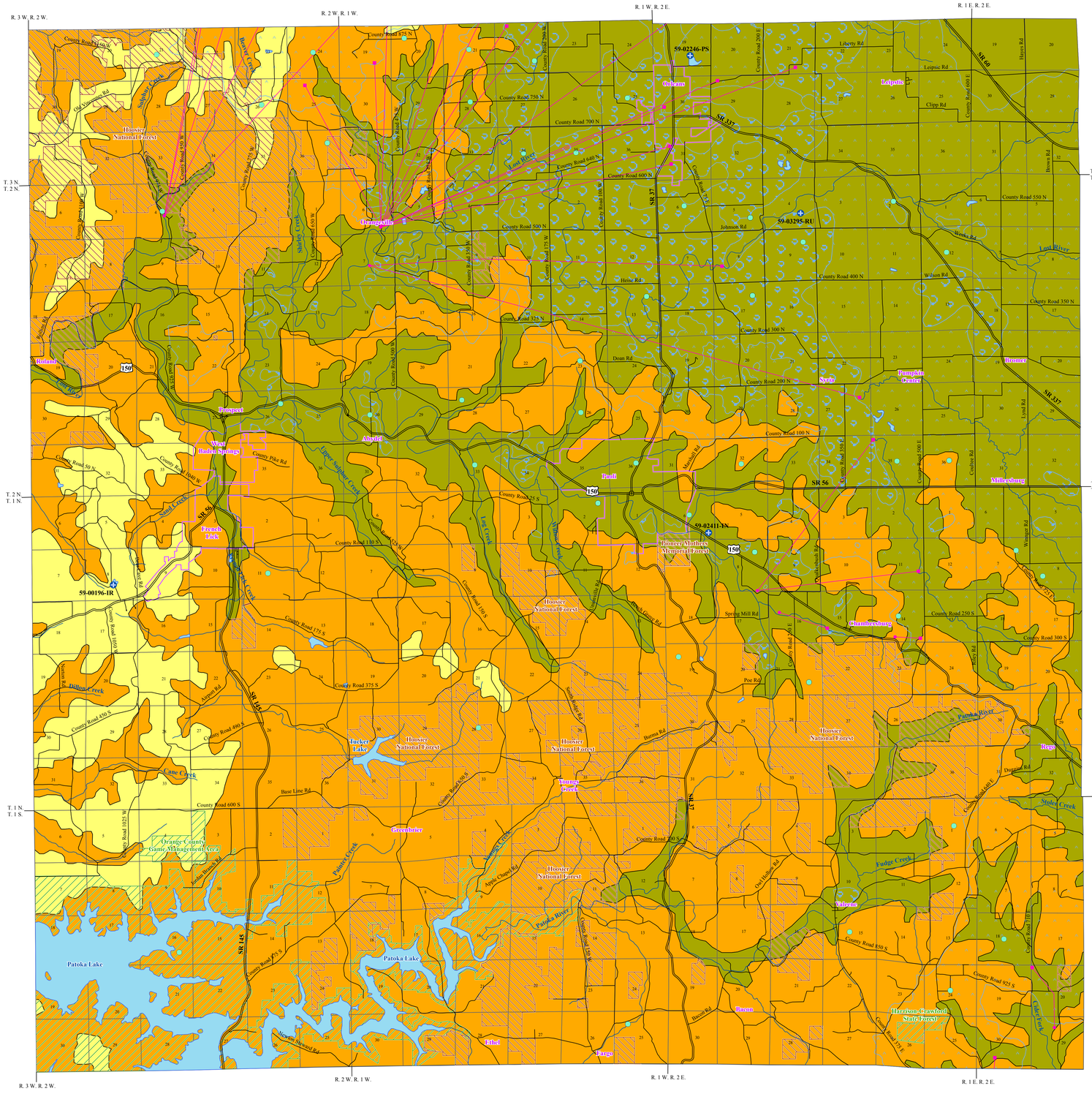
BEDROCK AQUIFER SYSTEMS OF ORANGE COUNTY, INDIANA



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 Orange County, rock types exposed at the bedrock surface range from relatively unproductive shales to moderately productive limestones and 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 Orange County increases rapidly for bedrock wells deeper than a few hundred feet. Mineralized water is noted in some springs and 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 Orange County based on bedrock lithology. They are, from west to east, youngest to oldest: Raccoon Creek Group of Pennsylvanian age; Buffalo Wallow, Stephensport, and West Baden Groups of Mississippian age; and Blue River and Sanders Groups of Mississippian age.

