Central Indiana's Regional Water Supply

A WATER SYNTHESIS REPORT WITH RECOMMENDATIONS FOR FUTURE MANAGEMENT

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INDY CHAMBER

Wittman Hydro Planning Associates,
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A Water Synthesis Report with Recommendations for Future Management

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EXECUTIVE SUMMARY

Population growth, variable weather conditions, and water-quality degradation in central Indiana require skilled management of our regional resources. As water becomes more valuable throughout the United States, central Indiana can become an economic destination. Long-term planning based on efficient use and a regional approach to managing finite water supplies will improve our economic opportunities, promote continued regional growth, and help secure central Indiana's future.

Indiana law allows individual high-capacity users to extract supplies from shared resources without considering the timing, purpose, or impact of their withdrawals. This local approach limits use of resources and is more likely to result in conflicts between users. Local single-user management generates a patchwork of uneven supply and demand and a general uncertainty in future yield. High-capacity users compete for the regional resource rather than work together to sustainably manage the resource to benefit all.

This approach to managing supply and demand does not provide flexibility during droughts or other water shortages. Where the region's water systems are not interconnected, it is impossible to move water when local demands outpace local supplies. This inability to move water between users means that during emergencies, a high-capacity user may not have an alternative source of water. During normal conditions, utilities may lose revenue because these individual utilities are not able to sell their excess water.

The existing patchwork of local water delivery systems does not provide economies of scale for supply, regulatory compliance, funding, support systems, or treatment. Some individual high-capacity users do not have reliable supplies or systems that are required for economic growth. Furthermore, water rates will continue to increase as additional infrastructure and regulatory compliance is required. If no change occurs, the region will be unprepared for future growth and unable to serve increasing demands in an affordable and reliable manner.

Compounding strain on central Indiana's water resources is the region's growing population. Hamilton and Hendricks counties are two of the fastest growing counties in the United States (U.S. Census Bureau, 2004). The population in these two counties and in Boone, Hancock, and Johnson counties is expected to increase more than 20 percent between 2005 and 2025 (Indiana Business Research Center, 2008). A 2004 central Indiana water report states that the region's surface water supplies are nearly fully developed and that net surface water use will likely exceed minimum stream flow requirements (7Q10) before 2020 (Malcolm Pirnie, 2004). As a result, central Indiana's surface water supplies will no longer be available to meet future water demand. Public water suppliers, industrial users, and energy producers (the three largest withdrawers of surface water) will have to use groundwater when new sources are needed. Currently, groundwater is central Indiana's buffer against drought. However, if groundwater withdrawals increase, less will be available during water shortages. Consequently, managing central Indiana's surface water and groundwater supplies now is imperative for the region's continued economic vitality.

The following are recommendations for cooperatively managing central Indiana's shared water resources.

1. Recognize the value of common goals among water users
2. Capture the value of the data needed to manage our water
3. Develop a regional conservation strategy
4. Create a regional water consortium to protect supplies
5. Change state law to require regional plans
6. Develop a regional water management plan

1 INTRODUCTION

Central Indiana's regional water supply has so far, kept up with demand. However, as the region grows, there is pressure on our water supply that requires us to plan today, or face a shortage tomorrow. Supplies are not limitless and are not always available where they are needed. Productive aquifers are not evenly distributed across the region, and surface waters are often limited by seasonal drought and poor water quality. Increasing demands from municipal utilities, power production, and irrigation may seasonally strain supplies and regulators must attempt to balance these demands with the needs of the aquatic systems. The amount, availability, and occurrence of central Indiana's water resources is ultimately the result of natural factors that we cannot change; however, we do control how we regulate, use, manage, and maintain this finite resource. Long-term planning based on a commitment to efficiently use and manage finite water supplies will provide economic stability, allow continued regional growth, and help secure central Indiana's future. It is imperative that central Indiana begins managing its water supplies to meet tomorrow's demands.

This report is designed to explain the distribution, timing, and availability of central Indiana's surface water and groundwater resources. In a parallel discussion we outline where we use water, what we use it for, and how that use is changing. For the purposes of this report, central Indiana is defined as Boone, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Morgan, and Shelby counties. Each county uses different amounts of water for different purposes. After describing where the water exists on the landscape and how we are using these supplies, the regulatory and policy framework is described. Lessons are offered from other Midwestern communities and recommendations are made for the future.

2 WATER AVAILABILITY IN CENTRAL INDIANA

Central Indiana's water demands are met using both surface water and groundwater. High-capacity users' primary supply source varies throughout the region, reflecting the availability of different sources. When water is available, it is impacted by seasonal changes in weather. How much water is available is also influenced by local geology and water quality.

2.1 Rivers, Streams, Reservoirs

Surface water is the water that flows in streams and rivers, and collects in lakes and reservoirs. Central Indiana has over 2,300 miles of streams that include portions of the West Fork of the White River, Big Blue River, Sugar Creek, Fall Creek, and Big Walnut Creek (Figure 1). In addition to the stream network, there are approximately 50 reservoirs in the region that have a surface area of 50 acres or greater or have a storage capacity of 32.5 million gallons or more (Clark, 1980). These reservoirs were built by the State for flood control and low-flow regulation, and over time they have become destinations for recreational users. Central Indiana also contains three major reservoirs: Geist Reservoir, Morse Reservoir, and Eagle Creek Reservoir. Morse and Geist reservoirs, which are owned by Indiana Water, are used to assure dependable flows in the White River and Fall Creek, respectively. Eagle Creek Reservoir, which is owned by the city of Indianapolis, is used as a supply source. While there are many streams in central

Indiana, most are not suitable water sources because they do not sustain adequate flows for withdrawal purposes throughout the year (Figure 1).

The White River supports the largest number of high-capacity withdrawals in central Indiana. However, unlike some other major rivers in Indiana, such as the Kankakee River and the St. Joseph River, the White River does not maintain high base flow during low-flow conditions. The low base flows are due to the relatively narrow band of sand and gravel deposits underlying the river, which limits the contribution of groundwater to base flow.

Since most high-capacity users require a constant supply of water, it is not enough have a source; the source must also be reliable. Reliable stream flows are represented by the 90 percent exceedence statistic. This statistic is the discharge that has been exceeded 90 percent of the time within a given period, or stated differently, discharge was less than this value 10 percent of the time. In this report, the 90 percent exceedence statistic is calculated for the period of 1/1/2007 to 12/31/2007; precipitation was approximately 3.5 inches below normal for the entire year. Each stream that receives discharge that is permitted by the State of Indiana under the National Pollution Discharge Elimination Systems program must maintain a minimum flow to protect water quality. Therefore, the streamflow available for withdrawals during low flows is often less than the 90 percent exceedence value.

The most reliable stream flows in central Indiana are in the West Fork of the White River in southwestern Morgan County (near Centerton) (Table 1). The Centerton gaging station is the farthest downstream station on the White River for this region and stream flow increases downstream. The least reliable stream flows are in Pleasant Run Creek, which is a small creek that runs through Indianapolis. Stream flows in Fall and Eagle creeks can be augmented from Geist and Eagle Creek reservoirs during low flows, which increase their reliability.

Geist, Morse, and Eagle Creek reservoirs began operating in 1943, 1955, and 1969, respectively. Reservoirs in central Indiana are created by damming a section of previously free-flowing rivers and streams. While there are many reservoirs in central Indiana, only the three large ones (Geist, Eagle Creek, and Morse reservoirs) are used for water supply and the other are used for flood control and recreation. Geist and Eagle Creek reservoirs are in Marion County, and Morse Reservoir is in Hamilton County (Figure 1). Each reservoir had an initial storage capacity between 21,000 – 25,380 acre-feet; however, over time, sediments have built-up in the reservoirs, reducing their storage capacity (Table 2). Sediment accumulation is a problem because it reduces a reservoir's storage capacity and usefulness for flood control and water supply.

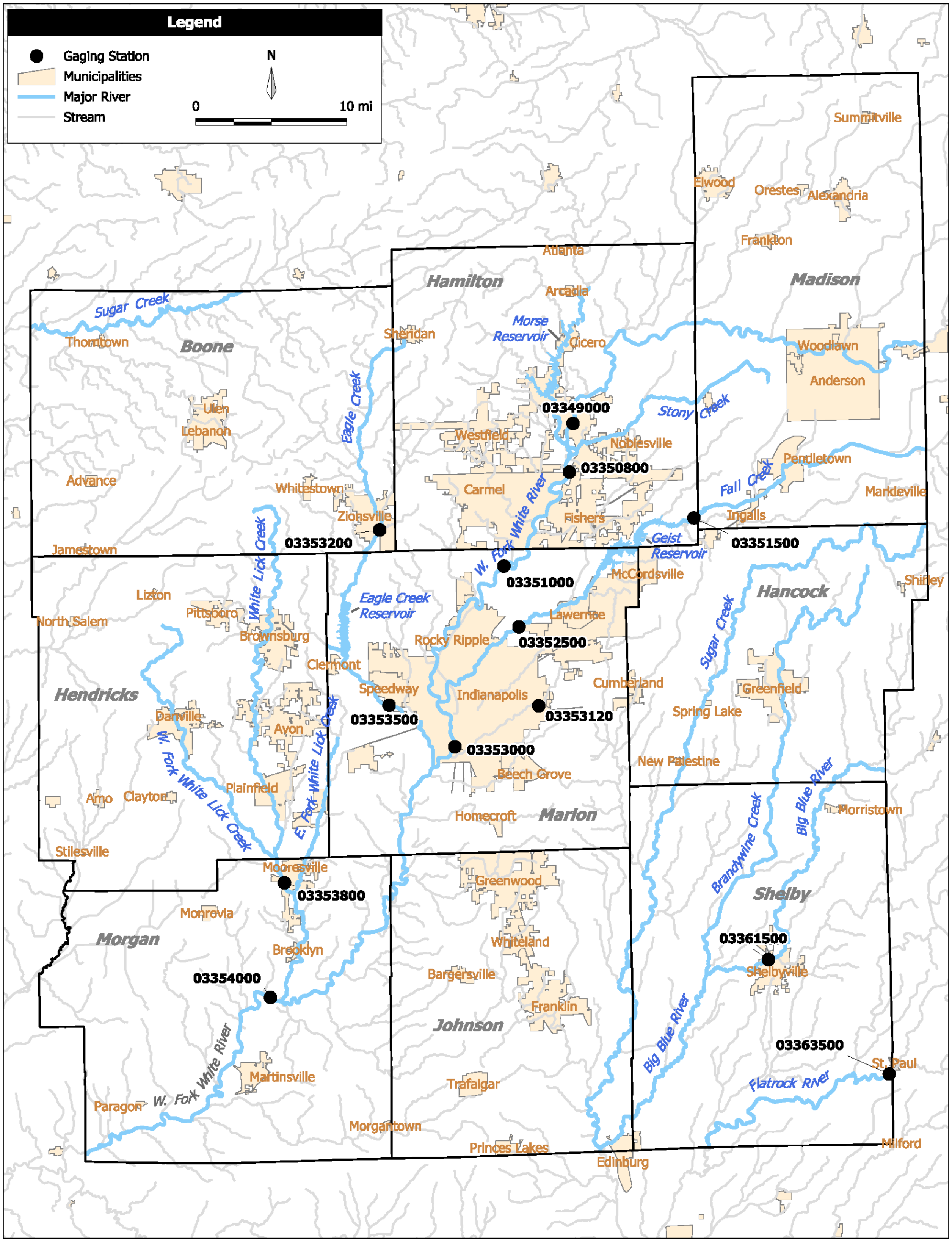

Figure 1. Rivers, streams, and reservoirs in central Indiana. Discharge values for the gaging stations shown are reported in Table 1.

Table 1. Flow characteristics of selected streams in central Indiana (USGS, 2007). The gaging stations are listed in downstream order for each stream, and the locations are shown in Figure 1.

