, and LW. As water recedes in the channel, both sediment and LW can get left behind as the stream loses power. The sediment and LW that is left behind is simply being stored until the next high flow event.

Many river scientists use the term "accumulation" rather than "jam" to emphasize that the material is not usually stuck. The stream simply cannot move it at lower flows. Some accumulations that occur after a large flood may need to be partially removed because it can be a long time between significant floods. Smaller accumulations may just need some channel spanning logs cut out to allow for recreational passage. It should be noted that the deposition and storage of water, sediment, and LW primarily occurs on the floodplain as flow recedes in the channel. This storage function is one of the many reasons that floodplains should be preserved. PCWDC expressed interest in a middle path where LW accumulations are reviewed for potential impacts and removed when necessary to protect infrastructure or property.

The removal of LW in Pigeon Creek along the "S" curve at the Warrick-Vanderburgh County line should be evaluated to potentially reduce bed aggradation and to help reduce the potential for logjam-induced bank instability. The log removal should be done carefully so as not to disturb/destabilize the adjacent channel banks. Spring 2026 aerial imagery indicates bank erosion is caused by the debris in at least one of the three current debris accumulation areas at this location. Erosive banks deposit sediments downstream. The trade-off between the negative effects of sediment release from bank erosion at a log jam and the storage capacity of the flooding above a log jam must be determined case-by-case.

Accumulation of debris should be evaluated over time to determine if it is temporary (expected to move with flooding events) or is more permanent (does not move or dissipate over flooding events). A determining factor could be debris that remains through two or more UAV aerial imagery collections, or debris that is causing bank erosion. These accumulations should be evaluated for removal. Short term accumulations, large wood that is moving over time to various locations along the creek, or accumulations in wide valley areas where the floodplain is accessible could be left for future re-evaluation.

### 5.1.4 CONSTRUCT STORAGE AREAS ALONG LATERALS

Where possible, it would be advantageous to either construct new retention/detention ponds along drainage ditches and tributaries to the Pigeon Creek or take advantage of existing low-lying, non-arable land in these areas to increase temporary storage capacities during runoff events. This would help attenuate the shorter runoff hydrographs and more intense peak flows that have developed

due to increased urbanization and agricultural drainage within the Pigeon Creek watershed. Utilization of "off-line" storage adjacent to ditches or tributaries would allow the agricultural lands to benefit from the increased drainage capacity that has been developed over time but reduce the impact that these activities have on downstream areas.

Storage areas (detention basins) should be constructed along tributaries to Pigeon Creek where feasible. Future drainage improvements that increase runoff volume and flow rates – both urban and agricultural – should be required to include offsetting volume and peak flow reduction measures. Basins should be constructed off-line (adjacent to, not in the channel) to maximize storage benefit without disrupting the channel during normal flows. Specific site selection and required storage volumes are beyond the scope of this Work Plan, but example sites identified during field visits are described below.

**1. Wesselman Woods Wetland Detention Evaluation**

It is recommended that the Wesselman Woods potential wetland site, shown on **Exhibit 4**, be evaluated for creation of wetland habitat and water storage.

In 2023, the Wesselman Woods Nature Preserve purchased approximately 42 acres of former University of Evansville athletic fields located directly adjacent to the preserve's southern boundary. Wesselman Woods has indicated interest in restoring the former ball fields area as a small wetland. The site provides an opportunity for off-line stormwater storage, wildlife habitat, water quality improvement, and community benefits.

A field visit to the site identified a beehive inlet in an existing swale with an approximately 8-inch diameter outlet discharging toward the north in the direction of the former soccer field. The presence of this inlet, combined with the likelihood that the former soccer field contains perforated underdrains installed as part of original athletic field construction, indicates that the site was designed to drain quickly.

Restoration of this site as a functional wetland would require engineering in addition to ecological planning. At minimum, the work would include survey of the existing drainage infrastructure to locate and document any perforated tiles and outlet pipe inverts, regrading of the area to create shallow, gently sloping topography that holds water at or near the surface during storm events, removal or plugging of the existing underdrain system and beehive outlet structure or conversion of the outlet to a controlled water level structure that can maintain target pool elevations, design of an inlet from the adjacent swale or drainage area to convey runoff into the restored wetland cell, and establishment of native wetland vegetation appropriate to the elevation gradients and hydroperiod created by the grading design. Coordination with Wesselman Woods leadership and a formal engineering evaluation of the site hydrology and drainage infrastructure is recommended as the next step.

Photographs of the site are provided in **Appendix 4**.

**2. Warrick County - Chandler Detention Basin Evaluation**

It is recommended that the existing detention basin in Chandler, shown on **Exhibit 5**, be evaluated for expansion of stormwater storage and potential for park development.

The Town of Chandler, located in Warrick County immediately east of Evansville, experiences recurrent stormwater flooding in its northwestern neighborhoods. The area along Inderrieden Road at the northwest edge of town is particularly vulnerable, receiving stormwater runoff draining from Chandler's developed interior as well as periodic backwater from Pigeon Creek during larger flood

events. Homes on the northwest side of town, including a flood-prone residence identified as Site 6 during field observations, are affected.

A regional stormwater detention basin southeast of the intersection of Green Valley Drive and Iowa Street functions to intercept and temporarily store runoff as it moves toward the northwest end of town. Field review of this facility indicates that the basin may have an undersized outlet structure based on the small storage volume available and the outlet dimensions. The existing primary outlet structure can overflow in larger runoff events due to lack of storage in the basin area. Increasing the basin storage would reduce peak outflow. In addition, the channel downstream of the basin that carries stormwater to Pigeon Creek is narrow with very little capacity, adding to the flooding concerns for houses. Expansion of this basin's storage capacity and reconstruction of the downstream outlet ditch represents the most direct opportunity to reduce the frequency of flooding in the adjacent residential areas. Although the basin's capacity is too small relative to the Pigeon Creek watershed to meaningfully reduce flood stages on the main channel, every reduction of peak flows to Pigeon Creek can have a cumulative effect on downstream flooding. The basin expansion may address the local drainage problem that generates the moderate, sub-bankfull storm events that create yard flooding.

The PCWDC, in coordination with the Town of Chandler and Warrick County, should commission a feasibility evaluation of expanding the existing regional detention basin. The evaluation should determine the contributing drainage area to the basin, the volume of storage currently available, the additional storage volume needed to reduce the frequency of flooding along Inderrieden Road to an acceptable level, and the extent of land available for expansion within and adjacent to the current basin footprint. Excavated material from basin expansion could be offered to area developers as structural fill, offsetting project costs and avoiding the need for off-site disposal. This can substantially reduce net construction costs. The expanded basin presents a secondary opportunity to create a passive park amenity with a permanent wetland pool and a walking trail around the shoreline. A shallow wetland bench around the perimeter of the expanded basin would provide water quality treatment, habitat value, and visual interest with minimal additional cost above the earthwork already required for basin expansion.

Photographs of the site are provided in **Appendix 5**.

**3. Centerpoint Energy Storage Expansion**

An existing storage basin is located at the northwest corner of Lynch Road and Green River Road in Evansville as shown on **Exhibit 6**. The existing surface area of the basin is approximately 7.5 acres, while the parcel is approximately 29 acres in size and is owned by Centerpoint Energy. An evaluation of LiDAR data indicates that approximately 400,000 cubic yards of excavation may be possible adjacent to the existing basin to expand the storage volume. This basin is adjacent to and in the floodplain of Pigeon Creek and could add to the floodplain storage if excavated and equipped with features that allow drawdown of the basin between peak flows.

**4. Timber Park Storage Expansion**

A City of Evansville-owned parcel of approximately 60 acres located west of Pigeon Creek and immediately west of the Timber Park subdivision, shown on **Exhibit 7**, was visited during the October 2025 field assessment. The parcel lies within the Pigeon Creek floodplain corridor on the east side of Evansville and represents a large contiguous tract of undeveloped, City-owned land. An adjacent landowner was present during the site visit and reported that flood water has risen to the tree line bordering his property during significant flood events, confirming that the parcel and its

margins experience deep, extended inundation consistent with the Pigeon Creek regulatory floodplain mapped in the FEMA Flood Insurance Study for Vanderburgh County.

The western section of the parcel, directly adjacent to Pigeon Creek, is undulating and heavily wooded, flooding as a connected floodplain during high water events and functioning as existing natural floodplain storage. The eastern section is comparatively flat and has been partially excavated as an apparent borrow source for the adjacent Timber Park subdivision and has subsequently grown up in small woody vegetation. A small area of tree mitigation plantings is along the southeastern property line. This mitigation planting is a border limit for the southeastern portion of the parcel and should not be disturbed.

The eastern, disturbed portion of the parcel is the most suitable area for expansion of existing storage capacity. A shallow storage area already exists within this section, which is cleared of mature timber, relatively flat, and separated from the active creek channel. Expansion of this existing facility through additional grading could increase its capacity to function as regional off-line detention, intercepting stormwater drainage from developed east-side neighborhoods before it reaches Pigeon Creek, temporarily storing runoff during moderate storm events, and releasing it at a controlled rate after peak flows have passed.

The existing shallow storage area could be graded to create a larger basin with an emergent fringe, additional inflow from Pigeon Creek through additional connection and forested buffer transitioning into the wooded western section of the parcel. Excavated material from grading operations could be offered to area developers as structural fill, which could substantially offset earthwork costs given the proximity of active development on Evansville's east side. The City of Evansville's ownership of the parcel eliminates land acquisition cost from the project budget, which is the most significant financial advantage this site holds over other potential regional detention locations in Vanderburgh County.

Principal cost and complexity considerations include the coordination required with the USACE regarding the existing mitigation planting area along the southeastern property boundary, and the design of a hydraulic connection to the Pigeon Creek system that routes inflow to the basin during storm events while preventing unrestricted creek backwater from filling the basin during high water on the main channel. This inlet control is critical to the off-line design concept; without it, the basin would simply fill with creek water during floods and provide no net storage benefit to the contributing drainage area.

The PCWDC should request that the City of Evansville formally identify this parcel as a candidate for the regional detention described here, and that a planning-level feasibility study be commissioned to determine the additional storage volume achievable through grading and the inlet and outlet structure configuration changes necessary to operate the expanded facility as effective off-line detention.

Photographs of the site are provided in **Appendix 6**.

### 5.1.5 BRIDGE ANALYSIS AND REPLACEMENT

Bridges in Vanderburgh County are along the flat downstream section of Pigeon Creek where flooding is most prevalent. It was noted in the stakeholder survey that at least one bridge may be undersized (Lynch Road Bridge), leading to backwater above that bridge in high local rainfall events. Bridge analysis was not completed as part of this Work Plan, but sizing analysis and replacement of bridges over time (to enlarge) could affect flooding. Climate changes in storm event frequency and intensity can change the hydrology of flow to a bridge and therefore the hydraulics of the bridge capacity. Backwater flooding from the Ohio River complicates local runoff events. Modeling should

consider the local watershed runoff event versus the Ohio backwater flooding to evaluate bridge capacities.

A hydraulic analysis to evaluate bridge opening capacity and its relationship to upstream flood stages requires existing bridge geometry documented through field survey to capture low chord elevation, span width, pier dimensions, and channel and floodplain cross-section surveys immediately upstream and downstream of each crossing. This data is incorporated into a hydraulic model that simulates water surface profiles through each bridge opening under design flood discharges derived from a flood frequency analysis. Design discharges for Pigeon Creek crossings could be developed using the proposed Lynch Road USGS cooperative gage once sufficient record accumulates. Until that time, discharges could be estimated by watershed runoff analysis and correlation with FEMA mapping and historic data. For replacement design, the target opening is sized to produce no net increase in water surface elevations compared to existing conditions for the 1% annual exceedance probability event (100-year storm).

All bridges on Pigeon Creek in Vanderburgh County could be evaluated using this methodology. The Lynch Road bridge in Vanderburgh County would be a logical priority, having been identified by a former county surveyor as potentially of concern and with new gage data to provide elevation of flow events. The Lynch Road gage will provide the calibration data needed to validate the hydraulic model at this crossing before the analysis would be extended to other bridges.

The Vanderburgh County Highway department has authority over the bridges and cooperation on evaluations should be with the Vanderburgh County Engineer.

### 5.1.6 RETROFIT EXISTING DEVELOPED AREAS WITH DETENTION

Some areas of Evansville were developed prior to implementation of stormwater runoff requirements. The developed areas can be evaluated through a combination of ownership records, GIS mapping, and onsite inventory to identify likely candidates for stormwater improvements. Likely sites for retrofit might include public buildings and properties that have space for detention to be added.

**Specific Site Recommendation – Evansville Day School**

Evansville Day School (EDS) is a private Jr. PreK–12 college preparatory school occupying a 40-acre wooded campus at the corner of North Green River Road and Lynch Road in Evansville, directly adjacent to the east bank of Pigeon Creek, as shown on **Exhibit 8**. The school was established in 1946, nearly six decades before Indiana's stormwater management requirements took effect and before Vanderburgh County adopted stormwater detention standards for new development. As a result, the school's buildings, paved parking areas, access drives, and associated impervious cover were constructed without stormwater detention or meaningful peak runoff controls. Unattenuated runoff from the developed portions of the campus discharges directly toward Pigeon Creek through a system of wooded ravines on the western edge of the campus, making EDS representative of the larger concern of pre-ordinance developed properties in the Pigeon Creek watershed that contribute incremental runoff volume to the creek without any compensating storage.

Field observations conducted in October 2025 documented multiple ravines running through the wooded strip west of the campus toward Pigeon Creek. Several of these ravines are severely eroded, narrow, deeply incised, and actively widening, indicating that they have been subjected to sustained high-velocity flows.

The recommended strategy, consistent with the assessment of the project geomorphologist, is to intercept stormwater from the school campus and Lynch Road drainage at the top of the ravines before it enters the wooded hillside, rather than attempting to stabilize the ravines from the bottom up. One or more stormwater storage practices could be designed and installed at the upland transition zone between the developed impervious area and the wooded ravine heads. This storage would capture concentrated flow from roof drains, parking lot outlets, and road drainage before it reaches the ravine rim, temporarily ponding the runoff and releasing it at a controlled rate that approximates the pre-development response. Even modest detention of the concentrated flows entering the ravine heads would meaningfully reduce peak erosive velocities within the ravines, slowing their active incision without requiring mechanical stabilization of the ravine walls themselves.

Implementation of this recommendation requires coordination with EDS, which owns the upland campus area where stormwater runoff control would be constructed. The PCWDC should initiate outreach to EDS administration to present the concept and discuss the school's interest in participating. The project could be attractive to EDS as an educational amenity.

A topographic survey of the ravine heads and a drainage area delineation for the developed impervious surfaces contributing to each ravine are recommended as the first engineering steps. This survey work can be accomplished using LiDAR-derived topography supplemented by field verification and will establish the design basis for sizing the storage components and confirming the number and location of interception points needed to capture the majority of the developed-area runoff before it enters the wooded hillside.

Photographs of the site are provided in **Appendix 7**.

## 5.2 PASSIVE MANAGEMENT RECOMMENDATIONS

### 5.2.1 UAV FLIGHTS

Pigeon Creek is prone to flooding and wood and debris collection. Flooding can occur from local Pigeon Creek watershed rainfall events and/or backwater from larger Ohio River rainfall events. Maintenance of the creek is difficult because debris and flooding can occur at various locations depending on flow dynamics. More can be understood and monitored along the creek with regular photography and/or video by use of a UAV. Each set of aerial photography should be evaluated by reach to document conditions and changes to the creek and to adjust work plans accordingly.

It is recommended that a UAV flight and evaluation of creek conditions be completed regularly to identify areas of needed maintenance, concern, or change over time. Regular evaluation would be a minimum of every 3 years, but more frequently after substantial storm events in the watershed, significant Ohio River flooding, and after implementing changes that need evaluation.

### 5.2.2 STREAM GAGES

The only stream gage providing Pigeon Creek data is currently in Gibson County (USGS Gage 03322011). Creek flow, elevation and other parameters are a key component to assessing areas of concern, flow patterns, and matching of channel capacity to rainfall measurements. This information allows for adjustments in stream capacity and practices based on actual channel flow. It is particularly critical in Pigeon Creek to capture flow and elevation data because of the backflow from the Ohio River and the flows coming from the Pigeon Creek watershed intermingling. It is difficult to model flow in two directions and with different watershed sizes. Stream gages can be of several types and can monitor water elevation and many other parameters. These can be purchased by individuals or the PCWDC and installed inexpensively or can be installed as part of the USGS process that enables

the USGS to monitor and report out the measured parameters. The PCWDC has determined that USGS gages should be selected as an initial gage station.

Establishing a new USGS stream gage on Pigeon Creek in Vanderburgh County would serve several purposes. Once several years of record have accumulated, flow rates and water surface elevations could be compared to the historical record from the discontinued US 41 gage to estimate how conditions have changed since the mid-1980s. Looking forward, gage data would allow tracking of land use, water resource management, and climate effects on stream flow and flood risk in Vanderburgh County. When used alongside the Ohio River gage at Court Street, a new gage would allow floodplain managers, emergency management officials, and others to better understand the interactions between Pigeon Creek and the Ohio River under various relative streamflow conditions in near real-time.

In addition to calibration of flooding for modeling, a stream gage can provide early warning for emergency management. The gage elevation can alert emergency professionals to needed road closures before they flood and other action items. Emergency action plans utilize stream gages for forecasting and warning to potentially save lives.

It is recommended that at least one stream gage be added at a critical reach of Pigeon Creek to measure channel flow. Initial locations of importance would be upstream of bridges in Vanderburgh County. Lynch Road bridge or Oak Hill Road bridge are examples of gage locations that could provide beneficial data. The Lynch Road bridge is especially beneficial as a gage site to allow for better evaluation of the bridge opening capacity.

The PCWDC and stakeholders should coordinate with USGS to determine the best location for the gage to maximize benefit to the county while considering calibration and maintenance needs for the gage itself. Other gages in critical locations should be considered as funding becomes available. Consider locations close to communities (near Chandler in Warrick County), areas of historic flooding, and upstream of bridges to allow for meaningful information to alert homeowners or provide flood data.

### 5.2.3 DEVELOP FLOOD RESPONSE PLANS

Flooding along the Pigeon Creek and its tributaries is unavoidable. Flood response plans should be developed for each flood-prone community along the corridor to help emergency responders take appropriate actions. Gage data can provide specific elevation data to support the plan efforts. Such plans would provide guidelines on how to forecast, detect, and classify the severity of the flooding event, communicate with emergency response personnel, notify affected citizens, take appropriate flood fight actions, and implement post-flood recovery. Similar to other flood response plans developed within Indiana, the funding and development of these flood response plans in Indiana may be undertaken directly by the affected communities, sometimes through potential grants from the Indiana Office of Community and Rural Affairs (OCRA) or the Indiana Department of Homeland Security (IDHS).

### 5.2.4 DEVELOP FLOOD RESILIENCE STRATEGIES

Flood resilience maps were provided for the Vanderburgh County reaches of Pigeon Creek with the 2023 Burke study. The resilience maps did not include all of Warrick or Gibson Counties. **Exhibit 9** provides an example resilience map from the 2023 study.

Resilience strategies should be adopted by counties and communities affected by flooding along Pigeon Creek and its tributaries to help curb an increase in flood vulnerability and mitigate flood

damages. Flood resilience plans include identifying and agreeing upon strategies specific to each distinct geographical planning area within each community, including: river corridor impact areas, undeveloped flood hazard/storage areas, moderate flood risk areas, vulnerable developed areas, safer areas, and the watershed. Typical mitigation measures identified through resilience plans include flood protection around critical infrastructure such as water and wastewater treatment plants, hospitals, and other major facilities. Similar to other flood resilience plans developed within Indiana, the funding and development of these flood resilience plans in Indiana can likely be undertaken directly by the affected communities, and possibly with potential grants from FEMA, DNR, OCRA, and/or IDHS.

Where significant flood risk exists in Evansville, Chandler, and other communities along Pigeon Creek, these areas should be viewed as a regularly occurring hazard. Adopting appropriate flood resilience strategies specific to each area can help curb an increase in vulnerability to flood and erosion induced damage, reduce flood damages, reduce interruptions, reduce recovery time, and establish a framework for future economic development in safer areas.

The Indiana Silver Jackets team, a group of volunteer federal and state agencies that cooperate to develop solutions to natural hazards, is a valuable resource for information related to flood risk.

Specific resilience strategies should be identified, agreed upon, adopted, and implemented by the City of Evansville within distinct resilience planning areas as specified below.

1. *River Corridor Impact Areas* – The river corridor impact area is defined by the floodway. The intent of strategies in this area is to protect land adjacent to the river and minimize streambank erosion. Preserve undeveloped areas in this zone by adopting a "River Corridor Impact Areas" overlay zone and prohibiting any disturbance (fill or excavation) in this zone except for reviewed and approved projects meeting regulatory criteria.

2. *Undeveloped High Flood Hazard/Flood Storage Areas* – These are the remaining high flood hazard areas within the 1% annual chance floodplains. The intent of the strategies in this area is to conserve land and maintain the natural and beneficial function of the floodway fringe. Preserve these areas by adopting a "High Hazard/Flood Storage Areas" overlay zone and limiting the development in these areas to only suitable open space land uses (no buildings), protecting undeveloped land in this zone through incentivizing compatible uses such as parks and trails with help from public land trusts, and requiring compensatory floodplain storage when placement of fill in these areas is unavoidable.

3. *Moderate Flood Hazard Areas* – These are areas within the 0.2% annual chance floodplain. The intent of the strategies in this area is to avoid placement of critical facilities and, to the extent possible, preserve these areas as additional storage areas that will likely be needed as the impacts of the ongoing changes in climate makes inundation of these areas in the future similar to how the 1% annual chance floodplain is inundated in today's climate.

4. *Vulnerable Developed Areas* – This designation would identify homes, critical facilities, and non-conforming structures that are already present either within the River Corridor Impact Areas or other high flood hazard areas. These areas have been or are expected to be vulnerable to future flood events. The goals in these areas would be the acquisition of the most vulnerable structures, floodproofing of existing structures (especially critical structures), the development of flood storage areas, and the adoption of a flood response plan. Potential buyout/acquisition priorities could be identified.

5. *Safer Areas* – This designation would identify areas where public investments and policies should encourage development. These areas would be land areas with higher elevations and

outside of designated floodplain. Steer public policy and investment to support development in "Safer Areas" within the community by revising comprehensive land use plans and capital improvement investments (such as expanding new sewer lines, electricity, and water only in these areas) to incentivize development in safer areas, promoting conservation design/LID/green infrastructure in these safer areas, and promoting placement of critical facilities only in these safer areas.

6. *Watershed* – This designation would identify the land within the entire watershed. Promote coordination and partnership with various jurisdictions within the entire Pigeon Creek watershed to slow, spread, and infiltrate flood water through encouraging adoption of higher, no-adverse-impact development/drainage standards for both urban and agricultural areas, adoption of natural resource overlay zones, and watershed-wide stormwater and flood risk management master plans.

The above strategies could be discussed with each community and incorporated within their planning department goals.

### 5.2.5 ORDINANCE/TECHNICAL STANDARDS REVIEW AND UPDATE

It is recommended that stormwater runoff be evaluated and controlled in each county. Up-to-date and progressive stormwater standards, such as that contained in the Indiana Local Technical Assistance Program (LTAP) Model Stormwater Management Ordinance and Model Stormwater Technical Standards Manual, may address some of the contributing factors and help reduce further increases in peak flow rates caused by new development and redevelopment.

Some degree of detention is already required in most of the counties within the Pigeon Creek watershed, but requirements are not consistent throughout. In many cases the current requirements lack up-to-date, no-adverse-impact measures. The current stormwater and floodplain regulations within all jurisdictions in the watershed should be updated to include, at a minimum, the following provisions:

- Retention (preferably) or detention storage, with maximum allowable release rates accurately pre-calculated and presented as unit flow rates (cfs/acre) for each sub-watershed to compensate for increases in flow rates due to new development and redevelopment

- Retention or, if not possible, extended detention of the channel protection volume (the volume of runoff created during the 1-year, 24-hour rainfall event) to prevent further increase in flow volumes and channel forming flows

- A minimum of 1.5:1 compensatory floodplain storage when the existing floodplain storage is proposed to be eliminated due to fill or berm protection

- Strict prohibition of any development or disturbance within floodways and the erosional hazard corridor impact areas along the rivers and tributaries

- Requirements and incentives for using Low Impact Development (LID) and Green Infrastructure (GI) practices throughout the watershed

These updates should be undertaken and funded directly by each respective drainage board or municipality within the watershed. The respective counties and municipalities should coordinate their stormwater standards to the greatest extent practicable to promote more consistent stormwater management throughout the Pigeon Creek watershed.

### 5.2.6 MITIGATE AGRICULTURAL & COUNTY DRAINAGE PROJECT IMPACTS

Typical stormwater ordinances and technical standards within Indiana do not apply to farm drainage practices and county drainage boards' ditch improvement projects. Similar to the impacts of new development and redevelopment in urban areas, farm drainage activities and county drainage board ditch improvement projects significantly increase runoff reaching Pigeon Creek. Provisions such as cover crops, agricultural drainage management structures, 2-stage ditches, and construction of detention ponds as part of drainage board ditch improvement projects can help offset these increases.

The use of 2-stage ditches (as opposed to conventional trapezoidal ditches) should also be encouraged or required when the tributary is experiencing instability. A constructed bench within the overall channel banks increases stability and conveyance capacity while providing water quality and habitat benefits. Runoff detention incorporated as constructed or restored wetlands, where feasible, improves the overall benefit and may open opportunities for cost-sharing with conservation partners.

The PCWDC should work with county drainage boards in the watershed to establish expectations that farm drainage and drainage board ditch improvement projects include compensating measures for increased runoff.

