



Water Demand and Availability in the Southwest Indiana Water Planning Region

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Executive Summary

This study evaluates historical and projected water demand and water availability in the Southwest Indiana planning region through 2075. The region includes downstream portions of the Wabash, White, East Fork White, and Patoka River systems. Its central water-planning issue is not a simple lack of water at the regional scale. Major rivers and reservoirs convey and store large volumes, but usable supply depends on where and when water is available, whether it can be treated economically, whether infrastructure can deliver it during peak demand, and whether local aquifers and streams can sustain withdrawals during dry periods.

Current demand is dominated by large energy-production withdrawals. Reported withdrawals in 2023 totaled approximately 790 million gallons per day (MGD), including about 584 MGD for energy production. Most thermoelectric cooling water is returned to the hydrologic system, so reported withdrawal totals substantially overstate consumptive demand. When the analysis is limited to water that is consumed or otherwise not promptly returned, groundwater accounts for approximately 75 percent and surface water for approximately 25 percent. Public supply, crop irrigation, rural livestock use, and some industrial activities therefore become much more prominent in the consumptive water balance than the gross-withdrawal totals suggest.

The location of supply is controlled strongly by geology. Productive groundwater is concentrated in alluvial and glacial-outwash deposits along major river valleys, while many upland areas south of the most recent glacial limit have thin unconsolidated deposits and lower-yielding bedrock aquifers. This pattern helps explain the region's unusually broad rural water-service areas, dependence on reservoirs such as Monroe Lake and Patoka Lake, and concentration of high-capacity irrigation and public-supply wells near river corridors. Karst landscapes create rapid connections between surface water and groundwater, increasing source-water vulnerability, while historical and active coal mining has altered local storage, flow paths, baseflow, and water quality.

Future demand was estimated with methods tailored to each water-use sector. Public-water projections distinguish baseline demand from climate-sensitive seasonal demand; utilities with similar historical behavior were modeled in groups, whereas Bloomington Utilities, Patoka Lake Regional Water and Sewer District, and Indiana-American Water-Terre Haute were evaluated separately. Climate-model influence on seasonal demand was bounded to historically plausible behavior. Crop- and turf-irrigation projections preserve observed monthly patterns and long-term trends, scaling the estimates by forecast climate variables. Other sectors were projected using

Highlights:

Current and future water demand in the Southwest Indiana region is dominated by energy production and public-water supply sector use.

The Southwest Indiana region is characterized by rural land uses including agriculture, forest land, and coal mining.

Public water utilities obtain water from surface-water reservoirs for regional distribution, as well as groundwater (where available) for smaller utilities.

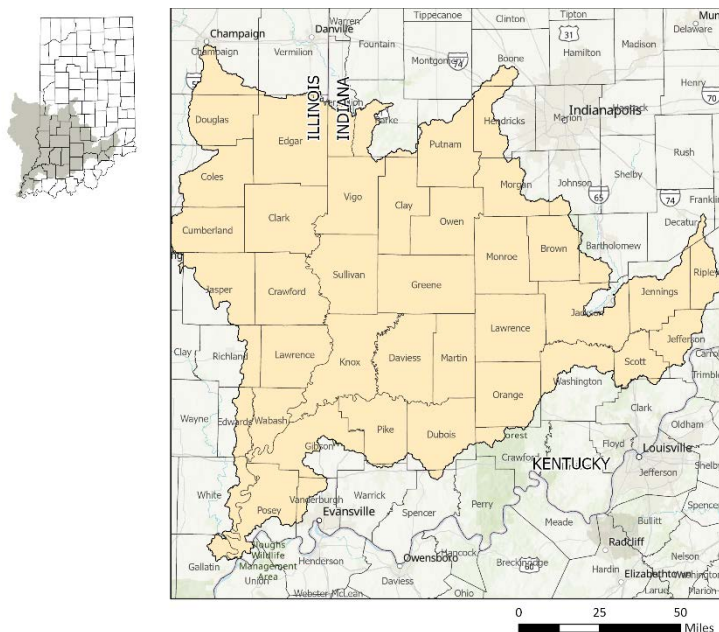
Current water demand in the region is 790 MGD, dominantly from surface water, with only 87 MGD of consumptive water use.

The largest consumptive-use water sector is agriculture (irrigation and livestock), using 59 MGD (at a higher rate during the growing season).

Future water demand in the region is estimated to decrease to 416 MGD by 2070, largely from fuel and technology conversions at energy plants.

Public water utilities are estimated to experience a very modest increase in water demand in the next 50 years (from 100 MGD to 103 MGD).

Summer and Fall water availability is supported by reservoir releases and wastewater return flows, particularly along major downstream river corridors.



facility information, sector trends, planned operational changes, and simplified return-flow rules where historical records did not support stable predictive relationships.

The future-demand outlook contains several important structural changes and uncertainties. Retirement or conversion of once-through thermoelectric facilities can sharply reduce gross surface-water withdrawals, even as new industrial processes may increase consumptive use. Proposed data centers are a potentially important but highly project-specific load because water demand depends on facility scale,

cooling technology, power supply, reuse, and whether water is purchased from a utility or self-supplied; in this study, proposals are therefore identified as planning risks rather than treated as uniform regional demand. Agricultural demand remains spatially concentrated, and facility-level records show that some irrigators have shifted a larger share of withdrawals into May and September even though most facilities show no statistically detectable change in seasonal timing.

This study used two methods to estimate historical and future natural baseflow, which is a major input to the water-availability calculations. Historical and future availability were evaluated by streamgage-defined subbasins using both local excess water availability (“local water availability”) and cumulative excess water availability (“cumulative water availability”). Local water availability represents water generated within a subbasin after accounting for instream-flow (habitat) thresholds, water withdrawals, wastewater returns, and reservoir operations.

Cumulative water availability includes upstream flow contributions routed through the river network. Future conditions were evaluated using two selected five-year periods from the climate projection: a relatively wet future period centered on 2050 and a relatively dry future period centered on 2070. Under the climate scenario evaluated, average annual local water availability is projected to decline in every regional basin during both future periods relative to historical conditions, even during the relatively wet 2050 period.

Winter is projected to be an important seasonal exception, with both local and cumulative availability projected to increase in 2050 across all four river systems relative to the historical Winter baseline. Availability is projected to be lower during the other seasons, with the greatest limits generally projected during Fall. By the dry 2070 period, local water deficits are projected during multiple seasons in several regions, and cumulative Fall deficits are also projected across much of the study area. Together, the future results project a shift toward wetter Winter conditions and drier conditions during Summer and Fall. Both methods used to estimate natural baseflow show this same broad pattern of future drying, even though they produce different estimates of how much water may be available.

Downstream river corridors are projected to retain much larger cumulative than local availability because of the inclusion of water generated and managed upstream. This distinction is particularly important along the White and Wabash Rivers, where cumulative availability is estimated to remain substantial even as locally generated availability is projected to decline. Future downstream water availability is therefore projected to depend more heavily on rainfall and streamflow, water use and return flows, reservoir operations, and water-management decisions elsewhere in the watershed.

The Patoka River is projected to remain the most water-limited of the four regional river systems, and the results show that reservoir operations can play an important role in maintaining water availability during low-flow periods. In this analysis, future reservoir releases followed historical monthly operating patterns; the model did not simulate how lake levels and stored volumes would change during a prolonged drought. It is therefore uncertain whether the modeled releases could be maintained throughout a long dry period. Overall, the projections show that future water availability may depend not only on how much water is present, but also on when, where, and how it is used and managed throughout the river system.

Public utilities are affected by both source-water and infrastructure risks. Large service areas and wholesale networks move water across subbasin boundaries, so the subbasin of withdrawal may differ from the subbasin of use and wastewater return. Bloomington's Lake Monroe withdrawals and Patoka Lake Regional Water's distribution network are prominent examples. Peak seasonal demand can approach treatment or system capacity even where the raw-water source remains adequate. Water-quality risks include rapid contaminant transport in karst voids, acid mine drainage and mineralized mine water, nutrients and pathogens, disinfection byproducts, and emerging contaminants. Small rural utilities also account for a disproportionate share of drinking-water compliance violations, reflecting possible technical, managerial, and financial constraints, as well as source-water conditions.

Taken together, the results show a region with substantial water in major rivers and reservoirs but uneven local resilience. The most consequential planning signals are the decline in locally generated future water, the coincidence of Summer demand with the season of least recharge and lowest flow, increasing dependence on upstream inflows and managed storage, concentration of productive aquifers along river corridors, and the importance of treatment and distribution capacity. These findings are scenario-based rather than predictions of a single inevitable future, but they identify where utilities and other water users are most sensitive to climate variability, development, infrastructure limits, source-water quality, and cross-basin dependence.

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List of Acronyms

ACRONYM	TERM
7Q2	Lowest 7-day average flow that occurs every 2 years (a measure of typical seasonal lows)
7Q10	Lowest 7-day average flow that occurs every 10 years (on average)
AET	Actual evapotranspiration
CAFO	Concentrated Animal Feeding Operation
CEG	Citizens' Energy Group
CFO	Confined Feeding Operation
CFS	Cubic feet per second (stream discharge)
CPI	Consumer Price Index
CSO	Combined Sewer Overflow
DOT	Department of Transportation
DWV	Drinking Water Viewer (utility database)
EIA	Energy Information Administration
EP	Energy Production (water-use sector)
EPA	U.S. Environmental Protection Agency
GPM	Gallons per minute
GW	Groundwater
GWR	Groundwater recharge
HUC	Hydrologic Unit Code
IAW	Indiana-American Water (water utility)
IBRC	Indiana Business Research Center
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IFA	Indiana Finance Authority
IGWS	Indiana Geological and Water Survey
IN	Industrial (water-use sector)
IPCC	Intergovernmental Panel on Climate Change
IR	Irrigation (water-use sector)
IRR	Irrigation
ISDA	Indiana State Department of Agriculture
IU	Indiana University
IURC	Indiana Utility Regulatory Commission
IWRRC	Indiana Waters Resource Research Center
LULC	Land use and land cover
MG	Million gallons
MGD	Millions of gallons per day
MI	Miscellaneous (water-use sector)
MK	Mann-Kendall trend test
MRO	Monthly Report of Operations (for public utilities)
NAD	National Address Database

NASS	National Agricultural Statistics Service
NCDC	National Climate Data Center
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System (EPA)
PART	Hydrograph separation (groundwater baseflow-estimation) method
PHDI	Palmer Hydrological Drought Index
PLRWSD	Patoka Lake Regional Water and Sewer District (“Patoka Lake”)
PER	Preliminary Engineering Report
PET	Potential evapotranspiration
PS	Public Supply (water-use sector)
PWS	Public Water System
Q90	Minimum flow that is present 90% of the time
Qea	Excess water availability (locally generated)
Qcea	Cumulative excess water availability (regionally aggregated upstream-to-downstream)
RU	Rural Use (water-use sector)
SEN	Theil–Sen estimator of slope
SSP	Shared Socioeconomic Pathways (population model)
SS-RES	Self-supplied residential (domestic) water
SWB2	Soil Water Balance model, v2
SWWF	Significant Water Withdrawal Facility (high-capacity water pumping)
TDS	Total dissolved solids (low = fresh water; high = brackish water)
UAV	Unmanned Aerial Vehicle (drone)
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VFC	Virtual Filing Cabinet (IDEM)
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

Maps for Report Navigation

Because this is a water-resources report, the results are presented in the context of their hydrologic watersheds as defined by the areas that drain to U.S. Geological Survey (USGS) streamgages. The portion of the area between two streamgages (or between a headwater tributary catchment and the next downstream gage) is referred to as a “subbasin” in this report.

The basins are referenced in two ways throughout the report: (1) by the USGS streamgage ID (e.g., 03341500, see MAP 1), or (2) by the internal study subbasin numbering (see MAP 2. Subbasin schematic using the Southwest Indiana internal numbering system.), consistent with all of the Indiana regional water studies. MAP KEY (below) is a cross-reference table to relate the two.

MAP KEY. List of subbasins used as spatial containers for water availability calculations in this study. The subbasins are the catchments or sub-watershed areas between streamflow monitoring stations. They can be identified by the USGS Gage ID number, or by the project Subbasin ID.

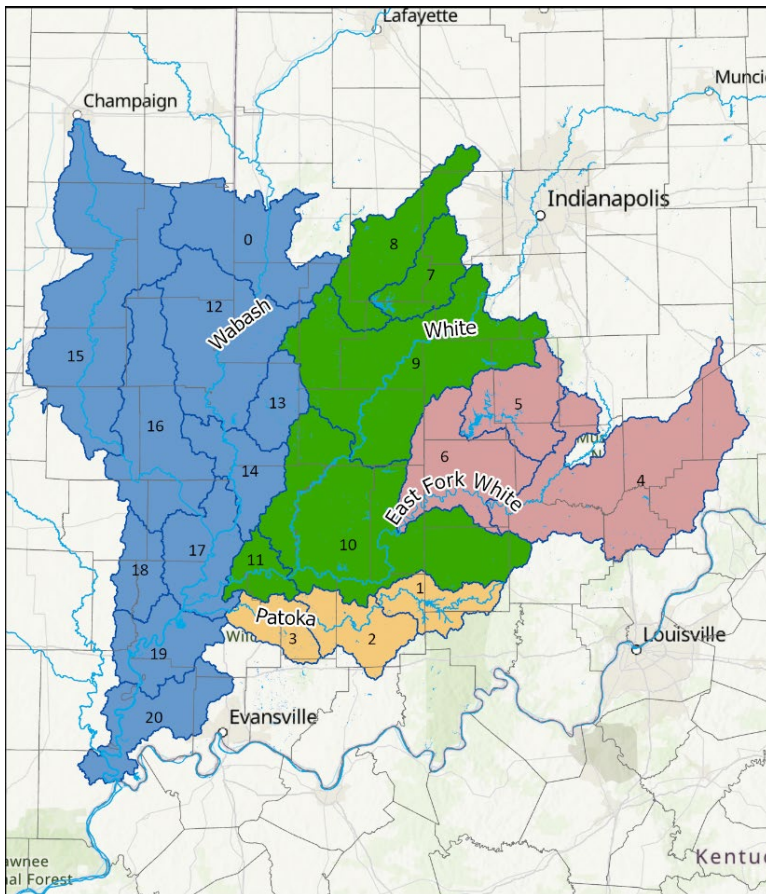
River Basin	USGS Gage ID	Subbasin	Waterway	Area (mi ²)
Patoka	USGS-03375500	1	Patoka River at Jasper, IN	262
Patoka	USGS-03376300	2	Patoka River at Winslow, IN	340
Patoka	USGS-03376500	3	Patoka River at Princeton, IN	219
East Fork White	USGS-03371500	4	East Fork White River near Bedford, IN	1469
East Fork White	USGS-03372500	5	Salt Creek near Harrodsburg, IN	432
East Fork White	USGS-03373500	6	East Fork White River near Shoals, IN	642
White	USGS-03359000	7	Mill Creek near Manhattan, IN	293
White	USGS-03360000	8	Eel River at Bowling Green, IN	537
White	USGS-03360500	9	White River at Newberry, IN	1412
White	USGS-03374000	10	White River at Petersburg, IN	1500
White	USGS-03374100	11	White River at Hazleton, IN	179
Wabash	USGS-03341500	0	Wabash River at Terre Haute, IN	696
Wabash	USGS-03342000	12	Wabash River at Riverton, IN	899
Wabash	USGS-03342500	13	Busseron Creek near Carlisle, IN	228
Wabash	USGS-03343010	14	Wabash River at Vincennes, IN	341
Wabash	USGS-03345500	15	Embarras River at Ste. Marie, IL	1510
Wabash	USGS-03346500	16	Embarras River at Lawrenceville, IL	816
Wabash	USGS-03377500	17	Wabash River at Mt. Carmel, IL	446
Wabash	USGS-03378000	18	Bonpass Creek at Browns, IL	228
Wabash	USGS-03378500	19	Wabash River at New Harmony, IN	396
Wabash	Ungauged	20	Lower Wabash River	450

Subbasins by USGS Gage ID

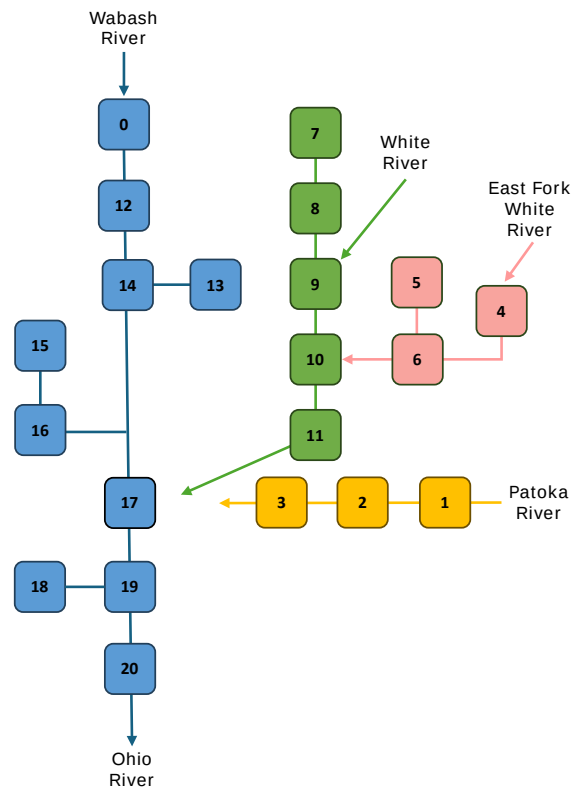


MAP 1. Subbasins defined by USGS streamgage locations. See MAP KEY to relate the gage ID numbers to the internal study subbasin numbering system.

Subbasins Schematic with Internal Study Numbering System



MAP 2. Subbasin schematic using the Southwest Indiana internal numbering system.



Water Demand and Availability in the Southwest Indiana Water Planning Region

Introduction

The focus of this study lies within Southwest Indiana, a region spanning approximately 12,700 square miles (Figure 1). Unlike the nearby Southeast-Central region, this is a massive downstream catchment that receives accumulated flow from four upstream river basins: the Upper and Middle Wabash River, White River, East Fork White River, and Patoka River, draining a total of 33,000 square miles in Indiana and Illinois (Figure 1). The primary objective is to identify key trends and challenges concerning water availability and demand in the region for public water utilities, incorporating region-specific economic factors, land use, water use, and geological factors.

The fundamental aim of this report is to assess historical and future public water utility use, with water withdrawals serving as a proxy for demand, and to incorporate those demand estimates into an assessment of historical and future water availability. Although the primary planning lens is the public water-supply sector, the analysis must consider all major water-use sectors because utilities, industries, agricultural users, energy producers, rural residents, reservoirs, and wastewater returns are connected within the same hydrologic system.

For Southwest Indiana, the interaction between demand and availability is strongly shaped by the region's position within the downstream portions of several major basin systems, the distribution of productive aquifers along major river corridors, the role of reservoirs as regional supply sources, the presence of karst landscapes with rapid surface-water/groundwater exchange, and the hydrologic legacy of coal mining. These regional characteristics influence where water can be withdrawn, how reliably supplies can meet seasonal peaks, how much water is returned to the water cycle, and where water-quality concerns may limit usable supply.

A map of Indiana illustrating the state's river network. Major river basins are outlined in blue and labeled: North Central, Central, Southeast Central, Southwest, and Wabash Headwaters. The central region is labeled 'INDIANA'. Major cities are marked with grey dots and labeled: Chicago (northwest), Indianapolis (center), Cincinnati (east), Louisville (southeast), and Frankfort (southeast). Specific rivers shown include the Wabash River, White River, and East Fork White River. The state boundary with Kentucky is shown in the south.

A detailed map of Indiana, showing its major rivers, cities, and wildlife refuges. The map is color-coded by region: Champaign (light blue), Terre Haute (light green), and Evansville (light yellow). Major rivers shown include the Wabash River, White River, and East Fork White River. Cities marked include Champaign, Terre Haute, Evansville, and many others. Wildlife refuges are highlighted in green, including the Patoka River National Wildlife Refuge and the Vermilion National Wildlife Refuge. The map also shows the state's borders with neighboring states: Michigan, Ohio, Kentucky, Tennessee, Mississippi, and Alabama.



Regional Overview

Southwest Indiana is a large, predominantly rural region with water-resource conditions shaped by agriculture, forested public lands, major river systems, regional reservoirs, energy production, coal mining, karst, and broad public-water service areas. The region's water-supply challenges are not defined solely by whether water is present at the regional scale, but by whether it is locally accessible, reliable during dry seasons, economically deliverable through infrastructure, and suitable for treatment and use.

Because Southwest Indiana is situated largely south of the most recent glacial limits (Wisconsinan and pre-Wisconsinan, Figure 1), the hydrogeologic setting differs drastically from central Indiana. The region's most productive groundwater sources are the alluvial, lacustrine, and backwater deposits and the Wabash River Outwash Aquifer System.

This unique hydrology is heavily influenced by two distinct landscape features. First, the region contains extensive karst solution landscapes with features (sinkholes, caves, and springs) that rapidly route surface water underground. Second, the landscape is heavily modified by both historical and active coal mining. These surface and underground mines have fundamentally altered the region's topography, subsurface porosity, and natural water storage capacities, creating highly localized artificial aquifers and unique baseflow characteristics.

Population Centers

The study area predominantly features agricultural lands interspersed with urban centers. Bloomington represents the largest urban area, housing a significant portion of the population alongside Terre Haute. Lesser urban hubs wholly or mostly within the study area include Seymour, Jasper, Vincennes, Bedford, Washington, and Martinsville, among others. In addition, the region hosts numerous smaller towns and municipalities. (Table 1). See Appendix A for a full list of population centers in the study area. Bloomington, Indiana, is home to Indiana University, which adds

Table 1. Population centers with at least 1,000 people principally in Southwest Indiana (SWI).

Municipality Name	2025 pop	Area (Sq. Miles)	Density (people/sq mi)	% in SWI
Bloomington	83,307	23.42	3,557	100
Terre Haute	58,764	34.91	1,683	100
Seymour	22,450	12.13	1,851	52
Jasper	17,279	13.43	1,287	100
Vincennes	16,378	7.56	2,166	100
Bedford	13,962	11.98	1,165	100
Washington	12,991	6.71	1,937	100
Martinsville	12,141	9.23	1,315	95
Greencastle	9,924	5.26	1,887	100
Princeton	8,524	5.47	1,559	86
Brazil	8,343	3.00	2,780	100
Scottsburg	7,478	5.51	1,356	100
Ellettsville	6,840	5.17	1,323	100
North Vernon	6,559	7.68	854	97
Huntingburg	6,522	5.31	1,227	100
Linton	5,245	3.15	1,667	100
Clinton	4,771	2.05	2,324	100
Austin	4,254	2.67	1,596	100
Sullivan	4,229	1.93	2,189	100
Mitchell	4,019	3.58	1,122	100
Paoli	3,596	3.75	959	100
Brownstown	3,154	1.62	1,943	100
Bicknell	2,982	1.32	2,256	100
Loogootee	2,633	1.58	1,667	100
Monrovia	2,485	1.76	1,413	58
Spencer	2,479	1.70	1,461	100
Bloomfield	2,306	1.32	1,744	100
Petersburg	2,289	1.47	1,556	100
Oakland City	2,274	1.12	2,022	100

around 45,000 students to the greater Monroe County population (148,000), and Terre Haute is home to three universities (Indiana State University, Rose Hulman Institute of Technology, and St. Mary-of-the-Woods College (adding 12,000 students to the greater Vigo County population (106,000).

Municipality Name	2025 pop	Area (Sq. Miles)	Density (people/sq mi)	% in SWI
Ferdinand	2,247	2.39	940	99
Cloverdale	2,174	3.55	613	100
West Terre Haute	2,160	0.70	3,101	100
Orleans	2,073	1.77	1,169	100
Jasonville	1,952	1.25	1,557	100
French Lick	1,772	2.06	861	100
Crothersville	1,506	1.16	1,299	100
Fairview Park	1,420	0.92	1,538	100
Worthington	1,403	0.76	1,858	100
Odon	1,378	0.94	1,471	100
Owensville	1,332	0.57	2,337	100
Nashville	1,273	1.61	793	100
Oolitic	1,142	0.67	1,701	100
Shelburn	1,103	0.73	1,519	100
Farmersburg	1,067	0.75	1,425	100
Morgantown	1,007	0.39	2,606	100
Seelyville	1,000	0.88	1,137	100

Land Cover / Use

Agricultural land is the largest mapped land-use class in the study area, including the contributing Illinois portion, followed by forest. Irrigated parcels are largely constrained to sandy near-river cropland. Hoosier National Forest covers about 320 square miles of public land southern Indiana. Muscatatuck National Wildlife Refuge covers approximately 12 square miles, primarily located in Jackson and Jennings. The Patoka River National Wildlife Refuge (17 square miles) is located in Pike and Gibson Counties. Several state parks are located in the Southwest Indiana region. Developed land occupies a much smaller fraction of the region. Wetlands are concentrated along river corridors, while mining disturbance is not represented in generalized land-cover datasets (Figure 2, Table 2).



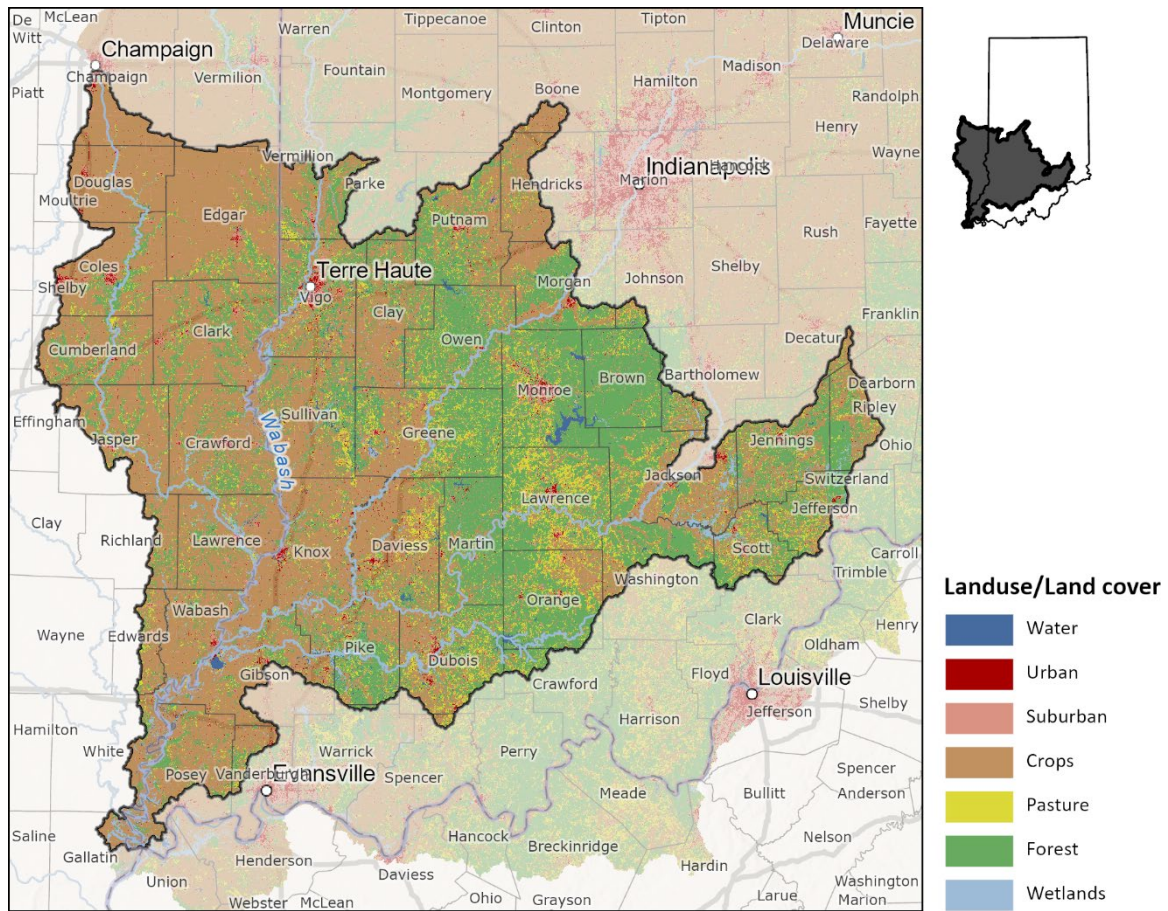


Figure 2. Agricultural land is the largest mapped land-use class in the study area, including the contributing Illinois portion, followed by forest. Developed land occupies a much smaller fraction of the region. Wetlands are concentrated along river corridors, while mining disturbance is not represented in generalized land-cover datasets.

Table 2. Land-use classes in the Southwest Indiana region. Cultivated cropland and pasture dominate the landscape, followed by managed forestland. Mining activities are not well represented in land-use data, but they occupy about twice the area of wetlands in the study area.

Land-use Class	Area (mi ²)	Percent
Water	159	1%
Cultivated crops	5806	48%
Pasture	1129	9%
Developed	1163	10%
Forest	3552	29%
Wetlands	315	3%

Climate

Indiana has a humid continental climate trending towards humid subtropical near the southern border of the state. Future projections under a range of climate-change scenarios include warming temperatures and increased (but seasonally redistributed) precipitation (Brettschneider, 2014; Widhalm et al., 2018; Seland et al., 2020; IPCC AR6 2021; Chen and Ford, 2022; Akinsanola et al., 2024).

A dominant aspect of Southwest Indiana's climate is its seasonality. Temperatures are increasing, most consequentially for nighttime lows, while precipitation has also increased but remains unevenly distributed through the year. There has been an increase in the frequency of high-intensity precipitation events in the Winter and Spring. Winter and Spring, consequently, generally provide the greatest streamflow, groundwater recharge, and baseflow. Summer and Fall provide much less recharge at the same time that vegetation, irrigation, and public-supply water demands are greatest. Changes in Winter snow cover and rainfall timing may further affect upland recharge, particularly away from major stream and river corridors.

Rapid shifts between abundant moisture and drought conditions (flash drought; Lesinger and Tian, 2022) are becoming more common, causing challenges for public water utilities and agricultural producers that depend on consistent water availability (both in aquifers and soil moisture) to meet their missions (Fowler et al., 2022). The lowest natural seasonal water availability coincides with the highest water withdrawals from all water-use sectors. Understanding the factors that influence water demand and availability, as well as the historical and likely future ranges - and timing - of demand and availability are necessary to strategically plan for sustainable and resilient water utilities.

Temperature

Southwest Indiana experiences significant seasonal temperature variation and a pronounced north-to-south climate gradient. Temperatures are generally warmest in the southern part of the study area, and both average and extreme heat are relevant to seasonal public-supply, agricultural, and ecological water demand.

Precipitation

Southwest Indiana receives substantial annual precipitation, with the greatest totals generally occurring during the first half of the year. Despite this humid setting, late-Summer and early-Fall droughts periodically reduce streamflow, soil moisture, and aquifer recharge during the same time that water demand is elevated. The 1999 and 2012 droughts provide important historical examples of this seasonal vulnerability.

Photo (right): Near Southern Crossing, East Walesboro, and Waynesville, Indiana.

Photo from @FloodsOfColumbus (Facebook) March 28, 2023.



Flooding

Downstream river reaches periodically experience major floods because they integrate runoff from large contributing areas. Agricultural drainage, impervious surfaces, antecedent soil moisture, and increasingly intense precipitation can accelerate runoff and raise flood peaks. Flood abundance does not eliminate seasonal water-supply risk: much of the floodwater moves through the system during Winter and Spring, while supply constraints are most likely during Summer and Fall.

Geology and Hydrogeologic Setting

The hydrogeologic setting of Southwest Indiana differs substantially from the rest of the state. Most of the region lies south of the most recent glacial limit (Figure 3) where continuous, thick, high-yield unconsolidated sand-and-gravel aquifers are less widely distributed. Productive groundwater sources are commonly localized in alluvial and outwash deposits along major river valleys, whereas bedrock aquifers, karst systems, reservoirs, and coal-mine hydrology play a larger role in the regional water story. Figure 4 shows major structural features (faults, folds, domes, and basins) that control the exposure and depth of bedrock units in the Midwest U.S.

The Southwest Indiana region relies heavily on bedrock aquifers; the southwestern fifth of the state is primarily underlain by sandstone and carbonate aquifers, as well as aquifers consisting of complexly interbedded sandstones, siltstones, shales, limestones, and coals. While these bedrock aquifers generally have lower yields than sand and gravel systems, they are widespread and serve as a critical water source for the region's rural populations. Because of these lower yields, public water supply strategies in the

southwest often necessitate expansive service areas—sometimes spanning entire counties—to adequately distribute water to residents who lack viable self-supplied residential well options.

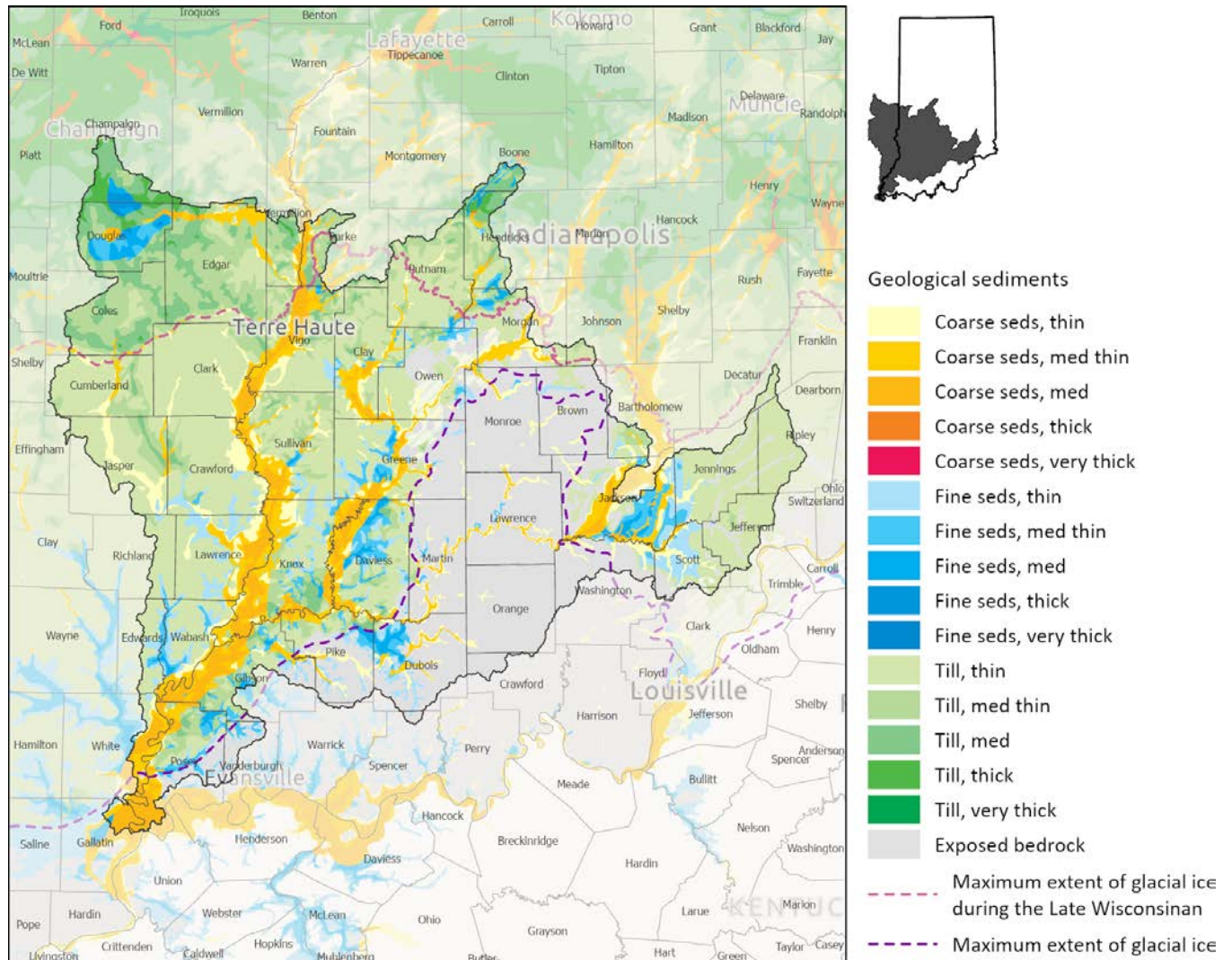


Figure 3. This map shows the geological material types at the ground surface, which gives context for the location and distribution of water withdrawals for some water-use sectors. Surface-water reservoirs are utilized for public water supplies where aquifers are not present. Irrigation wells are concentrated along the near-river sand-and-gravel aquifers (orange), where groundwater is available and often abundant. The blue areas on this map are floodplain sediment, which is where the near-river wetlands are located. In the legend, “seds” references sediments. Map derived from Soller et al. (2012; U.S. Geological Survey Data Series 656, <https://pubs.usgs.gov/ds/656>).

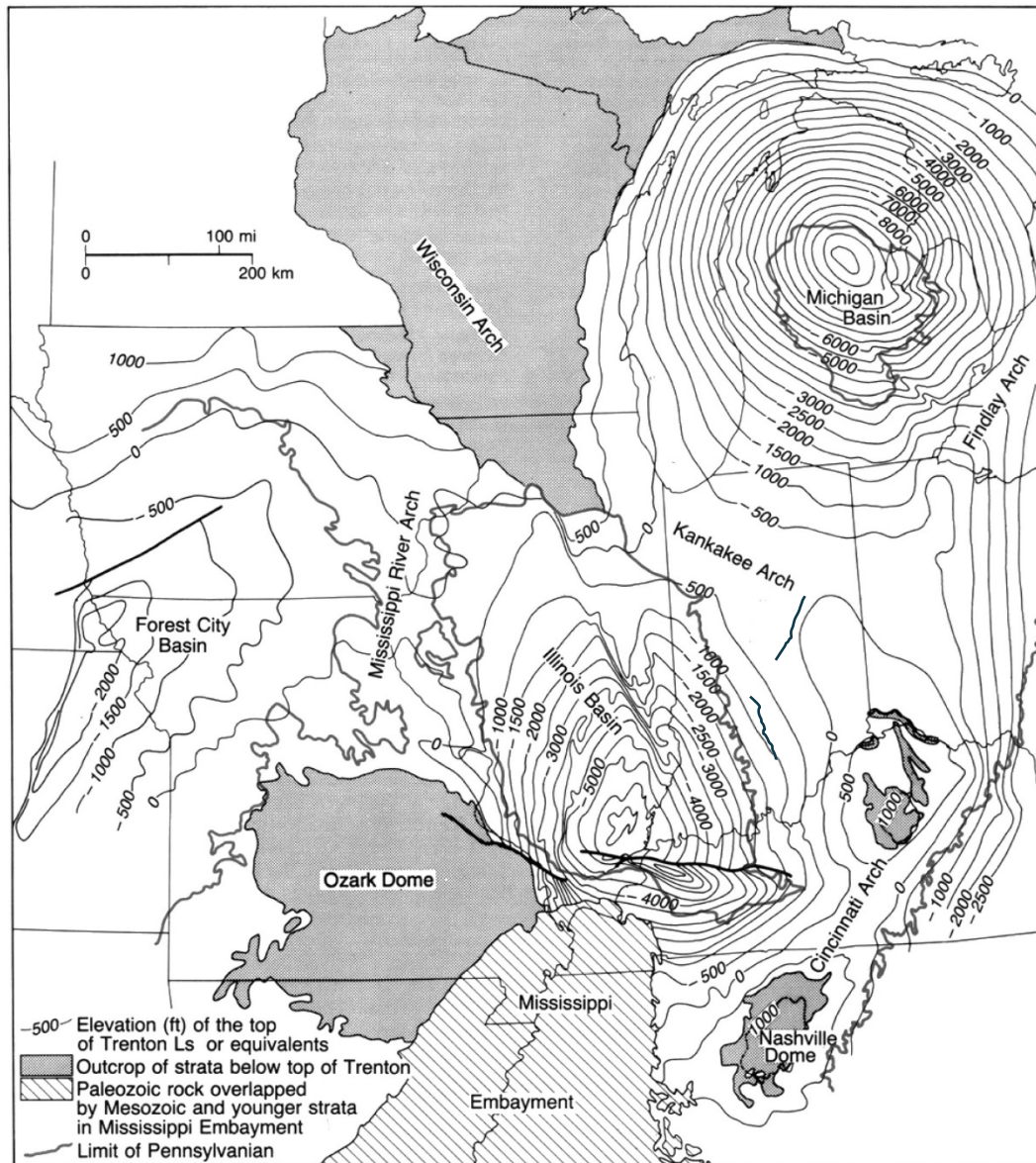


Figure 4. Map showing major structural features (faults, folds, domes, and basins) that control the exposure and depth of bedrock units in the Midwest U.S. The Cincinnati Arch to the east-southeast of the study area, and the Kankakee Arch to the north-northwest of the study area, are high-elevation subsurface features that control the direction and angle of bedrock strata in Indiana. Modified from Nelson (1995) and Collinson, et al. (1988).

Karst Geology and Hydrology

Karst landscapes in Southwest Indiana create rapid connections between the land surface, surface water, and groundwater. Sinkholes, sinking streams, springs, caves, and conduit flow can route water quickly through the subsurface with limited natural filtration (Figure 5). For water-supply planning, this means that source-water availability and source-water vulnerability must be considered together.

A unique challenge for hydrologic modeling in Southwest Indiana is the presence of karst geomorphology. In underflow and overflow karst basins, surface water is frequently captured by swallow holes and routed through subsurface conduits. These conduit-pirated streamflows often cross surface topographic divides and take completely different flow paths than surface drainages. Care was taken in this study to investigate and map karst basins and enforce (where possible and necessary for accuracy) karst drainages where they deviated from surface-water catchments in the White and East Fork White River Basins.

The Patoka Dam area has localized karst. Bledsoe (2015) documented rapid groundwater movement through solution-enlarged limestone to Robert Hall Cave Spring downstream of the dam. Spring discharge responded primarily to local precipitation. That shows rapid preferential flow and localized groundwater discharge, not necessarily large, slowly released groundwater storage throughout the watershed.

Although the karst region extends into the Ohio River Valley, the Wabash, and White River Basins have few karst features.



Karst spring, Greene County. Photo by Jason Krothe.

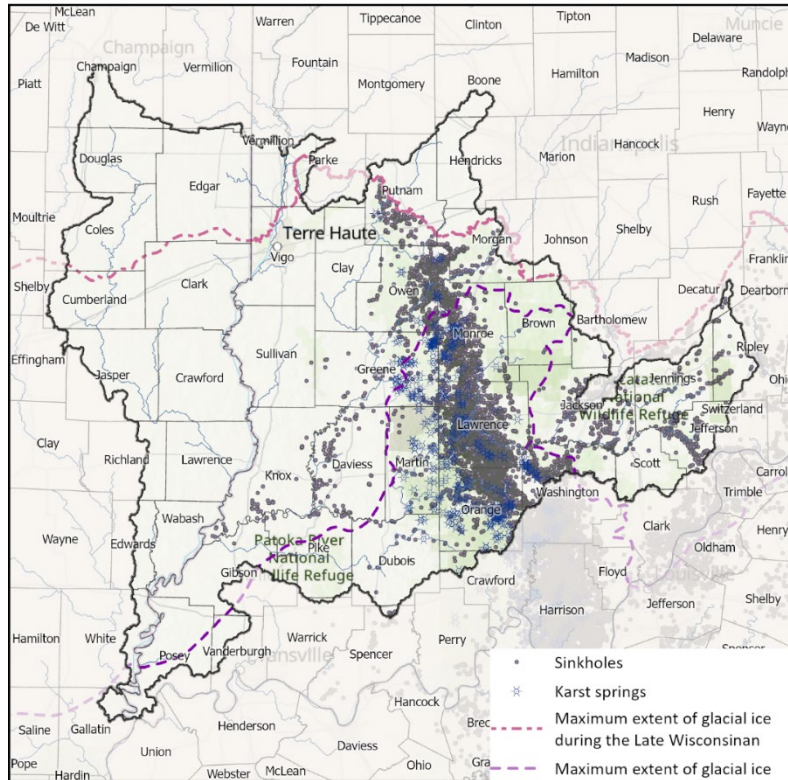


Figure 5. Map showing the distribution of karst features (described by locations of sinkholes and karst springs) in Southwest Indiana. Sinkholes, springs, and caves continue to the southeast, into the Ohio River Valley.

Coal-Mine Aquifer Systems and Mined Lands

There is a rich history of coal mining throughout a large portion of the study area, with mines dating back to as early as 1821 in Terre Haute (OSMRE, 2026). There are eleven different Pennsylvanian-aged coal seams that are productive enough to be included in Indiana's stratigraphic column (Figure 33). These units are primarily in the Carbondale and Racoon Creek Groups of middle and lower Pennsylvanian age. Moving upwards in the stratigraphic column, notable coal seams include the Lower Block, Upper Block, Minshall/Bufaloville, Seelyville, Colchester, Survant, Houchin Creek, Springfield, Herrin, Hymera, and Danville.

In the Southwest Indiana study area, abandoned and active coal mines are primarily located in the White, Patoka, and Wabash River basins (Figure 6). The majority of mines are present in a subset of Subbasins (0, 12, 13, 14, 14, and 19; 03341500, 03342000, 03342500, 03343010, and 03378500) in Vermillion, Vigo, Sullivan, and Knox Counties from the Wabash River Basin, Subbasins 9, 10, and 11 (03360500, 03374000, and 03374100) in Clay, Owen, Greene, Daviess, and Knox Counties from the White River Basin, and finally Subbasins 2 and, 3 (03376300 and 03376500) in Dubois, Pike, and Gibson Counties from the Patoka River Basin.

There are more surface mines in the east where the coal-bearing Pennsylvanian bedrock is exposed (IDNR, 2026). Moving westward, the coal units become buried by upper Pennsylvanian rocks (IGS, 2013), leading to a number of extensive underground coal mines being developed in the Wabash River Valley. Some of the largest coal mines in the study area Indiana include the Gibson Mine, Oaktown Mine, Carlisle Mine, Opportunity Mine, Prosperity Mine, Viking Mine, Francisco Mine, Bear Run Mine, Farmersburg Mine, and Shamrock Mine.

The process of mining out a portion of bedrock permanently alters the water table and potentially increases water availability by creating preferential flow paths and water reservoirs in the void space. While not always explicitly included in the active, consumptive water budget, the region's vast network of abandoned underground coal mines and reclaimed surface mines represent a massive volume of artificially stored water.

- **Underground Mine Storage:** More than 194,000 acres in Indiana are underlain by underground coal mines. The flooded voids of these abandoned room-and-pillar mines are estimated to hold up to 172 billion gallons of groundwater (Harper, Branam, and Olyphant, 2013). While this water is often highly mineralized, it represents a substantial secondary aquifer system.
- **Surface Mine Spoil and Lakes:** Modern surface mine reclamation practices have significantly altered local stream hydrology. The creation of final cut lakes and permanent sediment ponds significantly increases onsite water storage. Furthermore, reclaimed spoil aquifers act as hydrologic sinks due to their highly increased secondary porosity and permeability. According to local industry hydrogeologists, this increased infiltration capacity results in a flatter, less variable groundwater table. This ultimately decreases peak storm runoff but increases and prolongs stream baseflows, often converting historically ephemeral streams into intermittent or perennial post-mining streams.

Although these aquifers could in theory be used as a water source, the quality of the water is a concern that would need to be addressed before this becomes practical. Abandoned coal mines are known to produce acid mine drainage when water dissolves oxidized sulfate minerals like pyrite (FeS_2) that are common in coal deposits and associated spoil piles (Acharya and Kharel, 2020). The increased and prolonged contact between water and sulfate minerals in and around former coal mines leads to the water becoming contaminated and no longer safe to drink. There may be some limited industrial cooling applications that could utilize such acidic waters, but even then the water would likely first need to be treated to balance the pH and prevent corrosion of machinery. Although former coal mining areas have the potential to be a significant water source in certain parts of the study area, the effort and expense required to remediate and decontaminate this water may prevent it from ever being realistically considered by utilities, industries, or other users.

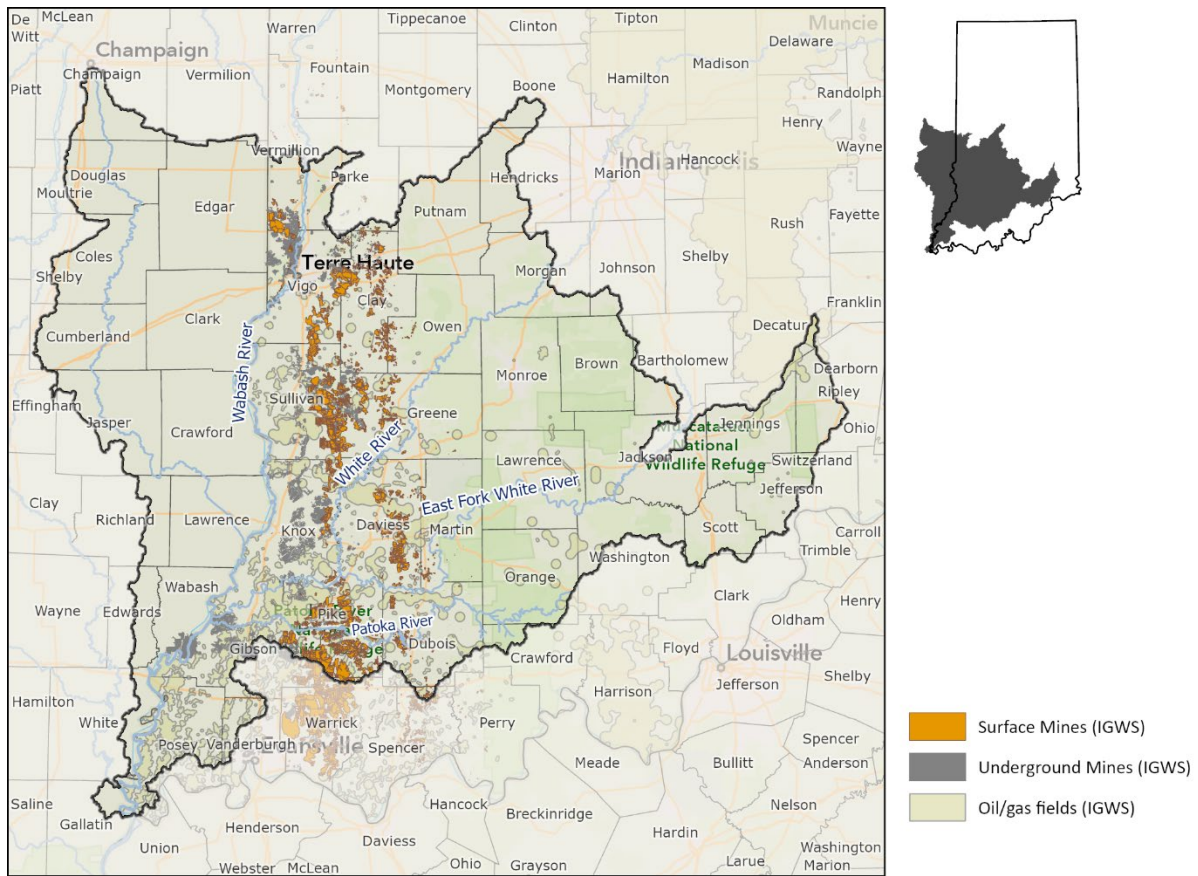


Figure 6. Southwestern Indiana sits on the edge of the Illinois Basin, a major regional depositional basin that collected thousands of feet of sediment during the Paleozoic Era. These rocks are sources of coal and petroleum. The map shows that active, closed, abandoned, and reclaimed minelands are located in a north-to-south swath in Southwestern Indiana. The region has a history of both underground and surface coal mining,

Streamflow Monitoring Network

Figure 7 below shows the 21 subbasins monitored by USGS streamgages (instrumented stations that measure water flow and stream depth) that provided much of the physical hydrology data used in the water availability assessment. Because water availability is an integration of human, ecological, and hydrogeologic factors, most of the report is spatially organized by major stream basin: Wabash River, White River, East Fork White River, and Patoka. Within those larger river systems are sub-watersheds, which are referred to in the report as “subbasins.” Water demand and returns are tracked in each subbasin and combined with seasonal streamflow and groundwater baseflow measurements to calculate water availability.