Gaging Station	Station No.	90% Exceedence[1] (2007, MGD[4])	50% Exceedence[2] (2007, MGD)	10% Exceedance[3] (2007, MGD)	2007 Annual Total (MGD)
White River					
At Noblesville	03349000	74	314	2,028	289,135
Near Noblesville	03350800	113	346	2,694	378,525
Near Nora	03351000	118	385	2,778	399,921
At Indianapolis	03353000	109	471	3,547	516,392
Near Centerton	03354000	269	730	5,497	763,814
Fall Creek					
Near Fortville	03351500	21	68	359	60,212
At Millersville	03352500	39	78	608	94,249
Pleasant Run					
At Arlington Ave at Indianapolis	03353120	0	1	12	2,315
Eagle Creek					
At Zionsville	03353200	4	16	187	29,648
At Indianapolis	03353500	7	12	300	44,237
White Lick Creek					
At Mooresville	03353800	15	35	397	58,106
Big Blue River					
At Shelbyville	03361500	34	140	891	136,386
Flatrock River					
At St. Paul	03363500	5	57	585	89,319

[1]The discharge that has been exceeded 90 percent of the time for the designated period.
[2]The discharge that has been exceeded 50 percent of the time for the designated period.
[3]The discharge that has been exceeded 10 percent of the time for the designated period.
[4]Millions of gallons per day

Table 2. Change in storage capacity of the three major reservoirs in Marion and Hamilton counties.

Reservoir	Initial Storage Capacity (acre-feet)	Age	2003 Storage Capacity (acre-feet)
Geist	21,000	67	19,280
Morse	25,380	55	22,820
Eagle Creek	24,000	41	23,296

Source: Black & Veatch, 2003

2.1.1 Annual/Seasonal Variation

Precipitation, runoff, and groundwater all contribute to surface water supplies. Indiana receives approximately 38 inches of rainfall a year. A portion of the 38 inches falls directly into the streams and reservoirs in central Indiana; the amount of precipitation a water body receives depends on its surface area.

Approximately 12 inches of the total 38 inches becomes runoff (Governor's Water Resource Study Commission, 1980). Runoff occurs when the land surface can no longer absorb rainfall during a rain event or when rain cannot pass through the surface it is falling on, for example parking lots and roads. The amount of runoff that enters a stream or reservoir depends on the intensity and duration of the rain event, the time of year, the condition of the surrounding soils, and the extent of impermeable surfaces. Runoff is greatest during the spring in central Indiana and is a major source of supply to surface waters.

The last supply component to surface water is groundwater. Groundwater discharges from aquifers into streams and reservoirs, and sustains a stream's base flow or a reservoir's water level. Base flow is the water flow in a stream during low-flow conditions and is present on a more or less continuing basis. Streams in groundwater-rich areas typically have higher, more dependable sustained flows than streams in groundwater-poor areas (Indiana Department of Natural Resources, 1990a).

2.1.2 Water Quality

Surface water availability is also impacted by water quality. If water is contaminated, it cannot be used for some purposes. The most common contaminants detected in central Indiana's rivers are pesticides, nitrates, and urban contaminants (Figure 2). Pesticide concentrations peak following late spring and early summer application because pesticides attached to soil particles are picked up by runoff during spring storms and washed into streams (Figure 3) (Fenelon, 1998). Surface waters are also contaminated by nitrate that runoff during storms or from airborne nitrate that combines with rain or falls as dry particles. The primary source of nitrate in the White River Basin is nitrogen fertilizer (Martin et al., 1996). Central Indian's several urban areas are a source for organic compounds, heavy metals, and nutrients that end up in surface waters and groundwater. Urban contaminants come from sources such as sewers, industrial discharge pipes, landfills, combined-sewer overflows, and chemical spills.

The Indiana Department of Environmental Management (IDEM) carried out water-quality monitoring of the White River in 2004. This monitoring is required by the 1972 Federal Clean Water Act, and helps identify waters that do not meet Indiana's water-quality standards for human health, full body contact recreation, aquatic life, and wildlife. Waters that do not meet these standards are added to Indiana's List of Impaired Waters. The three leading causes of surface-water impairments in central Indiana are 1) E. coli, 2) fish consumption advisories caused by mercury or PCBs, and 3) impaired biotic communities.

In central Indiana's reservoirs, elevated nitrate and phosphorous concentrations coupled with warm, slow-moving water creates a favorable environment for Cyanobacteria growth, which are more commonly known as blue-green algae. During periods of high nutrient concentrations in lakes, blue-green algae numbers explode, creating a floating mat that looks like pond scum. The algae produce

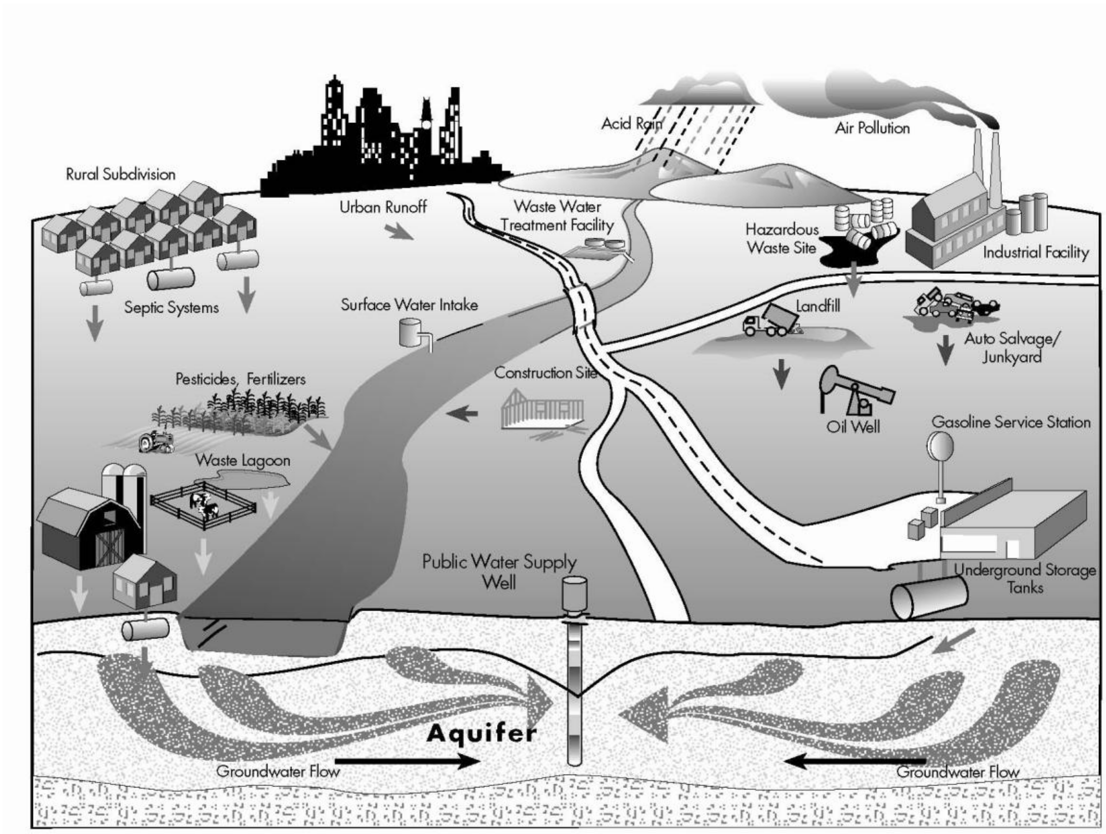

Figure 2. Sources and pathways for surface and groundwater contamination (Leatherman and Wilson, 1999*).*

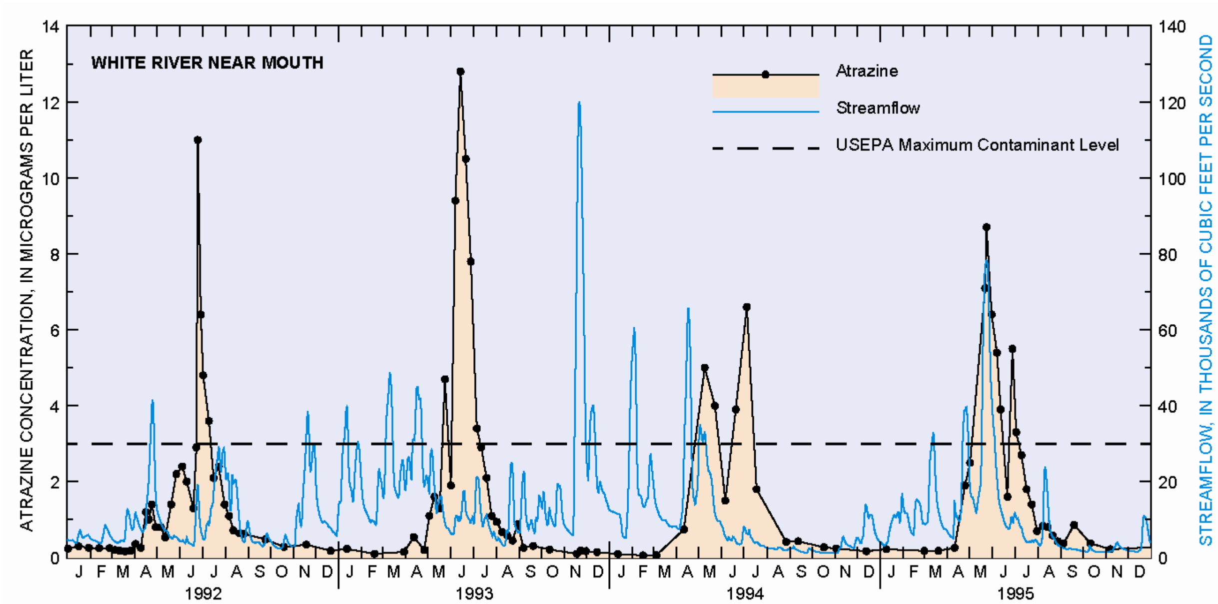

Figure 3. Pesticide and herbicide concentrations in rivers show a seasonal pattern - the seasonal pattern for concentrations of the herbicide atrazine in the White River Basin was typical of the pattern observed for most of the commonly used herbicides and pesticides (Fenelon, 1998).

toxins that are released into the water when they die. Blue-green blooms, which create aesthetic and taste and odor problems, have occurred in Geist, Morse, and Eagle Creek reservoirs.

2.2 GROUNDWATER

Groundwater is the water between pore spaces and fractures in subsurface soils and rocks, and aquifers are the subsurface materials that absorb, store, and transmit the groundwater. The availability of groundwater in a given area depends on

- the aquifer material;
- the amount of precipitation;
- the capacity of the overlying soils to absorb precipitation; and
- the properties of the aquifer, such as areal extent, thickness, porosity, and permeability.

Central Indiana is the transition zone between groundwater-rich northern Indiana and groundwater-poor southern Indiana (Governor's Water Resource Study Commission, 1980). The groundwater resources of the region are fair to good, but the productive aquifers are not evenly distributed.

The most productive aquifers are sand and gravel deposits adjacent to and under major streams. These deposits are limited to a narrow band along the White River and a few other large streams (Figure 4). High capacity wells regularly yield 500-2,000 gallons per minute (gpm) from these aquifers (Indiana Department of Natural Resources, 2002). Precipitation moves easily downward into the sand and gravel deposits because there is no overlying clay layer to impede its movement. The least productive aquifer system is in portions of Hendricks, Morgan, and Johnson counties. Here aquifer material is typically less than five feet thick, limiting yield and making it suitable only for domestic wells.