### 5.2.7 INCENTIVIZE SOIL HEALTH PRACTICES

In agricultural areas, soil health practices reduce runoff by increasing the soil's capacity to absorb and hold water. Higher organic matter content creates more pore space and a more active root system that draws moisture into the soil profile. Organic material in the soil functions much like bioinfiltration or rain gardens in the urban setting. There are also substantial benefits for agriculture in terms of decreased energy overhead and increased drought tolerance. The set of practices that the NRCS terms "soil health" appear to be the future of sustainable agriculture and have the potential to change water management in agricultural regions of the United States.

Current farming practices focus on tillage and clearing the land for "the crop". Soil health practices instead focus on continuing the crop and continuing to improve the soil. An example of a cover crop implementation is shown in **Figure 20**. NRCS reports that farmers using soil health practices can increase drought tolerance and storage gain of up to 27,000 gallons of water per acre for each 1% increase in soil organic matter. Results vary with soil texture, antecedent moisture, and management history, but even modest organic matter gains can produce meaningful improvements in the watershed's infiltration and storage capacity.

It is recommended that soil health practices be promoted through education and outreach programs to inform landowners of the benefits and available federal assistance for implementing the measures. The specific soil health practices that should be employed in the Pigeon Creek watershed are as follows:

1. Cover crops (with perennial plants in seed mixes)
2. No-till
3. Integrated pest management
4. Diverse crop rotations
5. Rotational livestock grazing

Currently, approximately 58% of this watershed is occupied by agriculture. Thus, increasing the infiltration and runoff storage potential of farmlands by employing soil health practices is one of the



**Figure 20: Cover Crop Growing in Harvested Corn Field**

most effective ways to reduce basin-wide runoff today.

The Vanderburgh County Soil and Water Conservation District currently offers the Lower Pigeon Creek Watershed Cost Share Program to assist landowners with conservation and nutrient management practices in part of the watershed. This program can be a model for PCWDC efforts or a partnership for implementing soil health through funding support.

### 5.2.8 PUBLIC INPUT AND INTER-COUNTY COORDINATION

The watershed counties can work together to implement best practices. This should be informed by public input and coordination across county and city departments and interested groups. A GIS-based watershed information platform is recommended to consolidate inventory data, UAV aerial photography, and planning information in a format accessible to Commission members, partner agencies, and the public.

The Burke team will provide a watershed inventory tool through an ArcGIS Online mapping application. The inventory will include land use, soils, hydrology, development areas, and watershed projects as the PCWDC implements them over time. This mapping application will be provided as public version, as approved by the PCWDC on the Commission's website. This inventory will be a living document that can be updated as changes occur and/or other counties join PCWDC. Updating and utilizing the GIS inventory map and interactive map can provide information to watershed landowners and stakeholders while collecting input from the public in location-specific areas.

### 5.2.9 WATERSHED-WIDE HYDROLOGIC AND HYDRAULIC STUDY

The 2014 Burke study of the Upper Pigeon Creek watershed provided a hydrologic and hydraulic analysis of Pigeon Creek and its watershed in Gibson County as a guideline for drainage system recommendations. A similar type of evaluation could be expanded to the entire watershed and provide a basis for long-term project implementation. The evaluation of each proposed flood-reduction practice will need to be analyzed against a baseline flood model, and the creation of a multiple-reach, watershed-wide model will provide that baseline to compare alternatives more quickly.

The purpose is to address specific drainage concerns and ditch maintenance issues in the watershed to include the following:

- Utilize new gage data to verify prior and new hydraulic models
- Evaluate the existing capacity for selected portions of the channels in the watershed
- Identify and provide improvement alternatives for restrictive channel segments and culverts
- Provide recommendations for channel maintenance to maximize the effectiveness of the drainage system

# CHAPTER 6: IMPLEMENTATION SUMMARY

**Table 6** describes recommended actions within the Pigeon Creek watershed that may reduce flood damage, improve drainage, promote long-term channel stability, and protect public and private assets. Schedule priority has been listed as near-term (within 2-years), mid-term (less than 5 years), long-term (within 10 years) or ongoing (recurrent or continuous). Cost factors of low, medium, and high are subjective based on implementation level and extent of practice (minimal versus maximal size and effort). Generally, the costs reflect magnitudes of <$100,000 (low), <$500,000 (medium) and >$500,000 (high). Schedule adjustments should be made as funding and opportunity for the work changes over time.

**Table 6: Work Plan Recommended Actions**

| Number | Recommendation | Schedule Priority | Cost Factor |
|---|---|---|---|
| ***ACTIVE MEASURES*** | | | |
| 1. | **Secure access at common debris-collection areas such as Stringtown Road bridge.** Purchase fee simple or easement of adjacent private property for debris removal access at the creek's only center-pier bridge. Evaluate two large leaning trees immediately upstream. | 2-yr Goal | Low |
| 2. | **Evaluate debris at Warrick/Vanderburgh County line.** Three debris accumulations should be evaluated for removal. | 2-yr Goal | Medium |
| 3. | **Remove channel-blocking debris – Vanderburgh County.** Clear debris blocking the full channel width when it accumulates for a substantial amount of time . | Ongoing | Medium |
| 4. | **Evaluate and construct off-line detention storage.** Assess various locations for offline wetland or detention storage construction. | 5-yr Goal | High |
| 5. | **Begin bridge hydraulic analysis and replacement program.** With County Highway support, analyze bridge openings beginning with Lynch Road (identified as significantly undersized for 50- to 100-year flows). Develop a prioritized replacement schedule calibrated to new gage data. | 5-yr Goal | High |
| 6. | **Begin retrofit of existing developed areas with stormwater detention.** Inventory pre-stormwater-ordinance development in Evansville for retrofit opportunities. Priority sites include the Evansville Day School area. | 5-yr Goal | High |
| ***PASSIVE MEASURES*** | | | |
| 7. | **Establish Vanderburgh County USGS stream gage.** Highest-priority data action. Cooperative gage upstream of Lynch or Oak Hill Road bridges. Paired with the Ohio River Court Street gage, enables real-time separation of local runoff from backwater flooding – a capability that does not currently exist. | 2-yr Goal | Medium |
| 8. | **Regular UAV monitoring program.** Annual and post-storm UAV flights to document debris accumulation, bank erosion, and | Ongoing | Low |

| | | | |
|---|---|---|---|
| | channel change. Results drive maintenance priorities and track project effectiveness. | | |
| 9. | **Develop flood response and resilience plans.** Flood response plans provide emergency action protocols tied to gage stage thresholds. Flood resilience plans define zoning overlays (river corridor, flood storage, vulnerable developed, safer areas) for Chandler (Warrick County), Evansville, and other at-risk communities. | 5-yr Goal | Medium |
| 10. | **Update and coordinate 3-county stormwater ordinances.** Adopt no-adverse-impact standards requiring compensatory storage for new development, channel protection volume retention, and 1.5:1 floodplain storage replacement. Coordinate across county lines to the greatest extent practicable. | 5-yr Goal | Medium |
| 11. | **Require mitigation for agricultural drainage improvements.** Work with drainage boards in all three counties to establish that new tile drainage and ditch improvements include compensating measures: controlled outlets, 2-stage ditches, constructed wetlands, and/or off-line detention. | Ongoing | Low |
| 12. | **Incentivize soil health practices.** With 58% of the watershed in agricultural use, no-till, cover crops, diverse rotations, and edge-of-field practices represent the highest-leverage basin-wide flood mitigation opportunity. Promote through NRCS cost-share programs and education. | Ongoing | Medium |
| 13. | **Public input and inter-county coordination**. Updating and utilizing the GIS inventory map and interactive map can provide information to watershed landowners and stakeholders while collecting input from the public in location-specific areas. | Ongoing | Low |
| 14. | **Watershed-wide hydrologic and hydraulic study.** A watershed-wide and select reach Pigeon Creek model can provide the baseline for future construction projects to evaluate flood reduction effects more easily. | 10-yr Goal | High |

**Figure 21** is a projected implementation timeline for recommended actions.

| Recommendations | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 20++ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Active** | | | | | | | | | | | | | |
| 1. Secure Access – Debris Removal (Stringtown Rd. Bridge) | | | | | | | | | | | | | |
| 2. Evaluate Debris – Warrick/Vanderburgh County Line | | | | | | | | | | | | | |
| 3. Remove Channel-Blocking Debris – Vanderburgh County | | | | | | | | | | | | | |
| 4. Evaluate & Construct Off-Line Detention Storage | | | | | | | | | | | | | |
| 5. Bridge Hydraulic Analysis & Replacement Program | | | | | | | | | | | | | |
| 6. Retrofit Existing Developed Areas – Stormwater Detention | | | | | | | | | | | | | |
| **Passive** | | | | | | | | | | | | | |
| 7. Establish Vanderburgh County USGS Stream Gage | | | | | | | | | | | | | |
| 8. Regular UAV Monitoring Program | | | | | | | | | | | | | |
| 9. Develop Flood Response & Resilience Plans | | | | | | | | | | | | | |
| 10. Update & Coordinate 3-County Stormwater Ordinances | | | | | | | | | | | | | |
| 11. Mitigate Agricultural & County Drainage Project Impacts | | | | | | | | | | | | | |
| 12. Incentivize Soil Health Practices | | | | | | | | | | | | | |
| 13. Public Input & Inter-County Coordination | | | | | | | | | | | | | |
| 14. Watershed-Wide Hydrologic & Hydraulic Study | | | | | | | | | | | | | |

**Figure 21: Implementation Timeline**

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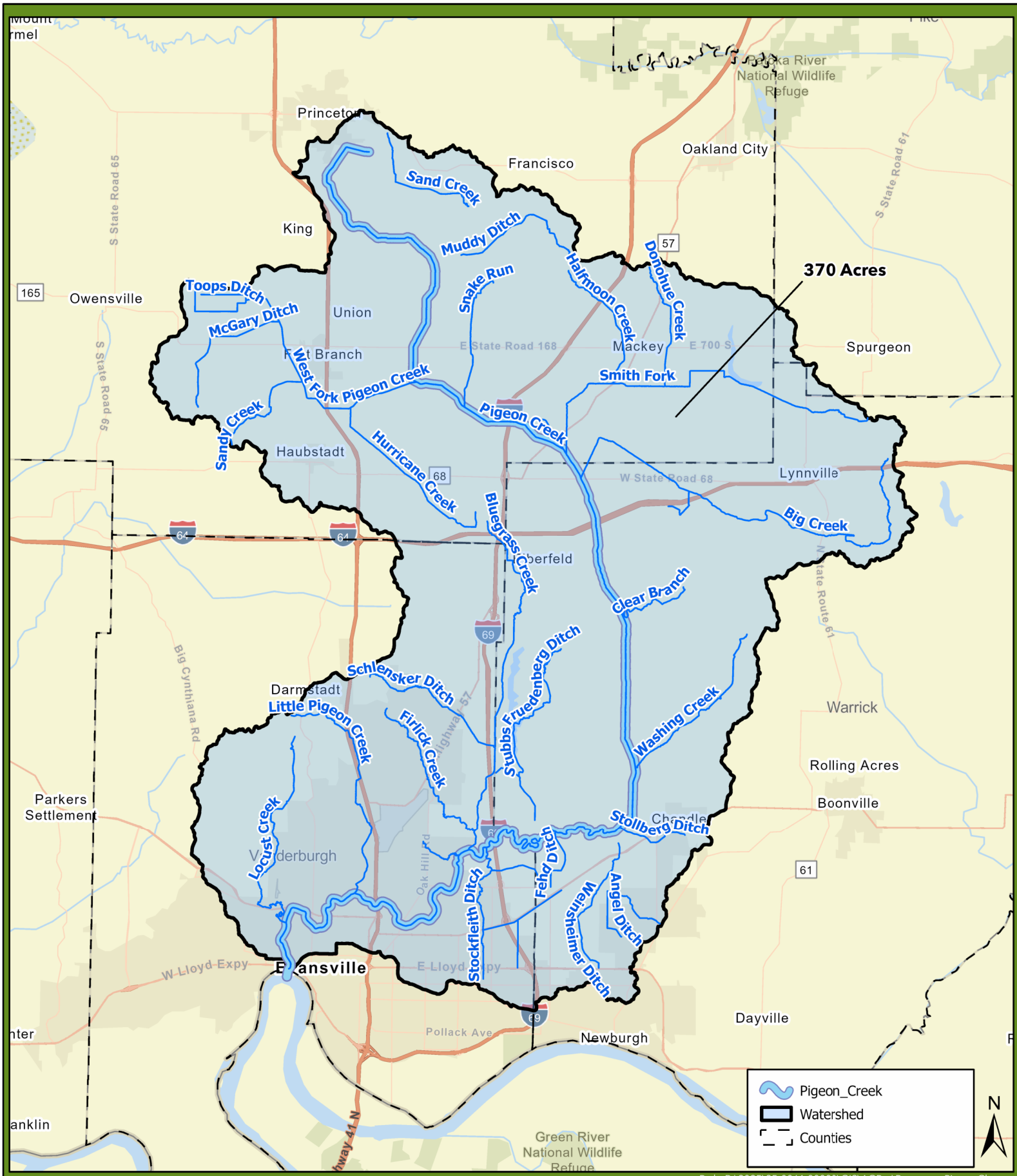
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U.S. Geological Survey. (2023). National Water Information System: Stream Gage Data for Station 03322100, Pigeon Creek at Evansville, Indiana. Available at https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=03322100

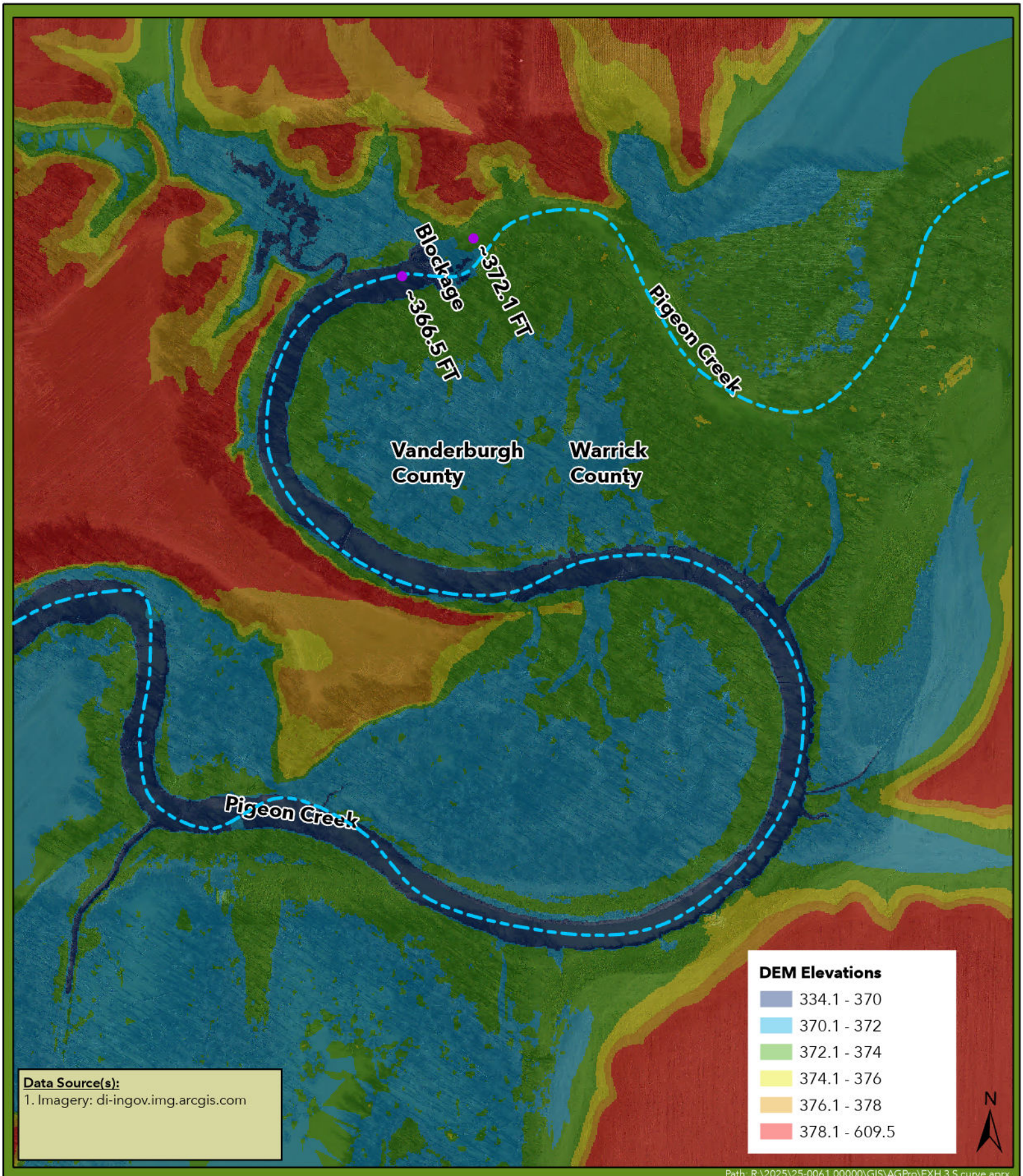
U.S. Geological Survey. (2022). National Water Information System: Web Interface. Data for USGS Gage 03321500, Pigeon Creek near Princeton, Indiana. Available at https://waterdata.usgs.gov/nwis/

# EXHIBITS




Path: R:\2025\25-0061.00000\GIS\AGPro\Basemap_PigeonCk.aprx

| | | | |
|---|---|---|---|
| **Christopher B. Burke Engineering LLC**<br>111 Monument Circle, Suite 3500<br>Indianapolis, Indiana 46204<br>(t) 317.266.8000 www.cbbel-in.com | **PROJECT:** Pigeon Creek Flood Damage Reduction and Drainage Work Plan | **PROJECT NO.** 25-0061 | **APPROX SCALE:** 1" = 20,000' |
| | | | **DATE:** 08/2026 |
| | **TITLE:** Pigeon Creek Watershed | | **EXHIBIT:** 1 |

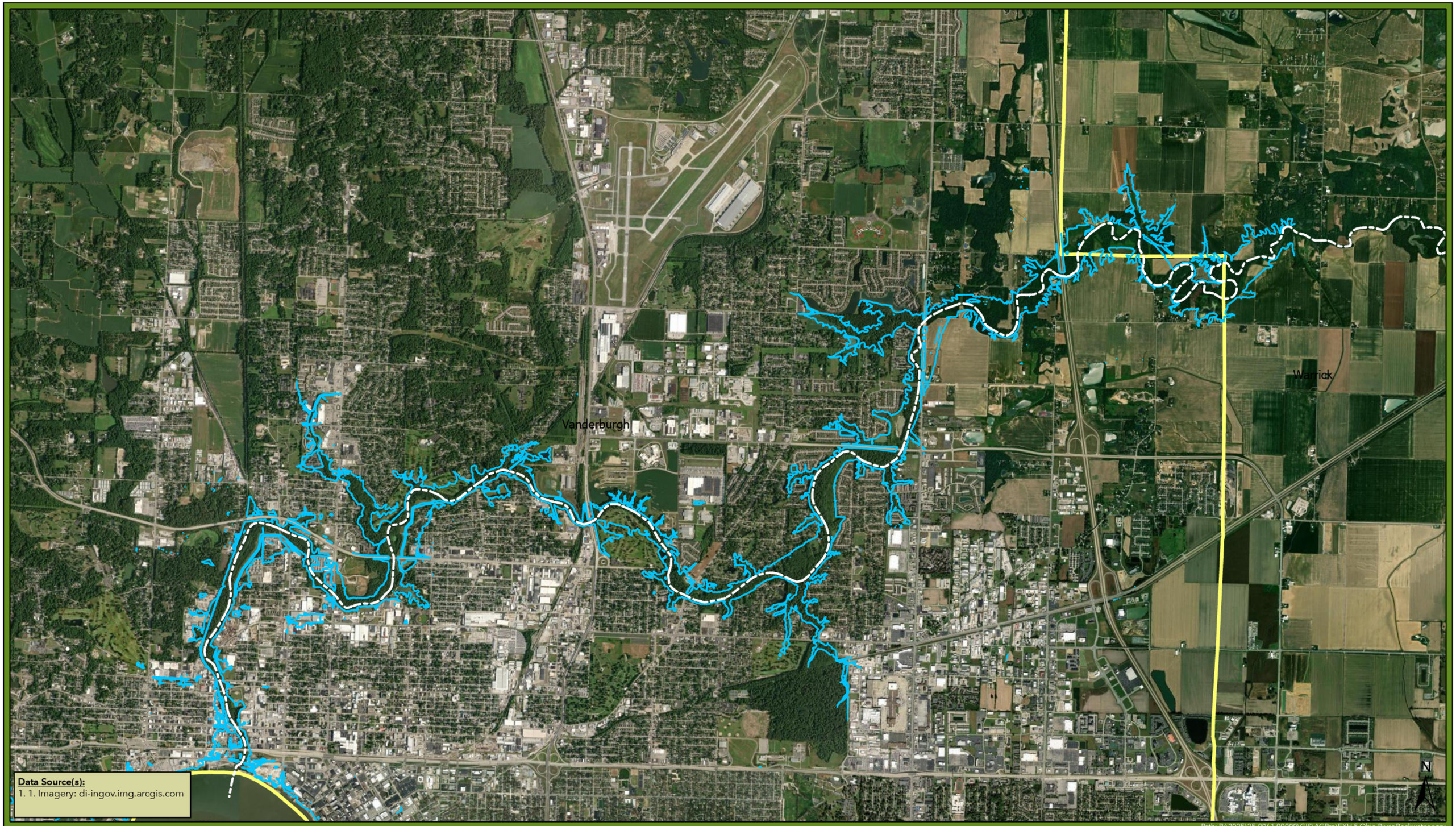



**Data Source(s):**
1. Imagery: di-ingov.img.arcgis.com

Path: R:\2025\25-0061.00000\GIS\AGPro\EXH 3 S curve.aprx

**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

| PROJECT: | PROJECT NO. | APPROX SCALE: |
|---|---|---|
| Pigeon Creek Flood Damage Reduction and Drainage Work Plan | 25-0061 | 1" = 250' |
| TITLE: Elevation Map of County Line "S" Curve | | DATE: 08/2026 |
| | | EXHIBIT: 2 |




**Data Source(s):**
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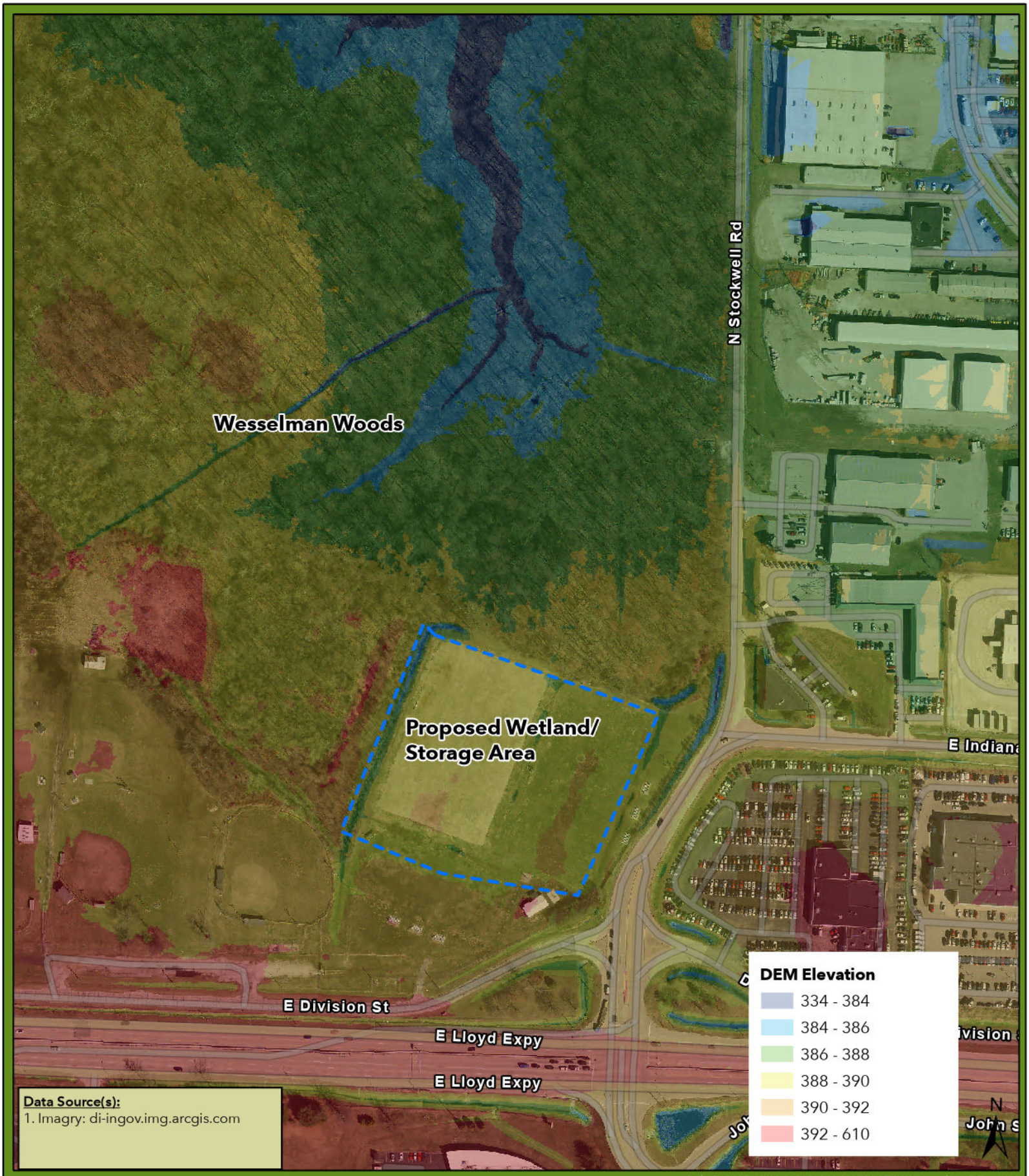
377.7 Elevation-100-yr Backwater