Figure 7. Local segments of river sub-watersheds (subbasins) in the Southwest Indiana regional water study area. The subbasins have USGS streamgages at their outlets (the downstream location to which the water in that subbasin flows). Those monitoring locations are marked with red triangles. The labels in the subbasin polygons are the USGS streamgage IDs.

Water Demand

Water demand in this study is evaluated using reported and estimated withdrawals, sector-specific assumptions, public utility operating data, and future projections. Demand is summarized by source, sector, season, and subbasin where possible. Because Southwest Indiana includes large non-consumptive surface-water withdrawals as well as localized consumptive groundwater demands, both volumes are presented.

Water withdrawal and consumptive use describe different parts of the same water-use cycle. A withdrawal is the total amount of water removed from a groundwater or surface-water source. Consumptive use is the portion that evaporates, is transpired by plants, is incorporated into crops or products, is consumed by people or animals, or is otherwise not promptly returned to the watershed. The remainder may return as treated wastewater, cooling-water discharge, septic-system recharge, irrigation drainage, or another return flow. At its simplest, consumptive use is the difference between the amount withdrawn and the amount returned. In this study, it was estimated using reported discharges where available and sector-specific return assumptions where direct measurements were unavailable (Shaffer, 2009).

This distinction is important because the largest withdrawal is not necessarily the use that removes the most water from the watershed. A power plant may withdraw an enormous volume for cooling and return nearly all of it, while a smaller irrigation withdrawal may be largely consumed through evaporation and plant growth. Wastewater returns are therefore included in the water-demand analysis—not because wastewater is itself a demand, but because the amount and location of the return determine the effect of that demand on water availability. The study tracks both withdrawals and returns by subbasin, including cases in which water is withdrawn in one subbasin and returned in another. Together, they provide the human-use part of the water balance that is later combined with natural streamflow, groundwater baseflow, and reservoir storage and releases in the water-availability analysis.

In this study, historical water demand for Indiana water-use sectors was assessed through the examination of monthly water-withdrawals reported in the Indiana Department of Natural Resources, Division of Water, Significant Water Withdrawal Facility (SWWF) database covering withdrawals spanning from 1985-2023. Figure 8 shows the locations of the largest water users in the region in the following sectors:

- Public supply (municipal and non-municipal, PS)
- Industrial (manufacturing and stone/aggregate mining, IN)
- Irrigation (agricultural and turf, IR)
- Energy production (power generation and coal mining, EP)
- Rural uses (fisheries, RU)

The SWWF database records monthly water-withdrawal volumes from registered facilities that meet the criteria of having the capacity of pumping ~70 GPM (100,000 GPD). They classify facilities in lumped categories as shown in the list above, but also include a miscellaneous (MI) category, often used for temporary water withdrawals, such as construction projects. In addition to the six main categories, this study estimated water use for self-supplied domestic residential and livestock operations (concentrated animal feeding operations and confined feeding operations, both collectively referred to as “CAFO” in this report).

Figure 9 and Figure 10 show why both withdrawal and consumptive-use volumes are needed. Reported withdrawals in 2023 totaled approximately 790 MGD and were dominated by approximately 584 MGD used for energy production. Most thermoelectric cooling water was subsequently returned, however, so

total consumptive use was estimated at approximately 87 MGD. Accounting for those returns shifts attention toward irrigation, public supply, livestock, and selected industrial uses and changes the apparent importance of the water sources: groundwater supplies approximately 75 percent of consumptive use, compared with approximately 25 percent from surface water. The withdrawal charts describe the amount of water handled by users and infrastructure, whereas the consumptive-use charts more directly represent the portion affecting the regional water balance.

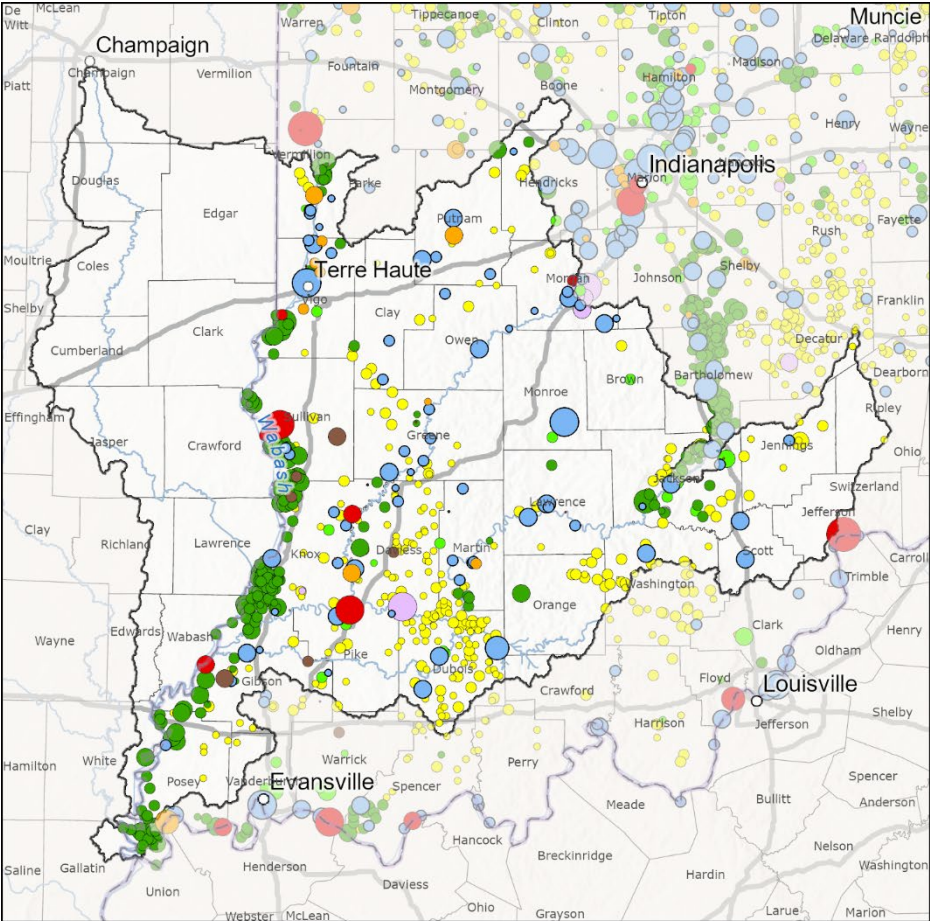
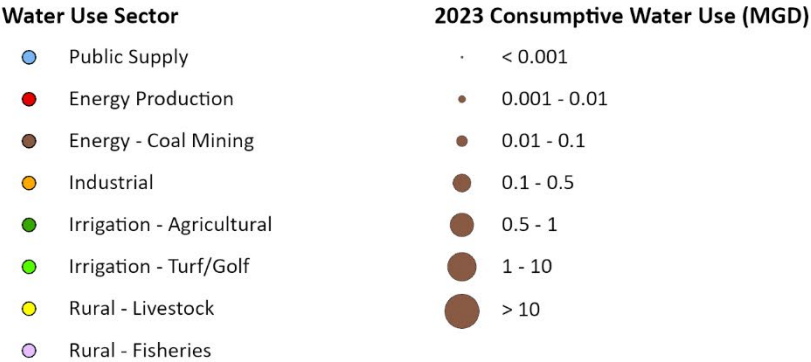


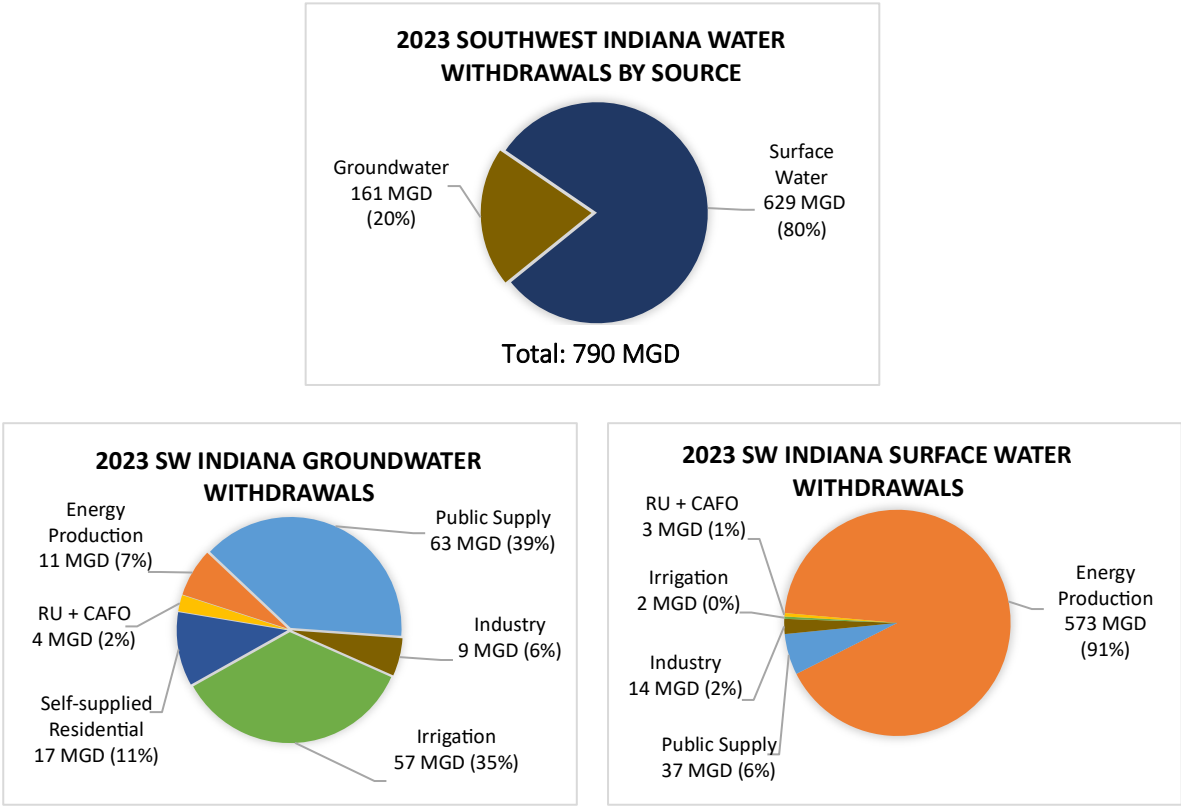
Figure 8. Locations of registered high-capacity (>70 GPM) wells and intakes in the Southwest Indiana region (IDNR, 2023, Significant Water Withdrawal Facilities). Symbol size represents estimated consumptive use—the portion of water withdrawn that is not returned to the watershed—rather than total withdrawal volume.



The figures and tables below present the current water demand in the Southwest Indiana region in a variety of ways to illustrate the water sources, water-use sectors, locations, and even the seasonality of water use.

Considering all water sources (ground- and surface water) in the study area, the following are the current total demands for each SWWF sector: Energy Production – 584 MGD; Public Supply – 77 MGD; Irrigation - 59 MGD; Industry – 23 MGD; Rural Use / CAFO - 7 MGD.

Figure 9. Current (2023) water withdrawals by water source (top) and water-use sectors by source (bottom) in the Southwest Indiana region in Millions of Gallons per Day. Data from IDNR SWWF 2023, except for self-supplied residential and livestock (CAFO) facility water use, which was estimated separately.



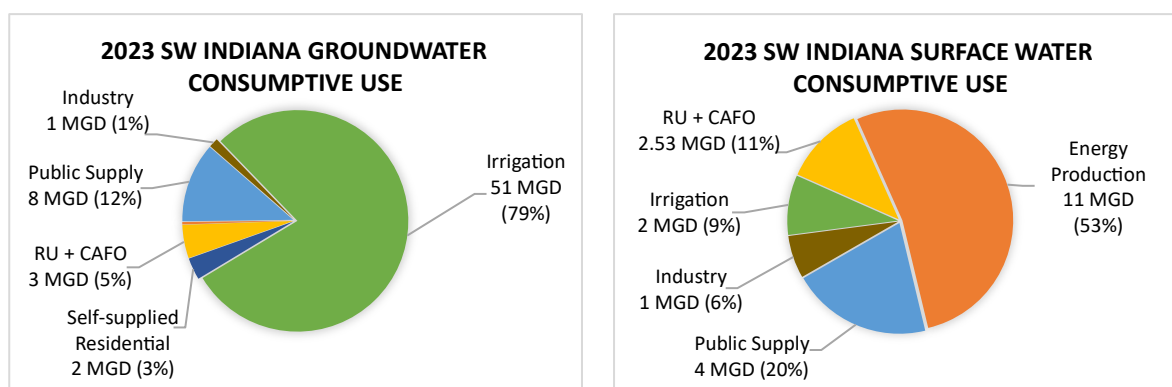
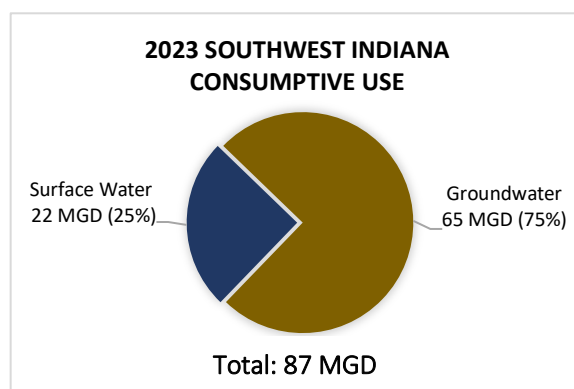


Figure 10. Current (2023) consumptive water use by water source (top) and water-use sectors by source (bottom) in the Southwest Indiana region in Millions of Gallons per Day. Raw water withdrawals by power plants (surface water) are largely non-consumptive (returned to the system in full); therefore, other water-use sectors with lower withdrawal volumes are relevant to subbasin water balances in this region.

Figure 11, Figure 12, and Figure 13 use Sankey diagrams to follow water through successive parts of the water-use system. The vertical bars, called nodes, show totals, while the width of each connecting band shows the volume flowing from one category to the next. Figure 11 follows all 2023 withdrawals from groundwater and surface-water sources to the sectors using the water. Figure 12 follows only the portion estimated to be consumed, and Figure 13 shows where withdrawals occur among the four river basins. The diagrams report annual volumes in millions of gallons (MG), whereas the pie charts in Figure 9 and Figure 10 report the equivalent average daily rate in millions of gallons per day (MGD). The keys above Figure 11, Figure 12, and Figure 13 guide the interpretation of the figures.

The difference between Figure 11 and Figure 12 illustrates why withdrawals and consumptive use are both important. Energy production accounted for 212,028 MG of power-generation withdrawals but only approximately 4,240 MG of estimated consumptive use because about 98 percent of the cooling water was returned to the hydrologic system. Irrigation presents nearly the opposite pattern: approximately 90 percent of the water applied to crops and turf was estimated to be consumed through evaporation, plant transpiration, and retention in plants and soils. When return flows are accounted for, irrigation—not thermoelectric cooling—becomes the largest consumptive-use sector.

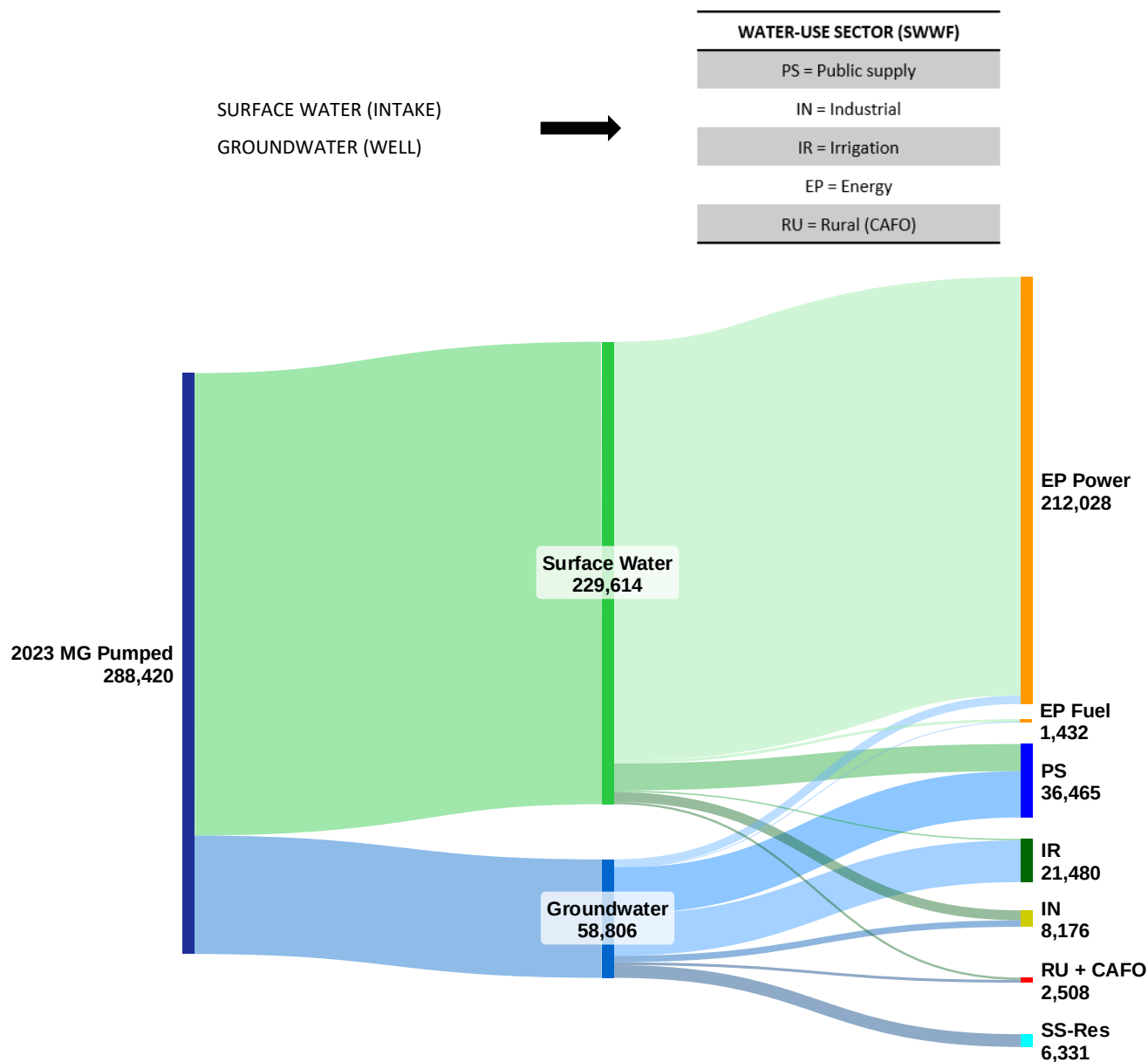


Figure 11. Annual sum of water pumped in Millions of Gallons per Year by source type (surface water or groundwater). EP Power is power generation, whereas EP Fuel represents coal mining withdrawals. Of the 288,420 MG withdrawn during the year, 229,614 MG came from surface water and 58,806 MG came from groundwater. Surface-water withdrawals were nearly four times groundwater withdrawals, primarily because of the large volume used for once-through cooling at thermoelectric power plants. Public supply and irrigation for agricultural and golf course watering were the next-largest sectors, and both relied principally on groundwater. Data are from the 2023 IDNR Significant Water Withdrawal Facility database, supplemented with separately estimated self-supplied residential and livestock-facility water use.

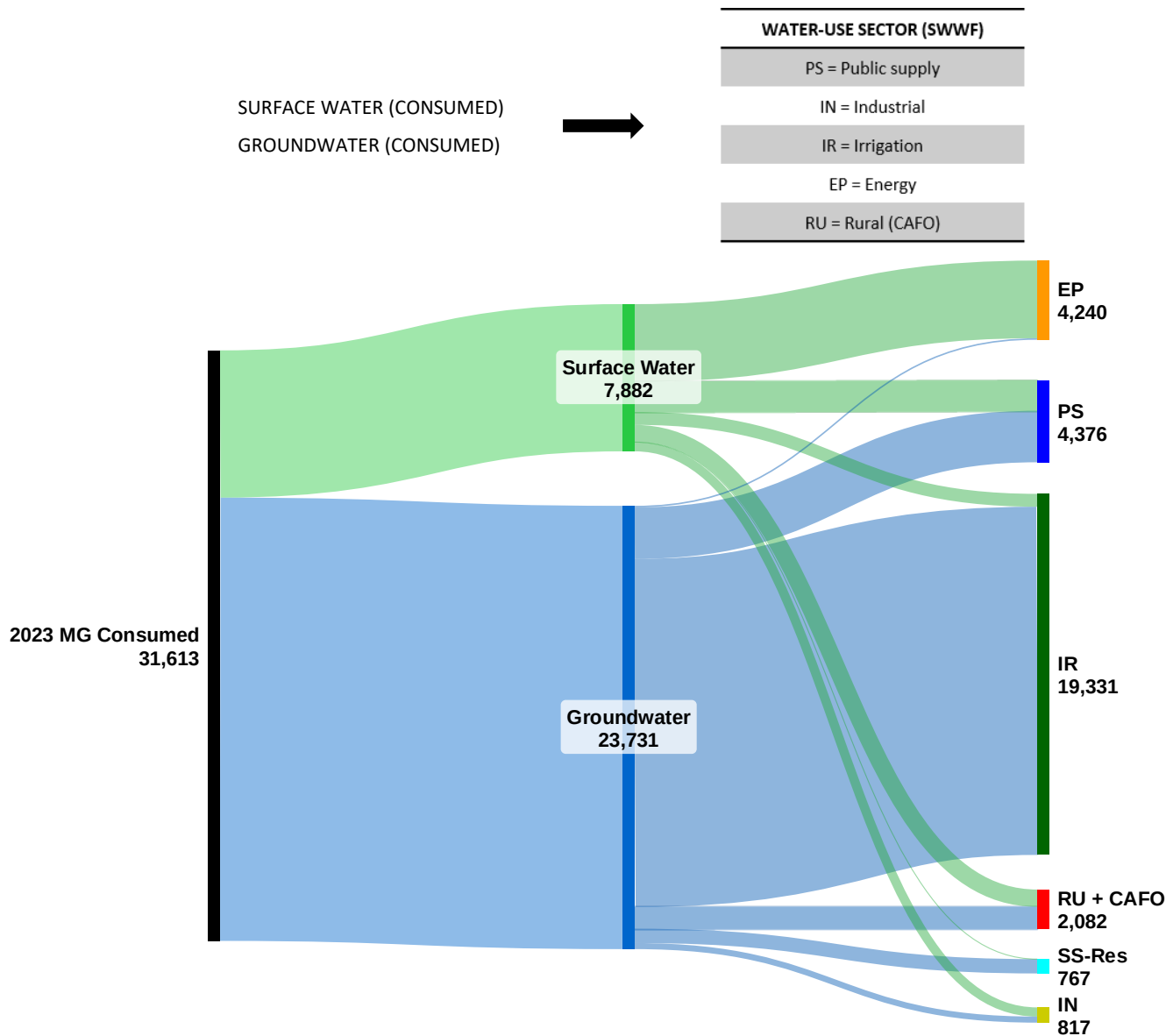


Figure 12. Annual sum of water consumed in the Southwest Indiana region (Indiana only) in Millions of Gallons per Year by source type (surface water or groundwater). Consumptive use totaled approximately 31,613 MG, or about 87 MGD. Groundwater supplied 23,731 MG, approximately 75 percent of the total, while surface water supplied 7,882 MG. Consumptive use represents water that was not promptly returned to the watershed and was estimated using reported discharges where available and sector-specific return assumptions where direct measurements were unavailable.

Figure 13 shifts the view from water source to geographic location. Most reported withdrawals occurred in the Wabash and White River basins, where the region’s largest thermoelectric power plants withdraw surface water for cooling. The Wabash River basin also contained most irrigation withdrawals and the largest share of public-supply withdrawals. The East Fork White River and Patoka River basins accounted for much smaller shares of the regional total. Because this diagram shows gross withdrawals, its spatial pattern is strongly influenced by power-plant cooling and should not be interpreted as the amount of water consumed within each basin.

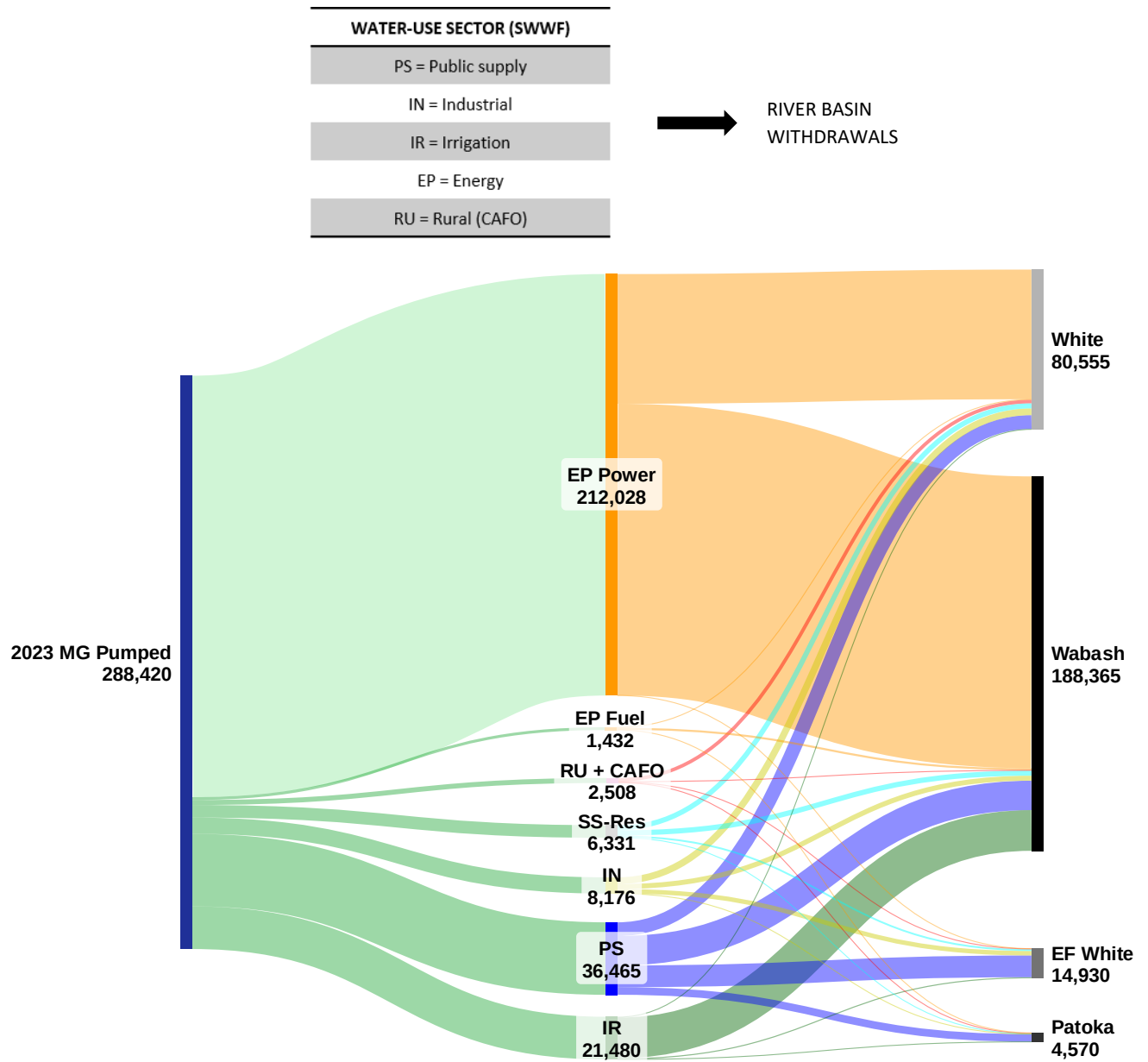


Figure 13. Annual sum of all water pumped in Millions of Gallons per Year. This diagram gives an overview of the spatial distribution of water withdrawals in the Southwest Indiana region. EP Power is power generation, whereas EP Fuel represents coal mining withdrawals. The majority of water used for EP Power thermoelectric cooling comes from surface water, and this figure shows that most of this water usage is occurring in the Wabash (188,365 MG) and White River Basins (80,555 MG), together representing more than 90 percent of regional withdrawals. The East Fork White River and Patoka River basins accounted for 14,930 MG and 4,570 MG, respectively. The Wabash Basin supports almost all Irrigation uses and sees the highest fraction of Public Supply water utilization as well. The White River Basin has a larger percentage of Fisheries and Livestock (RU+CAFO) water usage than the other three, although every basin has a notable amount. For an overview of the locations of these four basins, see Figure 18.

The 2023 diagrams provide a current snapshot, but water use in the region has changed substantially over time. Figure 14 through Figure 17 place the current totals in historical context. The historical figures rely principally on the consistent IDNR Significant Water Withdrawal Facility record and are intended to show changes in magnitude, timing, source, and sector. Their totals are not directly interchangeable with the 2023 diagrams, which also include separately estimated uses.

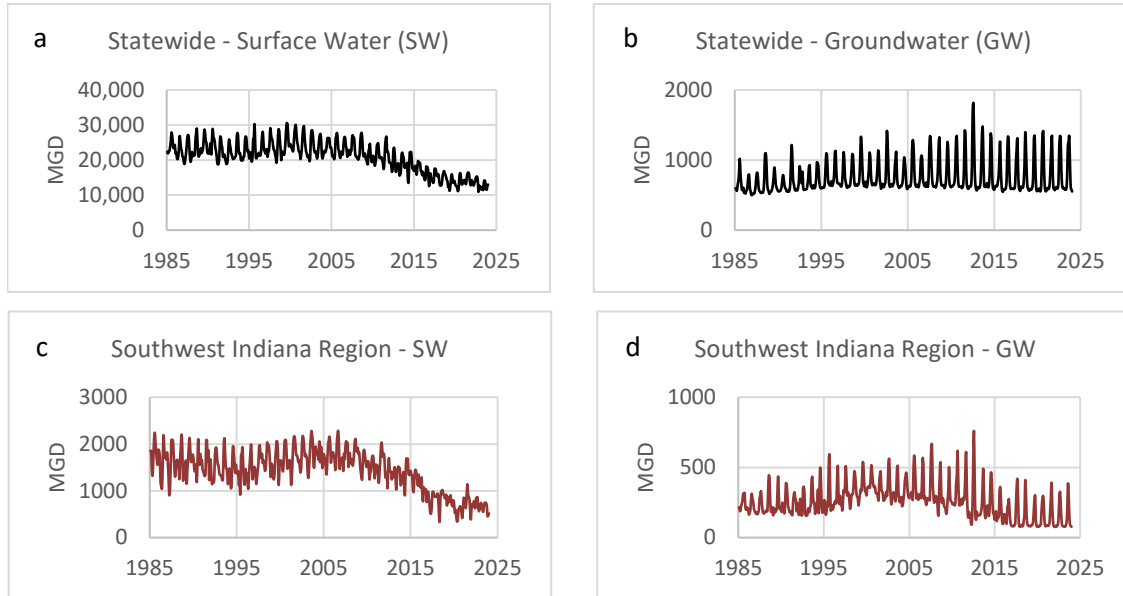


Figure 14. Historical monthly surface-water and groundwater withdrawals statewide and within the Southwest Indiana region, 1985–2023. Statewide and regional surface-water withdrawals declined substantially during the latter part of the record, largely reflecting changes in thermoelectric power generation. Groundwater withdrawals show stronger seasonal peaks associated with warm-season uses such as irrigation. Data are from the IDNR Significant Water Withdrawal Facility database.

Figure 15 shows that surface-water intakes for energy production dominate the historical regional total and largely control its overall trend. Consequently, reductions associated with power-plant closures, unit retirements, and conversions to less water-intensive generating technologies can produce large changes in reported withdrawals without a comparable reduction in consumptive use. The scale required to display those withdrawals also makes changes in the other sectors difficult to see.

Figure 16 presents the same history without surface-water energy-production intakes. At this scale, public supply, irrigation, industrial use, rural use, and groundwater withdrawals associated with energy production can be distinguished. These uses did not follow a single regional trend: public-supply withdrawals changed gradually, irrigation varied substantially among years, and industrial and energy-sector changes often occurred as shifts tied to individual facilities.

The sector histories in Figure 17 further show why future demand was not projected using a single regional trend. Public-supply withdrawals generally changed gradually and retained a repeating seasonal pattern. Irrigation was concentrated in the growing season and varied with weather, with groundwater irrigation increasing over much of the record. Energy production, coal mining, and manufacturing instead show pronounced operational changes associated with individual facilities. These different behaviors required sector-specific forecasting methods.

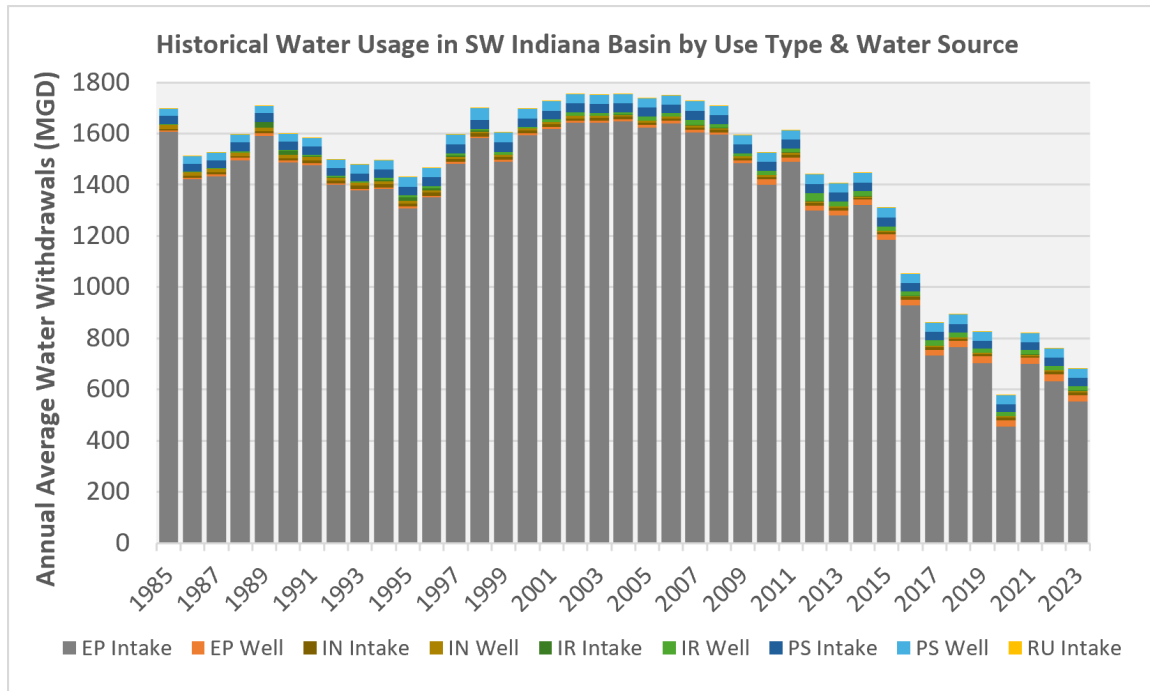


Figure 15. Historical water usage by sector. EP Intake dominates water usage with power generation cooling water. Surface-water intakes used for energy production dominate the historical total. Their decline, particularly after 2010, reflects structural changes in the regional power-generation sector. (IDNR SWWF, 2023)

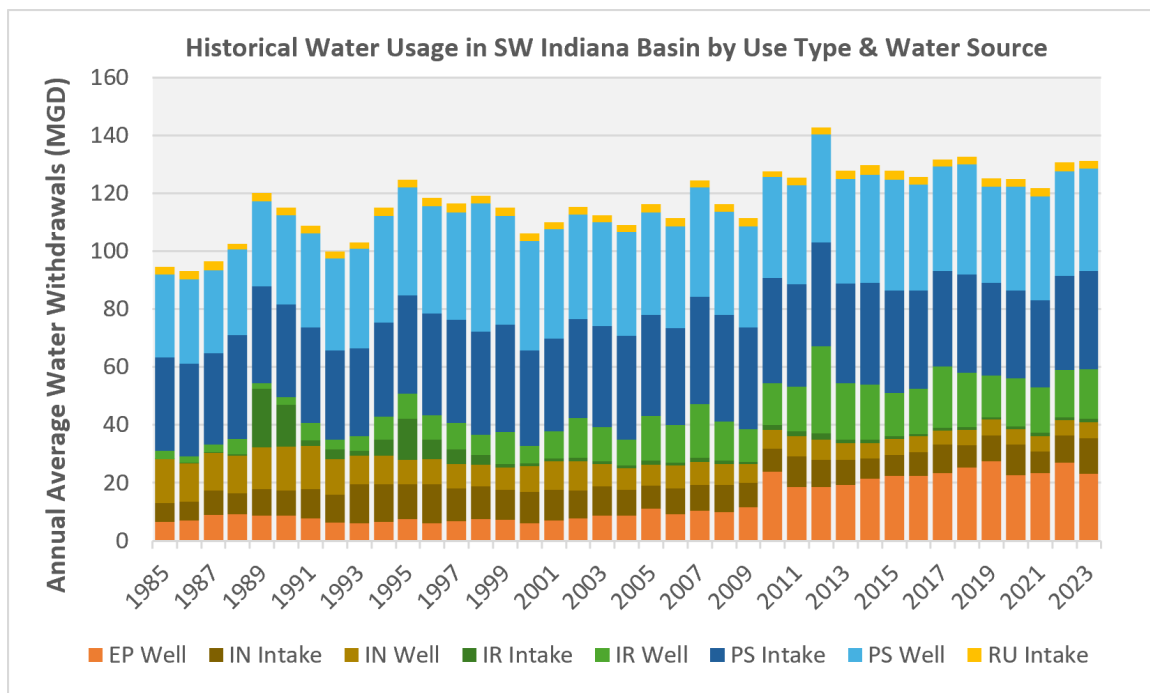


Figure 16. Historical water usage by sector, omitting EP Intake to highlight other sectors. Public supply and irrigation constitute much of the remaining demand, while industrial, rural, and groundwater energy-production withdrawals make smaller but locally important contributions. (IDNR SWWF, 2023)



Figure 17. Selected monthly water-withdrawal histories by sector and source in the Southwest Indiana region. The panels illustrate differences in long-term direction, seasonality, and facility-driven change among public supply, energy production, coal mining, industrial manufacturing and quarrying, irrigation, fisheries, and livestock use. SW indicates surface water and GW indicates groundwater. Reported withdrawals are from the IDNR Significant Water Withdrawal Facility database; livestock demand is not reported in the IDNR SWWF and was estimated separately beginning in 2007.

Figure 18 (left) shows the four river basins that converge in Southwest Indiana: Patoka, East Fork White, White, and Wabash River basins. Because this is a hydrological study, the calculations and assessments were done in the context of watersheds, also known as drainage areas. Each river basin has numerous tributaries, whose drainage areas are called “subbasins” (or sub-watersheds). Many of the tributary streams are monitored by U.S. Geological Survey (USGS) streamgaging stations. These stations monitor water depth, water flow (stream discharge), or both. This data underpins most of the water availability calculations in the Indiana Regional Water Studies Program (<https://www.in.gov/ifa/regional-water-studies>).

Throughout this report, we provide multiple ways to identify the geographical location of what is being discussed. One way is to use the USGS streamgage ID number (e.g., 03341500; MAP 1; Table 3). The second is to use a Subbasin ID internal to this project. The numbering generally progresses from the relatively self-contained Patoka River Basin through the East Fork White and White River systems to the Wabash River mainstem and its integrated downstream drainage areas. Because these river systems enter the Wabash at different locations, the numbering is not intended to represent a single continuous upstream-to-downstream sequence. Hydrologic connections among subbasins are shown in Figure 18 (right).

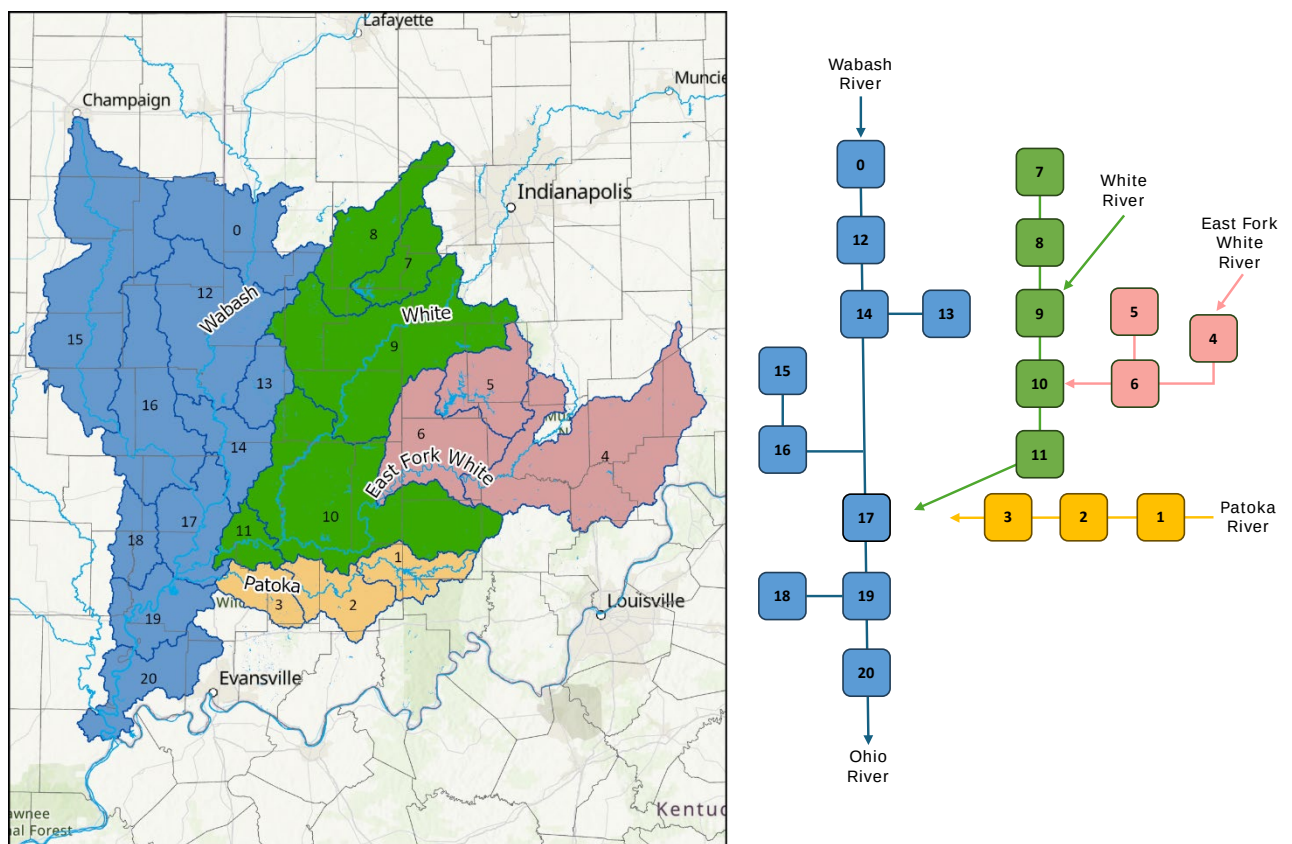


Figure 18. Subbasin map (left) and subbasin schematic (right) used in the study. In the water demand phase of the study, all withdrawals and returns in each subbasin were inventoried or estimated. In the water availability phase of the study, the natural streamflow, natural baseflow, reservoir operations, and ecological needs (in-stream flows) were accounted for in each subbasin. Cumulative water availability integrated all demand and availability volumes from upstream to downstream, simulating the aggregation of downstream flows through the hydrologic system.

Table 3. List of subbasins used as spatial containers for water availability calculations in this study. The subbasins are the catchments or sub-watershed areas between streamflow monitoring stations. They can be identified by the USGS Gage ID number, or by the project Subbasin ID.

River Basin	USGS Gage ID	Subbasin	Waterway	Area (mi ²)
Wabash	USGS-03341500	0	Wabash River at Terre Haute, IN	696
Wabash	USGS-03342000	12	Wabash River at Riverton, IN	899
Wabash	USGS-03342500	13	Busseron Creek near Carlisle, IN	228
Wabash	USGS-03343010	14	Wabash River at Vincennes, IN	341
Wabash	USGS-03345500	15	Embarras River at Ste. Marie, IL	1510
Wabash	USGS-03346500	16	Embarras River at Lawrenceville, IL	816
White	USGS-03359000	7	Mill Creek near Manhattan, IN	293
White	USGS-03360000	8	Eel River at Bowling Green, IN	537
White	USGS-03360500	9	White River at Newberry, IN	1412
East Fork White	USGS-03371500	4	East Fork White River near Bedford, IN	1469
East Fork White	USGS-03372500	5	Salt Creek near Harrodsburg, IN	432
East Fork White	USGS-03373500	6	East Fork White River near Shoals, IN	642
White	USGS-03374000	10	White River at Petersburg, IN	1500
White	USGS-03374100	11	White River at Hazleton, IN	179
Patoka	USGS-03375500	1	Patoka River at Jasper, IN	262
Patoka	USGS-03376300	2	Patoka River at Winslow, IN	340
Patoka	USGS-03376500	3	Patoka River at Princeton, IN	219
Wabash	USGS-03377500	17	Wabash River at Mt. Carmel, IL	446
Wabash	USGS-03378000	18	Bonpass Creek at Browns, IL	228
Wabash	USGS-03378500	19	Wabash River at New Harmony, IN	396
Wabash	South_03378500	20	Lower Wabash River	450

Power Generation

Energy production is the most dominant water-use sector in Southwest Indiana. Coal-fired plants use significantly more water than any other facility, and as of 2024 there were three remaining in the study area. These include the Gibson Generating Station near Mount Carmel, IL (Subbasin 19; 03378500), the Petersburg Generating Station (Subbasin 10; 03374000), and the Merom Generating Station adjacent to Turtle Creek Reservoir (Subbasin 12; 03342000).

Historically there were several other coal-fired power generation plants in the study area that used a significant amount of cooling water, but the majority of these plants have either closed or transitioned to less-water-intensive power generation methods such as natural gas, integrated gasification combined cycle (IGCC), or renewable energy (EIA, 2022). Examples of plants that transitioned from being coal-fired to natural gas or IGCC (coal gasification) include the Wabash River Generating Station in Terre Haute (Subbasin 0; 03341500), the Sugar Creek Natural Gas Combined Cycle Generating Station in Terre Haute (Subbasin 12; 03342000, formerly Dresser), the Eagle Valley Natural Gas Combined Cycle Generating Station in Martinsville (Subbasin 9; 03360500), and the Edwardsport IGCC Generating Station in Knox County (Subbasin 10; 03374000). The Wabash River Generating Station was first converted to burn both coal and coal gas in 1995, but was then updated to be a peaking station that uses natural gas in 2015.

The aforementioned Petersburg Generating Station retired two of their four coal-fired units in 2021 and 2023 and replaced them with a 250-MW solar farm and 180 MWh battery storage array (Solar Power World Online, 2026). The other two coal-fired units at Petersburg are currently in the process of being retrofitted to burn natural gas and are slated to go online in 2027 (Power Peak Digest, 2026). There were two coal-fired power plants referred to as the Breed Generating Station (Subbasin 12; 03342000) and the Frank E. Ratts Generating Station (Subbasin 10; 03374000) that were decommissioned in 2007 and 2015,

respectively. The former Breed site in Fairbanks is currently being redeveloped into a natural gas and diesel plant, slated to open in 2029 (SullivanEnergyData, 2026). Two natural gas-fired peaking stations in the study area known as Worthington (Subbasin 9; 03360500) and Lawrence (Subbasin 6; 03373500), near Bloomfield and Bedford respectively, help to support local grid stability during periods of high power use. There is a natural gas power plant near Wheatland (Subbasin 10; 03374000) that has been online since 2000, as well as two small petroleum-fired plants in the Illinois towns of Casey (Subbasin 3; 03346500) and Marshall (Subbasin 12; 03342000) that came online in 2002.

Coal Mining

The Indiana Department of Natural Resources, Division of Water, includes coal mining in the EP (energy production) water-use sector, but the water sources, quantities, and withdrawal patterns are much different for energy production versus coal extraction. In this report, they are treated as related, but separate water-use sectors and have separate water-demand and return projections.

Active coal processing plants handle significant volumes of water but function largely as closed-loop systems. The primary consumptive losses are limited to the moisture added to clean coal/refuse and evaporative losses from slurry basins. Because operations draw from massive onsite sediment basins and final cut lakes, supplementary makeup water from external rivers or groundwater aquifers is rarely needed. Future projections rely on trend analysis of consumptive losses modified by local information regarding planned facility closures or expansions, such as the potential development of the Liberty Mine in Warrick County.

There are several coal mines in the southern part of the study area (both underground and surface strip mines) that pump a significant amount of water due to the dewatering process. In addition to their pumping, the process of altering the water table through the removal of geologic materials often creates a local surplus of return flows that persist long after the mines stop pumping and are no longer active. Some of the largest active coal mining companies in the study area include Gibson County Coal with their North and South mines in Subbasins 17 and 19 (03377500 and 03378500), respectively, Peabody Midwest Mining with operations in four different subbasins (Subbasins 5, 14, 10, and 3 or 03342500, 03343010, 03374000, and 03376500), Sunrise Coal LLC with a large operation near Oaktown in Subbasin 14 (03343010), and Responsible Energy Operations with a mine near Washington in Subbasin 10 (03374000). In addition to this, there are numerous inactive and reclaimed coal mining sites that contribute to increased return flows in some subbasins.

Public Water Supply

The Southwest Indiana region is served by a complex and largely interconnected public-water network. The sector includes major regional systems such as Patoka Lake Regional Water and Sewer District, Bloomington Utilities, Indiana-American Water-Terre Haute, Vincennes, and Washington, as well as more than 150 smaller systems, many serving rural communities.

Public supplies in this region rely on a critical mix of both surface water and groundwater. Surface water reservoirs, such as Monroe and Patoka Lakes, provide over half of the public supply volume to approximately 50 utilities, while the remaining 100 utilities mostly represent the groundwater portion of the sector. To meet regional demand, these utilities are highly interdependent. Purchased water systems and hybrid systems are prevalent; currently, 65 out of the 154 utilities purchase water from other systems to redistribute to their own service connections. Purchased-water and emergency interconnections are common responses to uneven source availability.

To compensate for the lack of viable self-supplied options south of the glacial boundary, municipal systems frequently extend service well beyond municipal limits to supply rural households and communities. As a result, an important distinction exists between where water is withdrawn, treated, delivered, and ultimately returned to the hydrologic system. Many rural customers use onsite septic systems, making a portion of the supplied water effectively consumptive at the local scale. In addition, purchased-water arrangements and emergency interconnections often create cross-basin transfers and return-flow patterns that differ substantially from natural watershed boundaries.

The water-service-area map developed for this study (Figure 19) shows the geographic reach of this interconnected network and identifies the primary water source used by each utility.