The bedrock aquifer systems extend across Orange 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.

Bedrock aquifers are almost exclusively used in Orange County. This is because unconsolidated materials are typically very thin, primarily consisting of weathered bedrock residuum.

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.

Pennsylvanian -- Raccoon Creek Group Aquifer System

Aquifers contained within the Pennsylvanian age bedrock have generally low yield potential. 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.

The outcrop/subcrop area of the Raccoon Creek Group covers most of the uplands of western Orange County. The group consists in ascending order of the Mansfield, Brazil, and Staunton Formations. The Staunton Formation and the Brazil Formation are not present in the county. The Mansfield Formation rests unconformably on rocks of late Mississippian age. This erosional contact surface is quite irregular in elevation, resulting in quite a variable thickness of Mansfield rocks.

Total thickness of the group in the county ranges from 0 where the younger Mississippian rocks are exposed in the eastern half of the county to over 150 feet on ridge tops in western Orange County. 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, it is commonly massive and cross-bedded. Coal beds are typically quite thin, but could be as thick as 2 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 20 feet. Well depths in the Raccoon Creek Group outcrop area are highly variable, ranging from 45 to 503 feet. However, most are constructed at depths of 70 to 300 feet. The amount of rock penetrated by wells typically ranges from 50 to 280 feet. Many wells deeper than 100 feet penetrate through the Raccoon Creek Group Aquifer System into the underlying Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System. A few wells penetrate into the Blue River Group. Reported static water levels vary from 0 (flowing) to 300 feet below the land surface, but they are commonly 40 to 180 feet below the surface.

In Orange County, the Raccoon Creek Group is considered a minor ground-water source, with wells producing from the basal Mansfield Formation. Most domestic wells produce between 0 and 10 gallons per minute (gpm) with localized yields of up to 20 gpm. Several dry holes have been reported.

Water quality is generally good, with some wells producing hard water (calcium-magnesium-bicarbonate type) and some soft water (sodium bicarbonate type). The Raccoon Creek Group Aquifer System is not very susceptible to contamination from the land surface because of the typical presence of low-permeability strata above water-bearing zones.

EXPLANATION

- Registered Significant Ground-water Withdrawal Well
- Cave or Crevice Described on Water Well Record
- Dye Test Input Point
- Dye Test Detection Point
- Karst Dye Trace
- County Road
- State Road & US Highway
- Stream
- Municipal Boundary
- Sinkhole Area
- Sinking-Stream Basin
- State Managed Property
- Federal Managed Property
- Lake & River

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

This Upper Mississippian bedrock aquifer system outcrops primarily in central and southern Orange County. It also outcrops along the lower slopes in deeper stream valleys of western Orange County. Many rock units are laterally discontinuous and the system has been truncated northward because of pre-Pennsylvanian erosion. The present near-surface thickness and occurrence of the deposits forming this bedrock aquifer system have been altered by the Mississippian-Pennsylvanian unconformity throughout the county.

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. This group thins progressively northward in Orange County. The combined thickness of the West Baden, Stephensport, and Buffalo Wallow in the county ranges from 0 where the older Blue River Group rocks are exposed to a maximum of about 250 feet in the western part of the county where the younger Pennsylvanian rocks occur.

The depth to the bedrock surface is typically less than 20 feet on the uplands, but may be as much as 45 feet in the larger valley bottoms. Well depths in the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System range from 26 to 445 feet, with most wells completed at depths of about 100 to 300 feet. The amount of rock penetrated by a well typically ranges from about 100 to 300 feet, with a maximum of 440 feet. Many of the deeper wells penetrate through this aquifer system into the underlying Blue River and Sanders Groups Aquifer System. Most of the water will be found in the limestone and sandstone beds. However, no attempt has been made in this report to correlate yields with the amount of penetration or the individual geologic formations used. Static water levels are highly variable in the wells completed in this aquifer system. Reported water levels range from 0 feet to 275 feet below land surface, but are typically between 10 and 150 feet.

