

Water Resources and Use in Delaware County

- | | |
|----------------------------|-----------------------|
| Withdrawal Location | River |
| WELL INTAKE | 7Q2 Flow (MGD) |
| ● Energy/Mining | — <10 MGD |
| ● Industry | — 10 - 50 MGD |
| ● Irrigation | — 50 - 100 MGD |
| ● Misc. | — 100 - 500 MGD |
| ● Public Supply | — > 500 MGD |
| ● Rural Use | |

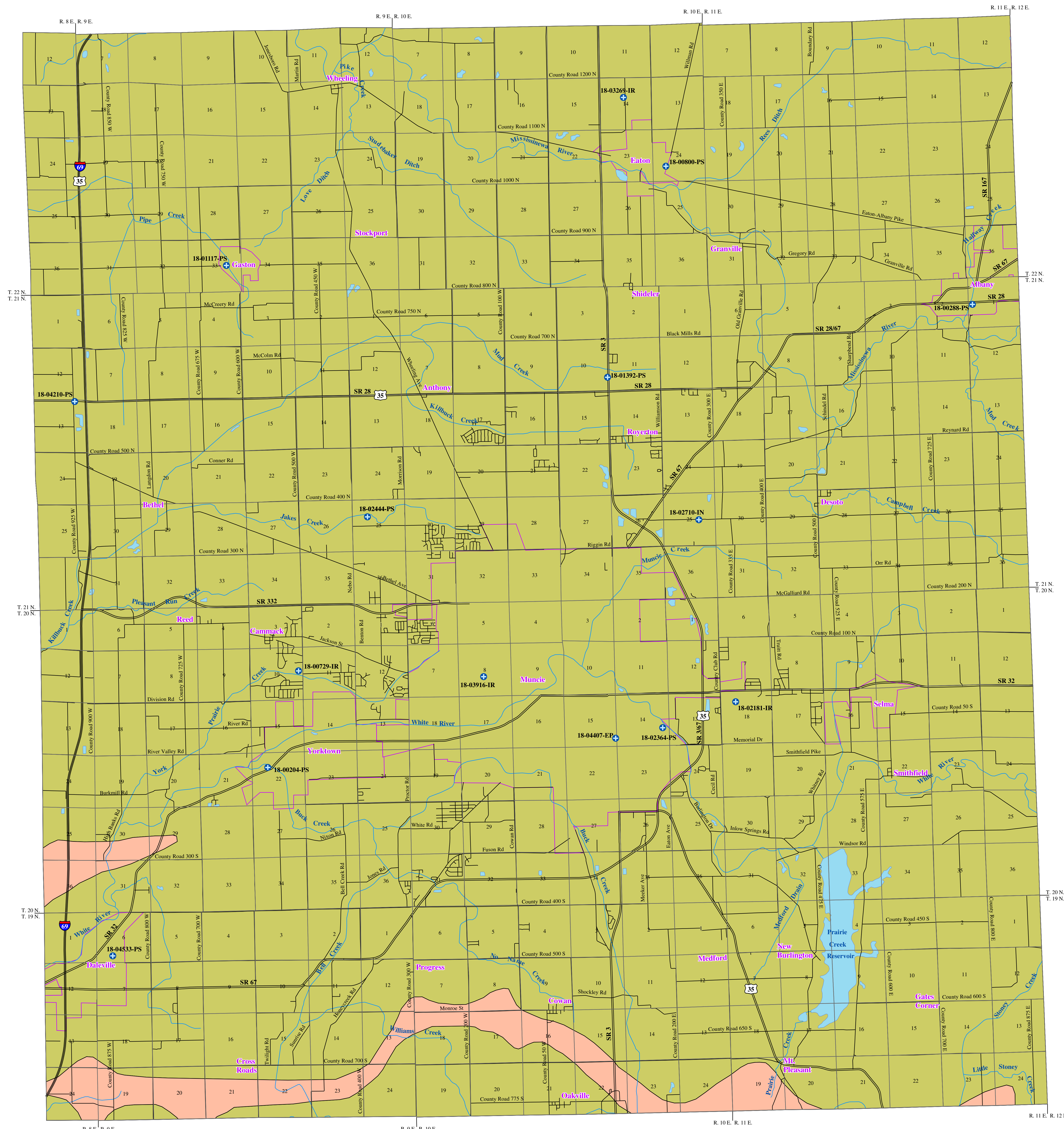
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Major Lakes: Interstate: County: City:

NORTH Miles
0 1 2

Data Sources: U.S. Geological Survey and Indiana Department of Natural Resources

BEDROCK AQUIFER SYSTEMS OF DELAWARE 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.