Bedrock aquifers in central Indiana do not yield as much water as sand and gravel aquifers (Figure 5). Low yields limit the use of bedrock aquifers for public supply; however, they are used for other purposes, such as domestic wells and irrigation wells. The most productive bedrock aquifer system is the Silurian and Devonian carbonates that underlie the northeastern and eastern portion of the region. This system is the only bedrock aquifer capable of supporting high-capacity wells (Indiana Department of Natural Resources, 2002). The bedrock system in the other half of the region is composed of unproductive Mississippian and Pennsylvanian shale and sandstone. Water quality can also limit the use of bedrock aquifers; the incidence of mineralized or saline groundwater increases at bedrock depths of 300 feet or greater (Indiana Department of Natural Resources, 2002).

2.2.1 Annual/Seasonal Variation

Recharge, which is the precipitation that infiltrates through soil layers into the aquifer, is the main source for replenishing groundwater. Throughout Indiana, recharge is estimated to be 3 inches; however, this value varies locally depending on the time of year, surrounding land uses, and soil conditions (Governor’s Water Resource Study Commission, 1980). Generally, groundwater levels are highest in the spring and decrease through the summer as recharge decreases and withdrawals increase. However, fluctuations in groundwater levels are generally much less than fluctuations in

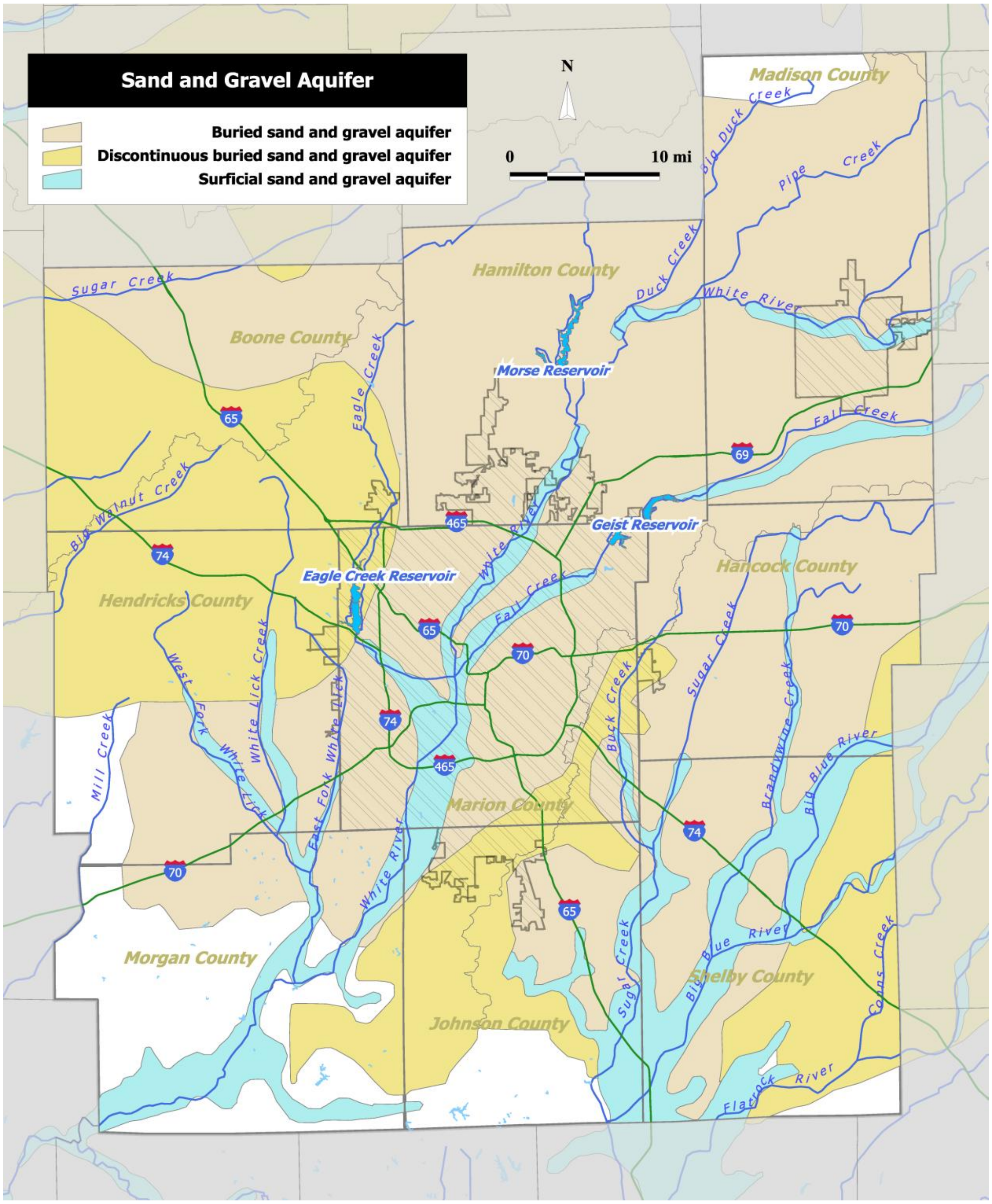

Figure 4. Sand and gravel aquifers in central Indiana (USGS and IGS, 2008b).

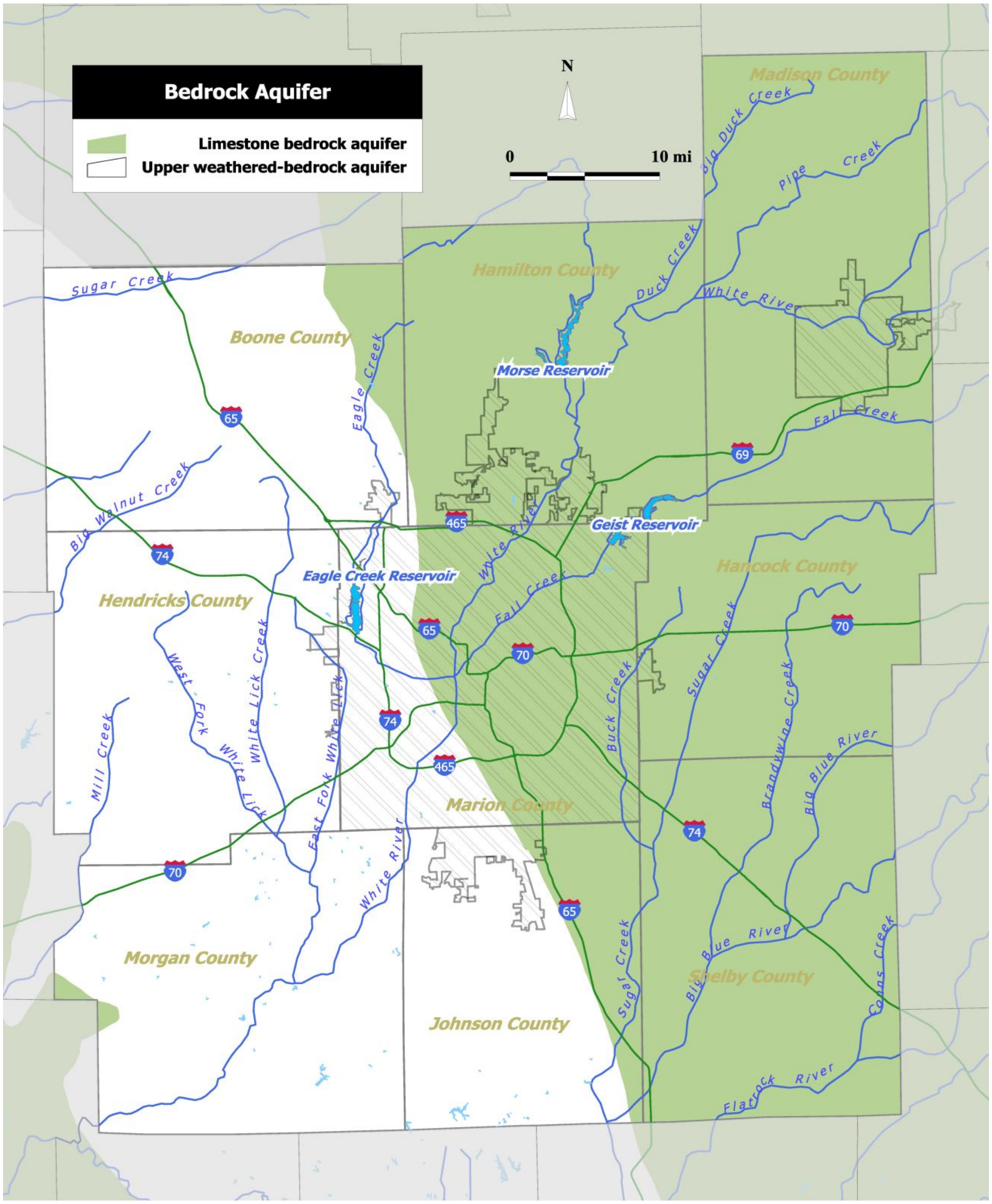

Figure 5. Bedrock aquifers in central Indiana (USGS and IGS, 2008a).

surface water. There are areas where the withdrawal rates are greater than recharge and the groundwater levels continuously decrease with time.

2.2.2 Water Quality

Like surface water, groundwater is susceptible to contamination. Pollution from industrial activities, commercial businesses, leaking underground storage tanks, septic systems, and agricultural activities will limit groundwater availability in the future. Typically, when a drinking well's water becomes contaminated, the well must be abandoned and another water source found. Remediating a contaminated aquifer or treating contaminated groundwater can be very expensive. When contaminants enter an aquifer they form a plume that extends down gradient and fills the void spaces of the rock and soil. Treating a plume is expensive, time consuming, and sometimes impossible.

The vulnerability of groundwater to contamination depends on the characteristics of the underlying aquifer. Aquifers composed of coarse-grained deposits such as sand and gravel, where water can easily move downward, are most vulnerable to contamination (Figure 6); aquifers with an overlying clay layer are less vulnerable to contamination. Sand and gravel aquifers are a major source of water in central Indian, and can easily be contaminated (Fenelon, 1998).

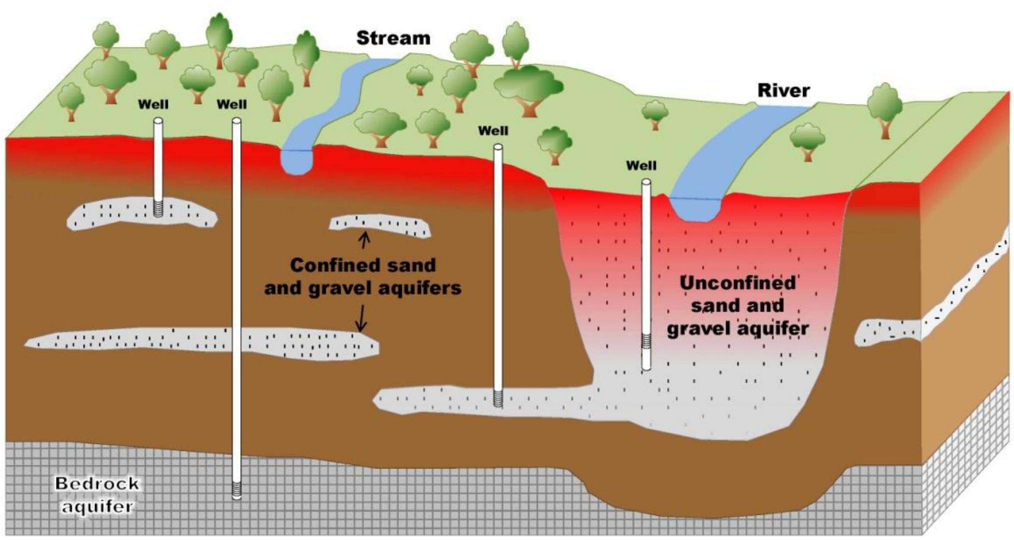

Figure 6. Aquifer type and depth determine vulnerability to nitrate contamination (Fenelon, 1998).

