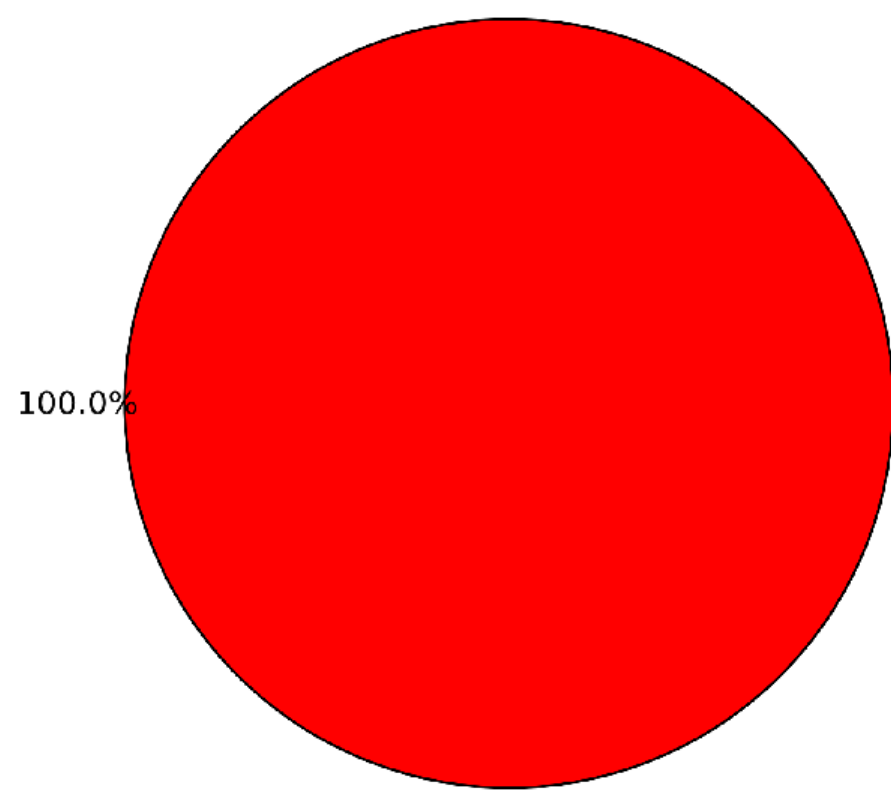
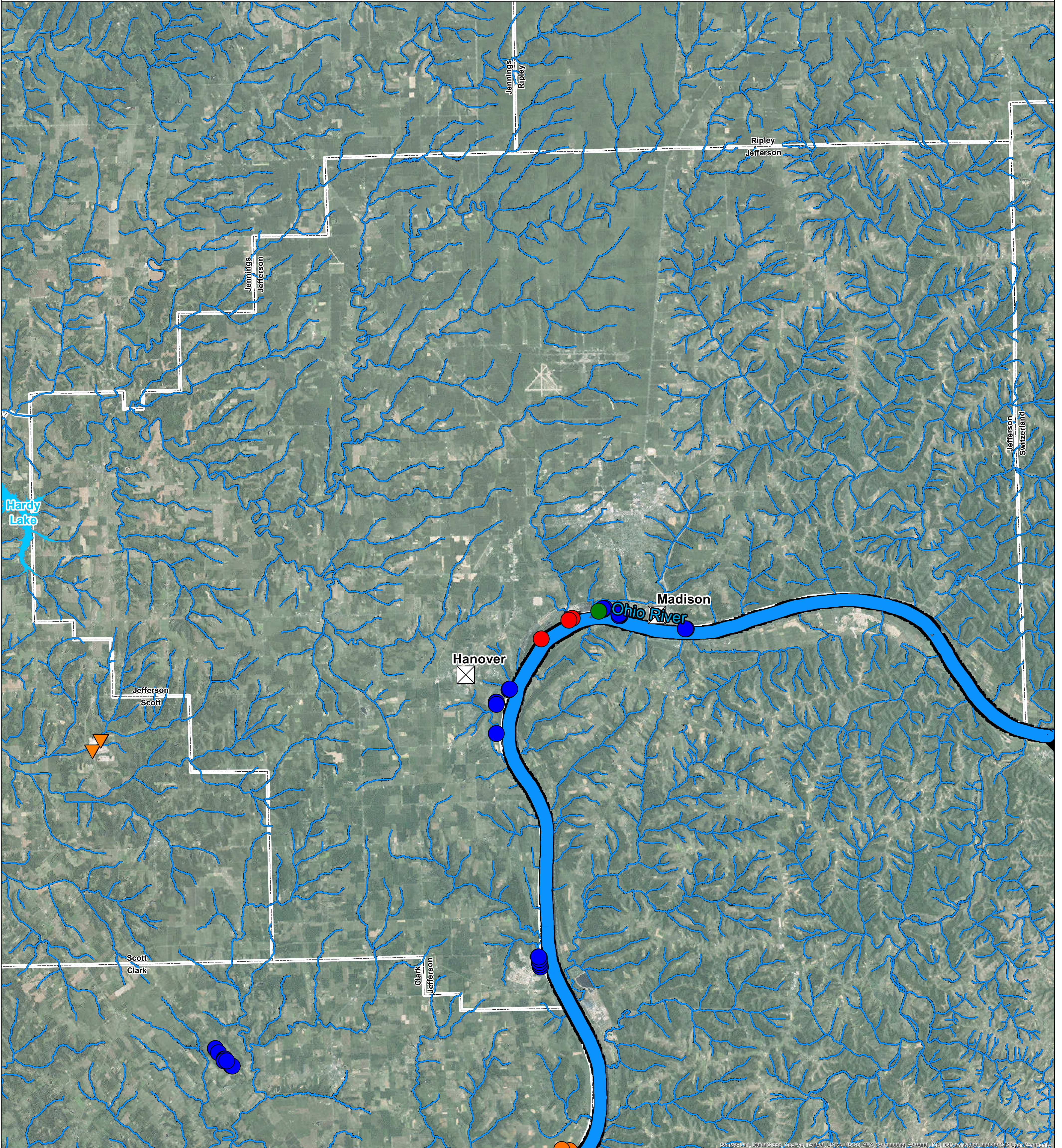
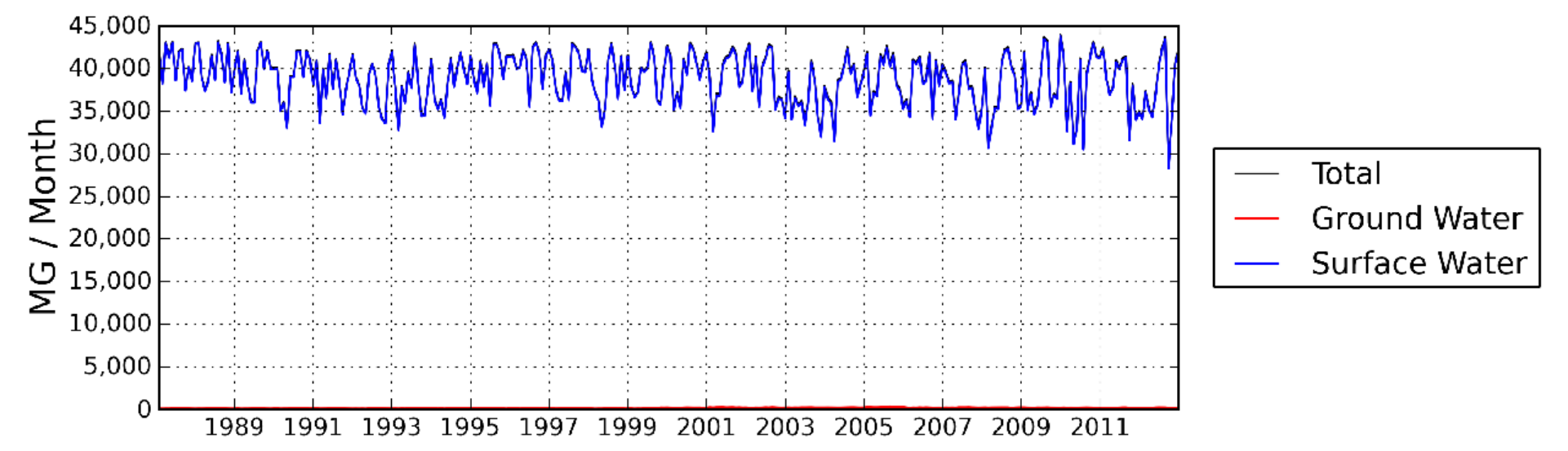
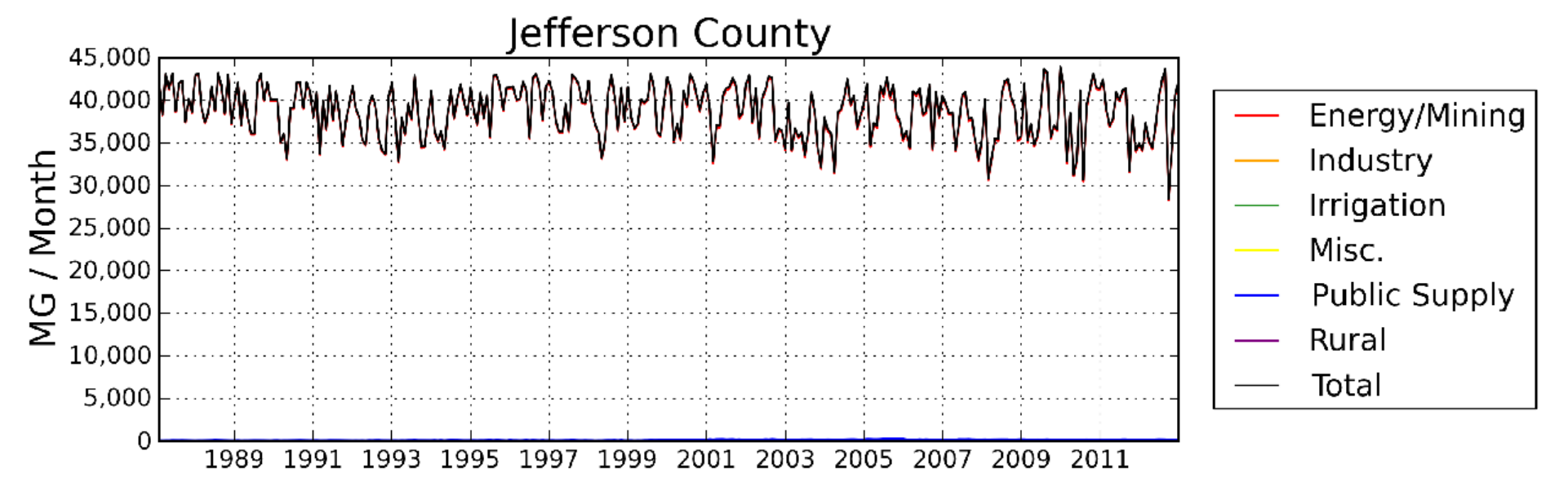


