

# **Bedrock Aquifer Systems of Daviess County, Indiana**

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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. In Daviess County, rock types exposed at the bedrock surface range from relatively unproductive shales to moderately productive sandstones.

Bedrock aquifer systems in the county are overlain by unconsolidated deposits of varying thickness. Refer to the map for unconsolidated aquifer systems for more information. 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.

In general, the potential for encountering mineralized or saline ground water in Daviess County increases rapidly for bedrock wells deeper than about 300 feet. In a few places mineralized water is noted in shallower wells, particularly in low-lying areas. Therefore, the discussion and evaluation of the ground-water potential of the bedrock aquifers is essentially limited to those geologic units lying above the expected limits of nonpotable water.

Three bedrock aquifer systems are identified for Daviess County based on bedrock lithology. They are, from west to east and youngest to oldest: Carbondale Group of Pennsylvanian age; Raccoon Creek Group of Pennsylvanian age; and Buffalo Wallow, Stephensport, and West Baden Groups of Mississippian age.

The bedrock aquifer systems extend across Daviess County generally as a series of bands trending north-northwest to south-southeast. In the county, the Mississippian age bedrock was truncated by thousands of years of erosion. Subsequent burial of the erosion surface by sediments during Pennsylvanian time created one of the most widespread regional unconformities in the world, the Mississippian-Pennsylvanian unconformity. Younger Pennsylvanian age rocks overlap onto progressively older Mississippian age rocks at increasing distances north of the Ohio River.

Division of Water records indicate about 80 percent of the water supply wells in the county are completed in bedrock aquifers. This is because in most of the county unconsolidated materials

are either relatively thin or consist predominantly of fine-grained silts and clays. The largest exception is the main valleys of White River and East Fork White River, where thick deposits of sand and gravel provide abundant ground water.

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.

Aquifers contained within the Pennsylvanian age bedrock have generally low-yielding capability. However, their value is most significant to the homes and farms using these sources. In general, well depths are greater in the Pennsylvanian rocks than in other aquifer systems in the state, and depths over 200 feet are common. Well casing diameters are usually six inches or greater, indicating the low yield capabilities of these aquifers. Because of the low permeability of the bedrock, the abundance of shale confining zones both above and below aquifer systems, and the limitation in available drawdown, it is seldom possible to divert large volumes of water into any particular pumping center.

### **Pennsylvanian -- Carbondale Group Aquifer System**

The outcrop/subcrop area of the Carbondale Group in western and southwestern Daviess County occupies about 30 percent of the county. The Carbondale Group consists in ascending order of the Linton, Petersburg, and Dugger Formations. It overlies the Raccoon Creek Group and underlies the McLeansboro Group. The Carbondale Group consists mostly of shales and sandstones with some coal and limestone. This group includes some laterally persistent limestones and four of Indiana's commercially important coals. Persistent shales and underclays are associated with several of these coals. Coal beds 5 to 8 feet thick are widespread. Clay beds as much as 10 feet thick underlie coals. Two limestone beds are 5 to 15 feet thick.

The Linton and Petersburg Formations, and the lower part of the Dugger Formation, are present in Daviess County. The Linton includes two coal members, sandstone, shale, and clay. The Petersburg includes the commercially important Springfield Coal Member (Coal V). Coal V and the overlying Dugger Formation occur in the city of Washington and parts of southwestern Daviess County in an area of less than 40 square miles. The total thickness of the Carbondale Group in the county ranges from 0 at its eastern outcrop to a maximum of about 280 feet a few miles southwest of Washington.

The depth to the bedrock surface is typically less than 45 feet. Exceptions are the larger stream valleys in western Daviess County where the depth to bedrock may be greater than 100 feet. Depths of wells open only to the Carbondale Group are highly variable, ranging from 30 to 300 feet. However, most are constructed at depths of 75 to 160 feet. The amount of rock open to the wells typically ranges from 25 to 105 feet, with a maximum of 253 feet. However, about one third of the wells drilled in the outcrop/subcrop area of the Carbondale Group penetrate through the Carbondale and into the underlying Raccoon Creek Group Aquifer System. Many of these wells receive water from both aquifer systems and are typically deeper than wells in only the

Carbondale. Combining all wells receiving at least some water from the Carbondale results in wells ranging in depth from 30 to 365 feet, with most completed at 85 to 225 feet. The amount of rock open to these wells commonly ranges from about 30 to 145 feet. These wells have reported static water levels that vary from about 5 to 135 feet. However, typical water levels range from about 15 to 60 feet below the land surface.