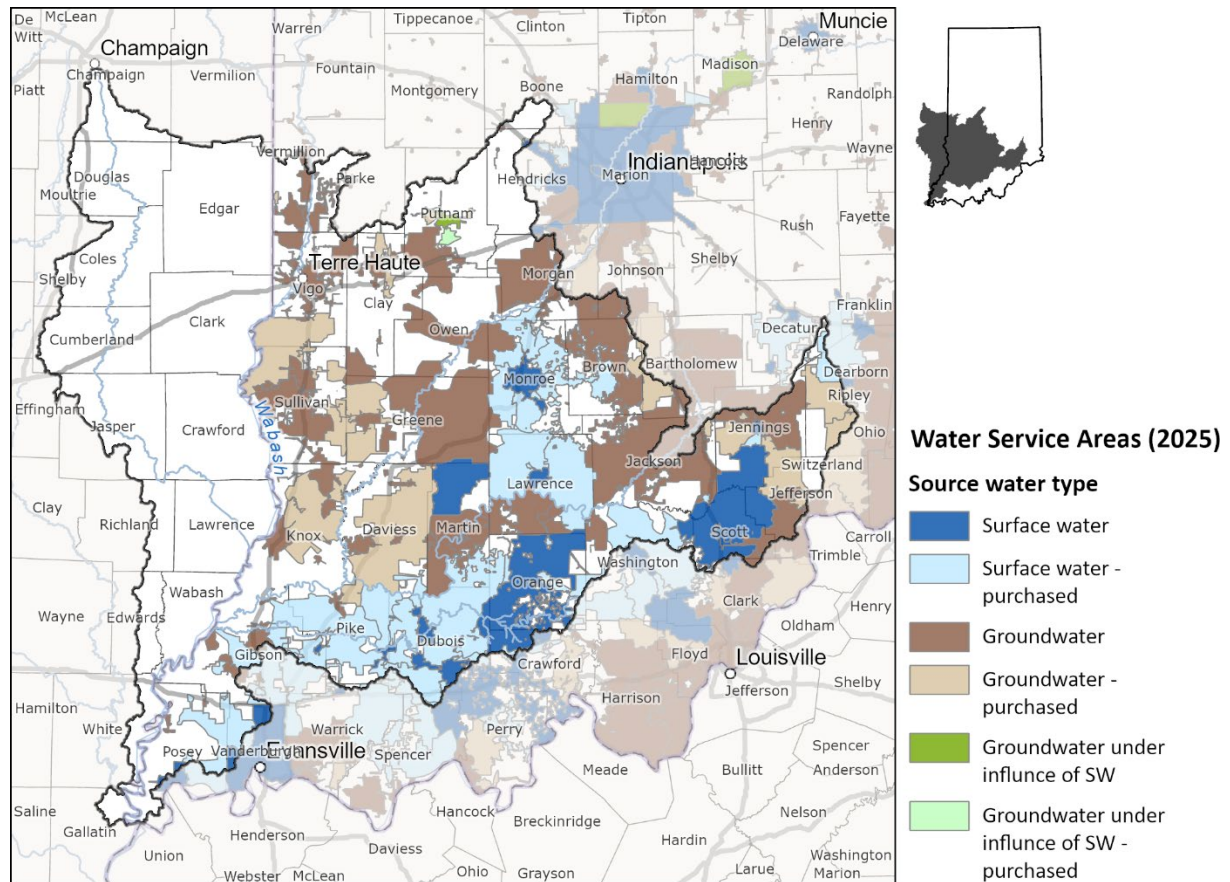


Figure 19. Map showing public utility service areas (2025), along with the primary water source type of each system. Water utility systems vary widely in service area, population, customer mix, and source. Groundwater is the most common source by utility count, while surface-water reservoirs support several of the largest regional networks. The study area is mostly south of the most recent glacial limit, which means the hydrogeological setting is dramatically different than the northern two thirds of the state and is characterized by large utility water service areas. The diversity in the customer base beyond residential and commercial/business properties for some utilities results from limited self-supplied water options in some areas.

There is also a self-served residential population in the region, some using unconventional water sources such as springs or cisterns. These self-served residences usually exist outside of established utility service areas and are typically assumed to provide their own water using private groundwater wells. There are places in the Southwest Indiana region where a cistern is not supplied with rain water, but through water

deliveries. This is both because of limited natural supply where wells yield very small amounts of water, but also because some aquifers have been contaminated by mining operations or oil and gas production.

Table 4 provides a companion summary of public water utilities serving at least 1,000 people, including their service-area size, population served, primary community, water source, and purchased-water status.

The service areas of the utilities listed in Table 4 range from approximately one-quarter square mile to nearly 600 square miles. The table is not comprehensive; roughly 50 additional small utilities serve fewer than 1,000 people, with the complete inventory provided in the technical appendix. Across the full inventory of 154 utilities, 65 purchase some or all of their water. Large regional suppliers include City of Bloomington Utilities, Patoka Lake Regional Water and Sewer District, Indiana-American Water–Terre Haute, Stucker Fork Water Utility, and Eastern Heights Utilities. Seventy-seven utility service areas span two or more subbasins, creating an important separation among the locations of water withdrawal, use, and return.

Table 4. Public water utilities in the Southwest Indiana region that serve at least 1,000 people. The utilities vary widely in the area and population they serve. Many utilities in this region are wholesale customers of larger utilities (see the * designation next to the source type), so the “population served” of large utilities can also include other communities.

Utility Name	Sq. Miles	Pop. Served	Density (people/SqMi)	Primary Town / Area Served	Source / *Purchased / +Both
City of Bloomington Utilities	48.72	83,000	1,703	Bloomington	SW
Indiana American - Terre Haute	46.58	67,765	1,455	Terre Haute	GW
Stucker Fork Water Utility	288.08	19,120	66	Scott and Surrounding Co	SW
Eastern Heights Utilities	349.04	19,028	55	Bloomfield and Greene Co	GW
Vincennes Water Utilities	26.75	18,701	699	Vincennes	GW
Jasper Municipal Water Utility	14.39	17,440	1,212	Jasper	SW
Brown County Water Utility	213.85	15,368	72	Brown Co	GW+
Martinsville Water Utility	14.61	15,000	1,027	Martinsville	GW
Ellettsville Water Works	21.62	14,500	671	Ellettsville	SW*
Bedford City Utilities	12.66	14,000	1,106	Bedford	SW
Washington Water Works	18.50	13,690	740	Washington	GW
Jackson County Water	366.41	13,667	37	Jackson Co	GW
Patoka Lake Regional Water	573.61	13,503	24	Orange and Dubois Co	SW
German Twp. Water Dist. Inc.	144.12	12,890	89	Posey and Vanderburgh Co	SW*
Greencastle Dept. Of Water	11.47	12,699	1,107	Greencastle	GW
Brazil City Water Works	20.26	12,000	592	Brazil	GW
North Lawrence Water Auth.	141.35	11,625	82	NW Lawrence Co	SW*
Princeton Water Dept	19.31	10,875	563	Princeton	GW
Pike Gibson Water, Inc.	268.00	10,000	37	Pike and E. Gibson Co	SW*
BBP Water Corporation	110.65	9,903	89	Spencer and Owen Co	GW
Dubois Water Utilities	217.19	9,078	42	Dubois and Martin Co	SW*
Southern Monroe Water, Inc.	32.79	8,877	271	S. Monroe Co	SW*
Morgan County Rural Water Co.	126.62	8,800	69	W. Morgan Co	GW+
Southwestern Bartholomew	68.95	8,652	125	SW Bartholomew Co	GW*
Jennings Water, Inc.	163.48	8,370	51	N. Jennings Co	GW
East Lawrence Water Authority	158.25	8,000	51	E. Lawrence Co	SW*
Daviess County Rural Water	276.31	7,969	29	Daviess Co	GW*
Linton Municipal Water Utility	12.57	7,430	591	Linton	GW
Scottsburg Water Department	8.36	7,369	882	Scottsburg	SW+
Kent Water Company	102.45	6,750	66	Jefferson and Scott Co	GW
Van Buren Water, Inc.	46.08	6,670	145	SW Monroe Co	SW*
Indiana American - Sullivan	11.05	6,598	597	Sullivan	GW

Utility Name	Sq. Miles	Pop. Served	Density (people/SqMi)	Primary Town / Area Served	Source / *Purchased / +Both
Naval Support Activities Crane	96.59	6,538	68	Northern Martin Co	SW
Huntingburg Municipal Water	10.86	6,526	601	Huntingburg	SW+
North Vernon Water Dept.	4.81	6,500	1,351	North Vernon	SW
South Lawrence Utilities	103.34	6,395	62	S. Lawrence Co	GW
Seelyville Water Works	34.78	6,393	184	Seelyville and NW Vigo Co	GW
Mitchell Water Department	10.39	5,000	481	Mitchell	GW
Clinton Water Utility	2.78	4,773	1,718	Clinton	GW
B&B Water Project, Inc.	30.63	4,695	153	NE Monroe Co	SW*
Ireland Utilities, Inc	43.34	4,395	101	NW Dubois Co	SW*
West Terre Haute Water	6.24	4,075	653	West Terre Haute	GW
Bicknell Municipal Utilities	8.01	4,064	508	Bicknell	GW
Petersburg Water Company	7.09	4,018	566	Petersburg	GW
Dupont Water Company	91.69	3,865	42	NW Jefferson and SE Jennings	GW*
Washington Twp Water Monroe	53.34	3,825	72	Northern Monroe Co	SW*
Paoli Water Department	4.56	3,677	806	Paoli	SW*
Jasonville Utilities	34.01	3,660	108	Jasonville and SW Clay Co	GW
East Monroe Water Corporation	30.20	3,648	121	E. Monroe Co	SW*
Knox County Water, Inc.	153.75	3,525	23	Knox Co	GW*
East Fork Water	138.50	3,485	25	SW Martin Co	GW
Town of Nashville Water Utility	13.01	3,315	255	Nashville	SW*
St. Henry Water Corporation	66.92	3,293	49	S. Dubois Co	SW*
Cataract Lake Water Corp.	35.90	3,215	90	S. Putnam and N. Owen Co	GW
Springs Valley Reg. Water Dist.	7.45	3,188	428	French Lick	SW*
Carlisle Water Department	4.17	3,125	750	Carlisle	GW
Jennings NW Regional Utility	2.17	2,955	1,365	NW Jennings Co	GW*
Oakland City Water Department	2.70	2,938	1,087	Oakland City	SW+
Ferdinand Water Department	2.43	2,918	1,202	Ferdinand Water	SW*
Ellis Water Company, Inc.	92.26	2,892	31	W. Greene Co	GW*
Brown County State Park	24.83	2,836	114	Brown Co State Park	SW*
Reelsville Water Company	54.13	2,800	52	SW Putnam Co	GW
Loogootee Water Works	4.36	2,800	643	Loogootee	GW
Putnamville Correctional Facility	0.75	2,505	3,356	Putnamville CF	GW*
Shelburn Water Utilities	31.27	2,500	80	Shelburn	GW
Hayden Water Association	39.30	2,395	61	W. Jennings Co	GW*
Holton Community Water Corp.	71.12	2,363	33	NW Ripley Co	GW*
Clinton Township Water Co.	21.42	2,300	107	S. Vermillion Co	GW
Town of Cloverdale	5.20	2,225	428	Cloverdale	GW
Owensville Water Works	16.21	2,148	133	Owensville	GW
Orleans Water Works	2.75	2,142	778	Orleans	SW*
Otwell Water Corporation #1	61.22	2,100	34	NE Pike Co	SW+
Indiana American - Farmersburg	5.75	2,095	364	Farmersburg	GW+
Paxton Water Corporation	97.07	2,013	21	Sullivan Co	GW
Fayette Township Water Assoc.	17.35	2,000	115	NW Vigo Co	GW
Dugger Utilities	8.15	1,935	237	Dugger	GW*
Crothersville Utilities	2.51	1,875	746	Crothersville	SW+
St. Anthony Water Utility	26.39	1,813	69	Central Dubois Co	SW*
Odon Water Utilities, Inc.	4.31	1,703	395	Odon	GW
Town of New Harmony	3.94	1,633	415	New Harmony	GW
Natural Public Supply, Inc.	0.25	1,560	6,359	SE Seymour	GW
Painted Hills Utility Company	4.67	1,560	334	SE Morgan Co	GW
Knightsville Water Works	2.75	1,523	553	Knightsville	GW*
South 43 Water Association, Inc.	11.02	1,431	130	Central Putnam Co	GW*

Utility Name	Sq. Miles	Pop. Served	Density (people/SqMi)	Primary Town / Area Served	Source / *Purchased / +Both
Poseyville Municipal Water	1.84	1,400	759	Poseyville	GW
FCI and FPC - Terre Haute	0.81	1,390	1,706	Federal CF, Terre Haute	GW
Fairview Park Water Utilities	1.53	1,386	907	Fairview Park	GW
Oolitic Water Works	1.10	1,315	1,200	Oolitic	SW*
Shoals Water Company	1.68	1,296	769	Shoals	GW
Freelandville Water Association	31.57	1,175	37	Freelandville	GW+
Clay City Water Works	1.45	1,152	794	N. Knox and S. Sullivan Co	GW
Morgantown Water Utility	1.05	1,125	1,069	Morgantown	GW
Carbon Water Corporation	9.82	1,088	111	Carbon and N. Clay Co	GW*
Jackson Co. Water - Reddington	9.23	1,080	117	NE Jackson Co	GW*
Montezuma Municipal Utility	1.18	1,022	863	Montezuma	GW
Winslow Water Works	0.74	1,010	1,356	Winslow	SW*
Lyford Water Works	14.24	1,000	70	SW Parke Co	GW
Jamestown Muni. Water Works	1.50	1,000	665	Jamestown	GW

Public water supply was evaluated using reported withdrawals, utility operating records, service-area estimates, stakeholder input, and available planning documents. The analysis distinguished average annual withdrawals from seasonal and maximum-day demand, treatment and system capacity, wholesale sales, purchased water, and service outside municipal limits.

Future baseline water demand relies primarily on the Shared Socioeconomic Pathways (SSP2) population-projection model. SSP2 projections were found to be suitable for most counties. Notably, counties surrounding Monroe County and counties north of Vanderburgh County did not conform to standard SSP projections, reflecting sub-year population shifts (university population) and commuter dynamics. To project future demand, multiple regression modeling was utilized, distinguishing municipal water systems from other PWS system types to accurately capture baseline economic growth while applying climate variables to estimate seasonal peaks. See Appendix D for in-depth presentation of future demand projection methods.

In this study, historical water demand for municipal water utilities was assessed through the examination of monthly water-withdrawals reported in the Indiana Department of Natural Resources, Division of Water, Significant Water Withdrawal Facility (SWWF) database covering withdrawals spanning from 1985-2023. Although water demand is closely related to water withdrawals, there are times when monthly reported water withdrawals alone is insufficient to describe demand. A limited number of years of additional data were incorporated into the demand analysis from the Indiana Department of Environmental Management, Drinking Water Branch, archive of Monthly Report of Operations (MRO) documents submitted by utilities each month. These reports record daily volumes of water processed by treatment plants (IDEM, 2026h).

The data recorded in MROs and the SWWF database often align quite well with one another (aggregated at monthly intervals); but the granularity of the daily data in the MRO documents are valuable for understanding peak flows, as well as often providing information on water flows related to pumping from storage or operational maintenance. Although utility water usage typically aligns well with local demand, there are a number of reasons that usage declines can occur when actual “demand” is highest. Summer demand experienced by water utilities is usually highest because of seasonal outdoor water-use such as residential lawn and garden irrigation. If a drought episode is severe enough, lawns can go dormant, or garden losses might negate the need to irrigate. Water-use restrictions (voluntary or mandatory) can also

cause a reduction in demand. However, there are cases where the source water, such as river flow, is inadequate for pumping and the utility must switch to another source or to withdrawing from storage.

City of Bloomington Water Utility

Monroe County, East Fork White River Basin, Subbasin 5 (03372500)

The biggest utility in the study area relative to customers served (both directly and through wholesale) is operated by the City of Bloomington Water Utility (Bloomington). Bloomington has historically had issues with procuring a reliable groundwater source for their growing community due to the area being located on an unglaciated limestone bedrock high with few productive bedrock aquifer units within a reasonable depth of the surface. The city and Indiana University have constructed several reservoir lakes to provide their citizens water, including Leonard Lake, Upper and Lower Twin Lakes, Wapehani Lake, University Lake, Lake Lemon, and Griffy Lake (Bloomington Herald-Times, 2024a). Leonard, Wapehani, and Twin Lakes failed due to porosity and fractures in the underlying bedrock allowing collected surface water to infiltrate as groundwater. Griffy Lake, University Lake, and Lake Lemon were constructed on less porous bedrock and were therefore more successful at containing water, but ultimately the city outgrew these water sources. The city last utilized Lake Lemon in the 1970s and Griffy Lake in 1996. These early water sources were replaced by the massive (over 10,000 acre) reservoir a few miles southeast of the city locally referred to as Lake Monroe. The impoundment is the largest lake inside of Indiana (IDNR, 2011c) and was constructed by the Army Corps of Engineers in the 1960s to serve as a more resilient water source for Bloomington and also to act as a flood control measure for the Salt Creek drainage (USACE, 2016). Lake Monroe is currently the sole source of water for Bloomington and all immediately surrounding community utilities.

In addition to their own customer base of approximately 83,000 people, Bloomington sells water to several other regional utilities including Ellettsville, B&B Water Project, Southern Monroe, East Monroe, RHS Water Corporation, Van Buren Water, Washington Township of Monroe County, and more (City of Bloomington Utilities PER, 2026). When all wholesale water is considered, estimates for the total number of people who receive water pumped from Lake Monroe by the City of Bloomington increases to over 125,000.

To further ‘muddy the waters’ of tracking water through distribution systems, Bloomington treats and returns their wastewater in two separate watersheds (Dillman WWTP in basin 03373500 and Blucher Poole WWTP in 03360500), both which are different than the basin from which they source their water (Lake Monroe in 03372500). Furthermore, people who receive their water through Ellettsville, Washington Township, and B&B primarily return their water to watershed 03360500; whereas those who purchase from East Monroe primarily return their water to 03372500; and those who purchase from RHS, Van Buren, and Southern Monroe primarily return their water to 03373500. With the exception of Ellettsville, all of these aforementioned utilities that purchase water from Bloomington distribute their water to portions of two different watersheds. Treated wastewater is returned to the watersheds either through residential septic systems or through one of several centralized area WWTPs.

The City of Bloomington recently renewed and expanded an agreement with the Indiana Department of Natural Resources who manages the water in Lake Monroe. Their new contract allows them to extract up to 30 MGD for the next 50 years, which is a significant increase from their old contract (24 MGD; Bloomington Herald-Times, 2025). In 2014 they upgraded their WTP from a treatment capacity of 24 MGD to 30 MGD (Bloomington Herald-Times, 2024b). On average, Bloomington pumps and treats around 14 MGD (IDEM, 2026d). Their two WWTPs can collectively treat 21 MGD of wastewater (for customers with sewer connections), but the amount of fresh water pumped will always exceed the amount of wastewater treated due to reselling.

Patoka Lake Regional Water and Sewer District
Dubois County, Patoka River Basin, Subbasin 1 (03375500)

Patoka Lake Regional Water and Sewer District (PLRWSD) is the largest utility in the Southwest Indiana region by service area and one of the largest in the state. Its service territory is nearly twelve times larger than Bloomington Utilities' service area while serving fewer than one-sixth as many people. This low customer density reflects the cost and operational demands of providing centralized water across sparsely populated areas with limited self-supplied options.

The rural water utility business model is somewhat common in the unglaciated (or “driftless”) areas of southwestern Indiana where shallow bedrock geologic materials with thin unconsolidated sediment cover do not generally provide sufficient aquifer capacity to support large-scale municipal utility pumping. In these areas, surface water sources such as constructed reservoirs or major river corridors are the only viable source of community-scale drinking water. However, in many regions within the Patoka Lake service area it is possible for individual domestic wells to produce (with appropriate storage) enough water to support a single household. This leads to a number of self-served residential properties within the service area that have so far opted out of connecting to the public water system. Some of these residences could eventually become future Patoka Lake customers if domestic well water quality deteriorates or the local water-table elevations decline.



When Patoka Lake Regional Water and Sewer District formed in 1975, they aptly chose their name based on the manmade reservoir in Dubois, Orange, and Crawford Counties known as Patoka Lake (PLRWSD, 2026) from which they procure their water. The reservoir has a similar origin story to Lake Monroe in that construction was authorized in 1965 to both help with flooding along the Patoka River and to provide a reliable water source for regional population centers and rural residences (Patoka Lake Regional Water PER, 2025). The reservoir was built as a joint venture between the Army Corps of Engineers and the Indiana Department of Natural Resources and has been in service since 1979.

There are currently two water treatment plants (WTPs) utilized by Patoka Lake to make pumped lake water potable; one was built in 1979, and the other in 1993. The older WTP is in poor condition, but the newer WTP does not have enough capacity on its own to allow for the older one to be closed and rehabilitated. As discussed in their Preliminary Engineering Report (Patoka Lake PER, 2025), the most viable solution to their water treatment issues is to expand the newer WTP to have sufficient capacity that the older WTP can be taken offline and rehabilitated.

Patoka Lake has a distribution network with around 850 miles of supply pipes to provide water for their roughly 13,500 customers. In addition to having their own residential customer base, Patoka Lake also sells wholesale to 30 other area utilities including Dubois, English, Huntingburg, Oakland City, Otwell, Paoli, Pike-Gibson, Springs Valley, and several others. On an average day, Patoka Lake provides more than four times as much water to their wholesale customers (6.46 MGD) as they do to their retail customers (1.47 MGD). Their service area extends to parts of nine different counties, the primary ones being Orange, Crawford, Perry, Spencer, and Dubois.

In addition to providing water to the area, Patoka Lake also provides limited wastewater collection and treatment for the towns of Dubois, Celestine, and St. Anthony located west and south of Patoka Lake. It is assumed that the majority of non-wholesale Patoka Lake customers treat their own wastewater using a residential septic system. The Patoka Lake WWTP discharges water into the same watershed as Patoka Lake (Subbasin 1, 03375500). The town of Dubois is also in this watershed, but Celestine, St. Anthony, and many of the rural Patoka Lake water customers utilize and return water in a different subbasin than where it is pumped.

Dye tracing near Patoka Dam has documented rapid groundwater movement through localized karst conduits to springs downstream of the dam; however, this preferential flow does not by itself indicate extensive or sustained groundwater storage throughout the Patoka watershed (Bledsoe, 2015).

Indiana-American Water: Terre Haute

Vigo County, Wabash Basin, Subbasins 0 and 12 (03341500 and 03342000)

The City of Terre Haute is the second largest population center in the Southwest Indiana study area (Table 4). Citizens are provided water by the Terre Haute operation of Indiana-American Water Company, Inc (IAW Terre Haute), a subsidiary of the American Water Company, Inc, which purchased the city water system over 100 years ago (The Indianapolis News, 1924). Rather than utilizing a surface water source like Lake Monroe or Patoka Lake, IAW Terre Haute has four deep groundwater wells and one radial collector well finished in the unconsolidated alluvium (sand-gravel aquifer) of the Wabash River at the northern end of the city.

IAW Terre Haute serves a population of over 65,000 people (Table 4), with a service area that extends beyond the city limits. Their water treatment plant has an average daily production of around 8 MGD and a maximum treatment plant design capacity of 13 MGD (IDEM, 2026d). They also wholesale water to the following nearby utilities: Indiana-American Farmersburg, Sullivan-Vigo Rural Water Corp, Sisters of Providence/St. Mary-of-the-Woods College, and Seelyville (emergency connection). The combined service areas IAW Terre Haute and the utilities to whom they wholesale span across four different subbasins: 03341500, 03342000, 03342500, and 03360500. The wellfield that IAW Terre Haute sources their water from extracts from both 03341500 and 03342000, while wastewater from the city's sewer network and WWTP is ultimately discharged into subbasin 03342000.

Wastewater Treatment and CSO

The City of Terre Haute operates a wastewater utility that is independent from their public water supplier Indiana-American. The primary wastewater treatment plant for the city is located along the Wabash River on the south side of town, downstream from their groundwater wellfield. It was originally constructed in 1963, but has had at least four expansions and upgrades in the intervening years (City of Terre Haute PER, 2014). The plant is currently designed to treat an average flow of 24 MGD, with a peak treatment capacity of 48 MGD. There are future plans to further expand the capacity of the main lift station to 96 MGD (City of Terre Haute CSO Program, 2026).

The city accepts wastewater from rural residences and suburban developments outside of Terre Haute municipal boundaries, as well as water from the nearby incorporated town of Seelyville. The WWTP receives both dry weather wastewater and a portion of combined wet weather sanitary / stormwater flows that are routed through a large interceptor. During extreme precipitation events or rapid snowmelts, this interceptor sewer can become overwhelmed with stormwater flow, causing some combined sewage overflows (CSOs) to be routed directly into the Wabash River without being treated. This is an issue that the city has already taken steps to remedy. At present, only eight active CSO outfalls remain (IDEM, 2026c)

and the CSO Reduction Program is aiming to reduce the average number of CSO events from 37 times a year to just 6, greatly reducing the amount of raw sewage that is discharged into the Wabash River untreated. One of the remaining CSOs just north of the I-70 bridge is now routed through a newly constructed 33 MGD high rate treatment facility that came online in early 2021 (Terre Haute Clean Water, 2026; IDNR SWWF Database, 2023).

Stucker Fork Water Utility

Scott County, East Fork White River Basin, Subbasin 4 (03371500)

Stucker Fork Water Utility (Stucker Fork) is another rural water provider with an expansive service area and low population density, similar to Patoka Lake Regional Water and Sewer District. They are the third largest water utility in the study area based on population served (Table 2), and provide water across nearly 300 square miles of territory primarily in Scott and Jennings Counties, but also covering parts of Jefferson, Jackson, and Washington Counties. In addition to selling water retail to residential customers, Stucker Fork provides wholesale water to several other area utilities including Crothersville, Kent, Marysville Otisco Nabb, Scottsburg, and Washington Township of Clark County.

While much of the area serviced by Stucker Fork is within Subbasin 4 (03371500), they also provide both retail and wholesale water to customers in the Ohio River Valley study area. They have two different water sources on opposite sides of their service territory; a surface water source in the Southwest Indiana region, and a groundwater source in the Ohio River Valley. Their original water treatment plant, known as the Austin WTP, is in Southwest Indiana and draws from the Muscatatuck River just north of the town of Austin. The flow levels of the river here are augmented during drought conditions through controlled releases from the nearby Hardy Lake Reservoir (Stucker Fork PER, 2025). Up to 7 MGD can be released when necessary to ensure that the river maintains a healthy level of water to support aquatic life and supply the Austin WTP which has a capacity of just under 6 MGD.

Stucker Fork opted to seek an alternative water source in the 1990s after required releases from Hardy Lake began exceeding inflows and caused reservoir levels to decline. In 1998, they were able to purchase a 10 MGD wellfield along the Ohio River that was formerly associated with the decommissioned Marble Hill nuclear power plant in Jefferson County. Their treatment plant at this location, known as the Marble Hill WTP, has a current capacity of 4 MGD. There are plans to upgrade this treatment plant to an 8 MGD capacity so that the utility can keep pace with projected customer increases over the next 20 years. Their current average daily flow is just under 5 MGD, with a collective total design capacity of around 8.3 MGD (IDEM, 2026d).

Stucker Fork Water Utility does not collect wastewater or operate a wastewater treatment plant, as the majority of their customers are rural residential properties and wholesale community water systems. Some of the towns that are supplied water from Stucker Fork such as Crothersville, Austin, and Scottsburg have their own wastewater treatment plants, and it is presumed that much of the water provided by Stucker Fork is treated and returned to watershed 03371500 (Subbasin 4) through community WWTPs and residential septic systems.

Eastern Heights Utilities

Monroe County, East Fork White River Basin, Subbasin 9 (03360500)

Eastern Heights Utilities is yet another rural water provider in Southwest Indiana with a large and sparsely populated service territory. They provide water to a population of nearly 20,000 people through over 7,500 connections and have a service area of approximately 350 square miles. Eastern Heights sells water

wholesale to the small town of Crane and has retail residential customers mostly in unincorporated portions of Greene County and the towns of Bloomfield, Worthington, Solsbury, Hendricksville, and Scotland.

Eastern Heights owns three wellfields with a series of 9 active groundwater wells located along the White River valley to the north, south, and west of the town of Bloomfield in subbasin 03360500. Their service area is almost entirely contained within subbasin 03360500, though a small portion in the southeast overlaps with subbasin 03373500. Collectively, Eastern Heights has an average daily flow of 1.5 MGD and a total design capacity of 2 MGD from their WTP located in Bloomfield (IDEM, 2026d).

The towns of Bloomfield and Worthington have their own wastewater treatment plants that return water to the same source subbasin of 03360500. It is assumed that the majority of residential customers outside of these communities treat their own wastewater using residential septic systems.

Other Water Utilities

With over 150 water utilities in the study area, there are far too many to discuss each one individually. Generally speaking, the utilities can be divided between those that pump their own water from a groundwater aquifer or surface water source, and those who purchase their water wholesale from another regional utility.

Pumping Utilities

While the unglaciated portions of the Southwestern Indiana study area generally have limited amounts of unconsolidated deposits to be used as groundwater aquifers, cities and small towns are often able to provide water for their community through localized moderate-capacity wells finished either in modern-day drainage alluvium aquifers or in productive underlying bedrock units. The cities of Vincennes, Martinsville, Washington, Greencastle, Brazil, and Princeton all pump their own groundwater from alluvium aquifers along local river valleys. Many smaller towns and rural utilities also pump groundwater to provide residents with a reliable water source. Cities such as Jasper and Bedford opt to pump and treat surface water directly from intakes along the Patoka River and East Fork White River, respectively. Most pumping municipalities also operate a wastewater treatment plant that returns treated water near their community. In many cases the water is pumped from and returned to the same subbasin. In some cases, however, water is transported across watershed divides before being treated and returned to local drainages.

Purchasing Utilities

In some parts of the study area, the local unconsolidated and bedrock geology does not facilitate the procurement of large amounts of potable drinking water. Alternatively, some communities that feasibly could pump their own water have found operating such a water treatment and supply system to be cost-prohibitive on a small-town scale. In these cases, communities will often purchase wholesale water from a nearby utility that has access to a sufficient surplus of treated water. Some of the largest wholesaling utilities and the communities they supply have already been discussed above, but the number of purchasing utilities exceeds those previously mentioned. Some of the bigger purchasing utilities not yet discussed include German Township Water District in Vanderburgh County, North Lawrence Water Authority in Bedford, Pike Gibson Water Inc. in Oakland City, Dubois Water Utilities, and Daviess County Rural Water.

Cross-Subbasin Water Transfers and Return-Flow Imbalances

Large utility service areas and wholesale networks often separate the locations of withdrawal, use, and wastewater return. These transfers can create apparent deficits in source subbasins and excess returns in receiving subbasins even when the water remains within the same major river basin.

Bloomington Utilities withdraws approximately 14 MGD from Monroe Lake in Subbasin 5 (03372500), whereas most retail and wholesale demand occurs in Subbasins 9, (03360500) and 6 (03373500). Wastewater is returned through the Blucher Poole and Dillman treatment plants and through decentralized septic systems. The Dillman plant alone returns approximately 10.5 MGD to Subbasin 03373500, which exceeds the combined withdrawals reported within that subbasin. Conversely, withdrawals from Monroe Lake substantially exceed recorded returns within Subbasin 5 (03372500). Because 03372500 drains to 03373500, much of the transferred water ultimately returns to the East Fork White River system, but not to the local source subbasin.

Patoka Lake Regional Water provides another prominent example. The utility withdraws approximately 7.7 MGD from Patoka Lake in Subbasin 1 (03375500) and distributes water through a nearly 600-square-mile retail and wholesale network (Table 5), including areas outside the study boundary. Sparse centralized sewer service and widespread septic use contribute to recorded withdrawals in Subbasin 5 (03375500) that are roughly an order of magnitude larger than reported returns. Downstream Subbasins 2 (03376300) and Subbasin 3 (03376500) exhibit persistent return-flow surpluses partly because water withdrawn at Patoka Lake is used and discharged elsewhere.

Table 5. Patoka Lake Regional Water provides water to many utilities as wholesale customers.

Purchasing Utility	PWSID	Contractual Daily Minimum (Gallons per Day)	Contractual Daily Maximum (Gallons per Day)
Dubois Water Utilities	IN5219002	700,000	1,050,000
St. Anthony Water Utilities	IN5219010	100,000	150,000
City of Huntingburg	IN5219007	350,000	525,000
Ferdinand Municipal Utilities	IN5219004	200,000	300,000
St. Henry Water	IN5219011	485,000	727,500
St. Meinrad Utilities	IN5274013	70,000	105,000
Town of Santa Claus	IN5274010	400,000	600,000
Finch-Newton Water	IN5274003	25,000	62,500
English Municipal Water Works	IN5213002	125,000	312,500
Town of Birdseye	IN5219001	45,000	67,500
Town of Paoli	IN5259004	400,000	600,000
And-Tro Water Authority	IN5262003	90,000	135,000
Posey Township Water	IN5288006	50,000	75,000
Town of Orleans	IN5259003	200,000	300,000
Springs Valley Regional Water District	IN5259002	475,000	1,440,000
Dubois Water Utilities	IN5219002	270,000	405,000
City of Huntingburg	IN5219007	100,000	150,000
Ireland Utilities	IN5219008	300,000	450,000

Purchasing Utility	PWSID	Contractual Daily Minimum (Gallons per Day)	Contractual Daily Maximum (Gallons per Day)
Otwell Water Corporation	IN5263001	75,000	112,500
Pike-Gibson Water	IN5263003	300,000	450,000
City of Oakland City	IN5226005	150,000	225,000
Town of Holland	IN5219006	110,000	165,000
Tennyson Water Utility	IN5287007	220,000	330,000
Town of Lynnville	IN5287006	85,000	127,500
Duff Water Corporation	IN5219003	40,000	60,000
Spurgeon Water Works	IN5263004	2,500	3,750
Town of Paoli	IN5259004	50,000	75,000
Posey Township Water	IN5288006	200,000	300,000

Self-Supplied Residential (Domestic) Water Supply

Estimates from 2015 for domestic self-supplied population and water use are presented in Dieter et al. (2018), but updated estimates are provided here because the self-supplied residential population is a sizeable fraction of demand in the Southwest Indiana region.

Self-supplied residential water use is estimated here for populations not served by public water systems (Figure 20). In Southwest Indiana, the distribution of domestic wells is influenced by bedrock aquifer yields, karst, rural service-area expansion, reservoir-supplied utilities, and local household water practices. In total, there are estimated to be more than 17,000 residential domestic wells in the study area. A detailed description of the process used to estimate self-served residential populations is included in Appendix D, but a summary is provided in the following section.

To approximate the self-served population in the study area, two different techniques were used for the Illinois and Indiana portions of the study area. In previous watershed studies in Indiana, residential addresses in the National Address Database (U.S. DOT NAD r19, 2025) were selected against utility service areas to identify households that are likely self-served. The NAD dataset was not used in the Illinois portion of this study due to a lack of address point attributes, but a modified version of the NAD technique was utilized for Indiana.

Indiana Self-Served Residential Water Use Estimation

For Indiana, a new technique was developed that leverages utility customer addresses (the Indiana Service Line Inventory). For this study, the Indiana Water Utility Service Areas mapping was modified to encompass all customers serviced by a given utility, and then these points were compared to a buffered version of the NAD database to identify nonvacant residential points that did not intersect with known customer addresses. These points were assumed to be self-served residential, whether within or outside of a utility service area boundary.

When compared to other self-served residential estimates, this method was found to capture the largest number of ‘holdout’ households inside rural utility service areas that are not yet purchasing water from a public utility. This method was chosen due to the number expansive rural utilities in the study area. Counts of households not purchasing water were multiplied by the average number of people in a household based on Census block group data (U.S. Census Bureau, 2024) to approximate at the total unserved population within a given subbasin.

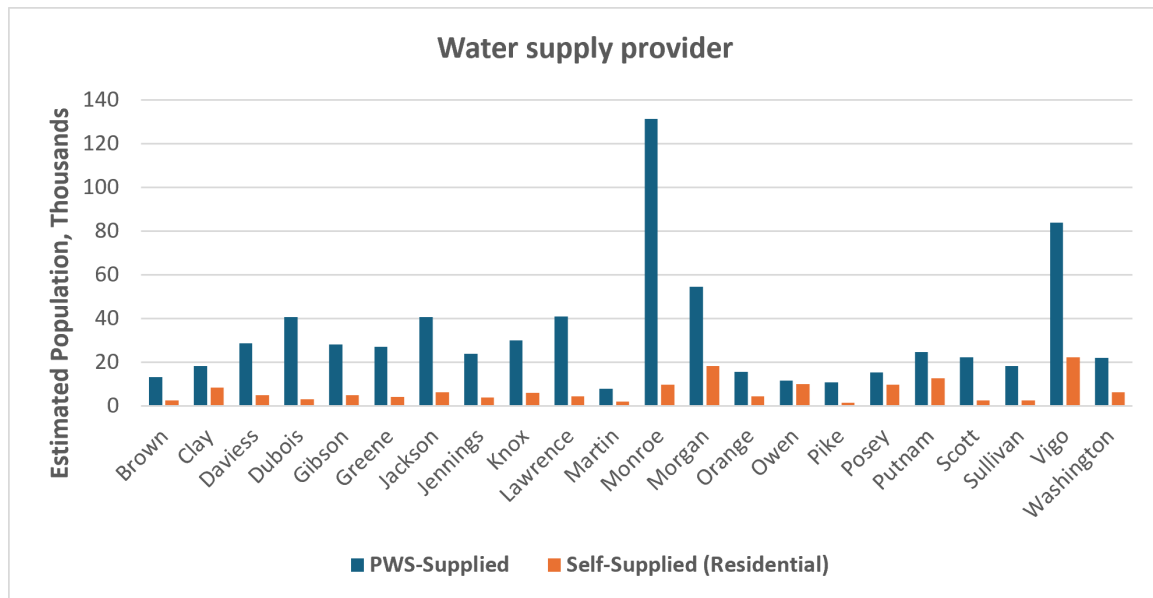


Figure 20. Estimated population of publicly-supplied and self-supplied water in the Indiana portion of the Southwest Indiana study area. Vigo County has the largest number of self-supplied residential water users.

Illinois Self-Served Residential Water Use Estimation

To estimate the self-served residential population in the Illinois portion of the study area, the most recent Census block populations (Esri Federal Data, 2020) were considered alongside a USGS Community Water Service Area dataset (USGS, 2022). Census blocks that do not intersect a utility service area are assumed to be entirely self-served. For census blocks overlapping a utility service area, population discrepancies between the two were resolved using a population adjustment multiplier based on the ratio of the Census block total population to the utility population served. Once the populations of these two datasets were aligned, the unserved population was tallied for each gage subbasin and used to estimate self-served withdrawal quantities.

Back-casting Self-Served Usage

The amount of self-served water usage was approximated by multiplying the number of unserved people in a given subbasin by an assumed average water usage of 76 GPD (Kindler and Russell, 1984; Dieter et al., 2018). A seasonal component to residential water usage was considered, but ultimately only applied to return flow estimates due to the complexity of how Summer and Winter residential water end uses fluctuate and offset each other (Malano, 2015). The return flows for self-served residential are assumed to vary seasonally with a consumptive factor of 19% in the Summer, 7% in the Fall, 2% in the Spring, and no consumption during the Winter (Schaffer, 2009). Backwards forecasts of self-served residential usage were

generated based historical population changes. Overall, the Indiana portion of the study area was determined to have experienced population growth over the past 30 years, whereas the Illinois portion experienced a population decline. Following these trends, the self-served population in Indiana was decreased by 0.027% every year moving back from 2025, and the self-served population of Illinois was increased by 0.0254% every year moving back from 2020 and decreased by the same amount moving forward to 2025. Different years were employed as the forecast points due to Illinois using 2020 Census block data and Indiana using a current (2025) water service line inventory.

Industrial Water Use

Industrial and energy-sector water uses are presented separately from public-supply and agricultural demand because their withdrawal volumes, return-flow patterns, seasonality, and future trajectories differ. The analysis distinguishes facilities that dominate gross withdrawals from those that dominate consumptive use and identifies known operational changes that could alter regional water balances.

The study area includes manufacturing, quarrying, aggregate production, and other industrial activities. Stone quarries and sand-and-gravel operations dominate this sector's reported water volumes in Southwest Indiana, although much of that flow is associated with dewatering and discharge rather than consumption. Major self-supplied manufacturers include Elanco, Taghleef Industries, and Novelis in Subbasin 0 (03341500); Danisco USA in Subbasin 12 (03342000); and Lone Star Industries in Subbasin 8 (03360000). Many other industrial customers purchase water from public utilities.

Manufacturing, Food, and Agriculture

There are several regional themes where industries supporting similar commercial and industrial sectors are clustered together. These tend to also be the industries that local economic development representatives plan and prepare for. Biomedical companies are located in the Bloomington area (Subbasin 5, 03372500) to take advantage of the local talent pool associated with Indiana University. The Dubois County area (Subbasin 1, 03375500) is the location of an upland manufacturing and municipal growth cluster. The Lower Wabash basin thrives on industrial development tied to the Ohio River and near-river aquifer access as well as proximity to the I-69 transportation corridor. Animal processing operations are being recruited by Pike County (Subbasin 10, 03374000).

Data Centers

As our collective reliance on cloud computing, AI processing, and streaming media services continues to expand, data centers will become a more common occurrence across the state and within the Southwest Indiana study area. At present, there are currently over 100 data centers throughout the state (DataCenterMap, 2026). In the Southwest Indiana region there are proposed data centers within and on the edges including near Brazil, in Gibson County near Princeton, near Dale and Spencer, and near Monrovia (Cleanview, 2026). Others have been proposed and withdrawn. Some economic development representatives mentioned that they have gotten inquiries, or that their county would have an ideal site for such industries.

Data centers generate enormous amounts of heat that must be dissipated to ensure efficient operation. Depending on the cooling technology used, a significant volume of water may be required, though not always consumptively. As with energy production, once-through evaporative cooling is the least efficient cooling technology. Closed-loop cooling systems have a much smaller water footprint, and air-cooled systems use very little water, but are accompanied by the tradeoff of increased electric energy

consumption. The power consumption and scale of a data center tend to have a direct positive correlation with water consumption (West Water Research, 2025).

Data-center proposals in and near the study area are treated as project-specific planning uncertainties. Their water requirements could range from limited operational use to substantial cooling demand depending on facility scale, cooling technology, reuse, power supply, and whether water is purchased or self-supplied. Because newly proposed projects did not consistently define those attributes, speculative demand was not assigned uniformly to the industrial or public-supply forecasts. Existing data centers in the study area have their energy and water demands built into the reported water use of their water and energy providers; therefore, those water demands were incorporated into the study. The study methods would allow scenario overlays to be examined, if the appropriate water balance information were available that distinguishes water source (utility, self-supplied, location), average demand, maximum-day demand, consumptive loss (or efficiency), wastewater return (amounts and proposed locations), and power-related water use.

Quarries

There are several limestone and sand/gravel aggregate quarries in the region, with major limestone quarrying operations occurring in the central portions of the study. Rogers Group is one of the biggest quarrying companies, with crushed limestone operations near Bloomington, Bloomfield, and Spencer in subbasin 03360500, and a sand and gravel quarry west of Vincennes in Subbasin 17 (03377500). Indiana Limestone Company is a major dimensional limestone quarrying company with operations south of Bloomington and near the town of Oolitic (Subbasin 6; 03373500). Some of the main sand and gravel quarrying companies in the area include US Aggregates with a large and active operation just north of Jenkinsville (Subbasin 8; 03360000) and Heidelberg Materials with active operations south of Versailles (Subbasin 4; 03371500) and northeast of Mitchell in Subbasin 6 (03373500).

Irrigation Water Supply

Many of the farms that grow cultivated crops in the portions of the study area located along the Wabash, East Fork White, White, and Patoka River valleys irrigate their fields during the growing season using groundwater wells. Unconsolidated outwash deposits associated with the last glaciation are utilized as groundwater aquifers whenever available. In some areas, Mississippian- and Pennsylvanian-aged bedrock aquifers are known to be utilized for small-scale pumping. In the Indiana portion of the study area, only around 10% of crop irrigation comes from surface water sources and the vast majority of this occurs in the Lower Wabash subbasin.

Crop irrigation was evaluated as a demand sector, but also analyzed spatially where irrigation density and practices might impact aquifers and streams. Results were summarized by source, season, facility trend, and subbasin.

Irrigation demand is spatially and seasonally concentrated. In Southwest Indiana, irrigation is clustered where productive groundwater or surface-water sources are available (Figure 3, Figure 8), especially along major river valleys and outwash deposits. Traditionally, the June–August (Summer) period has been when most crop irrigation water has



been applied across the state. Future irrigation demand may reflect changes in irrigated acreage, crop mix, shoulder-season irrigation, climate variability, and water availability during dry periods.

Agricultural Crop Irrigation Trends and Seasonality While surface-water withdrawals for agricultural irrigation have remained relatively steady, groundwater use has increased dramatically. High-capacity irrigation wells are predominantly clustered along streams and rivers underlain by prolific glacial outwash aquifers (notably along the East Fork of the White River and the Wabash River near Terre Haute).

A trend analysis found that increasing trends in irrigation over a larger number of months (e.g., May through September instead of the traditional June-July-August growing seasons) were found to be approximately proportional to the number of irrigators in southern Indiana. Much higher rates of “shoulder season” irrigation was found in northern Indiana, for comparison. Although crop types are similar across the state, the soil types (e.g., sandy versus clay-rich) and even the climate varies from north to south.

Rural Water Use: Livestock and Fisheries

Animal Agriculture

There are hundreds of Animal Feeding Operations (CFOs, CAFOs) in the study area where pigs, turkeys, chickens, dairy cows, beef cattle, and other livestock are raised (IDEM, 2026a). IDEM requires farms that exceed species-specific animal population thresholds to register as a CFO or CAFO and have their operation periodically inspected. Nearly every subbasin in the study area has a registered CFO/CAFO, and some subbasins have millions of animals. Current policy does not require large livestock operations to report their water use nor to report wastewater return volumes, so estimates were conducted to quantify the water use of this industry.

Rural water use includes fisheries, livestock, poultry, confined feeding operations, and other non-utility agricultural demands. Southwest Indiana features high densities of livestock operations, making rural water demand a critical component.

Animal counts were reconstructed as an annual time series from 2007 through 2026 using a combination of the 2007 USDA Census of Agriculture baseline and facility-specific capacity snapshots from the IDEM permit database (2018, 2022, 2024, and 2026; IDEM, 2026f).

A monthly operational calendar modeled how operations move cohorts of 16 distinct animal categories through their facilities, including facility cleaning in-between cohorts. Literature-recommended water

CFO vs CAFO

Farms in Indiana that exceed specific thresholds for the number of confined livestock are regulated under the Confined Feeding Control Law (IDEM, 2023). Whether a farm is considered a Confined Feeding Operation (CFO) or a Concentrated Animal Feeding Operation (CAFO) depends on the size of the farm. CAFOs are subject to additional permitting requirements under Indiana law. Both types of operations are referred to as CAFOs throughout this report.

CFO

A Confined Feeding Operation is any farm that has more than 300 cattle, 600 pigs or sheep, 30,000 poultry (chickens, turkeys, or ducks), or 500 horses.

CAFO

A Concentrated Animal Feeding Operation follows the US EPA definition of a ‘large CAFO’ which is a farm with more than 700 dairy cows, 1,000 beef cattle, 2,500 adult pigs, 10,000 adolescent swine, 500 horses, 10,000 sheep, 55,000 turkeys, or between 30,000 and 125,000 chickens (depending on the type of chicken and manure handling system employed).

Before being approved, CFOs and CAFOs are subject to a permitting process and inspections of associated buildings and manure storage structures. IDEM regulates nutrient management, storm water runoff from manure applied to fields, setback distances, and facility design.

consumption amounts were applied per animal, scaled by size, life stage (e.g., pregnant or producing animals), and adjusted for the hot Summer months. To connect the reconstructed 2007 baseline counts with the later IDEM permit snapshots, a piecewise linear interpolation method was used.

Detailed livestock-category cross-referencing across agency databases, interpolation procedures, occupancy schedules, and water-use coefficients are documented in the technical methods (Appendix D). The resulting monthly estimates allow livestock water demand to be included with other warm-season uses while retaining the uncertainty associated with facility operations and unreported water use.

Water demand in the confined animal feeding operations (CAFO/CFOs) sector is primarily composed of animal drinking water. While other water uses exist, this study focused on animal count and drinking water demand due to availability of data at the facility level, as opposed to more individualized sanitation and cooling uses, for example. Estimates of drinking water use are intentionally conservative, reflecting realistic industry practices and sector growth trends.

Up to 450 million gallons of water per year are applied towards CAFO/CFO livestock hydration in Daviess, Jackson, Jennings, Martin, Orange, and Scott Counties, with surrounding counties such as Clay, Dubois, Greene, Knox, Owen, and Pike withdrawing up to 180 million gallons per year. Several subbasins in Brown, Monroe, Parke Counties, and Vigo Counties have little or no regulated livestock operations (Figure 21, daily water use in MGD).

Livestock type influences drinking water use. In Southwest Indiana, the predominant livestock groups represented in CAFO/CFOs are pigs (20.8 million), chickens (122 million), and turkeys (13 million). Finisher pigs (13.5 million) are responsible for the greatest amount of drinking water use in the region, with 1.7 billion gallons anticipated to be withdrawn and used for their hydration in 2026. In total, pigs will consume 2.5 billion gallons of drinking water in 2026. Perhaps the most water-intensive livestock type is dairy cows, as they require the greatest amount of drinking water per day per animal of any category. As a result, 1.2

Estimated daily water use by regulated livestock operations

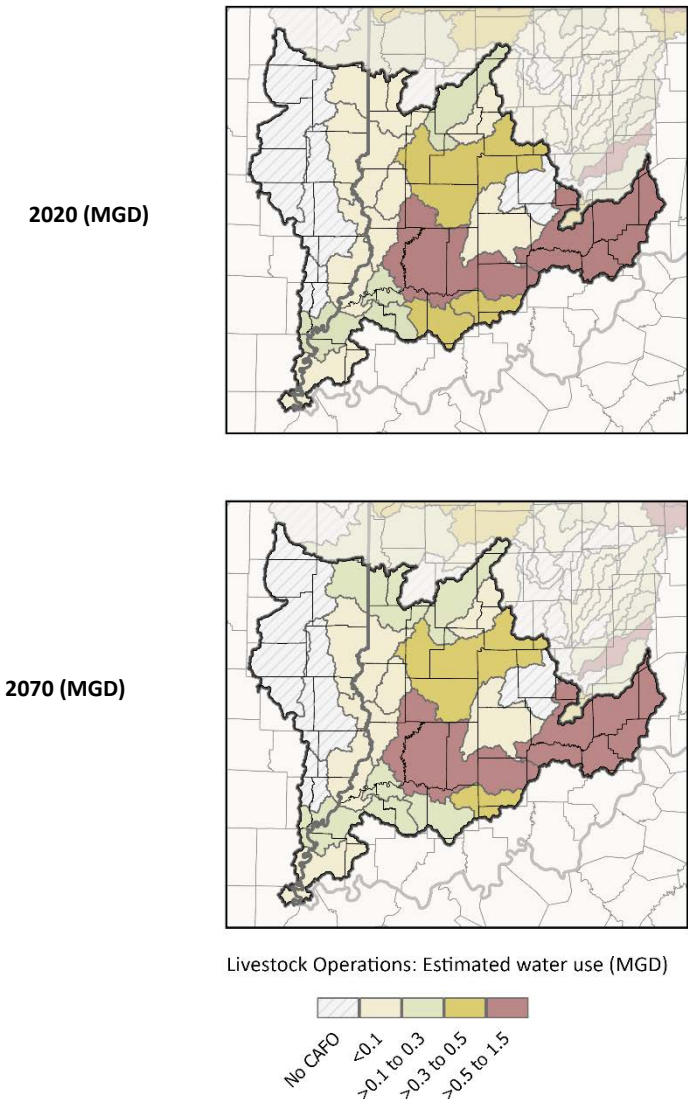


Figure 21. Estimated daily water use by regulated livestock operations in Southwest Indiana in MGD for the 5-year average centered on 2020 and the 5-year average centered on 2070.

billion gallons of water use can be attributed to dairy cows in 2026, despite their relatively low number (176 thousand). In the poultry industry, chickens will require a total of 1.2 billion gallons of water, and turkeys 0.4 billion gallons.

The Southwest region in total accounts for ~5.7 billion gallons of CAFO/CFO livestock drinking water demand per year.