2012 Water Use



Average Daily Use: 1233.6 MGD



Water Resources and Use in Jefferson County

Data Sources: U.S. Geological Survey and Indiana Department of Natural Resources

Withdrawal Location

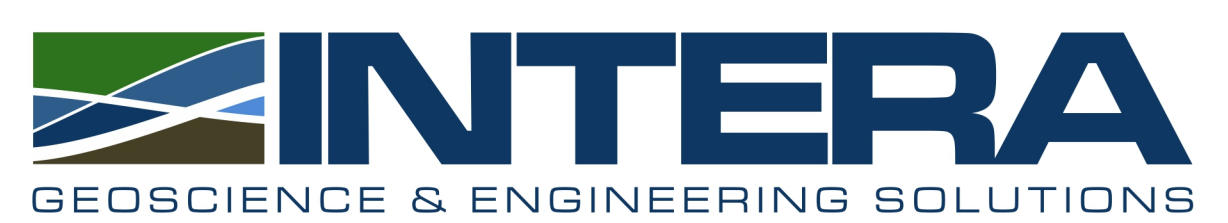
- | | | |
|-------------|---|---------------|
| WELL INTAKE | ▼ | Energy/Mining |
| ● | ▼ | Industry |
| ● | ▼ | Irrigation |
| ● | ▼ | Misc. |
| ● | ▼ | Public Supply |
| ● | ▼ | Rural Use |