The contaminants that degrade surface water also impact groundwater. Pesticides are detected in central Indiana's groundwater, but their occurrence and concentration are low; they are commonly detected at greater concentrations in surficial sand and gravel aquifers than in deeper aquifers. Nitrate concentrations are also high in surficial aquifers, especially when beneath cropland. Nitrate contamination typically diminishes with depth in surficial sand and gravel aquifers in part because nitrate is diluted as it moves down through the aquifer (Figure

6). Low concentrations of volatile organic compounds and solvents have been detected in urban groundwater; however, most of the contamination occurs in shallow aquifers (Fenelon, 1998). Other sources of groundwater contamination include leaking underground storage tanks and wastewater lagoons.

2.3 IMPACTS ON WATER AVAILABILITY

Central Indiana's water resources are not limitless. Several factors, some natural and some human made, impact the amount of water that can be withdrawn from our surface water and groundwater resources.

2.3.1 Drought

Dry weather is common during Indiana summers, and proper water resource management requires understanding water availability and viable alternatives that are available during water shortages. The occurrence of drought depends on ones relationship with water and the definition of a drought. Droughts are measured for different purposes using different criteria: precipitation and temperature statistics, groundwater levels, low-flow characteristics, soil moisture values, and economic factors such as crop yields (Water Shortage Task Force, 2009). Table 3 lists common drought definitions based on different perspectives. These droughts do not occur separately and often overlap.

Table 3. The six drought types recognized by the World Meteorological Organization (modified from Water Shortage Task Force, 2009)

Drought	Explanation
Meteorologic drought	Defined only in terms of precipitation deficits in absolute amounts for specific durations
Climatologic drought	Defined in terms of precipitation deficits, not in specific amounts but as a ratio of actual precipitation to mean or normal values
Atmospheric drought	Involves not only precipitation but possible temperature, humidity, or wind speed
Agricultural drought	Involves principally soil-moisture content and plant physiology, perhaps for a specific crop
Hydrologic drought	Defined in terms of reduced streamflow, reductions in lake or reservoir storage, and declining groundwater levels
Water-management drought	Characterizes water deficits resulting from water management practices of facilities

Dry, hot weather that lasts for more than a couple weeks can have adverse impacts on water availability in the state. Low precipitation and high temperatures during droughts reduce streamflow and are usually coupled with increased withdrawals. In Indiana, the commonly accepted minimum streamflow is the 7Q10, which is the lowest streamflow for 7 consecutive days that would be expected to occur once in 10 years (Water Shortage Task Force, 2009).

Groundwater can be used to augment dwindling surface water supplies during water shortages if the appropriate infrastructure is in place. However, if a well is pumped at a faster rate than the aquifer is recharged, the water level will decline. This can happen during extreme rainfall deficits or if several wells are pumping at the same time when rainfall is less than normal.

Central Indiana experienced droughts lasting multiple years in the 1930s, 1950s, 1960s, and 1980s. The 1988 drought served as the catalyst for addressing the impact of water shortages on the health, safety, and economic well-being of the state. Indiana created a Water Shortage Task Force (WSTF) to develop a plan to assess and manage Indiana's water resources during a water shortage. The WSTF recommendations for mitigating the impact of water shortages range from water conservation to implementing a water shortage stages advisory system.

2.3.2 Groundwater Withdrawal Impacts on Surface Water Availability

In addition to low flows caused by droughts, groundwater withdrawals impact surface water availability. Streams and groundwater interact in two primary ways: streams gain water from inflowing groundwater through the streambed, and streams recharge groundwater when water levels are higher in the stream than in the aquifer. Pumping wells intercept or capture groundwater that would have otherwise discharged into a stream and contributed to base flow. Pumping can actually draw water from a stream into the well particularly during low rainfall periods. The impact on the stream depends on the well's proximity and pumping rate.

The impact of groundwater withdrawals on surface water flows is not well quantified in central Indiana. Applicants applying for groundwater withdrawal permits are not required to demonstrate that the proposed withdrawals will not adversely impact surface water resources.

2.3.3 Wastewater Assimilation

Low precipitation and high temperatures during droughts reduce streamflow. The 7Q10 criterion is used for determining the treatment level required for discharges into the state's streams so that water- quality standards will still be met when stream flow is as low as the 7Q10 value. Therefore, maintaining flows above the 7Q10 is important for protecting water quality. Below the 7Q10 flow there is not enough "clean" water in the stream to adequately dilute the regulated discharge. However, a higher stream flow may be necessary to protect aquatic life and ecological integrity.

2.3.4 Recharge

Groundwater is replenished by precipitation; this replenishment mechanism is called recharge. The rate at which an aquifer is recharged depends on surficial geology, climate, land use, depth to water table, and vegetation. Groundwater levels are highest during the spring wet season, and decline during summer and fall because of reduced recharged and increased evapotranspiration (Indiana Department of Natural Resources, 2002). During droughts, groundwater levels drop even more because of decreased recharged and increased pumping due to greater demand. Quantifying recharge rates is necessary for accurately assessing sustainable withdrawals.

2.3.5 Well Interference

In addition to reduced recharge, well interference can also limit groundwater availability. When a high-capacity well is pumping, the local water table lowers, producing a cone of depression in the water table around the well. Well interference occurs when other wells are located within the cone of depression. The reduction in available drawdown reduces the capacity of other wells, and in extreme cases, interference can make other wells unusable. Indiana does not require an assessment of the impact a new well will have on surrounding wells.

2.3.6 Water Conservation

While several factors limit water availability, water conservation can extend supplies. Water conservation is a long-term strategy to meet water demands, extend the life of existing surface and groundwater supplies, and promote wise stewardship of a finite resource. Typical programs target both the water utility and its customers.

Water conservation is not about restricting a customer's water use but rather changing their behavior to use water more wisely and efficiently. Conservation programs typically target both indoor and outdoor water use; however, the largest reductions can be made by improving the way residential, commercial, and industrial customers water their landscapes. Outdoor water use contributes to summer peaks, which drives infrastructure expansions and development of new supply sources. Indoor water use has been decreasing since the passage of the 1992 Energy Policy Act, which set uniform water efficiency standards for showerheads, faucets, urinals, and toilets manufactured after January 1994. Indoor water use is projected to continue to decline for another 20-25 years as high-volume models are replaced and the plumbing code is updated (Vickers, 1999). As a result, many conservation programs primarily focus on reducing outdoor water use.

Public education is a necessary strategy for changing the common mentality of water being an unlimited resource to one of water being a limited resource. During droughts or water shortages, water users generally are willing to modify their behavior because there is a perceived water shortage. However, after the return to normal weather, users do not maintain their same level of water savings and revert back to previous behavior. Many communities have effective public education campaigns; two award-winning examples are Denver, Colorado and Cary, North Carolina. Denver Water started a campaign called *Use Only What You Need*. The campaign uses humor and flashy advertising to educate the community about reducing water waste. It has been so successful that 80 percent of Denver Water's customers recognize the campaign and support its message. The town of Cary created an annual *Beat the Peak* campaign to reduce summer peak demand and change the public's attitude toward the value of water. An effective public education campaign is crucial for a successful water conservation program.

In some instances, a utility may be the largest contributor to water waste because it does not have an active leak-detection and repair program. Some utilities resist including a program in their conservation plans because high water loss can be politically embarrassing (Vickers, 1999). Yet repairing system water leakage is one of the most cost effective and accessible sources of additional supply. The amount of savings that a utility can achieve with a leak-detection and repair program depends on the age of the infrastructure. Greater water savings can be achieved in older systems than in newer systems.

Agricultural and industrial operations can incorporate more efficient water use methods as well. Decreasing agricultural water use involves improving irrigation application efficiency; increasing precipitation capture and use; and adopting new technologies for water management. Industrial users can save substantial water by modifying cooling processes to recycle water, reusing water in another process, and using water efficient technology.

2.3.7 Water Reuse

In addition to water conservation, re-using water can positively impact water availability because water that would otherwise be discharged downstream is used a second time. Two common re-uses of water are: 1) using recycled water as an alternative water supply and 2) injecting water back into the ground.

An alternative water supply provides water for irrigation, cooling, or other uses that do not require potable water. Alternative water supplies may include harvested rainwater and stormwater, graywater, reclaimed water, and other lower-quality sources. Using these alternative sources for appropriate uses reduces demand for potable water, defers future expansion of treatment facility capacity, and may decrease utility operating costs. Water from an alternative supply must remain separated from potable supplies and is not to be used for drinking, bathing, or cooking.

The second option, injecting water back into the ground for later use, is referred to as aquifer storage and recovery (ASR). This technology is similar to storing water in a reservoir; however, the water is stored below ground in an aquifer. The water that is injected into the aquifer can be storm runoff or treated waste water. The water is stored in the aquifer for use during periods when supply exceeds demand. A major advantage of storing water in an aquifer rather than in a reservoir is that the water does not evaporate. Also, injecting water may restore and expand an aquifer with declining water levels. However, the degree to which an ASR system achieves useful storage varies because of the complex hydrogeology of aquifers.

3 WATER DEMANDS IN CENTRAL INDIANA

Central Indiana uses surface water and groundwater to meet a variety of demands including public supply, industrial, commercial, and agricultural. Within the region, 59 municipal and private water utilities provide water to 1,400,000 residents. The municipal and private water suppliers mainly serve the domestic needs of residential customers, but also provide water for commercial and industrial customers. However, some industrial and commercial facilities, some residents, and most agricultural users obtain their own water directly from the source rather than relying on a water utility.

Since 1985, the Indiana Department of Natural Resources (IDNR) has maintained a database of water use facilities that are able to withdraw more than 100,000 gallons of groundwater, surface water, or a combination of both in one day. These facilities are significant water users. In addition to tracking the monthly volume of water each facility uses, the database distinguishes between surface water intakes and wells, and classifies water use into five categories as listed in Table 5.

Traditionally, Marion County has met its energy, public supply, and industrial needs using the White River, its tributaries, and Geist, Morse, and Eagle Creek reservoirs while high-capacity users further from these sources relied on groundwater. In 1990, the region used five times more surface water than groundwater (Figure 7). However, the region has increased its reliance on groundwater as water demand grew by over 100 million gallons per day between 1990 and 2008. In that time, use of groundwater has almost tripled. In 2008, central Indiana used only three times more surface water than groundwater (Figure 7).

Central Indiana's reliance on surface water is not evenly distributed among the nine counties (Table 4). Marion County uses more surface water than any other county in the region. Hamilton and Morgan counties use significantly more surface water than the remaining counties, but Hamilton County uses less than half of what Marion County uses, and Morgan County's surface water use is 70 percent of Marion County's use.

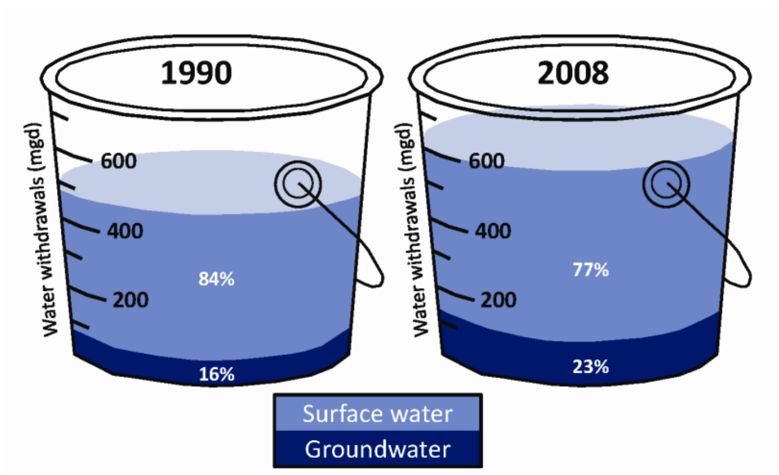

Figure 7. Water demand in central Indiana in 1990 and 2008 (IDNR, 1990b; INDR 2008).

Table 4. Central Indiana counties water withdrawals in 1990 and 2008 (INDR, 1990b; INDR, 2008).