Wastewater Returns

Some withdrawn water is consumed through evaporation, plant growth, incorporation into products, or other uses, while the remainder returns to the watershed as treated wastewater, cooling-water discharge, septic-system recharge, or another return flow. Wastewater returns are included in the water-demand analysis because they help show how much withdrawn water remains consumed (“consumptive use”) and where the rest reenters the hydrologic system.

The figures compare withdrawals and return flows within each subbasin. Their local balance is described as net (as in “total”) returns. Positive net returns mean that more water is returned to a subbasin than is withdrawn there; negative net returns mean that withdrawals exceed returns. This balance reflects both consumptive use and the movement of water among subbasins through utility networks, wastewater systems, mine dewatering, and other managed uses.

Figure 22 shows the spatial distribution of water withdrawals (Q_{ww}), return flows (Q_{rf}), and net returns (Q_{net}) in the Southwest Indiana region. The first set of maps illustrates how withdrawals and returns combine to produce the local net-return balance. The seasonal panels compare historical and projected net returns.

In the lower map, blue subbasins receive more return flow than is withdrawn locally, while orange subbasins have more withdrawals than returns. These patterns describe the human-use component of the water balance, not natural water availability.

The withdrawal–return balance also changes by season as public-supply demand, irrigation, energy production, and other water uses rise or fall. Figure 23 compares seasonal net returns for the historical period centered on 2020 with projected conditions in 2070. The 2070 period represents the later part of the study’s 50-year planning horizon.

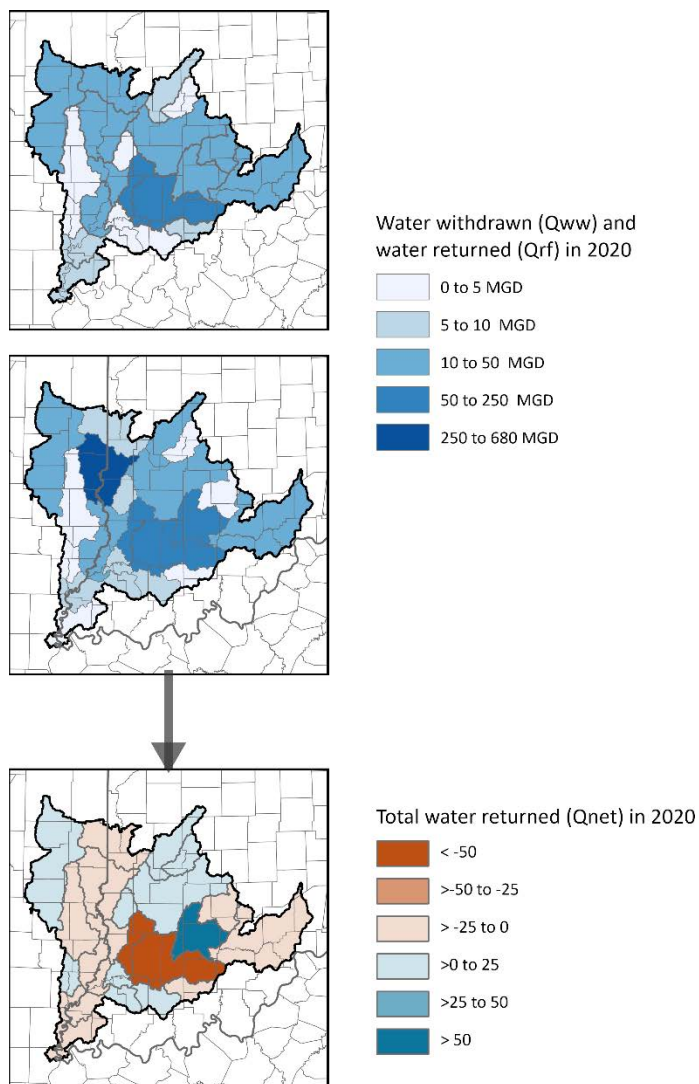


Figure 22. Example of the spatial distribution of water withdrawals (top), water return flows (middle) and the net returns (which is returns – withdrawals) in MGD for the 5-year average centered on 2020 for the Southwest Indiana region. Some subbasins have balanced withdrawals and returns ($Q_{net}=0$), whereas some subbasins have more pumping than returns ($Q_{net} < 0$) or more returns than withdrawals ($Q_{net} > 0$).

Net Return Flow

Net Return Flow
(millions of gallons per day)

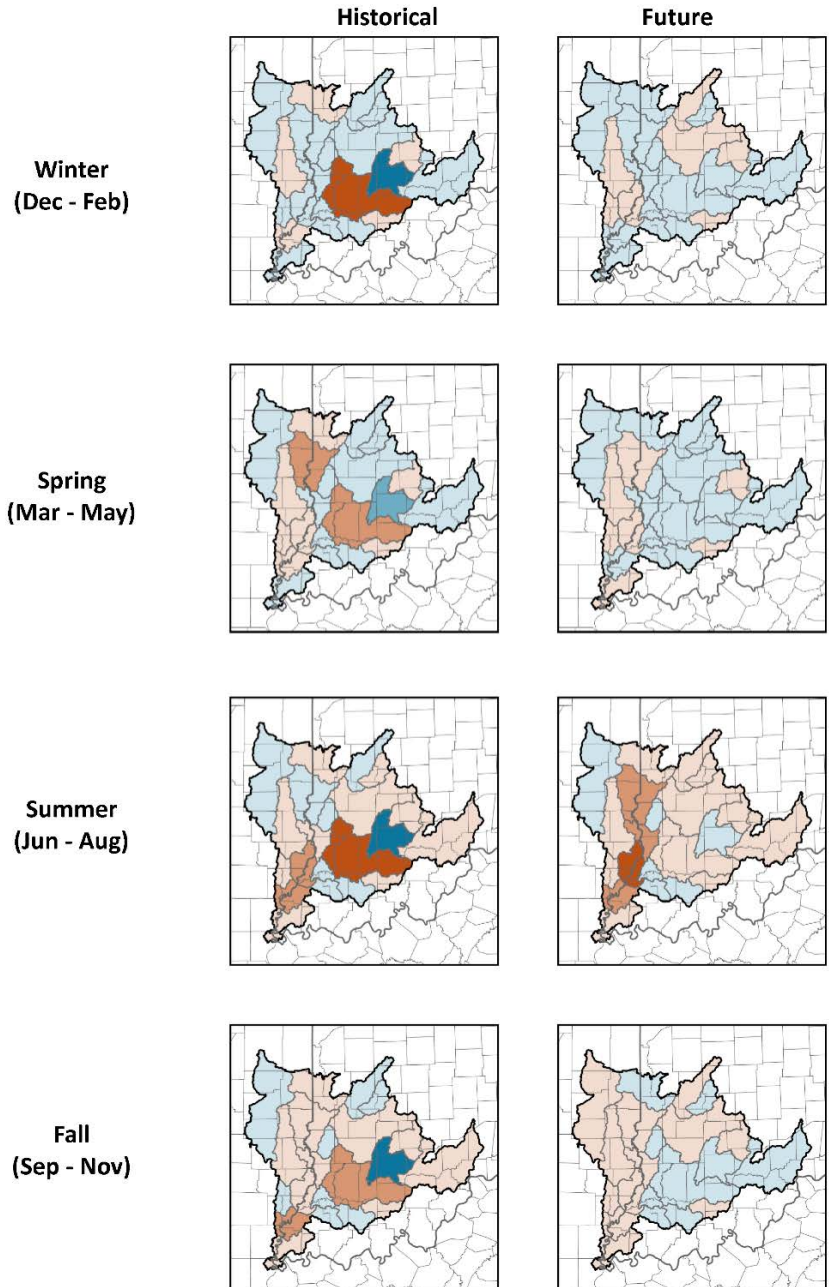
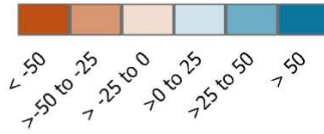


Figure 23. Seasonal net return flow for the historical period centered on 2020 (five-year average) and projected conditions in 2070. Blue subbasins have positive net returns, meaning that local returns exceed withdrawals; orange subbasins have negative net returns, meaning that withdrawals exceed returns. The maps show how the human-use portion of the local water balance varies by season and changes over the 50-year planning horizon. Net returns include the effects of consumptive use and water transferred among subbasins through public-water, wastewater, industrial, and other managed systems.

Figure 24 and Figure 25 show two contrasting ways that utility and industrial water systems appear in a subbasin water balance. Salt Creek below Monroe Lake is a source subbasin from which water is exported for use in an adjacent subbasin, whereas the Wabash River at Riverton contains both very large withdrawals and returns within the same subbasin.

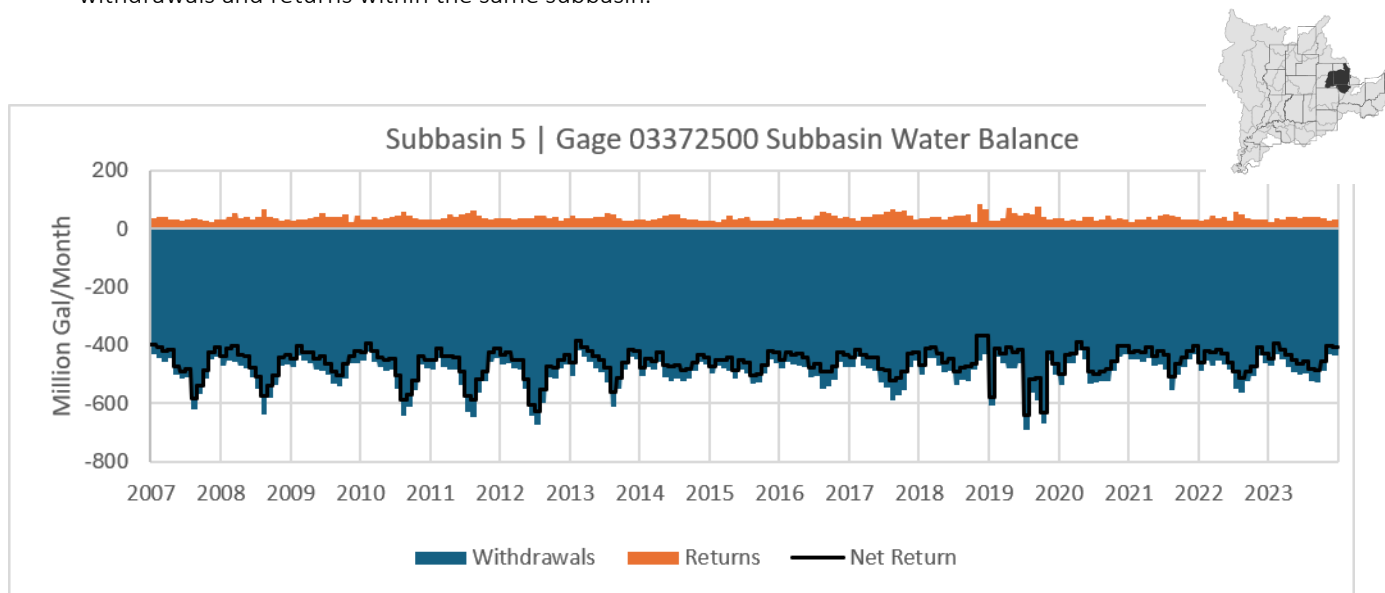


Figure 24. Subbasin water balance graph showing volumes of water withdrawals and wastewater returns for Subbasin 5 (03372500, Salt Creek near Harrodsburg, Indiana) from 2007 through 2024. The data in this graph reflect more withdrawals than wastewater returns. The water withdrawn in this basin is from the Lake Monroe (also known as Monroe Lake) reservoir, which is the water source for Bloomington, Indiana, and surrounding communities. Water is returned to the East Fork White River through two other tributaries. In 2023, its Qrf/Qww ratio was 0.07 (Table 6), meaning that returns within the source subbasin were only a small fraction of its withdrawals.

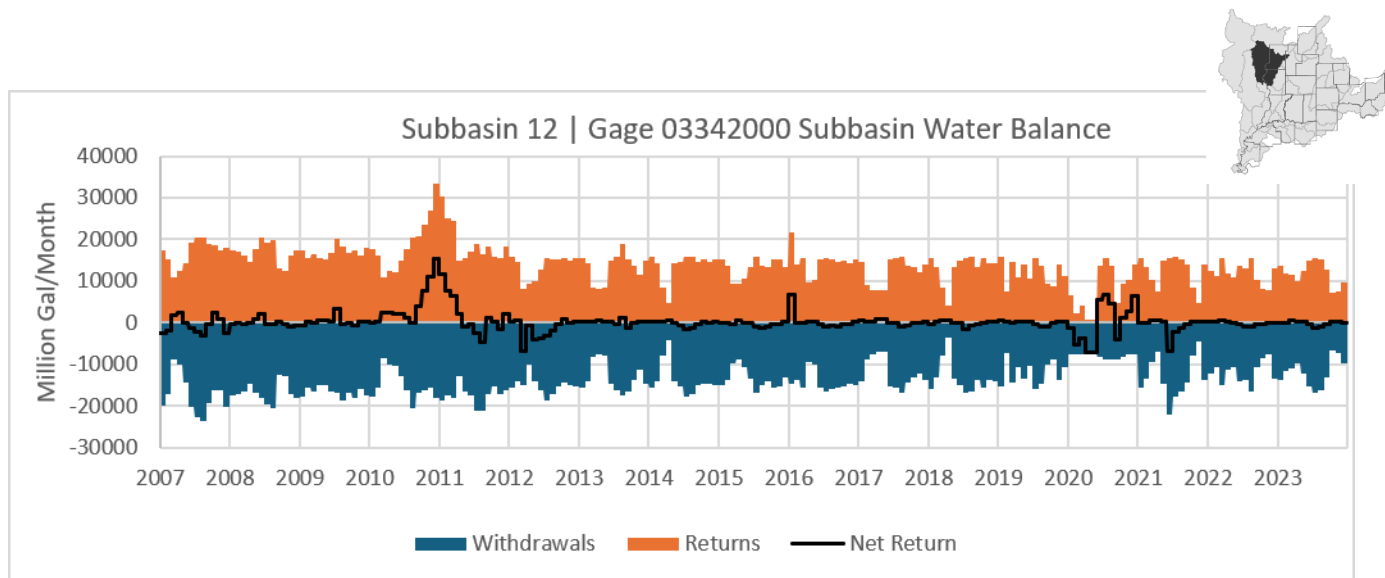


Figure 25. Subbasin water balance graph showing volumes of water withdrawals and wastewater returns for Subbasin 12 (03342000, Wabash River at Riverton, Indiana) from 2007 through 2024. The data in this graph reflect balanced withdrawals and wastewater returns. The water withdrawn in this basin is from the Wabash River and riverside aquifers, and the water is returned to the same subbasin. In 2023, the Qrf/Qww ratio was 0.99 (Table 6), indicating that total returns and withdrawals were nearly equal. Accordingly, Qnet—the difference between returns and withdrawals—was near zero.

Table 6 extends this comparison to all 21 subbasins. The return/water withdrawal ratio (Q_{rf}/Q_{ww}) provides a compact measure of the local withdrawal–return balance. The table is patterned after a similar analysis for Wabash River basins by Wiener et al. (2016), who refer to that ratio as “indirect reuse,” referring to the use of returned water by downstream users. A ratio near 1 indicates that returns approximately equal withdrawals. A ratio below 1 indicates that withdrawals exceed local returns, while a ratio above 1 indicates that the subbasin receives more return flow than is withdrawn there. A high ratio can identify places where returned water is an important part of the local and downstream water balance (indirect reuse).

Across the full Southwest Indiana region in 2023, withdrawals totaled approximately 790 MGD and returns approximately 685 MGD, producing a regional Q_{rf}/Q_{ww} ratio of 0.87. That regional value conceals pronounced local imbalances. Salt Creek below Monroe Lake had a ratio of 0.07, while the East Fork White River near Shoals had a ratio of 7.04 because the subbasin receives wastewater associated with water withdrawn and used elsewhere. The Wabash River at Riverton, by contrast, had a ratio of 0.99. These contrasts demonstrate why the locations of withdrawal, use, and return must be carried from the water-demand analysis into the water-availability assessment.

Table 6. Water withdrawals and wastewater returns for the Southwest Indiana region. This table is patterned after a table in Wiener et al. (2016) that tabulated withdrawals and wastewater returns (referred to as “discharges”) for subbasins in the Wabash River Basin in Indiana in 2007. Note: * Illinois EP data from <https://water.usgs.gov/nwaa-data/data-file-directory/?path=data/water-use/wu-thermoelectric/> is assumed to be SW. ** IR data with source listed as null were assigned to GW

2023	MGD		Energy Prod.		Industry		Irrigation		Public Supply		Rural Use		Estimated (GW)		Qww	Qrf	
Basin	GAGE	SUBBASIN	SW*	GW	SW	GW	SW	GW**	SW	GW	SW	GW	CAFOs	Self-Supply	Total Withdrawals	Total Returns	Qrf/Qww Ratio
Patoka	03375500	1							7.89				0.39	0.28	8.57	0.60	0.07
Patoka	03376300	2					0.03	0.06	2.56				0.27	0.24	3.15	5.32	1.69
Patoka	03376500	3	0.41					0.08	0.04				0.15	0.12	0.80	6.62	8.27
EF White	03371500	4			2.45		0.11	1.28	7.89	1.73	0.08		0.58	1.33	15.47	10.88	0.70
EF White	03372500	5					0.07		15.34					0.26	15.68	1.16	0.07
EF White	03373500	6		0.01	3.76		0.02		2.59	2.44			0.04	0.89	9.77	68.73	7.04
White	03359000	7								0.25			0.05	1.11	1.41	1.68	1.19
White	03360000	8		0.15	2.68					4.07			0.10	1.58	8.58	9.50	1.11
White	03360500	9		3.98	1.77	0.08	0.04	0.01		6.79	0.31		0.34	2.24	15.57	12.78	0.82
White	03374000	10	175.32		1.40	3.39	0.18	0.65	0.61	6.20	2.66		1.32	1.91	193.72	207.04	1.07
White	03374100	11	0.00				0.03	0.16		1.01	0.002		0.10	0.21	1.51	3.61	2.39
Wabash	03341500	0	0.01		0.38	4.10	0.00	1.18		13.45			0.08	1.64	20.84	25.02	1.20
Wabash	03342000	12	378.01	2.63		0.92	0.04	7.67		3.22			0.02	1.20	393.71	390.07	0.99
Wabash	03342500	13	0.34	0.58									0.02	0.28	1.22	6.23	5.11
Wabash	03343010	14	0.10	0.68			0.06	11.60		3.16			0.01	0.42	16.04	12.78	0.80
Wabash	03345500	15			0.02	0.00				8.38			0.08	1.81	10.29	10.61	1.03
Wabash	03346500	16						0.07		2.69			0.04	0.25	3.05	1.32	0.43
Wabash	03377500	17		0.06	1.06		0.11	17.71		6.92			0.02	0.34	26.21	11.53	0.44
Wabash	03378000	18								0.61			0.03	0.07	0.72	0.36	0.50
Wabash	03378500	19	19.30	3.24		0.39		8.91		2.00			0.13	0.46	34.43	7.93	0.23
Wabash	Lower Wabash	20					1.40	7.36		0.05			0.05	0.70	9.69	3.66	0.38
SUM	SW		573.49		13.52		2.10		36.92		3.05				629.16	684.82	1.09
SUM	GW			11.33	8.88		56.75		62.99		0.00		3.82	17.35	161.28		0.00
SUM	Total			584.82	22.40		58.85		99.90		3.05		3.82	17.35	790.43	684.82	0.87

Water Demand Forecasts

Future demand projections incorporated stakeholder interviews, utility and economic-development plans, regulatory datasets, historical withdrawal records, and sector-specific information. Methods were selected to match the quality and behavior of each dataset; they do not assume that one statistical relationship adequately represents all sectors or facilities.

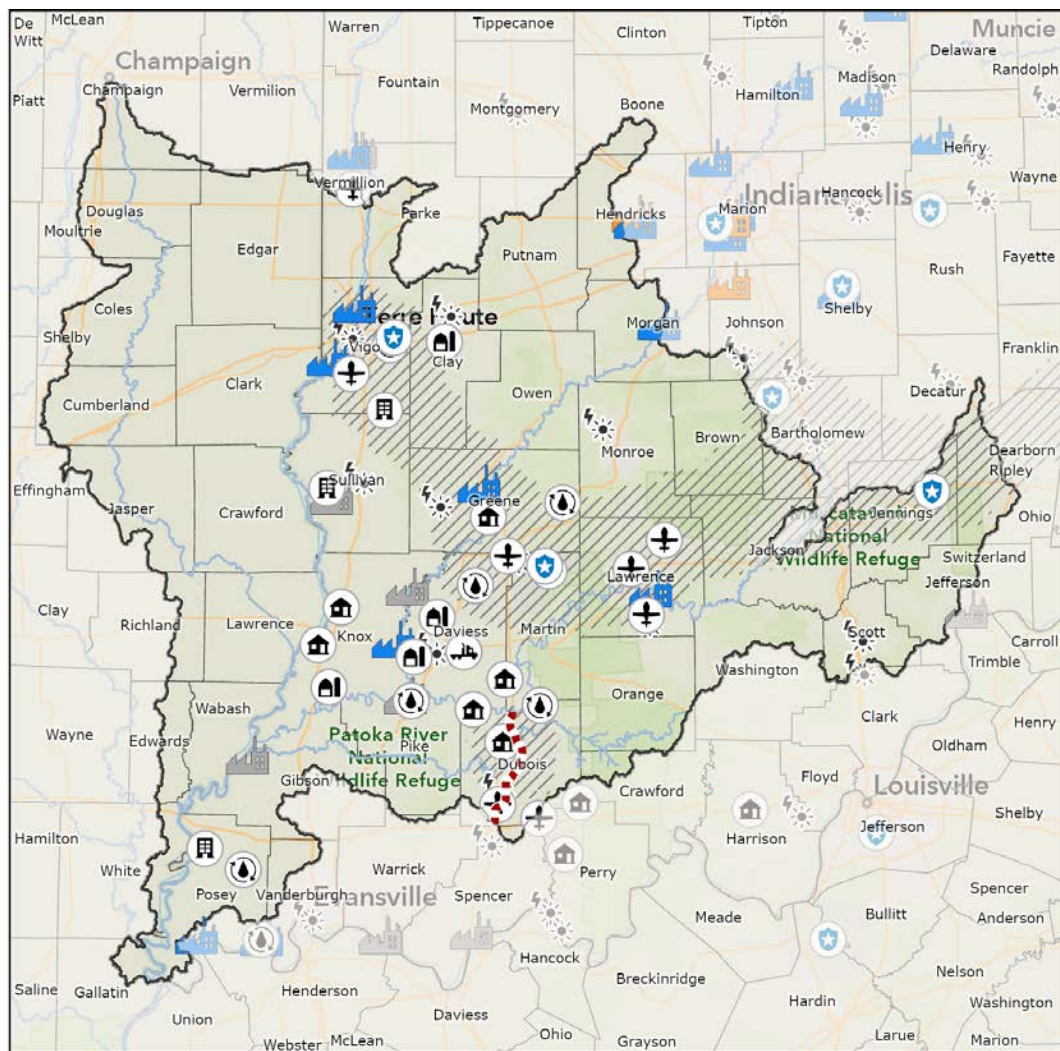
The projections represent planning scenarios rather than guaranteed facility build-out. Known closures, conversions, and proposed developments were incorporated where their timing and water requirements were sufficiently defined; less certain proposals are discussed as risks or sensitivities.

Regional Development Centers

A network of regional defense, aerospace, and high-tech industrial hubs represents the primary economic engine in southwest Indiana. The WestGate @ Crane Technology Park, straddling Daviess, Greene, and Martin counties, acts as a primary multi-county epicenter for microelectronics and advanced defense manufacturing, supported by expanding contractor facilities and a proposed munitions campus on East Harvest Church Road south of Bloomfield. To the west in Vigo County, local leaders are actively evaluating a 1,000-acre development south of the Terre Haute Regional Airport for a federally funded electric, water, and sewer utility corridor to attract aerospace, defense, and drone-manufacturing industries. Vigo County also features the massive 13,000-acre "Hoosier Jack" property, which is actively marketed for major industrial prospects or data centers. Other highly localized, high-demand technology centers include a proposed 120-acre data-center facility near the Interstate 69 and U.S. 50 interchange near Washington in Daviess County, and a cryptocurrency-mining (data center) project near the Merom power plant in Sullivan County (SullivanEnergyData, 2026b) that is currently under construction (GoogleStreetView, 2026).

Food processing, strategic commercial corridors, and targeted economic zones form a second layer of intensive growth nodes across the region. In Knox County, local economic development is anchored within the U.S. 41 Industrial Park in Vincennes, where the Farbest Foods turkey-processing plant is being targeted for potential shift and production-line expansions, alongside a new Amazon delivery station and several near-term downtown housing projects. In Dubois County, future growth is concentrated along the Jasper–Haysville corridor for mixed development and the Jasper–Ireland corridor for residential housing, bolstered by high-priority industrial leasing sites like the Ferdinand "Mobel Site" and 200 acres at the Huntingburg Regional Airport. Meanwhile, Clay County is focusing its strategic infrastructure and agribusiness planning on the U.S. Highway 59 and Interstate 70 corridor, and Lawrence County is actively marketing a newly constructed 50,000-square-foot shell building in Mitchell to capture incoming manufacturing tenants.

On the region's western border, Posey County features a distinct industrial development corridor extending from West Franklin on the Ohio River northward through Wadesville and Blairsville toward New Harmony, which has already drawn early site inquiries from a major data center and a large manufacturer. The concentration of these industrial and residential nodes across the region indicates that southwest Indiana's future water demand will be driven by discrete, site-specific economic development victories and localized utility expansions rather than uniform, regional population growth. Figure 26 below shows the locations of these regional industrial areas.



Active or planned development

Development type

-  Animal agriculture
-  Industrial (esp UAV tech)
-  Data center
-  Infrastructure upgrades
-  Housing
-  Transportation
-  Military installation

Energy Production

-  Solar
-  Natural Gas
-  Petroleum
-  Coal
-  Solar

Mid-States Corridor (planned)

Drone (UAV) technology corridor



Figure 26. Map compiling active or planned development activities in Southwest Indiana, as contributed through interviews and planning documents. Of particular note is the “drone corridor” connecting technology centers, airport infrastructure, military installations, manufacturing centers, and educational institutions across Indiana and eastward into Ohio. UAV stands for Unmanned Aerial Vehicle.

Infrastructure Constraints on Development

Implementing these development plans is heavily constrained by limitations well known by the local decision-makers. These primarily involve sanitary sewer limitations and the high capital cost of regional water transmission. In housing corridors like eastern Greene County and the U.S. 231 / I-69 corridor, public water supply is physically available, but residential growth is currently restrained by a lack of public sewer systems. A similar dynamic exists in Dubois County's Jasper–Haysville corridor, where unlocking commercial and housing growth depends entirely on forming a new Regional Sewer District to pipe wastewater back to Jasper's planned northside treatment plant. Conversely, in Posey County's Wadesville/Blairsville node, a new wastewater treatment plant has been installed, but the area lacks a municipal drinking-water supply.

Large utilities like Indiana American Water note that while the Ohio River alluvial wellfields offer massive raw water abundance, the true constraint is the high capital cost of transmission mains, high-pressure booster stations, and treatment systems required to supply finished water from the river valley to the bedrock-dominated rural and upland growth zones.

Surface-water treatment can be more operationally demanding, and therefore more expensive, than that for groundwater supplies. Unlike groundwater, which generally changes little through the year, surface-water quality varies seasonally and responds rapidly to runoff and other inputs from the surrounding watershed. In the Lake Monroe system (Subbasin 5, 03372500), for example, treatment reduces organic carbon and adjusts pH and alkalinity to control corrosion and the utility monitors the lake in the late Summer for harmful algal blooms. Surface-water utilities therefore must monitor changing source-water conditions and adjust treatment accordingly, which can increase treatment complexity and associated costs (Letsinger and Branam, 2019).

The region's heavy reliance on a single surface-water supply backbone also introduces significant long-term vulnerability. The Patoka Lake Regional Water and Sewer District serves as a critical regional water supplier, indirectly supplying approximately 50,000 people across a dozen counties where self-supplied groundwater is limited or non-potable. There is not a backup water supplier in the region. Beyond public supply, local physical and chemical water-quality issues further restrict groundwater availability.

Summary of Future Water Demand by Sector

As shown in Figure 27, total water withdrawals in the Southwest Indiana region are projected to decline from approximately 790 MGD in 2023 to approximately 407 MGD in 2070. Nearly all of this reduction is associated with anticipated retirements and technology changes in the energy-production sector, which substantially reduce the volume of surface water used for thermoelectric cooling. Projected surface-water withdrawals decline to approximately 242 MGD, while groundwater withdrawals remain comparatively stable at approximately 165 MGD. As a result, groundwater increases from about one-fifth of current withdrawals to 41 percent of projected withdrawals, even though the volume withdrawn changes relatively little.

The decline in total withdrawals does not produce a comparable decline in consumptive use (Figure 28). Approximately 88 MGD is projected to be consumed in 2070, similar to the current estimate of approximately 87 MGD. Reduced consumptive use by energy producers is largely offset by projected irrigation and public-supply demand. Groundwater supplies approximately 83 percent of projected consumptive use, principally for irrigation and public supply. Thus, the future water-demand profile is expected to be less dominated by very large, largely returned cooling-water withdrawals and more strongly influenced by groundwater-dependent uses that consume a greater share of the water withdrawn. The following sections present the assumptions and projections for each water-use sector.

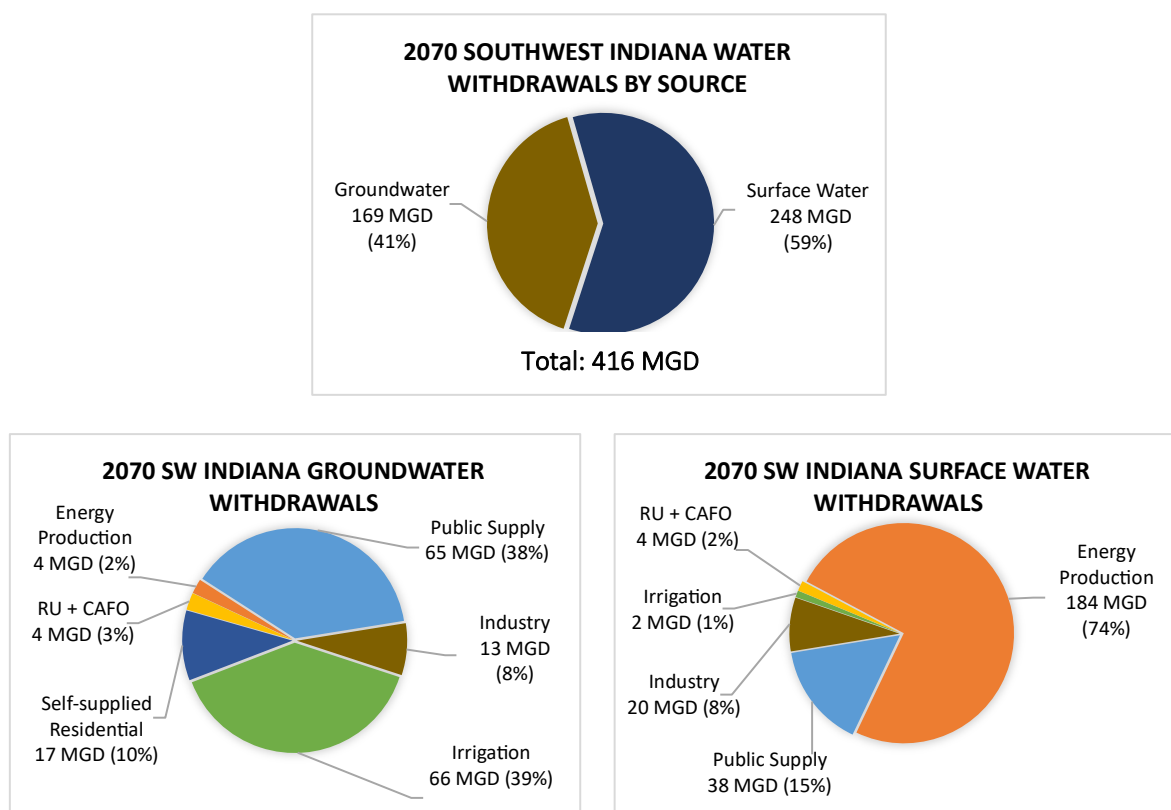


Figure 27. Future (2070) water withdrawals by water source (top) and water-use sectors by source (bottom) in the Southwest Indiana region. Total withdrawals are rounded to approximately 416 MGD, including 248 MGD from surface water and 169 MGD from groundwater. Energy production remains the largest surface-water use, but its projected withdrawals are substantially lower than in 2023.

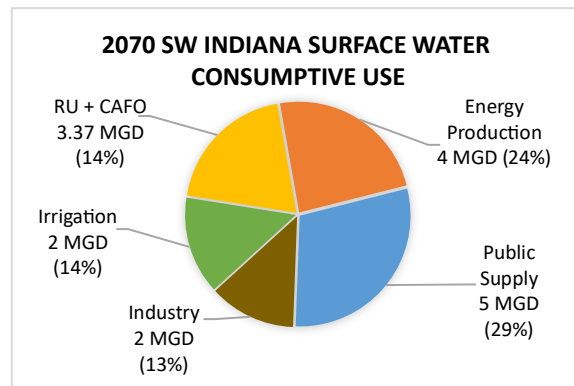
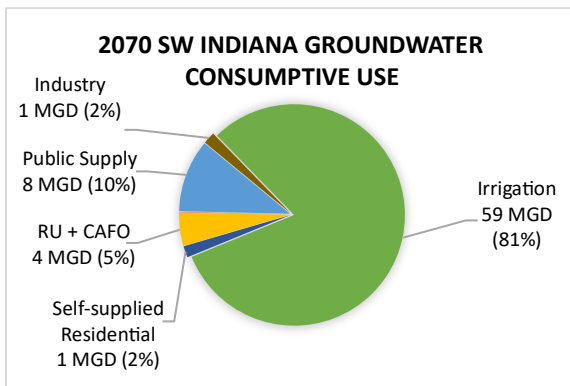
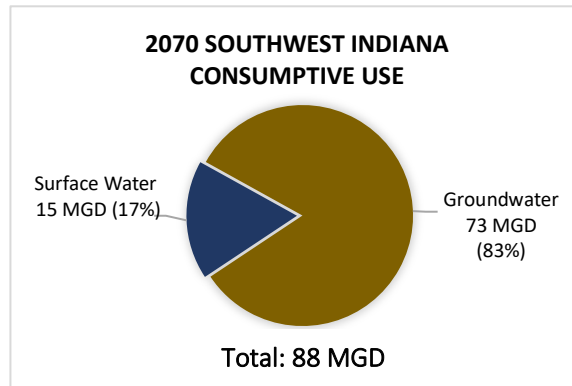
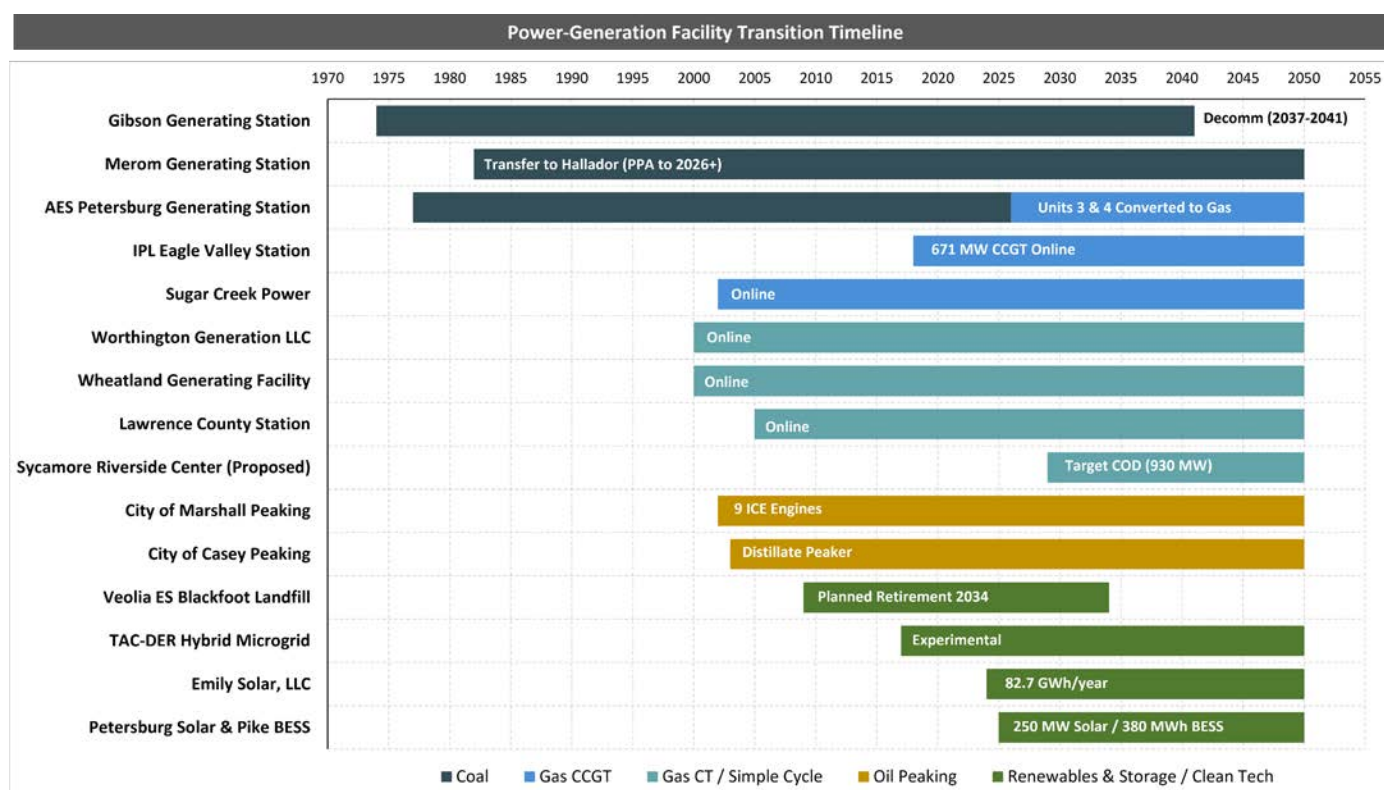


Figure 28. Future (2070) consumptive water use by water source (top) and water-use sectors by source (bottom) in the Southwest Indiana region. Total consumptive use is approximately 88 MGD, including 73 MGD from groundwater and 15 MGD from surface water. Irrigation accounts for most groundwater consumptive use, while public supply, rural and livestock use, energy production, and industry account for smaller shares.

Future Energy Generation Water Use

Energy Generation (Power Plants)

As the region's energy grid transitions, water demand for thermoelectric power generation was projected using a synthesis of local data on plant transitions and closures integrated with the Indiana Electrical Generation and Utility Facility Inventory, AES Indiana 2025 IRP IURC Filings, the "Freshwater Use by U.S. Power Plants" (ew3) report, and the Harris and Diehl (2019) thermoelectric withdrawal study. Figure 29 presents a compilation of the energy-production assets in the Southwest Indiana region, their fuel sources and generation technologies, as well as planned transitions and retirements.



Data source: Indiana Electrical Generation and Utility Facility Inventory; AES Indiana 2025 IRP IURC Filings

Figure 29. Historical and projected lifespans and technology transitions of grid-connected electrical utilities in the Lower Wabash River Basin (1970–2050). The timeline illustrates a regional shift from older technology coal-fired steam generation to modern natural gas combined-cycle and peaking units, transitioning to zero-water utility-scale solar-plus-storage hybrids. Notable milestones include the complete repowering of AES Petersburg Units 3 and 4 from coal to natural gas by December 2026, and the projected retirement of Duke Energy's 3,132 MW Gibson Generating Station between 2037 and 2041. This progressive retirement of legacy, water-intensive technologies restructures the water-demand future for the energy production sector.

Fuel for Power Generation: Future Coal Mining Water Use

The Indiana Department of Natural Resources, Division of Water, includes coal mining in the EP (energy production) water-use sector. Future manufacturing and mining withdrawals were projected from reported monthly water use during 2007–2023. For manufacturing facilities, recent historical trends were extended into the future, with limits applied to prevent implausible growth or decline. Facilities that remained active in 2022–2023 were not projected to decline automatically to zero, and the trend-based projections were held constant after 2035 because long-term changes in industrial production, technology, ownership, and water-use efficiency cannot be predicted reliably from the historical record alone.

Mining withdrawals were treated similarly through 2035, but were subsequently reduced to reflect the expected long-term contraction of regional coal production. These projections represent planning scenarios based on recent water-use patterns rather than forecasts of individual facility operations. Actual future demand could change substantially if facilities close, expand, alter production processes, improve water-use efficiency, or if new industries enter the region.

Power generation and coal mining were projected separately because their water uses respond to different factors. Power-generation demand changes primarily when individual generating units retire or convert to less water-intensive technologies, as illustrated in Figure 29. Coal-mining demand instead reflects recent withdrawal patterns and the expected long-term contraction of regional coal production.

Table 7 recombines the two projections to present total energy-sector demand by subbasin, consistent with the IDNR SWWF EP classification used in the regional water-use inventory.

The projected technology transitions produce a substantial reduction in energy-sector withdrawals, from a five-year average of approximately 682 MGD in 2020 to 189 MGD in 2050 and 187 MGD in 2070 (Table 7). The largest reductions occur in Subbasins 12 (03342000) and 10 (03374000), which contain the region’s largest thermoelectric withdrawals. By 2070, most remaining energy-sector demand is concentrated in Subbasin 10. Because much of the historical thermoelectric withdrawal was returned after cooling, this large decline in gross withdrawals does not represent an equally large decline in consumptive use; it instead reflects the reduced movement of cooling water through the region’s power plants.

Table 7. 5-year historical (2020) and projected future (2050 and 2070) demands by subbasin for the Energy (EP) sector in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	0	0	0
03376300	2	0	0	0
03376500	3	0.18	0	0
03371500	4	0	0	0
03372500	5	0	0	0
03373500	6	0.02	0.01	0.01
03359000	7	0	0	0
03360000	8	0.12	0.22	0.22
03360500	9	2.37	3.98	3.98
03374000	10	279.43	174.43	174.43
03374100	11	0.00	0	0
03341500	0	0.32	0.01	0.01
03342000	12	371.85	5.03	5.03
03342500	13	4.08	2.19	2.19
03343010	14	0.96	0.85	0.85
03345500	15	0	0	0
03346500	16	0	0	0
03377500	17	1.00	0.05	0.05
03378000	18	0	0	0
03378500	19	21.22	2.72	0.54
L. Wabash	20	0	0	0

Future Public Water Utilities

Future public-water demand was projected using methods that distinguish baseline demand from seasonal peak demand. Baseline demand is associated with economic and demographic conditions, while peak demand reflects the added influence of climate, seasonality, outdoor use, and episodic stressors.

Future public water-supply demand was projected from historical monthly withdrawals using an approach that accounts for both long-term baseline demand and seasonal sensitivity to weather. Utilities were first screened for data quality, changes in operation, seasonal demand patterns, and relationships between warm-season demand and climatic conditions. Utilities with similar characteristics were grouped for modeling, while several large or operationally distinctive systems were evaluated separately. Projected climate conditions were allowed to influence future seasonal demand, but that influence was bounded to prevent extreme climate-model values from producing implausible projections.

The projections represent potential water demand rather than a guarantee that existing infrastructure or water sources can supply that amount. Consequently, projected demands were not automatically reduced when they approached or exceeded an estimated capacity or historical-use threshold. Instead, those utilities were flagged as locations where future demand could require additional source capacity, infrastructure improvements, conservation, operational changes, or further utility-specific evaluation.

Monthly withdrawal records from 1985 through 2023 were evaluated for approximately 100 public water-supply utilities in the study area. The screening identified differences in utility size, source type, seasonal demand, climatic sensitivity, record completeness, and operational stability. Twenty-seven utility records required additional review because of missing data, structural changes, discontinuities, or other reliability concerns; 15 of these appeared to be inactive by the end of the historical period. Most active systems could be modeled using utility groups representing broadly similar demand behavior, while Patoka Lake Regional Water and Sewer District, Bloomington Utilities, and Indiana-American Water–Terre Haute received separate treatment because their size, source, wholesale function, or historical behavior differed materially from the grouped systems.

Across the modeled utilities, future demand reflects two distinct influences: changes in underlying or baseline demand and changes in climate-sensitive seasonal use. This distinction is important because projected Summer peaks may increase even where average or Winter demand changes relatively little. Utilities for which modeled demand approaches or exceeds the applicable historical or capacity-related threshold are identified as potential planning concerns rather than assumed to have sufficient future capacity.

Table 8. 5-year average historical (2020) and projected future (2050, 2070) demands by subbasin for the Public Supply (PS) sector in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	7.54	7.65	7.11
03376300	2	2.28	2.44	2.17
03376500	3	0.05	0.03	0.03
03371500	4	9.31	9.75	8.93
03372500	5	15.83	17.20	17.48
03373500	6	5.30	5.16	4.80
03359000	7	0.26	0.23	0.19
03360000	8	4.24	4.03	3.74
03360500	9	7.16	6.90	6.61
03374000	10	7.10	7.41	7.35
03374100	11	1.19	1.10	1.10
03341500	0	12.94	16.62	16.20
03342000	12	3.40	3.98	3.81
03342500	13	0	0	0
03343010	14	3.16	3.37	3.36
03345500	15	8.37	8.42	8.40
03346500	16	2.78	2.75	2.72
03377500	17	7.02	6.25	5.43
03378000	18	0.58	0.60	0.61
03378500	19	2.08	1.92	1.72
L. Wabash	20	0.05	0.05	0.05

The resulting public-supply projections are summarized by subbasin in Table 8. Regional five-year average demand changes relatively little, increasing from approximately 101 MGD in 2020 to 106 MGD in 2050 and then declining to approximately 102 MGD in 2070. That regional stability conceals differences among utilities and subbasins. The largest projected increases occur in Subbasin 0 (03341500), which contains part of the Indiana-American Water–Terre Haute system, and Subbasin 5 (03372500), the source subbasin for Bloomington Utilities. These increases are partly offset by stable or declining demand elsewhere. The values in

Table 8 represent average demand rather than seasonal or maximum-day requirements; utility-level projections, seasonal patterns, and model assignments are presented in Appendix D. A demand peaking analysis is presented in Appendix B.

Self-supplied Residential Water Use

Domestic self-supplied water is estimated spatially to complete the subbasin water-use inventory. Estimates should be reconciled with service areas and population data, recognizing uncertainty in rural areas and where source-water constraints encourage public-water service.

Future self-supplied water usage (Table 9) is assumed to remain static and unchanging at the current subbasin usage rates. While there may be some new residential developments in some areas that initially procure their own water through domestic wells, these additions are anticipated to be offset by the expansion of rural water utilities both spatially (through growing service areas) and by capturing additional self-served customers already within their established service areas. The seasonal component to domestic water returns (increased consumption during warmer months) is retained in future forecasts to represent water used for irrigation purposes (lawn and garden maintenance).

Table 9. 5-year average historical (2020) and projected future (2050 and 2070) demands by subbasin for the Self-supplied Residential (SS-Res) sector in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	0.28	0.28	0.28
03376300	2	0.23	0.24	0.24
03376500	3	0.12	0.12	0.12
03371500	4	1.32	1.34	1.34
03372500	5	0.26	0.27	0.27
03373500	6	0.89	0.90	0.90
03359000	7	1.10	1.11	1.11
03360000	8	1.57	1.59	1.59
03360500	9	2.22	2.25	2.25
03374000	10	1.89	1.92	1.92
03374100	11	0.20	0.21	0.21
03341500	0	1.63	1.64	1.64
03342000	12	1.19	1.21	1.21
03342500	13	0.27	0.28	0.28
03343010	14	0.42	0.42	0.42
03345500	15	1.83	1.80	1.80
03346500	16	0.25	0.25	0.25
03377500	17	0.34	0.34	0.34
03378000	18	0.08	0.07	0.07
03378500	19	0.46	0.46	0.46
L. Wabash	20	0.69	0.68	0.68

Future Industrial Water Use

Future manufacturing withdrawals (Table 10) were projected from reported monthly water use during 2007–2023. For manufacturing facilities, recent historical trends were extended into the future, with limits applied to prevent implausible growth or decline. Facilities that remained active in 2022–2023 were not projected to decline automatically to zero, and the trend-based projections were held constant after 2035 because long-

term changes in industrial production, technology, ownership, and water-use efficiency cannot be predicted reliably from the historical record alone.

Several new or expanding industrial projects are under construction or have been approved, and those projects were included in the respective subbasin water demand projection if enough information was available to estimate withdrawals and returns for the facilities. Examples include a lithium battery plant (Subbasin 12, 03342000) and a facility conversion to an agricultural fertilizer plant (Subbasin 0, 03341500). Detailed information about future demand projections for these facilities can be found in Appendix D.

Wabash Valley Resources (WVR) is a chemical manufacturer, designed to process up to 600,000 tons of solid feedstock (petroleum coke and coal) annually to produce 500,000 tons of anhydrous ammonia fertilizer for the agricultural market. The project is being built on the footprint of the retired Wabash River Coal Gasification Repowering Demonstration Project (WRCGRDP), just northwest of Terre Haute. The site is transitioning from an active steam-cycle power plant to a modern chemical synthesis plant. Under its historical power-generating configuration, the site utilized a once-through cooling cycle. To support this, it withdrew 521,500 gallons per minute (GPM) from the Wabash River. WVR is updating their Indiana SWWF registration to reflect a much-reduced withdrawal rate. By replacing the once-through steam condenser system with two multiple-cycle, closed-loop non-contact cooling towers, much of the water will be recycled internally. The facility will only withdraw 5,500 GPM of make-up water to compensate for evaporative losses—representing an immediate reduction in active river water withdrawals at that intake.

The Indiana Department of Natural Resources, Division of Water, includes quarries (e.g., gravel, aggregate) and stone mining (e.g., dimension limestone) in the IN (industrial) water-use sector. The water sources, volumes, and withdrawal patterns differ between industrial manufacturing and mining, so in this report, the two industries are treated as related, but future demand and return forecasts are projected separately. Stone mining and quarries were projected to follow the recent trend (if any) for water use in each subbasin into the future. The seasonal proportion (often higher in the Spring, likely from dewatering pits because of high water levels) was retained, if a signal was present. Although dewatering withdrawals are not traditional consumptive water uses, it was not possible to distinguish these volumes from other operational water uses. Uncertainty remains in the Industrial-Mining subcategory, but that is why it was subclassified for its own projection.

Table 10. 5-year average historical (2020) and projected future (2050 and 2070) demands by subbasin for the Industrial (IN) sector in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	0	0	0
03376300	2	0.00	0.00	0.00
03376500	3	0	0	0
03371500	4	2.21	3.16	3.16
03372500	5	0	0	0
03373500	6	1.91	5.74	5.74
03359000	7	0	0	0
03360000	8	2.15	3.41	3.41
03360500	9	1.13	1.92	1.92
03374000	10	4.25	4.41	4.41
03374100	11	0	0	0
03341500	0	4.69	8.95	8.95
03342000	12	0.75	3.28	3.28
03342500	13	0	0	0
03343010	14	0	0	0
03345500	15	0.02	0.02	0.02
03346500	16	0	0	0
03377500	17	0.93	1.00	1.00
03378000	18	0	0	0
03378500	19	0.39	0.38	0.38
L. Wabash	20	0	0	0

Future Irrigation Water Use

Warmer overnight temperatures during critical parts of the growing season (i.e., July) in Indiana have been linked to reduced corn yields over the last decade (Hayhoe et al., 2009; Bowling et al., 2018). Warming

temperatures and tenuous plant-available water in the Summer months can be disastrous for crops if flash droughts develop and starve growing crops at critical times (Pendergrass et al., 2020; Iglesias et al., 2022).