River

- | | |
|----------------|---------------|
| 7Q2 Flow (MGD) | < 10 MGD |
| 7Q2 Flow (MGD) | 10 - 50 MGD |
| 7Q2 Flow (MGD) | 50 - 100 MGD |
| 7Q2 Flow (MGD) | 100 - 500 MGD |
| 7Q2 Flow (MGD) | > 500 MGD |

Major Lakes

- Major Lakes
- Interstate
- County
- City



BEDROCK AQUIFER SYSTEMS OF JEFFERSON COUNTY, INDIANA

Jefferson County Bedrock Aquifer Systems

The occurrence of bedrock aquifers depends on the original composition of the rocks and subsequent changes which influence the hydraulic properties. Post-depositional processes which promote jointing, fracturing, and solution activity of exposed bedrock generally increase the hydraulic conductivity (permeability) of the upper portion of bedrock aquifer systems. Because permeability in many places is greatest near the bedrock surface, bedrock units within the upper 100 feet are commonly the most productive aquifers. In Jefferson County, rock types exposed at the bedrock surface range from relatively unproductive shales to limestones and dolomites with limited productivity.

Bedrock aquifer systems in the county are overlain by unconsolidated deposits of varying thickness. Most of the bedrock aquifers in the county are under confined conditions. In other words, the potentiometric surface (water level) in most wells completed in bedrock rises above the top of the water-bearing zone.

The yield of a bedrock aquifer depends on its hydraulic characteristics and the nature of the overlying deposits. Shale and glacial till act as aquitards, restricting recharge to underlying bedrock aquifers. However, fracturing and/or jointing may occur in aquitards, which can increase recharge to the underlying aquifers. Hydraulic properties of the bedrock aquifers are highly variable.

Outside of the main Ohio River valley, with its prolific sand and gravel aquifer, nearly all wells in Jefferson County are completed in bedrock aquifers. This is because in most of the county unconsolidated materials are relatively thin and consist predominantly of fine-grained silts and clays. Bedrock aquifers in the county have generally low-yielding capability, a condition illustrated by the fact that a great majority of bedrock wells have casing diameters of six inches or greater in order to obtain additional bore storage. Well yields are generally so limited in eastern Jefferson County that centralized public water systems are much preferred.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. Just as recharge for bedrock aquifers cannot exceed that of overlying unconsolidated deposits, susceptibility to surface contamination will not exceed that of overlying deposits. However, because the bedrock aquifer systems have complex fracturing systems, once a contaminant has been introduced into a bedrock aquifer system, it will be difficult to track and remediate.

Three bedrock aquifer systems are identified for Jefferson County. They are, from west to east and youngest to oldest: New Albany Shale of Devonian and Mississippian age; Silurian and Devonian Carbonates of Silurian and Devonian age; and Maquoketa Group of Ordovician age. The bedrock strata dip gently to the west-southwest at about 15 to 20 feet per mile.

New Albany Shale Aquifer System

The outcrop/subcrop area of the New Albany Shale in western Jefferson County occupies about 18 percent of the county. The New Albany Shale overlies the Devonian carbonate bedrock and is primarily Devonian age, except for the upper few feet that are Mississippian age. The total thickness of the New Albany Shale in the county ranges from 0 at its eastern outcrop to a maximum of about 80 feet near the western border with Scott County.

This bedrock aquifer system is predominantly brownish-black carbon-rich shale. It is often mistakenly reported as slate. It contains minor amounts of dolomite and dolomitic quartz sandstone. Several years ago, when crude oil prices were much higher, the shale was considered as a source rock from which to extract hydrocarbons.

Although a few wells produce water from the New Albany Shale, the formation is not considered a significant aquifer. It is relatively thin and reported yields range from practically zero up to 10 gallons per minute (gpm). Most drillers will penetrate the New Albany Shale, case it off, and continue drilling into the underlying Devonian limestones. Wells producing from the New Albany Shale vary in depth from about 40 to 165 feet, with most of those greater than 100 feet also penetrating into the underlying Devonian limestones. Static water levels in this aquifer system typically range from about 15 to 30 feet below the land surface.

Water quality in this aquifer system is generally satisfactory for domestic use. However, some drillers report "sulfur water" in scattered wells within the outcrop/subcrop area of the New Albany Shale. This aquifer system is regarded as only moderately susceptible to contamination from surface sources. Although the cover of surficial materials is generally not very thick, the clay and silt-rich residuum and glacial till have relatively low permeability (a measure of the ability of the material to transmit water).

Silurian and Devonian Carbonates Aquifer System

The outcrop/subcrop area of the Silurian and Devonian carbonate rocks covers about 55 percent of Jefferson County. These rocks occur predominantly in the central part of the county on the broad uplands and on some of the higher ridge tops in the northeastern part of the county. The total thickness of the Silurian and Devonian carbonates ranges from 0 where eroded in the eastern part of the county to a maximum of about 160 feet where overlain by the New Albany Shale in the western part of the county.

Although it is not a major resource in the county, the Silurian and Devonian Carbonates Aquifer System is the most productive bedrock aquifer system. This aquifer system is composed primarily of limestones and dolomite with some interbedded shale units. Because most individual units of the Silurian and Devonian systems are composed of similar carbonate rock types and cannot easily be distinguished on the basis of water-well records, they are considered as a single water-bearing system.

In the outcrop/subcrop area of this aquifer system the rock is predominantly shallow and contains numerous, irregular joints. In limited areas, especially near the larger stream valleys in the western half of the county, some karst (see Karst Features and the Dissolution of Carbonate Rocks in Jefferson County) has developed in the limestone beds. Some of the most visible karst features in the county include caves, sinkholes, and springs. Within the carbonate rocks themselves, water is primarily stored and transmitted in joints, fractures, bedding planes, and along solution features. Because these openings are highly variable, the direction and amount of site specific or local ground-water flow may be quite complex. In addition, shale units within the Silurian and Devonian Carbonate Aquifer System, such as the Missisnewa Shale and the Waldron Shale, can limit the hydraulic connection between the water-producing zones and limit karst development.