Pigeon Creek

County Boundary

**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

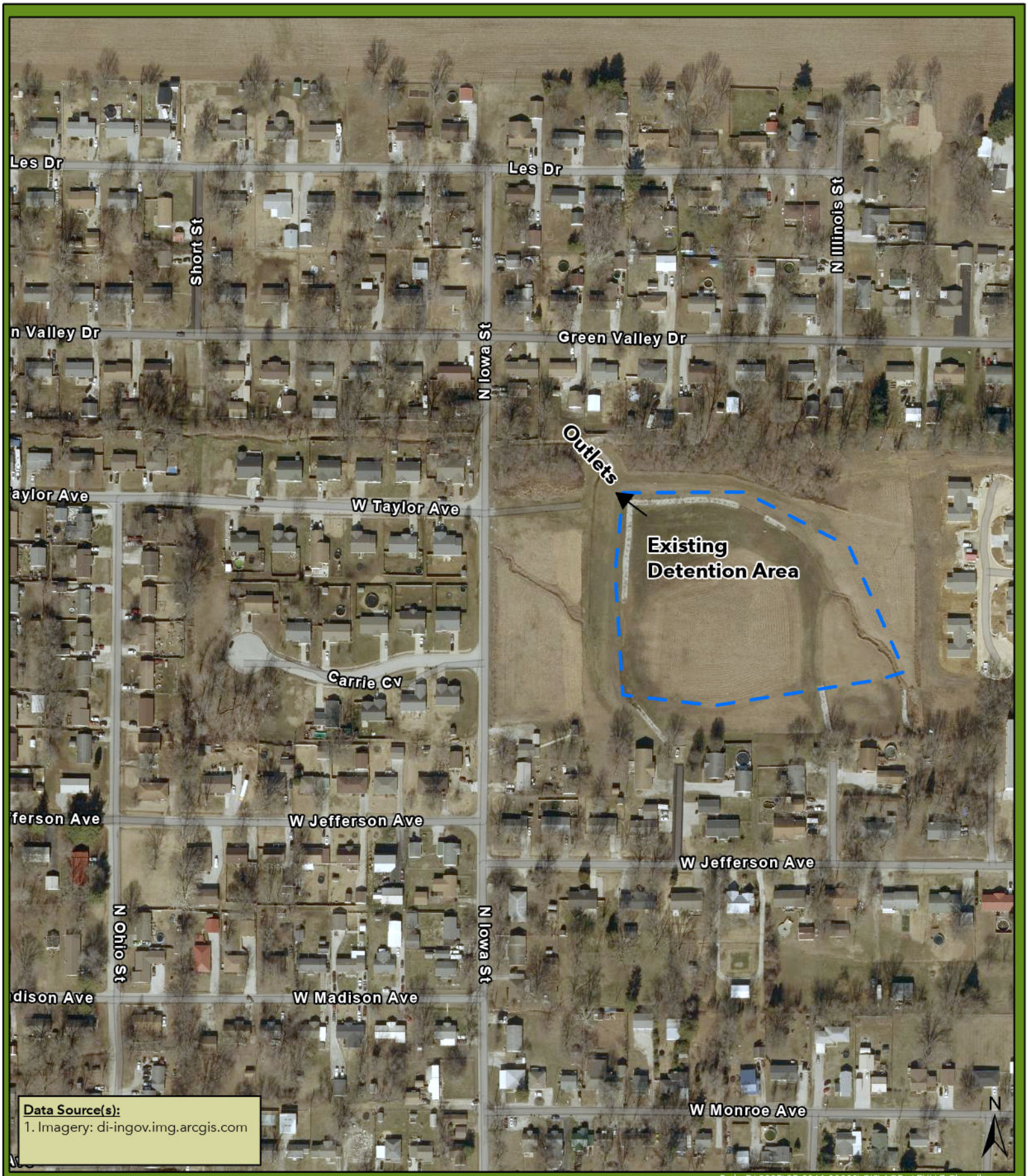
| | | | |
|---|---|---|---|
| PROJECT: Pigeon Creek Flood Damage Reduction and Drainage Work Plan | | PROJECT NO. 25-0061 | APPROX SCALE: 1" = 3,500' |
| TITLE: Map of 100-yr Ohio River Backwater | | | DATE: 08/2026 |
| | | | EXHIBIT: 3 |




Path: R:\2025\25-0061.00000\GIS\AGPro\EXH 6 WesselmanDEM.aprx

**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

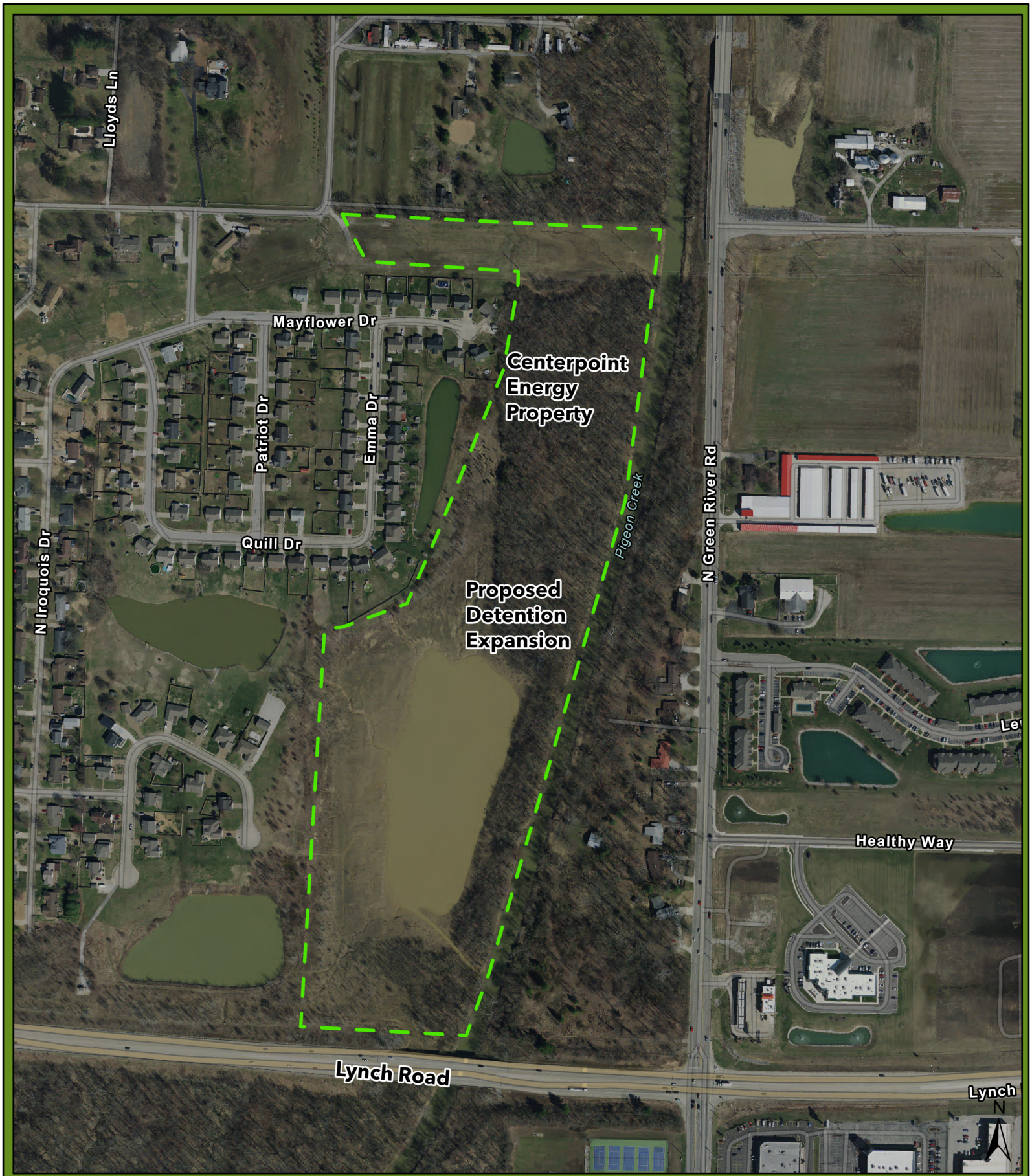
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|---|---|---|
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| TITLE: | | DATE: 08/2026 |
| Wesselman Woods Enhancement | | EXHIBIT: 4 |




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**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com


| PROJECT: | PROJECT NO. | APPROX SCALE: |
|---|---|---|
| Pigeon Creek Flood Damage Reduction and Drainage Work Plan | 25-0061 | 1" = 250' |
| TITLE: Chandler Detention Basin Expansion | | DATE: 08/2026 |
| | | EXHIBIT: 5 |




Path: R:\2025\25-0061.00000\GIS\AGPro\EXH 8 CP Energy.aprx


**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

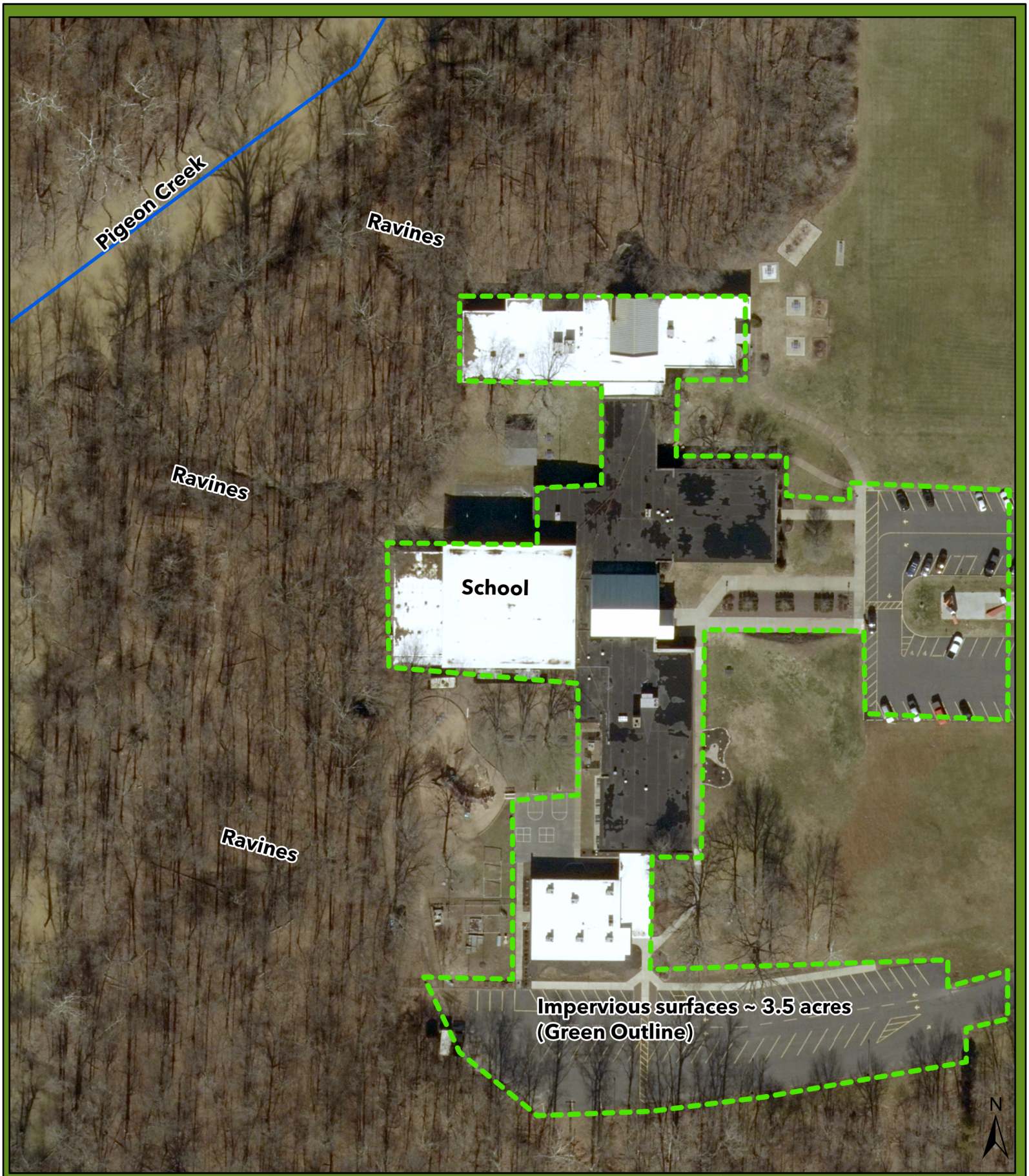

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|---|---|---|---|
| PROJECT: Pigeon Creek Flood Damage Reduction and Drainage Work Plan | | PROJECT NO. 25-0061 | APPROX SCALE: 1" = 400' |
| TITLE: Centerpoint Energy Storage Expansion | | | DATE: 08/2026 |
| | | | EXHIBIT: 6 |




Path: R:\2025\25-0061.00000\GIS\AGPro\Exh 9 Timber road.aprx

**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

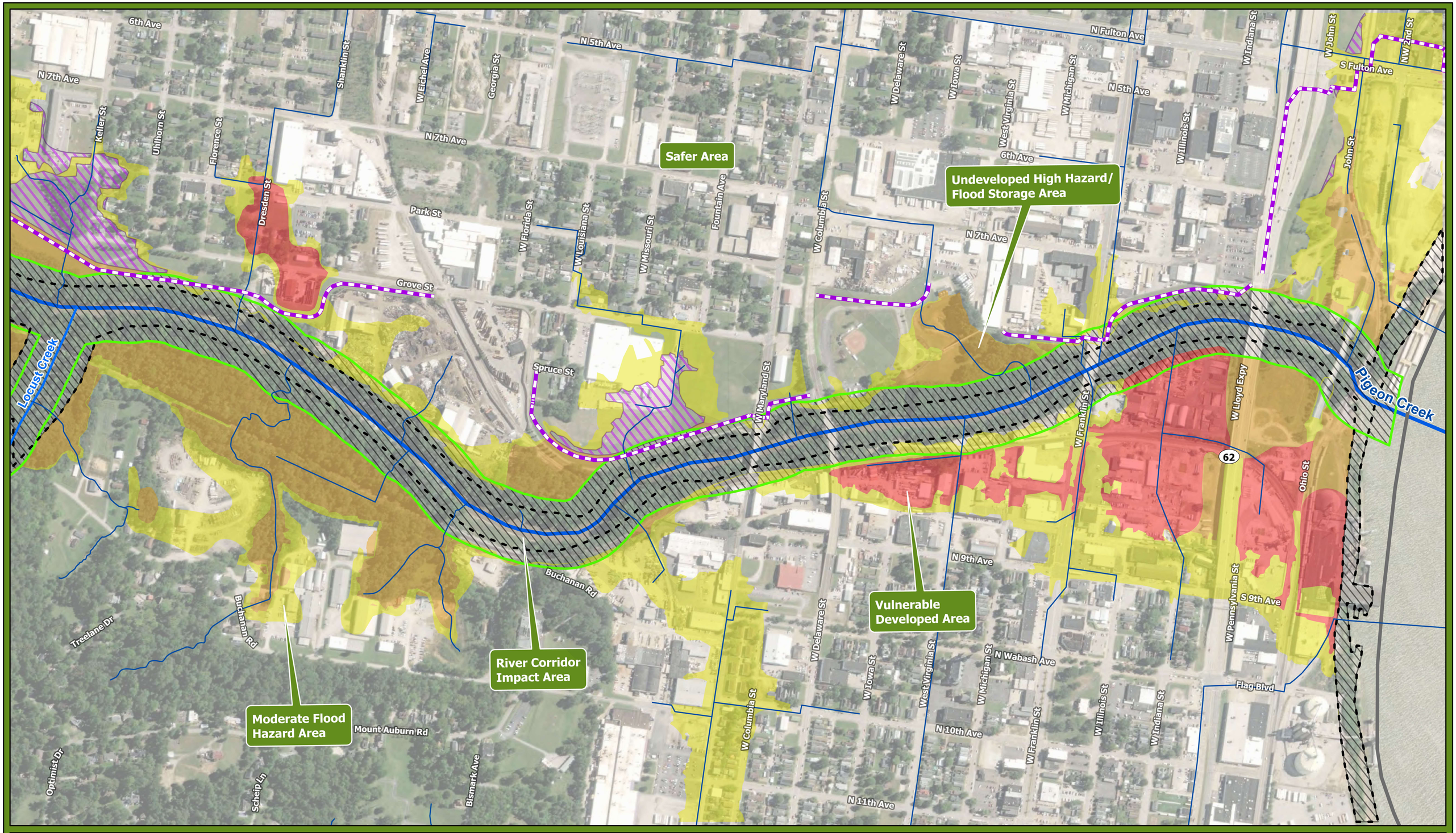
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|---|---|---|
| Pigeon Creek Flood Damage Reduction and Drainage Work Plan | 25-0061 | 1" = 160' |
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| TITLE: Timber Road Storage Expansion | | EXHIBIT: 7 |




Path: R:\2025\25-0061.00000\GIS\AGPro\Exh 10 - Dayschool.aprx

**Christopher B. Burke Engineering LLC**
111 Monument Circle, Suite 3500
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

| PROJECT: | PROJECT NO. | APPROX SCALE: |
|---|---|---|
| Pigeon Creek Flood Damage Reduction and Drainage Work Plan | 25-0061 | 1" = 100' |
| TITLE: Evansville Day School Retrofit | | DATE: 08/2026 |
| | | EXHIBIT: 8 |




River Corridor Impact Area
Vulnerable Developed Area
Undeveloped High Flood Hazard/Storage Area
Moderate Flood Hazard Area
Floodway
Fluvial Erosion Hazard
Levee (Accredited)
Area with Reduced Flood Risk due to Levee


**Christopher B. Burke Engineering LLC**
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com


| PROJECT: | PROJECT NO. | APPROX SCALE: |
|---|---|---|
| Pigeon Creek Corridor<br>Flood Risk Management Plan | 19-0469 | 1" = 500' |
| | | DATE: 04/2023 |
| TITLE: Flood Resilience Planning Areas | Sheet 1 of 9 | EXHIBIT: 11 |

# APPENDIX 1: MRLC SUMMARIES

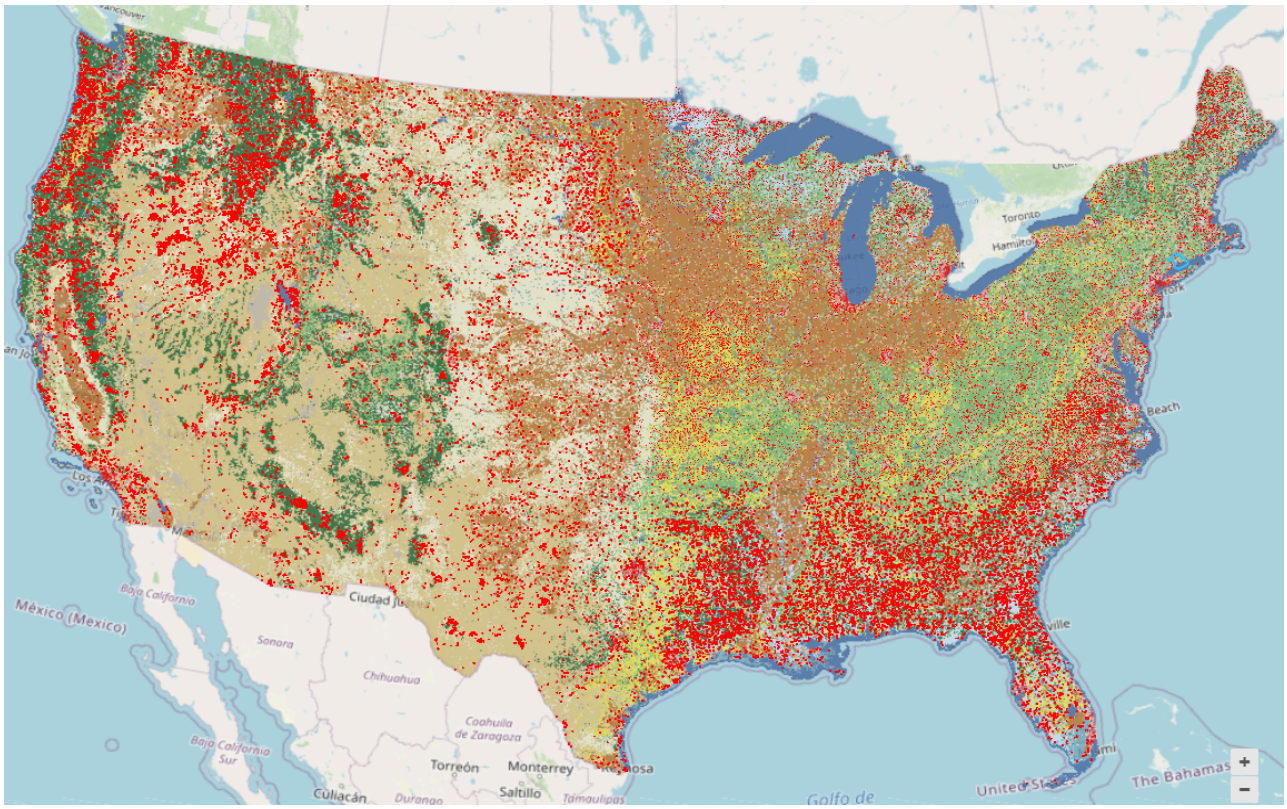
# Warrick County, Indiana

## *2024 Land Cover*

Having an accurate picture of an area's landscape and understanding how that landscape is changing is important information for any planning effort. Land cover data can help provide that big-picture view.

The data seen in the map below was derived through the Multi Resolution Land characteristics Consortium (MRLC). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States Multiple dates of satellite imagery are used to document changes in various types of land cover. The 2024 land cover for Warrick County can be seen below.

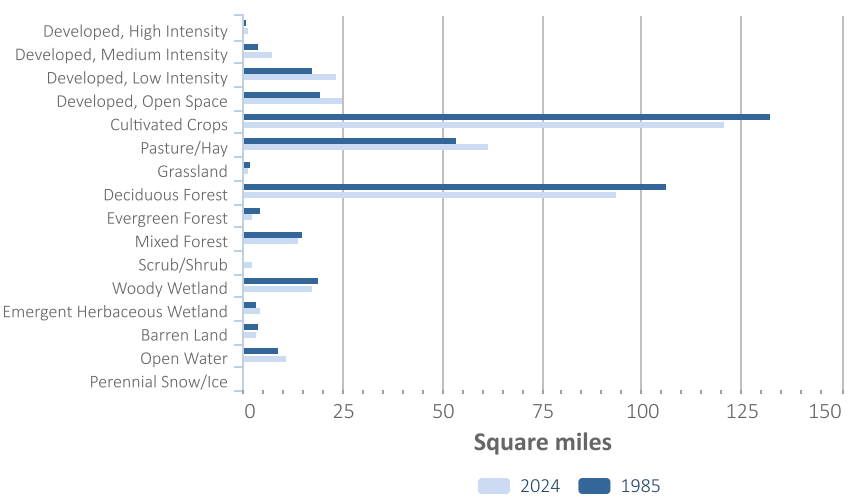
These summary sheets provide an easy way to understand some of the important information derived from these data for Warrick County.



# Land Cover Overview
*Warrick County, Indiana*
***Land Cover Data: 1985 to 2024***

## Land Cover Basics

**22.1 percent of this County changed.**




Communities comparing data from one year to the next can evaluate how their land use management efforts are working, and can also use information on trends to aid future planning initiatives. In this bar chart, showing each land cover class, the difference between the two bars represents the net difference in the area for that category. This data represents a beginning to end year comparison,and does not quantify cumulative change between years. For instance, an evergreen forest that was harvested after the beginning year and re-grew to Evergreen forest before the end year would not be represented in the statistics. Additional GIS analysis is needed for this type of cumulative change. Other data sources available through the MRLC consortium include developed impervious surface, percent forest canopy cover, and nine discrete rangeland components for the Western United States. All of these additional components provide increased and complementary detail for analysis across the United States.

| Land Cover Categories | Area 1985 | Area Lost | Area Gained | Area 2024 | Net Change | Percent Change |
|---|---|---|---|---|---|---|
| Developed, High Intensity | 0.93 | -0.04 | 0.49 | 1.39 | 0.46 | 49.12% |
| Developed, Medium Intensity | 4.04 | -1.15 | 4.77 | 7.66 | 3.62 | 89.68% |
| Developed, Low Intensity | 17.39 | -2.08 | 8.03 | 23.34 | 5.95 | 34.23% |
| Developed, Open Space | 19.47 | -2.37 | 8.17 | 25.27 | 5.80 | 29.79% |
| Cultivated Crops | 132.44 | -26.02 | 14.59 | 121.01 | -11.43 | -8.63% |
| Pasture/Hay | 53.66 | -20.01 | 27.85 | 61.50 | 7.84 | 14.62% |
| Grassland | 1.76 | -1.59 | 1.37 | 1.54 | -0.22 | -12.25% |
| Deciduous Forest | 106.46 | -19.09 | 6.58 | 93.95 | -12.51 | -11.75% |
| Evergreen Forest | 4.27 | -1.77 | 0.13 | 2.62 | -1.65 | -38.56% |
| Mixed Forest | 14.98 | -2.53 | 1.65 | 14.10 | -0.88 | -5.86% |
| Scrub/Shrub | 0.36 | -0.34 | 2.53 | 2.55 | 2.19 | 609.69% |
| Woody Wetland | 19.04 | -1.80 | 0.38 | 17.62 | -1.42 | -7.47% |
| Emergent Herbaceous Wetland | 3.36 | -0.77 | 1.74 | 4.33 | 0.97 | 28.84% |
| Barren Land | 4.10 | -3.81 | 3.09 | 3.39 | -0.72 | -17.47% |
| Open Water | 8.86 | -3.07 | 5.05 | 10.85 | 1.99 | 22.46% |
| Perennial Snow/Ice | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00% |

*All numbers expressed in square miles

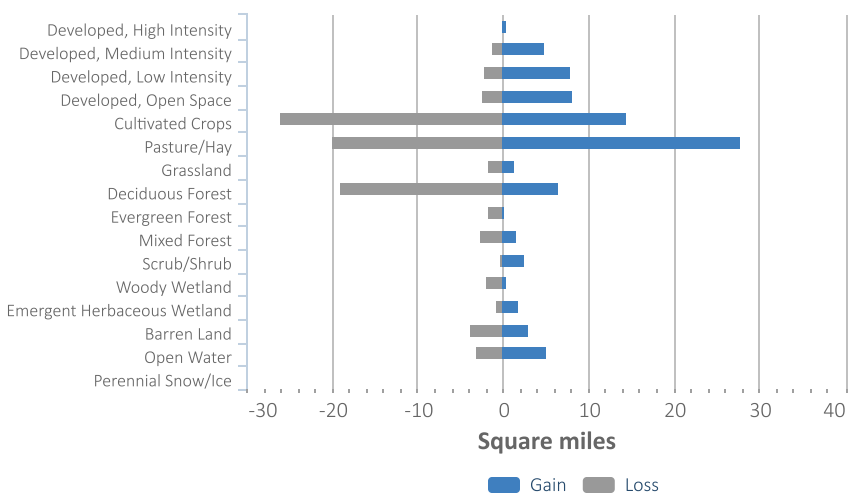
# Land Cover Overview

*Warrick County, Indiana*

***Land Cover Data: 1985 to 2024***

**Area Gained - Area Lost = Net change**

Net change numbers can be deceiving; forests may be lost on one side of the County, while another area may experience an increase. The net change might be minimal, yet the total area of change could be substantial, and the quality of new growth areas may be different than those lost. It is important to look at these offsetting losses and gains, in addition to the overall net difference.