Irrigation can amend crop water requirements but usually cannot be applied in sufficient amounts during persistent drought conditions to salvage crops. Irrigation from water wells can draw down groundwater levels and increase soil water evaporation and plant evapotranspiration by bringing water to the ground surface, especially during the hot Summer months (Qing et al., 2023). These interacting processes in the water cycle are expected to intensify as temperatures continue to increase (Hayhoe et al., 2009; Rosa et al., 2020; Douville et al., 2021; Haqiqi et al, 2021).

Crop and turf irrigation forecasts (Table 11) were developed in two steps. First, historical monthly irrigation withdrawals from 2007 through 2023 were used to estimate the typical seasonal pattern of irrigation demand in each subbasin. This preserved the observed timing of irrigation withdrawals while allowing future annual demand to follow the trend identified from recent historical use. Non-growing-season irrigation was retained as zero where it was zero historically; the method did not assume that the irrigation season would expand in the future based only on climate-model output.

Second, the irrigation forecasts were adjusted to reflect future growing-season water stress using the difference between potential evapotranspiration and actual evapotranspiration, or PET minus AET, from the SWB2 water-balance model. PET minus AET represents unmet atmospheric water demand: larger positive values indicate conditions under which vegetation would likely require more supplemental water. Historical relationships between monthly PET minus AET and observed crop and turf irrigation were evaluated separately. Because irrigation records are influenced by many factors besides weather, including facility activity, crop choices, irrigation capacity, and reporting patterns, PET minus AET was used as a bounded adjustment to the trend-based forecast rather than as the sole predictor of future irrigation. The adjustment increases projected irrigation during unusually dry, high-deficit months and reduces or leaves it near baseline during wetter or lower-deficit months, while limiting the adjustment to the range of historically observed behavior, including the 2012 drought as a dry end-member.

Table 11. 5-year average historical (2020) and projected future (2050 and 2070) demands by subbasin for the Irrigation (IR) sector in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	0	0	0
03376300	2	0.08	0.10	0.10
03376500	3	0.10	0.12	0.12
03371500	4	1.23	1.75	1.83
03372500	5	0.06	0.09	0.10
03373500	6	0.04	0.06	0.07
03359000	7	0.03	0.05	0.05
03360000	8	0	0	0
03360500	9	0.03	0.08	0.08
03374000	10	1.11	0.90	0.89
03374100	11	0.13	0.22	0.22
03341500	0	0.80	2.53	2.55
03342000	12	8.38	9.65	9.72
03342500	13	0.01	0.01	0.01
03343010	14	12.79	15.02	15.16
03345500	15	0	0	0
03346500	16	0.04	0.04	0.04
03377500	17	17.43	18.82	19.14
03378000	18	0	0	0
03378500	19	8.09	9.88	10.13
L. Wabash	20	7.10	8.35	8.43

Illinois concentrated animal feeding operation (CAFO) withdrawals were not available through the same regulatory reporting system as Indiana facilities. Where historical Illinois CAFO water-use records existed but were insufficient to support development of a process-based forecasting relationship, future monthly withdrawals were estimated using Excel's Exponential Triple Smoothing (FORECAST.ETS) algorithm. This approach was applied only to a limited number of Illinois subbasins to preserve the observed temporal behavior where more defensible predictive relationships were unavailable.

Future Rural Water Use: Livestock and Fisheries

Future CAFO/CFO water demand projections (Table 12) were constructed at the facility level because livestock production can shift among subbasins, facility consolidation can alter local demand, and seasonal and life-stage assumptions affect monthly water-use estimates. Detailed crosswalks and assumptions are reserved for the technical appendix.

Following the grouping and adjustment processes, the animal counts from IDEM were extended to develop a time series of the CAFO/CFO industry from 2007-2075. The USDA publishes a forecast of national livestock trends each year that predicts changes over the next 50 years. A combination of these USDA trend forecasts and the 5-year Agriculture Census was used to calculate likely CAFO/CFO animal counts in each subbasin. To do this, known historical animal counts were ramped over time using the percent change calculated between each year of national prediction data from the USDA. This method prevented the oversimplification and overestimation that would accompany linear projection, as the rates of change used reflect actual industry trends.

All groups were initially assumed to follow national trends, but corrections were made to account for Indiana's livestock specialties. Each group was assessed for realism in projection, especially the pig, chicken, and duck groups. By assuming that the facilities from 2026 with the fewest animals could grow to be the size of the current largest facilities by 2075, a maximum growth rate was calculated. That growth rate and resulting animal count served as the "upper lid" for each group. A "middle lid" was calculated in a similar manner, but with the exclusion of outlier facilities identified as having an animal count greater than two standard deviations above the mean. Lastly, a "lower lid" was created by using the Q3 animal count as the target size, or one standard deviation above the mean. With the national trends percent change method described previously, nearly every group was found to be under the lower lid value by 2075. In other words, these industries are growing at realistic rates with the exception of the chicken groups.

The industry as a whole is moving towards a "fewer facilities, higher productivity" style of operation. New construction is less common than consolidation or capacity expansion of existing facilities. Large conglomerates are expanding at a similar rate as the closure of smaller facilities; therefore, there are no clear signals regarding where additional growth would occur. Existing facilities are expected to increase in capacity and productivity over time. However, both Jackson and Daviess Counties have recently grown their animal capacity while reducing livestock operation counts.

The RU (Rural Use) water-use category, which in the Southwest Indiana region consists almost entirely of fisheries operations, was forecast using recent seasonal water-distribution patterns along a linear trend calculated separately for each subbasin.

Further details of the CAFO and RU water-use projection methodology can be found in Appendix D.

Table 12. 5-year average historical (2020) and projected future (2050 and 2070) demands by subbasin for the Rural Use (RU) and CAFO sectors in Millions of Gallons per Day (MGD).

Gage ID	Subbasin	2020	2050	2070
03375500	1	0.43	0.46	0.48
03376300	2	0.31	0.25	0.26
03376500	3	0.13	0.16	0.16
03371500	4	0.66	0.66	0.71
03372500	5	0	0	0
03373500	6	0.07	0.05	0.05
03359000	7	0.05	0.04	0.04
03360000	8	0.10	0.12	0.13
03360500	9	0.64	0.75	0.79
03374000	10	4.13	4.58	4.64
03374100	11	0.10	0.12	0.13
03341500	0	0.08	0.09	0.11
03342000	12	0.02	0.02	0.02
03342500	13	0.02	0.02	0.02
03343010	14	0.02	0.01	0.01
03345500	15	0.08	0.08	0.08
03346500	16	0.04	0.04	0.04
03377500	17	0.02	0.01	0.01
03378000	18	0.03	0.03	0.03
03378500	19	0.13	0.15	0.16
L. Wabash	20	0.05	0.03	0.04

Future Wastewater Returns

The preceding sections describe how much water each sector is projected to withdraw. To determine the effect of those demands on water availability, the study also estimated how much water would return to the hydrologic system and where those returns would occur. These distinctions matter because a power plant may return most of its cooling water, irrigation returns comparatively little, and a public utility may withdraw water in one subbasin but return it through a wastewater system in another. Projecting future returns therefore completes the human-use portion of the demand analysis and provides a necessary input to the water-availability assessment.

Future return flows were projected monthly and assigned to the subbasins where the water is expected to reenter the hydrologic system. They should not be interpreted as an additional water demand or as a natural source of water. Rather, withdrawals and returns together describe the effect of projected human water use on each subbasin's water balance.

Initial screening evaluated whether reported NPDES return flows could be forecast from reported water withdrawals by sector and subbasin. Linear regressions, seasonal regressions, and active-pair filtering were tested to determine whether consistent withdrawal-return relationships existed. The results showed that most basin-sector relationships were not sufficiently stable for regression-based forecasting. In many cases, the transition from historically reported returns to regression- or ratio-based estimates produced unrealistic month-to-month discontinuities, indicating that the reported returns reflect system configuration, facility operations, cross-basin routing, reporting differences, and other factors that are not captured by withdrawal volumes alone.

Because of these limitations, future return flows were estimated using simplified sector-specific rules based on observed historical return proportions and withdrawal volumes, rather than basin-specific regression equations (Table 13). This approach avoids imposing false precision where the historical data do not support a predictable withdrawal-return relationship, while still preserving the approximate magnitude of return flows needed for regional water-balance forecasting.

Table 13. Methods used to project regulated and nonregulated return flows for the future water-demand and water-availability analyses. Detailed sector assumptions and monthly processing methods are presented in Appendix D.

Return-flow component	Projection approach	Basis
Regulated NPDES discharges	Historical monthly median ratio of NPDES returns to regulated withdrawals within each subbasin	Preserves observed seasonal withdrawal-return relationships
Regulated NPDES discharges where ratios were unstable	Historical monthly median discharge	Avoids unrealistic return-flow estimates caused by highly variable ratios
Nonregulated returns	Projected sector withdrawals combined with sector-specific consumptive-use or return-flow assumptions	Represents uses without directly reported discharges

Historical monthly NPDES return-to-regulated withdrawal ratios were summarized using monthly medians for each subbasin. Future monthly return flows were estimated by multiplying projected regulated withdrawals by the corresponding historical monthly median ratio. In subbasins where historical ratios exhibited excessive variability, monthly returns were represented using historical monthly median NPDES discharges rather than withdrawal-scaled estimates.

Water Availability

Water availability is evaluated as a combination of natural hydrologic inputs, source-water characteristics, withdrawals, consumptive use, return flows, storage, and water-quality limitations. For planning purposes, the relevant question is not only whether water is present in the region, but whether sufficient

water is available in the right place, at the right time, from a usable source, and under conditions that utilities and other water users can reliably manage.

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Water Availability is a Function of:

- geologic materials
- anthropogenic impacts
- timing of demand (seasonality)
- ecosystem needs
- climate/future climate

The following part of the report involves water availability, which includes the physiographic, hydrogeological, and climatic factors that characterize water resources in this region. A comprehensive analysis of water availability includes not only natural features but requires an inventory of anthropogenic (man-made) withdrawals and wastewater returns to the regional water cycle, as discussed in the previous report section.

Indiana has a surprisingly diverse set of hydrogeologic environments that govern the distribution of aquifer resources in the subsurface. Therefore, conditions at the surface can have a variety of effects, some of which will be felt immediately, and some of which might not be of concern for decades or centuries.

The structure of this section of the report begins with an overview of the natural characteristics of the water cycle including the geologic framework as well as current and future climate.

The availability method follows the general framework of the Central Indiana Water Study (IFA, 2021) and incorporates an anthropogenic inventory of withdrawals and returns. Public-supply projections and forecasts for other sectors were assigned to the subbasins in which withdrawal and return occur. This spatial assignment is essential because large utilities and industrial facilities can dominate the local balance even when their demand is modest relative to total regional river flow.

Just as in the water demand analysis, the water availability model based on historical data was extended into the future using projected water-withdrawal and return flows along with simulated natural baseflows matched to future climate variability. The details of the approach are presented along with the results of the current and future excess water availability analysis.

Following the results of the location-specific water availability analyses, other factors that can hinder sustainable and resilient water supply and distribution are discussed including water conservation, water quality, and other risk factors.

Factors Influencing Water Availability

In Southwest Indiana, water availability is influenced by the spatial distribution of aquifers and surface-water sources, reservoir operations, karst drainage, mined lands, land cover, wastewater returns, irrigation withdrawals, and the seasonal timing of precipitation and evapotranspiration. These controls are evaluated at subbasin scale so that any local constraints are not obscured by regional totals.

All regional aquifers, including glacial outwash, till, buried sand and gravel, and bedrock, are interconnected with surface waters. Aquifer recharge eventually discharges to a stream or river. The distribution of geologic materials controls the locations and types of aquifers, which are varied and complex in the Southwest Indiana

region. A brief overview of the geologic history will be given, followed by an overview of factors that control the amount and timing of water available in the aquifers and streams used for water supply.

Figure 30 presents a regional map of the generalized surficial geology for the Midwest states in the U.S. The Southwest Indiana region lies at (and beyond) the southern extent of the Pleistocene glaciation, and the glacial deposits containing valuable aquifer materials thin near this glacial limit. Much of the Southwest Indiana region has little or no glacial material mantling the shallow bedrock except near the river corridors where glacial outwash pushed south of the furthest extent of glacial ice. Therefore, self-supplied water through onsite water wells is much more limited for residential, industrial, and even public supply use than in the northern two thirds of Indiana.

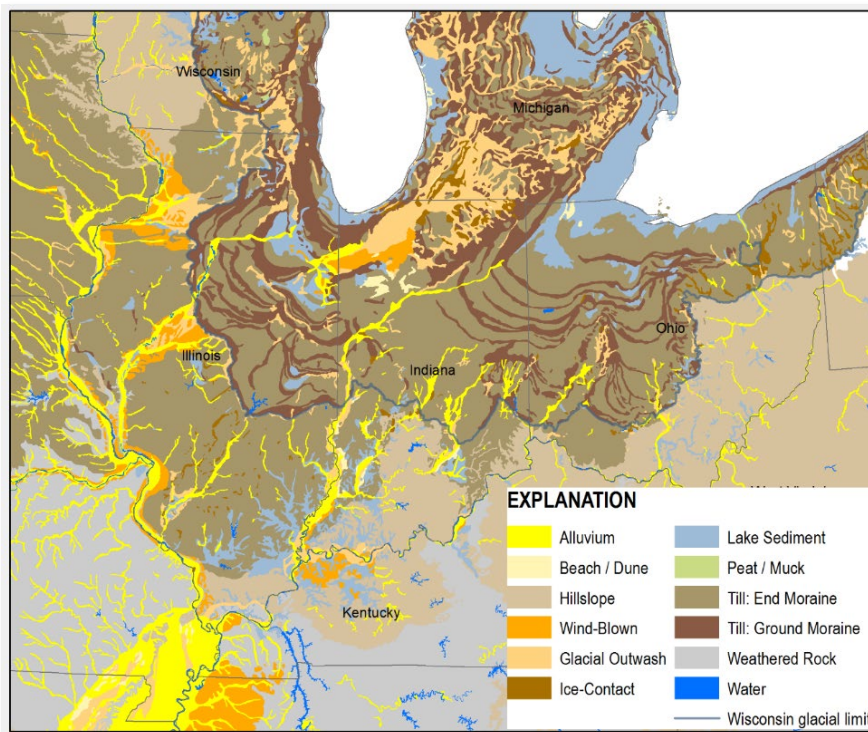


Figure 30. Generalized surficial geology for the Midwest U.S. states. The surface materials are dominated by Pleistocene continental glacial deposits that originated from the Great Lakes basins to the north. Underlying the surface unconsolidated (not yet cemented into rock) materials are sedimentary bedrock deposits of limestone, sandstone, and shale. The local geological setting is an important factor in how water is distributed or stored across the landscape. Modified from Fullerton et al., 2003.

Figure 31 shows both unconsolidated and bedrock aquifer system types mapped in Indiana by the U.S. Geological Survey (Fenelon et al., 1994). The yellow and orange streaks represent the sand and gravel materials that line the river corridors. Public water supplies and agricultural irrigation take advantage of these aquifers.

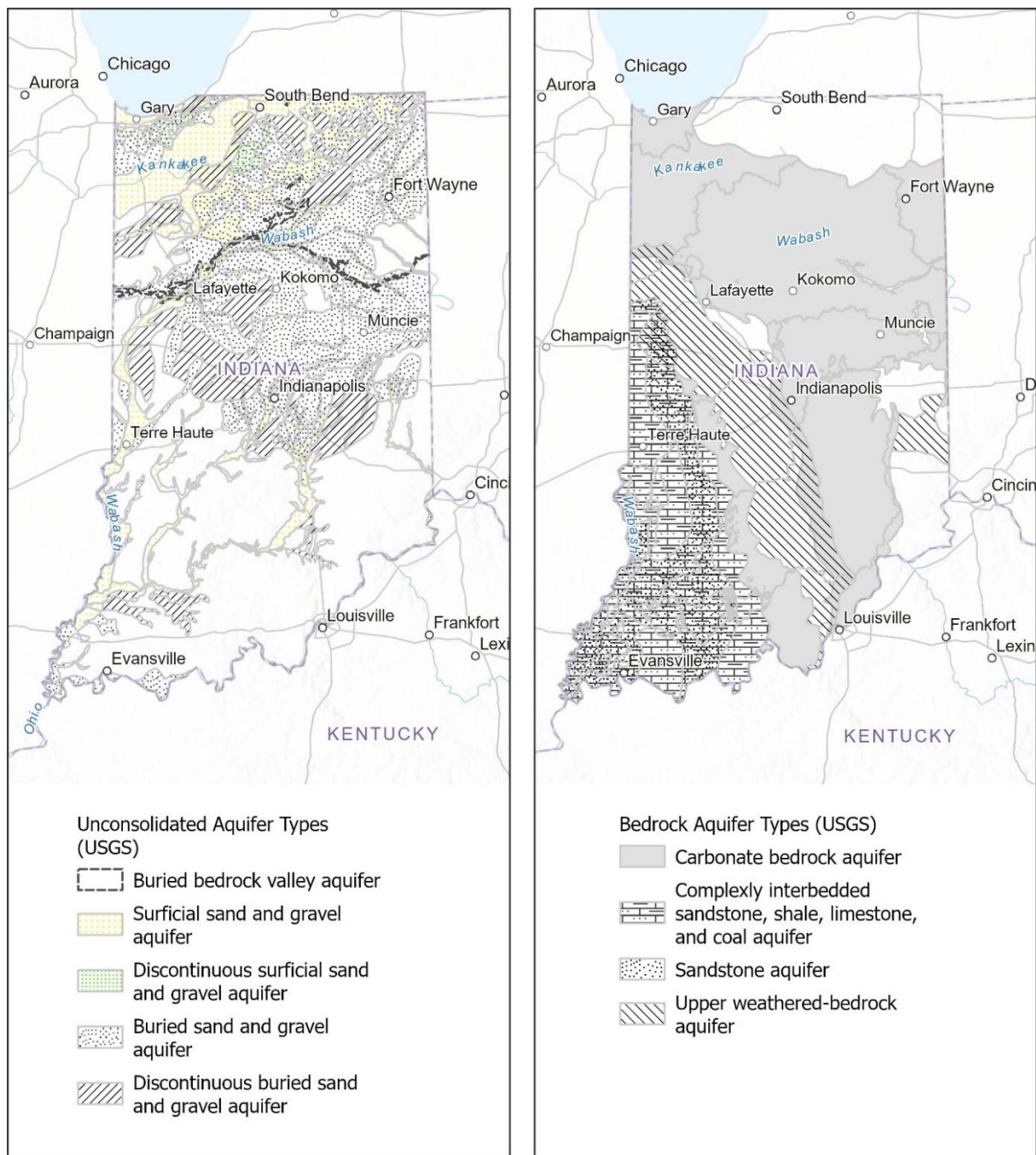


Figure 31. Aquifer system types mapped in Indiana by the U.S. Geological Survey (Fenelon et al., 1994). In the left panel are mapped un lithified, or unconsolidated, aquifer types. These aquifer systems are water-laden sediments deposited during geologically recent times from continental glaciation that originated from the north. In the Southwest Indiana region, near-river alluvial and outwash sediments dominate the unconsolidated aquifer types. In the right panel are mapped generalized bedrock aquifer systems in Indiana. These aquifer systems underlie the glacial deposits and consist of nearly flat-lying sedimentary deposits of limestone, sandstone, and shale. Although these bedrock types are described as aquifers, the depth, yield, and quality are extremely site-specific.

Bedrock Aquifers

The majority of the Southwestern Indiana study area relies on either unconsolidated sand and gravel aquifers or bedrock aquifers developed within Pennsylvanian and Mississippian aged units. While Devonian and Silurian bedrock aquifers are known to occur across the southern third of Indiana (Fenelon, 1994), their utilization within the study area is limited and largely confined to its peripheral margins.

The Lower Wabash River Basin has a significant number of sand and gravel aquifers south of the most recent Wisconsin glacial border that are utilized as a primary water source, but there are also some bedrock units that can serve as aquifers in this area. These include the Inglefield Sandstone, the Busseron Sandstone, and the West Franklin Limestone units of the upper Pennsylvanian (Fenelon, 1994, Lower Wabash section).

In the northern portion of the study area, within the central third of the White River Basin, aquifers developed in the upper weathered zone of the Devonian New Albany Shale and Mississippian Borden Group are present but are noted to be unreliable (Fenelon, 1994, White River section). While there are unconsolidated sand and gravel aquifers along the major river valleys, a more widespread aquifer for the southern part of the White River basin can be found in the interbedded sandstones, limestones, coals, and shales of the Mississippian and Pennsylvanian. Specific units include the Mansfield, Linton, and Petersburg sandstone formations.

Along the eastern edge of the study area in the East Fork White River basin, the Silurian-Devonian carbonate bedrock aquifer extends roughly to the Brown/Bartholomew County line; to the west of this boundary, the aquifer becomes too deeply buried for practical use (Fenelon, 1994, East Fork White River section). While large-scale withdrawals are unlikely, a small number of domestic or stock wells may still tap into these units along the eastern edge of this subregion. More reliable bedrock aquifer units for this region are the thick carbonate rocks of the Mississippian Blue River and Sanders Groups.

No bedrock aquifers older than Mississippian have been identified in the Patoka River valley portion of the study area (Fenelon, 1994, Patoka section). Thus, the only potential utilization of Devonian or Silurian carbonate units occurs at the extreme eastern fringes of the East Fork White River basin, where a limited number of residential or stock wells may intersect undifferentiated Silurian-Devonian aquifers. Similarly, in the northern fringes of the study area in the central White River basin, a few wells may draw from the weathered upper section of the Devonian New Albany Shale. However, these occurrences appear to be minimal, and high-capacity wells in these older units have not been documented. The limestone members of the Blue River, West Baden, and Stephensport Groups are the most commonly used bedrock aquifers in the Patoka River basin.

While the majority of bedrock wells in the study area are completed in Mississippian and Pennsylvanian units, the potential for deeper Devonian carbonate aquifers—particularly in the easternmost portions of the East Fork White River basin—cannot be entirely ruled out. A revised stratigraphic column incorporating Pennsylvanian and Mississippian units is presented in Figure 33. If there is any utilization of Silurian-Devonian carbonate aquifers in this region, they likely target the upper and middle Devonian formations rather than extending into the Silurian. Because there do not appear to be any high-capacity wells in our study area that utilize Devonian or Silurian aquifers, Figure 33 only includes the Mississippian and Pennsylvanian units that are widely accessed.

Figure 32 shows the mapped hydrostratigraphic units in Indiana above which have been found to have fresh (potable, not saline) water. The stratigraphic column in Figure 33 shows the sequence of rock units (oldest at the bottom, youngest at the top) in the Southwest Indiana region. Most wells developed in this aquifer system yield less than 100 GPM, but yields around 500 GPM are possible in near-river outwash aquifers (see Figure 34 and Figure 35).

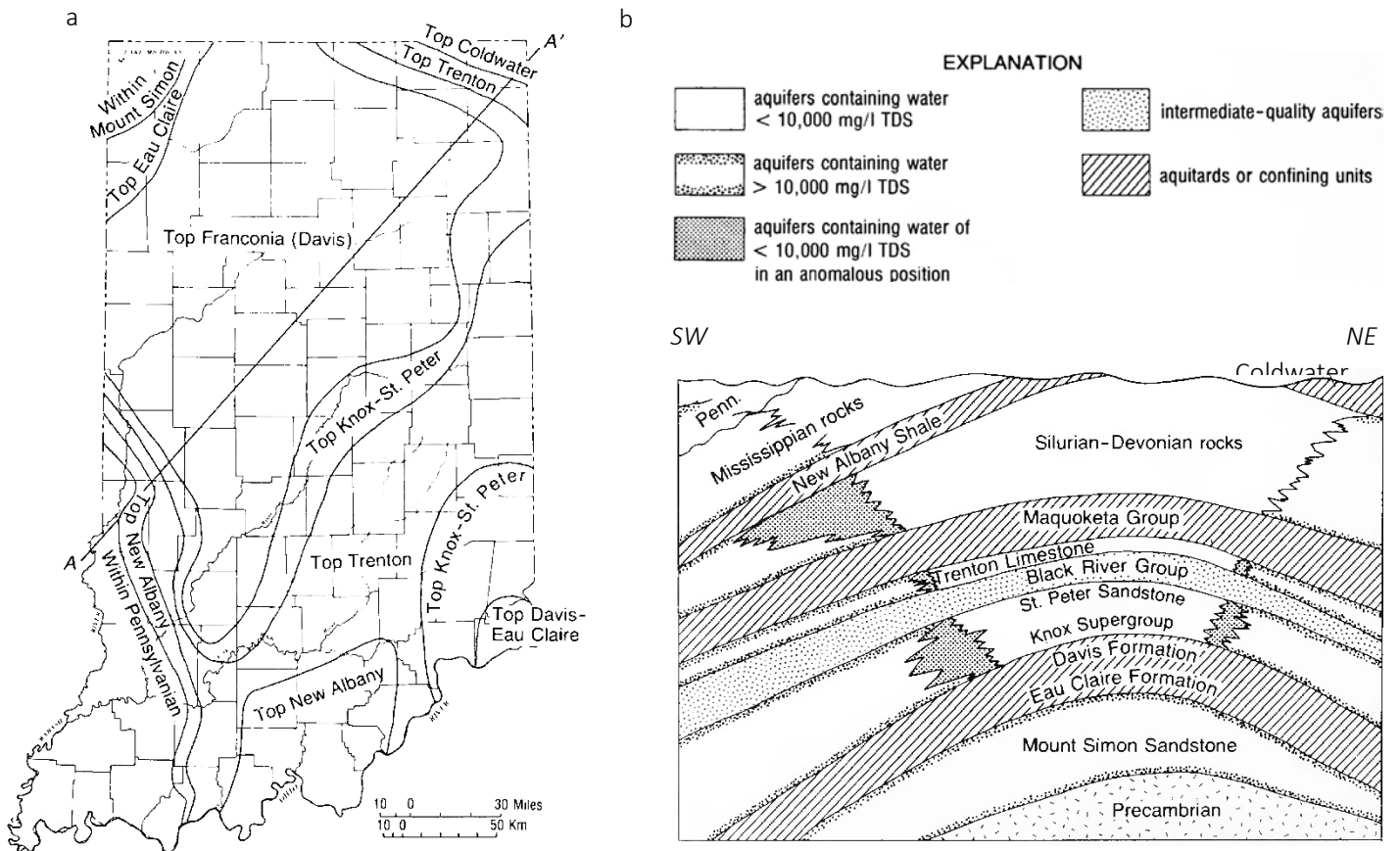


Figure 32. The map on the left (a) shows the hydrostratigraphic units in the state of Indiana that delineate fresh (potable, low total dissolved solids [TDS]) water from brackish (briny, saline, high total dissolved solids [TDS]) water. The figure on the right (b) is a cross-section (side view of the subsurface) view of the bedrock stratigraphy in Indiana along the Cincinnati and Kankakee Arches. The fresh water in the Southwest Indiana region can be found above the Trenton Limestone (see the stratigraphic column in Figure 33) according to Rupp and Pennington (1987). The Maquoketa Group is a confining unit that separates the gas-bearing Trenton Limestone from the Silurian-Devonian Carbonate Aquifer System. Although not currently widely used as an aquifer source in the study area, the Silurian-Devonian Carbonate Aquifer System shown in (b) is a possible option for future groundwater exploration. Figures from Rupp and Pennington (1987).

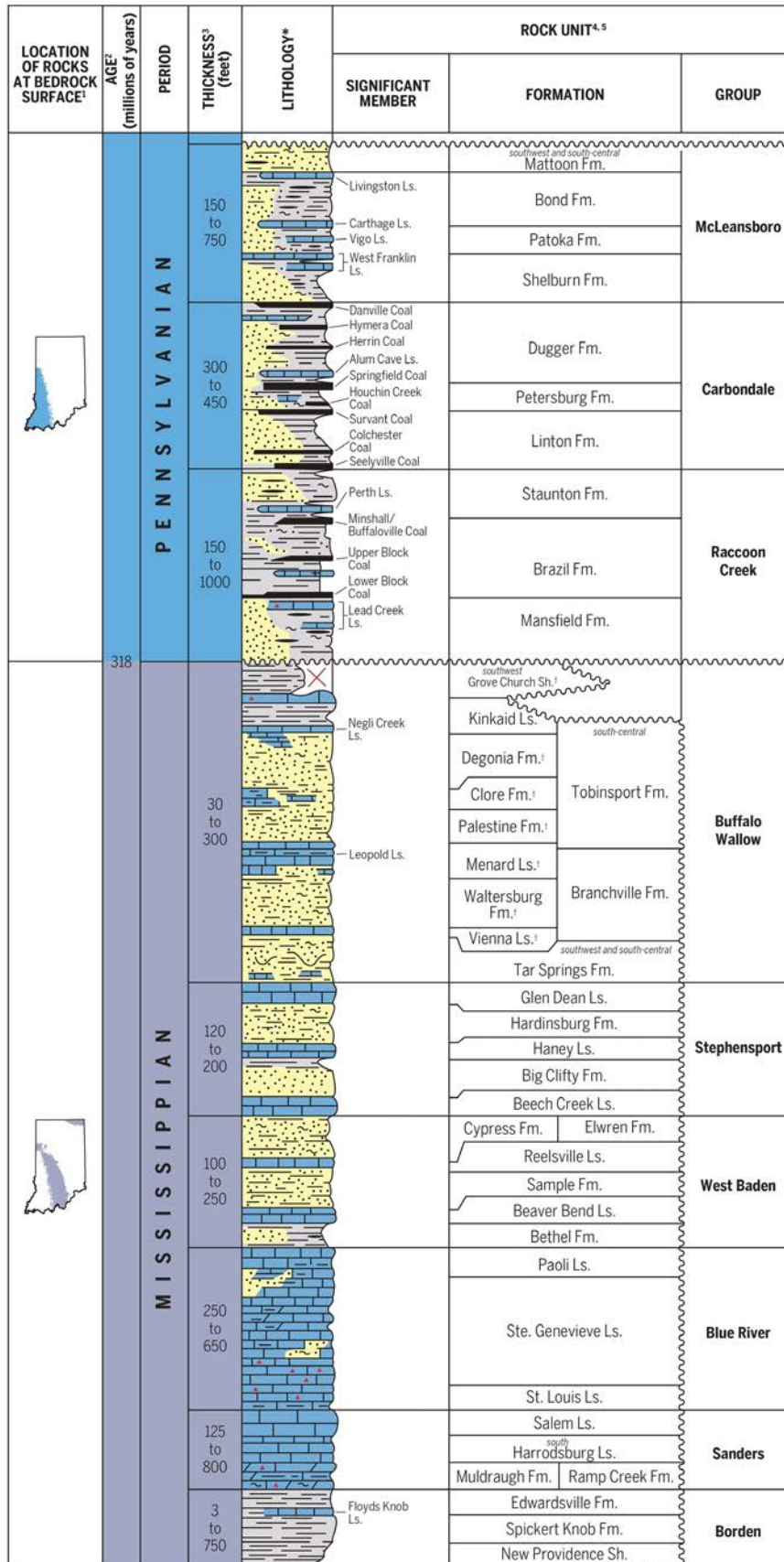


Figure 33. This diagram is a portion of the stratigraphic column representing bedrock units in the Southwest Indiana region with the oldest units shown at the bottom of the diagram (also the deepest, or farthest below ground surface) and the youngest units shown at the top (closest to the surface). The discussion below notes that the upper weathered portions of the Devonian New Albany Shale are occasionally utilized for low-capacity domestic wells, but wells developed in this aquifer system do not typically produce high yields. Modified from Thompson et al., 2015.

Expected high-capacity well yields

High-capacity wells are concentrated in alluvial and glacial-outwash aquifers along major river valleys. Bedrock wells support selected public-supply, industrial, quarry, and agricultural facilities, but their yields are more site-specific and generally lower.

There are a total of 1220 high-capacity (IDNR SWWF, 2023) wells in the study area at 375 unique facilities. In 2023, there were 229 active facilities that utilized 780 wells to extract nearly 30 billion gallons of groundwater from aquifers.

There are several industrial manufacturers in the study area that use high-capacity wells such as Elanco US, Novelis Corp., Danisco USA, and Tagleef Industries. More than 50 public utilities have high-capacity groundwater wells including Indiana American Water, Vincennes, Petersburg, Greencastle, Princeton, Eastern Heights, Brazil, Washington, and many others. There are also over 125 agriculture operations with high-capacity irrigation wells, along with several mines and energy production facilities that pump groundwater for use at their facilities.

The vast majority (744) of active high-capacity wells in the study area access unconsolidated sand and gravel aquifers, with only 34 listed as being finished in bedrock of Mississippian age (Figure 34). The handful of high-capacity bedrock wells in the study area are often associated with quarrying operations and have an average depth of around 140 feet and an average pump capacity of approximately 130 GPM.

High-capacity unconsolidated wells in the study area (Figure 34) share a similar distribution pattern to domestic unconsolidated wells, primarily being located along major river valleys and accessing associated alluvium and outwash deposits (Figure 3, Figure 35). These wells have an average depth of around 70 feet and pump capacity of nearly 800 GPM, but many of the largest wells can pump more than 1000 GPM. There are portions of these river valleys, especially along the Wabash River, where aquifer yields are mapped as being greater than 1500 GPM (Regional Aquifer Yield Map, Figure 35). However, the majority of the study area has a mapped aquifer yield of 10 GPM or less (see areas of dry holes and bucket wells in Figure 36). There are only two facilities in the Patoka River valley with high-capacity wells - a golf course and a small public utility.

Recent mapping near Jasper identifies more than 150 feet of glacial-lake and ice-marginal sediment filling a buried ancestral valley of the East Fork White River (Antinao et al., 2025). The sequence includes fine-grained lake deposits interbedded with deltaic sands, illustrating that sediment thickness alone does not indicate a uniformly productive aquifer. Groundwater yield and storage depend on the thickness, extent, connectivity, and hydraulic properties of the sand and gravel intervals within the larger sediment package. Site-specific subsurface information is therefore needed before buried-valley deposits can be interpreted as a high-capacity groundwater source.

Water availability is inherently linked to the dynamics of aquifer recharge and storage, particularly as it relates to seasonal fluctuations. Drawing water from groundwater storage to augment water availability during low-flow scenarios is not always feasible. While sediment deposits near river corridors in southern Indiana are characterized by high transmissivity aquifers such as outwash and alluvial deposits, significant flow rates are largely restricted to these formations. Other formations, like bedrock, typically exhibit minimal groundwater transmission and inadequate storage properties. Therefore, water withdrawals for public supplies and

irrigation are mostly confined to outwash and alluvium close to streams. However, focusing the majority of pumping in these regions presents the danger of risking stream depletion.

Expected residential well yields

Domestic-well records confirm a sharp contrast between comparatively shallow wells completed in valley outwash or other coarse-grained deposits and lower-yielding wells completed in upland deposits or bedrock.

There are currently estimated to be around 17,000 domestic residential wells within the study area that serve as the primary water source for thousands of self-supplied residents. More than 75% of these wells are finished in bedrock (IDNR Water Well Database), with Mississippian-aged carbonate and Pennsylvanian-aged sandstone units most often utilized as bedrock aquifers (see Figure 33). Bedrock wells with pump test data generally have a low-yield of ≤ 10 GPM, making them suitable only for domestic use. These wells reach bedrock at around 160 feet of depth on average. Many of the bedrock wells do not have pump test data, and large areas are known to have dry bedrock wells that do not produce any water (Figure 36).

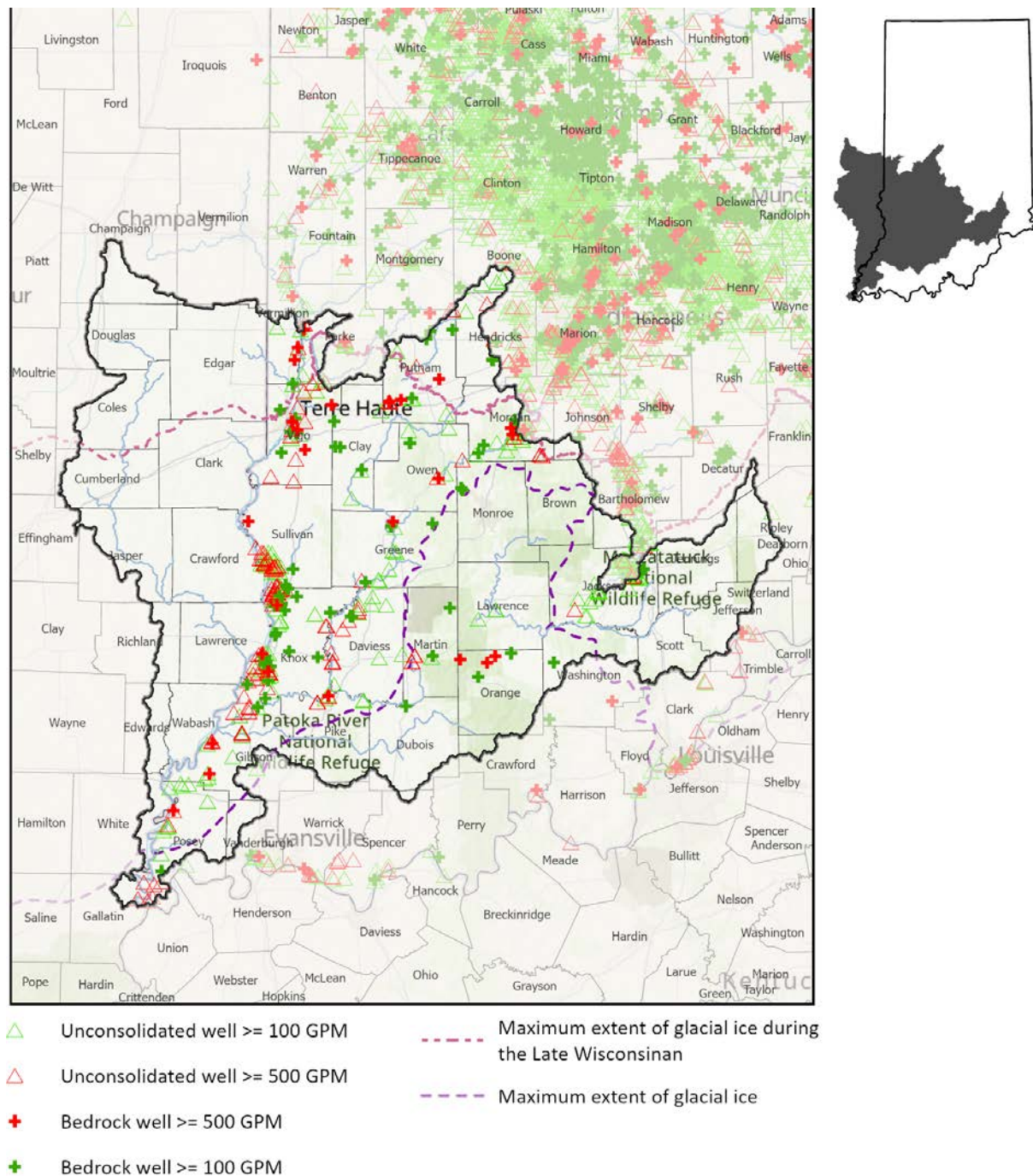


Figure 34. High-capacity wells extract from unconsolidated and bedrock aquifers, with yields typically less than 500 GPM unless located in near-river glacial outwash aquifers. Data are from the IDNR 2023 Significant Water Withdrawal Facility (SWWF) Database and the IDNR water well record database. Map format and symbology are based on Bayless et al., 2017, for ease of comparison with their Figure 5K (which presents these data for the entire state of Indiana).

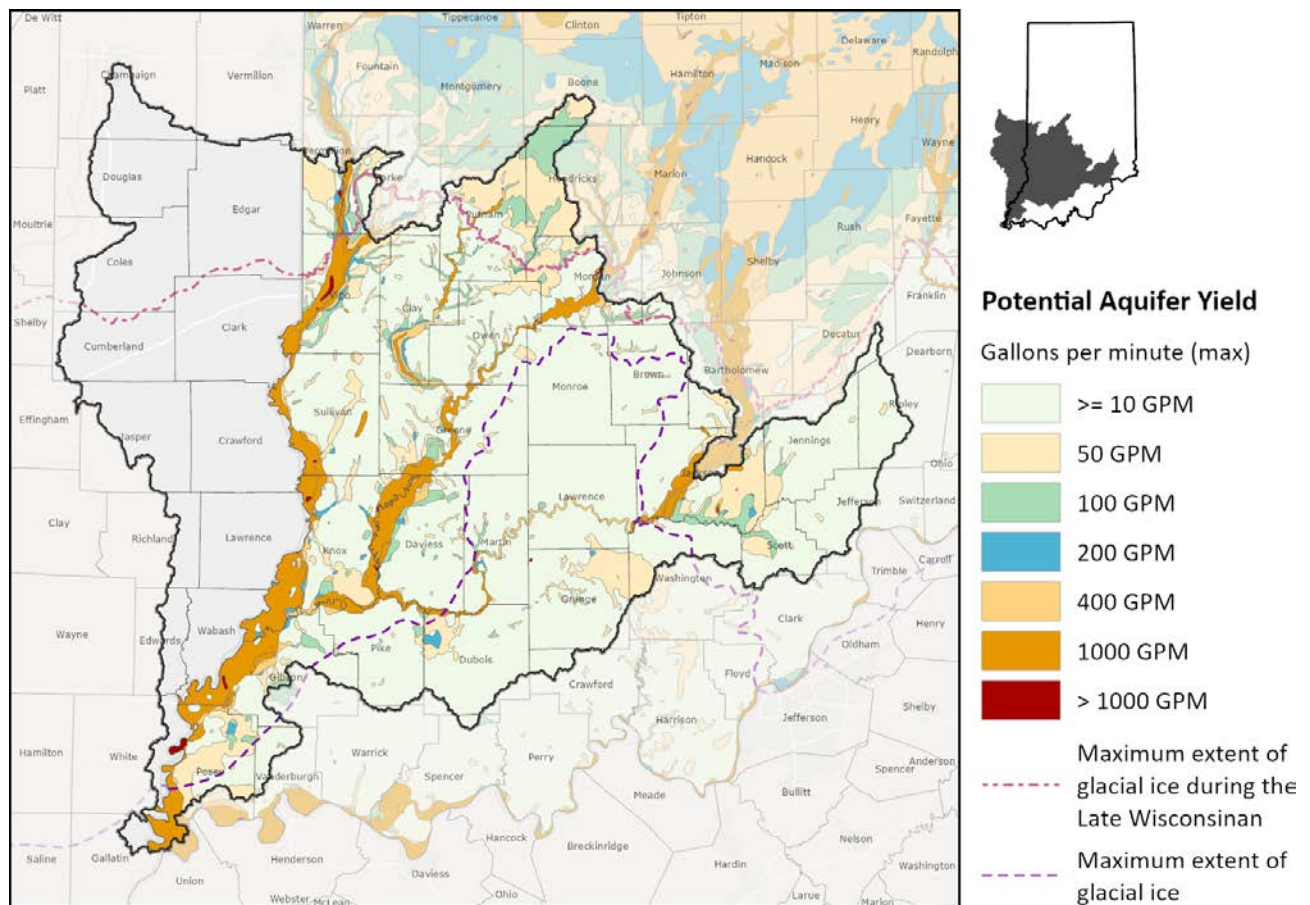


Figure 35. Map showing generalized potential groundwater aquifer yields in gallons per minute. The mapping does not distinguish between unconsolidated (e.g., sand and gravel) aquifers and bedrock aquifers. Much of Southwest Indiana is south of the glaciated portion of the state, and is characterized by shallow bedrock with thin soil cover. These areas (light green on the map) are difficult to reliably obtain self-supplied water from onsite wells. Even if successful, most yields are less than 10 GPM. Much higher yields can be found in the near-river-corridor alluvium and outwash deposits, where yields from 100-500 GPM can be obtained. This map is a new compilation of data and map sources (Governor's Water Resource Study Commission, 1980; IDNR, 2011a, 2011b; this study).

The majority of the study area lies south of the most recent glacial boundary, meaning that unlike much of Indiana, many parts of southwestern Indiana do not have extensive deposits of unconsolidated material to serve as potential aquifers. The exception to this is along the major river valleys where glacial outwash and alluvial deposits can contain water-bearing sediment suitable for supporting groundwater extraction. The IDNR Water Well Database lists over 3,000 unconsolidated domestic wells in the study area, and those with pump test data have an average pump rate of around 20 GPM and an average depth of 75 feet. Unconsolidated aquifers are most commonly found in the Wabash, East Fork White, and White River valleys, though parts of the latter two lack productive unconsolidated wells where water is drained away from the surface by sinkholes and carbonate bedrock aquifers.

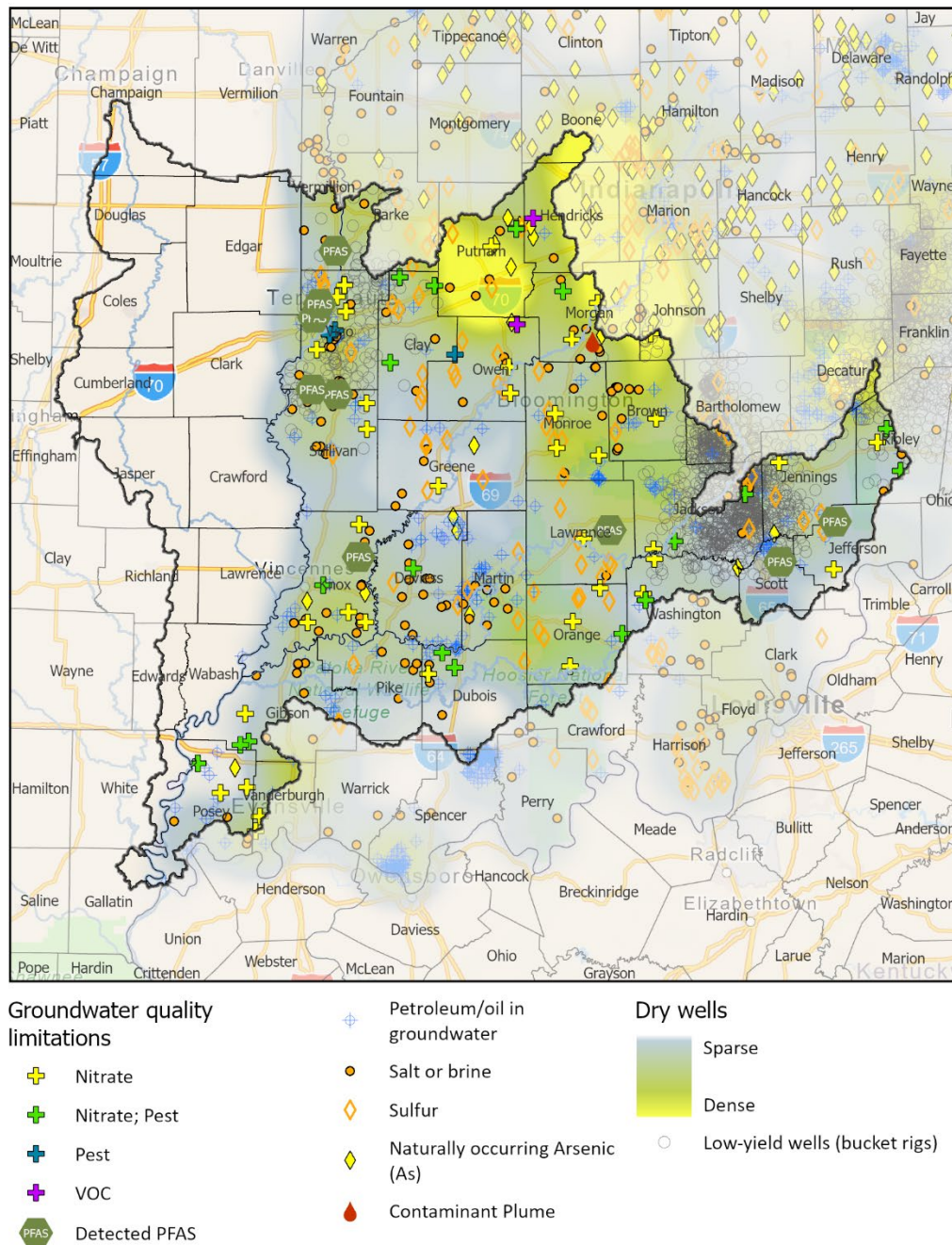


Figure 36. Shown on this map are locations of shallow low-productivity wells (“bucket rig wells” used to collect groundwater from low-yielding aquifers and store it for later use) and locations where dry holes (well attempts that did not encounter water) were recorded in water well records. Also shown are groundwater-quality limitations to obtaining potable water from aquifers in the Southwest Indiana region.

Water Sources and Trends

Historical trends in precipitation, streamflow, groundwater levels, and drought indicators help place current demand and future model results in context.

The Indiana Water Cycle

Previous work in Indiana (Widhalm et al., 2018; and Hamlet et al., 2019) has noted increasing statewide trends in precipitation, temperature, growing season, and snow cover from 1900 to (near) present (Figure 37). Ford et al. (2021) note trends in the standardized precipitation index (SPI) from 1951 to 2019 for the Midwest U.S. Purdue University (Profs. Cherkauer and Bowling) have tracked increasing and decreasing long-term trends in surface and groundwater levels (<https://www.agry.purdue.edu/indiana-water>).

Water resources are affected by seasonality, especially in a state like Indiana that experiences four distinct seasons. During dry conditions, high water-use demand for a number of water sectors could be met with declining aquifer levels responding to an insufficient amount of groundwater recharge.

The north-to-south precipitation gradient has been intensifying in recent years, with precipitation increases concentrated in southern and central Indiana (Figure 37). The pattern of increasing stream flows and groundwater levels from southwest to northeast in the state is a common pattern in many of the trends, likely a result of increasing precipitation along the Ohio River Valley. More about these trends will be presented later in the report.

Those familiar with the concept of water balance usually think of the natural water cycle; however, the volume of water (pools) and how it moves (fluxes) is much more complex (see: water cycle diagram from the U.S. Geological Survey at <https://water.usgs.gov/vizlab/water-cycle/index.html>).

Table 14. Indiana Temperature Trends (1960 to 2016).
Source: NOAA Climate at a Glance Database.

Variable	Winter	Spring	Summer	Fall	Annual
Temp max	0.5°F	0.6°F	0.1°F	0.2°F	0.3°F
Temp average	0.7°F	0.5°F	0.3°F	0.2°F	0.4°F
Temp min	0.8°F	0.5°F	0.5°F	0.3°F	0.5°F

Units = °F per decade

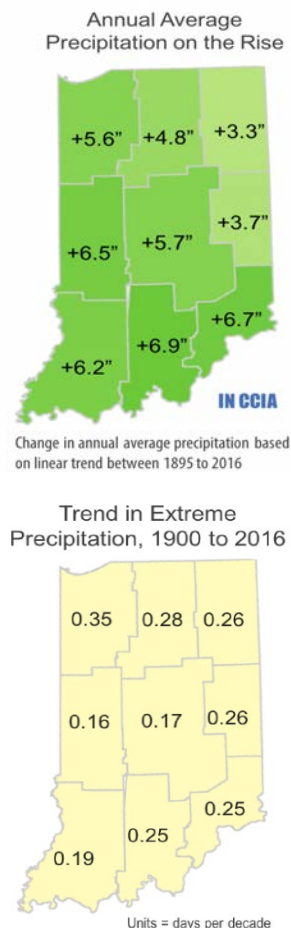


Figure 37. Indiana has experienced widespread increases in annual precipitation since 1895 (top), accompanied by an increasing frequency of extreme precipitation events (bottom) across all climate divisions, indicating both wetter conditions and more intense rainfall events over time (Widhalm et al., 2018).