Unconsolidated deposits of varying thickness overlie bedrock aquifer systems in Delaware County. 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 formation.

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.

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

Two bedrock aquifer systems are identified for Delaware County. They are: the Silurian and Devonian Carbonates; and the Maquoketa Group of Ordovician age.

Silurian and Devonian Carbonates Aquifer System **Ordovician - Maquoketa Group Aquifer System**

The Silurian and Devonian Carbonates Aquifer System is extensive throughout nearly all of Delaware County. The system includes Silurian age carbonate rock units (limestone and dolomite) with some interbedded shale units. Total thickness of the Silurian bedrock deposits ranges from 200 to 400 feet. Depth to the bedrock surface ranges from about 0 to 300 feet but is commonly 35 to 110 feet. Total well depths range from 23 to 505 feet but are typically 80 to 180 feet with penetration into bedrock commonly 20 feet or less. Deeper wells in some areas may reach the upper portion of the underlying Maquoketa Group.

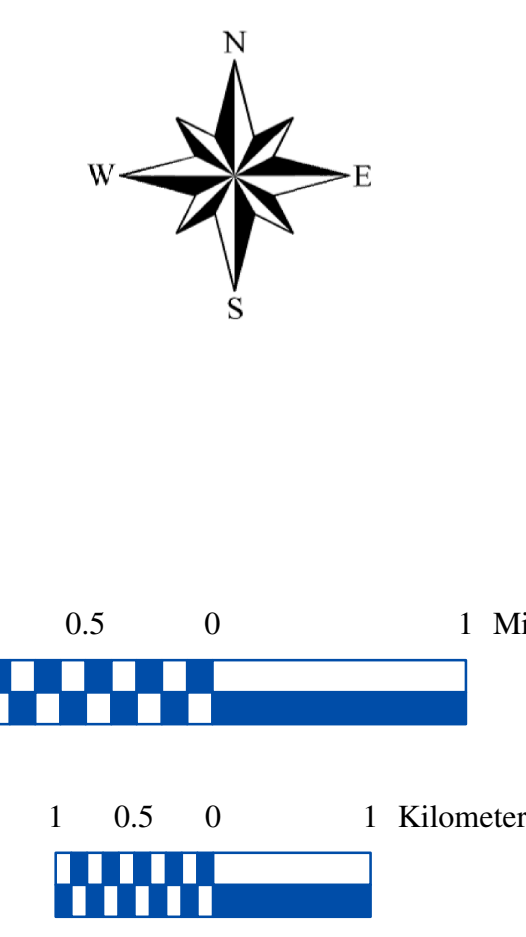
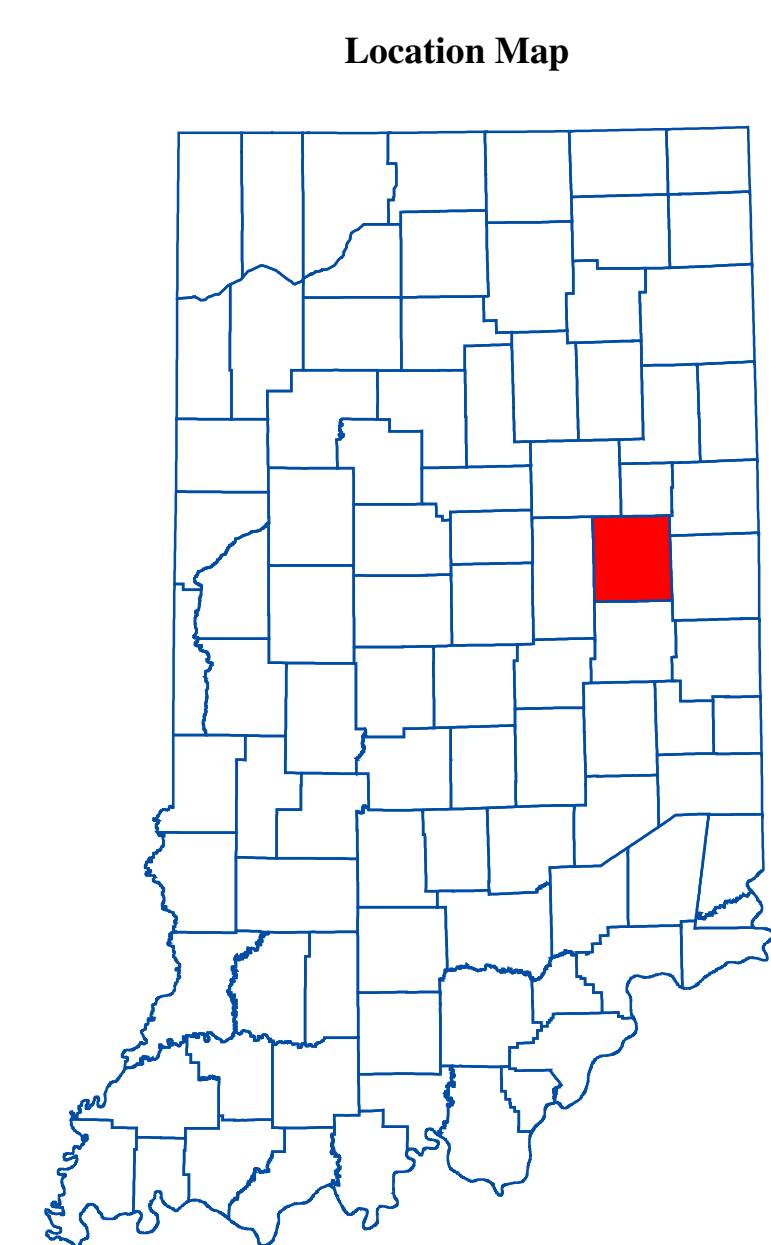
The Silurian and Devonian Carbonates Aquifer System in Delaware County is considered quite dependable of sustaining yields for domestic and some high-capacity users. Many domestic and high-capacity well records, however, note variable thicknesses of sand and/or gravels that directly overlie the bedrock surface. These deposits are present in the central part of the county near the White River and suggests the potential connection of overlying sands and gravels to the bedrock aquifer system. Typical domestic yields range from 10 to 45 gallons per minute (gpm), although some isolated wells are noted at less than 10 gpm. There are 15 registered high-capacity facilities (40 wells) with yields that range from 70 to 800 gpm. Static water levels range from flowing to 80 feet but are commonly 10 to 30 feet.