# Development

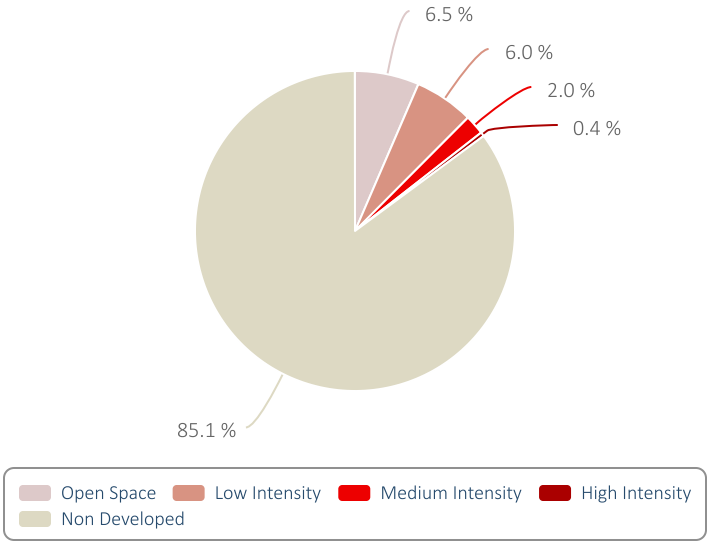
*Warrick County, Indiana*

***Land Cover Data: 1985 to 2024***

**Development and Impervious Surfaces (2024)**

**14.74% of Warrick County is developed and 3.79% is impervious.**

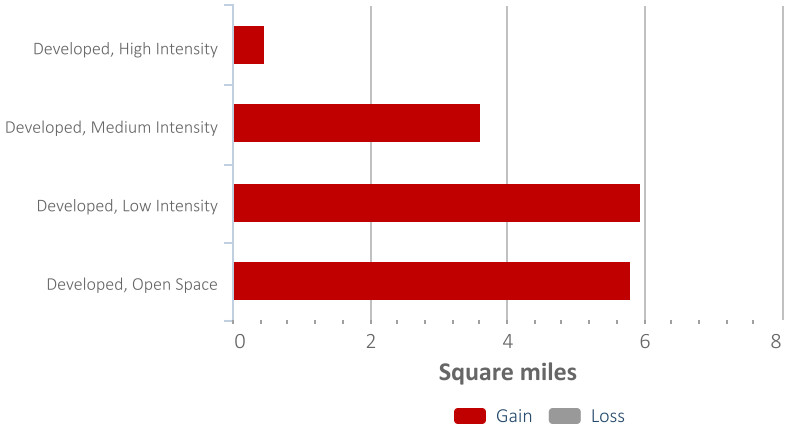
More development means more impervious surfaces, which translates into a greater risk for increased flooding and decreased water quality. Areas with impervious surface rates approaching or exceeding 12 percent to 15 percent will likely experience negative impacts to water quality. Severe degradation can be expected when rates reach 25 percent. This chart highlights the percentage of the County developed in 2024.




**Development Change**

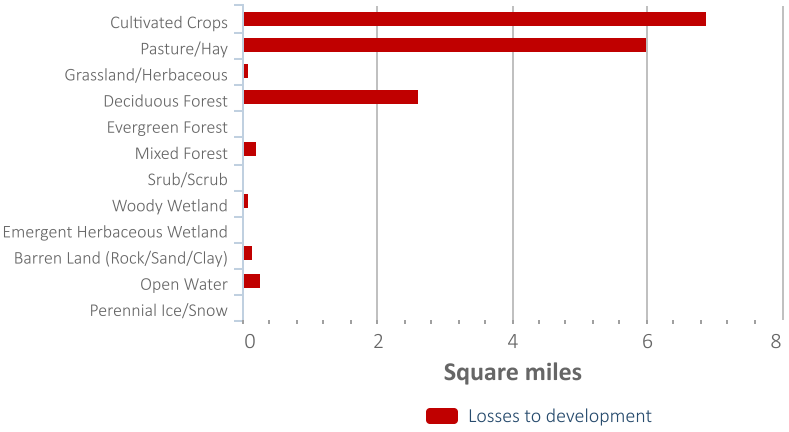
**15.83 square miles of development and 4.77 square miles of impervious surfaces were gained between 1985 and 2024.**

Low density and open space development can impact water quality negatively, though usually to a lesser degree than with higher density development. This graph shows how each type of development changed between 1985 and 2024.




**What's Being Lost**

Unlike natural land cover changes, land lost to development tends to be permanent. This graph shows the types of lands that changed to developed between 1985 and 2024. It does not show any potential losses of previously developed areas, as this is a rare occurrence.



# Forests

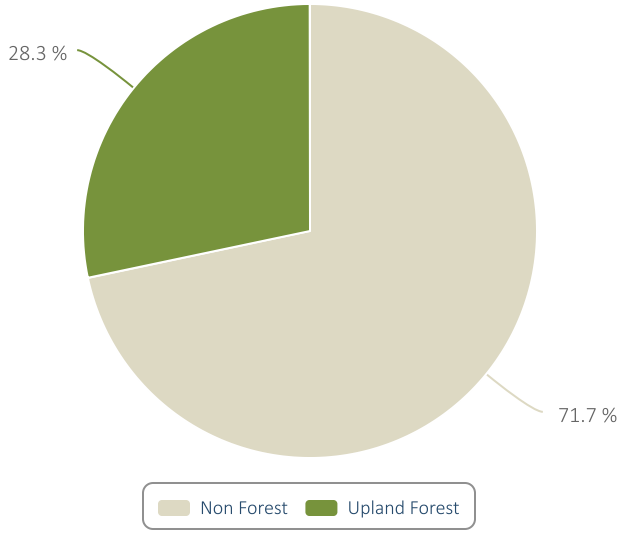
*Warrick County, Indiana*

***Land Cover Data: 1985 to 2024***

### Current State of Forests (2024)

**28.30% of Warrick County is forest.**

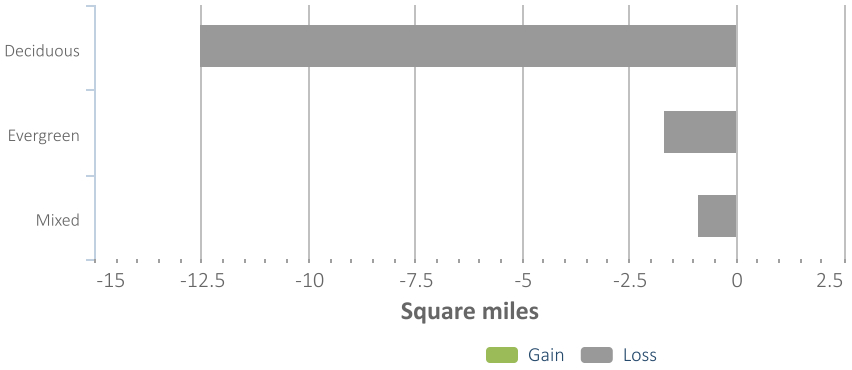
Healthy forests are a vital part of a healthy ecosystem, but it is important to understand the types of forest that are present. This chart shows the percentage of the County that is forested as well as the percentage in uplands and wetlands.




### Forest Change

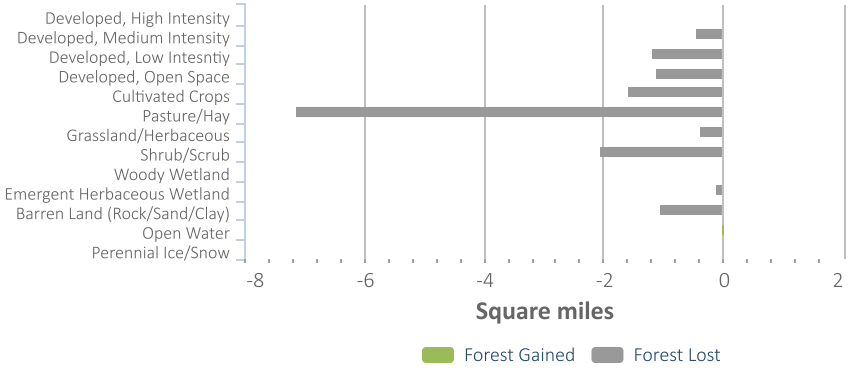
**15.03 square miles of the forest was lost between 1985 and 2024.**

Knowing which types of forests are being lost or gained can be as important as knowing about changes in the total forest area. Different forest types can differ in ecosystem value. This graph highlights changes in each forest type over a specific time frame.




### What is Changing

A forest can go through a transitional period after a fire, other natural disaster, or logging operation, but typically can be expected to recover. Some losses, such as forests converted to development, tend to be permanent. This graph highlights the transformation of forestlands into different land cover types. It also highlights the origin of any forest gains.



# Wetlands

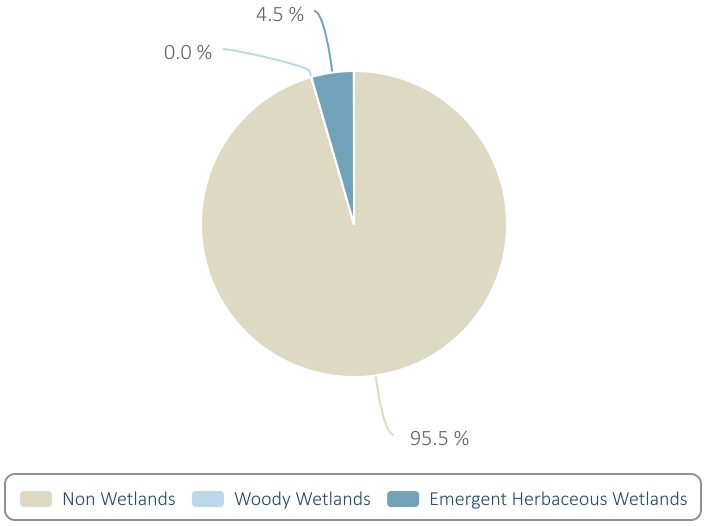
*Warrick County, Indiana*

***Land Cover Data: 1985 to 2024***

### Current State of Wetlands (2024)

**5.61% of Warrick County is wetland.**

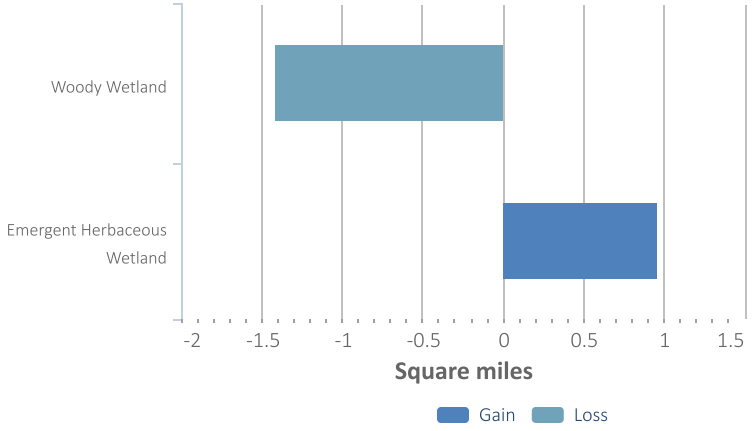
Wetlands are among the most productive environments on Earth. Wetlands provide habitat and food, buffer the impacts of storm surge and flooding, and help control erosion. Wetlands also absorb, store, and filter urban and agricultural runoff to maintain water quality. This chart highlights how much of the County is covered by wetlands.




### Wetland Change

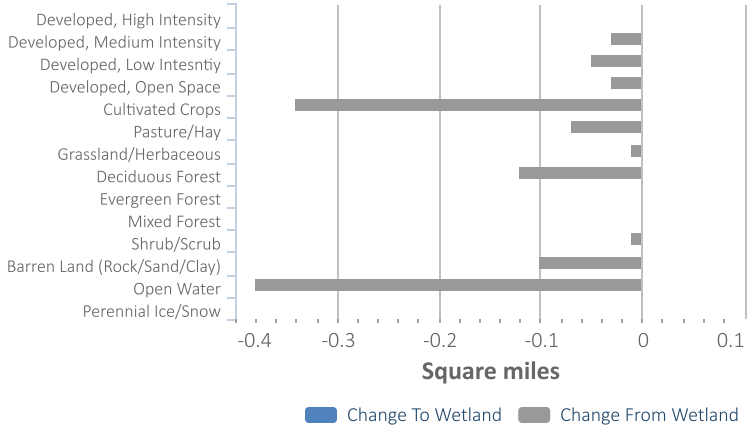
**0.45 square miles of wetlands were lost between 1985 and 2024.**

When a wetland area or type undergoes change, the benefits of the wetland will change as well. Understanding which type of wetland is changing, and how, can help in determining the eventual impacts of the change. This graph highlights the change or changes in each type of wetland.




### What Is Changing

Understanding wetland changes can help communities identify potential management actions to reverse or mitigate the trend. This graph highlights the transformation of lost wetlands into different land cover types. It also highlights the origin of any wetland gains.



# Agriculture

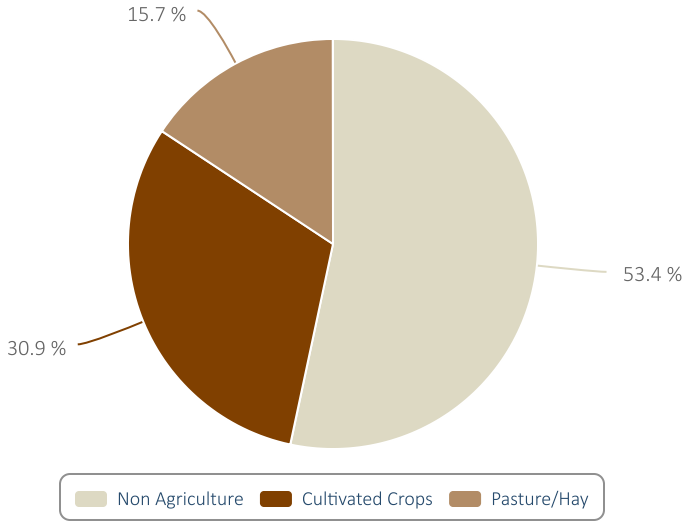
*Warrick County, Indiana*

***Land Cover Data: 1985 to 2024***

**Current State of Agriculture (2024)**

**46.67% of Warrick County is agriculture.**

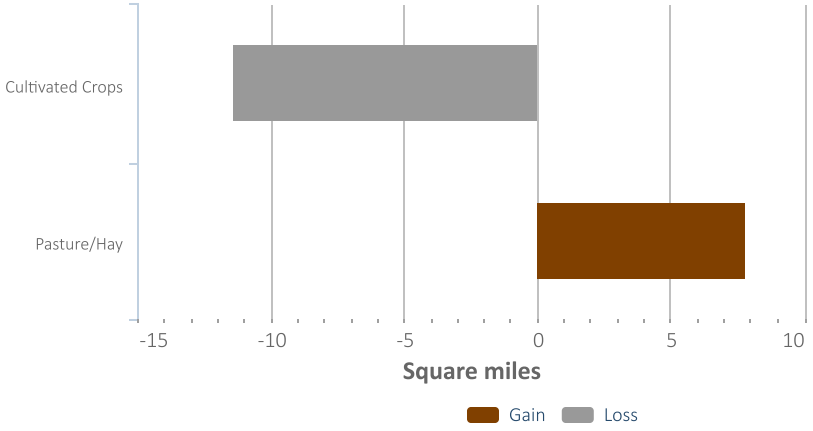
NLCD Agriculture classes include land used for production of annual crops as well as areas intensively managed for livestock production. Agricultural areas are managed in in a variety of ways including tillage, fertilization, and other man-made interventions that make the area more productive than it would be naturally.




**Agriculture Change**

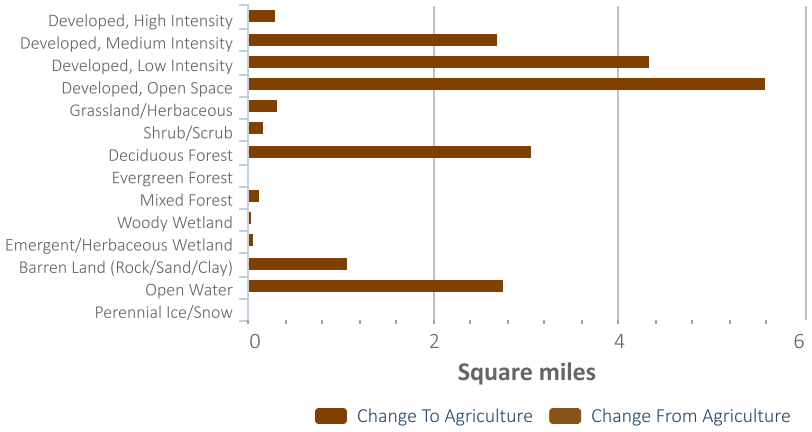
**3.59 square miles of agriculture were lost between 1985 and 2024.**

Agricultural lands can have a high impact on surrounding areas. This can be for a variety of reasons including runoff, pesticide application, fertilizer application, etc. This can also show conversion of natural areas to more highly managed areas which relate to overall increases for local impacts. This can also include areas of hay pasture, which generally have lower impacts on the landscape, to higher production cultivated crops. Decreasing agricultural land can show habitat restoration, increased urbanization, decreasing water availability, and a host of other factors important for resource managers and local communities.



**What Is Changing**

As agricultural lands increase or decrease, a variety of impacts can happen. Increasing agricultural lands can sometimes identify increased water usage as well as loss of natural habitat. Decreasing agricultural lands can highlight droughts, long-term water shortages, habitat restoration, etc. etc. Understanding how these changes are occurring and to what extent help to identify usage and potential risks for producers and the community.



# Digging Deeper

Understanding how your County's land cover has changed over the years is an excellent way to document trends, understand the effects of past land use decisions, and consider future land use planning needs. This report, which covers 1985 and 2024, provides a solid foundation.

Communities adding additional data and analysis are able to generate findings designed to meet their specific needs. There are additional tools developed by NOAA's Digital Coast. This provides data and information useful for this purpose in coastal areas. Visit the website at coast.noaa.gov/digitalcoast. Some examples are listed below.

## Land Cover Resources

Interested in more information related to land cover, or in taking this analysis one step further? Start with the following tools that use land cover to analyze specific issues.

- **Nonpoint - Source Pollution and Erosion Comparison Tool -** Investigates potential water quality impacts from development, and other change. coast.noaa.gov/nspect
- **Coastal County Snapshots**- Provides local officials with easy-to-understand graphics and analysis that cover a county's demographics, infrastructure, and environment. https://coast.noaa.gov/snapshots
- **Sea Level Rise Impacts Viewer**- Displays maps of potential impacts of sea level rise along the coast and provides related information and data for community officials. https://coast.noaa.gov/slr
- **Coastal Flood Exposure Mapper**- Supports communities that are assessing their coastal hazard risks and vulnerabilities. The tool creates a collection of user-defined maps that show the people, places, and natural resources exposed to coastal flooding. https://coast.noaa.gov/floodexposure

## About the Source Data

The data seen in the map below was derived through the MRLC(Multi Resolution Land characteristics Consortium). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States. Multiple dates of satellite imagery are used to document changes in various types of land cover.

- **Notes and Limitations** While efforts have been made to ensure that data are accurate and reliable within the limits of current technology, NLCD data sets were made for analysis at a regional and national scale. These data are intended for use in identifying regional landscape patterns and major functional habitats. NLCD is a national and regional data set that should be used only as a screening tool for very local or site-specific management decisions. Small features and changes should be verified with a higher resolution data source. Additional resources on accuracy and methodology can be found on the MRLC publications page Publications | Multi-Resolution Land Characteristics (MRLC) Consortium (https://www.mrlc.gov/publications)

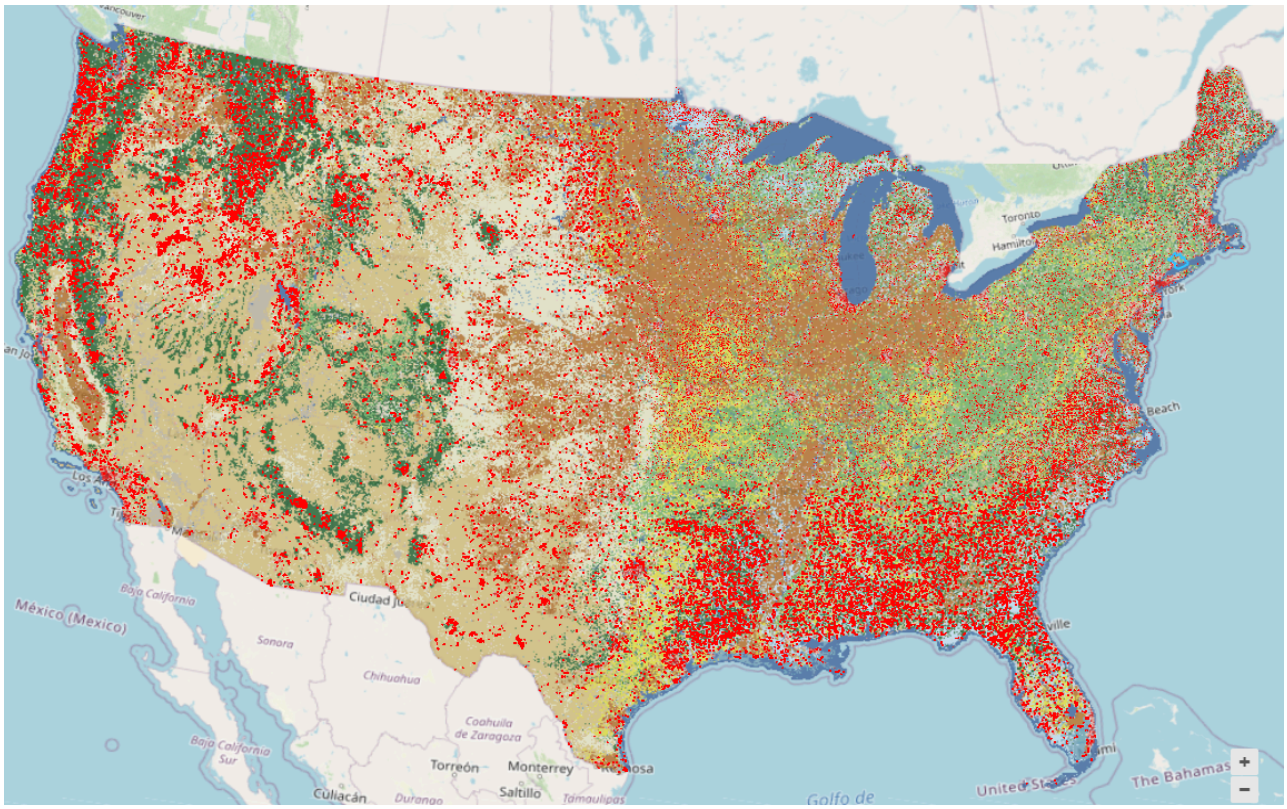
# Gibson County, Indiana

## *2024 Land Cover*

Having an accurate picture of an area's landscape and understanding how that landscape is changing is important information for any planning effort. Land cover data can help provide that big-picture view.

The data seen in the map below was derived through the Multi Resolution Land characteristics Consortium (MRLC). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States Multiple dates of satellite imagery are used to document changes in various types of land cover. The 2024 land cover for Gibson County can be seen below.