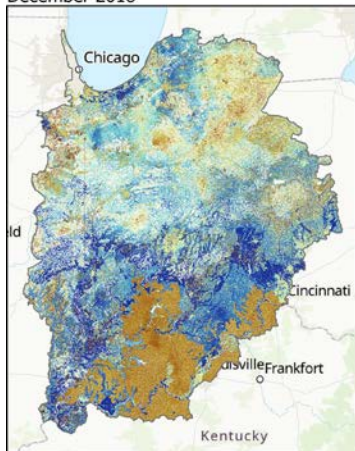
Indiana is experiencing increasing temperatures, including warmer nighttime lows (Figure 38 shows an example of how annual groundwater recharge is distributed through the seasons in the state, with Winter (December panel) and Spring (March panel) showing the highest rates of net infiltration. The geologic materials and land uses (such as urban impervious surfaces) ultimately control rates of infiltration. Near-surface glacial till (i.e., fine-grained) deposits are more resistant to water migration into the subsurface than coarser grained deposits such as alluvium (river sediment) and glacial outwash deposits. Summer (July panel) and Fall (October panel) show that virtually no potential aquifer recharge is received in many areas of the state, including the Southwest Indiana region.

). Drought risk reflects the combination of low precipitation, high temperature, and elevated evaporative demand, which simultaneously affect soil moisture, streamflow, aquifer recharge, reservoir storage, and water use.

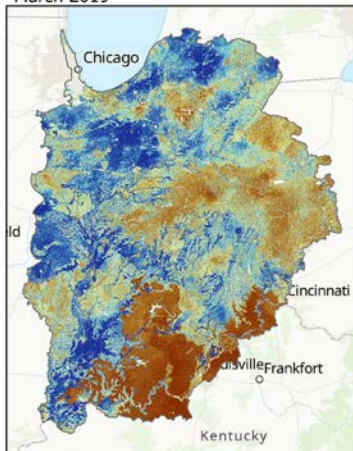
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Stored groundwater is responsible, therefore, for groundwater baseflow contributions in the Summer and Fall for many stream and river systems in the state.

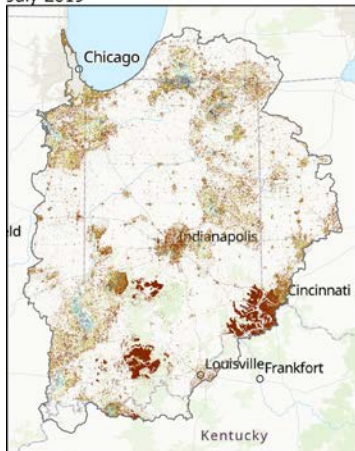
December 2018



March 2019



July 2019



October 2019

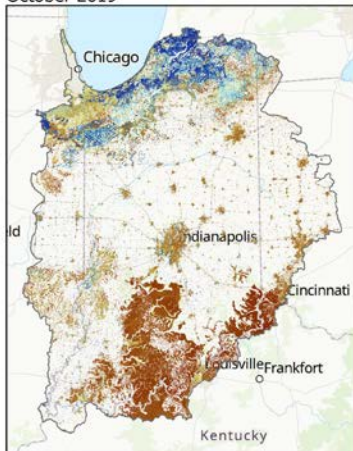
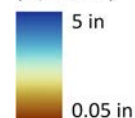


Figure 38. Monthly potential groundwater recharge (net infiltration, inches/month) snapshots for four months (Winter of 2018/2019 to Fall of 2019). These maps, all scaled across the same range for comparison, show the dynamic seasonal water cycle in the Midwest U.S. (Letsinger et al., 2021).

NOTE: the color ramp range starts at 0.05 in/month instead of zero (which is white or transparent on these maps), so that the non-zero recharge rates can be seen on the Summer (July) and fall (October) maps.

Potential groundwater recharge (in/month)



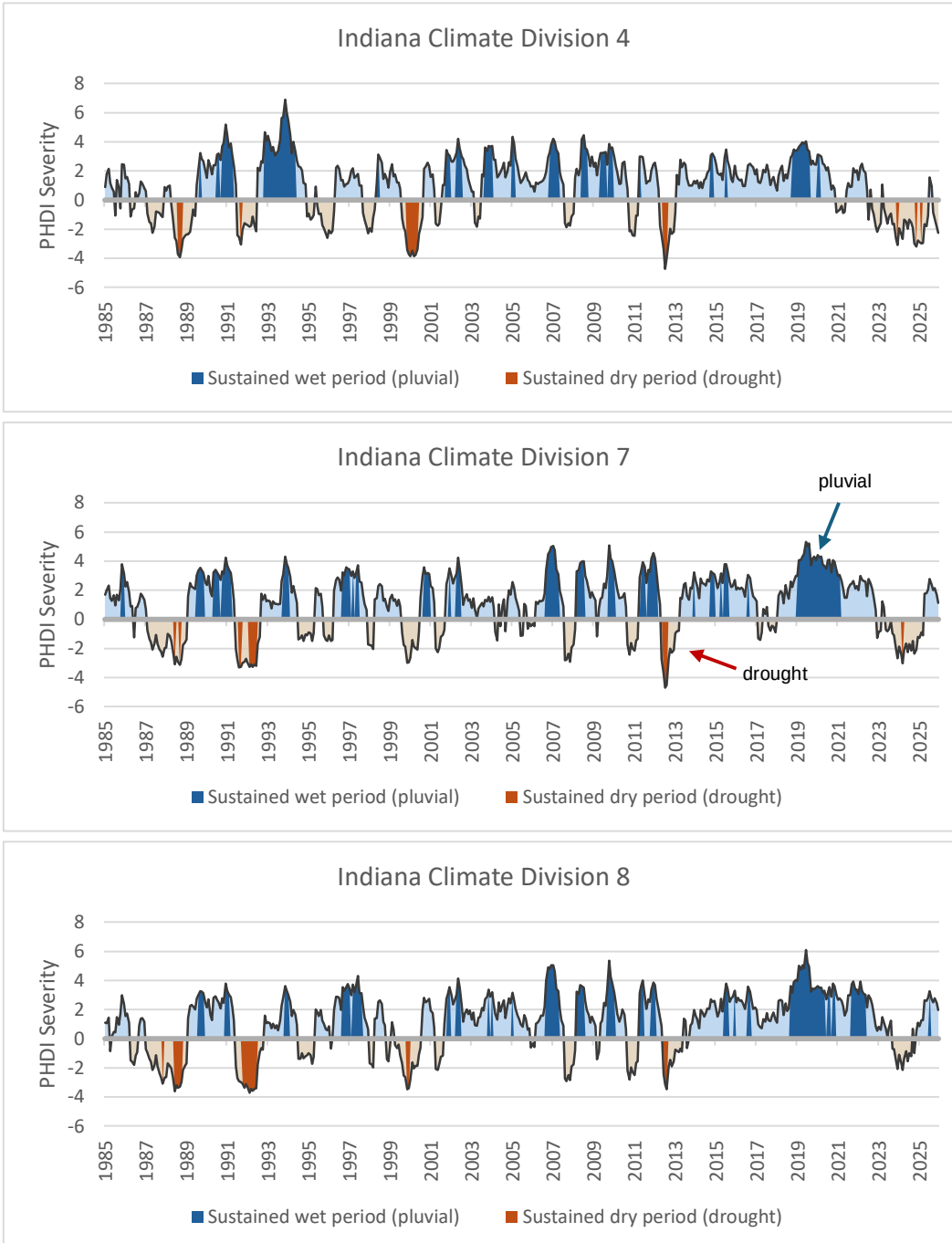


Figure 39. Graphs for three Indiana climate divisions (4, 7, and 8, see index map) showing droughts (deep red) and pluvials (dark blue) in the study area from 1985 through 2025. Droughts are sustained dry periods, whereas pluvials are sustained wet periods. There are regional differences for severity and duration of extreme climate conditions in the state. These differences also affect water use and water availability. No one event will be recorded the same way in every stream hydrograph in a region this extensive. PHDI means Palmer Hydrological Drought Index.

Drought and wet conditions are defined as sustained episodes rather than as isolated years. The Palmer Hydrological Drought Index (PHDI) reflects this accumulated moisture condition: negative values indicate dry conditions, whereas positive values indicate wet conditions. Figure 39 shows that Indiana experienced several recognizable statewide droughts and pluvials between 1985 and 2025, but their timing, duration, and severity differed among the three climate divisions that overlap the study area. For example, the 2012 drought is visible in all three records, but other dry and wet periods were more pronounced or persisted longer in one part of the region than another.

These differences are important in a study area that spans several large drainage systems. A drought considered the “drought of record” in one location may not be the most severe event in another, even under the same general regional climate. Local precipitation, basin geology, groundwater storage, reservoir operations, and upstream water management further influence how a climate event appears in an individual stream hydrograph. The study therefore does not treat one historical drought as a universal condition for every subbasin. Instead, water demand and availability are evaluated across seasons and multiple historical and future periods, recognizing that clusters of wetter and drier conditions will continue to occur.

Annual and Seasonal Hydrologic Trends

The hydrology of the state is tied closely to the geology of the state, so the glacial maximum boundary (see Figure 3) is an important physiographic marker of a change in natural baseflow and therefore water availability. North of this boundary, aquifers derived from glacial material deposits are common. Southwest Indiana largely lies south of the boundary; where bedrock is very shallow, groundwater resources are limited. The north-to-south precipitation gradient has been intensifying in recent years, with precipitation increases concentrated in south and central Indiana.

Streamflow Trends

There is a pattern of increasing stream flows and groundwater levels from southwest to northeast in the state that is likely a result of increasing precipitation trends along the Ohio River Valley. Not all streams and rivers in the state are experiencing increasing flow, although all of the streams in the Southwest region are. Figure 40 shows the results of a Mann-Kendall trend analysis of streamflow at 12 USGS streamgages with complete stream (discharge, or streamflow) hydrograph datasets for the 30-year period between Dec 1, 1991 – Nov 30, 2021. All streams exhibited an increasing trend in river discharge during that period. Increases were higher in Winter/Spring (especially March), enough to dominate the annual trend. Summer/Fall streamflow is not significantly increasing or decreasing.

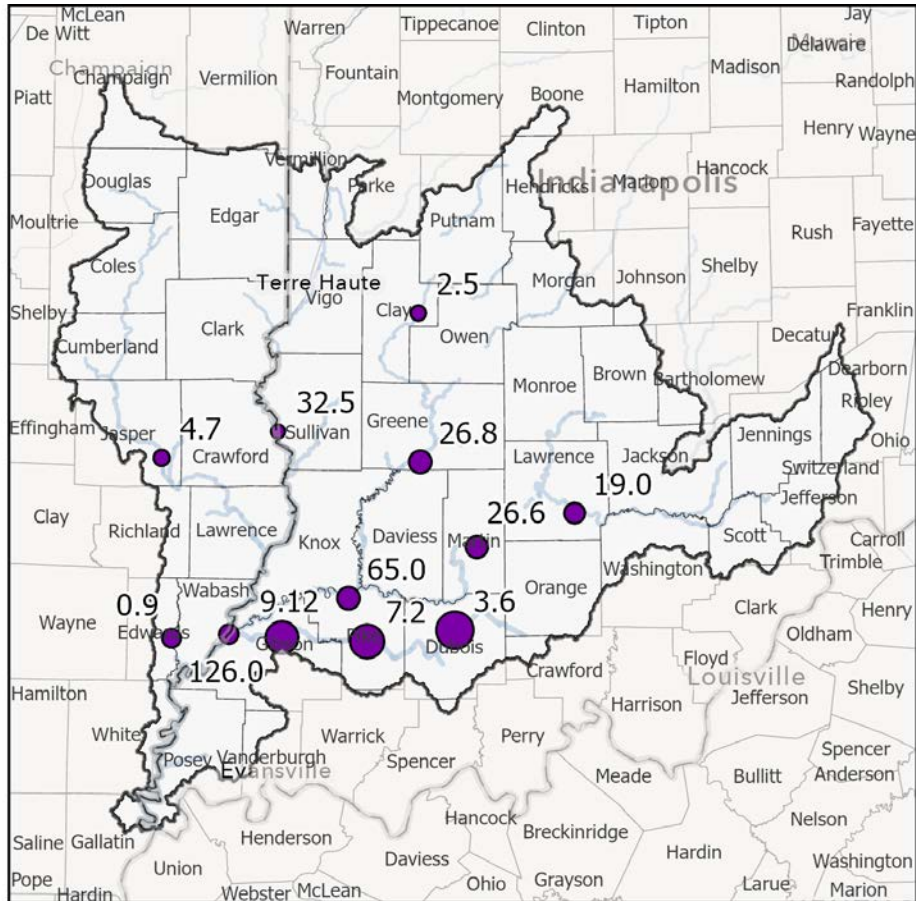


Figure 40. Mann-Kendall trend analysis of stream discharge hydrographs in the study area. Period of record: Dec 1, 1991 – Nov 30, 2021. Twelve (12) gages have full data; all exhibit an increasing trend in river discharge. Winter/Spring is responsible for trend (especially March). Summer/Fall is not significantly increasing or decreasing.

Instream Flows

Healthy ecosystems require minimum amounts of water to thrive. The amount of water for these uses is referred to as minimum “instream flows” (see sidebar).

Although there are recommendations for minimum instream flows by the IDNR Water Shortage Plan (i.e., the 7Q10 statistic; IDNR, 2015, Section VII. B1, B2) to maintain ecological stream functions, assessment of excess availability of water is not limited by any current regulatory statute. In this study, following the practice used in the Central Indiana Water Study (IFA, 2021; Phase III: Water Availability, Chapter 2, Section 2.9), the annual Q90 is used as a default value for instream flow in the Winter and Spring, and the 7Q10 is used in the seasonally dry Summer and Fall (using 1992-2022 streamflow data; Blum et al., 2019). Excess availability is calculated only after these flows are set aside, and should regulatory guidance increase the instream flow requirements, there would be a commensurate decrease in calculated excess water availability.

Low-flow conditions are less severe and less frequent in recent years than in the past, reflecting runoff and baseflow from upstream catchments. The increases in streamflow and some groundwater levels are widespread throughout the region. Previous work (Letsinger et al., 2021a) noted a shift in precipitation and other climate variables since 2000 in Indiana. Although the increase in Winter and Spring stream flows is likely attributable to changes in climate patterns, the increase in Summer and Fall low-flows in several drainage networks in Southwestern Indiana can be attributed to reservoir releases that maintain low flows. Further, in the mining regions of Southwest Indiana, there are elevated baseflows that result from extended drainage from mine spoil and gob piles whose secondary porosity contains a lot of water storage and acts as an artificial aquifer.

Given the fluctuations in stream flows in the region with commensurate changes in what is considered to be “low flow,” it is important that state and federal agencies establish consistent methodologies or guidance for instream flows. The reliance on low-flow metrics for environmental flows is not related to specific instream ecological or habitat needs; indeed, the low-flow metrics change along with whatever baseline time period is used in the calculations.

It is recommended that IDNR regularly update these metrics, especially in the face of changing climate and hydrological patterns. This would ensure that water resource management remains adaptive and responsive to current and future challenges.

Several studies and examples of alternative approaches can be found in Hersh, 2007; Poff et al. (1997, 2013, 2018), Acreman et al. (2014), Acreman (2016), Arthington et al. (2018); and the Texas SB3 program (<https://www.twdb.texas.gov/surfacewater/flows/environmental/index.asp> and FAQs here: <https://www.twdb.texas.gov/surfacewater/flows/faqs/index.asp>).

Instream Flows

A minimum amount of water flow is required in streams and rivers to support aquatic life and preserve water quality. There are two main statistical metrics for determining how much flow is necessary to accomplish this:

7Q10

7Q10 is defined as the lowest 7-day average flow in a stream that occurs once every ten years. The Indiana Department of Natural Resources recommends this metric as the minimum standard to maintain during low-flow periods through water use reductions (IDNR, 2015.)

Q90

Q90 is the minimum amount of flow that is present 90% of the time in a given stream. In other words, flow levels should only be lower than the Q90 levels 10% of the time.

Both of these statistical metrics are based on the “normal” streamflow data to which discharges are compared (usually a 30-year period, see Blum et al., 2019). The flow volumes required to achieve these standards will vary greatly depending on the size of the stream, the local geology, and the area of the contributing watershed.

Stream Low-Flow Trends

The Patoka River at Jasper (USGS 03375500, Subbasin 1) provides clear evidence that reservoir operations have increased the minimum flows sustained during dry conditions (Table 15, Figure 41). Before Patoka Lake was constructed, annual 7-day minimum flows occasionally reached zero, and the pre-dam 7Q10 for 1949–1978 was zero cubic foot per second (cfs; dry). During the regulated period from 1981–2010, the estimated 7Q10 increased to 19.3 cfs. A separate estimate was conducted for 2000–2024 and was 13.3 cfs, indicating that the substantial upward shift in the low-flow floor was already present before the principal post-2000 regional increase in low flows associated with wetter climatic conditions (Letsinger et al., 2021a). Although individual droughts and reservoir operating decisions continue to produce year-to-year variation, the Jasper record indicates that releases from Patoka Lake have helped prevent the extremely low or zero-flow conditions that occurred before regulation.

The other two gages provide supporting, although less isolated, evidence of this regional effect (Table 15). At the East Fork White River near Shoals, the 7Q10 increased from 217.6 cfs before operation of Monroe Lake to 377.2 cfs during 1968–1999 and 396.0 cfs during 2000–2024. This gage integrates a much larger contributing area, including wastewater returns associated with the Bloomington service area, so the observed change cannot be attributed solely to reservoir releases. The Wabash River at Mt. Carmel is at the confluence of four major river basins and the effects of numerous upstream reservoirs, further blurring the influence of any individual project. Nevertheless, its lower-tail estimate increased from 2,669 cfs during the matched pre-regulation period to 3,412 cfs during 1981–1999 and 3,654 cfs during 2000–2024. Together, these records suggest that reservoir operations have contributed to sustaining downstream low flows, while more recent climate-related increases may have provided an additional regional influence after 2000.

Table 15. Low-flow statistics for three streamgages in the study area that receive dam- or reservoir-operations releases in their upstream drainage system. The statistics record the effect of the dam on increasing dry season flows in these streams.

GAGE	DAM / REGULATION	PRE YEARS N=30	PRE 7Q10 (CFS)	POST YEARS N=30	POST 7Q10 (CFS)	CHANGE (CFS)	CHANGE (%)
03373500 EAST FORK WHITE RIVER NEAR SHOALS	Monroe Lake	1935– 1964	214.2	1968– 1997	397.4	183.2	85.5%
03375500 PATOKA RIVER AT JASPER	Patoka Lake	1949– 1978	0.0	1981– 2010	19.3	19.3	
03377500 WABASH RIVER AT MT. CARMEL, IL	Multiple upstream reservoirs	1949– 1978	2,554.5	1981– 2010	3,645.6	1,091.1	42.7%

The East Fork White River near Shoals integrates a large contributing area that includes the Monroe Lake drainage and wastewater returns associated with the Bloomington service area.

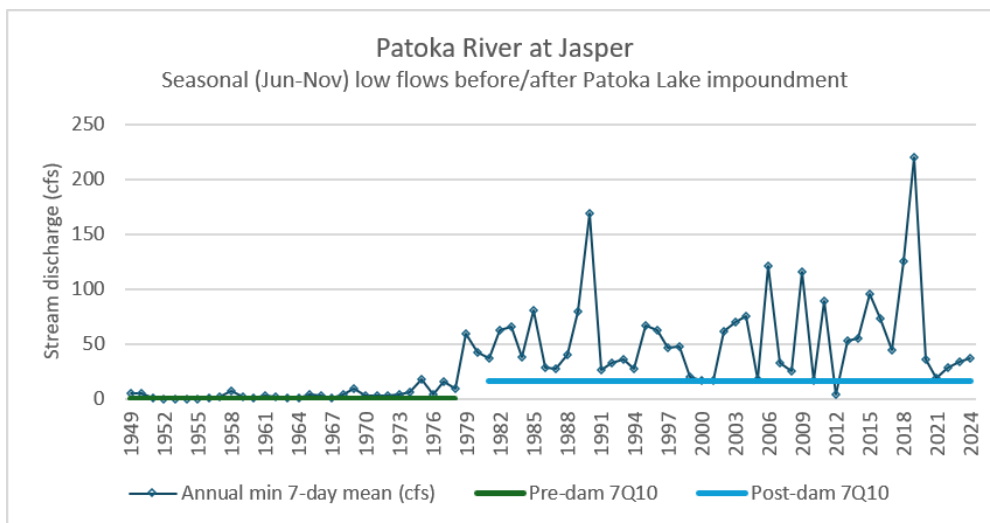


Figure 41. Line graph showing seasonal low flows and the 7Q10 low-flow statistic for the Patoka River at Jasper stream gage (USGS 03375500, Subbasin 1) before and after the dam installation, reservoir filling, and operations in 1978. The data show that the river was regularly dry in the June through November period prior to the installation and operation of the dam, which has a minimum release rate of 3.2 MGD.

Groundwater Level Trends

Figure 42 is a schematic cross-section showing subsurface flow paths for infiltrated water. Shallow aquifers are replenished by modern rainwater (or snowmelt) on short time scales (monthly/annual/decades) because rates of flow are faster and flow paths are usually shorter because the water remains close (in distance and depth) to where it originated. Regional flow can originate from much farther away, and water flowing to discharge areas (such as river valleys) often travels deeper in the subsurface and at slower flow rates (decades to centuries). <https://www.usgs.gov/special-topics/water-science-school/science/groundwater-photo-gallery>

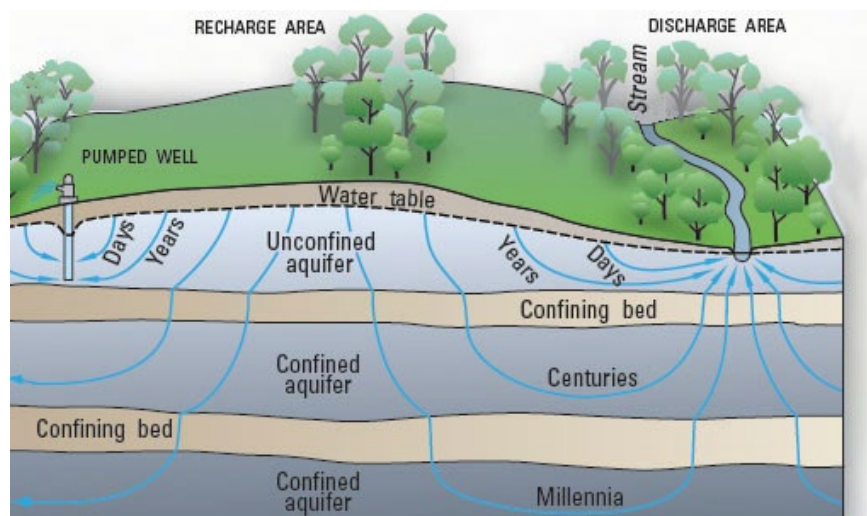


Figure 42. Schematic cross-section showing subsurface flow paths for infiltrated water. Shallow aquifers are replenished by modern rainwater (or snowmelt) on short time scales (monthly/annual/decades) because rates of flow are faster and flow paths are usually shorter as the water remains close (in distance and depth) to where it originated. Regional flow can originate from much farther away, and water flowing to discharge areas (such as river valleys) often travels deeper in the subsurface and at slower flow rates (decades to centuries). <https://www.usgs.gov/special-topics/water-science-school/science/groundwater-photo-gallery>

A statewide water-balance study (Letsinger et al., 2021a) showed that the statewide average annual groundwater recharge rate is about 6 inches per year, but it is not uniformly distributed – some areas receive very little recharge (1 inch per year in southern Indiana), while others receive more than 14 inches per year. Trend analyses (Letsinger et al., 2021a) show that recharge is increasing most in near-stream aquifers (e.g., outwash aquifers) as a result of intensified and episodic stormwater runoff.

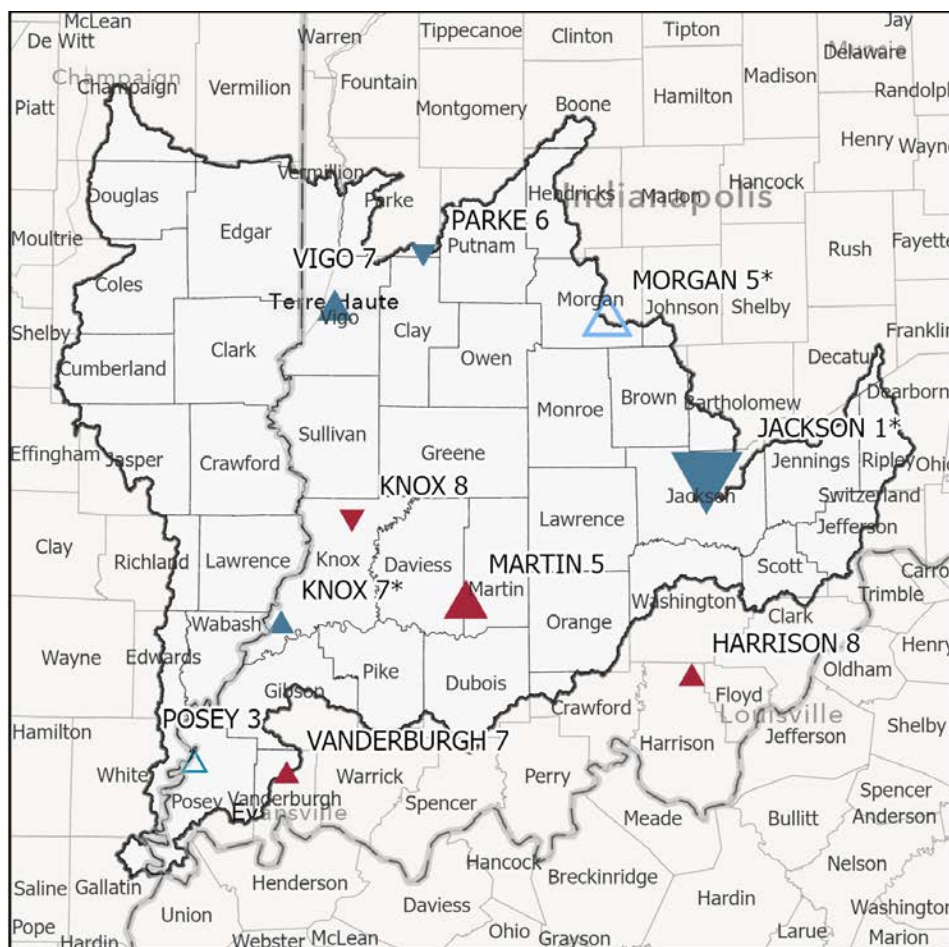
Over approximately the last two decades, groundwater recharge has shifted modestly from Spring toward Winter. The consequences vary by aquifer setting: near-river outwash and alluvial aquifers respond relatively quickly, while discontinuous upland sand-and-gravel lenses and bedrock systems may respond more slowly or show stronger seasonal declines.

Groundwater-level records in the study area generally show stable or rising annual conditions, but annual trends can mask dry-season declines. Seasonal declines are most consequential where high-capacity withdrawals, limited recharge, and lower-yielding aquifers coincide.

Groundwater-level trends for 9 observation wells (listed in Table 16) are shown in Figure 43. Seven of them show statistically significant trends – with most of the bedrock aquifers (shown in red) showing increasing water levels, and a more mixed picture of the wells developed in unconsolidated aquifers (shown in blue). The rising water tables are shown with the triangles pointing up. The falling water tables are showing with the triangles pointing down. The triangles pointing to the right do not have statistically significant trends upward or downward.

Table 16. List of USGS groundwater observation wells in the Southwest Indiana study area.

Site number	Well name	Longitude	Latitude	Subbasin
384949085251901	JEFFERSON 5 (JF 5)	-85.4213	38.83061	4
385601085365701	JENNINGS 3 (JN 3)	-85.6158	38.93367	4
383659086545901	MARTIN 5 (MT 5)	-86.9164	38.61644	10
383946086475701	MARTIN 7 (MT 7)	-86.7992	38.66278	10
384047087142702	DAVIESS 10 (DA 10)	-87.2408	38.67972	10
393619087043001	PARKE 6 (PA 6)	-87.075	39.60532	0
390758087363301	SULLIVAN 10 (SU 10)	-87.6092	39.13278	12
392820087242601	VIGO 7 (VI 7)	-87.4092	39.4717	12
384951087202501	KNOX 8 (KN 8)	-87.3403	38.83088	14
383247087361001	KNOX 7 (KN 7)	-87.6028	38.54644	17
380758087551001	POSEY 3 (PY 3)	-87.9198	38.13199	19
380626087344401	VANDEBURGH 7 (VA 7)	-87.5789	38.10727	20



Observation wells: Water table trend

Symbol size is proportional to magnitude of the trend

-  Well monitoring a sand and gravel aquifer
-  Well monitoring a bedrock aquifer
-  Increasing water table over time (statistically significant)
-  Decreasing water table over time (statistically significant)
-  Increasing water table over time (not significant)

STATION* indicates a short time series (less than 10 years)

Figure 43. Mann-Kendall trend analysis of groundwater levels in observation wells in the study area. Period of record varies by gage: generally 1985 or 1989 – 2024. Six (6) observation wells have full data. Three (3) observation wells have short records. Seven of them are showing statistically significant trends – with most of the bedrock aquifers (shown in red) showing increasing water levels, and a more mixed picture of the wells developed in unconsolidated aquifers (shown in blue). The rising water tables are shown with the triangles pointing up. The falling water tables are showing with the triangles pointing down. The triangles pointing to the right do not have statistically significant trends upward or downward. Unconsolidated aquifers show a mixture of increasing, decreasing, and stable water tables.

Water Availability Assessment

Water availability was evaluated using a regional water-balance framework designed to estimate the amount of water remaining within the stream system after accounting for major natural and human-influenced components of the water budget. This follows the conceptual framework developed for previous Indiana regional water studies (IFA [INTERA], 2021; Phase III: Water Availability, Chapter 2). The framework focuses on natural baseflow—the portion of streamflow supported by groundwater—as the natural hydrologic contribution to available water. This contribution was combined with anthropogenic (human) water use, reservoir operations (storage and releases), and environmental flow (habitat) requirements to estimate the amount of water available within each study subbasin (Figure 44).

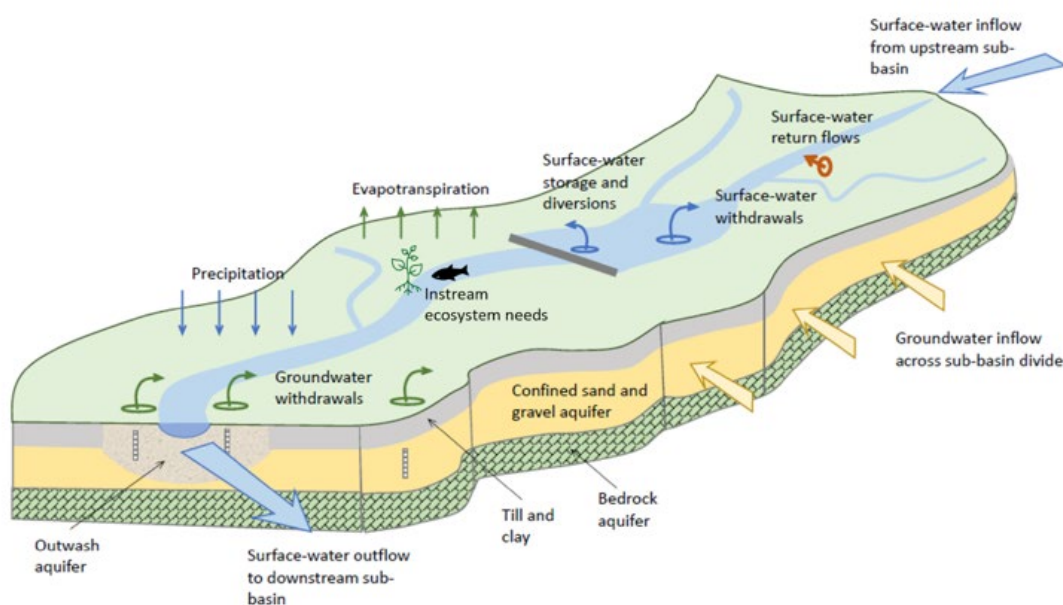


Figure 44. Schematic block diagram illustrating the water-availability framework used in the Indiana regional water studies. The focus is on natural baseflow—the portion of streamflow supported by groundwater—as the natural hydrologic contribution to available water. This water volume is combined with anthropogenic (human) water use, reservoir operations (storage and releases), and environmental flow (habitat) requirements to estimate the amount of water available within each study subbasin. Figure is modified from IFA [INTERA], 2021.

Two complementary methods were used to estimate natural baseflow. The primary method used a calibrated Soil-Water-Balance (SWB2, Westenbroek et al., 2018) model to simulate runoff and groundwater recharge, with simulated recharge routed to streams to estimate natural baseflow. An alternative approach used the USGS PART hydrograph-separation method (Rutledge, 1998) to estimate historical baseflow from measured streamflow and a Baseflow Index (BFI) relationship to estimate future baseflow (Appendix G). The SWB2 method is presented preferentially throughout the main report, while the PART/BFI method provides an alternative estimate for evaluating the sensitivity of water-availability results to uncertainty in groundwater contributions. Detailed descriptions of both approaches are provided in Appendix G.

Water availability was evaluated from both local and cumulative perspectives. Local excess water availability (“local water availability”) represents water generated or managed within an individual subbasin after accounting for local baseflow, net water use, reservoir operations, and the local instream-flow requirement.

Cumulative excess water availability (“cumulative water availability”) represents the corresponding water balance at the subbasin outlet after incorporating contributions and water-management effects from the connected upstream watershed. This distinction is particularly important along the White and Wabash Rivers, where much of the water available at downstream locations originates outside the local subbasin.

The framework is intended as a regional accounting tool rather than a complete representation of all groundwater–surface-water interactions. It assumes relatively direct and temporally instantaneous interactions among the represented water-budget components and focuses on groundwater contributing to the surface-water system; deeper or hydraulically disconnected groundwater systems are not explicitly represented. The framework also does not fully represent localized gaining and losing stream conditions or complex flow behavior associated with karst systems. These assumptions allow the major hydrologic and managed-water fluxes to be evaluated consistently across the study area, but the resulting availability estimates should be interpreted as regional planning estimates rather than precise predictions of water available at an individual location or time.

Water availability results were summarized using centered five-year averages to represent historical and future conditions while reducing the influence of individual anomalous years. Historical conditions are represented by the 2020 centered five-year period (2018–2022). Because the future climate simulation exhibits variability between wetter and drier periods, two future intervals are presented to illustrate the range of projected conditions rather than relying on a single end-of-simulation snapshot. The 2050 centered five-year period (2048–2052) represents a relatively wet future interval, whereas the 2070 centered five-year period (2068–2072) represents a relatively dry future interval. These periods are illustrative snapshots within the same future climate projection and should not be interpreted as predictions that specific wet or dry conditions will occur during those exact years.

Historical Water Availability

The historical assessment represents the baseline condition to compare to a model of future conditions in the study area. The results are intended to represent the amount of water remaining in each subbasin after accounting for existing water demands and instream-flow requirements included in the assessment. Instream-flow requirements represent minimum streamflow thresholds retained within the water-availability calculation to support existing stream uses and aquatic resources. Consistent with Indiana Department of Natural Resources (IDNR) low-flow guidance, seasonal thresholds were represented using the 90-percent flow-duration exceedance flow (Q90) during Winter and Spring and the 7-day, 10-year low flow (7Q10) during Summer and Fall (using 1993–2022 streamflow data; Blum et al., 2019). Additional information describing development and application of these low-flow metrics is provided in Appendix G. Historical water availability results are summarized in millions of gallons per day (MGD) using five-year centered averages to reduce the influence of individual wet and dry years and provide a representative characterization of recent historical conditions. Historical local water availability (2020) exhibits substantial spatial and seasonal variability across the Southwest Indiana study area (Table 17).

Table 17. Historical (2020) average annual and seasonal local excess water availability for the four Southwest Indiana study regions. Values are reported in million gallons per day (MGD) and represent a 5-year centered average.

	Average Local Excess Water Availability (MGD)				
Region	Annual	Winter	Spring	Summer	Fall
Patoka	37.9	17.0	121.4	8.1	4.4
East Fork White	328.1	270.7	838.6	193.3	5.1
White	350.7	316.6	949.2	122.8	9.6
Wabash	244.7	229.2	658.1	110.3	-21.9

Regional annual patterns indicate that the greatest local water availability occurs within the White River and East Fork White River systems (Figure 45, left panel; Table 17). These calculated balances reflect not only modeled natural baseflow but also anthropogenic return flows and reservoir operations. Many subbasins have positive annual local balances, but those values should not be interpreted as evidence of uniformly large natural groundwater storage or positive availability during every season. In contrast, the Patoka River watershed exhibits substantially lower local water availability, consistent with the small modeled baseflow contributions and limited high-capacity groundwater development observed within much of the watershed.

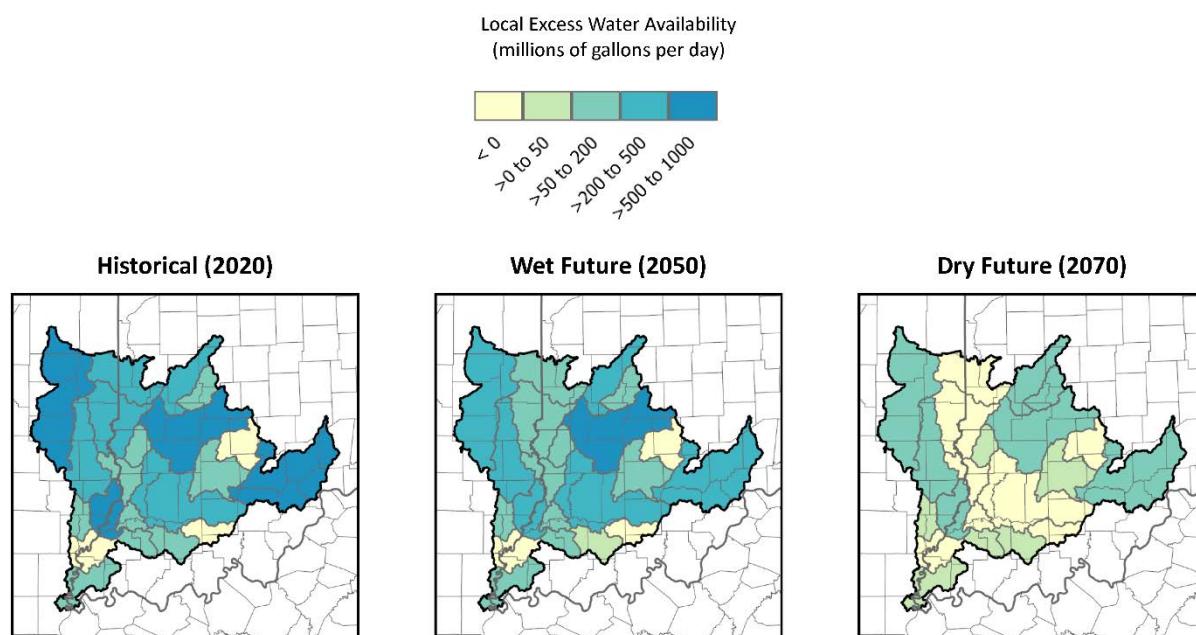


Figure 45. Maps of average annual local water availability (MGD) for Historical (2020), Wet Future (2050) scenario, Dry Future (2070) scenario for Southwest Indiana subbasins. Representative years denote a 5-year average centered on that year. Local water availability represents the balance within the individual subbasin without incorporating upstream balances. Cumulative water availability may be greater or smaller than local availability depending on whether the connected upstream watershed contributes a surplus or carries a deficit.

Seasonality reflects the variability of the prevailing Midwest U.S. climate on historical water availability throughout the study area (Table 17). All four major river basins show maximum availability during Spring, corresponding to increased runoff generation from storms, groundwater recharge, and streamflow contributions following Winter precipitation. In contrast, Fall represents the period of greatest hydrologic scarcity, with water deficits in several subbasins. This seasonal pattern highlights the importance of the timing of groundwater recharge and demonstrates that annual water availability as a single metric may not fully capture periods of greatest water vulnerability.

As mentioned above, Fall is traditionally the season with lowest flows in Southwest Indiana streams and rivers. Accordingly, historical Fall local water availability is negative (in deficit) for the Wabash River region on average (Table 18), indicating that locally generated water within several Wabash subbasins is insufficient to meet the amount of water allocated for habitat needs (instream flow requirement) during this season. This deficit primarily reflects locally generated baseflow falling below minimum habitat flow requirements during Fall, although negative net returns further reduce local availability at several locations. For example, at Wabash River at Terre Haute (Subbasin 0, 03341500), Riverton (Subbasin 12, 03342000), and Vincennes (Subbasin 14, 03343010), local baseflow averaged approximately 78, 90, and 64 MGD, respectively, compared with local instream-flow requirements of approximately 138, 177, and 213 MGD (Table 18). Negative net returns (i.e., more pumping than water returned to the river) further reduced Fall local availability at these locations, particularly at Wabash River at Terre Haute, as well as downstream Wabash River Mt. Carmel, IL (Subbasin 17, 03377500) and New Harmony (Subbasin 19, 03378500).

Importantly, negative local availability does not mean that the Wabash River mainstem itself lacks available water. Local availability represents only the incremental contribution generated within an individual subbasin, whereas cumulative availability incorporates water contributed from the entire upstream drainage network. Accordingly, cumulative Fall water availability remains strongly positive throughout the Wabash River corridor (Table 18) because substantial upstream contributions (inflows) from the greater Wabash Basin continued to sustain streamflow. This contrast illustrates that low historical Fall local water availability within the Wabash River corridor primarily reflects local water limitations rather than a shortage of water conveyed through the regional river network.

Table 18. Historical Fall (2020) local and cumulative excess water availability and contributing water-balance components for the 21 Southwest Indiana study subbasins. Values are reported in millions of gallons per day (MGD) and represent a centered five-year average.

Subbasin ID	Gage ID	Historical Fall (2020, 5-Year Centered Average) values in million gallons per day (MGD)					
		Net Returns	Reservoir Storage	Local Natural Baseflow	Local Instream Flow	Local Excess Water Availability	Cumulative Excess Water Availability
1	03375500	-7.5	28.4	0.8	9.1	12.7	12.7
2	03376300	3.1	0.0	2.4	5.2	0.3	13.0
3	03376500	6.1	0.0	2.0	7.9	0.3	13.3
4	03371500	-3.8	0.0	74.7	53.7	17.2	140.2
5	03372500	-15.2	-30.2	0.7	31.2	-76.0	-76.0
6	03373500	60.4	0.0	19.9	6.2	74.1	122.7
7	03359000	0.1	10.5	9.8	9.7	10.7	10.7
8	03360000	1.6	0.0	62.8	12.2	52.2	62.9
9	03360500	-1.0	0.0	194.4	81.6	111.8	193.9
10	03374000	-41.8	0.0	67.2	164.1	-138.7	177.9
11	03374100	3.1	0.0	94.1	85.1	12.1	189.2
0	03341500	-12.9	0.0	77.8	138.3	-73.4	647.7
12	03342000	-4.3	0.0	90.3	177.2	-91.2	556.5
13	03342500	0.9	0.0	4.1	2.7	2.4	2.4
14	03343010	-3.6	0.0	63.8	213.3	-153.1	405.7
15	03345500	1.4	0.0	122.4	14.3	109.6	109.6
16	03346500	-1.7	0.0	68.6	11.1	55.8	165.3
17	03377500	-16.5	0.0	280.8	162.9	101.4	873.4
18	03378000	0.8	0.0	13.7	0.1	14.4	14.4
19	03378500	-33.1	0.0	27.9	165.3	-170.5	717.3
20	Lower Wabash	-5.7	0.0	30.0	38.7	-14.3	702.9

Headwater and smaller tributary systems exhibit little or no difference between local and cumulative availability. This can be seen in Table 18 above and Figure 46 below for Patoka River at Jasper (Subbasin 1, 03375500), Mill Creek near Manhattan (Subbasin 7, 03359000), and Busseron Creek near Carlisle (Subbasin 13, 03342500) where the numbers in the table and the blue (local availability) and purple (cumulative availability) bars in the figure are identical. Conversely, downstream locations along the mainstem White River and Wabash River systems commonly have much greater cumulative water availability because upstream inflows accumulate downstream contributing additional water volumes to locally generated baseflows (Figure 46, see Subbasin 17, 03377500, as an example).

Historical Annual Excess Water Availability

2020 conditions showing local (blue) and cumulative (purple) excess water availability

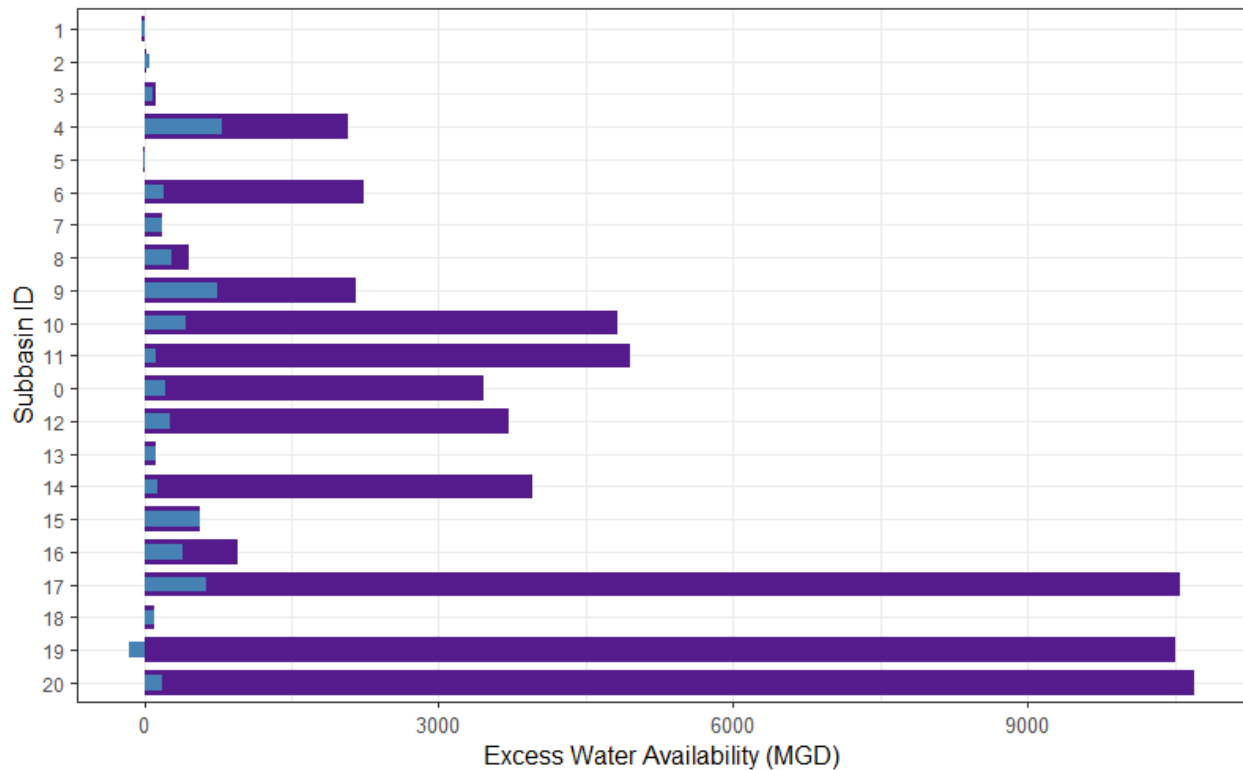


Figure 46. Comparison of local water availability and cumulative water availability for the 21 Southwest Indiana study subbasins under historical (5-year centered average 2020) conditions. Local water availability values (blue) are shown nested within cumulative water availability values (purple) to illustrate the relationship between locally generated water availability and the cumulative availability resulting from the upstream contributions through the watershed network. Values represent 5-year centered annual averages and are reported in million gallons per day (MGD).

Patoka River

The Patoka River watershed represents the most water-limited region within the study area, with substantially lower annual and seasonal local availability than the other major river systems. The comparatively small natural baseflow contributions within the Patoka River system provide limited natural resilience during seasonal low-flow conditions (Table 17, Table 18). This sensitivity is particularly evident during Fall, when locally generated baseflow is small relative to instream flow requirements for the three Patoka River subbasins. Managed water (reservoir releases) inputs partially offset these limitations: reservoir releases from Patoka Lake increase availability downstream at Jasper (Subbasin 1, 03375500), while positive net returns (i.e., more wastewater returns than withdrawals, see Appendix C) help maintain slightly positive local availability further downstream. Patoka River watershed availability is therefore strongly influenced by the timing of reservoir operations, which redistribute water and can substantially affect downstream availability during low-flow periods. During the historical (2020) Fall reporting period, reservoir releases increased local availability immediately downstream of Patoka Lake and propagated through the cumulative downstream water balance. The Patoka River system therefore illustrates how low natural baseflow conditions can magnify the importance of seasonal timing of managed reservoir releases and return flows to downstream water availability.

The comparatively low availability calculated for the Patoka River is consistent with both watershed characteristics and historical water-supply experience. The upper watershed is steep and heavily dissected, with shallow bedrock in some areas and slowly permeable soils that favor runoff over infiltration (Gray, 1963; Borries, 2008). Before Patoka Lake was constructed, summer low flows periodically made it difficult for Jasper to rely on the Patoka River alone, and releases from Beaver Lake were used to supplement the municipal supply (Borries, 2008). Patoka Lake therefore provides an essential managed-water buffer within a river system that historically had limited natural low-flow capacity.

East Fork White River

The East Fork White River generally exhibits relatively high local and cumulative availability, although the contributing components vary substantially among subbasins. The East Fork White River near Bedford subbasin (Subbasin 4, 03371500) exhibits one of the larger annual local-availability estimates in the study area (Figure 46). Williams Dam is located within this subbasin but is not explicitly represented as a reservoir-storage term. Consequently, the calculated balance should not be interpreted as a reconstruction of the regulated hydrograph, and comparisons with observed streamflow or gage-derived low-flow statistics should recognize the dam's influence.

Both natural hydrologic contributions and anthropogenic wastewater return flows provide available water within portions of the system. This influence is particularly evident in the East Fork White River near Shoals subbasin (Subbasin 6, 03373500), where positive net returns (i.e., more returns than withdrawals) averaged approximately 60 MGD during the historical Fall reporting period, compared with 20 MGD of locally generated baseflow. The return flows therefore represent a substantial component of the approximately 74 MGD of calculated Fall local availability in this subbasin.

Salt Creek (Subbasin 5, 03372500) below Lake Monroe (Bloomington, Indiana) represents an important contrast. During the historical Fall reporting period, estimated local baseflow at this gage averaged less than 1 MGD compared with an instream-flow requirement of approximately 31 MGD. Negative net returns (approximately -15 MGD, reflecting withdrawals for Bloomington's water supply) and net reservoir storage (approximately -30 MGD, a negative number representing water being stored rather than released downstream) further reduced the calculated balance, resulting in local water deficit of approximately -76 MGD. Interpretation of this subbasin's availability results requires caution, in part due to the combined effects of Lake Monroe reservoir operations and the cross-subbasin transfers of water associated with Bloomington Utilities (withdrawals from the reservoir returned outside of the subbasin). The scale of the analysis in this case separates two adjacent subbasins that drain to a common river system through two different tributary streams. An integrated analysis that combined those two tributaries into a single unit would reflect that the water management of those subbasins is coordinated by the Bloomington water utility. The East Fork White River system therefore demonstrates that regional water availability can reflect a combination of natural hydrologic contributions, upstream connectivity, and managed-water influences, and that individual availability estimates must be interpreted within the context of those influences.

White River

The White River provides a useful example of the importance of both watershed connectivity and managed-water inputs in sustaining downstream water availability. The three mainstem White River subbasins generally retain substantial cumulative availability because they integrate water contributed from the upstream drainage network from the greater Indianapolis region, even where locally generated availability becomes

constrained during seasonal low-flow conditions. This distinction is particularly evident during Fall in the White River at Petersburg (Subbasin 10, 03374000), where locally generated baseflow averaged approximately 67 MGD compared with a local instream-flow requirement of 164 MGD. Negative net returns (more water withdrawn than returned to the subbasin) of approximately –42 MGD further reduced the local balance, resulting in local deficit of approximately –139 MGD. However, the cumulative availability remained positive at approximately 178 MGD for the White River at Petersburg, which is just downstream of the convergence of the mainstem White and East Fork White River systems. These combined upstream contributions were sufficient to offset the calculated local Fall deficit and produce a positive cumulative balance (Table 18).