The Carbondale Group Aquifer System in Daviess County is considered a minor ground-water source, with most wells producing from the thicker sandstone and coal units. Most domestic wells have reported testing rates between 2 and 15 gallons per minute (gpm). However, a few dry holes have been reported.

Water quality is generally satisfactory for domestic use, with some wells producing hard water (calcium-magnesium-bicarbonate type) and some soft water (sodium bicarbonate type). However, salty water is noted in records of a few of the deeper wells. Such water quality may also be noted in shallower wells in scattered low-lying areas. The 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. However, in the limited areas of surface and underground coal mining, some localized contamination may have occurred. (Refer to the unconsolidated aquifer systems map for locations of surface coal mined areas.) Contaminants are typically dissolved solids, including calcium, magnesium, sulfate, bicarbonate, and iron. The natural quality of well water gets progressively more mineralized (often changing from a calcium-magnesium-bicarbonate type to a sodium bicarbonate or sodium chloride type) as wells are drilled deeper than about 300 feet and the rock strata dip beneath younger rocks to the southwest.

### **Pennsylvanian -- Raccoon Creek Group Aquifer System**

The outcrop/subcrop area of the Raccoon Creek Group covers about 70 percent of Daviess County. The group consists in ascending order of the Mansfield, Brazil, and Staunton Formations. All three formations are represented in the county. The Mansfield Formation rests unconformably on rocks of late Mississippian age (which are not exposed in the county). This erosional contact surface is quite irregular in elevation, resulting in quite variable thickness of Mansfield rocks.

Total thickness of the group in the county ranges from about 150 feet in the valley of First Creek in northeastern Daviess County to about 600 feet in the southwestern part of the county where it is overlain by the younger Carbondale Group. Shale and sandstone compose approximately 95 percent of the group. Clay, coal, and limestone make up nearly all the rest. Shale is more common than sandstone and it is usually light gray to dark gray in color. The shale may be soft and non-silty, hard and silty, or sandy. The sandstone is mostly fine grained. Where the sandstone is present in the subsurface, massive cross-bedded sandstone seems to be common. Coal beds are typically quite thin, but could be as thick as 5 feet in some areas. Clay beds from 1 to 10 feet thick underlie coal seams. A limestone bed up to 3 feet thick may be present in isolated areas. The lowermost part of the Mansfield commonly contains a large percentage of sandstone. Much of it is cross-bedded and may contain a quartz-pebble and chert conglomerate.

The depth to the bedrock surface is typically less than 45 feet. Exceptions are the larger stream valleys and some areas of northern Daviess County where the depth to bedrock may be over 100 feet. Depths of wells finished in the Raccoon Creek Group are highly variable, ranging from 25 to 490 feet. However, most are constructed at depths of 135 to 310 feet. The amount of rock open to the wells typically ranges from 60 to 220 feet, with a maximum of 411 feet. Although not differentiated for this report, several Raccoon Creek Group wells drilled in the eastern one third of Daviess County also penetrate into the underlying Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System. These wells receive water from both aquifer systems and are typically deeper than wells in only the Raccoon Creek. For all bedrock wells tapping the Raccoon Creek Group, the reported static water levels vary from about 1 to 197 feet below land surface. However, typical water levels range from about 20 to 80 feet below the surface. An observation well, Martin 5, located one-half mile east of Daviess County near Whitfield, shows that water levels in unused bedrock wells typically have seasonal fluctuations of only a few feet per year.