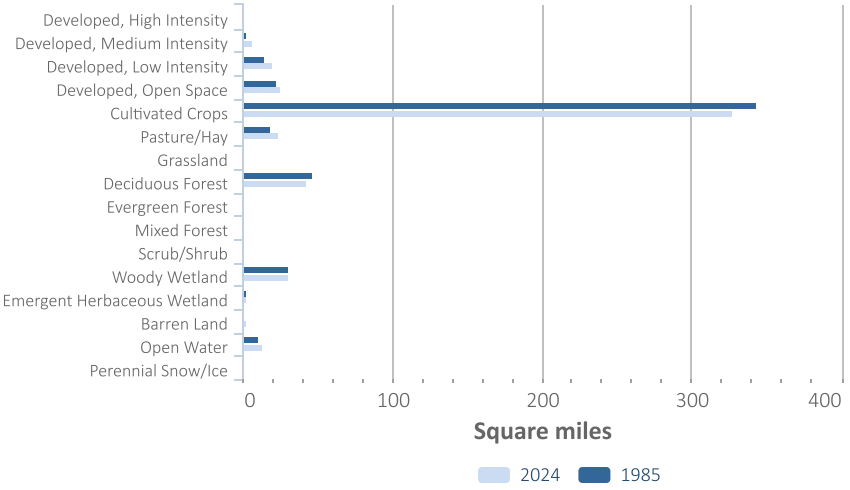
These summary sheets provide an easy way to understand some of the important information derived from these data for Gibson County.



# Land Cover Overview
*Gibson County, Indiana*
***Land Cover Data: 1985 to 2024***

## Land Cover Basics

**10.39 percent of this County changed.**




Communities comparing data from one year to the next can evaluate how their land use management efforts are working, and can also use information on trends to aid future planning initiatives. In this bar chart, showing each land cover class, the difference between the two bars represents the net difference in the area for that category. This data represents a beginning to end year comparison,and does not quantify cumulative change between years. For instance, an evergreen forest that was harvested after the beginning year and re-grew to Evergreen forest before the end year would not be represented in the statistics. Additional GIS analysis is needed for this type of cumulative change. Other data sources available through the MRLC consortium include developed impervious surface, percent forest canopy cover, and nine discrete rangeland components for the Western United States. All of these additional components provide increased and complementary detail for analysis across the United States.

| Land Cover Categories | Area 1985 | Area Lost | Area Gained | Area 2024 | Net Change | Percent Change |
|---|---|---|---|---|---|---|
| Developed, High Intensity | 0.49 | -0.03 | 0.89 | 1.35 | 0.86 | 177.25% |
| Developed, Medium Intensity | 3.20 | -0.32 | 3.64 | 6.53 | 3.33 | 103.93% |
| Developed, Low Intensity | 15.34 | -1.15 | 5.68 | 19.87 | 4.53 | 29.55% |
| Developed, Open Space | 22.52 | -3.10 | 5.81 | 25.23 | 2.71 | 12.05% |
| Cultivated Crops | 344.41 | -27.41 | 10.71 | 327.71 | -16.70 | -4.85% |
| Pasture/Hay | 19.13 | -8.38 | 13.81 | 24.56 | 5.43 | 28.38% |
| Grassland | 0.19 | -0.14 | 0.32 | 0.36 | 0.18 | 96.26% |
| Deciduous Forest | 47.30 | -6.89 | 3.05 | 43.45 | -3.84 | -8.13% |
| Evergreen Forest | 0.16 | -0.03 | 0.00 | 0.13 | -0.03 | -18.42% |
| Mixed Forest | 1.48 | -0.18 | 0.18 | 1.48 | 0.00 | -0.23% |
| Scrub/Shrub | 0.05 | -0.04 | 0.13 | 0.13 | 0.08 | 181.68% |
| Woody Wetland | 30.51 | -1.02 | 0.82 | 30.31 | -0.19 | -0.64% |
| Emergent Herbaceous Wetland | 2.37 | -0.80 | 0.44 | 2.01 | -0.36 | -15.15% |
| Barren Land | 0.67 | -0.45 | 1.97 | 2.19 | 1.52 | 227.01% |
| Open Water | 11.18 | -1.90 | 4.39 | 13.66 | 2.49 | 22.24% |
| Perennial Snow/Ice | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00% |

*All numbers expressed in square miles

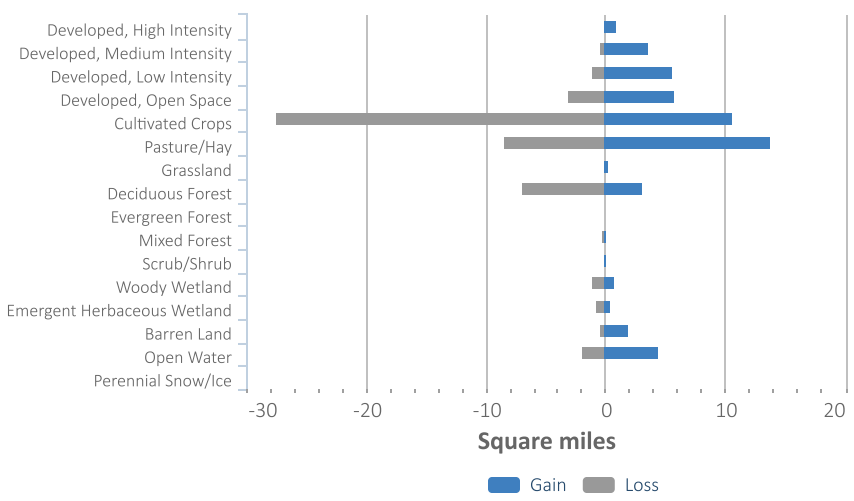
# Land Cover Overview

*Gibson County, Indiana*

***Land Cover Data: 1985 to 2024***

**Area Gained - Area Lost = Net change**

Net change numbers can be deceiving; forests may be lost on one side of the County, while another area may experience an increase. The net change might be minimal, yet the total area of change could be substantial, and the quality of new growth areas may be different than those lost. It is important to look at these offsetting losses and gains, in addition to the overall net difference.



# Development

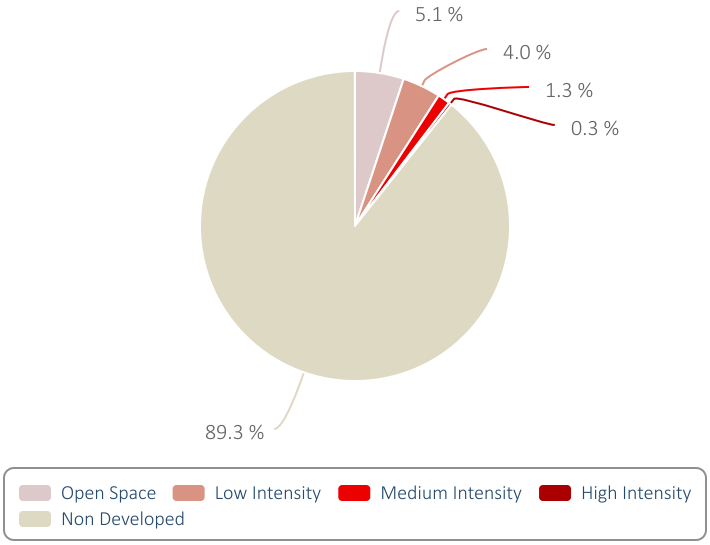
*Gibson County, Indiana*

***Land Cover Data: 1985 to 2024***

**Development and Impervious Surfaces (2024)**

**10.62% of Gibson County is developed and 2.63% is impervious.**

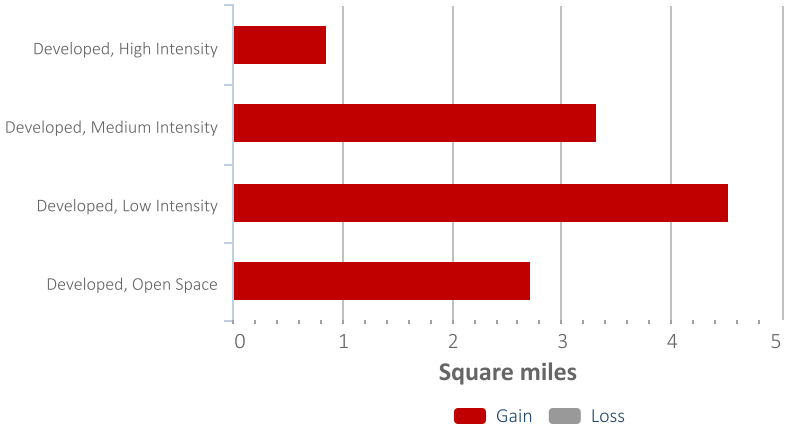
More development means more impervious surfaces, which translates into a greater risk for increased flooding and decreased water quality. Areas with impervious surface rates approaching or exceeding 12 percent to 15 percent will likely experience negative impacts to water quality. Severe degradation can be expected when rates reach 25 percent. This chart highlights the percentage of the County developed in 2024.




**Development Change**

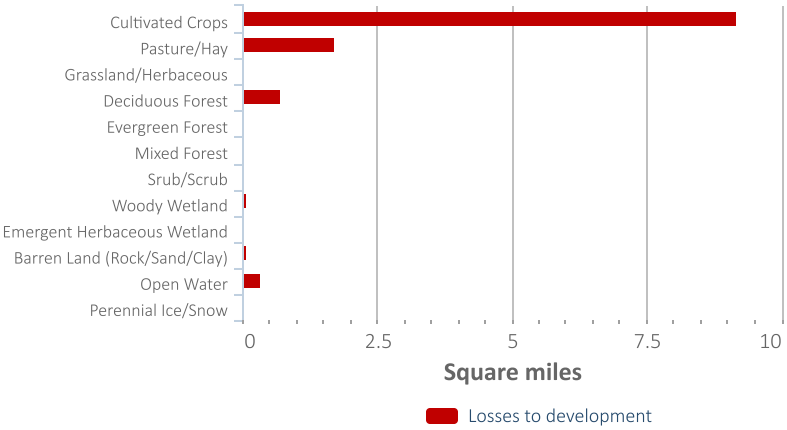
**11.44 square miles of development and 4.24 square miles of impervious surfaces were gained between 1985 and 2024.**

Low density and open space development can impact water quality negatively, though usually to a lesser degree than with higher density development. This graph shows how each type of development changed between 1985 and 2024.




**What's Being Lost**

Unlike natural land cover changes, land lost to development tends to be permanent. This graph shows the types of lands that changed to developed between 1985 and 2024. It does not show any potential losses of previously developed areas, as this is a rare occurrence.



# Forests

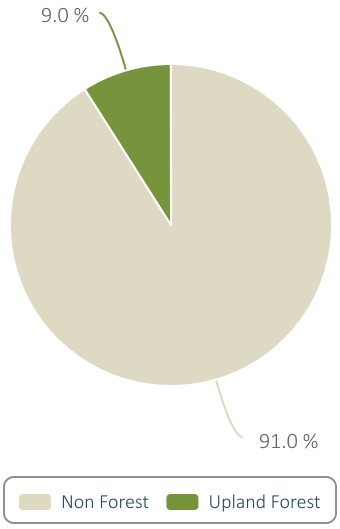
*Gibson County, Indiana*

***Land Cover Data: 1985 to 2024***

**Current State of Forests (2024)**

**9.03% of Gibson County is forest.**

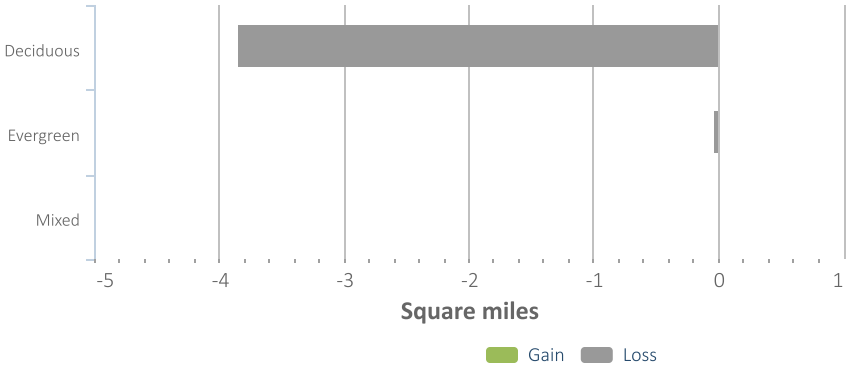
Healthy forests are a vital part of a healthy ecosystem, but it is important to understand the types of forest that are present. This chart shows the percentage of the County that is forested as well as the percentage in uplands and wetlands.




**Forest Change**

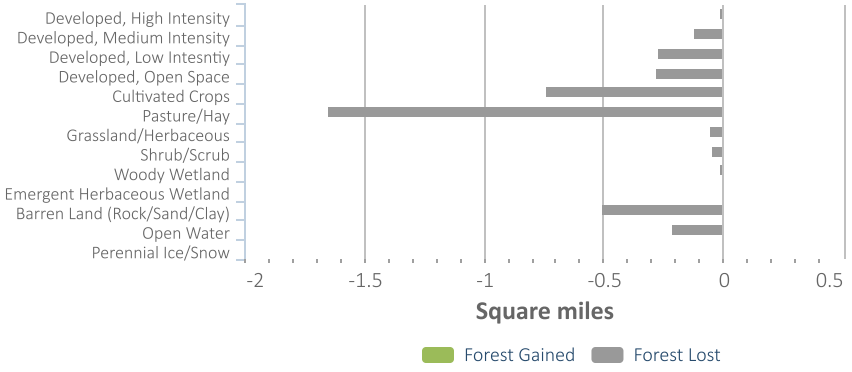
**3.88 square miles of the forest was lost between 1985 and 2024.**

Knowing which types of forests are being lost or gained can be as important as knowing about changes in the total forest area. Different forest types can differ in ecosystem value. This graph highlights changes in each forest type over a specific time frame.




**What is Changing**

A forest can go through a transitional period after a fire, other natural disaster, or logging operation, but typically can be expected to recover. Some losses, such as forests converted to development, tend to be permanent. This graph highlights the transformation of forestlands into different land cover types. It also highlights the origin of any forest gains.



# Wetlands

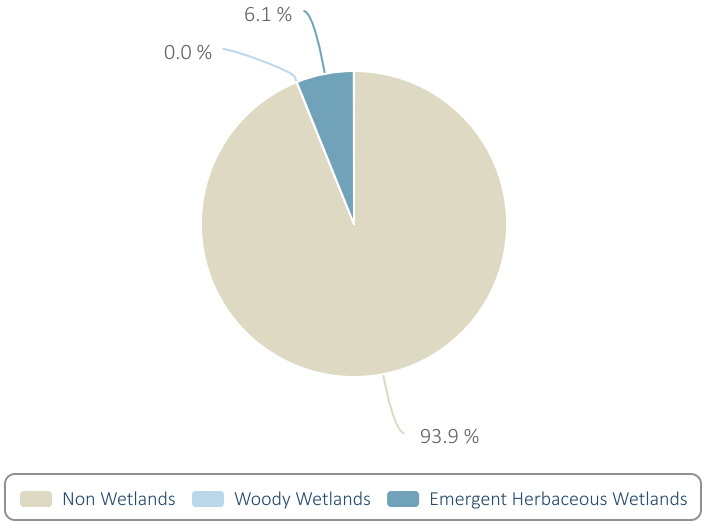
*Gibson County, Indiana*

***Land Cover Data: 1985 to 2024***

### Current State of Wetlands (2024)

**6.48% of Gibson County is wetland.**

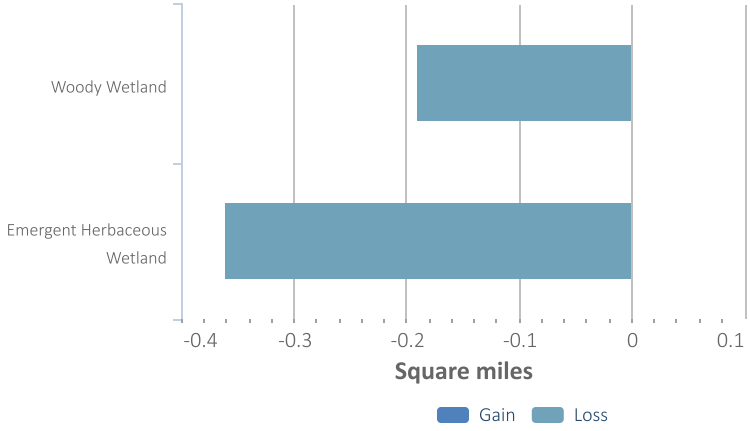
Wetlands are among the most productive environments on Earth. Wetlands provide habitat and food, buffer the impacts of storm surge and flooding, and help control erosion. Wetlands also absorb, store, and filter urban and agricultural runoff to maintain water quality. This chart highlights how much of the County is covered by wetlands.




### Wetland Change

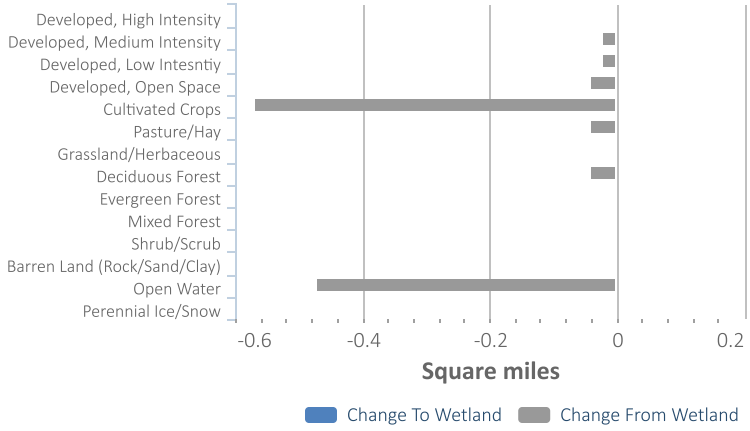
**0.55 square miles of wetlands were lost between 1985 and 2024.**

When a wetland area or type undergoes change, the benefits of the wetland will change as well. Understanding which type of wetland is changing, and how, can help in determining the eventual impacts of the change. This graph highlights the change or changes in each type of wetland.




### What Is Changing

Understanding wetland changes can help communities identify potential management actions to reverse or mitigate the trend. This graph highlights the transformation of lost wetlands into different land cover types. It also highlights the origin of any wetland gains.



# Agriculture

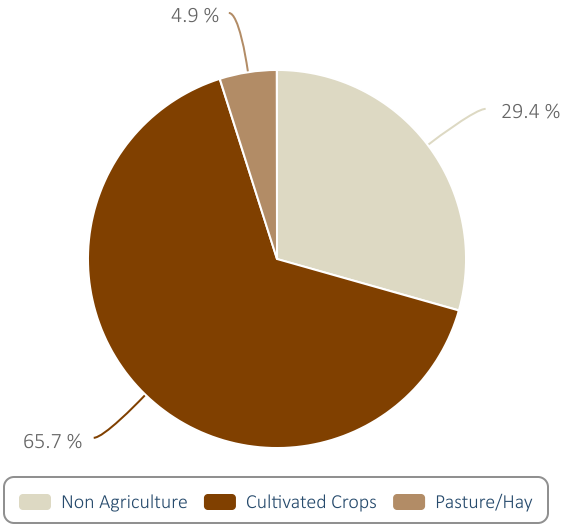
*Gibson County, Indiana*

***Land Cover Data: 1985 to 2024***

**Current State of Agriculture (2024)**

**70.60% of Gibson County is agriculture.**

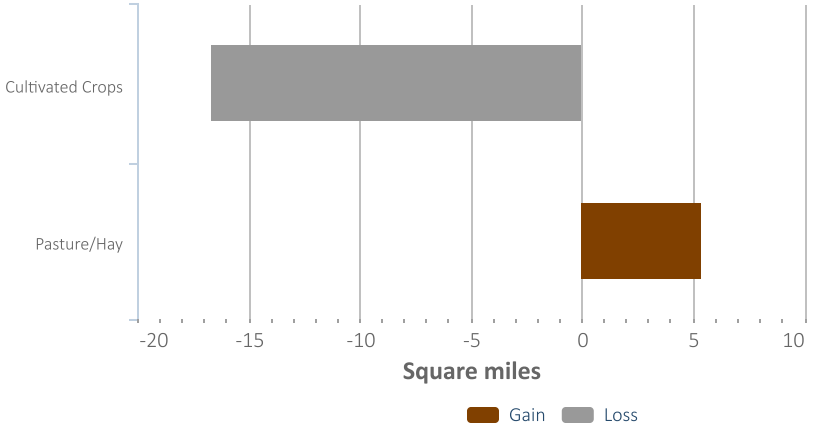
NLCD Agriculture classes include land used for production of annual crops as well as areas intensively managed for livestock production. Agricultural areas are managed in in a variety of ways including tillage, fertilization, and other man-made interventions that make the area more productive than it would be naturally.




**Agriculture Change**

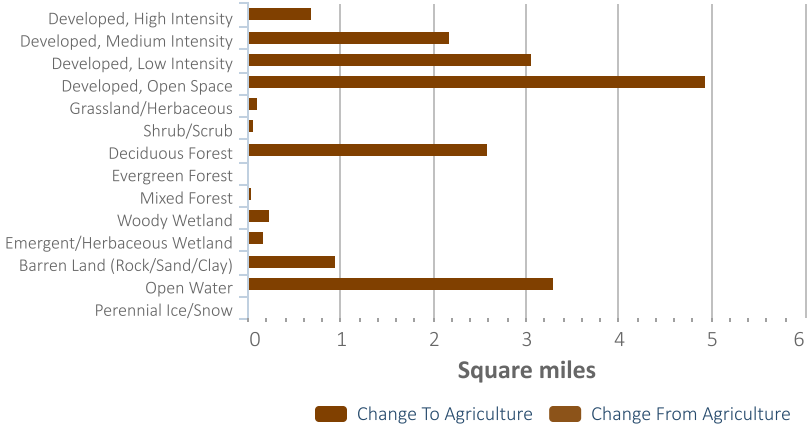
**11.27 square miles of agriculture were lost between 1985 and 2024.**

Agricultural lands can have a high impact on surrounding areas. This can be for a variety of reasons including runoff, pesticide application, fertilizer application, etc. This can also show conversion of natural areas to more highly managed areas which relate to overall increases for local impacts. This can also include areas of hay pasture, which generally have lower impacts on the landscape, to higher production cultivated crops. Decreasing agricultural land can show habitat restoration, increased urbanization, decreasing water availability, and a host of other factors important for resource managers and local communities.



**What Is Changing**

As agricultural lands increase or decrease, a variety of impacts can happen. Increasing agricultural lands can sometimes identify increased water usage as well as loss of natural habitat. Decreasing agricultural lands can highlight droughts, long-term water shortages, habitat restoration, etc. etc. Understanding how these changes are occurring and to what extent help to identify usage and potential risks for producers and the community.



# Digging Deeper

Understanding how your County's land cover has changed over the years is an excellent way to document trends, understand the effects of past land use decisions, and consider future land use planning needs. This report, which covers 1985 and 2024, provides a solid foundation.

Communities adding additional data and analysis are able to generate findings designed to meet their specific needs. There are additional tools developed by NOAA's Digital Coast. This provides data and information useful for this purpose in coastal areas. Visit the website at coast.noaa.gov/digitalcoast. Some examples are listed below.

## Land Cover Resources

Interested in more information related to land cover, or in taking this analysis one step further? Start with the following tools that use land cover to analyze specific issues.

- **Nonpoint - Source Pollution and Erosion Comparison Tool -** Investigates potential water quality impacts from development, and other change. coast.noaa.gov/nspect
- **Coastal County Snapshots**- Provides local officials with easy-to-understand graphics and analysis that cover a county's demographics, infrastructure, and environment. https://coast.noaa.gov/snapshots
- **Sea Level Rise Impacts Viewer**- Displays maps of potential impacts of sea level rise along the coast and provides related information and data for community officials. https://coast.noaa.gov/slr
- **Coastal Flood Exposure Mapper**- Supports communities that are assessing their coastal hazard risks and vulnerabilities. The tool creates a collection of user-defined maps that show the people, places, and natural resources exposed to coastal flooding. https://coast.noaa.gov/floodexposure

## About the Source Data

The data seen in the map below was derived through the MRLC(Multi Resolution Land characteristics Consortium). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States. Multiple dates of satellite imagery are used to document changes in various types of land cover.