The cumulative water entering the Southwest Indiana study area through the White River includes substantial managed-water contributions from the Indianapolis metropolitan area. The Central Indiana Water Study identified wastewater returns and reservoir releases as important components of White River flow upstream of the study area at the Centerton gage (Central Indiana Water Study Subbasin 13, 03354000), which is upstream of Subbasin 9 (03360500, White River at Newberry) in this study. New work in this study included wastewater return estimates from the DigIndy Deep Tunnel Collector Project (Appendix D), which was completed in phases between 2017 and 2025.

Managed reservoir operations also influence availability within the Southwest Indiana portion of the White River basin, including seasonal storage and releases from four reservoirs in the Indianapolis region (Geist, Citizens, Morse, and Eagle Creek Reservoirs), and Cagles Mill Lake in Subbasin 7, 03359000). Thus, the difference between local and cumulative availability in the White River reflects not only natural upstream hydrologic contributions but also the accumulated effects of water use, return flows, and reservoir operations throughout the connected watershed.

Wabash River

The Wabash River is the principal integrating river system within the study area and provides the clearest example of the distinction between local and cumulative water availability (Figure 46). Although locally generated availability is limited in several Wabash subbasins, particularly during Fall, cumulative availability remains comparatively large because the mainstem integrates substantial upstream tributary inflows and managed-water contributions across a large drainage area. More than 90 percent of cumulative availability at several mainstem Wabash locations is attributable to water contributed from upstream. At several mainstem Wabash locations, only a small portion of cumulative availability is contributed by the local subbasin; most is inherited from the upstream watershed (Figure 46). Consequently, the relatively large cumulative availability along the Wabash should not be interpreted as an abundance of locally generated water. Instead, downstream availability is strongly dependent on hydrologic conditions, water use, return flows, reservoir operations, and other water-management decisions throughout the upstream watershed. This dependence is particularly important when evaluating the reliability of the Wabash River as a water source for large surface-water users, because changes occurring well upstream of an individual subbasin can propagate downstream and affect the amount and timing of water available within the study area.

Overall, historical conditions demonstrate four primary characteristics of water availability within Southwest Indiana:

- (1) availability is strongly seasonal: highest in the Spring and lowest in the Fall;
- (2) substantial regional differences reflect the combined influence of natural hydrology, watershed characteristics like geological materials or average slope gradients, the balance between water use and return flows, and reservoir operations, with the White River and East Fork White River generally exhibiting the greatest local availability and the Patoka River exhibiting the least;
- (3) managed-water components can materially alter local availability, with reservoir operations and net returns either increasing or decreasing the amount of water remaining available depending on location and season; and
- (4) watershed connectivity becomes increasingly important as drainage area increases, allowing upstream contributions to sustain substantial cumulative availability even where local availability is low.

These historical patterns provide the context for evaluating projected future water availability and identifying locations where additional demands may encounter limited water supplies under changing climate and water-use conditions.

Future Water Availability

Future Climate Representation

The future water availability analysis used daily precipitation and minimum and maximum temperature from the Norwegian Earth System Model (NorESM2-LM), the lower-resolution version of the Norwegian Earth System Model, under the SSP2-4.5 scenario (Seland et al., 2020; IPCC, 2021). Global climate models simulate how the atmosphere, oceans, and land interact over time; LOCA2 statistical downscaling translates those large-scale results into weather information at a scale useful for studying Indiana (Pierce et al., 2014, 2023). This model provided a continuous daily sequence of future weather through 2075.

One internally consistent model scenario was used instead of averaging daily weather outputs across several climate models. An ensemble average is useful for describing the “central tendency” across many projections, but averaging daily values can weaken or blur the individual wet and dry periods that matter for water planning. The selected model therefore represents one plausible future, not the full range of possible climate outcomes. Weather does not occur as a series of “average” days: heat, rainfall, drought, and soil moisture develop in sequences, and the timing of one event affects the consequences of the next. Preserving those sequences allows representation of prolonged dry periods, clusters of heavy rainfall, developing soil-water deficits, and their effects on seasonal groundwater recharge and stream baseflow. Maybe more importantly, seasonal transitions are simulated continuously – so that conditions in the Summer and Fall of one (modeled) year extend into the Winter and Spring of the next (modeled) year.

For Indiana, that future resembles an intensification of weather patterns residents, farmers, and water managers already recognize. NorESM2-LM projects greater seasonal contrast rather than a uniform increase or decrease in rainfall: Winter and Spring become wetter and more prone to heavy precipitation, saturated soils, and flooding, while Summer rainfall becomes more variable. Heavy downpours may still occur, but they are increasingly separated by longer dry spells and accompanied by higher temperatures and greater crop-

water demand. The practical result is a greater likelihood of rapid shifts from excessive spring moisture and delayed planting to Summer soil-moisture stress and agricultural drought. These types of seasonal changes have already been observed and documented in Indiana and the broader Midwest U.S. (Akinsanola et al., 2024; Bowling et al., 2018; Chen and Ford, 2023; Cherkauer et al., 2023; Indiana State Climate Office, 2025; Letsinger et al., 2021; NOAA, 2022; Widhalm et al., 2018).

In terms of a warming trajectory, NorESM2-LM simulates a long-term global temperature increase of approximately 2.2°C by the 2090s relative to the pre-industrial baseline. Given that today's actual temperatures have already risen by roughly 1.5°C above pre-industrial levels (NOAA, 2022), the model projects an additional net warming of approximately 0.7°C to 0.8°C across the coming decades. Within global climate frameworks, the SSP2-4.5 scenario is classified strictly as an intermediate emissions pathway. This intermediate warming occurs because global carbon dioxide emissions are not projected to undergo immediate reductions; instead, they hover near current levels until approximately 2050 before beginning a gradual decline, failing to reach net-zero by the end of the century.

NorESM2-LM is on the lower-sensitivity side of the CMIP6 model range, and SSP2-4.5 represents an intermediate emissions and warming pathway rather than either a minimal-change or worst-case scenario (Seland et al., 2020; IPCC, 2021). Together, they provide a moderate but meaningful “stress test” of how changing seasonal weather could affect water demand, soil moisture, recharge, and water availability through 2075. Population and land-use projections used elsewhere in the study were also based on SSP2, keeping the climate, demographic, and land-development assumptions within the same middle-of-the-road storyline. This does not predict exactly what Indiana’s future will be; it provides a physically and internally consistent future against which the region’s water systems can be evaluated. Therefore, this model was selected to reflect the hydrological regime in Indiana under climate stress, rather than select a model purely based on statistical criteria.

The continuous 2020–2075 simulation provides important context for the future periods evaluated in this study. The modeled climate does not progress smoothly from present conditions toward a single future state. Instead, seasonal cycles occur within longer clusters of relatively wet and dry years. Figure 47 shows this variability through projected temperature range and the difference between potential and actual evapotranspiration (PET–AET). Larger PET–AET values indicate periods when atmospheric demand for water exceeds the amount supplied through actual evapotranspiration, signaling greater moisture stress.

Figure 48 places the projected precipitation sequence alongside modeled irrigation demand. Irrigation demand generally increases during dry growing seasons and decreases during wetter periods, although the response also depends on antecedent soil moisture, temperature, land cover, and the timing of precipitation. Together, Figure 47 and Figure 48 illustrate why individual future years should not be interpreted as points along a simple linear trend.

The figures present Subbasin 12 (03342000) as an example of the variability contained within the continuous simulation. Conditions and event severity differ across the study area, just as historical droughts and pluvials have affected Indiana’s climate divisions differently (Figure 39). The purpose is therefore not to identify a single future “drought of record,” but to show the sequences of wet and dry conditions from which the contrasting 2050 and 2070 analysis periods were selected.

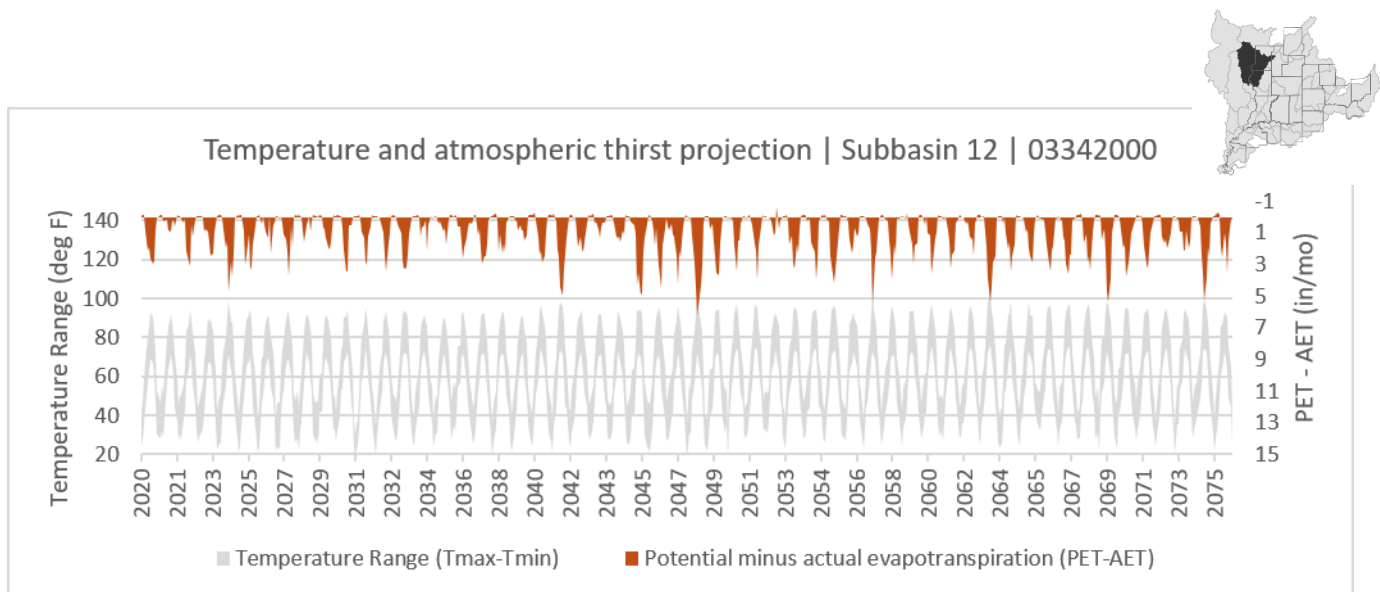


Figure 47. Projected monthly temperature range (Tmax–Tmin) and climatic water deficit (PET–AET) for Subbasin 12 (03342000) from 2020 through 2075. The projections use the LOCA2-downscaled NorESM2-LM SSP2-4.5 climate simulation as input to SWB2. Potential evapotranspiration (PET) was calculated in SWB2 using the temperature-based Hargreaves method; actual evapotranspiration (AET) represents the water transferred to the atmosphere under the modeled water and land-surface conditions. Larger PET–AET values indicate greater moisture stress. The recurring seasonal cycles and clusters of relatively wet and dry years demonstrate that the projected future is not a linear progression.

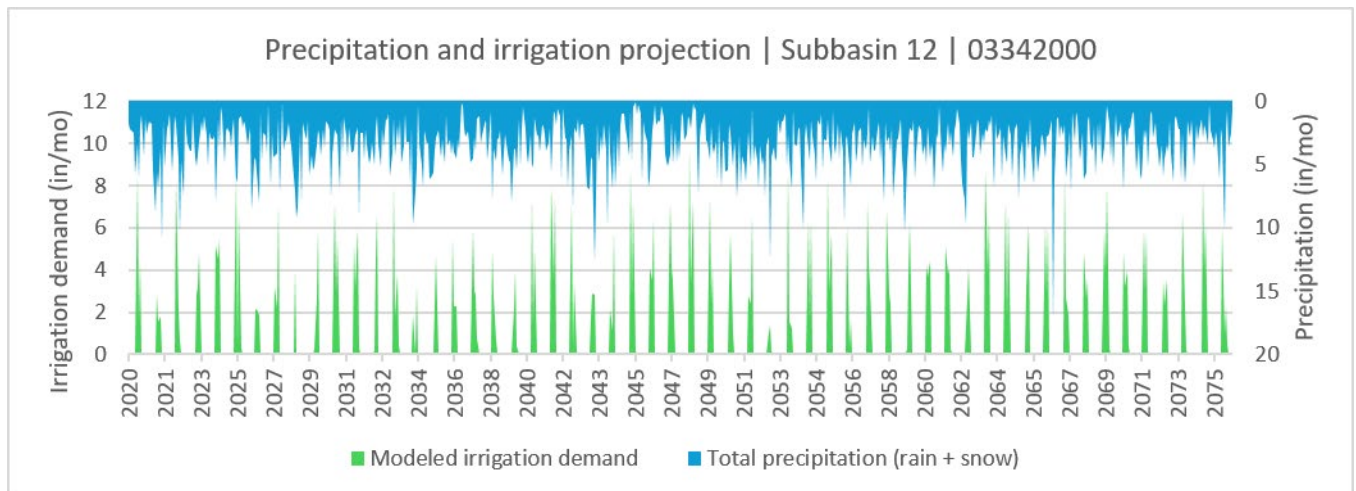


Figure 48. Projected monthly total precipitation and modeled irrigation demand for Subbasin 12 (03342000) from 2020 through 2075. Total precipitation includes rain and snow as interpreted by SWB2. Irrigation demand generally increases during dry growing seasons and decreases during wetter periods, but it also reflects temperature, antecedent soil moisture, land cover, and precipitation timing. The time series provides context for the contrasting 2050 and 2070 periods used in the future water-availability assessment.

Wet Future Example (2050) and Dry Future Example (2070)

Projected future water availability exhibits considerable variability through time. To illustrate this variability, results are presented for a relatively wet future period centered on 2050 (2048–2052) and a relatively dry future period centered on 2070 (2068–2072). Both periods are derived from the same NorESM2-LM SSP2-4.5 climate simulation and represent illustrative intervals within the modeled future sequence rather than predictions that specific wet or dry conditions will occur during those years.

Even during the relatively wet 2050 period, average annual local and cumulative availability are projected to remain below the historical 2020 baseline in all four river basins (Table 19). The magnitude of the difference varies among river systems, with the White and Wabash Rivers retaining comparatively large cumulative availability because of upstream contributions, while annual cumulative availability in the Patoka region is projected to be slightly negative. The 2070 interval represents a substantially drier portion of the same continuous climate simulation. In that period, average annual local availability is negative in the Patoka and Wabash regions, while East Fork White and White retain positive but greatly reduced local availability. Cumulative annual availability for the future dry period is also projected to remain positive in the larger river systems but is substantially reduced relative to historical.

The 2050 and 2070 panels of Figure 45 show the spatial distribution of projected annual local water availability. Figure 49 presents the corresponding annual cumulative water availability, while Figure 50 and Figure 51 show how cumulative availability varies by season.

Table 19. Average regional annual and Winter local and cumulative water availability for the historical 2020 period, relatively wet future 2050 period, and relatively dry future 2070 period. Both future periods are derived from the same NorESM2-LM SSP2-4.5 climate simulation. Values are reported in millions of gallons per day (MGD) and represent centered five-year averages.

Period	Region	Annual Local Availability (MGD)	Annual Cumulative Availability (MGD)	Winter Local Availability (MGD)	Winter Cumulative Availability (MGD)
Historical (2020)	Patoka	37.9	37.2	17.0	-27.8
Future Wet (2050)	Patoka	17.7	-3.5	38.4	31.5
Future Dry (2070)	Patoka	-7.6	-43.4	-14.1	-53.0
Historical (2020)	East Fork White	328.1	1439.2	270.7	1259.1
Future Wet (2050)	East Fork White	190.5	898.0	288.0	1354.3
Future Dry (2070)	East Fork White	64.9	288.4	14.2	214.9
Historical (2020)	White	350.7	2515.9	316.6	2159.5
Future Wet (2050)	White	243.6	1750.4	408.5	2581.0
Future Dry (2070)	White	48.9	590.9	38.7	543.7
Historical (2020)	Wabash	244.7	4463.1	229.2	3591.4
Future Wet (2050)	Wabash	155.8	3416.5	270.2	5117.8
Future Dry (2070)	Wabash	-22.5	623.8	-38.2	307.2

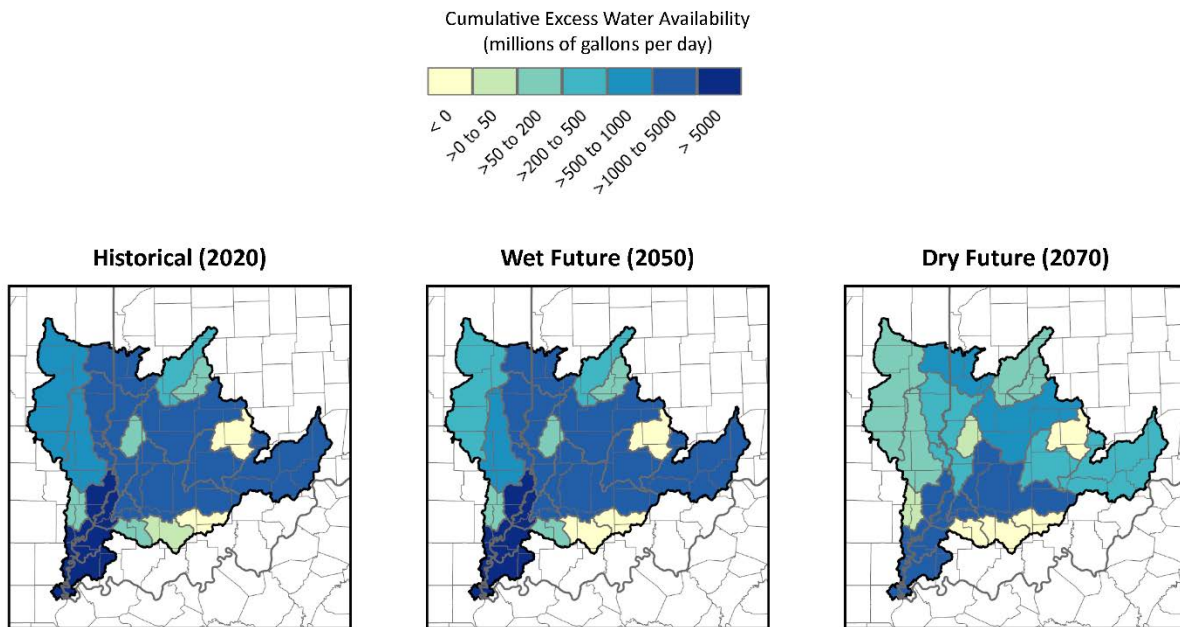


Figure 49. Maps of average annual cumulative water availability (MGD) for Historical (2020), the relatively wet future period (2050), and the relatively dry future period (2070) for Southwest Indiana subbasins. Representative years denote a 5-year average centered on that year. Positive values indicate water remaining after the modeled requirements are met; negative values indicate a modeled water deficit.

Seasonal variability remains a defining characteristic of projected water availability. The relatively wet 2050 period is distinguished by increased Winter availability, with average Winter local and cumulative availability greater than the historical baseline in all four river systems (Table 19). This wetter Winter signal does not persist uniformly through the remainder of the year. Spring and Summer availability are generally projected to be lower than historical conditions, and Fall local availability becomes negative in the East Fork White, White, and Wabash systems (Appendix H).

These seasonal limitations intensify during the dry 2070 period. Local availability declines substantially across most regions, while cumulative Fall availability becomes negative in the East Fork White, White, and Wabash systems (Figure 50 and Figure 51; Appendix H). The contrast between the 2050 and 2070 periods demonstrates that future water availability depends not only on total precipitation but also on its seasonal timing, antecedent conditions, and the resulting distribution of recharge and baseflow.

Historical and Projected Seasonal Cumulative Water Availability

Average cumulative availability across subbasins within each region

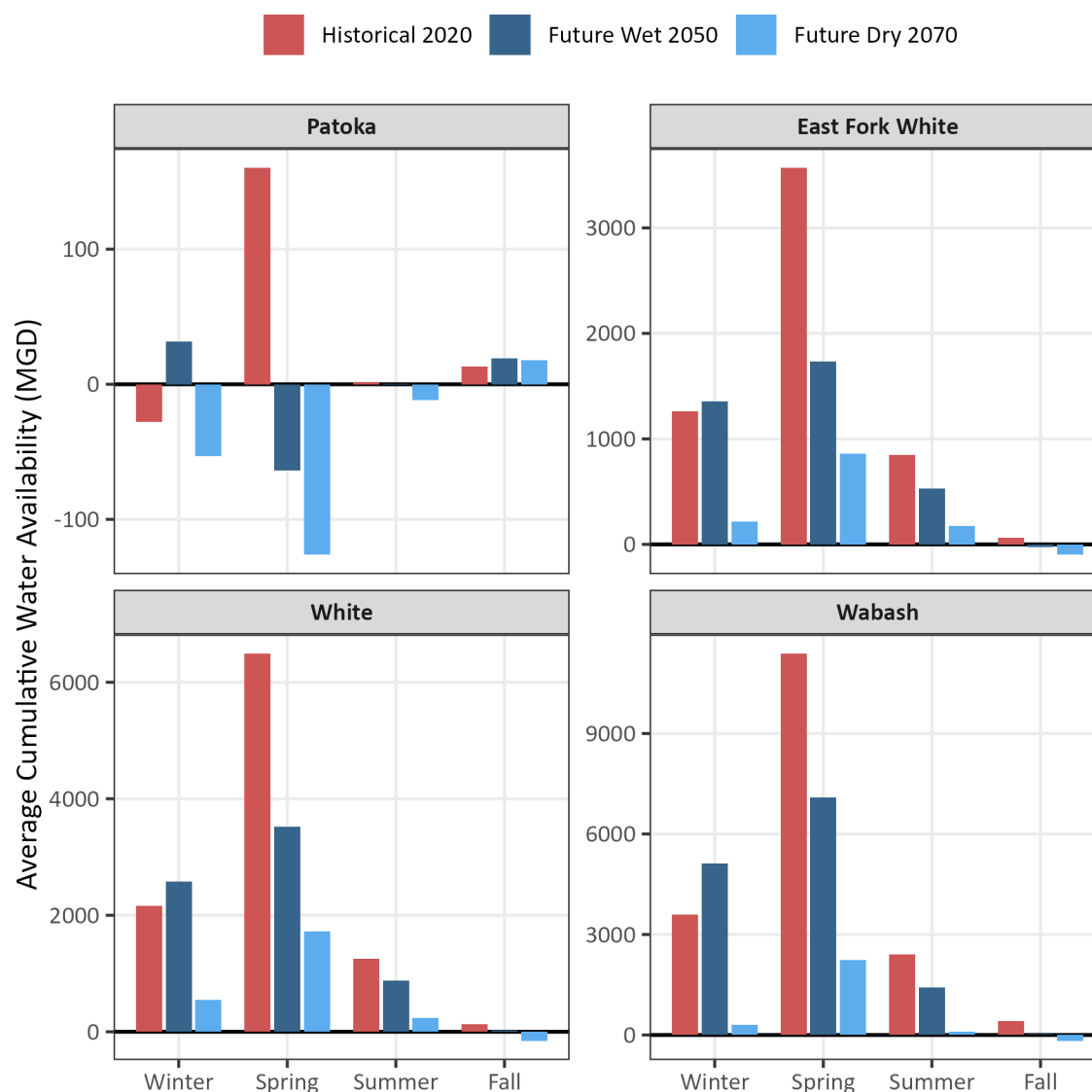


Figure 50. Seasonal comparison of average cumulative excess water availability for the historical (2020), relatively wet future (2050), and relatively dry future (2070) conditions for the four Southwest Indiana study regions under the NorESM2-LM SSP2-4.5 climate scenario. Values represent 5-year centered averages calculated for Winter, Spring, Summer, and Fall and are reported in million gallons per day (MGD). Seasonal values represent the average cumulative availability across all contributing subbasins within each geographic region (Patoka River, East Fork White River, White River, and Wabash River). Y-axis scales vary among regional panels to accommodate differences in the magnitude of cumulative availability; therefore, bar heights should be compared within, rather than among, regional panels.

**Cumulative
Water
Availability**
(SWB2
Method)

Cumulative Excess Water Availability
(millions of gallons per day)

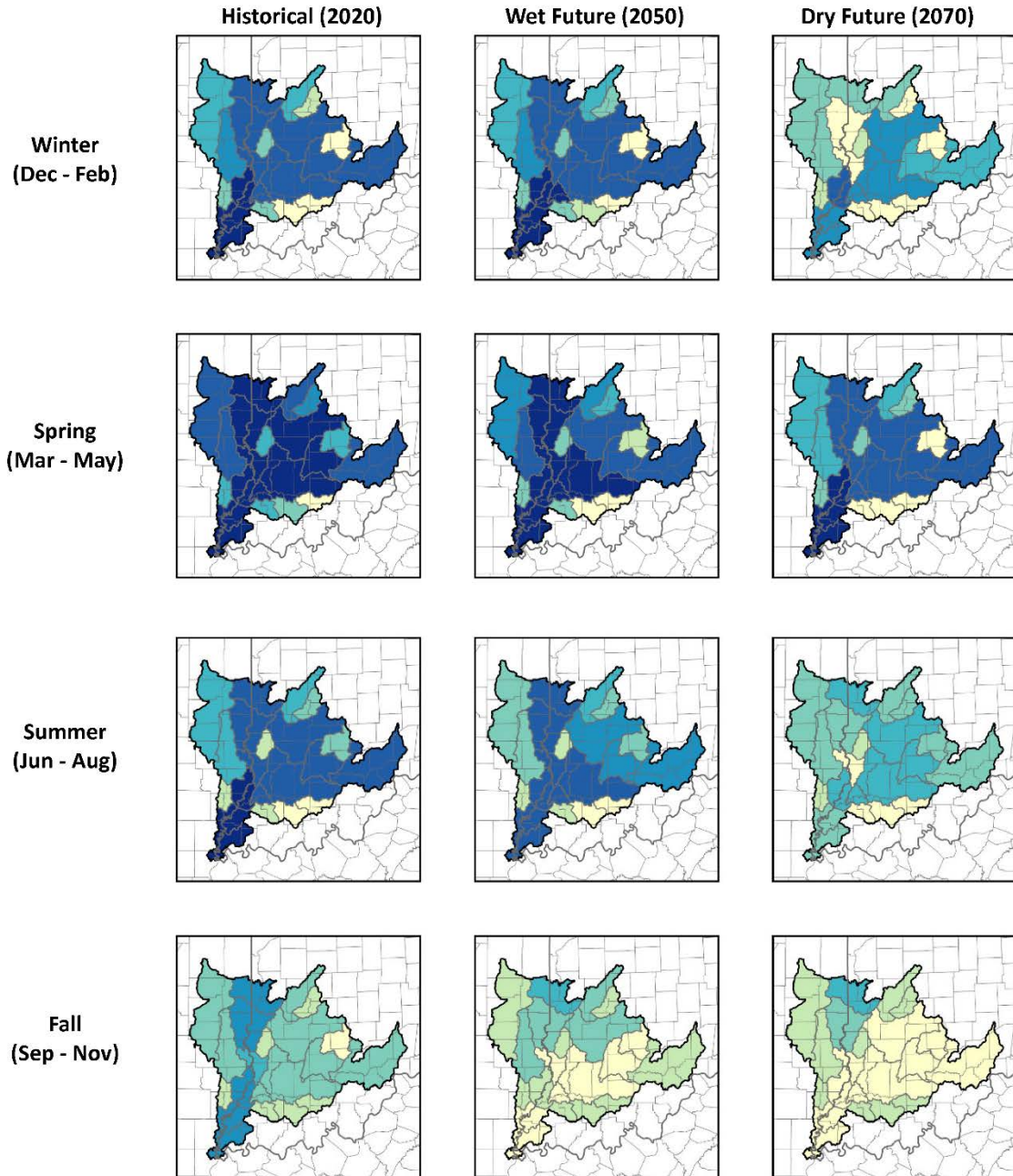
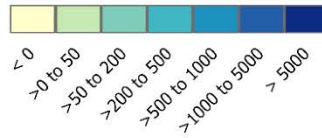


Figure 51. Maps of average seasonal cumulative water availability (MGD) for Historical (2020), the relatively wet future period (2050), and the relatively dry future period (2070) for Southwest Indiana subbasins. Representative years denote a 5-year average centered on that year. Positive values indicate water remaining after the modeled requirements are met; negative values indicate a modeled water deficit.

Patoka River

The Patoka River remains the most water-limited of the four regional systems under projected future conditions. Mean annual local availability is projected to decrease from approximately 38 MGD during the historical period to 18 MGD during the relatively wet 2050 period and becomes negative (approximately –8 MGD) during the dry 2070 period (Table 19). Cumulative annual availability projections are slightly negative in 2050 and decrease further to approximately –43 MGD in 2070, illustrating the limited capacity of upstream contributions to buffer reductions in locally generated water within this comparatively small river system.

Seasonal results are more variable than the annual averages suggest. Much of this is a result of how the Patoka Lake reservoir operations were simulated in the future water availability analysis. Historical reservoir operating patterns were propagated into the future analysis rather than assuming changes in future reservoir management. Consequently, the prescribed future releases do not account for whether sufficient water would be stored and available to sustain those releases, particularly during prolonged or extreme dry conditions. Future Patoka River availability should therefore be interpreted in the context of this reservoir-operation assumption.

The Fall 2050 subbasin results illustrate both the importance of reservoir operations to the Patoka River water balance and the influence of this assumption. Immediately downstream of Patoka Lake at Jasper (Subbasin 1, Gage 03375500), locally generated baseflow is projected to be less than 1 MGD and net returns are approximately –8 MGD, while the prescribed reservoir release of approximately 37 MGD results in approximately 20 MGD of calculated local availability (Table 20). Farther downstream at Winslow and Princeton, local availability is slightly negative, but cumulative availability remains positive at approximately 19 and 17 MGD, respectively, as the upstream reservoir contribution is conveyed through the system. Thus, the positive Fall availability projected within portions of the Patoka system is largely dependent on the assumed continuation of dry-season reservoir releases.

The proposed 2024 revision to the Patoka Lake Water Control Manual illustrates the seasonal and operational constraints on that managed-water contribution. The revision would increase releases during the December–April non-crop season to recover flood-storage capacity more quickly, but would not change minimum-flow requirements (USACE, 2024). It therefore does not provide a basis for assuming larger Summer or Fall releases or demonstrate that historical dry-season releases could be sustained during a prolonged future drought.

This reservoir influence is also evident in the regional seasonal results. During the relatively wet 2050 conditions, Winter local availability is greater than during the historical period, whereas Spring availability decreases substantially. By the dry 2070 period, average local availability is projected to be negative during Winter, Spring, and Summer. Fall represents an important exception, with average local and cumulative availability remaining slightly positive during both future periods because of the prescribed dry-season reservoir releases. These results illustrate the importance of the seasonal timing of natural and managed-water contributions but should not be interpreted as demonstrating that historical-style reservoir releases can necessarily be sustained under future dry conditions.

Table 20. Future Wet Fall (2050) local and cumulative water availability and contributing water-balance components for the 21 Southwest Indiana study subbasins. Values are reported in millions of gallons per day (MGD) and represent a centered five-year average.

Subbasin ID	Gage ID	Future Wet Fall (2050, 5-Year Centered Average) values in million gallons per day (MGD)					
		Net Returns	Reservoir Storage	Local Natural Baseflow	Local Instream Flow	Local Availability	Cumulative Availability
1	03375500	-7.7	36.9	0.4	9.1	20.5	20.5
2	03376300	1.8	0.0	2.1	5.2	-1.3	19.2
3	03376500	4.2	0.0	1.9	7.9	-1.8	17.4
4	03371500	0.8	0.0	50.1	53.7	-2.8	20.7
5	03372500	-16.4	-14.0	0.3	31.2	-61.2	-61.2
6	03373500	9.4	0.0	12.5	6.2	15.6	-34.7
7	03359000	0.0	10.9	10.5	9.7	11.7	11.7
8	03360000	-3.9	0.0	77.0	12.2	61.0	72.7
9	03360500	-0.3	0.0	120.9	81.6	39.0	110.8
10	03374000	2.4	0.0	62.5	164.1	-99.2	-25.3
11	03374100	2.1	0.0	65.4	85.1	-17.7	-43.3
0	03341500	3.0	0.0	44.1	138.3	-91.2	281.3
12	03342000	-3.8	0.0	41.5	177.2	-139.5	141.4
13	03342500	2.2	0.0	3.2	2.7	2.8	2.8
14	03343010	-4.1	0.0	64.6	213.3	-152.8	-8.7
15	03345500	-0.1	0.0	58.1	14.3	43.6	43.6
16	03346500	-1.8	0.0	34.8	11.1	21.9	65.5
17	03377500	-11.2	0.0	180.9	162.9	6.8	33.4
18	03378000	-0.2	0.0	3.7	0.1	3.4	3.4
19	03378500	-3.8	0.0	28.3	165.3	-140.7	-103.9
20	Lower Wabash	-4.7	0.0	31.8	38.7	-11.6	-115.5

East Fork White River

The East Fork White River retains substantially greater annual water availability than the Patoka River under projected future conditions, but both local and cumulative availability decrease relative to the historical period. Average annual local availability declines from approximately 328 MGD historically to 190 MGD during the relatively wet 2050 period and 65 MGD during the dry 2070 period; cumulative availability declines from approximately 1,439 to 898 and 288 MGD, respectively (Table 19). Seasonal limitations are particularly evident during Fall. Both local and cumulative availability shift from slightly positive historical conditions to negative values by 2050, with larger deficits during the dry 2070 period (Figure 50, Appendix H).

The 2050 (Future Wet) subbasin results illustrate considerable spatial variability within the river system. At Salt Creek below Lake Monroe (Subbasin 5, 03372500), very small locally generated baseflow, large withdrawals, and reservoir storage combine to produce a deficit of approximately -61 MGD in the Fall (Table 20).

Farther downstream at the East Fork White River near Shoals (Subbasin 6, 03373500), positive net returns and modeled local baseflow produce approximately 16 MGD of local availability during Fall 2050. Even so, cumulative availability remains approximately -35 MGD because the river reaches Shoals carrying deficits from

upstream, including the approximately –61 MGD deficit at Salt Creek below Lake Monroe (Table 20). Projected wastewater returns within the Shoals subbasin are approximately 9 MGD, substantially less than the approximately 60 MGD represented during the historical period. This difference reflects the future return-flow projection, not a modeled decline in natural baseflow. The unusually large historical returns are associated in part with quarry dewatering in limestone terrain. Groundwater can also move rapidly through local karst fractures, caves, and springs, although rapid movement does not necessarily provide large, dependable water storage (USGS, 2021). In 2050, projected returns account for more than half of the local surplus; without them, local availability would be only about 6 MGD. East Fork White River near Shoals is therefore sensitive both to water management within the subbasin and to deficits (or reduced flows) carried from upstream. Although the East Fork White River retains substantially more annual availability than the Patoka River, the Fall results show how seasonal limits and upstream conditions can determine availability at a particular location.

White River

The White River retains substantial annual cumulative availability under projected future conditions, but both local and cumulative availability decrease as conditions become more constrained. Average annual local availability is projected to decrease from approximately 351 MGD historically to 244 MGD during the relatively wet 2050 period and 49 MGD during the dry 2070 period, while cumulative availability is projected to decrease from approximately 2,516 MGD (2020s) to 1,750 (2050s) and 591 (2070s) MGD, respectively (Table 19).

As with the other regional systems, these annual averages mask important seasonal and spatial differences. During Fall 2050, the White River at Newberry (Subbasin 9, 03360500), where substantial upstream contributions from Indianapolis enter the Southwest Indiana study area, retains approximately 39 MGD of local and 111 MGD of cumulative availability. Farther downstream, Fall local availability is approximately –99 MGD at Petersburg (Subbasin 10, 03374000) and –18 MGD at Hazleton (Subbasin 11, 03374100). After water arriving from upstream is included, Fall cumulative availability is still negative, reaching approximately –25 MGD at Petersburg and –43 MGD at Hazleton (Table 20). These results show that water arriving from upstream can offset local deficits, but in Fall 2050 it is not enough to maintain positive availability at Petersburg or Hazleton.

Interpretation of White River availability requires particular caution because water entering the study area includes substantial managed-water contributions from the Indianapolis metropolitan area, including wastewater returns and reservoir operations. This influence is not limited to the future water-use assumptions: the observed White River hydrograph used to characterize historical hydrologic conditions is itself influenced by upstream urban withdrawals, wastewater returns, and reservoir operations.

Although our methods make an attempt to do so, these anthropogenic influences cannot be completely removed from the observed streamflow record, introducing additional uncertainty in distinguishing natural hydrologic contributions from human-influenced flow. Although the future net-return projections and reservoir-operation projections were updated for this study to capture the generalized growth and significant changes in magnitude and timing of inflows from that region, a complete revision of the Central Indiana regional water study was not conducted. Consequently, future cumulative availability in the White River is particularly dependent on assumptions regarding upstream water use, return flows, and reservoir management. The White River results therefore demonstrate both the importance and the uncertainty associated with upstream managed-water contributions to downstream availability as hydrologic conditions become increasingly constrained.

Wabash River

Projected future conditions increasingly separate local from cumulative water availability along the Wabash River, as reductions in local availability increase the importance of water contributed throughout the upstream watershed. Average annual local availability is projected to decrease from approximately 245 MGD historically to 156 MGD during the relatively wet 2050 period and will become slightly negative (approximately –23 MGD) under the dry 2070 conditions (Table 19).

Cumulative annual availability is likely to remain comparatively large because of the extensive upstream drainage network but is projected to decrease from approximately 4,463 MGD historically (2020s) to 3,417 MGD in 2050 and 624 MGD in 2070 (Table 19). Seasonal conditions are substantially drier than historical conditions, particularly during Fall. Average Fall local availability is already negative historically and decreases from approximately –22 MGD to –46 MGD in 2050 and –66 MGD in 2070. Cumulative Fall availability decreases from approximately 420 MGD historically to 34 MGD in 2050 and is projected to become negative, reaching approximately –172 MGD in the dry 2070 period (Figure 50; Appendix H).

The projected 2050 subbasin results show how water arriving from upstream offsets local deficits at some locations along the mainstem but not at others. At Terre Haute (Subbasin 0, 03341500), the projected local Fall availability is approximately –91 MGD while cumulative availability remains approximately 281 MGD because of water entering from the upstream Wabash watershed. Farther downstream, the estimated cumulative availability decreases to approximately 141 MGD at Riverton (Subbasin 12, 03342000) and becomes slightly negative at Vincennes (Subbasin 14, 03343010) as local deficits accumulate. Tributary contributions subsequently increase projected cumulative availability near Mt. Carmel (Subbasin 17, 03377500), but the balance again becomes negative farther downstream at New Harmony (Subbasin 19, 03378500) and along the Lower Wabash (Subbasin 20, Wabash Outflow; Table 20). These results illustrate both the benefit and an important limitation of evaluating water availability cumulatively: as upstream hydrologic and managed-water contributions are routed downstream, uncertainties in those estimates are carried into the downstream results as well.

This is particularly important along the downstream Wabash River because the projected cumulative availability integrates inputs developed across multiple upstream regional water studies, each with its own data limitations and assumptions. Consequently, uncertainty in projected water availability generally increases with dependence on conditions and water-management decisions occurring throughout the broader upstream watershed.

Overall, the future projections depict a future where water availability within Southwest Indiana will be characterized by substantial temporal, seasonal, and spatial variability rather than a uniform progression toward drier conditions. The relatively wet 2050 period demonstrates that future Winter availability can equal or exceed historical conditions, while many locations are projected to have less water available during Spring, Summer, and especially Fall.

These seasonal limitations are substantially more pronounced during the dry 2070 period, when projected local and cumulative availability become negative in portions of the major river systems. Across both future periods, the results reinforce the importance of distinguishing local from cumulative availability. When local deficits occur, downstream locations rely more heavily on water arriving from elsewhere in the upstream watershed. The Fall 2050 results show that this water may still be insufficient when several subbasins along

the river also have deficits. Managed-water components, including withdrawals and return flows, reservoir storage and releases, and transfers among subbasins, can either increase or decrease availability and become proportionally more important where natural hydrologic contributions are limited. Consequently, the continued presence of water within a major river corridor should not be interpreted as an abundance of locally available water or as assurance of future supply. These results emphasize the importance of considering both local conditions and the broader connected watershed when evaluating future water-supply opportunities and constraints.

Dependence on Upstream Contributions

Comparison of local and cumulative water availability shows how much downstream availability depends on water contributed by upstream subbasins (Table 21).

Table 21. Average percentage of cumulative water availability contributed by upstream subbasins under historical (2020) and dry future (2070) conditions for the East Fork White, White, and Wabash regions. Percentages were calculated for each subbasin as the difference between cumulative and local water availability divided by cumulative water availability, using centered five-year annual values from the SWB2 alpha-2 implementation, and then averaged within each region. Future conditions use the NorESM2-LM SSP2-4.5 climate simulation.

Region	Average Upstream Contribution to Cumulative Water Availability, Historical (2020)	Average Upstream Contribution to Cumulative Water Availability, Dry Future (2070)
East Fork White	51%	50%
White	59%	64%
Wabash	64%	74%

Average upstream contribution percentages increased modestly in the White River and Wabash River regions between historical and future conditions, indicating greater reliance on water arriving from upstream as local water availability declines. Annual upstream dependence increased from approximately 59 to 64 percent in the White River and from 64 to 74 percent within the Wabash River (Table 21).

This comparison shows why local and cumulative availability answer different questions. A subbasin can have little or no locally available water while the river still carries water contributed by upstream subbasins.

The Patoka River was excluded from this comparison because cumulative availability approaches or crosses zero in portions of the watershed, which can produce unstable or misleading percentage contributions.

Influence of Reservoir Operations

Reservoir operations represent an important component of cumulative water availability throughout the Southwest Indiana study area (Table 22). Cagles Mill Lake (Subbasin 7, 03359000), Monroe Lake (Subbasin 5, 03372500), and Patoka Lake (Subbasin 1, 03375500) change the seasonal timing of downstream flow by storing water during some periods and releasing it during others.



Figure 52. Locations of the three major reservoirs included in the Southwest Indiana water-availability accounting: Cagles Mill Lake on Mill Creek in the White River watershed (Putnam and Owen Counties, Indiana), Monroe Lake (also known as Lake Monroe, Monroe County, Indiana) on Salt Creek in the East Fork White River watershed, and Patoka Lake on the Patoka River (Dubois County, Indiana). Other reservoirs and dams also discussed in the report are shown, including Hardy Lake, John Hay Lake, Scottsburg Lake, Lake Greenwood, and Williams Dam.

Table 22. Seasonal and annual reservoir storage and release terms (Qstor) used in the regional water-availability accounting for the historical (2020) and dry future (2070) reporting periods. Values represent centered five-year averages for each reporting year. Future values were estimated by applying historical reservoir operating patterns within the NorESM2-LM SSP2-4.5 climate simulation. Positive values indicate a net contribution to downstream flow, and negative values indicate net storage or removal from downstream flow. Changes represent the 2070 value minus the 2020 value and were calculated from unrounded values. Values are reported in million gallons per day (MGD).

Reservoir System	Season	Reservoir Storage/Release Historical (2020)	Reservoir Storage/Release Future (2070)	Change between 2020 to 2070 (MGD)
Cagles Mill Lake - West Fork/White	Annual	-0.9	-0.3	0.6
Cagles Mill Lake - West Fork/White	Winter	-134.4	-58.3	76.1
Cagles Mill Lake - West Fork/White	Spring	70.1	-15.2	-85.4
Cagles Mill Lake - West Fork/White	Summer	47.7	60.7	13.0
Cagles Mill Lake - West Fork/White	Fall	10.5	10.9	0.4
Lake Monroe - East Fork White	Annual	-12.5	-17.6	-5.1
Lake Monroe - East Fork White	Winter	-327.9	-175.5	152.4
Lake Monroe - East Fork White	Spring	131.1	-45.7	-176.8
Lake Monroe - East Fork White	Summer	170.7	161.9	-8.8
Lake Monroe - East Fork White	Fall	-30.2	-14.0	16.3
Patoka Lake - Patoka	Annual	-22.4	-45.0	-22.6
Patoka Lake - Patoka	Winter	-88.6	-37.7	51.0
Patoka Lake - Patoka	Spring	-28.4	-178.1	-149.7
Patoka Lake - Patoka	Summer	-1.8	-0.2	1.5
Patoka Lake - Patoka	Fall	28.4	36.9	8.5

Sensitivity of Water-Availability Results to Baseflow Estimates

Natural baseflow—the portion of streamflow supported by groundwater—is a major component of the water-availability calculation (IFA, 2021; Appendix G). Uncertainty in baseflow therefore affects the amount of available water calculated by the study. Two methods were used to examine that effect. The primary analysis used the calibrated Soil-Water-Balance model (SWB2; Westenbroek et al., 2018) to estimate water moving below the root zone. A calibrated routing calculation then estimated when that water reaches streams as baseflow. Because the model runs continuously through time, wet and dry conditions carry over from one season to the next rather than resetting at the end of each month or year. This allows the simulation to represent the buildup of drought and the time required for groundwater and streamflow to recover.

The alternative method used the USGS PART hydrograph-separation method to estimate historical baseflow from measured streamflow (Rutledge, 1998). Historical Baseflow Index values were then used with projected natural streamflow to estimate future baseflow (Appendix G). The Baseflow Index, or BFI, is the estimated share of total streamflow supplied by groundwater. That share generally changes by season as groundwater drains toward streams, commonly increasing during wetter periods and reaching its lowest levels during the dry season. This approach is referred to here as the PART/BFI method.

Both methods used the same water-availability accounting, water-demand projections, reservoir operations, river-routing network, and instream-flow requirements. The principal difference was how natural baseflow was estimated.

The methods produced different estimates of available water because they represent groundwater contributions to streams differently. In general, the PART/BFI method estimated more natural baseflow than the SWB2 method and therefore produced greater local and cumulative water availability under historical and future conditions. It also produced fewer subbasins with calculated deficits and generally indicated more available water during Summer and Fall (Figure 53; Appendix H). These results show that the calculated amount of available water is sensitive to the baseflow method and should not be interpreted as a precise prediction.

Despite differences in the calculated volumes, the methods produced similar geographic and seasonal patterns. Both showed greater availability in the White River and East Fork White River systems and identified the Patoka River as the most water-limited of the four systems. Both identified Spring as the season with the greatest availability and Summer and Fall as the seasons when water is generally most limited. The methods also showed why local and cumulative availability must be distinguished along the White and Wabash Rivers, where water arriving from the larger upstream watershed can strongly affect downstream conditions.

Neither method should be interpreted as producing a uniquely correct value. SWB2 is used for the primary results because it provides a continuous and internally consistent way to evaluate historical and future hydrologic conditions. PART/BFI provides an alternative estimate showing how strongly the results depend on the representation of groundwater contributions to streams. Because both methods use the same NorESM2-LM SSP2-4.5 climate simulation, this comparison does not represent the full range of possible future climates. Where a management decision depends on a small surplus or deficit—or on a value close to zero—baseflow uncertainty should be considered explicitly, and more detailed site-specific analysis may be warranted.

**Cumulative
Water
Availability**

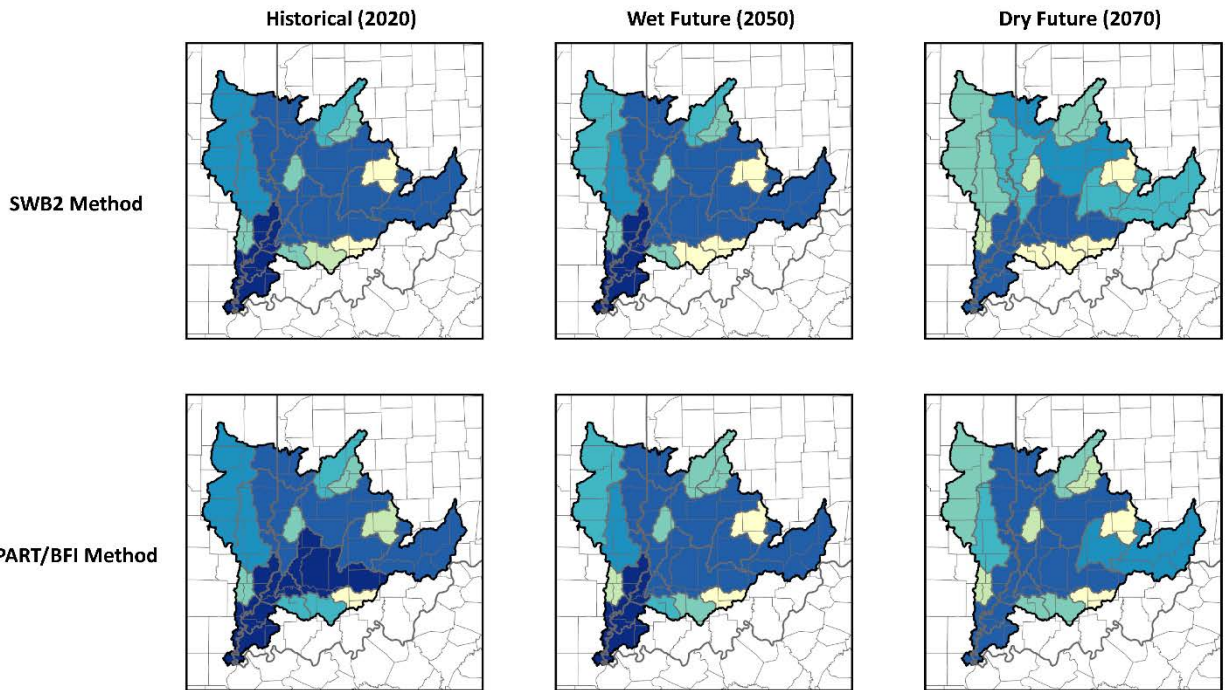
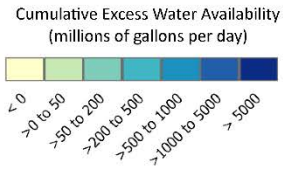


Figure 53. Comparison of average annual cumulative water availability estimated using the SWB2 method (top row) and PART/BFI method (bottom row) for historical (2020), wet future (2050), and dry future (2070) conditions. Values are five-year centered averages representing 2018–2022, 2048–2052, and 2068–2072, respectively, and are reported in million gallons per day (MGD). The same color ranges are used in all panels to allow direct comparison between methods and reporting periods. Complete annual and seasonal results for local and cumulative water availability are provided in Appendix H.

Risks to the Water Supply

Water-supply risk is not limited to the total volume of water in rivers, reservoirs, or aquifers. A water source may be physically present but constrained by treatment requirements, contamination risk, seasonal low flows, infrastructure capacity, storage limitations, redundancy, regulatory compliance, or distance from demand centers. This section synthesizes the major risks identified in the demand and availability analyses.

Climate Risks

Climate risks include rising temperatures, changes in the timing and intensity of precipitation, greater evaporation, atmospheric thirst, and shifts in when water reaches streams and aquifers. Even if annual precipitation remains adequate—or increases—longer dry periods and hotter summers can raise peak public-water and irrigation demand while reducing the water available during Summer. The seasonal timing of water supply and demand may therefore be as important as the annual total.

Water Quality

Water quality directly affects water availability because water that is physically present may not be usable without additional treatment, blending, an alternative source, or new infrastructure. Important concerns in Southwest Indiana include rapid contaminant movement through karst, mine drainage, agricultural runoff, wastewater discharges, industrial contaminants, PFAS and other emerging contaminants, and drinking-water compliance challenges.