County	Surface Water (Million of gallons per day)		Groundwater (Million of gallons per day)	
	1990	*2008*	*1990*	*2008*
Boone	0.64	0.74	0.06	2.30
Hamilton	21.83	44.41	2.36	26.14
Hancock	0.00	0.05	2.47	3.82
Hendricks	0.70	0.11	3.11	6.81
Johnson	0.00	1.40	8.02	13.94
Madison	0.85	4.88	12.02	14.45
Marion	271.12	241.06	40.42	58.23
Morgan	104.99	168.29	3.56	8.55
Shelby	1.08	1.65	4.02	4.67

3.1.1 Regional Water Users

The reason surface water withdrawals in the region are still greater than groundwater withdrawals is because of energy production demands (Table 5). Very little groundwater is used for energy production. Water use classified as energy production is used for power generation, coal mining, oil recovery, geothermal purposes, and cooling water. Much of the water used in energy production is non-consumptive, which means that the water withdrawn is returned to the source. The majority of other uses (domestic, industrial, and commercial) consume water and any water that is returned, is discharged to another location within the watershed. If groundwater is used, it is always considered consumed because very little water is returned to the aquifer.

The greatest demand after energy production is public supply. This category is comprised of water utilities that provide water for domestic, commercial, and some industrial needs. It is within this category that groundwater withdrawals have tripled. This increase in withdrawals is most likely due to increased population and because groundwater is less expensive to treat and requires less treatment facilities.

Industrial withdrawals have decreased by 4 MGD since 1990. Industry uses water for processing, cooling, mineral extraction (excluding coal mining), quarry dewatering, and waste assimilation.

The last three uses, agriculture/irrigation, rural, and miscellaneous, used very little water in both 1990 and 2008. Agriculture/irrigation (crop and golf course irrigation, farm needs) and rural (livestock and fisheries) demand use both surface water and groundwater, whereas miscellaneous uses such as fire protection, construction, and pollutant abetment, use only groundwater.

Table 5. Water withdrawal uses and amounts for central Indiana in 1990 and 2008 (IDNR, 1990b; INDR, 2008).

Water Use	1990 Surface Water Withdrawals (MGD)	1990 Groundwater Withdrawals (MGD)	2008 Surface Water Withdrawals (MGD)	2008 Groundwater Withdrawals (MGD)
Energy Production	242	8	302	5
Public Supply	116	41	110	117
Industry	42	18	48	8
Agriculture / Irrigation	0.03	0.2	2	2
Rural Use	0	0.2	1	2
Miscellaneous	0.09	8	<0.01	4
Total	*401*	*76*	*464*	*138*

3.1.2 Water Use by County

Marion County uses the most water, which is expected since it has the greatest concentration of people and industry. Six of the nine counties use less than 20 MGD per day (Figure 8). Hamilton County's withdrawals have increased mostly because its population more than doubled between 1990 and 2008 (U.S. Census, 1990, U.S. Census, 2008).

Several notable changes have occurred during the past 18 years. Withdrawals increased in every county primarily because public supply demands increased; however, although Marion County's public supply demands did increase, total withdrawals decreased because of reduced industrial needs. In fact, industrial withdrawals decreased in every county except Hamilton, Johnson, and Madison counties. Energy production demands have increased, offsetting the decreases in industrial withdrawals. Energy production made up 60 to 65 percent of surface water withdrawals in 1990 and 2008, but this use is limited mainly to Marion and Morgan counties. The other counties use little to no water for energy production purposes. The vast majority of water used in all other counties is for public supply.

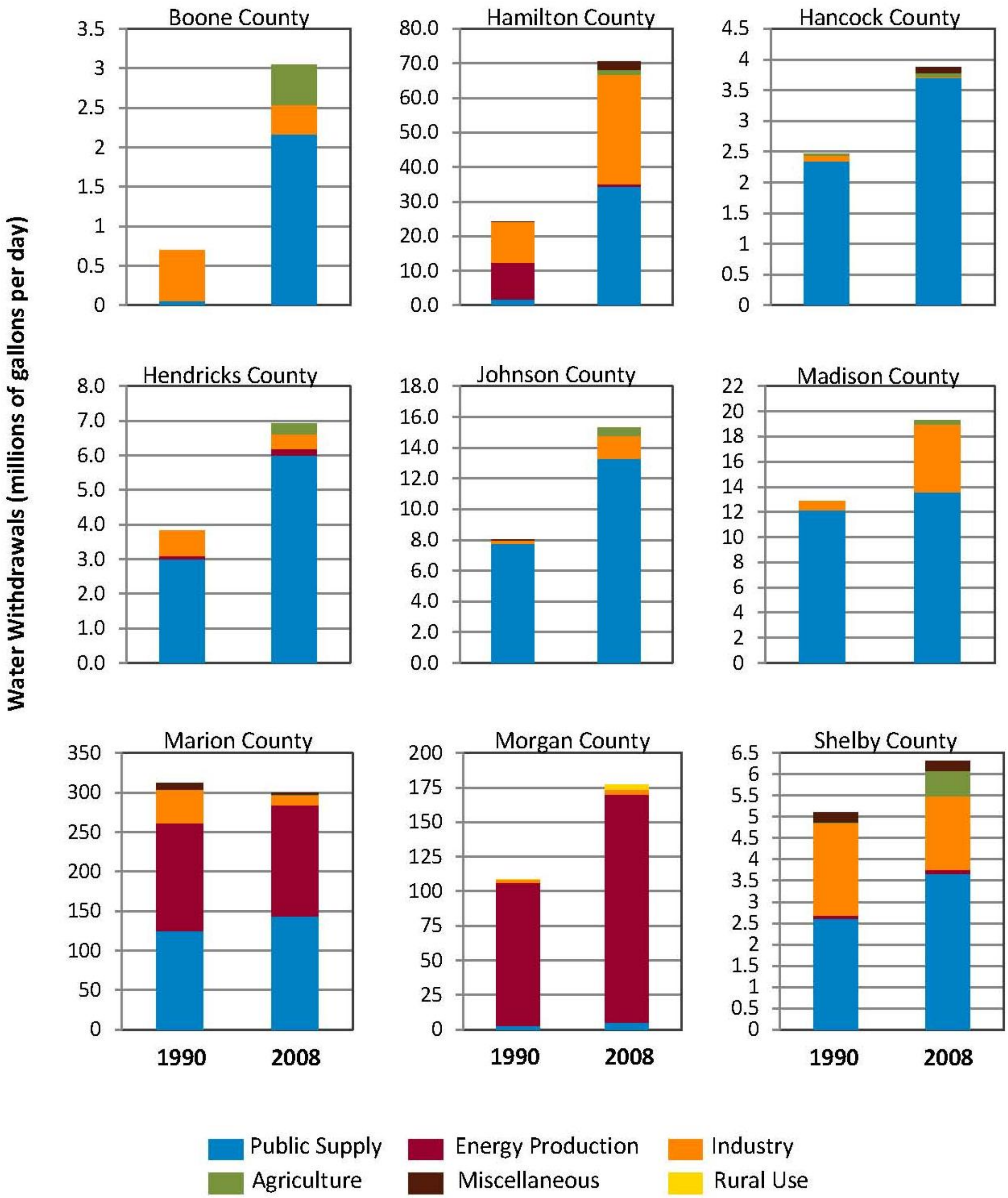

Figure 8. Water withdrawals by county in central Indiana (IDNR, 1990b; IDNR, 2008). Please note the different scales of water withdrawals for each county.

3.1.3 Seasonal Variations in Water Demands

Central Indiana's water demands are greatest during the summer when customers are watering their lawns and gardens, using water for recreational purposes, and energy production increases. Commercial and industrial users also use more water for landscape watering and cooling needs during the summer. The summer months (June, July, August, and September) when demand is high, are also when stream flows are low, particularly during hot and dry weather (Figure 9). Increased withdrawals, evaporation, and decreased precipitation contribute to low stream flow. Additionally, summer demands necessitate increased groundwater withdrawals that reduce groundwater levels and further decrease surface water flows.

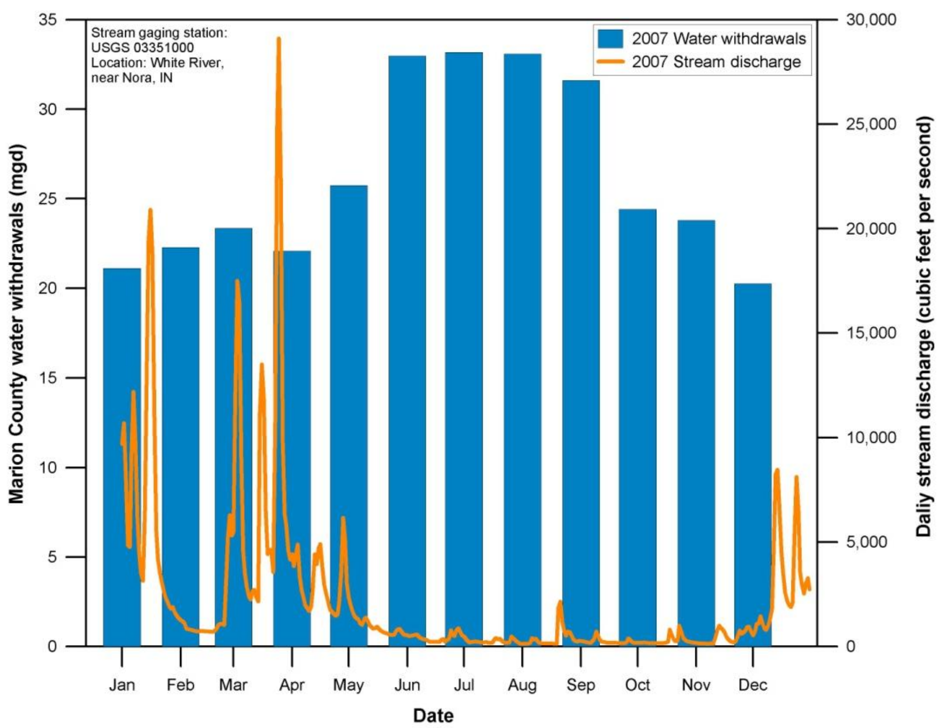

Figure 9. Monthly water demand and stream flow for Marion County, Indiana in 2007.

3.1.4 Future Water Use

Population growth is a major driver of water use and central Indiana has several of the fastest growing counties in Indiana, and Hamilton and Hendricks counties are two of the fastest growing counties in the United States (U.S. Census Bureau, 2004). The population in Hamilton, Hendricks, Boone, Hancock, and Johnson counties is expected to increase more than 20 percent between 2005 and 2025 (Table 6) (Indiana Business Research Center, 2008). Marion and Morgan counties will likely experience an 8 to 20 percent population increase, Shelby County will grow less than 4 percent, and Madison County is predicted to have the largest population decline in the state (Indiana Business Research Center, 2008).

Table 6. Central Indiana's projected population in 2010 and 2030 (Indiana Business Research Center, 2008).

County	2010	2030	Numerical Difference
Hamilton	301,091	409,402	108,311
Marion	872,883	967,547	94,664
Hendricks	147,906	190,370	42,464
Johnson	142,382	169,958	27,576
Hancock	70,536	82,807	12,271
Boone	58,303	69,599	11,296
Morgan	72,073	77,149	5,076
Shelby	43,394	44,226	832
Madison	127,256	125,728	-1,528

As central Indiana's population grows, so will its demand for water. The region's public supply water withdrawal in 2008 was 227 MGD; by 2030, it is expected to be between 280 and 320 MGD Table 7) (Malcolm Pirnie, 2005). Please note this projection does not include Madison County. Just as groundwater withdrawals increased between 1990 and 2008, they will continue to increase through 2030 because surface water supplies (excluding reservoirs) in the region are nearly fully developed. Malcolm Pirnie (2005) estimated that net surface water use will probably exceed minimum stream flow requirements (7Q10) before 2020. Consequently, public water suppliers, industrial users, and energy producers (the three largest withdrawers of surface water) will have to shift to groundwater to satisfy demand.