The elevations of water-bearing zones in this aquifer system vary substantially, although water well data indicate that the most productive part of the carbonate aquifer commonly occurs within the upper 100 feet, and in many places, within a few feet of the bedrock surface. However, other zones of relatively high permeability do occur at greater depth.

In some areas near the contact between the New Albany Shale and the Devonian carbonates, wells are drilled through the shale and into the more productive carbonate rocks. Because the overlying shale inhibits recharge from precipitation, and because fracturing may not be as well developed in the carbonates, these wells may be somewhat less productive than wells completed in carbonates not overlain by shale. However, no statistical analysis has been performed.

The Silurian and Devonian Carbonates Aquifer System is considered a minor ground-water source in Jefferson County. Records for about 140 wells that tap this aquifer system in the county show that the depth to bedrock is typically less than 20 feet. Well depths range from 33 to 265 feet, but are commonly from 60 to 100 feet. Reported testing rates vary from 0 (dry hole) to 75 gpm, but are typically between 1 and 10 gpm. Static water levels range from 0 to 80 feet below the land surface, but are typically between 10 and 35 feet.

Water quality is generally satisfactory for domestic use. It is typically hard water with relatively high concentrations of calcium, magnesium, and bicarbonate. In many places, because of the shallow rock, open joints, and solution channels, the aquifer system is susceptible to contamination from the land surface.

Maquoketa Group Aquifer System

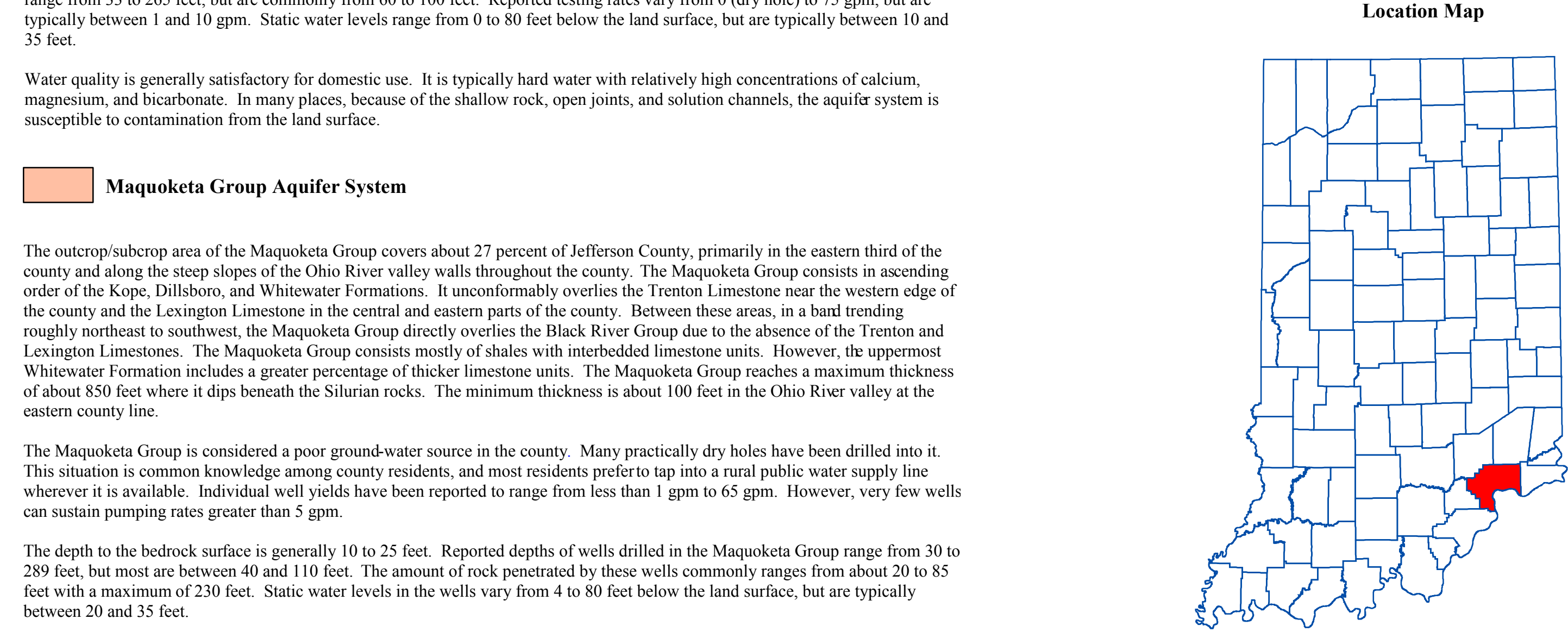
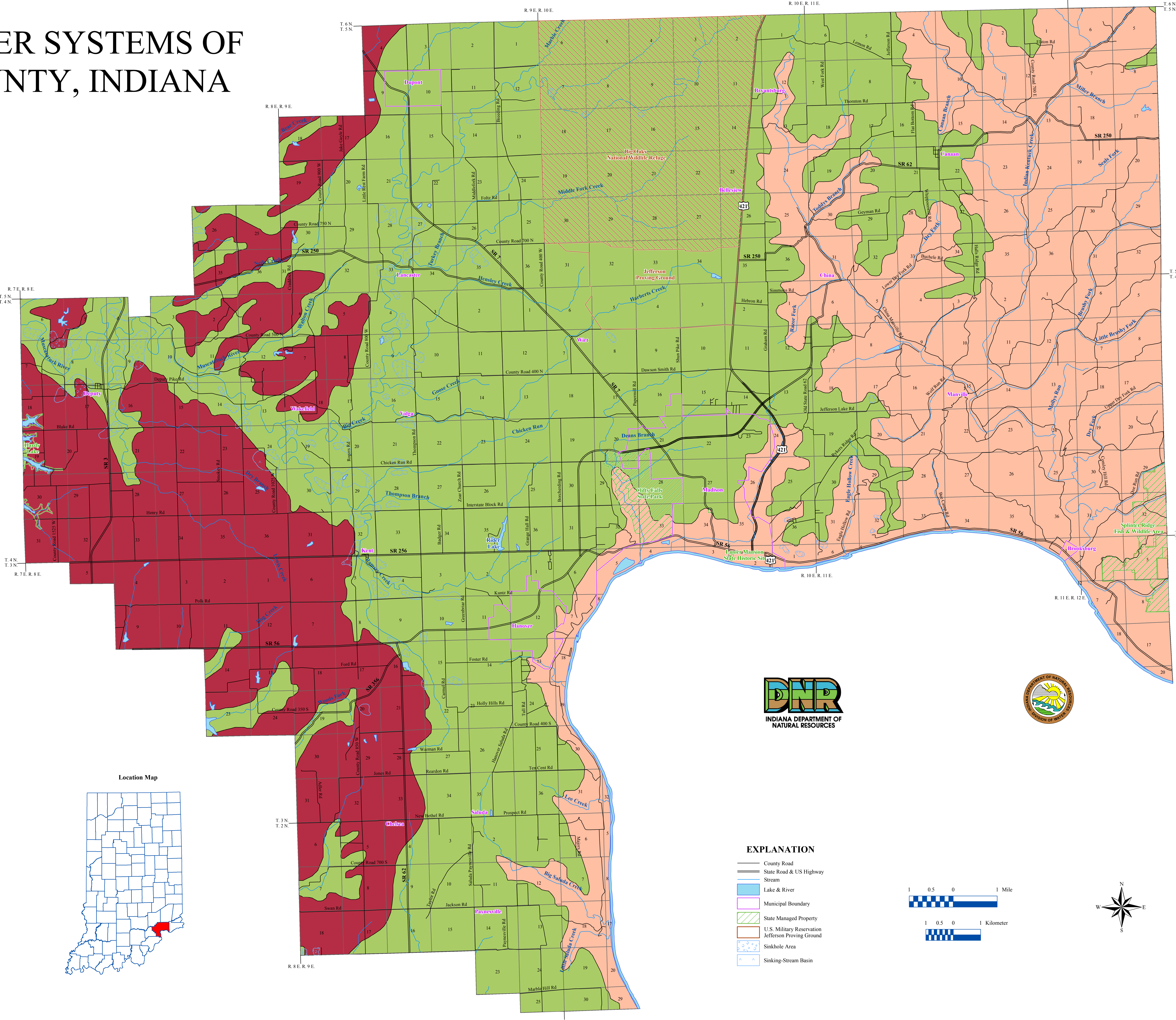
The outcrop/subcrop area of the Maquoketa Group covers about 27 percent of Jefferson County, primarily in the eastern third of the county and along the steep slopes of the Ohio River valley walls throughout the county. The Maquoketa Group consists in ascending order of the Kope, Dillsboro, and Whitewater Formations. It unconformably overlies the Trenton Limestone near the western edge of the county and the Lexington Limestone in the central and eastern parts of the county. Between these areas, in a band trending roughly northeast to southwest, the Maquoketa Group directly overlies the Black River Group due to the absence of the Trenton and Lexington Limestones. The Maquoketa Group consists mostly of shales with interbedded limestone units. However, the uppermost Whitewater Formation includes a greater percentage of thicker limestone units. The Maquoketa Group reaches a maximum thickness of about 550 feet where it dips beneath the Silurian rocks. The minimum thickness is about 100 feet in the Ohio River valley at the eastern county line.