Most of the Silurian and Devonian Carbonates Aquifer System in Delaware County is overlain by clay of variable thicknesses. Where overlying clay materials are thick, the aquifer system is considered at low risk to contamination. However, solution features (caves) are described in a few well records suggesting minor karst development and there are localized areas, especially near the White River, where the bedrock surface is shallow or exposed. These areas, therefore, are at moderate to high risk to contamination.

The extent of the Maquoketa Group Aquifer System subarea is limited to two buried pre-glacial bedrock valleys located along the south and southwest edges of Delaware County. The system includes mostly shale with some interbedded limestone units. Thickness of the Maquoketa Group in Delaware County ranges from 650 to 750 feet and thins as it dips beneath younger strata to the northwest. The depth to the bedrock surface ranges from 100 to 330 feet.

Few wells have been reported in this system in Delaware County due to the availability of overlying unconsolidated sand and gravel resources and overlying Silurian and Devonian Carbonates. Reported depths of the few wells drilled in the Maquoketa Group range from 140 to 255 feet with the amount of rock penetration typically 20 to 90 feet. Reported well yields range from 2 to 25 gpm with static water levels ranging from 3 to 50 feet.

Thick clay deposits cap this aquifer system; therefore, the Maquoketa Group Aquifer System is not very susceptible to contamination from the land surface.