Central Indiana's groundwater supply, in terms of estimated yield and wellfield pumping capacity, is adequate through 2030 (Malcolm Pirnie, 2005); the available supply after 2030 is unknown because it has not been studied. The groundwater analysis, however, did not account for: 1) drought; 2) the impact surface water deficit has on groundwater; 3) the location of groundwater resources relative to water users; or 4) future contamination. The Malcolm Pirnie (2005) report states that a repeat of the 1940s drought, which is when the one hundred year drought occurred, would have placed the region's average 2004 water demand beyond the available supply. Groundwater is central Indiana's buffer against drought. However, if groundwater withdrawals increase, less will be available during water shortages. Consequently, managing central Indiana's surface water and groundwater supplies now is imperative for the region's continued economic vitality.

Table 7. Projected public water supply use in central Indiana, excluding Madison County (Malcolm Pirnie, 2004; IDNR, 2008).

Year	Average Day Projection (MGD)	Maximum Day Projection* (MGD)
2008	227	363
2010	220-230	352-365
2020	250-270	400-432
2030	280-320	448-512

*Maximum Day = 1.6 × Average Day

4 WATER LAWS AND GOVERNANCE

The United States Congress passes laws that outline general requirements for surface water and groundwater protection, but it does not provide details on how to accomplish these requirements. It is up to federal regulatory agencies, such as the U.S. Environmental Protection Agency (EPA), to interpret the mandate of the law, create the funding program, carry out necessary research, and develop the baseline regulatory requirements for each law (Veil et al., 1999). It is the state of Indiana and local governments' responsibility to use the federal agency's regulations as guidelines for implementing and administering the laws protecting the state's water resources.

4.1 Federal Level

At the federal level there are two laws that protect surface water: the Safe Drinking Water Act of 1974 (SDWA) and the Clean Water Act of 1948 (CWA) (formally referred to as the Federal Water Pollution Control Act) (Table 8). For groundwater protection and quality, there are four major environmental laws: SDWA, CWA, the Resource Conservation and Recovery Act of 1976 (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (Table 9).

4.1.1 Surface Water

The EPA sets the agenda and standards for the CWA and SDWA and it is the responsibility of the states to carry out and enforce them. However, states are subject to EPA oversight, and if the EPA believes a state has failed to take appropriate action, it has the right to assess penalties. The SDWA and CWA apply not only to public water systems, but individuals, corporations, companies, associations, partnerships, and other government agencies.

Originally, the objective of the CWA was to provide state and local governments technical assistance funds for addressing water pollution problems, but it provided no objectives or guidelines on controlling pollution (Copeland, 2001). Over the past six decades, the CWA has evolved and adopted the broad goal of protecting, restoring, and maintaining the chemical, physical, and biological integrity of the nation's waters in order to support the protection and propagation of fish, shellfish, and wildlife, and support recreation in and on the water (U.S. EPA, 2008). Since the 1980s, the CWA has expanded to include runoff, a nonpoint source of pollution, and now emphasizes restoring impaired water *and* protecting healthy waters. Currently, the CWA has two parts: 1) the title II and VI municipal wastewater treatment construction program, which authorizes grants for planning, design, and construction of municipal sewage treatment facilities; and 2) the permits, regulations, and enforcement program, which limits discharge into the nation's waters.

More than 90 percent of people in the United States get their drinking water from a community water system (Tiemann, 2006). To ensure that drinking water is safe, Congress passed the SDWA. This SDWA authorizes the EPA to enforce and implement the drinking water program; the EPA sets drinking water standards and oversees state, local, and private entities that implement these standards. The SDWA focuses on treating naturally occurring and human-made contaminates; however, since its enactment, it has expanded to include protecting the nation's drinking water sources such as rivers, lakes, reservoirs, springs, and groundwater.

4.1.2 Groundwater

No single federal law protects or manages groundwater in the United States. Instead, the four laws listed in Table 9 control the management of groundwater. Of the four major federal environmental laws, the SDWA provides the most direct groundwater protection regulations. States, with support from local government, bare the greatest responsibility for managing the SDWA's programs (Veil et al., 1999). The CWA provides very little direction on groundwater protection; however, §319, the nonpoint source control program does require that groundwater protection be part of a nonpoint source management program in order to receive grants from the EPA. RCRA and CERCLA govern groundwater remediation and seek to restore groundwater to beneficial use (Veil et al., 1999). RCRA addresses operating sites and facilities, targets hazardous substances, and is either EPA-led, state-led, or both. CERCLA address abandoned sites without owners, targets hazardous substances, and is EPA-led.

Table 8. Federal law protecting surface water.

Surface Water Protection	

Safe Drinking Water Act
Enacted: 1974
Amended: 1986, 1996
	• Regulates public drinking water systems
	• Originally established standards for drinking water quality and focused on water treatment to meet standards
	• Emphasis on source water protection with passage of amendments
	• Relevant Rules
	    • Surface Water Treatment Rule
	    • Enhanced Surface Water Treatment Rule

Clean Water Act
Enacted: 1948
Amended: 1956, 1961, 1965, 1966, 1971, 1972, 1977, 1981, 1987
	• Primary statute protecting surface water resources
	• Objectives
	    • Reduce direct pollutant discharges into waterways
	    • Finance municipal wastewater treatment facilities
	    • Manage polluted runoff
	• Two programs
	    • Titles II and VI – Municipal Wastewater Treatment Construction
	    • Permits, Regulations, and Enforcement
	        ▪ § 303 – Water quality standards and implementation plans (total maximum daily loads)
	        ▪ § 319 – Nonpoint source of pollution
	        ▪ § 403 – NPDES program
	        ▪ § 404 – Permits for dredge and fill materials
	        ▪ § 405 – Disposal or use of sewage sludge

Table 9. Federal laws protecting groundwater.

Groundwater Protection	
Safe Drinking Water Act Enacted 1974 Amended 1986, 1996	• Sets maximum contaminate loads (MCLs) for delivered drinking water • Regulates injection of fluids into wells through the Underground Injection Control program • Withholds federal assistance for projects which it determines may contaminate a an aquifer that is the principal drinking water source for an area • Directs states to develop wellhead protection programs that protect the areas around water supply wellheads from contaminants
Clean Water Act Enacted: 1948 Amended: 1956, 1961, 1965, 1966, 1971, 1972, 1977, 1981, 1987	• 1987 Amendment placed more emphasis on groundwater quality • Regulates and permits pollutant discharges • Encourages states to pursue groundwater projection activities as part of nonpoint pollution control efforts
The Resource Conservation and Recovery Act (RCRA) Enacted: 1976 Amended: 1986	• Regulates the handling, transport, and disposal of solid and hazardous wastes, and underground storage tanks • Established a permit program for solid and hazardous waste disposal • Focuses on active and future facilities; does not address abandoned or historical sites • Regulates underground storage tanks and provides for response to leaking tanks
Comprehensive Environmental Response Compensation, and Liability Act (CERCLA or Superfund) Enacted: 1980 Amended: 1986	• Provides for cleanup of groundwater at old or abandoned sites contaminated by hazardous substances • Relies on CWA and SDWA standards • Provides broad federal authority to respond directly to releases or threatened releases of hazardous substances that pose threats to public health or the environment

4.2 STATE LEVEL

In addition to the federal laws protecting the nation's waters, the Indiana General Assembly has created state legislation for managing and allocating the state's water resources. The rules governing the use of surface water and groundwater in Indiana originate in common-law property doctrine and are defined by state legislation. For surface water, Indiana water law follows the riparian principle, which means that if any party has land with direct access to a stream or lake (in the riparian area along the water), they have the property right to use as much water as needed as long as they do not harm their neighbors. Only significant withdrawals of groundwater (greater than 100,000 gallons per day) are regulated by the Indiana Water Resource Management Act of 1983 which requires facilities to register with the Indiana Department of Natural Resources (IDNR) and report water use on a monthly basis.

4.2.1 Governance

The federal laws regarding surface water and groundwater protection authorize a regulatory agency, such as the EPA, to develop and oversee programs and set standards; it is the responsibility of the states to implement and monitor the programs. Indiana's water resources management is delegated to the IDNR, the Indiana Natural Resources Commission, IDEM, the Indiana Utility Regulatory Commission (IURC), and the Water Pollution Control Board (Figure 10).

Within IDNR, the Division of Water manages Indiana's surface and groundwater resources. Significant water withdrawal facilities (capable of withdrawing more than 100,000 gallons of surface water or groundwater in a day) are required to register with IDNR (Ind. Code §14-25-7-15).

The Natural Resources Commission (the Commission), an advisory council to IDNR, is responsible for assessing availability of water resources, maintaining an inventory of significant water withdrawals, and overseeing beneficial uses of state's water resources (Ind. Code §14-25-7-11). The Commission does not have regulatory authority, but is responsible for establishing minimum stream flows that consider the importance of in-stream and withdrawal uses, water-quality standards, and public water supply needs. It can also establish groundwater levels, below which would significantly harm the water resource of the area (Ind. Code §14-25-7-14). At this time the commission has not established minimum stream flows or groundwater levels. The Commission is also required to develop and maintain an inventory of Indiana's water resources (Ind. Code §14-25-7-13).

IDEM's Office of Water Quality is responsible for water-quality monitoring and permitting. It operates the CWA's National Pollutant Discharge Elimination System (NPDES) permit program and implements the SDWA in Indiana.

The Indiana Utility Regulatory Commission (IURC) is a state mandated fact-finding body that ensures utilities are providing adequate and reliable service, and charging reasonable prices. The IURC's Water/Sewer Division monitors and evaluates water utilities performance. Topics the IURC rule on include rate changes, mergers and acquisitions, service area matters, and conservation matters. Municipal utilities may opt out of IURC jurisdiction; however, private utilities are required to report to the IURC. Of the 835 water utilities in the state, 125 have rates set by the IURC. In central Indiana, Indiana American Water, Indianapolis Water, Carmel Municipal Water, and Anderson Municipal Water are regulated by the IURC and are four of the largest regulated water utilities. Currently, the IURC is requiring all regulated utilities to develop water conservation plans when a utility files for a rate change.

The Water Pollution Control Board is a 12-member governor-appointed board. The board works with the IDEM implementing the CWA and the SDWA. State statute gives the board authority to set rules for controlling and preventing water pollution and minimizing harm to aquatic life.

4.2.2 Indiana Water Statutes

As mentioned, Indiana follows the riparian principle for surface water allocation, which means a landowner with direct access to a stream or lake (in the riparian area along the water), has the right to use as much surface water as needed without harming their neighbors. The extent of the landowner's water use entitlement depends on the landowner's intended water use. Domestic uses have priority to all other uses and may be used without regard to the effects on other riparian landowners (Ind. Code §14-25-1-3). Domestic uses are defined as water for household purposes, and drinking water for livestock, poultry, and domestic animals. Uses other than domestic fall within the definition of reasonable beneficial use (Table 10); a reasonable beneficial use is considered necessary for economic and efficient utilization and must be reasonable and consistent with public interest (Ind. Code §14-25-7-6).