The Maquoketa Group is considered a poor ground-water source in the county. Many practically dry holes have been drilled into it. This situation is common knowledge among county residents, and most residents prefer to tap into a rural public water supply line wherever it is available. Individual well yields have been reported to range from less than 1 gpm to 65 gpm. However, very few wells can sustain pumping rates greater than 5 gpm.

The depth to the bedrock surface is generally 10 to 25 feet. Reported depths of wells drilled in the Maquoketa Group range from 30 to 289 feet, but most are between 40 and 110 feet. The amount of rock penetrated by these wells commonly ranges from about 20 to 85 feet with a maximum of 230 feet. Static water levels in the wells vary from 4 to 80 feet below the land surface, but are typically between 20 and 35 feet.

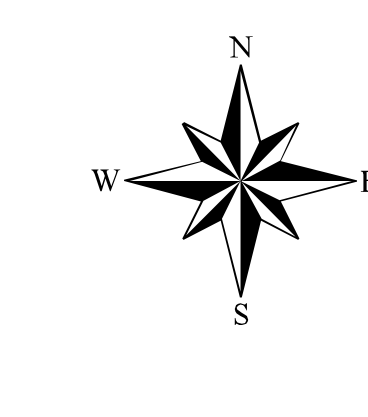
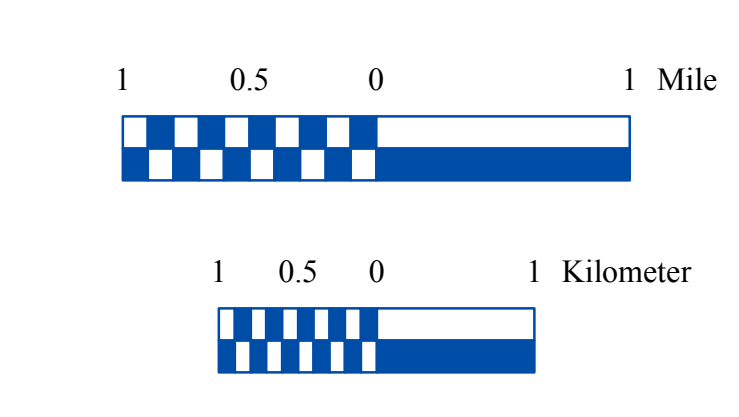
The quality of water in this aquifer system is generally acceptable for domestic use. However, somewhat salty water has been reported in a few wells drilled in the valleys of larger streams in the county.

Except in limited areas of karst development, this aquifer system is not very susceptible to contamination from the land surface because of the typical presence of low-permeability materials above the water-bearing zones. Karst development is predominantly confined to the outcrop/subcrop area of the Whitewater Formation in the upper part of the Maquoketa Group. The map shows some of the larger areas of sinkholes, but there are many others too small to show at the map scale.