- **Notes and Limitations** While efforts have been made to ensure that data are accurate and reliable within the limits of current technology, NLCD data sets were made for analysis at a regional and national scale. These data are intended for use in identifying regional landscape patterns and major functional habitats. NLCD is a national and regional data set that should be used only as a screening tool for very local or site-specific management decisions. Small features and changes should be verified with a higher resolution data source. Additional resources on accuracy and methodology can be found on the MRLC publications page Publications | Multi-Resolution Land Characteristics (MRLC) Consortium (https://www.mrlc.gov/publications)

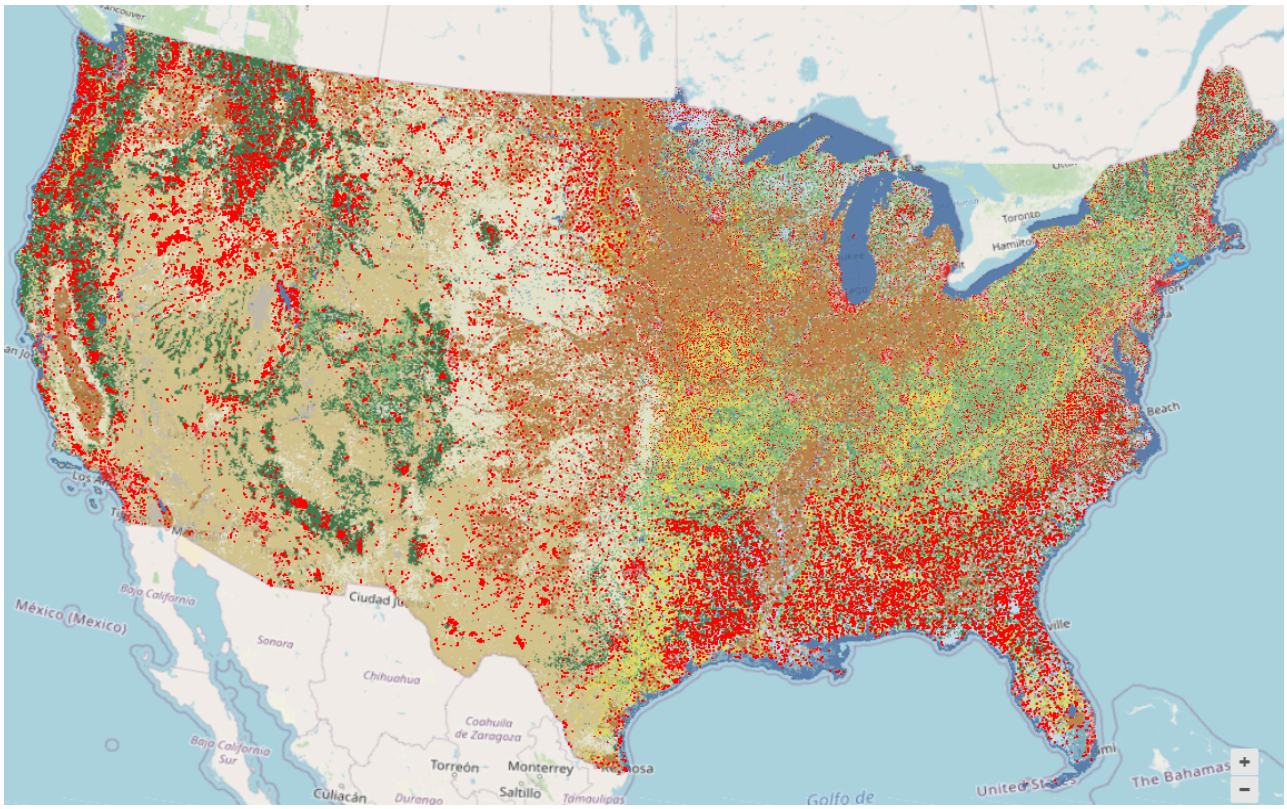
# Vanderburgh County, Indiana

## *2024 Land Cover*

Having an accurate picture of an area's landscape and understanding how that landscape is changing is important information for any planning effort. Land cover data can help provide that big-picture view.

The data seen in the map below was derived through the Multi Resolution Land characteristics Consortium (MRLC). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States Multiple dates of satellite imagery are used to document changes in various types of land cover. The 2024 land cover for Vanderburgh County can be seen below.

These summary sheets provide an easy way to understand some of the important information derived from these data for Vanderburgh County.



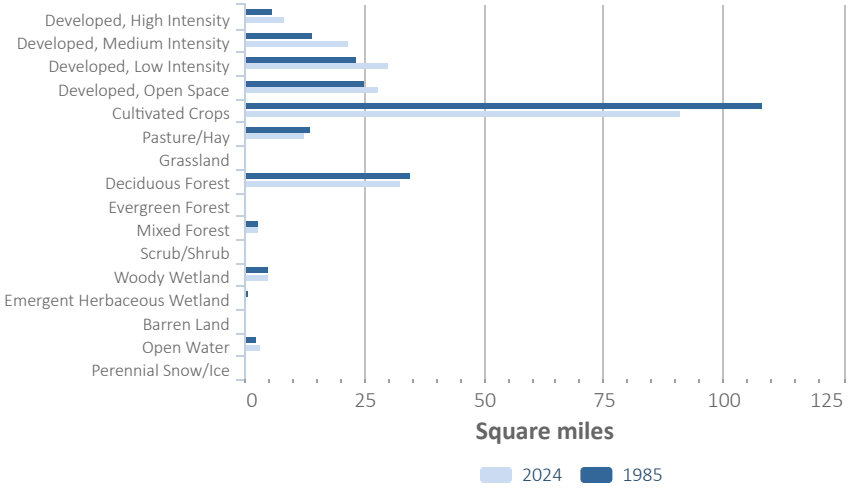
# Land Cover Overview

*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

## Land Cover Basics

**16.01 percent of this County changed.**




Communities comparing data from one year to the next can evaluate how their land use management efforts are working, and can also use information on trends to aid future planning initiatives. In this bar chart, showing each land cover class, the difference between the two bars represents the net difference in the area for that category. This data represents a beginning to end year comparison,and does not quantify cumulative change between years. For instance, an evergreen forest that was harvested after the beginning year and re-grew to Evergreen forest before the end year would not be represented in the statistics. Additional GIS analysis is needed for this type of cumulative change. Other data sources available through the MRLC consortium include developed impervious surface, percent forest canopy cover, and nine discrete rangeland components for the Western United States. All of these additional components provide increased and complementary detail for analysis across the United States.

| Land Cover Categories | Area 1985 | Area Lost | Area Gained | Area 2024 | Net Change | Percent Change |
|---|---|---|---|---|---|---|
| Developed, High Intensity | 6.00 | -0.10 | 2.33 | 8.23 | 2.23 | 37.26% |
| Developed, Medium Intensity | 14.26 | -1.15 | 8.43 | 21.54 | 7.28 | 51.01% |
| Developed, Low Intensity | 23.42 | -2.43 | 9.20 | 30.19 | 6.76 | 28.87% |
| Developed, Open Space | 25.02 | -5.08 | 8.10 | 28.04 | 3.03 | 12.10% |
| Cultivated Crops | 108.21 | -18.88 | 1.91 | 91.24 | -16.97 | -15.68% |
| Pasture/Hay | 13.82 | -5.74 | 4.64 | 12.72 | -1.10 | -7.94% |
| Grassland | 0.09 | -0.08 | 0.16 | 0.17 | 0.08 | 83.39% |
| Deciduous Forest | 34.74 | -3.17 | 1.10 | 32.67 | -2.07 | -5.96% |
| Evergreen Forest | 0.10 | -0.03 | 0.01 | 0.07 | -0.03 | -26.07% |
| Mixed Forest | 3.04 | -0.32 | 0.33 | 3.06 | 0.01 | 0.45% |
| Scrub/Shrub | 0.05 | -0.05 | 0.00 | 0.00 | -0.04 | -90.65% |
| Woody Wetland | 4.98 | -0.26 | 0.15 | 4.87 | -0.11 | -2.22% |
| Emergent Herbaceous Wetland | 0.64 | -0.19 | 0.09 | 0.53 | -0.10 | -16.28% |
| Barren Land | 0.02 | -0.01 | 0.11 | 0.13 | 0.11 | 531.58% |
| Open Water | 2.38 | -0.40 | 1.33 | 3.30 | 0.92 | 38.89% |
| Perennial Snow/Ice | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00% |

*All numbers expressed in square miles

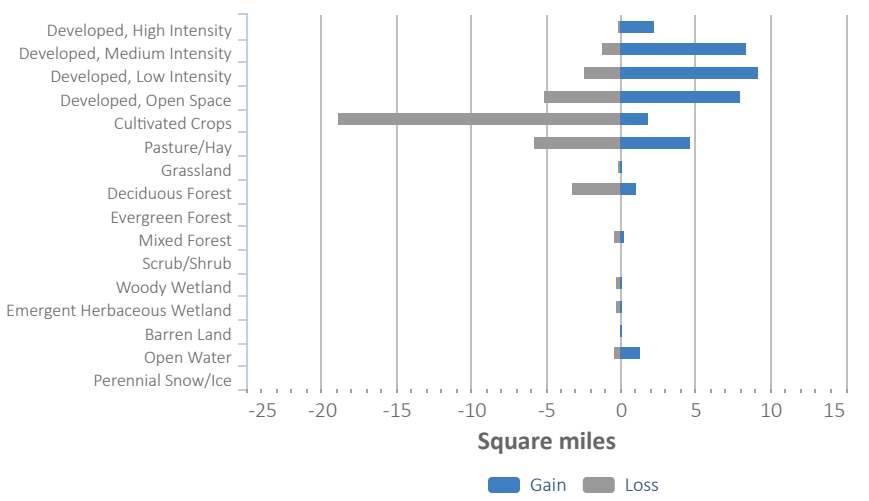
# Land Cover Overview

*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

**Area Gained - Area Lost = Net change**

Net change numbers can be deceiving; forests may be lost on one side of the County, while another area may experience an increase. The net change might be minimal, yet the total area of change could be substantial, and the quality of new growth areas may be different than those lost. It is important to look at these offsetting losses and gains, in addition to the overall net difference.



# Development

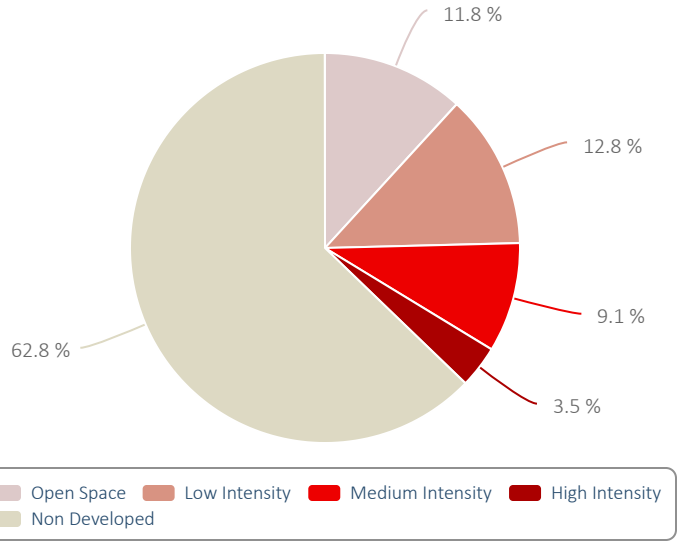
*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

**Development and Impervious Surfaces (2024)**

**37.17% of Vanderburgh County is developed and 13.05% is impervious.**

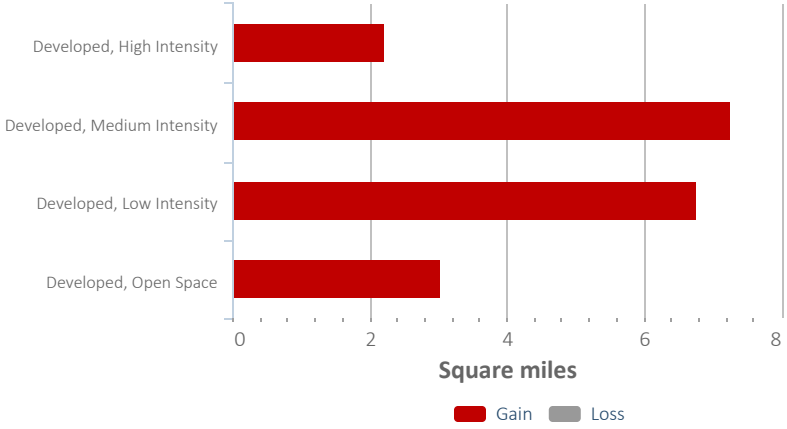
More development means more impervious surfaces, which translates into a greater risk for increased flooding and decreased water quality. Areas with impervious surface rates approaching or exceeding 12 percent to 15 percent will likely experience negative impacts to water quality. Severe degradation can be expected when rates reach 25 percent. This chart highlights the percentage of the County developed in 2024.




**Development Change**

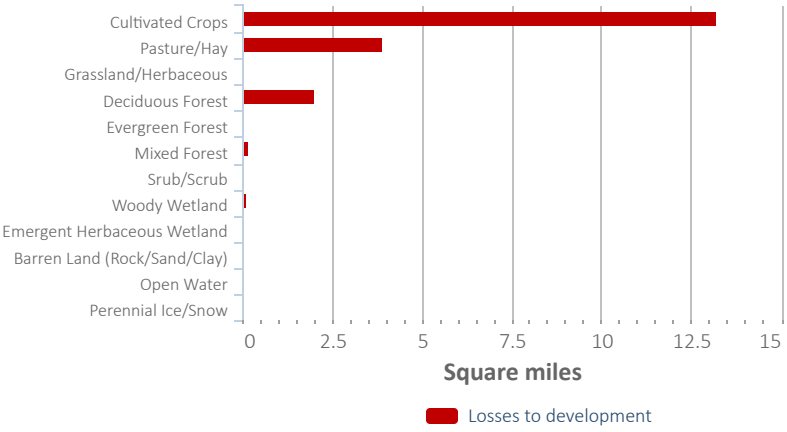
**19.30 square miles of development and 8.36 square miles of impervious surfaces were gained between 1985 and 2024.**

Low density and open space development can impact water quality negatively, though usually to a lesser degree than with higher density development. This graph shows how each type of development changed between 1985 and 2024.




**What's Being Lost**

Unlike natural land cover changes, land lost to development tends to be permanent. This graph shows the types of lands that changed to developed between 1985 and 2024. It does not show any potential losses of previously developed areas, as this is a rare occurrence.



# Forests

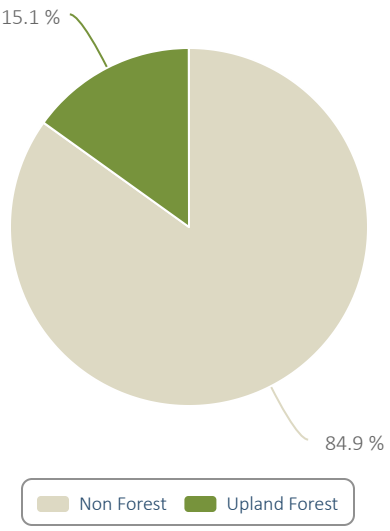
*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

**Current State of Forests (2024)**

**15.12% of Vanderburgh County is forest.**

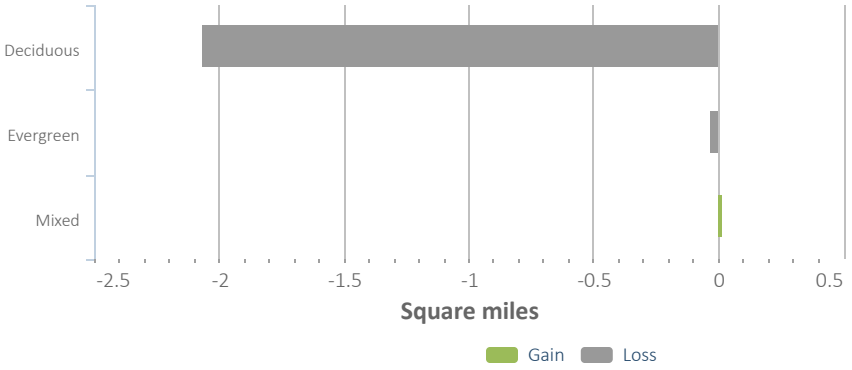
Healthy forests are a vital part of a healthy ecosystem, but it is important to understand the types of forest that are present. This chart shows the percentage of the County that is forested as well as the percentage in uplands and wetlands.




**Forest Change**

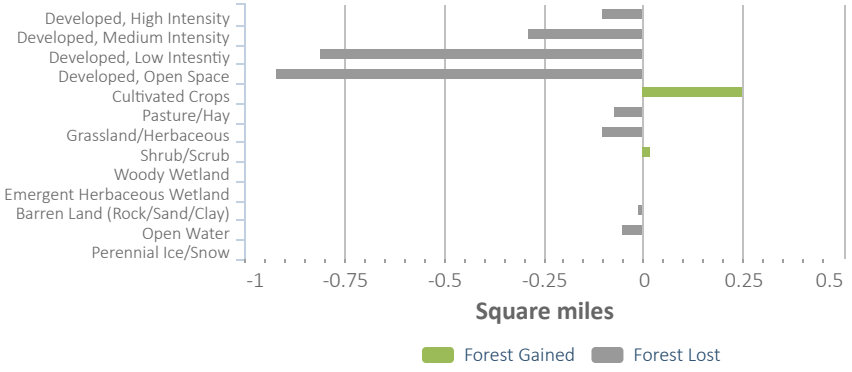
**2.08 square miles of the forest was lost between 1985 and 2024.**

Knowing which types of forests are being lost or gained can be as important as knowing about changes in the total forest area. Different forest types can differ in ecosystem value. This graph highlights changes in each forest type over a specific time frame.




**What is Changing**

A forest can go through a transitional period after a fire, other natural disaster, or logging operation, but typically can be expected to recover. Some losses, such as forests converted to development, tend to be permanent. This graph highlights the transformation of forestlands into different land cover types. It also highlights the origin of any forest gains.



# Wetlands

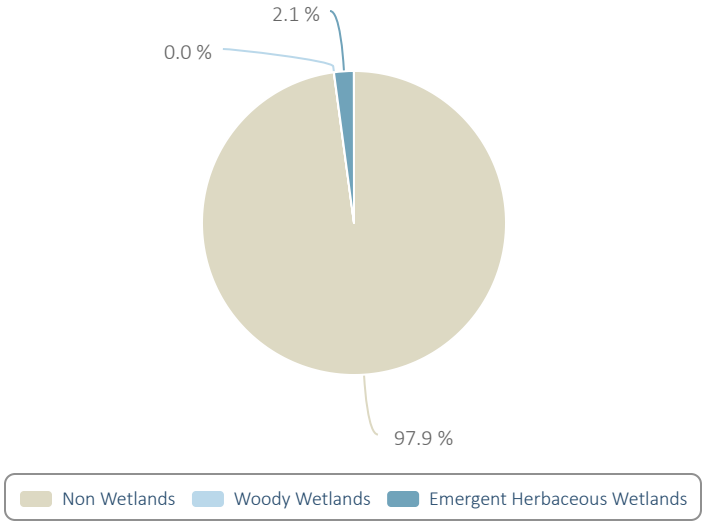
*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

### Current State of Wetlands (2024)

**2.28% of Vanderburgh County is wetland.**

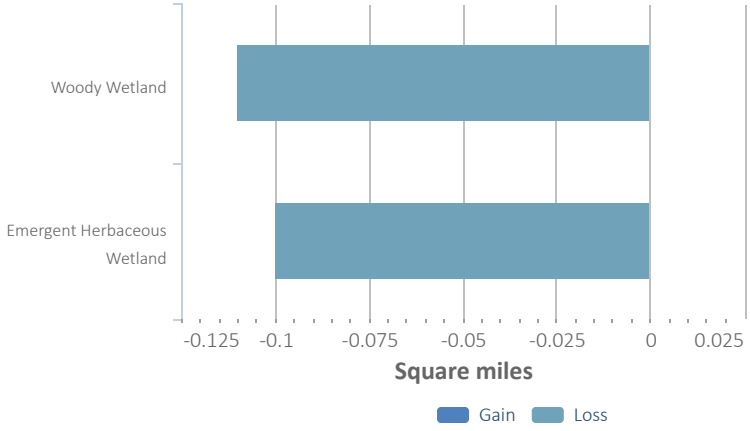
Wetlands are among the most productive environments on Earth. Wetlands provide habitat and food, buffer the impacts of storm surge and flooding, and help control erosion. Wetlands also absorb, store, and filter urban and agricultural runoff to maintain water quality. This chart highlights how much of the County is covered by wetlands.




### Wetland Change

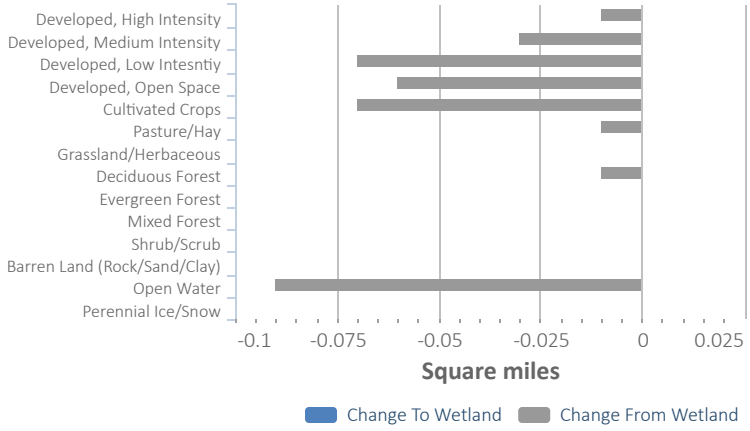
**0.21 square miles of wetlands were lost between 1985 and 2024.**

When a wetland area or type undergoes change, the benefits of the wetland will change as well. Understanding which type of wetland is changing, and how, can help in determining the eventual impacts of the change. This graph highlights the change or changes in each type of wetland.




### What Is Changing

Understanding wetland changes can help communities identify potential management actions to reverse or mitigate the trend. This graph highlights the transformation of lost wetlands into different land cover types. It also highlights the origin of any wetland gains.



# Agriculture

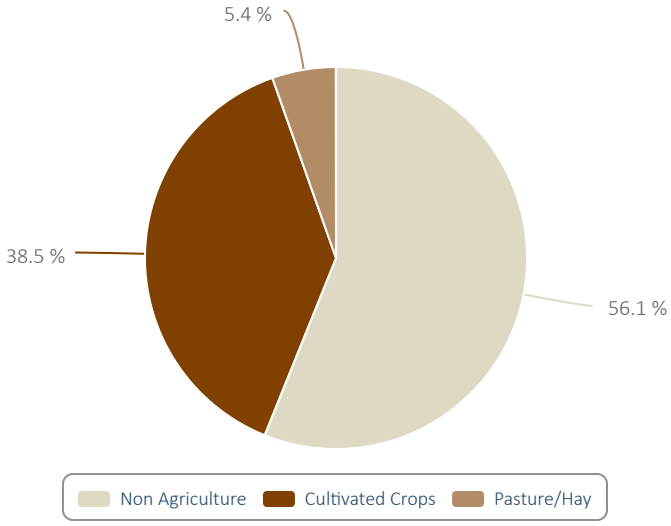
*Vanderburgh County, Indiana*

***Land Cover Data: 1985 to 2024***

**Current State of Agriculture (2024)**

**43.91% of Vanderburgh County is agriculture.**

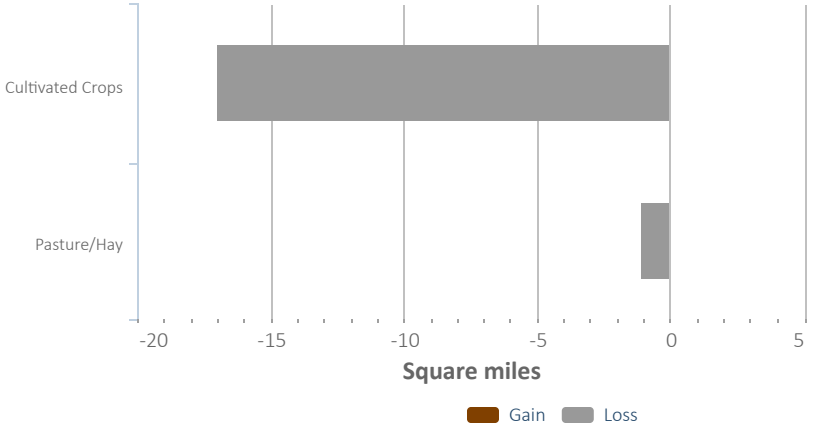
NLCD Agriculture classes include land used for production of annual crops as well as areas intensively managed for livestock production. Agricultural areas are managed in in a variety of ways including tillage, fertilization, and other man-made interventions that make the area more productive than it would be naturally.




**Agriculture Change**

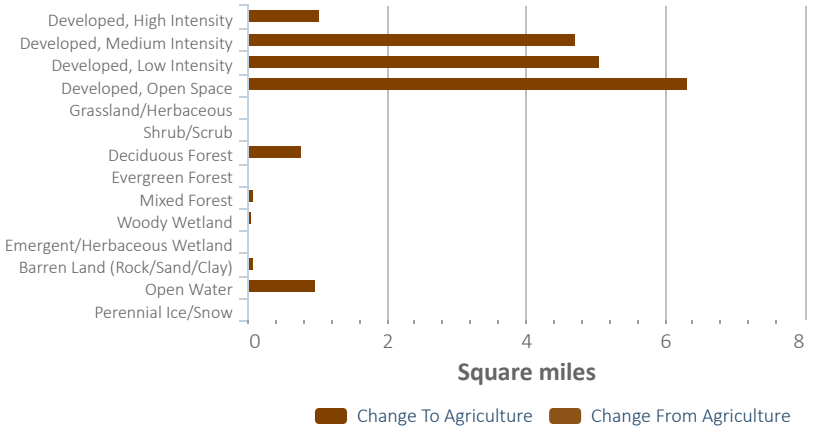
**18.07 square miles of agriculture were lost between 1985 and 2024.**

Agricultural lands can have a high impact on surrounding areas. This can be for a variety of reasons including runoff, pesticide application, fertilizer application, etc. This can also show conversion of natural areas to more highly managed areas which relate to overall increases for local impacts. This can also include areas of hay pasture, which generally have lower impacts on the landscape, to higher production cultivated crops. Decreasing agricultural land can show habitat restoration, increased urbanization, decreasing water availability, and a host of other factors important for resource managers and local communities.



**What Is Changing**

As agricultural lands increase or decrease, a variety of impacts can happen. Increasing agricultural lands can sometimes identify increased water usage as well as loss of natural habitat. Decreasing agricultural lands can highlight droughts, long-term water shortages, habitat restoration, etc. etc. Understanding how these changes are occurring and to what extent help to identify usage and potential risks for producers and the community.



# Digging Deeper

Understanding how your County's land cover has changed over the years is an excellent way to document trends, understand the effects of past land use decisions, and consider future land use planning needs. This report, which covers 1985 and 2024, provides a solid foundation.

Communities adding additional data and analysis are able to generate findings designed to meet their specific needs. There are additional tools developed by NOAA's Digital Coast. This provides data and information useful for this purpose in coastal areas. Visit the website at coast.noaa.gov/digitalcoast. Some examples are listed below.

