

# **Bedrock Aquifer Systems of Clark 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 increases 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 Clark County, rock types exposed at the bedrock surface are moderately productive limestones and dolomites with varying amounts of interbedded shales, and poorly productive shales and siltstones.

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.

Six bedrock aquifer systems are identified for Clark County. They are, from west to east and youngest to oldest: Buffalo Wallow, Stephensport, and West Baden Groups of Mississippian age; Blue River and Sanders Groups of Mississippian age; Borden Group of Mississippian age; New Albany Shale of Devonian and Mississippian age; the Silurian and Devonian Carbonates and the Maquoketa Group of Ordovician age. Bedrock aquifers are not highly productive in this county. However, bedrock wells represent about 90% of all wells completed in the county.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. 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.

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

This Upper Mississippian bedrock aquifer system consists of three groups, from oldest to youngest: West Baden, Stephensport, and Buffalo Wallow. The Buffalo Wallow and Stephensport Groups are not present in the county. In Clark County, the West Baden outcrops

only in a small area in the southwest corner of the county. The West Baden is comprised of various percentages of shale, limestone, and sandstone.

The Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System is less than 50 feet thick in Clark County. No wells have been reported in the county in this system. This system is not regarded as a major ground-water resource in Clark County. Clay materials of varying thickness overlie the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System. Where the clay materials are thin, the aquifer system has a moderate risk to contamination; where thick, there is low risk.

### **Mississippian -- Blue River and Sanders Groups Aquifer System**

This Middle Mississippian age aquifer system outcrops primarily in the western quarter of the county. The Sanders Group consists in ascending order of the Ramp Creek, Harrodsburg, and Salem limestone formations. These are primarily limestone but contain some dolomite. The Blue River Group includes in ascending order the St. Louis, Ste. Genevieve, and Paoli limestone formations. These formations are primarily limestone, but they contain significant amounts of gypsum, anhydrite, shale, chert, and calcareous sandstone.

The combined thickness of the Blue River and Sanders Groups ranges from less than 1 foot where the older Borden Group is exposed to over 100 feet. The formations thicken as they dip to the west-southwest. Depth to bedrock is generally between 5 and 40 feet below land surface. In Clark County, there are few reported wells actually producing from the Blue River and Sanders Groups Aquifer System.

This aquifer system is considered very susceptible to contamination from the land surface in Clark County because overlying clays are thin, and the upper part of the Blue River and Sanders Groups Aquifer System has many open joints, and solution channels.

### **Mississippian -- Borden Group Aquifer System**

The outcrop/subcrop area of the Mississippian age Borden Group Aquifer System includes most of the western third of Clark County. This bedrock aquifer system is composed mostly of siltstone and shale, but fine-grained sandstones are common. Carbonates are rare, but are present as discontinuous interbedded limestone lenses, mostly in the upper portion of the group.

The thickness of the Borden Group in Clark County ranges from less than one foot where the older New Albany Shale rocks are exposed to a maximum of about 550 feet in the northeastern part of the county. The formation thins as it dips to the west-southwest.

Because the Borden Group is generally not very productive, it is typically used only where overlying deposits do not contain an aquifer. The Borden Group is often described as an aquitard and yields of wells completed in it are usually quite limited. Many wells, however, are able to produce sufficient water for domestic purposes by relying on extra well-bore storage by drilling relatively large diameter and relatively deep wells.

Wells started in the outcrop/subcrop area of the Borden Group in Clark County have reported depths ranging from 25 to 200 feet, but are commonly 40 to 100 feet deep. The amount of rock penetrated in this system generally ranges from 20 to 75 feet. Most domestic wells completed in the system have reported testing rates of less than 5 gpm and many dry holes have been reported. Static water levels are commonly between 10 to 30 feet below land surface. However, a few wells have been tested at rates greater than 20 gpm in the New Providence (Borden P.O.) area along Muddy Fork. Higher capacities may result by constructing wells along significant bedrock fractures where they are overlain by alluvium. However, it is doubtful that the higher pumping rate could be sustained. Overall, there is little chance for development of high-capacity wells in the Borden Group Aquifer System in Clark County.