The Raccoon Creek Group in Daviess County is considered a minor ground-water source with many wells producing from the basal Mansfield Formation. Most domestic wells have reported testing rates between 4 and 30 gpm. However, a few dry holes have been reported. Well yields for light industrial, irrigation, farm operation, or small municipal usage of up to 50 gpm may be obtained in isolated areas. At one time, the town of Odon had a rock well, 175 feet deep, tested at 50 gpm.

Water quality is generally satisfactory for domestic use, with some wells producing hard water (calcium-magnesium-bicarbonate type) and some soft water (sodium bicarbonate type). However, records of a few of the deeper wells note salty water. Such water quality may also be noted in shallower wells in scattered low-lying areas. The 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. However, in the limited areas of surface and underground coal mining, some localized contamination may have occurred. (Refer to the unconsolidated aquifer systems map for locations of surface coal mined areas.) Contaminants are typically dissolved solids, including calcium, magnesium, sulfate, bicarbonate, and iron. Generally, natural water quality gets progressively worse (more salty) in wells ranging in varying depths from roughly 250 to 450 feet as the strata dip beneath younger rocks to the southwest.

### **Underground Mine Areas**

In these areas various coal seams within the Carbondale Group and Raccoon Creek Group have been removed by underground mining methods. Approximately 50 percent of the coal was typically removed, leaving the potential for storage of substantial amounts of water in the larger mines. The Division of Water has information on three wells drilled into abandoned underground mines for such purposes as dust control and to prevent water in underground mines from flooding the overlying active surface mine pits. These wells had capacities of 180 to 300 gpm. In addition, a well completed in an underground mine in central Daviess County was once used to irrigate a golf course. It was discontinued because of concerns about the somewhat mineralized water.

## **Mississippian -- Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System**

This Upper Mississippian bedrock aquifer system does not outcrop in Daviess County. However, some deeper wells along the eastern edge of the county penetrate through the Raccoon Creek Group and into this aquifer system. As noted above, the contact surface (unconformity) between the two groups is quite variable in elevation. This bedrock aquifer system, composed primarily of shale, limestone, and sandstone, consists of three groups, from oldest to youngest: West Baden, Stephensport, and Buffalo Wallow. The three groups comprising this bedrock aquifer system differ in their percentages of shale, limestone, and sandstone.

The West Baden Group consists dominantly of shale and mudstone (40 percent) and thin-bedded to cross-bedded sandstone (35 percent); however, it has limestone beds of variable thickness (25 percent). The Stephensport Group is comprised of limestone (approximately 40 percent), shale (25 percent), and cliff-forming sandstone (35 percent). The Buffalo Wallow Group is primarily shale, mudstone, and siltstone (approximately 75 percent). It also contains prominent beds of sandstone (20 percent) and limestone (5 percent), some of which are laterally extensive. The limestone and sandstone beds, principally in the lower part of the unit, are 1 to 15 feet thick and 5 to 90 feet thick, respectively. The Buffalo Wallow Group thins progressively northward and is likely completely eroded at the Mississippian-Pennsylvanian unconformity in northern Daviess County. The combined thickness of the West Baden, Stephensport, and Buffalo Wallow in the county is expected to vary from about 200 to 300 feet.

Specific data on well depths, static water levels, open intervals, testing rates, and quality are not available for this aquifer system. It is very difficult to distinguish which aquifer system was penetrated because of the very similar rock types in this system and the overlying Raccoon Creek Group. In addition, the highly variable elevation of the contact (unconformity) between this system and the Raccoon Creek Group compounds the problem.

As in the other bedrock aquifer systems, natural water quality is expected to get progressively worse (more salty) in wells deeper than 300 or 400 feet as the strata dip beneath younger rocks to the southwest.

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.

### **Registered Significant Ground-water Withdrawal Facilities**

There is only one active significant ground-water withdrawal facility registered in Daviess County that uses a bedrock aquifer system. The well has a reported capacity of only 1 gpm. (The same facility has a well with a capacity of 60 gpm in an unconsolidated aquifer system.) Two discontinued facilities used wells in abandoned underground coal mines. These wells had capacities of 180 to 300 gpm. Refer to Table 1 for more details on the wells and to the map for facility locations.

### **Map Use and Disclaimer Statement**

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