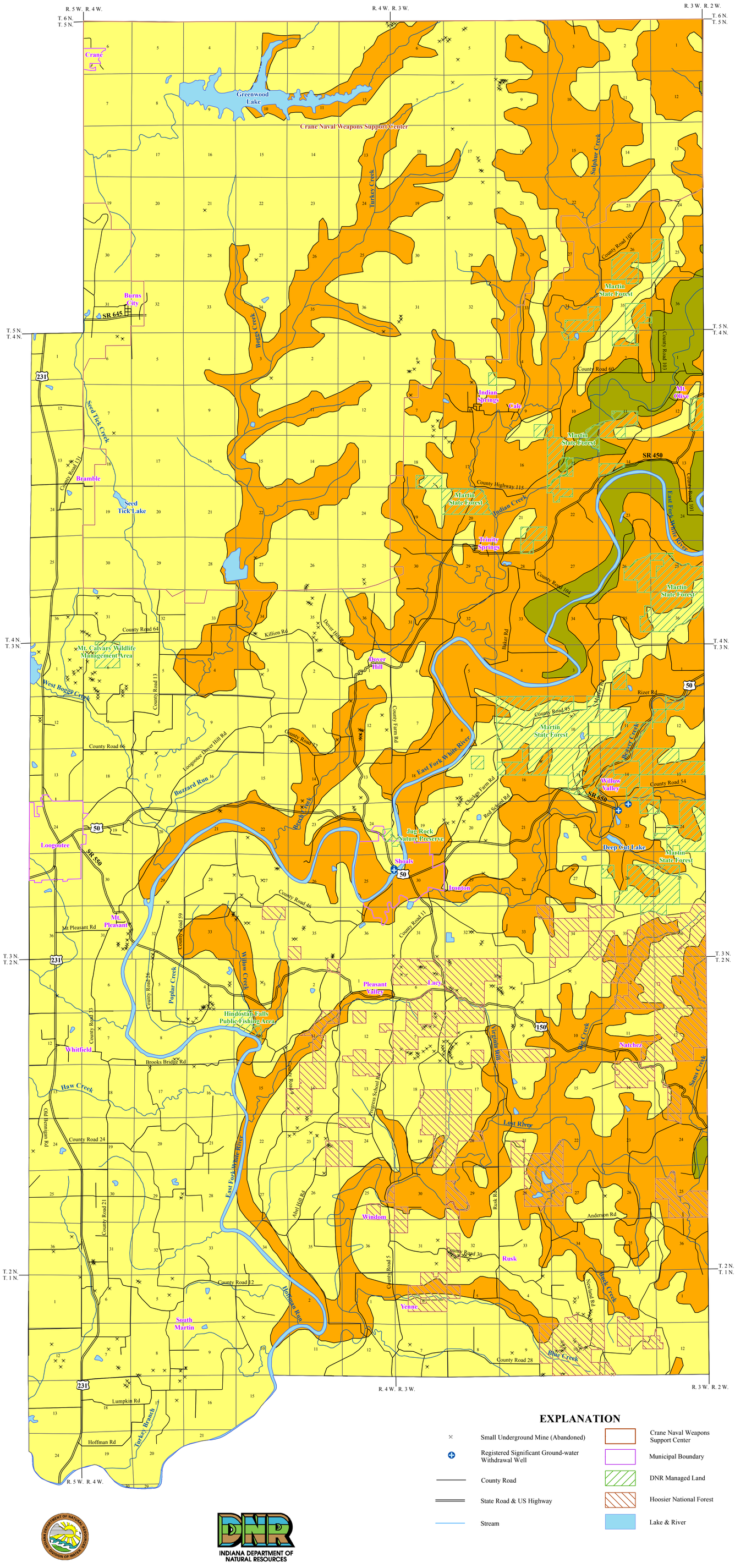
BEDROCK AQUIFER SYSTEMS OF MARTIN COUNTY, INDIANA



Martin 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 is often greatest near the bedrock surface, bedrock units within the upper 100 feet are generally the most productive aquifers. In Martin 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 Martin County increases rapidly for bedrock wells deeper than about 300 feet. Mineralized water is sometimes noted in 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 Martin County based on bedrock lithology. They are, from west to east and 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 Martin 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 used much more than unconsolidated aquifers in most of the county. This is because unconsolidated materials are typically very thin, primarily consisting of weathered bedrock residuum. The largest exception is the main valley of the 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.