The Buffalo Wallow; Stephensport, and West Baden Groups Aquifer System is not regarded as a major ground-water resource in this county, thus most drillers finish the wells in the more productive Blue River Group. Most domestic wells completed in the system have been tested between 2 and 15 gpm and some dry holes have been reported. A few wells have been tested as high as 20 gpm. However, very few wells can sustain a pumping rate over 10 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.

In the outcrop/subcrop area of this aquifer system the rock is predominantly shallow and contains numerous, irregular joints. In limited areas, some karst (see Karst Features and the Dissolution of Carbonate Rocks) has developed in the limestone beds. Some water well records describe caves up to 20 feet high, but the caves are typically less than five feet high (see map for location of these wells). These conditions warrant considering the aquifer system as a whole to be somewhat susceptible to contaminants introduced at and near land surface.

Mississippian -- Blue River and Sanders Groups Aquifer System

This Middle Mississippian age aquifer system outcrops in the northeastern quarter of Orange County. It also outcrops in parts of the northwest and southeast quarters of the county, primarily in the valley bottoms of Lost River, Patoka River, their tributaries, and a short distance up the hillsides. The older Sanders group is not exposed in Orange County, but is exposed nearby in Lawrence and Washington Counties. The Sanders Group consists in ascending order of the 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 may contain significant amounts of gypsum, anhydrite, shale, chert, and calcareous sandstone.

The total thickness of the Blue River and Sanders Groups ranges from about 100 feet where nearly all eroded in northeastern Orange County, to about 900 feet in the southwestern part of the county. The formations thicken considerably as they dip to the west-southwest. Limestones within the Blue River Group are especially noted for development of karst features on the land surface where the bedrock is quite shallow. Some of the karst features in the county include caves, sinkholes, collapsed sinkholes, gulfs, sinking streams, stream rises, and springs. These features are produced by the action of ground water dissolving the limestone, primarily along planes or zones of weakness. Weak zones include vertical or nearly vertical joints, nearly horizontal bedding planes between limestone units, and zones within the formations that are more easily dissolved. Most of the permeability (a measure of the ability of the rock to transmit water) of these limestones results from the joints that developed after the rock was formed and their subsequent enlargement by the dissolving action of water.

Some well records describe cavities or solution channels up to 28 feet in height (see map for location of these wells). Not surprisingly, the yields of wells tapping this aquifer system are quite variable. Yields should vary roughly in proportion to the number, size, depth, and degree of interconnection of joints and solution channels. However, the effects of those variables at any specific location cannot be predicted with any degree of accuracy. Where the rock is overlain by sand and gravel, or broken limestone such as in a river valley or on the Mitchell Plateau, somewhat higher sustained yields are believed possible. The Division has records for over 300 wells in this aquifer system in the county. The depth to solid bedrock is typically between 20 and 50 feet on the Mitchell Plateau, but may be as much as 95 feet where broken limestone and clay are present due to extensive weathering or collapsed karst features. Isolated sand and gravel seams up to 5 feet thick may be present in the Lost River or Patoka river valley bottoms. Well depths range from about 28 to 363 feet, with most wells completed at depths of about 80 to 190 feet. Reported test rates for water wells vary between 0 and 250 gpm. The registered significant ground-water withdrawal facilities with wells completed in this system are reported to have pumping capacity ranging from 100 to 135 gpm. Most domestic wells completed in the system have been tested between 5 and 25 gpm and a few isolated dry holes have been reported. Reported water levels range from 0 feet to 285 feet below land surface, but are typically between 10 and 100 feet.

In Orange County, the Blue River and Sanders Groups Aquifer System is considered a very dependable ground-water source. Water quality is generally good, except for several wells reporting sulfur odor, which may be due to the gypsum deposits in the Blue River Group. However, because of the shallow rock, open joints, and solution channels, the aquifer system is very susceptible to contamination from the land surface.

INDIANA DEPARTMENT OF NATURAL RESOURCES

Map generated by Jennifer McMillan
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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), County Boundaries of Indiana (polygon shapefile, 20050621), Selected Subsurface Dye Traces in Parts of Southern Indiana (line shapefile, 20000225), and Input and Detection Points for Selected Subsurface Dye Traces in Parts of Southern Indiana (point shapefile, 20001124), 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. 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. Sinkhole Areas and Sinking-Stream Basins in Part of Southern Indiana (polygon shapefile, 20001124) was also from the Indiana Geological Survey, but based on a 1:126,720 scale.

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