The Borden Group is composed primarily of fine-grained materials that limit the movement of ground water to fractures and joints. This, along with the overlying, typically fine-grained clay materials, puts most of the Borden Group Aquifer System at low risk to contamination from the surface or near surface. However, in areas where coarse-grained alluvium overlies the fractured and jointed rock, there is a high risk of contamination from surface or near-surface sources.

### **Devonian and Mississippian -- New Albany Shale Aquifer System**

The New Albany Shale consists mostly of brownish-black carbon-rich shale and greenish-gray shale, along with minor amounts of dolomite and dolomitic quartz sandstone. In Clark County the thickness of the New Albany Shale ranges from 0 to about 120 feet and generally thickens as it dips southwest. The outcrop/subcrop area for the New Albany Shale is present in a north-south band in the central part of the county. Depth to bedrock is generally between 0 and 60 feet below land surface.

This aquifer system is considered a poor aquifer resource and is generally described as an aquitard and many dry holes have been reported in this county. Over 40 percent of the wells penetrating this system are completed in the underlying Silurian and Devonian Carbonates Aquifer System. However, wells completed in the New Albany Shale Aquifer System in Clark County have reported depths ranging from 30 to 108 feet deep. The amount of rock penetrated in this system typically ranges from 10 to 45 feet. Reported yields for domestic wells range from less than 1 to 45 gpm. However, very few wells can sustain a pumping rate over 5 gpm. Where the more porous or jointed rock units are overlain by sand and gravel, such as in a river valley, somewhat higher sustained yields may be possible. Static water levels typically range from 10 to 30 feet below land surface.

This aquifer system has a low susceptibility to surface contamination because clay deposits cover most of the county and low permeability of shale materials. However, the New Albany Shale aquifer System is moderately to highly susceptible where overlain by unconsolidated deposits composed primarily of sand and gravel alluvial materials.

### **Silurian and Devonian Carbonates Aquifer System**

In Clark County, this aquifer system consists primarily of middle Devonian age carbonates of the Muscatatuck Group and underlying Silurian carbonates. Because 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. The maximum thickness of the Silurian and Devonian Carbonates Aquifer System in Clark County is about 250 feet. The depth to the bedrock surface is typically less than 30 feet on the uplands, but is greater than 100 feet in the Ohio River Valley.

Water wells completed in this system are generally capable of meeting the needs of domestic users in this county. Wells utilizing the Silurian and Devonian Carbonates Aquifer System in Clark County have reported depths ranging from 31 to 243 feet, but are commonly 50 to 120 feet deep. The amount of rock penetrated in this system generally ranges from 20 to 120 feet. Typical yields for domestic wells range from 1 to 10 gpm. Static water levels commonly range from 10 to 45 feet below land surface.

This aquifer system has a low susceptibility to surface contamination because clay deposits cover most of the county. However, the Silurian and Devonian Carbonates Aquifer System is moderately to highly susceptible where overlain by unconsolidated deposits composed primarily of sand and gravel outwash materials and in places where clay aquitards are absent.

### **Ordovician -- Maquoketa Group Aquifer System**

The outcrop/subcrop area of the Maquoketa Group is limited to the eastern part of Clark County along the Ohio River and some of the deeply incised tributary stream valleys. The Maquoketa Group consists in ascending order of the Kope, Dillsboro, and Whitewater Formations. The Kope is not identified in Clark County. The Maquoketa Group consists mostly of shales with interbedded limestone units. Few wells have been completed in this system in Clark County. These wells generally use little more than the top 100 feet for water production, although this system is approximately 700 to 850 feet thick in the county.

The Maquoketa Group is considered a minor ground-water source in Clark County. Although well data are sparse for this aquifer system in the county, expected water production from the Maquoketa Group should be similar to that in neighboring Jefferson County, where very few wells are capable of sustaining yields of greater than 5 gpm. Except in areas where overlying clay-rich till and residuum is thin or absent, this aquifer system is not very susceptible to contamination from the land surface.

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