## Land Cover Resources

Interested in more information related to land cover, or in taking this analysis one step further? Start with the following tools that use land cover to analyze specific issues.

- **Nonpoint - Source Pollution and Erosion Comparison Tool -** Investigates potential water quality impacts from development, and other change. coast.noaa.gov/nspect
- **Coastal County Snapshots**- Provides local officials with easy-to-understand graphics and analysis that cover a county's demographics, infrastructure, and environment. https://coast.noaa.gov/snapshots
- **Sea Level Rise Impacts Viewer**- Displays maps of potential impacts of sea level rise along the coast and provides related information and data for community officials. https://coast.noaa.gov/slr
- **Coastal Flood Exposure Mapper**- Supports communities that are assessing their coastal hazard risks and vulnerabilities. The tool creates a collection of user-defined maps that show the people, places, and natural resources exposed to coastal flooding. https://coast.noaa.gov/floodexposure

## About the Source Data

The data seen in the map below was derived through the MRLC(Multi Resolution Land characteristics Consortium). The MRLC produces the National Landcover Database (NLCD), a nationally standardized land cover and land change information product for the United States. Multiple dates of satellite imagery are used to document changes in various types of land cover.

- **Notes and Limitations** While efforts have been made to ensure that data are accurate and reliable within the limits of current technology, NLCD data sets were made for analysis at a regional and national scale. These data are intended for use in identifying regional landscape patterns and major functional habitats. NLCD is a national and regional data set that should be used only as a screening tool for very local or site-specific management decisions. Small features and changes should be verified with a higher resolution data source. Additional resources on accuracy and methodology can be found on the MRLC publications page Publications | Multi-Resolution Land Characteristics (MRLC) Consortium (https://www.mrlc.gov/publications)

# APPENDIX 2: TYPICAL COUNTY STORMWATER MANAGEMENT REQUIREMENTS

PURDUE UNIVERSITY | Local Technical Assistance Program (LTAP)

Quick facts on local Stormwater Ordinances & Technical Standards...

# *The Necessity for Updating Local Development Standards*

Complying with the minimum Federal and State regulations **has not and will not** protect our communities against the increased flood stages and increased streambank erosion that we have observed throughout Indiana. This Fact Sheet is a tool to educate community leaders on proven methods to implement proactive measures that are appropriate for and tailored to local conditions aimed at preventing an increase in community's vulnerabilities to flooding, erosion, and stormwater quality degradation: local **Stormwater Ordinances** and **Stormwater Technical Standards**.




## *Our Vulnerabilities:*

- There is visual, scientific, and statistical evidence that Indiana communities are experiencing more frequent and higher rainfalls.
- If we do not address stormwater runoff from increased rainfall and future changes to land use (such as converting green space to developed/impervious areas and filling depressional areas and floodplains), flood stages will continue to rise and the flow path of flood waters will continue to spread further and further into our communities.

  In addition, while most communities regulate land use for stormwater runoff from medium (2-year storm events) to large (100-year) storms, many do not regulate smaller (1-year to 2-year) storms that cause rivers and channels to seek a new shape and erode streambanks. This must change to protect our communities.
- MS4 communities across Indiana must update local ordinances to incorporate the latest stormwater quality requirements and the updated requirements contained within IDEM's new Construction Stormwater General Permit (CSGP) that became effective on December 18, 2021.

## *Our Response:*

Local governments can implement No-Adverse-Impact stormwater measures that encompass:

- Prohibiting/discouraging development in floodplain areas and prohibiting encroachment into floodways and erosional corridors.
- Implementing stormwater control measures appropriate for local conditions by upgrading Stormwater Ordinances and Stormwater Technical Standards. These must include regulations and guidance for smaller (1-year to 2-year) storms; the storms that are shaping our local streams and channels.
- Improved water quality through incorporating best practices and mandated IDEM requirements for smaller floods.
- The collection and organization of all stormwater-related legal requirements into a single, streamlined comprehensive document, along with detailed technical requirements organized into a companion technical standards manual. This will help both the development community better navigate the requirements and help plan reviewers better focus on major items.

CHRISTOPHER B. BURKE ENGINEERING, LLC

PURDUE UNIVERSITY | Local Technical Assistance Program (LTAP)

## Why have a Model Ordinance & Standards?

**For over 40 years**, Purdue University (through LTAP, formerly HERPIC) has helped develop drainage standards and ordinances that could be adopted by Indiana jurisdictions to satisfy local needs related to: the current state of stormwater engineering practice; reasonable drainage control regulations; and reasonable engineering standards.

## Who are these tools intended for?

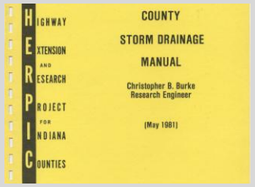
While the model ordinance and standards meet the minimum requirements of the new IDEM CSGP which includes requirements for MS4-designated communities, they also contain practices and standards that every community in the state should consider adopting. These tools establish a baseline standard for responsible stormwater management, regardless of whether or not such a standard is required by a federal or state agency.

## How were the 2025 updates prepared?

Following past practice, LTAP worked with experts in stormwater management, IDEM, County Surveyors, and MS4 Coordinators to make this periodic update and prepare the 2025 updated model ordinance and accompanying technical standards updates. Christopher B. Burke Engineering, LLC, developed the initial drafts, followed by peer review and incorporation of comments.

### Timeline of Drainage Standards and Model Ordinance Updates Developed by HERPIC and LTAP:

1981:

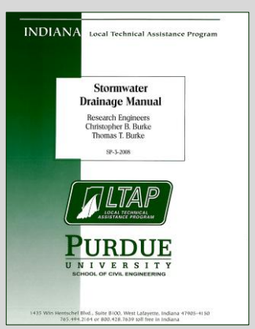



1988: General Stormwater Ordinance

1989: Erosion & Sediment Control Ordinance

1995: Stormwater Drainage Manual Update

2008:




2015: Stormwater Drainage Manual Update

2025: General Stormwater Ordinance Update

2025: Stormwater Technical Standards Update

# THE MODEL ORDINANCE

The Model Ordinance is organized into seven sections as identified and summarized below. Sections 2, 4, and the stormwater quality portion of section 5 have been specifically developed to meet current best practice, the IDEM CSGP requirements, and the most recent legislative provisions (including HEA 1037) for entities that have MS4 designation. However, these provisions are prudent and recommended to be adopted by all entities regardless of federal or state mandates. Non-MS4 communities who do not wish to proactively regulate the water quality or prohibited non-stormwater flows in their communities can delete the sections highlighted in green.

### *SECTION 1: GENERAL INFORMATION*

This Ordinance provides for the health, safety, and general welfare of the citizens of the *Jurisdiction Entity* through the regulation of stormwater and non-stormwater discharges to the storm drainage system and to protect, conserve and promote the orderly development of land and water resources within the *Jurisdiction Entity*.

### *SECTION 2: PROHIBITED DISCHARGES AND CONNECTIONS*

No person shall discharge to a MS4 conveyance, watercourse, or waterbody, directly or indirectly, any substance other than stormwater or an exempted discharge. Any person discharging stormwater shall effectively minimize pollutants from also being discharged with the stormwater, through the use of best management practices.

### *SECTION 3: STORMWATER QUANTITY MANAGEMENT*

Most streams and drainage channels serving the Jurisdiction Entity do not have sufficient capacity to receive a: nd convey stormwater runoff resulting from continued urbanization. Accordingly, the storage and controlled release of excess stormwater runoff shall be required for all developments and redevelopments within the Jurisdiction Entity.

### *SECTION 4: STORMWATER POLLUTION PREVENTION FOR CONSTRUCTION SITES*

Effective stormwater pollution prevention on construction sites is dependent on a combination of preventing movement of soil from its original position (erosion control), intercepting displaced soil prior to entering a waterbody (sediment control), and proper on-site materials handling.

### *SECTION 5: POST-CONSTRUCTION STORMWATER QUALITY MANAGEMENT AND CHANNEL PROTECTION*

Developed areas generally have increased imperviousness, decreased infiltration rates, increased runoff rates, and increased concentrations of pollutants (fertilizers, herbicides, greases, oil, and salts). As new development continues, measures must be taken to intercept and filter pollutants from stormwater runoff prior to reaching regional creeks, streams, and rivers. Measures must also be taken to protect channel and minimize streambank erosion.

### *SECTION 6: PERMIT REQUIREMENTS AND PROCEDURES*

The project site owner shall submit an application for a Stormwater Management Permit to the Jurisdiction Entity. The application will include an application checklist, construction plan sheets, a stormwater drainage technical report, a stormwater pollution prevention plan, and any other necessary support information.

### *SECTION 7: COMPLIANCE AND ENFORCEMENT*

If the Jurisdiction Entity determines that an applicant has failed to comply with the terms and conditions of a permit, an approved stormwater management design plan, a recorded stormwater management maintenance agreement, or the provisions of this ordinance, it shall issue a written Notice of Violation and impose fimes to such applicant.

# TECHNICAL STANDARDS

This up-to-date, consistent, comprehensive Model Stormwater Technical Standards Manual works hand-in-hand with its companion Model Stormwater Ordinance. The standards provide details of how the ordinance provisions will need to be satisfied and are intended to help counties and communities in Indiana manage stormwater impacts in a changing climate, which has exacerbated these impacts and created new concerns. Chapters 7, 8, and 9 have been specifically developed to meet IDEM's requirements for entities that have MS4 designation. Non-MS4 communities who do not wish to proactively regulate the stormwater quality in their communities can delete these chapters highlighted in green.

**Chapter 1:** INTRODUCTION

**Chapter 2:** METHODOLOGY FOR DETERMINATION OF RUNOFF RATES

**Chapter 3:** METHODOLOGY FOR DETERMINATION OF RETENTION/ DETENTION STORAGE VOLUMES

**Chapter 4:** STORM SEWER DESIGN STANDARDS AND SPECIFICATIONS

**Chapter 5:** OPEN CHANNEL DESIGN STANDARDS AND SPECIFICATIONS

**Chapter 6:** STORMWATER DETENTION DESIGN STANDARDS FOR PEAK FLOW CONTROL

**Chapter 7:** CONSTRUCTION SITES STORMWATER POLLUTION PREVENTION STANDARDS

**Chapter 8:** POST-CONSTRUCTION STORMWATER QUALITY MANAGEMENT AND CHANNEL PROTECTION STANDARDS

**Chapter 9:** METHODOLOGY FOR DETERMINATION OF REQUIRED SIZING OF BMPS

**Chapter 10**: LOT/BUILDING GRADING AND DRAINAGE STANDARDS

- **A.** GRADING AND BUILDING PAD ELEVATIONS
- **B.** LOT DRAINAGE
- **C.** ACCEPTABLE OUTLET AND ADJOINING PROPERTY IMPACTS POLICIES

**Chapter 11:** RIVER CORRIDOR, BLUFFS, AND FLOODPLAIN STRAGE PRESERVASTION STANDARDS

- **A.** DEVELOPMENT WITHIN FLOODWAYS AND FLUVIAL EROSION HAZARD CORRIDORS
- **B.** ADDITIONAL CONSIDERATION FOR DEVELOPMENT WITHIN OR ADJACENT TO BLUFF ZONES AND STEEP SLOPES
- **C.** FLOODPLAIN STORAGE PRESERVATION STANDARDS

**Chapter 12**: STANDARDS ASSOCIATED WITH DAMS AND LEVEES

- **A.** POLICY ON DAMS AND LEVEES
- **B.** STANDARDS ASSOCIATED WITH DEVELOPMENTS DOWNSTREAM OF DAMS

**Chapter 13:** SPECIAL STANDARDS FOR PROPOSED SOLAR FARMS

**Appendix B:** STANDARD FORMS

**Appendix A:** ABBREVIATIONS AND DEFINITIONS

CHRISTOPHER B. BURKE ENGINEERING, LLC

*November 2025*

# APPENDIX 3: FEMA FLOOD INSURANCE STUDY INFORMATION

# FLOOD INSURANCE STUDY



# VANDERBURGH COUNTY, INDIANA
## AND INCORPORATED AREAS

| COMMUNITY NAME | COMMUNITY NUMBER |
|---|---|
| DARMSTADT, TOWN OF | 180629 |
| EVANSVILLE, CITY OF | 180257 |
| VANDERBURGH COUNTY UNINCORPORATED AREAS | 180256 |



**Vanderburgh County**

REVISED: JANUARY 29, 2021

Federal Emergency Management Agency

**FLOOD INSURANCE STUDY NUMBER**
**18163CV000B**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Nurenbern Ditch | | | | | | | | |
| A | 625[1] | 309 | 263 | 1.2 | 386.9 | 384.4[5] | 384.4 | 0.0 |
| B | 1,786[1] | 316 | 272 | 1.2 | 386.9 | 385.3[5] | 385.3 | 0.0 |
| C | 2,706[1] | 335 | 559 | 0.6 | 386.9 | 386.1[5] | 386.2 | 0.1 |
| D | 3,408[1] | 320 | 527 | 0.6 | 386.9 | 386.1[5] | 386.2 | 0.1 |
| E | 3,761[1] | 195 | 185 | 1.3 | 386.9 | 386.1[5] | 386.2 | 0.1 |
| Ohio River | | | | | | | | |
| A | 816.0[2] | 20800 / 17[3] | 277,348 | 3.3 | 373.5 | 373.5 | 373.6 | 0.1 |
| B | 795.8[2] | 8092 / 3085[3] | 209,638 | 2.6 | 377.5 | 377.5 | 377.6 | 0.1 |
| C | 793.2[2] | 6674 / 155[3] | 170,168 | 3.3 | 377.7 | 377.7 | 377.8 | 0.1 |
| D | 790.9[2] | 7563 / 1585[3] | 197,738 | 2.8 | 378.1 | 378.1 | 378.2 | 0.1 |
| E | 785.5[2] | 15600 / 7180[3] | 288,226 | 3.2 | 379.0 | 379.0 | 379.1 | 0.1 |
| F | 784.5[2] | 15803/10705[3] | 266,507 | 3.5 | 379.3 | 379.3 | 379.4 | 0.1 |
| G | 782.8[2] | 16644 / 7560[3] | 319,662 | 2.7 | 380.2 | 380.2 | 380.3 | 0.1 |
| Pigeon Creek | | | | | | | | |
| A | 433[4] | 181 | 2,892 | 4.9 | 377.7 | 359.5[6] | 359.6 | 0.1 |
| B | 2,017[4] | 168 | 2,543 | 5.6 | 377.7 | 360.3[6] | 360.4 | 0.1 |
| C | 6,239[4] | 205 | 3,299 | 4.3 | 377.7 | 363.0[6] | 363.1 | 0.1 |
| D | 9,407[4] | 449 | 6,182 | 2.2 | 377.7 | 364.2[6] | 364.3 | 0.1 |
| E | 13,631[4] | 211 | 3,098 | 4.5 | 377.7 | 365.6[6] | 365.7 | 0.1 |
| F | 15,848[4] | 241 | 3,332 | 4.1 | 377.7 | 366.5[6] | 366.6 | 0.1 |
| G | 19,280[4] | 268 | 4,562 | 3.0 | 377.7 | 369.0[6] | 369.1 | 0.1 |
| H | 24,192[4] | 411 | 4,550 | 3.0 | 377.7 | 371.4[6] | 371.5 | 0.1 |
| I | 28,944[4] | 222 | 3,717 | 3.7 | 377.7 | 373.0[6] | 373.1 | 0.1 |
| J | 34,224[4] | 258 | 3,744 | 3.6 | 378.0 | 378.0 | 378.1 | 0.1 |

[1]Feet above confluence with Lockwood Ditch
[2]Miles below headwaters at Pittsburgh
[3]Width extends beyond county boundary
[4]Feet above confluence with Ohio River
[5]Elevation computed without consideration of backwater effects from Lockwood Ditch
[6]Elevation computed without consideration of backwater effects from Ohio River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

# VANDERBURGH COUNTY, IN AND INCORPORATED AREAS

# FLOODWAY DATA

## NURENBERN DITCH – OHIO RIVER - PIGEON CREEK

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD) | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| Pigeon Creek (continued) | | | | | | | | |
| K | 37,445[1] | 583 | 6,097 | 2.2 | 379.7 | 379.7 | 379.8 | 0.1 |
| L | 40,109[1] | 449 | 6,396 | 2.1 | 380.7 | 380.7 | 380.8 | 0.1 |
| M | 44,861[1] | 1,043 | 10,907 | 1.2 | 381.4 | 381.4 | 381.5 | 0.1 |
| N | 48,029[1] | 950 | 11,979 | 1.1 | 381.7 | 381.7 | 381.8 | 0.1 |
| O | 51,197[1] | 1,377 | 17,538 | 0.8 | 382.0 | 382.0 | 382.1 | 0.1 |
| P | 54,365[1] | 657 | 7,154 | 1.9 | 382.4 | 382.4 | 382.5 | 0.1 |
| Q | 58,114[1] | 921 | 10,054 | 1.3 | 383.4 | 383.4 | 383.5 | 0.1 |
| R | 64,556[1] | 2,111 | 18,770 | 0.6 | 383.9 | 383.9 | 384.0 | 0.1 |
| Pond Flat Ditch | | | | | | | | |
| A | 1,072[2] | 968 | 1,582 | 2.1 | 423.2 | 423.2 | 423.3 | 0.1 |
| B | 2,793[2] | 261 | 936 | 3.5 | 425.1 | 425.1 | 425.2 | 0.1 |
| C | 4,393[2] | 1,375 | 2,486 | 1.3 | 427.9 | 427.9 | 427.9 | 0.0 |
| D | 7,830[2] | 1,674 | 3,345 | 1.0 | 428.6 | 428.6 | 428.6 | 0.0 |
| E | 13,031[2] | 2,296 | 6,205 | 0.5 | 429.1 | 429.1 | 429.2 | 0.1 |
| F | 14,942[2] | 1,120 | 2,444 | 0.9 | 429.3 | 429.3 | 429.3 | 0.0 |
| G | 16,796[2] | 171 | 676 | 3.3 | 430.0 | 430.0 | 430.1 | 0.1 |
| H | 19,789[2] | 1,150 | 2,998 | 0.7 | 431.0 | 431.0 | 431.1 | 0.1 |
| I | 20,962[2] | 700 | 6,733 | 0.2 | 431.7 | 431.7 | 431.7 | 0.0 |
| J | 22,356[2] | 1,195 | 5,458 | 0.2 | 431.7 | 431.7 | 431.8 | 0.1 |
| K | 24,357[2] | 529 | 440 | 1.9 | 434.3 | 434.3 | 434.3 | 0.0 |
| L | 26,141[2] | 338 | 425 | 1.9 | 437.7 | 437.7 | 437.8 | 0.1 |
| Pond Flat Ditch Lateral “A” | | | | | | | | |
| A | 2,429[3] | 636 | 399 | 3.1 | 431.7 | 427.7[4] | 427.8 | 0.1 |
| B | 3,469[3] | 444 | 683 | 1.5 | 431.7 | 430.8[4] | 430.9 | 0.1 |
| C | 4,293[3] | 300 | 195 | 4.5 | 435.6 | 435.6 | 435.6 | 0.0 |
| D | 5,227[3] | 267 | 922 | 1.0 | 439.5 | 439.5 | 439.5 | 0.0 |

[1]Feet above confluence with Ohio River
[2]Feet above mouth
[3]Feet above confluence with Pond Flat Ditch
[4]Elevation computed without consideration of backwater effects from Pond Flat Ditch

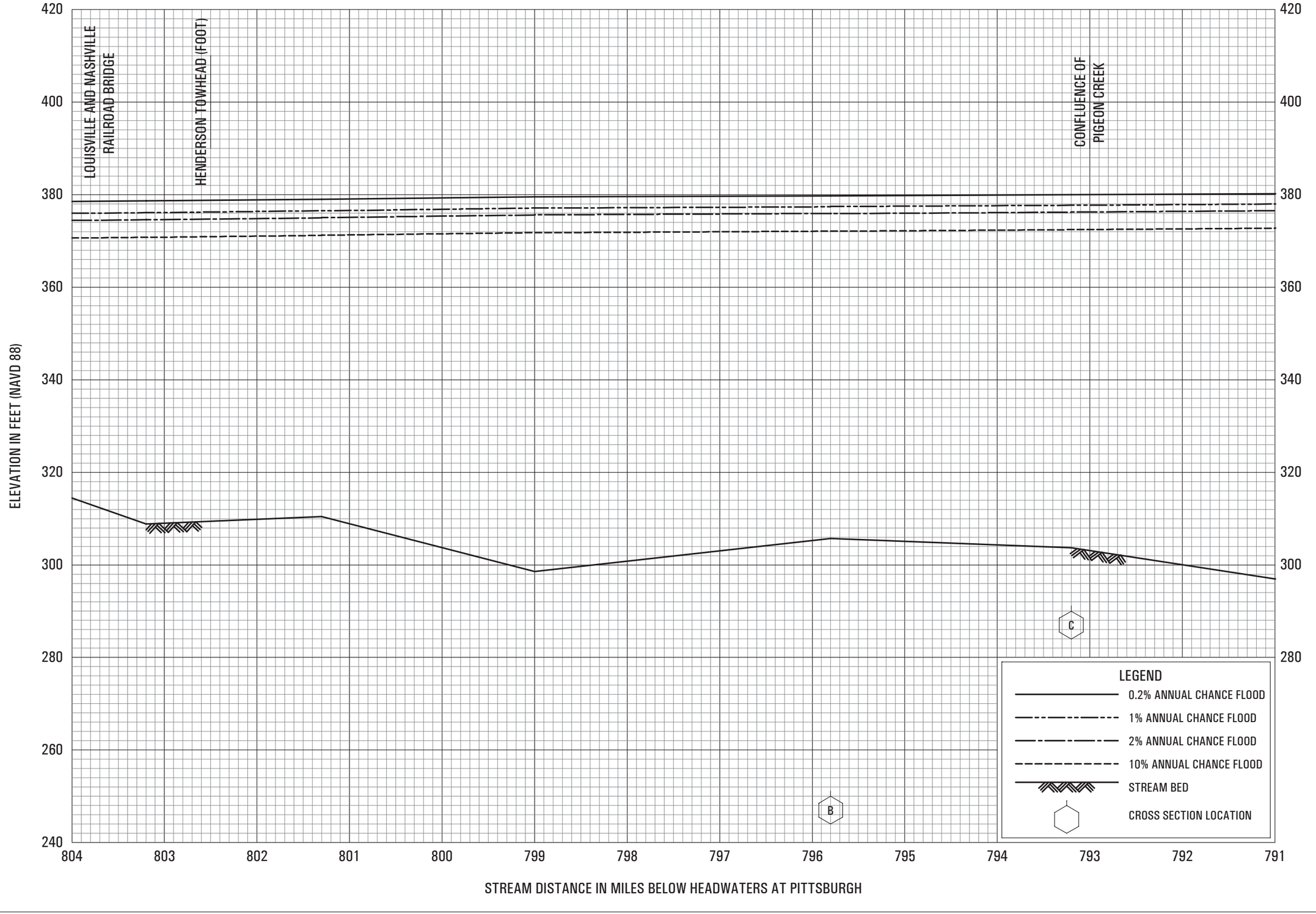
TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

# VANDERBURGH COUNTY, IN AND INCORPORATED AREAS

# FLOODWAY DATA

## PIGEON CREEK - POND FLAT DITCH - POND FLAT DITCH LATERAL “A”




# FLOOD PROFILES

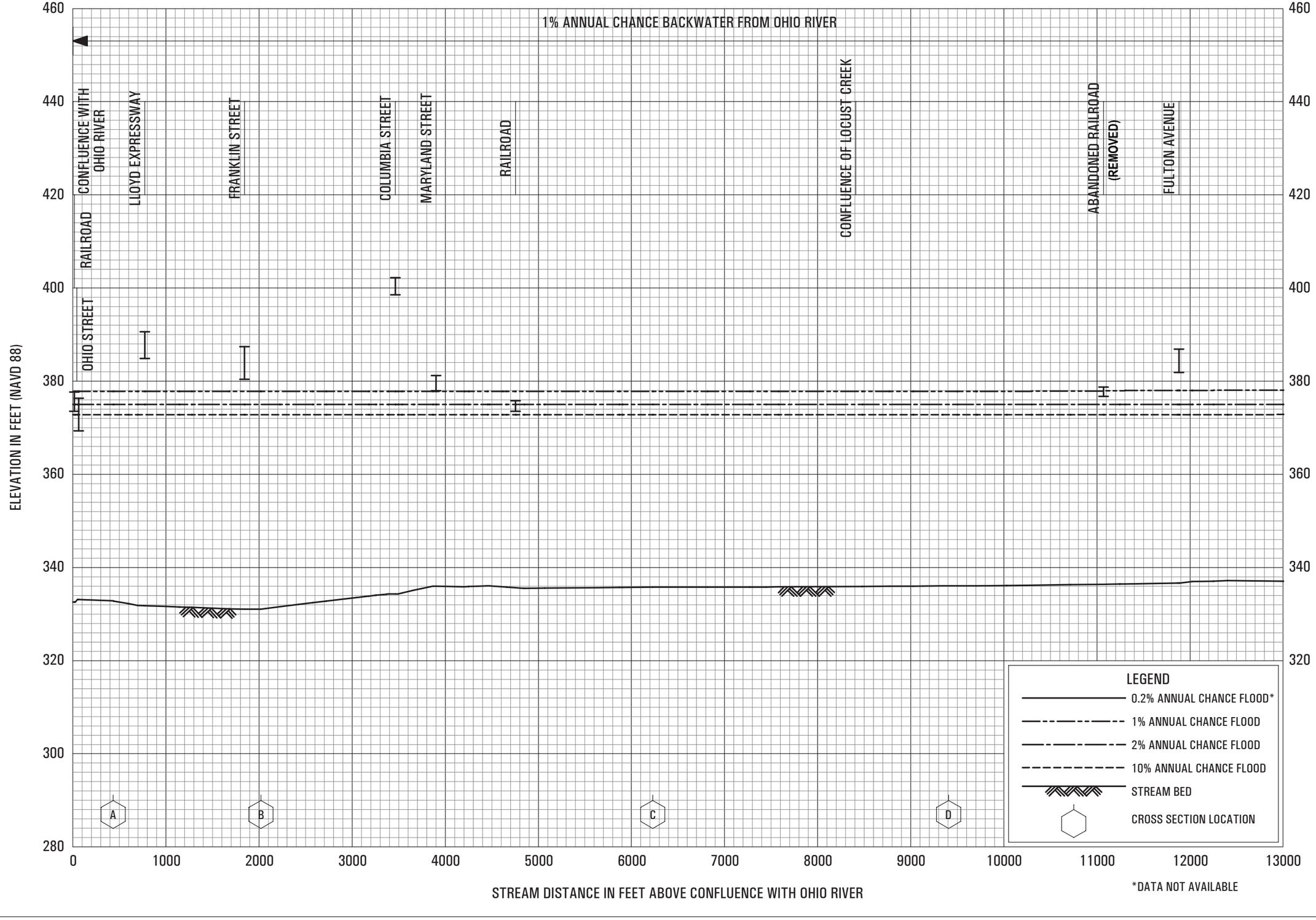
OHIO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