To map listed impaired waters in the study area, the finalized 2026 IDEM impaired-waters data were joined to the EPA ATTAINS Water Quality GIS dataset (IDEM, 2026g; EPA, 2025). For this regional screening, impairment parameters were grouped into agriculture-associated and industry- or mining-associated categories based on activities commonly linked to those parameters. These groupings do not establish the source of an impairment at a particular location; some conditions, including low pH, can have more than one natural or human cause. Stream lengths were then summarized by river basin and screening category. A separate mine-related dataset was used to identify streams affected by acid mine drainage. Figure 54 shows the listed impaired waters and selected potential sources of surface-water contamination included in the regional screening. Mapped combined-sewer outfall locations were obtained from IDEM's CSO Outfall Map (IDEM, 2026b).

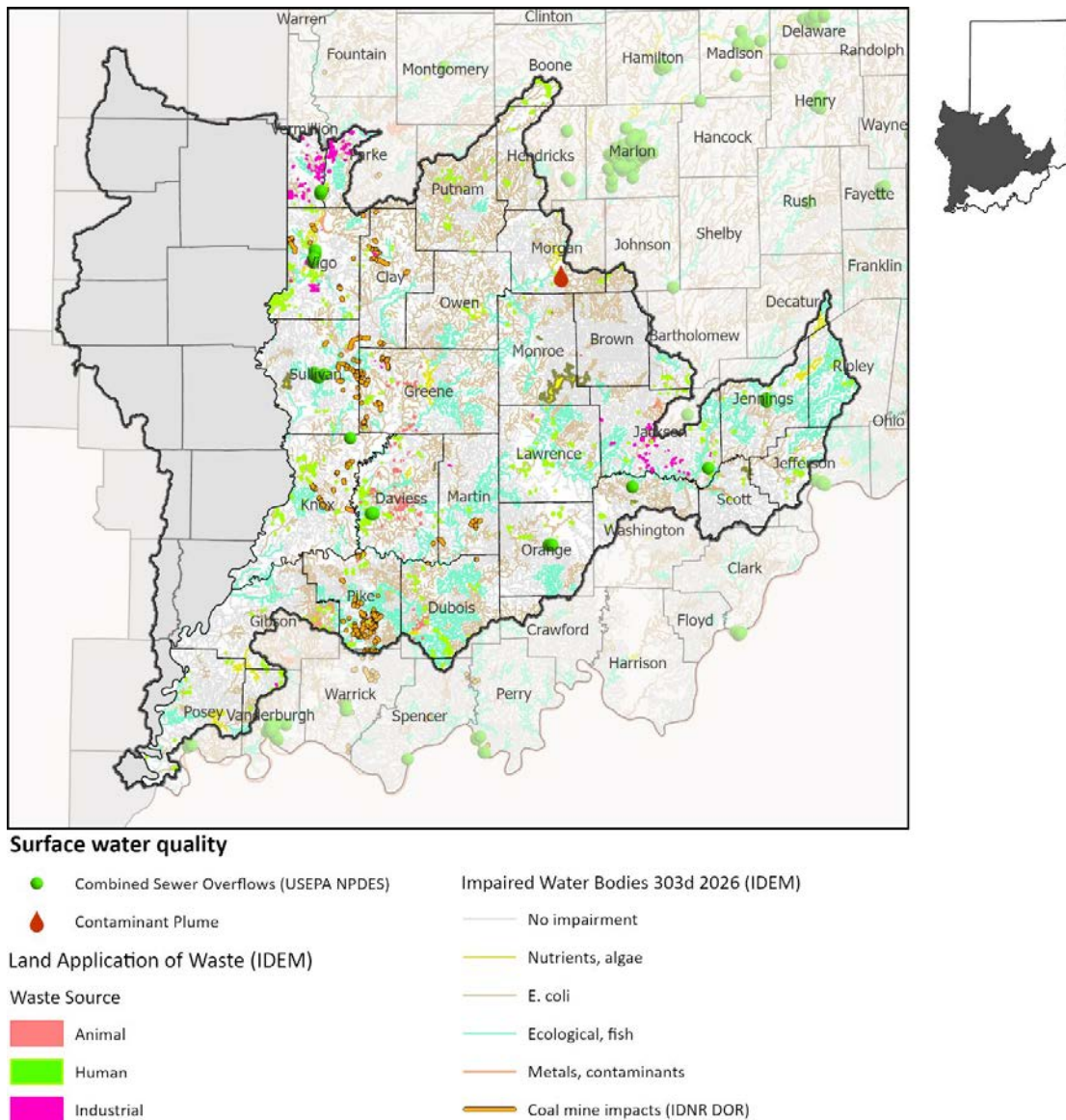


Figure 54. Listed impaired water bodies and mapped potential sources of surface-water contamination in the Southwest Indiana study area. Potential sources include combined sewer overflows, land application of waste, residential septic systems, and industrial, agricultural, and mining activities. Proximity to a mapped potential source does not establish the cause of a particular water-body impairment.

The screening produced approximately 6,000 agriculture-associated stream-impairment miles and just under 2,000 industry- or mining-associated stream-impairment miles (Figure 55). The East Fork White River watershed had the largest summed total. Because a stream reach may have more than one listed impairment or association, these values should not be interpreted as miles of distinct waterways or added together to estimate total impaired stream length. Additional methods and results are provided in Appendix A.

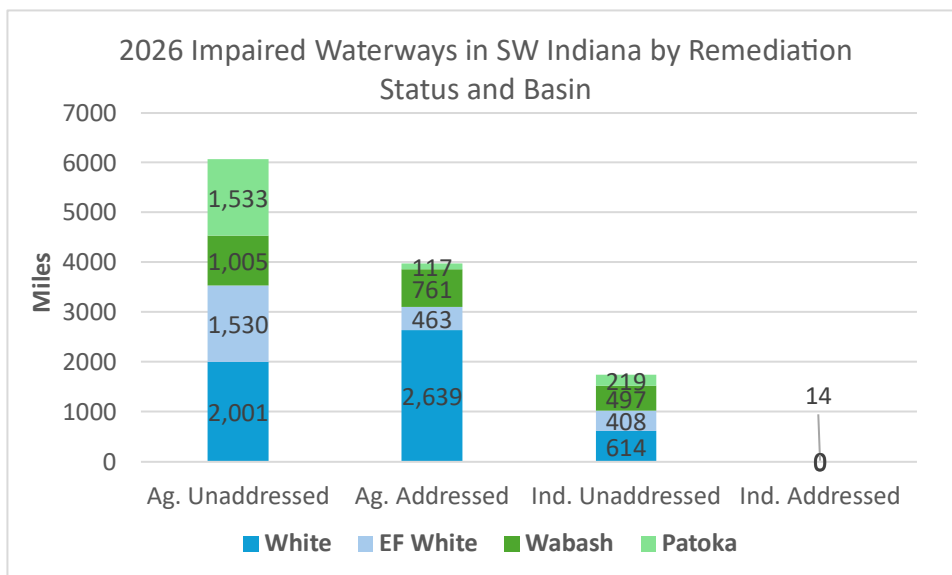


Figure 55: Impaired Waterways in the Study Area. Some agricultural concerns include Nutrients, Pesticides, Ammonia, Chloride, E. coli, Algae, Dissolved Oxygen, Biological Integrity, and Habitat Alterations.

Industrial concerns include PCBs, Metals, Cyanide, Dioxins, Fluoride, Selenium, Oil and Grease, Iron, and Temperature.

Unaddressed = EPA Category 5, Addressed = EPA Category 4.

Karst-related Vulnerabilities

Karst develops where groundwater dissolves carbonate bedrock, creating sinkholes, fractures, caves, and underground conduits. In portions of the Mitchell Plateau and Crawford Upland, these pathways provide rapid connections between surface water and groundwater, allowing contaminants to move underground with limited natural filtration. This vulnerability is important for drinking-water source protection, monitoring, emergency response, agricultural practices, and wastewater planning. Mississippian carbonate units, including the Blue River and Sanders Groups, also serve as bedrock aquifers for some small utilities, farms, and private wells in the East Fork White River basin.



Figure 56. Photo of epikarst, which is near-surface dissolution of limestone that creates cavities and enlarged natural pipes that can convey water and contaminants into the subsurface. These voids are often filled with soil and surrounded by vegetation, so the additional vulnerability to water quality and infrastructure is not evident. Photo by Noel Krothe, date unknown.

The Lost River illustrates the close connection between surface water and groundwater in karst areas. The river flows westward across Orange County before entering sinkholes and moving through underground conduits formed in carbonate bedrock. Water later returns to the surface through several springs and ultimately enters the East Fork White River in southern Martin County (IDEM, 2026e). Contaminants entering the river or nearby sinkholes can therefore move rapidly through the underground drainage system. Reported watershed concerns include nutrients, suspended sediment, *E. coli*, low pH, low dissolved oxygen, and degraded aquatic habitat.

The Orleans wastewater system provides a local example of the direct connections created by karst. The town's utility history reports that treated effluent has been discharged to a sinkhole, providing a direct route into the karst groundwater system (Town of Orleans, 2026). Even when wastewater is treated and the discharge is permitted, a sinkhole outfall provides less travel time and natural filtration than discharge to a surface stream. Orleans has purchased its drinking water from PLRWSD since 2001, although private wells and other groundwater users remain in the surrounding area. This setting underscores the importance of discharge monitoring and groundwater-source protection.

Karst can also create physical risks for buried infrastructure. Sinkholes and underground voids can remove support beneath water and sewer lines, while water from a broken main may drain underground instead of pooling at the surface, making the break more difficult to locate. During a November 2023 water-main break in Corydon, an estimated 5 million gallons of water entered a sinkhole before the break was found (WAVE, 2023). Development can also increase impervious surface area; if stormwater is directed into sinkholes, contaminants may move rapidly into the groundwater system.

Mine Hydrology and Potential Water Storage

Mined lands and abandoned underground mines can affect both water quantity and water quality. Flooded mine workings can store substantial volumes of groundwater and redirect flow through mine passages, coal beds, shafts, boreholes, subsidence fractures, seeps, and springs. Their behavior varies greatly among sites, however, and the recharge, discharge, and internal connections of many Indiana mine pools remain poorly understood. Surface-mine spoil can also alter local drainage, but its ability to store and transmit water is highly variable. The secondary porosity of spoil and gob material can create aquifer-like storage that slows runoff, extends the baseflow recession period, and helps sustain streamflow. Mine water commonly contains elevated sulfate and may also contain acidity, iron, chloride, or other dissolved constituents; additional flow from a mine pool therefore does not necessarily represent usable water (Harper et al., 2013).

Mine pools and former quarries may also represent potential water-storage resources, although their suitability must be evaluated individually. Flooded coal mines can contain substantial volumes of water, but mapped mine volume should not be equated with reliable water yield. Uncertain connections among mine workings, variable recharge and recovery, subsidence, water quality, treatment needs, and access can limit their practical use (Harper et al., 2013).



Figure 57. A view of a deposit of coal preparation plant waste in Pike County, Indiana, in 2023. Photo courtesy of Maria Mastalerz, Indiana Geological and Water Survey.

Retired limestone quarries present a different type of opportunity. Citizens Energy Group converted a former limestone quarry beside Geist Reservoir into Citizens Reservoir, which became operational in 2020 and provides more than 3 billion gallons of storage without inundating additional land. Former dimension-stone quarries in Southwest Indiana’s limestone belt could warrant similar feasibility screening. Storage capacity, leakage, water quality, available water for filling, pumping requirements, infrastructure connections, ownership, and permitting would need to be evaluated before any site could be considered a dependable supply (Citizens Energy Group, 2026; IURC, 2014).

Figure 54 shows mapped mining-related impacts on area streams, based in part on data from the Indiana Department of Natural Resources, Division of Reclamation (IDNR DOR). Mineralization, metals, and low pH are hallmarks of contamination from the mining industry. IDNR DOR also maps streams and stream segments that have undergone restoration. For a region with such a lengthy history of legacy coal mining, restoration activities are an ongoing priority for Indiana.

Public Water Utility Capacity, Reliability, and Compliance

One important risk is that peak-day demand can approach the amount of water a utility can reliably treat and deliver. In these cases, the immediate limit may be aging or undersized infrastructure rather than a lack of raw water at the source.

The Patoka Lake Regional Water and Sewer District (PLRWSD, “Patoka Lake”) serves as a prime example. Patoka Lake is a major regional supplier, providing water to nearly 6,000 retail connections and 30 wholesale community systems across seven counties (Crawford, Dubois, Orange, Perry, Pike, Spencer, and Warrick). Patoka Lake is a federally owned and USACE-operated reservoir managed cooperatively with IDNR. Indiana holds contractual rights to approximately 77.5 percent of the designated water-supply and water-quality storage and contracts with PLRWSD for raw-water withdrawals. The utility’s immediate constraint is therefore not the State’s reservoir storage allocation, but the amount of water its treatment system can reliably process during peak demand. However, its treatment infrastructure is approaching its limits:

- Current capacity: PLRWSD operates two water-treatment plants with a combined firm capacity of 12.0 MGD. According to the PLRWSD preliminary engineering report, IDEM identifies systems for capacity planning when maximum-day demand reaches 90 percent of firm capacity—10.8 MGD in this case. PLRWSD’s current maximum-day demand of 10.36 MGD is approximately 86 percent of firm capacity and only 0.44 MGD below that planning benchmark (PLRWSD PER, 2025).
- Future capacity need: The preliminary engineering report (PLRWSD PER, 2025) projects maximum-day demand of approximately 18.03 MGD by 2044. Maintaining that demand near the 90-percent planning benchmark would require approximately 20 MGD of firm treatment capacity.
- Rehabilitation and expansion: WTP #1 requires substantial rehabilitation but cannot be taken offline while WTP #2 lacks sufficient capacity to meet system demand on its own. The preliminary engineering report therefore calls for expanding WTP #2 before WTP #1 is taken offline, allowing the utility to continue serving customers during the rehabilitation work (PLRWSD PER, 2025).

Utility Peak Usage

Peak usage matters because water-treatment, pumping, and storage systems must be able to meet the highest demands, not merely the annual average. Demand commonly rises during Summer as households water lawns and gardens, fill swimming pools, and use more water outdoors. Outdoor uses account for an

estimated 16 to 20 percent of annual public-supply water use in Indiana, with larger seasonal peaks possible during hot, dry conditions (Shaffer, 2009). The size of the peak also varies with a utility's customer mix.

Two different datasets were analyzed to assess peak usage for utilities in our study area: the Significant Water Withdrawal Facilities database (SWWF) managed by IDNR, and Monthly Reports of Operations (MROs) managed by IDEM. The SWWF database is a fairly comprehensive digital product that records monthly volumes of water pumped by any facility capable of pumping 0.1 MGD from groundwater and/or surface water sources. In contrast, MROs are worksheets submitted by utilities that record the amount of water treated each day. The Indiana Finance Authority recently (July 2026) initiated a project on behalf of IDEM to convert the MRO submittal process to digital records, so future records should be easier to analyze.

Because this project was conducted before the new system was in place, a considerable amount of work was required to gather and process the MRO data, so the analysis focused on a limited subset of years – ‘normal’ years with average precipitation, ‘drought’ years with decreased precipitation and abnormally high temperatures, and ‘recovery’ years following drought years. For this study, 2011 and 2021 are examples of normal years, 2012 and 2022 as drought years, and 2013 and 2023 as recovery years. Some utilities had incomplete data for specific months or years in either the SWWF dataset, the MRO documents, or both. Efforts were made to fill in gaps in both datasets by either copying data from adjacent months / years or averaging their values. After analyzing the different years, it was determined that the drought year of 2012 and the normal year of 2021 most clearly highlight the differences in peak demand, and those years were accordingly used in the peaking factor analysis.

The Summer peaking trend becomes clear when data is averaged across utilities, and this can be taken one step further to consider the operational differences between large and small utilities. Based on the distribution of utility sizes in our study area, a service population of fewer than 5,000 or 5,000 or more was used as the threshold to differentiate between small and large utilities, respectively. The results from the MRO analysis are shown in Figure 58.

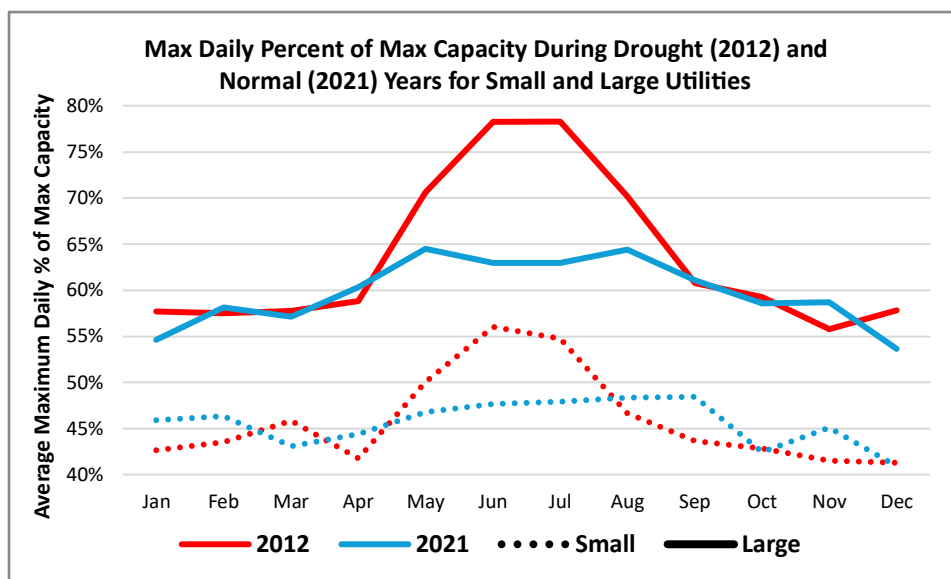


Figure 58. Average Maximum Percent of Max Capacity for small and large utilities during a drought year (2012) and a normal year (2021). The colors represent the years and dashed vs solid lines represent small and large utilities, respectively.

With both large and small utilities, it is evident that the Summer drought of 2012 led to a much larger peak demand than is seen during years with normal precipitation and temperature (2021). Although this trend is mirrored between large and small utilities, there is an important distinction between the two groups. In general, larger utilities seem to have a baseline operational level that is closer to their maximum capacity, and they tend to see a larger proportional peak during extreme conditions. During the normal year of 2021, average Summer demand at large utilities was approximately 60 to 65 percent of maximum capacity, rising to nearly 80 percent during the 2012 drought. Average Summer demand at small utilities increased from approximately 45 to 50 percent of maximum capacity in 2021 to approximately 55 percent in 2012.

Some utilities have a more extreme peak that exceeds 2x their baseline usage, while others see a muted seasonal peak of around 1.2x their baseline usage. To make a meaningful comparison to the MRO analysis, this SWWF peaking analysis was performed for both 2012 and 2021 and averaged across groups of small and large utilities that serve fewer than 5,000 or 5,000 or more people. The results of this are shown in Figure 59.

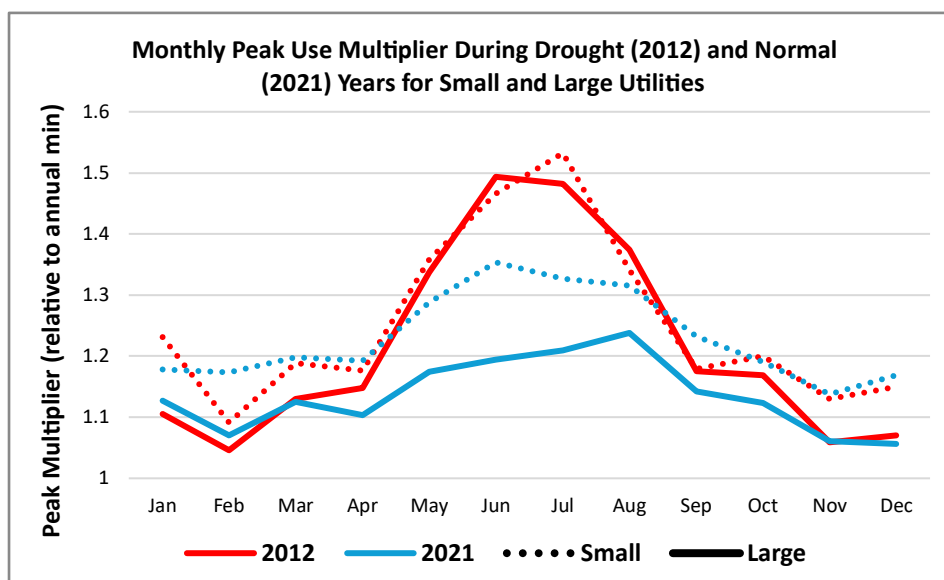


Figure 59. Average Peak Usage Multiplier (relative to annual minimum) for small and large utilities during a drought year (2012) and a normal year (2021). The colors represent the years and dashed vs solid lines represent small and large utilities, respectively.

When looking at average peak usage multipliers, a similar but distinct trend emerges as compared to the MRO analysis above. During the 2012 drought, small and large utilities had nearly identical average peak-usage multipliers of approximately 1.5 times their minimum monthly use. During the normal year of 2021, both large and small utilities show relatively decreased Summer peaking. However, small utilities tend to see greater peaking factors during normal Summer months (~1.35x baseline) than larger utilities (~1.2x baseline). One reason for this might be related to larger utilities typically serving a more diverse set of customers from different sectors. For example, the relatively steady and significant monthly demand from industrial manufacturing facilities helps to minimize the peaking factor caused by increased domestic irrigation during normal years for large utilities. In contrast, small utilities that are serving almost entirely residential customers will see more exaggerated peaks when the majority of their customers begin irrigating their yards and gardens during the growing season. The caveat of all this is that during drought conditions, large utilities experience the

same peak usage multiplier as small utilities but on average have less available capacity to meet that increased demand.

Per-Capita Usage

An additional way to consider the fluctuations of seasonal usage at various utilities is to convert water usage into per-capita water usage. This was accomplished by dividing monthly usage totals by the product of the utility population served and the number of days in a given month. It uses the same monthly totals that are employed in the SWWF Peaking analysis, but relates the water used to an individual consumption rate rather than the minimum annual month. The same 'drought' and 'normal' years – 2012 and 2021 – were used to facilitate comparison with the other peaking analyses.

There is a fair amount of variability in per-capita water usage across the study area, with the biggest utilities tending to have the highest rates. Patoka Lake had the highest calculated per-capita use, exceeding 600 GPD during the 2012 drought. This value does not represent household consumption alone: nonresidential customers increase total use, and the reported service population does not fully include people served indirectly through wholesale customers.

With this in mind, the per-capita water usage is considered for both large and small utilities, divided using a population served fewer than 5,000 or 5,000 or more people. The results (Figure 60) echo each of the first two analyses – the 2012 droughts caused a notable increase in per-capita usage for both small and large utilities relative to their 2021 baseline usage, with larger utilities both having a higher baseline per-capita usage and showing a more pronounced increase in per-capita usage during the summer of 2012.

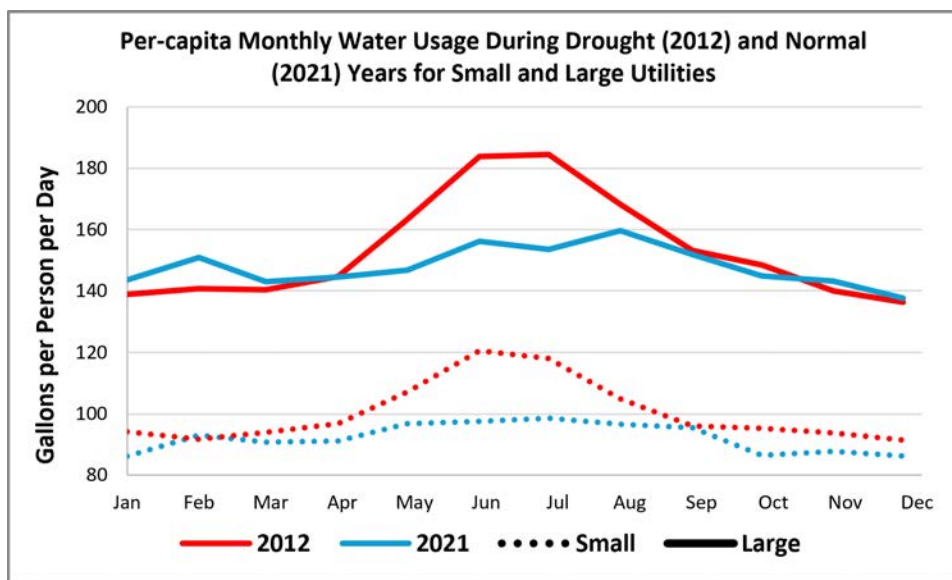


Figure 60. Per-Capita monthly water usage as it varies during drought conditions and by utility size. The colors represent the years and dashed vs solid lines represent small and large utilities, respectively.

Though the MRO and SWWF analyses show similar trends, only by combining the results of these methods can inferences be made about the difficulties that utilities of different sizes may experience during future climate extremes. It is clear from Figure 58 and Figure 60 that during normal operational conditions, larger utilities are operating closer to their maximum capacity and experience greater per capita demand than smaller utilities. In contrast, Figure 59 suggests that during normal years, smaller utilities tend to experience more extreme peak usages. These facts work in tandem – larger utilities are able to safely operate closer to their maximum

capacity because they tend to experience less extreme peaks during typical summers. In contrast, smaller utilities have a baseline operation that is not as close to their maximum capacity, but on average they experience more severe peaking factors during normal years.

Future droughts may equal or exceed the duration and intensity of recent events such as 2012. During drought, both small and large utilities can experience increased peaking factors, but large systems may operate closer to treatment or pumping capacity because the absolute increase is much larger. Bloomington imposed watering restrictions during the 2012 drought when seasonal demand approached treatment constraints even though Monroe Lake retained raw-water volume. The utility has since increased its treatment capacity and authorized withdrawal allocation.

Emergency interconnections between utilities are one safeguard that could help prevent regional water shortages during future drought conditions. However, larger utilities are already operating closer to their maximum capacity, and during drought conditions they may be unable to provide emergency wholesale water if their own system is struggling to handle increased peak demand. Smaller utilities tend to have more operational capacity leeway during these extreme conditions, but the scale of their operation means that they are not capable of supplying the quantities of water that larger utilities require during prolonged droughts. Larger utilities may face particular difficulty during drought because they must accommodate a much greater absolute increase in demand while often operating closer to their treatment capacity. If they do not expand their overall capacity to account for future demand increases and usage peaks, Summer watering restrictions may become a common practice to ensure that the public supply systems do not become overstressed and can reliably provide water for critical uses like fire protection, hydration, and sanitation.

Non-Revenue Water Analysis

Every water utility produces some water that does not provide revenue for the utility. Such “non-revenue water” has three causes: 1) real losses, which happen when water is lost through physical leaks; 2) apparent losses, which occur when water is consumed but not metered accurately; and 3) unbilled authorized consumption, which describes water that is provided without charge to certain consumers, such as local governments (IFA, 2024; <https://www.in.gov/ifa/water-loss-audits>). If these non-revenue water volumes become too large, they can strain the finances and capacity of the utility as well as waste natural resources.

The 2024 Indiana Finance Authority water-loss audit dataset was used to provide an overview of non-revenue water in the region for 99 utilities in Southwest Indiana. These water audits tracked the water supply for each utility during calendar year 2023 to estimate non-revenue water.

Utilities of different sizes were compared by expressing non-revenue water as gallons per service connection per day, consistent with the 2024 IFA statewide analysis., which is in line with the 2024 IFA statewide analysis. For each utility, a number of parameters were calculated including unit non-revenue water, unit real loss, unit apparent loss, and unit unbilled authorized consumption, all of which are measured in gallons/service connection/day. Overall, the median unit non-revenue water was 57.28 gallons/service connection/day. Real losses were the greatest contributor to non-revenue water, with the median unit real loss at 48.65 gallons/service connection/day. Median unit apparent loss was 2.61 gallons/service connection/day, and median unit unbilled authorized consumption was 1.25 gallons/service connection/day. Non-revenue water cost these utilities more than \$7.5M in 2023, according to the water-audit data.

Utilities with large non-revenue water losses cannot be simply characterized or grouped (see the water-loss analysis in Appendix B); but with the right resources and infrastructure improvements, utilities can decrease this burden to safeguard their finances and water supply.

Public Utility Compliance Violations

The Safe Drinking Water Act (SDWA) is the primary federal law governing drinking-water quality in the United States. Under the SDWA, the U.S. Environmental Protection Agency (EPA) establishes water-quality standards and required treatment techniques for public water systems. Violations can occur when a utility fails to complete required monitoring or reporting, does not publish an annual consumer confidence report, fails to apply a required treatment technique, or exceeds an EPA maximum contaminant level (MCL). To assess compliance challenges in Southwest Indiana, SDWA violation data were obtained from the Safe Drinking Water Information System through EPA's Enforcement and Compliance History Online (ECHO) platform. The dataset included 109 regional water utilities, 83 of which had one or more of the 571 violations recorded from 2019 through 2025.

Of the 571 SDWA violations reported by SDWIS, 87% (n = 497) were administrative violations (failure to monitor contaminant levels or to publish a consumer confidence report). 5% (n = 31) of violations involved failure to apply a required treatment technique, and 8% (n = 43) of violations involved the exceedance of a maximum contaminant level. The latter two categories are known as health-based violations (Statman-Weil et al., 2020; Allaire et al., 2018). Health-based violations were recorded by contaminant type. Inorganic chemicals, such as lead and copper, were the subject of 41% (n = 30) of health-based violations. Microorganism-related violations—which include violations of the Ground Water Rule, the Surface Water Treatment Rules, and the Revised Total Coliform Rule—comprised 32% (n = 24) of health-based violations. The remaining 27% (n = 20) of health-based violations involved disinfectants and disinfection byproducts, such as haloacetic acids and total trihalomethanes. There were no health-based violations related to organic chemicals or radionuclides.

To explore factors associated with SDWA violations, the compliance data were analyzed by utility-specific characteristics as compiled by the 2024 Indiana Finance Authority water-loss audit (<https://www.in.gov/ifa/water-loss-audits>) and the 2025 utility water service area dataset (this study). The audit supplied utility location, ownership, source type, purchased-water share, and service population. The water service area dataset was used to classify utilities as rural or urban. Following Statman-Weil et al. (2020), utilities were classified as urban when at least 50 percent of their service area overlapped a U.S. Census Bureau urban area.

Ten of the 109 SDWIS utilities were absent from the audit, leaving 99 facilities and 558 violations for the spatial and utility-characteristic comparison. The maps show where violations were concentrated but do not explain why they occurred.

Table 23 summarizes 99 utilities, 485 administrative violations, and 73 health-based violations by utility characteristic. Figure 61 shows the regional distribution of violation counts. Municipal and regional systems, groundwater systems, systems that produce most of their own water, systems serving fewer than 5,000 people, and rural systems accounted for the largest shares of recorded violations. Because several of these are also common utility types in Southwest Indiana, violation counts alone do not demonstrate that a particular characteristic caused noncompliance. Surface-water utilities, however, accounted for a larger share of violations than their share of the regional utility portfolio. These patterns are broadly consistent with findings that small utilities may require additional technical, managerial, or financial support to maintain SDWA compliance (Statman-Weil et al., 2020; Allaire et al., 2018).

Table 23. Distribution of administrative and health-based SDWA violations among 99 Southwest Indiana utilities, grouped by utility characteristics. Green shading identifies the largest percentage within each group. Because the groups contain different numbers of utilities, violation percentages should be considered alongside the percentage of utilities represented.

	Utility Characteristic	Percentage of Utilities	Percentage of Administrative Violations	Percentage of Health-based Violations
Ownership	Conservancy District	2% (n = 2)	2% (n = 8)	0% (n = 0)
	Federal/Federal Facility/Government	3% (n = 3)	1% (n = 3)	0% (n = 0)
	Investor Owned	5% (n = 5)	1% (n = 7)	0% (n = 0)
	Municipal/County	72% (n = 71)	83% (n = 404)	92% (n = 67)
	Not-for-Profit	14% (n = 14)	10% (n = 50)	7% (n = 5)
	Private	2% (n = 2)	2% (n = 9)	1% (n = 1)
	Regional Water District	2% (n = 2)	1% (n = 4)	0% (n = 0)
Water Source	Groundwater	78% (n = 77)	68% (n = 332)	62% (n = 45)
	Surface water	22% (n = 22)	32% (n = 153)	38% (n = 28)
Percentage of Purchased Water	< 50% purchased water	84% (n = 83)	86% (n = 417)	95% (n = 69)
	> 50% purchased water	16% (n = 16)	14% (n = 68)	5% (n = 4)
Service Population Size	0-999	31% (n = 31)	33% (n = 161)	14% (n = 10)
	1000-4999	40% (n = 40)	39% (n = 187)	51% (n = 37)
	5000-9999	12% (n = 12)	16% (n = 76)	33% (n = 24)
	10000-19999	14% (n = 14)	12% (n = 60)	1% (n = 1)
	65000-84999	2% (n = 2)	0% (n = 1)	1% (n = 1)
Rural/Urban Classification of Utility	Rural	88% (n = 87)	93% (n = 451)	93% (n = 68)
	Urban	12% (n = 12)	7% (n = 34)	7% (n = 5)

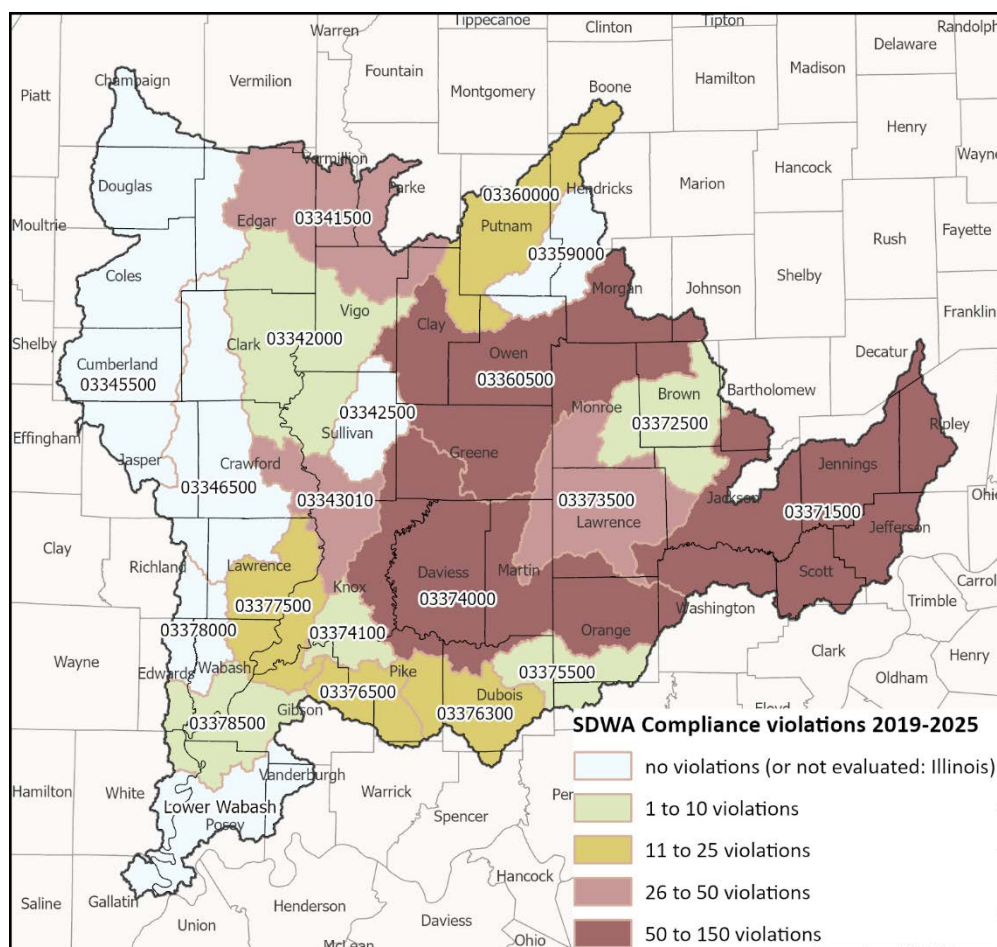


Figure 61. Distribution of public water utilities and recorded SDWA compliance violations in Southwest Indiana, 2019–2025. Violations were most common among small, rural utilities, many of which rely on limited local groundwater sources. Utilities are located throughout the study area except in Subbasin 13 (03342500, Busseron Creek near Carlisle, Indiana).

Williams Dam Removal Proposal

The Indiana Department of Natural Resources (DNR) commissioned a comprehensive alternatives study in July 2025 to evaluate the decommissioning of the 17-foot-tall, 300-foot-wide Williams Dam on the East Fork of the White River in Bedford. Originally built in 1910–1911, the dam is over 110 years old and has surpassed its useful lifespan. Decommissioning was proposed to eliminate severe public safety hazards—associated with a dangerous low-head hydraulic effect that has claimed at least nine lives—and to restore the natural flow and ecology for migrating fish and freshwater mussels. Although the study evaluated full and partial removal, Public Law 24-2025 prohibits IDNR from ordering the dam’s closure or removal if that action would affect public water service or the supply of water to private wells. Dam removal is not currently being pursued.

If decommissioning of the dam were to proceed, it would introduce distinct operational risks to local water utilities that rely on the hydrological conditions maintained by the impounded water. Specifically, two groundwater-based systems draw from the highly productive, river-fed White River and Tributaries Outwash Aquifer upstream of the dam: the North Lawrence Water Authority, which operates five wells approximately 3 miles upstream, and the South Lawrence Utility Corporation, which operates five wells (three currently in use)

about 7 miles upstream. Under the modeled normal-flow scenario, the river remains a gaining stream and projected groundwater-level declines at both wellfields are less than 1 foot. Under a conservative worst-case scenario, modeled declines reach as much as 9 feet at the North Lawrence wellfield and 2 feet at the South Lawrence wellfield, potentially reducing available drawdown and well yield.

The most acute and immediate risk is to the City of Bedford's municipal water utility, which operates a surface-water intake on the north bank of the river approximately 14 miles upstream of the dam. The intake system is designed to support a capacity of up to 7 MGD and relies entirely on the pooled river stages maintained by the dam's impoundment. Hydraulic modeling shows that removing the dam would lower the river's water surface elevation at the Bedford intake by 2.2 feet under normal flow conditions and by 2.6 feet during critical low-flow conditions. This substantial drop in water level could impair the physical ability of the intake to capture and gravity-feed raw water into its wet well and treatment plant, particularly during dry seasons when water demand is at its peak.

Reservoir Operations and Surface-Water Supply Reliability

Reservoirs are important regional water sources in Southwest Indiana (Figure 52). Their reliability depends on storage, inflow, operating rules, competing uses, drought conditions, sedimentation, water quality, and infrastructure capacity. There are two large reservoirs in the study area that provide water to more than 100,000 people: Monroe Lake (Bloomington Utilities) and Patoka Lake (Patoka Lake Regional Water). There are also several smaller reservoirs in the study area that are used by smaller utilities, including Hardy Lake (Stucker Fork), John Hays Lake (Salem), Scottsburg Lake (Scottsburg), and Lake Greenwood (Naval Support Activity Crane).

Monroe Lake was constructed in the mid-1960s under the flood control act of 1958 and contains a volume of around 182,250 acre-feet (nearly 60 billion gallons) of water during summer and winter operations (IDNR, 2011d). The City of Bloomington is authorized to withdraw up to 30 MGD and is currently the only major public water utility using Monroe Lake as a source.

Bloomington recently received permission to increase their withdrawal limits (formerly 24 MGD) after approaching their maximum capacity during intense summer droughts (Bloomington Herald-Times, 2024b).

Patoka Lake was constructed in the 1970s under the Flood Control Act of 1965 and on average contains a volume of around 165,000 acre-feet (nearly 54 billion gallons), with a slightly higher summer pool level than in winter (IDNR, 2011d). PLRWSD's two treatment plants have a combined firm capacity of 12 MGD and a design capacity of 15 MGD, while average production is approximately 7.7 MGD (IDEM, 2026d; PLRWSD PER, 2025). The utility projects that approximately 20 MGD of firm capacity will be needed by 2044 to accommodate customer growth (PLRWSD PER, 2025). Treatment capacity and average production should not be compared directly with the lake's total stored volume because not all reservoir water is available for utility withdrawal, and usable supply also depends on inflow, required releases, evaporation, operating levels, and Indiana's storage allocation.

In the future water availability assessment, future reservoir operations within this study area were assumed to remain consistent with historical operating conditions by applying historical monthly release patterns throughout the future simulation period. Consequently, projected changes in cumulative water availability primarily reflect changes in climate-driven hydrology rather than modifications to reservoir-operating policies.

In the future scenario, cumulative water availability remained substantially greater than local availability in downstream portions of the White and Wabash River watersheds. This difference reflects the combined influence of reservoir releases, upstream tributary inflows, and wastewater return flows, which help sustain downstream availability when local runoff declines.

Reservoir operations are especially important in the Patoka River watershed because natural groundwater contributions and locally generated runoff are comparatively limited. Releases from Patoka Lake support downstream flow in the same way that reservoir releases do elsewhere, but the Patoka has less local water available to supplement them. In the future climate scenario, reduced runoff decreases both local and cumulative water availability, making the watershed particularly sensitive to reservoir storage and release operations.

Monroe and Patoka Lakes have operated for more than 50 years, and sedimentation will gradually reduce their available storage as regional water demands grow. The water-availability analysis also shows that managed releases help sustain Lower Wabash flows during the dry Summer and Fall seasons. Long-range planning should therefore consider how existing reservoir storage and release functions will be maintained or supplemented. Options may include rehabilitation or sediment management at existing reservoirs, construction of new reservoirs, and reuse of suitable former quarries, dimension-stone mines, or underground coal mines. As discussed above, any former mine proposed for water storage would require a site-specific evaluation of capacity, water quality, leakage, recoverable yield, infrastructure needs, and permitting.

Conclusions

Southwest Indiana contains large volumes of water in its major rivers and reservoirs, but regional totals obscure substantial differences in local supply. Productive aquifers are concentrated along river valleys, whereas many upland and unglaciated areas depend on lower-yielding bedrock, long-distance public-water service, or reservoir sources. Water availability must therefore be interpreted in terms of accessibility, season, quality, treatment, and infrastructure, rather than just total volume.

Reported water withdrawals are dominated by largely non-consumptive thermoelectric cooling, whereas public supply, irrigation, rural livestock use, and selected industrial activities account for a much larger share of consumptive demand. Energy-sector transitions can sharply reduce withdrawals, but new industrial loads—including proposed data centers and fertilizer manufacturing—remain uncertain because their water requirements depend on project scale, cooling technology, reuse, and source-water and energy-service arrangements.

Future public-water demand reflects both baseline change and climate-sensitive seasonal use. Even when annual average demand changes modestly, Summer peaks can stress treatment, pumping, storage, and distribution capacity. Large utilities with wholesale customers are especially important because they serve broad areas and move water across subbasin boundaries; smaller rural utilities face different but significant source-water, infrastructure, and compliance constraints.

Under the intermediate-emissions climate scenario evaluated, many parts of the region are projected to have less water available from within their own subbasins, especially during Summer and Fall and during the dry future period. Downstream cumulative availability remains comparatively high along the Wabash and other major river corridors because of upstream inflows, wastewater return flows, and reservoir operations. The

increasing difference between local and cumulative availability means that downstream users may become more dependent on watershed-scale conditions and decisions outside their immediate subbasins.

Water quality and reliability are inseparable from quantity. Karst features permit rapid contaminant transport, mined lands can alter both storage and water chemistry, reservoir supplies face sedimentation and treatment constraints, and near-river pumping can interact with streamflow. Utility compliance and capacity data further show that a physically available source does not automatically translate into a reliable public supply.

The results are scenario-based and retain important uncertainties in future development, climate, facility operations, return flows, and source-water response. Even so, the analyses consistently point to the same planning needs: account for strong seasonal differences, protect areas that depend on a limited number of productive aquifers, recognize the growing importance of upstream flows and reservoir storage, track utility transfers across basin boundaries, and plan for peak demand and the amount of water that can actually be treated and delivered—not regional water volume alone.

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Glossary

Term	Definition
7Q10	The lowest 7-day average flow that occurs (on average) once every 10 years. In this study, the 7Q10 low flow was used as a minimum instream flow. Most NPDES discharges are permitted based on a 7Q10 low flow for adequate dilution.
Actual evapotranspiration	A measure of the amount of water that the earth surface and vegetation lose due to evaporation and transpiration.
Alluvium	Unconsolidated geologic sediment of any grain size deposited by a river, stream, or creek.
Anthropogenic	Man-made, or influenced by man. In this report, anthropogenic refers to interventions by humans, such as water withdrawals from aquifers and streams, wastewater returns, land use, land-cover modifications, and sources of contamination.
Aquifer	Subterranean voids, generally as bedrock fractures or interstitial voids in sand and gravel alluvium that facilitate the flow of groundwater.
Baseflow	The part of a flowing water body that represents the stream-adjacent groundwater surface and is not associated with runoff.
Basin (watershed)	The contributing land area that drains water, such as rainfall or snowmelt, to a basin outlet, or pour point. Also called a drainage basin or catchment.
Bedrock	Any lithified geologic material that remains intact and in place where it was deposited.
Biome	A biome is suite of vegetation and fauna that establishes in a certain location as a result of climatic (e.g., temperature, precipitation) and morphogenetic or topoclimatic factors.
Confined (aquifer)	An aquifer that flows beneath an impermeable geologic layer, allowing water pressure to build. Sometimes called “artesian” aquifer.
Continuous corn	The agricultural experiment of growing a monoculture of corn in the same field for multiple successive years rather than rotating crops.
Crop rotation	The agricultural technique of changing the specific crop that is planted in a given field from year to year to reduce nutrient depletion.
Discharge	Streamflow volume, usually measured in cubic feet per second (cfs) or cubic meters per second (cms). See stream discharge
Evapotranspiration	The removal of water from the earth’s surface and vegetation through the processes of evaporation and transpiration.
Excess water availability	Water available for beneficial uses after other needs and demands are met, such as water withdrawals and ecosystem needs

Fall	Season, Autumn. Defined as September-October-November
Glacial till (till)	An often thick, poorly sorted, clay-rich, unconsolidated geologic deposit that is created by the movement of a glacier.
Headwaters	The most up-gradient, or first-order, tributary watersheds contributing water and sediment downstream to the stream network.
Hydrograph	A graph showing stream discharge (y-axis) over time (x-axis), reflecting runoff from the area upstream of the measurement point.
Hyporheic flow	The area of a watershed adjacent to and below a stream channel where active exchange of surface water into subsurface sediments, mixing with near-surface groundwater, and then back to surface flow occurs.
Induced recharge	A hydrologic condition where the level of the underground water table in an area is lower than the level of a nearby surface drainage, causing the groundwater to be recharged from the drainage.
Indiana Department of Environmental Management	IDEM, Ground Water Section, maintains the Indiana Groundwater Quality Monitoring Network; Confined Animal Feeding Section; Virtual File Cabinet; Drinking Water Branch
Indiana Finance Authority	Funding agency for this study
Indiana University	IU, provided expertise and research infrastructure for this study.
Instream flow	Minimum instream flow is a lower limit on streamflow that is used as a drought-response threshold. Guidance on minimum instream flows are intended to ensure a supportive hydrologic environment for riparian ecosystems.
Interflow	Shallow subsurface flow down gradient along a hillslope.
Irrigation well	Water well that extracts groundwater from an aquifer for the purpose of amending the available water for plant, often crops or turf, growth.
Mann-Kendall trend test	A statistical test used to assess temporal datasets for increasing or decreasing trends as well as statistical significance of the trend. The Mann-Kendall test does not assess the magnitude of change. See Sen slope.
Natural baseflow	Discharge from aquifers to streams. Baseflow is the groundwater contribution of streamflow. Streams can have gaining (groundwater contribution to the stream) or losing (water loss from the stream bed to recharge groundwater) reaches. Natural baseflow is an estimate of the groundwater discharge contribution to a stream reach without considering anthropogenic (man-made) interventions such as water withdrawals or wastewater-return flows.
Natural streamflow	The streamflow that would be measured if anthropogenic (man-made) effects of surface-water and groundwater withdrawals and wastewater return flows were removed.

Net Infiltration	The theoretical amount of water that could be added to a groundwater aquifer through the process of infiltration after other components are satisfied. “net_infiltration” is the variable name in SWB2 for potential groundwater recharge.
Observation well	A subsurface borehole (groundwater well) that, instead of pumping, is used to observe and monitor the water-table elevation.
Outwash	The geologic alluvium deposited by meltwater from a receding glacier.
Patoka Lake	Patoka Lake Regional Water and Sewer District (PLRWSD)
Peaking factor	Ratio of maximum water demand to the average demand, such as peak daily demand to average daily demand.
Peak use multiplier	Ratio of maximum water demand to the minimum demand. Similar to peaking factor, but maximum demand is relative to minimum demand (not average demand).
Potential evapotranspiration	The theoretical maximum amount of water that could be suspended in the atmosphere, assuming the surface water available for evaporation and transpiration is not limited.
Potential groundwater recharge	The theoretical amount of water that could be added to a groundwater aquifer through the process of infiltration after other components are satisfied. “net_infiltration” is the variable name in SWB2 for potential groundwater recharge.
Public Water System	PWS, water utilities that distribute water from either surface-water or groundwater sources. A PWS can be a community system that serves a large population, or a non-community non-transient (NCNT) system such as a school that has their own water well(s). PWS are subject to the LCR.
Recharge (groundwater recharge)	The amount of water that is added to a groundwater aquifer through the process of infiltration.
Runoff	Precipitation that is unable to infiltrate into a groundwater aquifer and instead flows along the earth’s surface.
Sankey diagram	A Sankey diagram is a data-visualization tool to illustrate flow from one set of values to another.
Sen slope	Theil–Sen estimator of slope used along with the Mann-Kendall trend test to calculate the magnitude of trends in the long-term temporal data.
Spring	Season. Defined as March-April-May
Streamflow volume	Streamflow discharge, usually measured in cubic feet per second (cfs) or cubic meters per second (cms)
Stream discharge	Streamflow volume, usually measured in cubic feet per second (cfs) or cubic meters per second (cms)

Stream gage	A location where a flowing body of water is confined to a known geometry to facilitate the estimation of flow volume.
Subwatershed	A smaller portion of a larger watershed, defined as the region up-slope from or above a given point that directs rainwater toward that point as drainage.
Summer	Season. Defined as June-July-August
Surface water	Locations where there is an uninhibited interface between water and the atmosphere, either due to the water table being exposed at the earth's surface or because of water flowing over an impermeable surface.
Till (glacial till)	An often thick, poorly sorted, clay-rich, unconsolidated geologic deposit that is created by the movement of a glacier.
Unconfined (aquifer)	An aquifer that does not flow beneath an impermeable geologic layer and is free to flow in accordance with gravity. Sometimes called "water table aquifer" in shallow wells.
Unconsolidated	Geologic material (such as sediment, alluvium, soil, and till) that has not gone through the process of lithification.
Water budget	An accounting method of calculating the net sum movement of water into and out of a hydrologic system through precipitation, evapotranspiration, recharge, and runoff.
Water cycle	The conceptual model that describes the closed-loop system of water – from water vapor in the atmosphere to precipitation, then through or across the surface as infiltrated groundwater or runoff (respectively), and back into the atmosphere as water vapor by the processes of evaporation and transpiration.
Water demand	The amount of water required for different purposes and in different water-use sectors, such as for residential, institutional, industrial, and public water supplies. Demand is often quantified by water-withdrawal volumes.
Watershed (basin)	The contributing land area that drains water, such as rainfall or snowmelt, to a basin outlet, or pour point. Also called a drainage basin or catchment.
Winter	Season. Defined as December-January-February

Technical Appendices

Appendix A: Data Sources and Processing

Appendix B: Utility Analyses

Appendix C: Water Balance Graphs

Appendix D: Water Demand, Return-Flow, and Upstream Boundary-Condition
Projection Methods

Appendix E: Water Demand Results

Appendix F: Fact Sheets: Southwest Indiana Subbasin Water Resources

Appendix G: Water Availability Assessment Framework and Modeling Methods

Appendix H: Water Availability Results