EXPLANATION

- County Road
- State Road & US Highway
- Stream
- Lake & River
- Municipal Boundary
- State Managed Property
- U.S. Military Reservation
- Jefferson Proving Ground
- Sinkhole Area
- Sinking-Stream Basin



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Bedrock Aquifer Systems of Jefferson County, Indiana

by
William C. Herring
Division of Water, Resource Assessment Section

April 2004

UNCONSOLIDATED AQUIFER SYSTEMS OF JEFFERSON COUNTY, INDIANA

Four unconsolidated aquifer systems have been mapped in Jefferson County: the Dissected Till and Residuum; the Alluvial, Lacustrine, and Backwater Deposits; the Muscatatuck Plateau Till Subsystem; and the Ohio River Outwash. The first system includes relatively thin deposits left by continental ice sheets as well as eroded residuum (a product of bedrock weathering). The next three systems comprise sediments deposited by, or resulting from, glaciers, glacial meltwaters, and post-glacial precipitation events. Boundaries of these aquifer systems are commonly gradational and individual aquifers may extend across aquifer system boundaries. However, a relatively distinct boundary occurs where the Ohio River Outwash Aquifer System abuts the steep rocky hillsides of the Dissected Till and Residuum Aquifer System.

Outside of the main valley of the Ohio River, nearly the entire county has less than 25 feet of unconsolidated materials overlying the bedrock. Bedrock outcrops are especially common in the eastern half of the county. However, a few scattered areas in northwest Jefferson County contain unconsolidated materials exceeding 50 feet in thickness. Most unconsolidated deposits contain some sand or gravel. However, only within the main valley of the Ohio River are the sand and gravel deposits of sufficient thickness and extent to constitute major groundwater resources capable of supplying large municipal, industrial, and irrigation needs.

Regional estimates of aquifer susceptibility to contamination from the surface can differ considerably from local reality. Variations within geologic environments can cause variation in susceptibility to surface contamination. In addition, man-made structures such as poorly constructed water wells, unplugged or improperly abandoned wells, and open excavations can provide contaminant pathways that bypass the naturally protective clays.

Dissected Till and Residuum Aquifer System

The Dissected Till and Residuum Aquifer System, which covers about 97 percent of Jefferson County, has the most limited groundwater resources of all the unconsolidated aquifer systems in the county. In most of the county the aquifer system is so thin that it is not seriously considered as a source of water. The unconsolidated materials of this aquifer system consist primarily of eroded bedrock residuum and limited amounts of pre-Wisconsin glacial till and loess on the broad uplands and hillsides. Also included are many of the stream valleys are relatively thin deposits of alluvium, colluvium, and lacustrine materials. In the eastern half of the county the stream bottoms are noted for having rock outcrops and pieces of broken limestone and other materials ranging in size from large slabs to gravel, sand, silt, and clay. Overall, the unconsolidated materials of this aquifer system are relatively high in clay and silt content. In scattered places a thin sand layer is noted. The total thickness of the Dissected Till and Residuum Aquifer System in Jefferson County typically ranges from about 5 to 25 feet.

Unconsolidated materials above the bedrock are so thin in most places that the aquifer elevations roughly approximate the elevations of the bedrock surface. The bedrock surface elevations in the areas of this aquifer system range irregularly from about 450 feet above mean sea level (m.s.l.) near the Ohio River at the south county line to about 950 feet m.s.l. on uplands in the northeastern corner of the county. Static water levels in the few wells for which the Division has records range from about 6 to 17 feet below land surface.

Due to the thinness of the aquifer system, dry holes are common. A few dug wells are likely still used, but their yields would typically be quite low. The majority of newer wells drilled in this system would typically be large-diameter bored (bucket-ri) wells. The 3 bored wells for which the Division has records have been tested at 0.5 to 1 gallon per minute (gpm). Potential yields of conventionally drilled wells are generally known to be so small that most drillers in this area prefer to complete wells in the underlying bedrock.

Because of the low permeability of the surface materials, this system is not very susceptible to surface contamination.

Alluvial, Lacustrine, and Backwater Aquifer System

The Alluvial, Lacustrine, and Backwater Deposits Aquifer System is composed of unconsolidated deposits in a few larger valleys tributary to the Ohio River. The unconsolidated deposits primarily come from two sources. One source is alluvium and perhaps some old outwash, deposited by the streams along with colluvium eroded from the valley walls and upland areas. The second major source is glaciolacustrine deposits that were formed in bodies of relatively stagnant lake water, and are marked by soft silt and clay. These lake deposits were formed when the Ohio River valley was choked with coarse material carried by glacial meltwater. Thick deposits of this material effectively dammed tributary streams, creating lakes. Thick deposits of silt and clay, sometimes called "slackwater clay," mark the former locations of these glacial lakes. These lacustrine deposits are often noted on Quaternary geology maps and soil maps. They can occur up to an elevation of about 500 feet m.s.l. in the county. They are especially noted near Brooksbury in the valley of Indian Kentucky Creek.

There are areas in this aquifer system where the thickness of unconsolidated materials approaches 100 feet. This is true for the downstream portions of the system where the Ohio River Outwash Aquifer System joins the Ohio River Outwash Aquifer System upstream. In these valleys typically become thinner and finer grained upstream, only near the gradational contact with the Ohio River Outwash Aquifer System could higher capacity wells be expected. In areas where the aquifer system is thin, and where only fine-grained sand and silt are present, large-diameter bored (bucket-ri) wells could be employed where conventional drilled wells would not be successful. Overall, prospects for completing domestic wells range from good to excellent, but prospects for high-capacity wells are poor in most areas.

This aquifer system is generally marked by thick surface deposits of soft silt and clay that have low susceptibility to surface contamination. However, the surface cap of silt and clay may be thin substantially in some of the upstream areas so that the aquifer system would have a moderate susceptibility to surface contamination.

Muscatatuck Plateau Till Aquifer Subsystem

The Muscatatuck Plateau Till Aquifer Subsystem occurs in the northwestern part of Jefferson County. The system is discontinuous, occurring as individual areas within a larger area in southern Indiana covered by pre-Wisconsin till and other glacial deposits. The system is typically found on scattered upland areas where glacial drift ranges from about 50 to 80 feet in thickness. Boundaries with other aquifer systems, particularly the Dissected Till and Residuum Aquifer System, are gradational. Some of the aquifers within the two systems are similar in their origin and placement, but differ in thickness and extent.

