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 predominately 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 Mississinewa 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

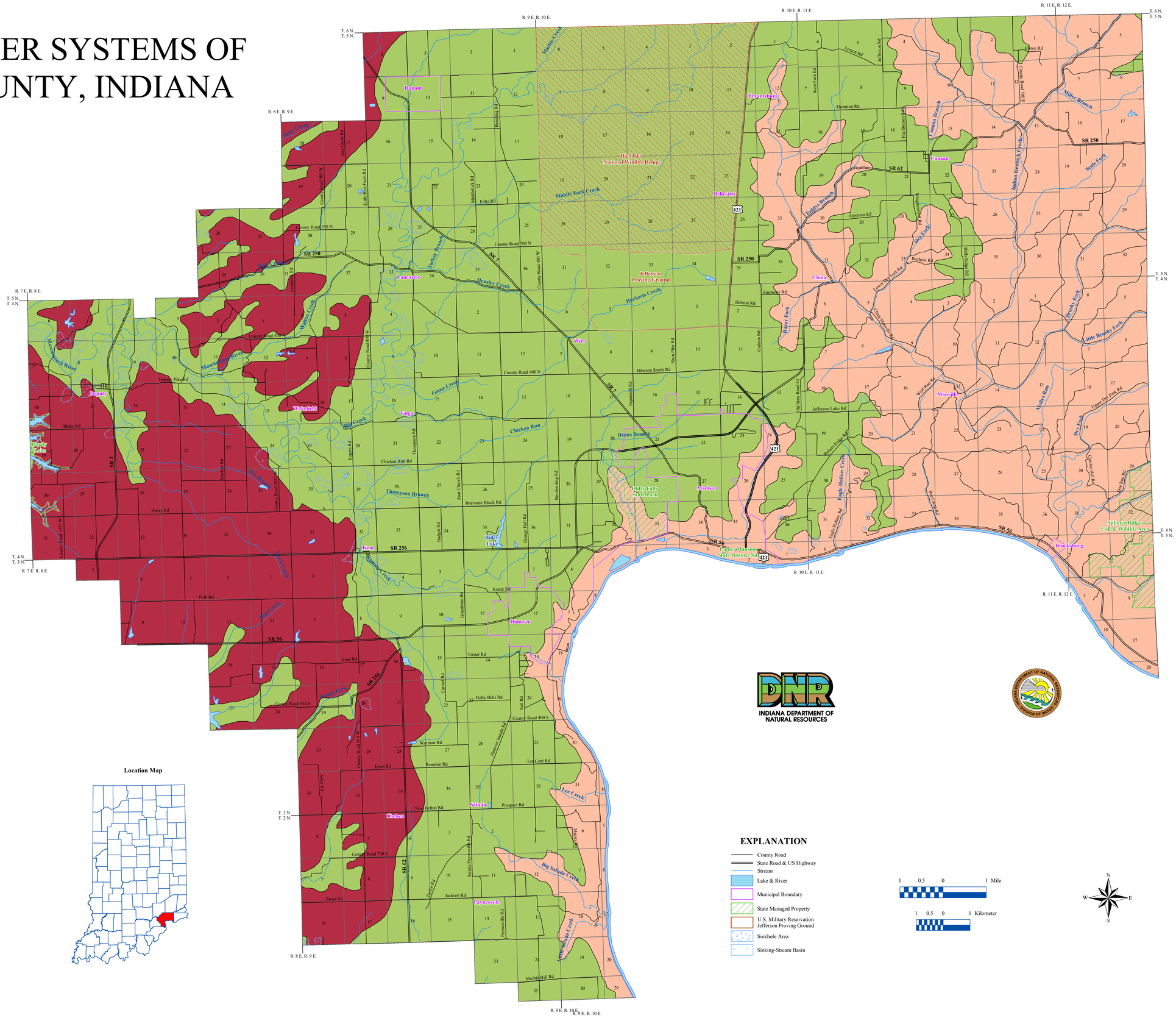
The outcrop/subcrop area of the Maquoketa Group covers about 27 percent of Jefferson County, primarily in the eastern third of the county and along the steep slopes of the Ohio River valley walls throughout the county. The Maquoketa Group consists in ascending order of the Kope, Dillsboro, and Whitewater 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 850 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 predominately 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.



Map generated by Jennifer K. Mc Millan and Randal D. Maier
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This map was created from several existing shapefiles: Township and Range Lines of Indiana (line shapefile, 20020621), Land Survey Lines of Indiana (polygon shapefile, 20020621), and County Boundaries of Indiana (polygon shapefile, 20020621), were all from the Indiana Geological Survey and based on a 1:24,000 scale, except the Bedrock Geology of Indiana (polygon shapefile, 20020318), which was at a 1:500,000 scale and the Sinkhole Areas and Sinking-Stream Basins of Indiana (polygon shapefile, 20001124), which was based on a 1:126,720 scale. Draft road shapefiles, System1 and System2 (line shapefiles, 2003), were from the Indiana Department of Transportation and based on a 1:24,000 scale. Populated Areas in Indiana 2000 (polygon shapefile, 20021000) was from the U.S. Census Bureau and based on a 1:100,000 scale. Streams27 (line shapefile, 20000420) was from the Center for Advanced Applications in GIS at Purdue University. Managed Areas 96 (polygon shapefile, various dates) was from IDNR.

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