EXPLANATION

- Registered Significant Ground-Water Withdrawal Facility
- Stream
- County Road
- State Road & US Highway
- Interstate
- Municipal Boundary
- Lake & River



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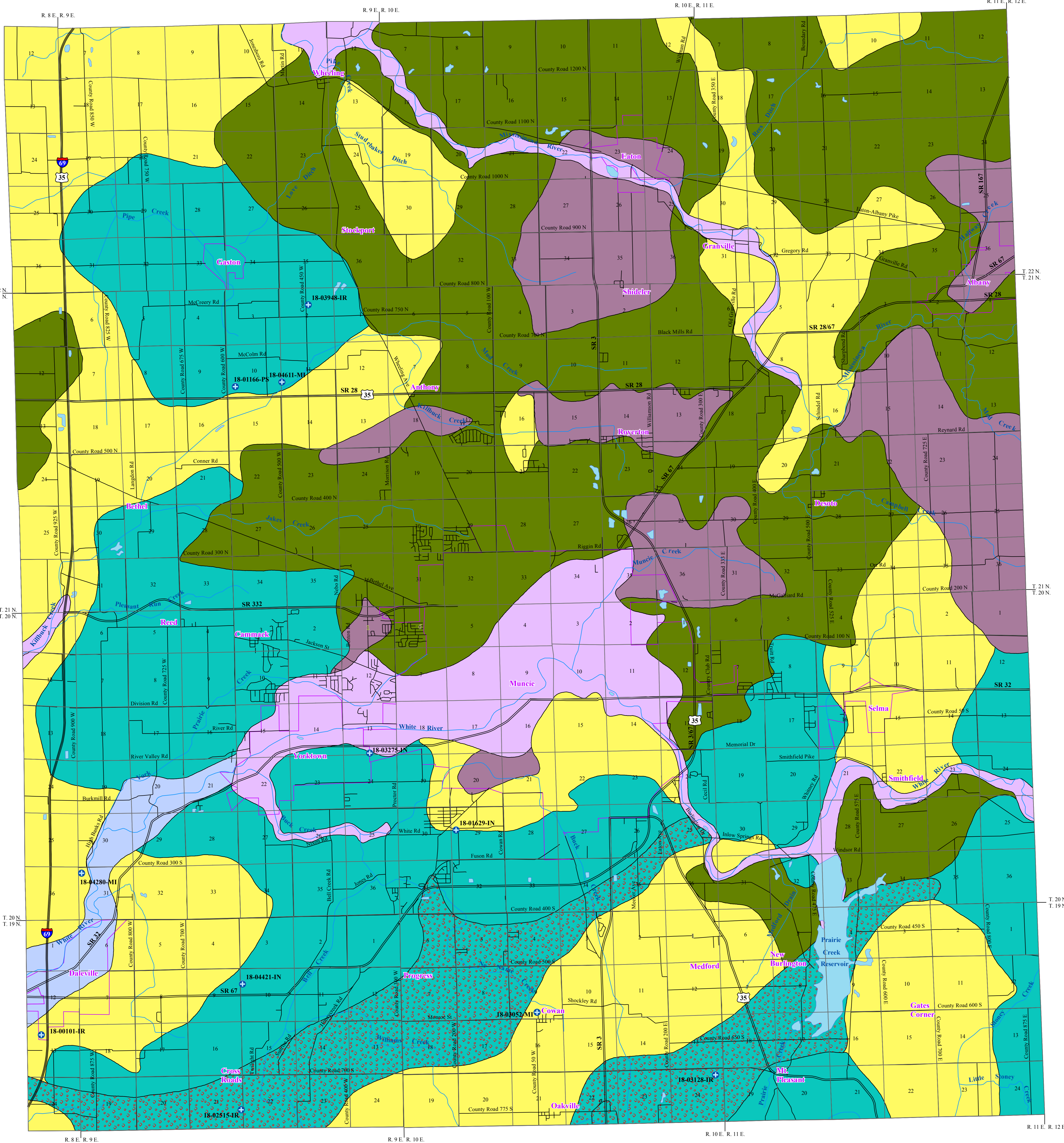
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Bedrock Aquifer Systems of Delaware County, Indiana

by
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Division of Water, Resource Assessment Section