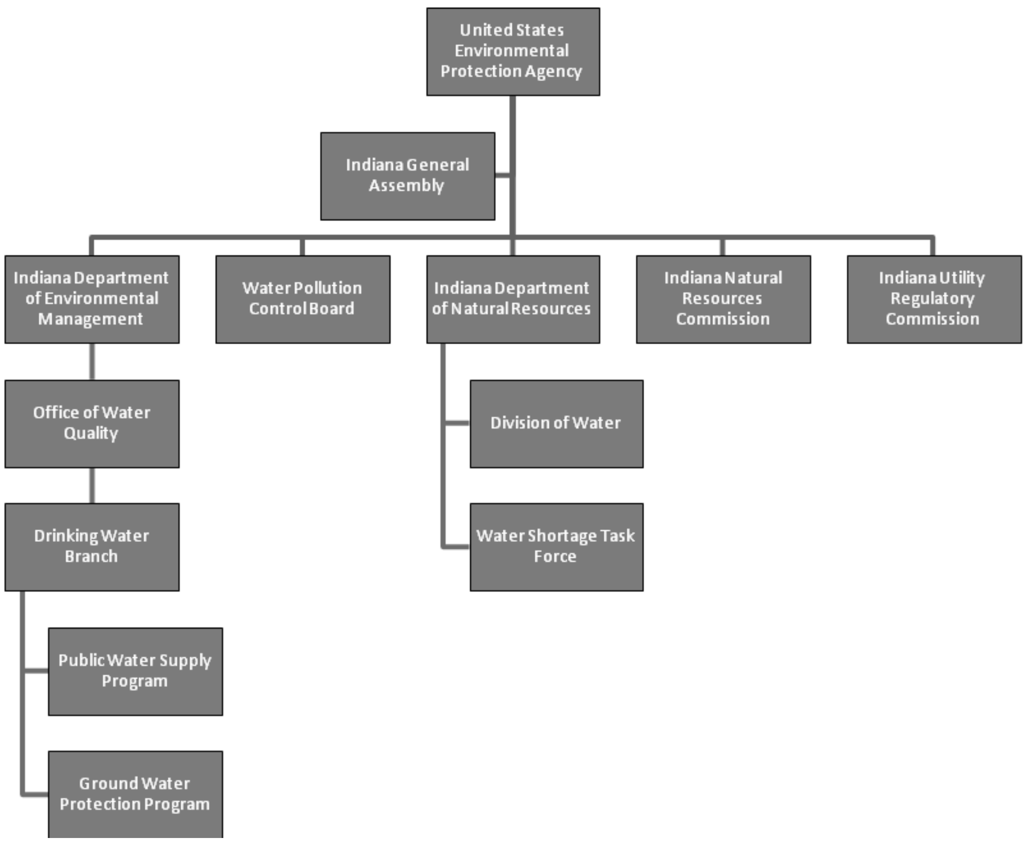

Figure 10. Indiana agencies responsible for the state's water resources.

Landowners are entitled to groundwater under property they own as long as the water is put to full beneficial use, is not excessively lost if transported, and when withdrawn does not cause salt water or contaminated water to enter the aquifer (Ind. Code §14-25-3-2). IDNR does have the authority to restrict withdrawals in areas it designates as restricted use areas. These are areas where groundwater withdrawals may exceed the aquifers' recharge rate. Indiana law does not require consideration of the effect groundwater pumping may have on connected surface waters.

Significant water withdrawal facilities are required to register with IDNR and report the amount of water they withdraw each month (Ind. Code §14-25-7-15). IDNR may restrict the quantity of groundwater a significant *groundwater* withdrawal facility may extract if a non-significant groundwater facility (small-capacity user) notices a problem with his or her supply well, such as if the well failed to provide its normal supply of water or failed to provide potable water (Ind. Code §14-25-4). Also, if IDNR has reasonable evidence indicating continued groundwater withdrawals from a significant groundwater withdrawal facility will exceed the recharge capability of the groundwater resource of the area, it may declare a groundwater emergency (Ind. Code §14-25-4-10). A similar system is in place for lakes, but not streams.

The Commission is granted power to establish minimum stream flows and minimum groundwater levels (Ind. Code §14-25-7-12). However, minimum flow and water levels have not been established in the state. In-stream flow requirements are determined by the limits imposed by the low-flow requirements of individual NPDES permits and the restrictions built into federal permits for power plant cooling water withdrawn from surface waters.

Recently, the Indiana General Assembly created the Indiana Water Shortage Task Force (Ind. Code §14-25-14). The task force's purpose was to revise and update the 1994 Water Shortage Plan to include a low flow and drought priority use schedule. The 2009 Water Shortage Plan emphasizes conservation and efficient water use as the first step in planning for a water shortage. To address immediate shortages, the task force developed criteria for identifying different stages of drought conditions and specified the response actions to be taken during each stage. The Water Shortage Plan is most appropriate for responding to regional droughts in the state rather than localized droughts.

Another recent action by the General Assembly was the 2009 creation of the Water Resources Task Force (Ind. Code §14-25-16). This task force is different from the Water Shortage Task Force in that it studies and makes recommendations concerning water availability as an economic and environmental necessity; it is not directly involved with water shortage planning. The task force will submit annual reports on available quantities and sources of water, future water needs, resource management, ownership rights (particularly in groundwater), drinking water delivery systems, opportunities to work with neighboring states concerning shared drinking water resources, and any other related issues established by Ind. Code §2-5-25-1.

4.2.3 Water Quality

IDEM Office of Water Quality implements federal and state regulations by providing permits, compliance assistance, and enforcement to protect surface and groundwater quality. It also operates the CWA's National Pollutant Discharge Elimination System permit program and implements the SDWA for Indiana. In addition to NPDES permits, IDEM issues and manages permits for wastewater treatment facilities, sewer lines, and storm water discharges. It also works with the Water Pollution Control Board on rules regarding water quality and safe drinking water.

Table 10. Beneficial uses of surface water and groundwater in Indiana (Ind. Code §14-25-7-2).

Beneficial uses in order of priority
1. Domestic
2. Agricultural, including irrigation
3. Industrial
4. Commercial
5. Power generation
6. Energy conversion
7. Public water supply
8. Waste assimilation
9. Navigation
10. Fish and wildlife
11. Recreational

4.3 LOCAL LEVEL

State government primarily oversees water withdrawal rights, and some water quality regulation. However, local governments have more control over activities affecting water quality than state or federal government. Local governments are responsible for wastewater treatment, storm water management, and drinking water treatment. Each one of these local programs directly affects water quality.

It is the responsibility of local governments to build and operate wastewater treatment plants. These facilities remove contaminants from wastewater and sewage. The treatment process uses chemical and biological processes to remove contaminants before discharging the treated wastewater back into the environment, typically a stream or river. Most facilities must have a National Pollutant Discharge Elimination System (NPDES) permit to legally discharge the treated wastewater. The permit establishes pollution limits and specifies monitoring and reporting requirements for each facility. Some industrial point sources and concentrated animal feeding operations are required to have NPDES permits as well. The NPDES program is part of the Clean Water Act and is administered by the state.

In the past, states were only concerned with point source contamination such as discharge pipes, landfills, and hazardous waste sites. However, the focus has expanded to include runoff, a nonpoint source of pollution. As rainwater and melting snow runs across the lands surface into nearby water bodies, it carries with it sediment, oils, salts, pesticides, and other contaminants it picks up from streets, parking lots, farms, and residential areas. Runoff is also referred to as stormwater and it either flows directly into a surface water body or is channeled into city storm sewers and then discharged into surface waters. Local governments are in charge of using best management practices to control water that enters city storm sewers and is discharged into streams. These discharge sites are considered point sources of pollution and require an NPDES permit.

Local government is also responsible for treating drinking water when the water system is owned by the city and is not an investor-owned utility. The SDWA requires water systems to provide water treatment to ensure quality drinking water. To do this, water utilities use various methods and technologies to reduce or eliminate chemical, bacterial, or radiological contamination in the water.

Several local programs and agencies work to minimize contaminants from entering the environment and water bodies (Table 11). City and county governments can also develop protection areas around water sources that limit or restrict development.

Table 11. Local programs and government agencies involved with water quality protection.

Programs	Agencies
Wellhead Protection Municipal Separate Storm Sewer Systems (MS4)	County Health Department Soil & Water Conservation District Solid Waste Management District Emergency Responders County & City Planning Departments County Surveyor County Drainage Boards

5 APPROACHES TO WATER SUPPLY MANAGEMENT

Central Indiana has many options for managing its regional water resource, which range from the current system to regionalizing the water system under one entity. Each option is discussed below. Some options overlap with others and a conglomeration of approaches can and have been taken in other states.

5.1 Individual Users Locally Manage Supply

Indiana law allows individual high-capacity users to extract supplies from shared resources without considering the timing, purpose, or impact of their withdrawals. This individual, local approach ultimately limits use of resources and is likely to result in conflicts between users. Local single-user management generates a patchwork of uneven supply and demand and a general uncertainty in future yield. High-capacity users compete for the regional resource rather than work together to sustainably manage the resource to benefit all.

Local single-user management of supply and demand does not provide flexibility during droughts or other water shortages. For example, where the region's water systems are not interconnected, it is impossible to move water to areas where local demands outpace local supplies. This inability to move water between users means that during emergencies, a high-capacity user may not have an alternative source of water. Also, during normal conditions, utilities may lose revenue because they are not able to sell excess water.

The existing patchwork of local water delivery systems does not provide economies of scale for supply, regulatory compliance, funding, support systems, or treatment. Some individual high-capacity users do not have the reliable supplies or systems required for economic growth. Furthermore, water rates will continue to increase as additional infrastructure and regulatory compliance is required. If no change occurs, the region will be unprepared for future growth and unable to serve increasing demands in an affordable and reliable manner.

5.2 Regional Planning

Regional planning involves high-capacity users and stakeholders identifying, discussing, and collecting data on technical issues important to water resource management. Regional planning is required by law in most of the surrounding states including: Illinois, Kentucky, and Michigan. This has resulted in regional planning in many Midwest metropolitan areas that are similar in size to central Indiana including Northeastern Illinois; Twin Cities, Minnesota; Cincinnati, Ohio; and Southeastern, Wisconsin (see section 6).

Regional planning bodies are comprised of high-capacity users and stakeholders. The planning body is responsible for collecting data and information on regional water demand, regional water supply, water conservation, water re-use, climate change, small water systems, stream flow and groundwater levels, and conflict mediation. The data collection and technical analysis is usually completed by a third-party that provides technical results, while the regional planning body makes policy and implementation decisions. A process for dealing with conflicts that arise is also developed. The technical information and data collected by the regional planning body is used by high-capacity users for their own planning and management activities and for future regional processes.

Funding must be obtained to convene a regional planning body and to complete studies of demands, availability, and impacts. Many regional planning efforts do not provide funding mechanisms for local implementation, but it is recommended that funds be available for local implementation. The regional plan provides guidance to individual high-capacity users, but it is up to the high-capacity users to determine how and what measures to implement. Regional planning does not require a change in governance.

The benefits of regional planning include: 1) a balanced approach to managing a regional resource; 2) an understanding of the availability of the resource; 3) an understanding of demands on the resource; 4) a way to manage conflicts when they arise; and 5) it demonstrates to prospective economic developers that central Indiana is planning for and addressing future water needs.

5.3 Sub-regional Collaboration and partnerships

Sub-regional collaboration and partnerships are based on aquifer and watersheds within the larger region. These partnerships would include institutional infrastructure, which are the legal and financial agreements between two or more entities that use the same resource. These agreements can take many forms; for example, agreements to provide water in times of shortages, cooperatively funding sub-regional studies, or cooperatively funding educational programs.

These sub-region groups can also develop physical interconnections between existing supplies. Transferring existing supplies between users is less expensive and has less of an environmental impact than developing new structures such as wells and reservoirs. Interconnections reduce the risk of supply shortfalls and can save high-capacity users in need of water from searching for and developing new supplies. Also, interconnections provide additional income to those with water surpluses. Most importantly, the risk of either failing to provide or receive water, either because of emergencies or drought, is lowered. A reliable water source is imperative for continued economic growth.

The data and analysis that occurs at a sub-regional level and during regional planning gives high-capacity users a better understanding of the resource and it limitations, which allows them to optimize withdrawals and uses. These data are used in combination with the institutional infrastructure to increase reliability, decrease operating costs, and respond to emergency and drought conditions.