Pennsylvanian--Raccoon Creek Group Aquifer System

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.

The outcrop/subcrop area of the Raccoon Creek Group covers most of western Martin County. The group consists in ascending order of the Mansfield, Brazil, and Staunton Formations. The Staunton Formation is not present in the county. The outcrop area of the Brazil Formation is less than one square mile 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 variable thickness of Mansfield rocks.

Total thickness of the group in the county ranges from 0 where the younger Mississippian rocks are exposed in stream valleys in the eastern half of the county to about 400 feet on ridge tops in southwestern Martin 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, 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 25 feet. Exceptions are the larger stream valleys and small areas of western Martin 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 22 to 335 feet. However, most are constructed at depths of 90 to 220 feet. The amount of rock open to the wells typically ranges from 35 to 135 feet, with a maximum of 275 feet. However, about one third of the wells drilled in the outcrop/subcrop area of the Raccoon Creek Group penetrate through the Raccoon Creek Group and 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. These wells range in depth from 65 to 405 feet, with most completed at 200 to 345 feet. The amount of rock open to these wells commonly ranges from about 115 to 255 feet. For all bedrock wells in the Raccoon Creek outcrop/subcrop area the reported static water levels vary from about 8 to 230 feet. However, typical water levels range from about 30 to 105 feet below the land surface. An observation well, Martin 5, located near Whitfield, shows that water levels in unused bedrock wells typically vary only a few feet per year.

In general, the Raccoon Creek Group is considered a minor ground-water source in Martin County with many wells producing from the basal Mansfield Formation. Most domestic wells have reported testing rates between 4 and 30 gallons per minute (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. The town of Shoals has two wells completed in a coarse-grained sandstone or conglomerate at the base of the Mansfield Formation. The wells have a capacity of 350 gpm each. These high capacities should not be viewed as typical. They result from a coincidence of a deep Pennsylvanian channel deposit that is overlain by more recent outwash sand and gravel in the East Fork White River valley.

Water quality is generally good, with some wells producing hard water (calcium-magnesium-bicarbonate type) and some soft water (sodium bicarbonate type). 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 numerous small areas, various coal seams within the Raccoon Creek Group have been removed by underground mining methods. Approximately 50 percent of the coal has been removed, leaving the potential for storage of substantial amounts of water in the few larger mines. Although the Division has no records of wells drilled into these mines, short-term yields of a few hundred gpm may be possible. A limitation on use of the water could be its more mineralized nature.

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

This Upper Mississippian bedrock aquifer system outcrops primarily in eastern Martin County. It is laterally discontinuous and 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. The Buffalo Wallow Group thins progressively northward and is likely completely eroded at the Mississippian-Pennsylvanian unconformity in northern Martin 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 200 to 250 feet at the base of the Pennsylvanian Mansfield Formation in western Martin County.

The depth to the bedrock surface is usually less than 25 feet. Well depths in the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System range from 45 to 445 feet, with most wells completed at depths of about 95 to 235 feet. The amount of rock open to the wells typically ranges from about 45 to 155 feet, with a maximum of 366 feet. About 10 percent of the bedrock wells within the outcrop/subcrop area of this aquifer system actually penetrate into the underlying Blue River and Sanders Groups Aquifer System. These wells tend to be deeper than wells open only to the Buffalo Wallow, Stephensport, and West Baden Groups. Reported static water levels for all bedrock wells in this outcrop/subcrop area range from 0 (flowing) to over 200 feet below land surface, but are typically between 20 and 100 feet.

The Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System is not regarded as a major ground-water resource in Martin County. However, most attempts to drill a domestic well into it are successful. Most domestic wells completed in the system have been tested at 3 to 15 gpm. A few wells have been tested as high as 75 gpm. However, very few wells can sustain a pumping rate over 20 gpm. Most of the water will be found in the limestone and sandstone beds. However, no attempt has been made to correlate yields with the amount of penetration or the individual geologic formations used. 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.