November 2006

UNCONSOLIDATED AQUIFER SYSTEMS OF DELAWARE COUNTY, INDIANA



Six unconsolidated aquifer systems have been mapped in Delaware County: the Till Veneer, the New Castle / Bluffton Till, the New Castle / Bluffton Till Subsystem, the New Castle / Bluffton Complex, the White River and Tributaries Outwash, and the White River and Tributaries Outwash Subsystem / Wabash River and Tributaries Outwash Subsystem. Boundaries of these aquifer systems are commonly gradational, and individual aquifers may extend across aquifer system boundaries.

Pre-Wisconsin and Wisconsin glacial sediments completely cover Delaware County. However, the thickness of unconsolidated sediments is quite variable. Depth to the bedrock surface of central Delaware County is shallow and, in general, deepens to the north and south. Thickness of sediments that overlie bedrock range from 0 feet, where bedrock is exposed near the White River in east-central Delaware County, to as much as 330 feet where glacial sediments have filled pre-glacial valleys.

Regional estimates of aquifer susceptibility to contamination from the surface can differ considerably from local reality. Variations within geologic environments can cause variation in susceptibility to surface contamination. In addition, man-made structures, such as poorly constructed water wells, unplugged or improperly abandoned wells, and open excavations, can provide contaminant pathways that bypass the naturally protective clays.

Till Veneer Aquifer System

The Till Veneer Aquifer System has the most limited ground-water resources of the unconsolidated aquifer systems in the county. The system is generally mapped in areas where the bedrock surface is shallow and the overlying unconsolidated deposits are commonly less than 50 feet.

There is little potential for ground water production in the Till Veneer Aquifer System in Delaware County. Clay materials dominate the unconsolidated deposits but in some isolated areas thin, fine grained sand and gravel units are present. Most wells in the mapped area are completed in the underlying bedrock and there are no reported wells that produce from the Till Veneer Aquifer System. However, large diameter bucket wells may be successful in meeting the needs of some domestic users.

Because of the generally low permeability of the near-surface materials, this system is not very susceptible to contamination from surface sources. However, there are areas where bedrock is extremely shallow. These areas are moderately susceptible to contamination.

New Castle / Bluffton Till Aquifer System

In Delaware County the New Castle / Bluffton Till Aquifer System typically consists of thick clay with intermittent sands and gravels that in places are up to 250 feet in total thickness.

The New Castle / Bluffton Till Aquifer System is capable of meeting the needs of domestic and some high-capacity users. Well depths generally range from 45 to 95 feet below surface. Potential aquifer materials include sands and/or gravels that typically range from 5 to 25 feet thick and are overlain by 30 to 75 feet of clay with intermittent sands. Domestic well capacities are typically 10 to 50 gallons per minute (gpm). There are four registered significant ground-water withdrawal facilities (5 wells) that report well capacities ranging from 75 to 800 gpm. However, it is not expected that the upper range of high-capacity yields are typical throughout Delaware County. Static water levels are commonly 10 to 30 feet below surface with some reports of flowing wells.

This aquifer system is generally not very susceptible to surface contamination because intratill sand and gravel units are overlain by thick till deposits.

New Castle / Bluffton Till Aquifer Subsystem

The New Castle / Bluffton Till Aquifer Subsystem is mapped mostly in the northern portion of Delaware County. The subsystem is mapped similar to that of the New Castle / Bluffton Till Aquifer System. However, potential aquifer materials are thinner and potential yield is less in the subsystem.

Although approximately 85 percent of wells in the area utilize the underlying bedrock aquifer system, the subsystems are capable of meeting the needs of some domestic users. However, in some cases it is necessary for drillers to continue below the aquifer bearing zone into underlying clay deposits. This increases well capacity by allowing for extra borehole storage. Typical well depths range from 30 feet to 70 feet. Potential aquifer materials include thin, intratill sand and gravel deposits that are generally 4 to 12 feet thick and are capped by till 25 to 55 feet thick. Typical well yields range from 5 to 35 gpm. Static water levels are generally 10 to 25 feet below land surface.