5.4 Water Consortium

A water consortium is a regional body that uses a multi-jurisdictional, multiple user approach to managing and protecting the water resources. A consortium is made up of all interested or required high-capacity users (in some cases, courts have required all users to be a part of the consortium) and includes full-time staff to implement the consortium's goals. A consortium should include as many different sectors and high-capacity users as possible. Without participation from all parties, the consortium is less effective.

A consortium's main goal is to protect the regional, shared water resources. The source water protection measures could include water-level and water-quality monitoring, source water delineation, potential contaminant source inventories, contingency planning, alternative water supply plans, public education, and management strategies. A consortium is funded through the high-capacity users that benefit from the protection of the resources and are a member of the consortium.

5.5 Regionalization

The ultimate step in managing shared water resources is regionalization. Regionalization involves one entity managing or owning the water sources, treatment plants, and regional distribution system. Managing water assets of natural and built infrastructure under one entity allows for optimized use of the resources. Regionalization provides economies of scale in regulatory compliance, funding, regional assets, and system flexibility. This option requires considerable political will and funding and does not occur quickly. Regionalization is a difficult step because of the variety of high-capacity users in the region, which includes private, public, and conservancy districts.

This arrangement provides many advantages to a region where water is abundant in some areas and becoming limited in other areas, regulations are becoming more stringent, and a stable water future is desired. Interconnections between different water sources and communities allow for flexibility within the system and provide additional supplies for emergency and day-to-day demands. Smaller systems benefit because they are better able to comply with regulations and have access to a larger capital base. Regionalization affords a stable, diversified, and balanced water source portfolio, which would provide the region with economic stability and growth.

6 REGIONS THAT HAVE TAKEN CRITICAL STEPS IN WATER MANAGEMENT

Water professionals throughout the United States have acknowledged that they can no longer disregard the regional implications of individual water system decisions. Water supplies do not stop at community or property boundaries, and consequently, interjurisdictional cooperation is critical to ensure maximum and efficient use of the regional water supply.

Central Indiana differs from other large metropolitan areas in its relative lack of water supply management. Many metropolitan areas are using regional solutions to manage their water resources and utility service needs. This regional effort can be accomplished with interjurisdictional planning and cooperation, or taken a step further with regionalization of water systems. Many high-capacity users have found that consolidating multiple utilities into a single authority has increased system operations efficiency, provided economies of scale, and produced more reliable supplies.

6.1 Twin Cities, Minnesota

The Twin Cities metropolitan area, Minnesota, has historically had ample groundwater and surface water supplies, but this supply is not always located where it is needed most. Additionally, utilities in the region face challenges with competing demand between groundwater withdrawal and surface water protection, contamination issues, and occasional droughts. To address the seven-county region's water supply needs and concerns, the Minnesota Legislature directed the Metropolitan Council, with assistance from the Metropolitan Area Water Supply Advisory Committee, to prepare an area master water supply plan. The overarching goal of the master water supply plan is to ensure a sustainable water supply in the region for current and future generations.

To ensure a sustainable water supply, the Metropolitan Council developed seven principles that are to be followed when making decisions regarding the region's water supply (Metropolitan Council, 2009).

Principle 1 Water supply planning is an integral component of long-term regional and local comprehensive planning.
Principle 2 An understanding of the region's long-term water supply availability and demand is necessary to identifying a specific community's or sub-region's water sources.
Principle 3 All hydrologic system components, naturally occurring and man-made, must be carefully evaluated when making water infrastructure plans.
Principle 4 The quality of the region's water is a critical component of water supply planning.
Principle 5 Interjurisdictional cooperation is a viable option for managing short-term water supply disruptions and sustainably meeting long-term water supply needs.
Principle 6 Regional and local cost-effectiveness and equity are considered when identifying water supply options.
Principle 7 Wise use of water supplies is critical to ensuring adequate supplies for future generations.

The Metropolitan Council divided its planning efforts into two phases. During the first phase in 2007, the Metropolitan Council conducted an assessment of: 1) water demand and availability within the Twin Cities region; 2) the water supply decision-making and approval process; and 3) the safety, security, and reliability of the region's water supply system. The assessment included a list of topics that would be addressed in the master water supply plan and provided recommendations to the Minnesota Legislature. During the second phase, the Metropolitan Council worked with the Water Supply Advisory Committee and other interested parties to improve the understanding of water supply sustainability; facilitate collection, sharing, and analysis of regional data; and identify water supply alternatives in resource-limited areas (Metropolitan Council, 2009). The regional planning effort has allowed the region to identify areas of current and future shortages, and develop strategies for minimizing their impacts.

6.2 Northeastern Illinois

The 11-county region of northeastern Illinois, which includes the city of Chicago, is experiencing rapid population growth and diminishing water supplies. Currently, the region withdraws water from the Fox and Kankakee rivers, groundwater sources, and Lake Michigan; however, the U.S Supreme Court Consent Decree limits Illinois' withdrawal from the Lake, rendering it adequate only until 2030.

As a result of population growth and projected water shortages, Executive Order 2006-1 established regional water-supply planning in northeastern Illinois. The Chicago Metropolitan Agency for Planning (CMAP) and the Regional Water Supply Planning Group (RWSPG) developed the Northeastern Illinois Region Water Supply/Demand Plan. This plan is directed at state, regional, county, municipal, and other public agencies responsible for the region's water supply. The plan makes recommendations for improving resource and demand management using conservation, pricing strategies, and graywater and wastewater reuse. To achieve its mission, the RWSPG adopted the following goals.

1. Ensure water demand and supply result in equitable availability through drought and nondrought conditions alike.
2. Protect the quality of ground- and surface-water supplies.
3. Provide sufficient water availability to sustain aquatic ecosystems and economic development.
4. Inform the people of northeastern Illinois about the importance of water-resource stewardship.
5. Manage withdrawals from water sources to protect long-term productive yields.
6. Foster intergovernmental communication for water conservation and planning.
7. Meet data collection needs so as to continue informed and effective water supply planning.
8. Improve integration of land use and water use planning and management.

CMAP and RWSPG stressed developing a regional understanding of water use and supply. The plan relies on voluntary action and cooperation among utilities, but does not change the region's existing governance structure for water supply planning and management (Chicago Metropolitan Agency for Planning, 2009).

6.3 Cincinnati, Ohio

Public water supply planning plays a critical role in the management of the Greater Cincinnati Water Works (GCWW). In 1967, the GCWW joined the Hamilton to New Baltimore Ground Water Consortium after neighboring utilities became concerned about the potential negative impacts of a new high-capacity groundwater production facility. The Consortium's initial focus was on water quantity, but over the years it has extended to water-quality issues. Six utilities and one industrial user make up the Consortium and provide the necessary funding. The members individually pump water from the Great Miami buried valley aquifer, and as required by the Safe Drinking Water Act of 1986, have worked together to develop a multiple supplier, multi-jurisdictional source water protection plan.

6.4 Boston, Massachusetts

Water-supply planning in the metropolitan Boston area has taken a step beyond regional planning to establish a public regional water authority. Boston is one of the oldest cities in the United States, has one of the oldest public water supply systems dating back to 1652, and was one of the first water supply system to be integrated into a metropolitan system with the formation of the Metropolitan Water District (MWD) in 1895 (Wallace, Floyd, Associates Inc., 1984). The MWD eventually became the Metropolitan District Commission (MDC) after water, sewage, and parks were merged into one agency in 1919. During the MDC's tenure, the antiquated water system was leaking, regularly failing, and violating Massachusetts laws on water pollution prevention and remediation. However, the MDC was underfunded and unable to make necessary repairs and upgrades. Additionally, the water withdrawals were annually exceeding the safe yield level by more than 10 percent (U.S. EPA, 2002).

In 1985, the Massachusetts Legislature established the Massachusetts Water Resources Authority (MWRA) as an independent water authority with rate raising ability. The MWRA immediately began making treatment plant upgrades, repairing leaks and community pipes, and instituted an aggressive water conservation program. Currently, the MWRA owns and maintains the water system that provides wholesale drinking water and sewage service to 61 communities in the Boston area.

7 RECOMMENDATIONS TO MORE EFFECTIVELY MANAGE CENTRAL INDIANA'S WATER

Central Indiana's regional water supply has, so far, kept up with demands. However, future supply limitations are likely masked by a lack of knowledge about regional supplies, demands, and impacts; and the fact that no major drought has occurred here in the last 20 years. Compounding supply limitations is the lack of a regional approach to managing a shared resource. While the state has created a valuable water use database, little has been done with this information. States around Indiana have struggled to contain the effects that accompanied recent water shortages, therefore, central Indiana needs to systematically plan for what is certain to occur here - an increase in water demand when there is a short or long-term decrease in supplies.

The bad news is that we need to act now to avoid problems. The good news is that we have most of the information necessary to begin responsibly managing our regional resource. We make the following recommendations.

1. **Recognize the value of common goals among water users.**

   No municipal utility, industry, power plant, or irrigator wants anyone to suffer the effects of a water shortage. Furthermore, all water users are comfortable with the state's existing approach to protecting the water we have and collecting information about water use. These common goals - adequate long-term water supplies and high-quality streams, lakes, and groundwater - are the basis for successful regional planning. Recognizing these common goals, users must work together to determine how their collective needs affect the future availability of the region's surface water and groundwater resources. Based on these common goals, users should develop the necessary plan for cooperative action in the event of water shortages or prolonged drought.

2. **Capture the value of the data needed to manage our water.**

   When it comes to water supply planning, Indiana has several strategic advantages over its neighbors. Unlike many states in the nation, we have a history of water use information that can be used to assess future needs. This information, when combined with existing stream flow data from USGS gages, groundwater level information from wells monitored by the DNR, and precipitation information from the state climatologist, can be used to track trends, forecast future demands and supplies, and develop management strategies. Continued investment in regional hydrologic data collection and analysis infrastructure is critical for determining when and how to respond to changes in water use.

3. Develop a regional conservation strategy.

Since central Indiana is a large region with diverse high-capacity users, a one-size fits all approach to water conservation will not work. However, there are several strategies that apply to and would benefit the whole region. The region is a single media market and a public education campaign, which is an important part of overall conservation efforts, will reach the entire region. Other conservation measures must be evaluated on a regional basis with individual utilities determining the specific measures that apply to their system. Data collected by the state can be used in the water use analysis and demand forecasting portions of each utility's conservation plan. Some implementation efforts may also be coordinated at the regional level.

4. Create a regional water consortium to protect supplies.

Protecting existing source waters is critical. A consortium provides a vehicle for working together, protecting the shared resource, and enables economies of scale for management, research, education, alternative water supplies, and contingency planning. The high-capacity users should jointly develop aquifer recharge systems and aquifer and watershed protection plans. The consortium provides political leverage to connect source water protection to counties' comprehensive plans. At least one full-time staff is needed to implement the source water protection strategies.

5. Change state law to require regional plans.

Unlike its neighbors, Indiana does not require regional water supply planning. Regional planning demonstrates we are committed to optimizing our water supplies for future growth. Additionally, Indiana can market itself as an economic destination to businesses in water limited regions that require a stable water supply. By changing the law, we send the message that Indiana is prepared to handle increasing demands and accommodate economic growth.

6. Develop a regional water management plan.

Regional planning builds on the previous recommendations and assesses region-wide long-term water-supply availability, demands, and water-quality. Existing data should be leveraged to complete the demand and supply assessments and to inform management strategies.

Since groundwater is the region's buffer against drought and will be the only source available to satisfy new demands, particular groundwater management strategies need to be addressed. Groundwater recharge and storage is not often used in Indiana because we have previously had adequate supplies. However, as supplies become more limited and demands increase, groundwater recharge and storage should be explored and, where appropriate, incentivized. Additionally, a regional plan should include an adaptive framework for implementing water conservation programs throughout the region.

While these recommendations take time, energy, concerted effort, and money, inaction is more costly and detrimental to the region. We must prepare now.

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