The Muscatatuck Plateau Till Aquifer Subsystem is composed primarily of glacial tills that contain intertil sand and gravel aquifers of limited thickness and extent. The grain size of aquifer materials in the intertil deposits varies locally and ranges from fine or muddy sand to coarse gravel. Sand and gravel lenses within the system may range in thickness from about 1 to 20 feet, but are commonly less than 10 feet thick. Well depths in this aquifer system are variable and are influenced by bedrock elevation and the depth to protective sand and gravel layers within the thicker tills. The one location-verified well record on file at the Division of Water shows a well depth of 68 feet. The reported static water level was 20 feet below land surface. A pumping rate of 60 gpm was sustained for 9 hours.

Well yields in the Muscatatuck Plateau Till Aquifer Subsystem would be expected to be quite variable, but generally adequate for domestic use. However, because sand and gravel aquifer zones are not very thick in much of this aquifer system, large-diameter bored wells may be used to increase yield. The large diameter of such wells permits them to store water from thin sand zones or as seepage from fractures within the till.

The Muscatatuck Plateau Till Aquifer Subsystem has a low susceptibility to surface contamination because intertil sand and gravel units are generally overlain by several feet of low-permeability glacial till.

Ohio River Outwash Aquifer System

The Ohio River Outwash Aquifer System occupies the main valley of the Ohio River. This valley carried great quantities of outwash from the melting glaciers during Wisconsin and pre-Wisconsin glacial periods. However, only pre-Wisconsin ice sheets actually covered Jefferson County.

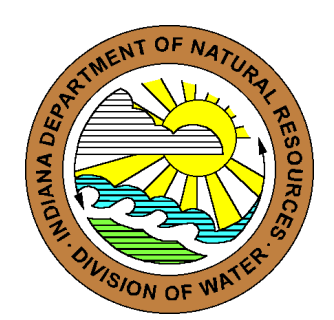
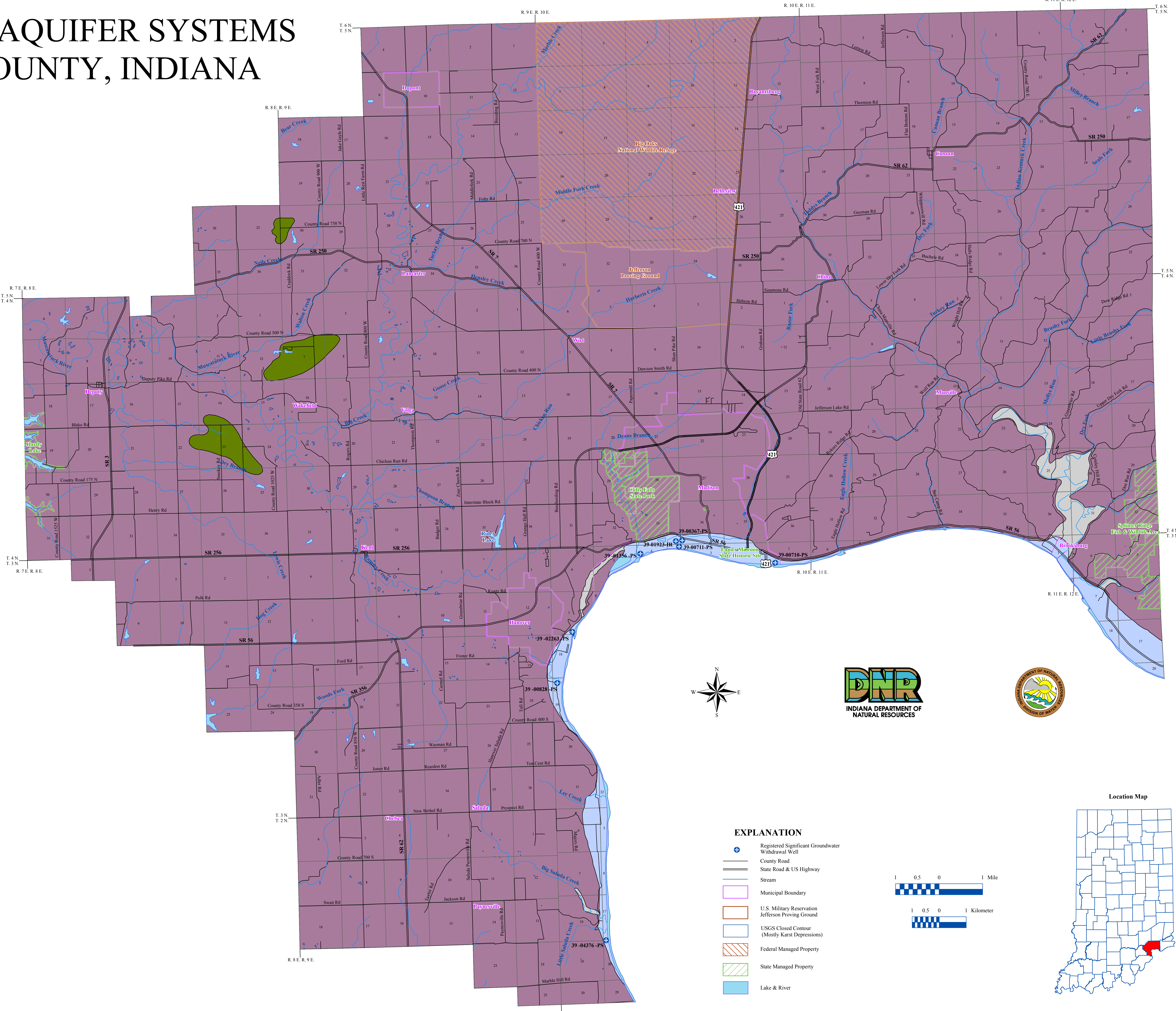
This aquifer system contains large volumes of sand and gravel that fill the main river valley. As the glaciers melted, the sediment contained within them was delivered to the Ohio River in quantities too large for the stream to transport. As a result, the increased sediment load was stored in the valley as vertical and lateral accretionary deposits. As long as the retreating glaciers continued to provide sediment in quantities too large for the stream to transport farther downstream, the valley continued to be filled. This valley-filling process formed the most prolific aquifer system in the county.