024P




# FLOOD PROFILES

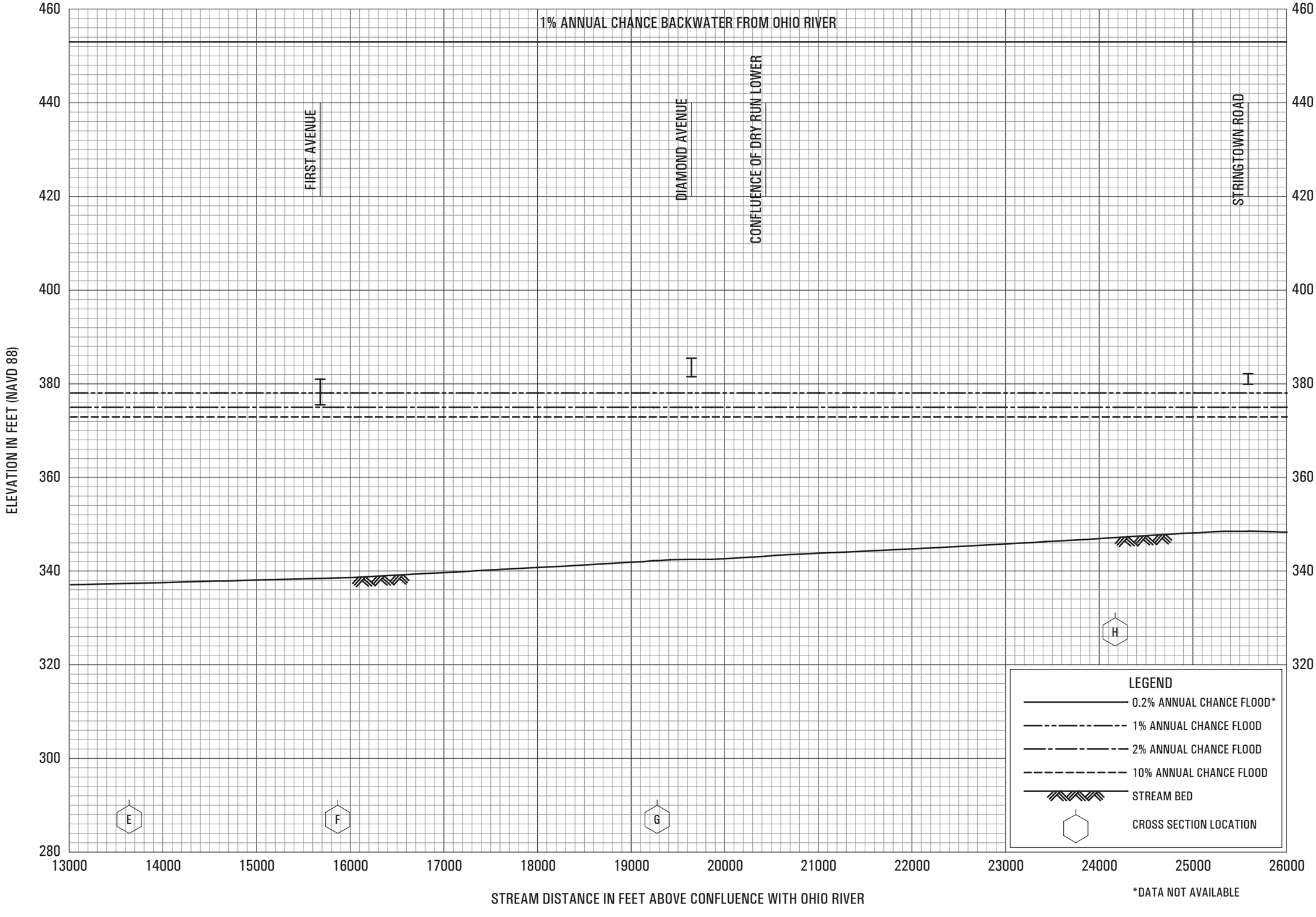
## PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

026P




# FLOOD PROFILES

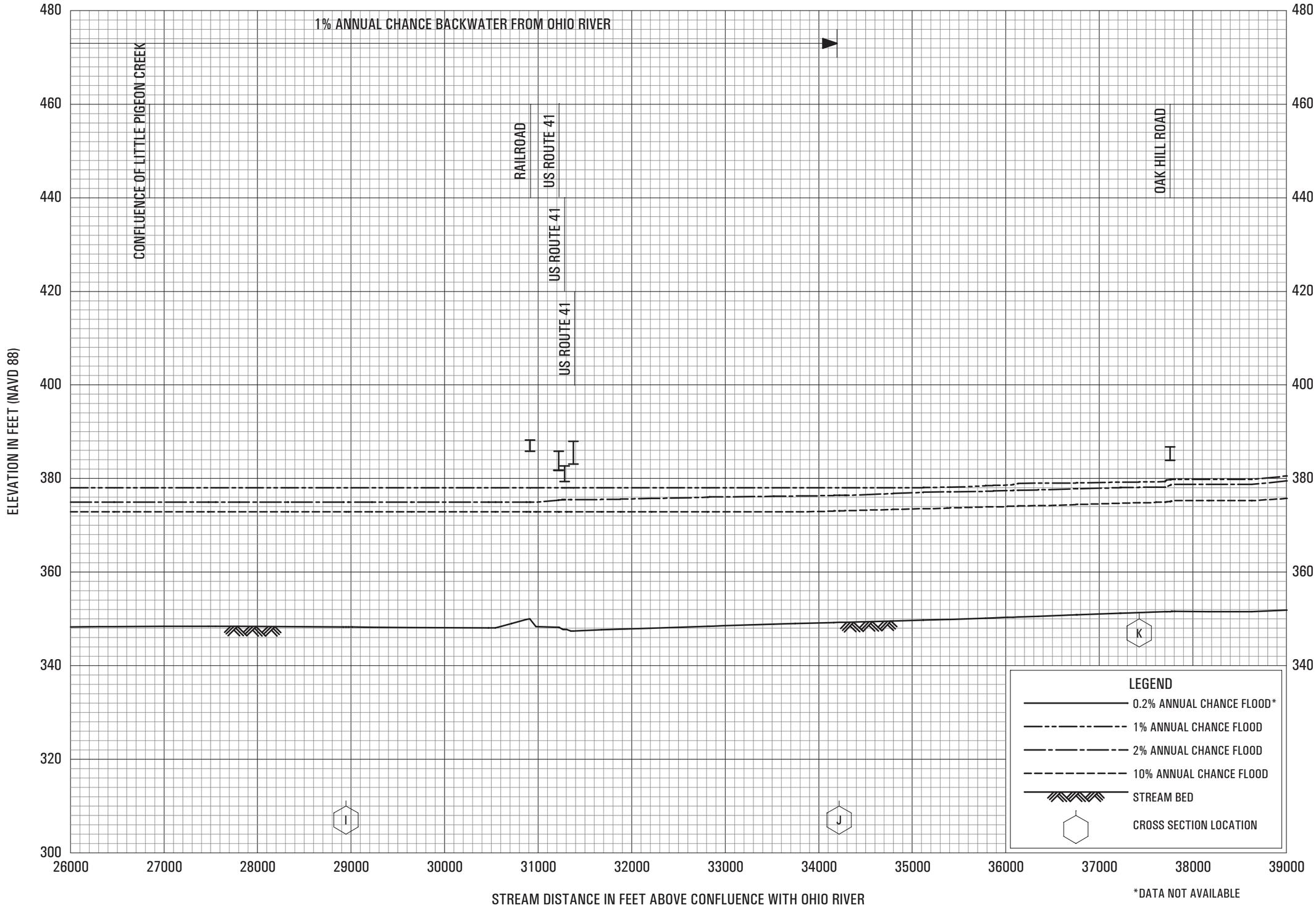
## PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

027P




# FLOOD PROFILES

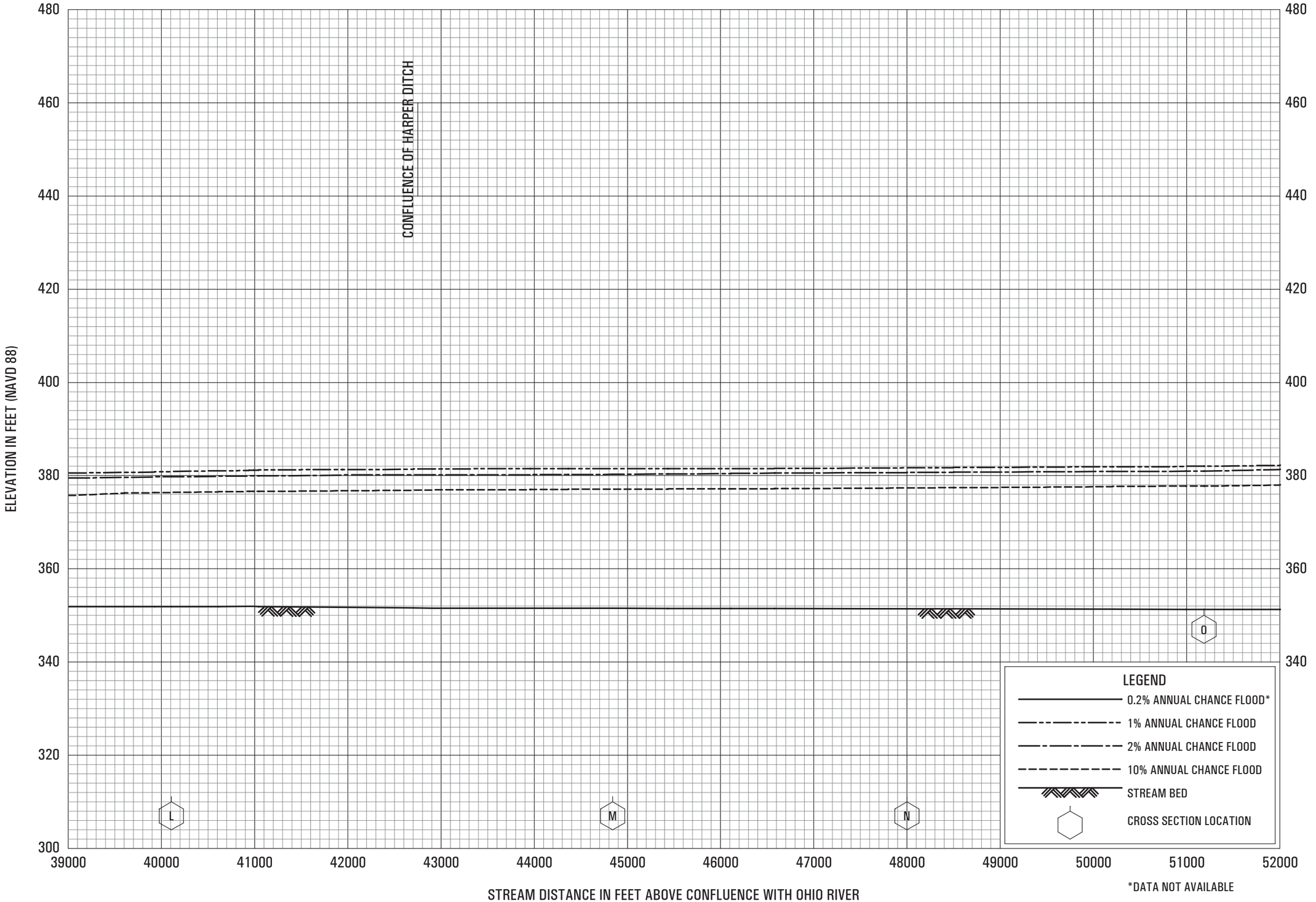
PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

028P




*DATA NOT AVAILABLE

# FLOOD PROFILES

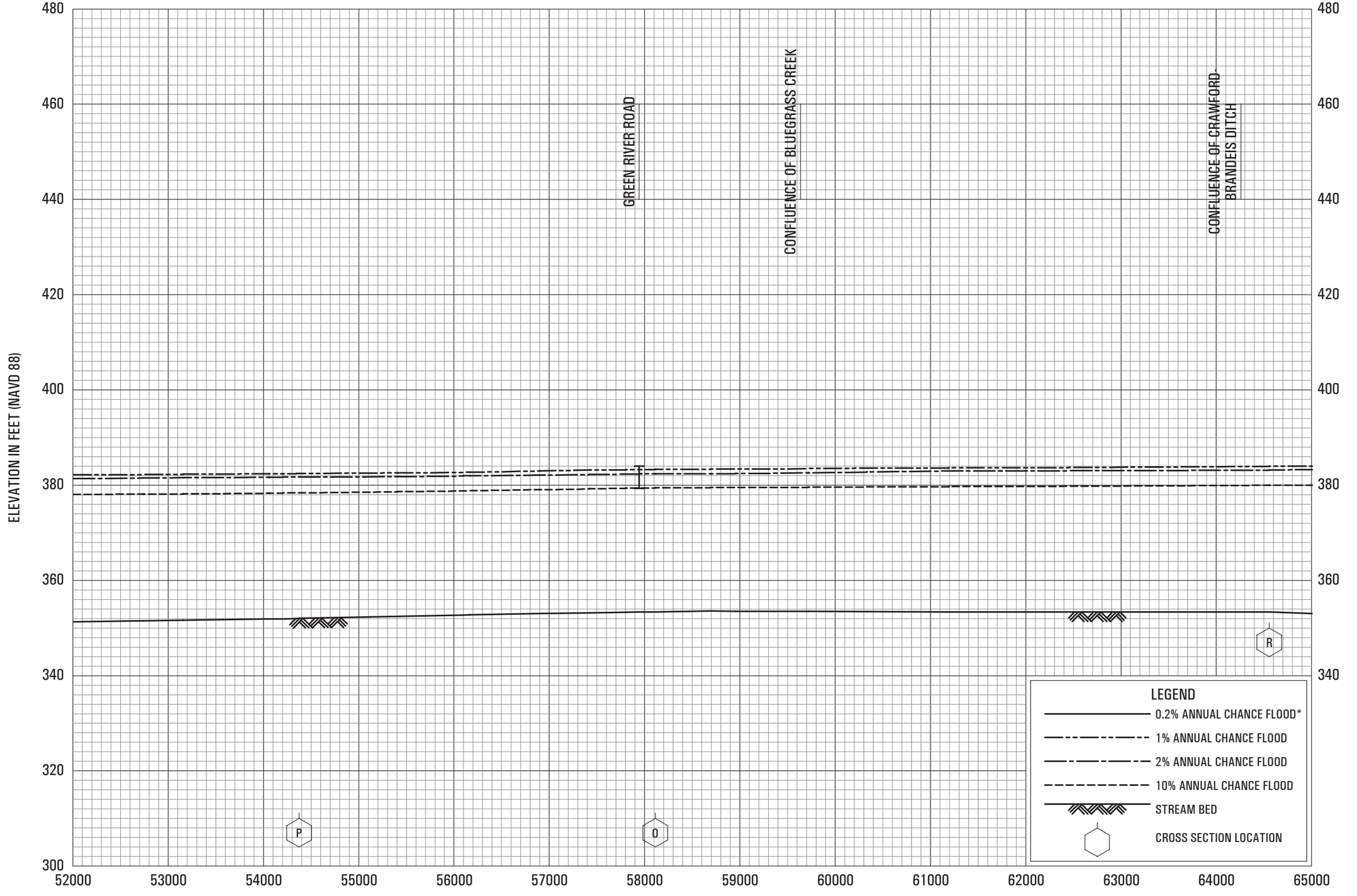
PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

029P




# FLOOD PROFILES

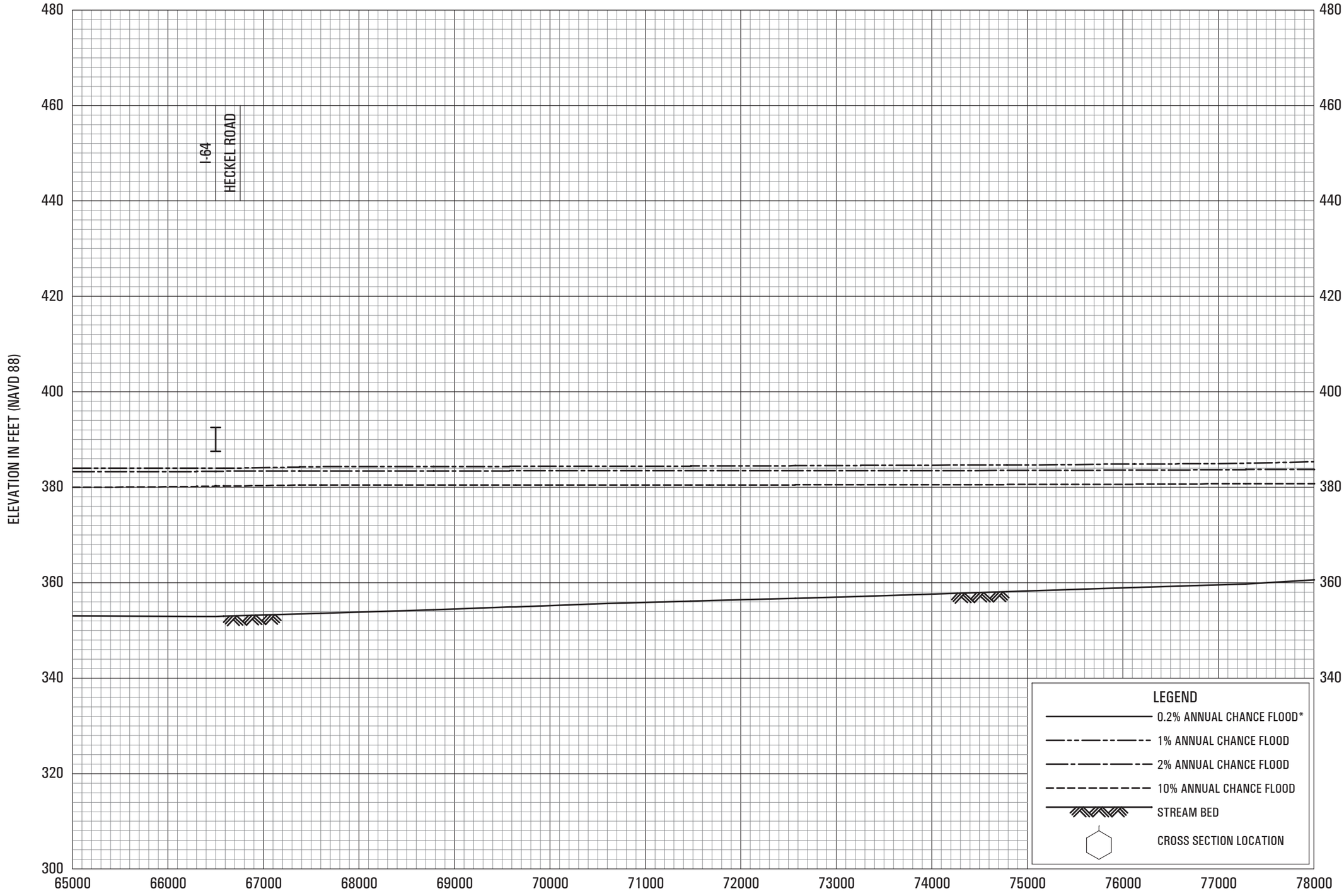
## PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

030P




*DATA NOT AVAILABLE

# FLOOD PROFILES

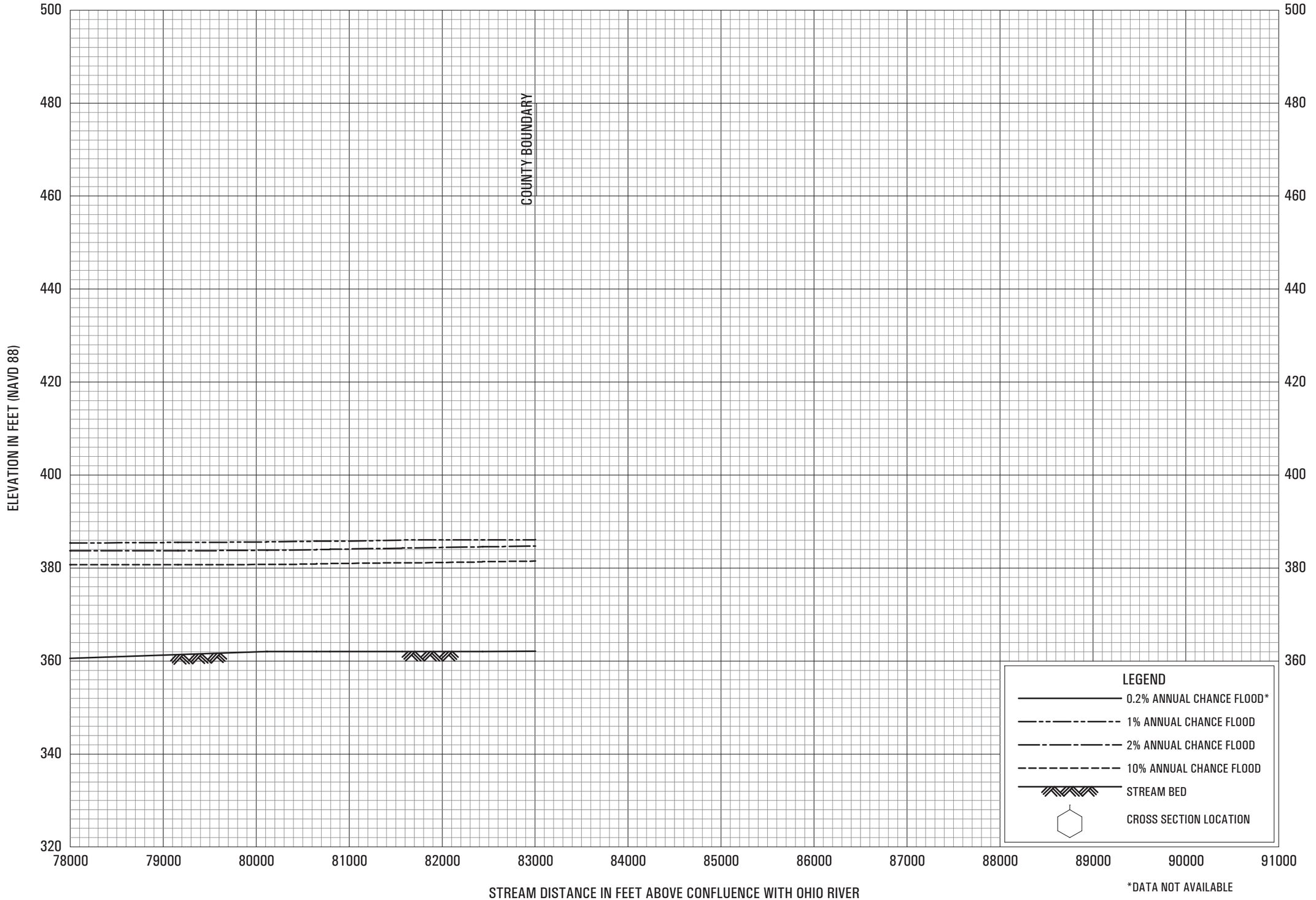
PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

031P




# FLOOD PROFILES

PIGEON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VANDERBURGH COUNTY, IN

AND INCORPORATED AREAS

032P

# APPENDIX 4: WESSELMAN WOODS PHOTOGRAPHS



Top: Observation #1 - Looking east at south side of property



Bottom: Observation #2 - Looking north along east property ditch



Top: Observation #3 - Looking NW at area of proposed excavation



Bottom: Observation #4 - Inlet with pipe heading north on south side of sports field

# APPENDIX 5: CHANDLER DETENTION BASIN PHOTOGRAPHS



Top: Observation #1 - Looking north from south side of detention area



Bottom: Observation #2 - Existing detention outlet structure



Top: Observation #3 - Looking west along south levee of detention area



Bottom: Observation #4 - Eventual outlet of detention water to NW housing area ditch

# APPENDIX 6: TIMBER PARK PHOTOGRAPHS



Top: Observation #1 - Access lane heading west into low area



Bottom: Observation #2 - Wooded area with mature trees



Top: Observation #3 - Looking north along east bank of Pigeon Creek at west side of woods



Bottom: Observation #4 - Ditch running through woods to Pigeon Creek

# APPENDIX 7: EVANSVILLE DAY SCHOOL PHOTOGRAPHS



Top: Observation #1 - Looking north at west side of school



Bottom: Observation #2 - Ravine in wooded area between school and Pigeon Creek