Water quality is generally good. However, some well records indicate "bad" water or sulfur water (hydrogen sulfide gas). In addition, some springs, such as Sulphur Springs, in the outcrop/subcrop area are noted for mineralized or sulfur water. Such water quality may also be found in relatively shallow wells in scattered low-lying areas. As a general rule, 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.

In the outcrop/subcrop area of this aquifer system the rock is predominantly shallow and contains numerous, irregular joints. In limited areas, some karst has developed in the limestone beds. 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 is limited in the outcrop/subcrop to only a few square miles, primarily in northeastern Martin County in the valley bottoms of Indian Creek and East Fork White River and a short distance up the hillsides. The older Sanders group is not exposed in Martin County, but is exposed about four miles east in Lawrence County. The Sanders Group consists in ascending order of the Harrodsburg and Salem limestone formations. These are primarily limestone but include some dolomite content. 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. Deposits of gypsum and anhydrite within the St. Louis have commercial importance to two large underground mines located two to four miles east of Shoals.

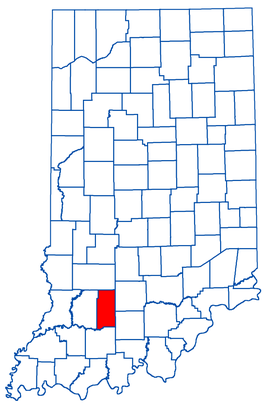
The total thickness of the Blue River and Sanders Groups ranges from about 400 feet in northeastern Martin County, where roughly 100 to 150 feet of the Blue River Group is eroded, to as much as 1000 feet in the southwestern part of the county. The formations thicken considerably as they dip to the west-southwest. 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 sinkholes, sinking streams, 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.

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, such as in a river valley, somewhat higher sustained yields are believed possible. Overall, the Blue River and Sanders Group Aquifer System is considered a minor ground-water source in this county.

The Division has identified records for only 36 wells in this aquifer system in the county, including 20 wells that are also open to the overlying aquifer system. The depth to bedrock is typically less than 15 feet on the hillsides, but may be as much as 100 feet in the larger valley bottoms, such as the East Fork White River. Well depths range from about 80 to 445 feet, with most completed between 145 and 360 feet. The amount of rock open to the wells typically ranges from about 95 to 260 feet. Drillers report testing rates from less than 1 gpm to as much as 25 gpm. However, most report between 3 and 15 gpm. Static water levels are reported to range from less than 15 to over 200 feet below land surface, but are commonly between 50 and 150 feet below the surface. The deep wells located on higher ground, and also open to the overlying bedrock aquifer system, tend to skew the statistics for well depth, amount of rock open to the wells, and static water levels.

Ground water is generally of good quality, but is typically high in hardness. However, a few well records indicate sulfur water. Because of the typically shallow rock, open joints, and solution channels, the aquifer system is very susceptible to contamination from the land surface. 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.

Location Map



EXPLANATION

- Small Underground Mine (Abandoned)
- Registered Significant Ground-water Withdrawal Well
- County Road
- State Road & US Highway
- Stream
- Crane Naval Weapons Support Center
- Municipal Boundary
- DNR Managed Land
- Hoosier National Forest
- Lake & River

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

INDIANA DEPARTMENT OF NATURAL RESOURCES

Map generated by Jennifer Mc Millan
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This map was created from several existing shapefiles. Underground Coal Mines in Southwestern Indiana (polygon shapefile, 20001002), Township and Range Lines of Indiana (line shapefile, 20020621), Land Survey Lines of Indiana (polygon shapefile, 20020621), and County Boundaries of Indiana (polygon shapefile, 20050621) were all from the Indiana Geological Survey and based on a 1:24,000 scale, except the Bedrock Geology of Southwestern Indiana (polygon shapefile, 20001124), 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. City Areas in Southwestern Indiana (polygon shapefile, 1999) was from ESRI and based on a 1:100,000 scale. Managed Areas 96 (polygon shapefile, various dates) was from IDNR. Streams27 (line shapefile, 20000420) was from the Center for Advanced Applications in GIS at Purdue University.

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