Unconsolidated deposits of the Ohio River Outwash Aquifer System range from about 40 feet to 150 feet in thickness. This aquifer system, with its thick sand and gravel, contrasts sharply with the adjacent Dissected Till and Residuum Aquifer System, which has practically no sand and gravel. However, not all of the unconsolidated deposits are saturated with water. Actual aquifer thickness (saturated sand and gravel) of the Ohio River Outwash Aquifer System ranges from about 7 to 83 feet, but most of the system has an aquifer thickness between 40 and 70 feet. Static water levels typically range from about 15 to 35 feet below land surface. Because water levels in some places are near the base of an overlying fine-grained clay, silt, or muddy sand the aquifer could be under confined or unconfined conditions.

The elevations of high terraces in the Ohio River valley range from approximately 480 feet m.s.l. upstream where the river enters southeastern Jefferson County and approximately 470 feet m.s.l. downstream where it leaves the county. Accurate elevations of the top and bottom of the aquifer itself are hard to determine because there are not many records available for wells completed in the aquifer. However, several records show 10 to 45 feet of clay or muddy sand and silt above the aquifer. The bottom elevation of the aquifer is expected to range from about 340 to 300 feet m.s.l. in that part of the valley where the depth to bedrock is greatest.

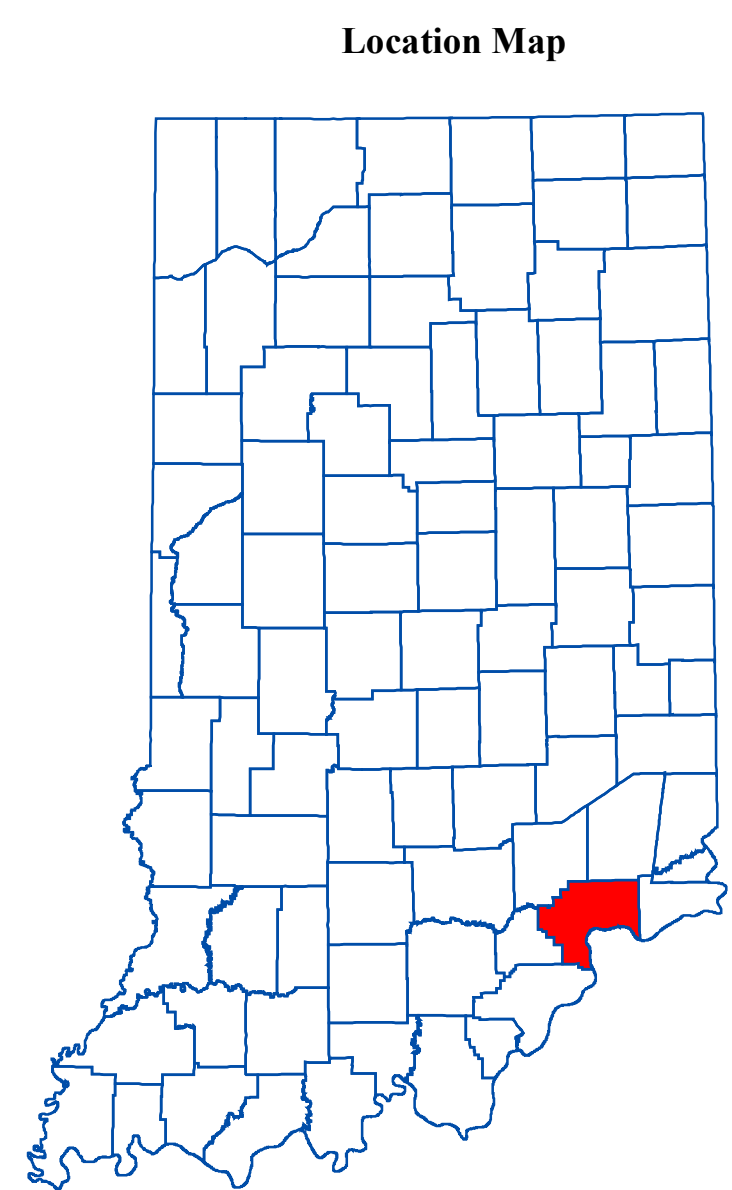
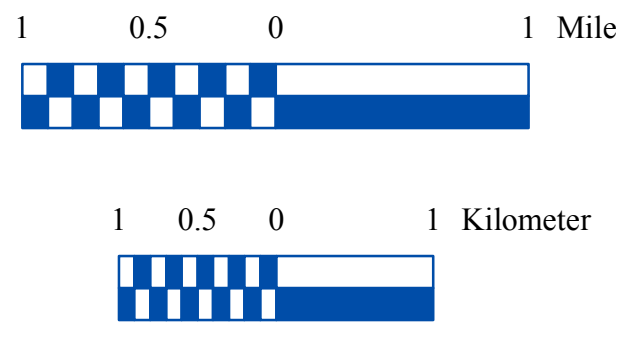
The Ohio River Outwash Aquifer System is by far the most productive aquifer system in the county and has the potential to consistently meet the needs of high-capacity water users. Large-diameter well yields of 300 to 2100 gpm have been obtained in this system. Ten registered significant groundwater withdrawal facilities currently use (or did use) this aquifer system in Jefferson County. The system could support considerably more development.

This aquifer system is highly susceptible to contamination from surface sources in areas that lack overlying clay layers. The system is only moderately susceptible where it is overlain by thick clay or silt deposits.



EXPLANATION

- Registered Significant Groundwater Withdrawal Well
- County Road
- State Road & US Highway
- Stream
- Municipal Boundary
- U.S. Military Reservation Jefferson Proving Ground
- USGS Closed Contour (Mostly Karst Depressions)
- Federal Managed Property
- State Managed Property
- Lake & River



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Unconsolidated Aquifer Systems of Jefferson County, Indiana

by
William C. Herring
Division of Water, Resource Assessment Section

November 2003

Jefferson County