The subsystems are generally not very susceptible to surface contamination because intratill sand and gravel units are overlain by thick till deposits.

White River and Tributaries Outwash Aquifer System

In Delaware County the White River and Tributaries Outwash Aquifer System is mapped along a part of the White River from the western county line to Yorktown. This system contains outwash valley train and alluvial deposits that filled portions of the White River Valley. Total thickness of unconsolidated deposits are as much as 135 feet with up to 110 feet of continuous sand and gravel in places. In some areas, however, clay deposits, generally less than 15 feet thick, disrupt the continuity of the sands and gravels. Well depths are typically 40 to 75 feet. Aquifer materials are commonly 15 to 40 feet thick and are capped by 10 to 20 feet of clay or silt.

The system has the potential to meet the needs of domestic and high-capacity users. Domestic well yields commonly range from 10 to 35 gpm. Static water levels range from 10 to 25 feet below surface with some reports of flowing wells. Although there are no registered significant water withdrawal facilities using this system in Delaware County, several high-capacity facilities in nearby Madison County utilize the outwash system.

In areas that lack overlying clays, this aquifer system is highly susceptible to contamination from surface sources. Where the aquifer system is overlain by clay or silt deposits, the aquifer is moderately susceptible to surface contamination.

White River and Tributaries Outwash Aquifer Subsystem / Wabash River and Tributaries Outwash Aquifer Subsystem

The White River and Tributaries Outwash Aquifer Subsystem is mapped along part of the White River floodplain and a small part of Killback Creek. The Wabash River and Tributaries Outwash Aquifer Subsystem is mapped along the floodplain of the Mississippi River. In general, the subsystems are mapped where the topographic position is higher and thickness of saturated outwash deposits is considerably less than the main outwash system. Also, aquifer units are generally overlain by greater thicknesses of fine-grained materials. In the central part of the county the White River and Tributaries Outwash Aquifer Subsystem broadens to include areas where bedrock is shallow but thick outwash sediments, capped by clay, are likely in connection with White River alluvial and outwash sediments.

There are few wells completed in these subsystems. Most wells in the mapped area bypass the unconsolidated sediments and continue to bedrock allowing for extra borehole storage. However, penetration of some bedrock wells is less than a few feet and it is likely that the overlying sands and gravels contribute to the overall well yield. Well depths typically range from 35 to 80 feet below surface. Sand and gravel aquifer deposits range from 2 to 60 feet thick but are generally 10 to 30 feet thick. The sand and gravel deposits in some areas are separated by intermittent clay or sandy clay materials that disrupt the continuity of the sands and gravels. Aquifer materials are commonly capped by silt, sandy clay, or clay ranging from 5 to 40 feet thick.

These aquifer systems have the potential to meet the needs of domestic and some high-capacity users. Domestic well yields are typically from 5 to 25 gpm and static water levels are 10 to 20 feet below surface. There are no registered significant water withdrawal facilities in the outwash subsystems in Delaware County. However, one public well reportedly pumped 90 gpm.

Areas within these aquifer systems that have overlying clay or silt deposits are moderately susceptible to surface contamination; whereas, areas that lack overlying clay or silt deposits are highly susceptible to contamination.

Location Map



New Castle / Bluffton Complex Aquifer System

The New Castle / Bluffton Complex Aquifer System is mapped in portions of northwestern and southern Delaware County. The system includes unconsolidated deposits that are quite variable in materials and thickness. Sand and gravel aquifer deposits vary from thin to massive and are typically overlain by a thick till. However, in some areas the system also exhibits multiple layers of outwash and till above the primary aquifer resource. Total thickness of unconsolidated deposits is as much as 200 feet in places.

Typical well depths range from 45 to 90 feet. Aquifer materials range from 1 to 100 feet in thickness but are typically 5 to 35 feet thick. These aquifer deposits are commonly overlain by till with intermittent sands and gravels that are generally 30 to 75 feet thick. The multiple intermittent sands and gravels are typically 5 to 15 feet thick. This system is capable of meeting the needs of domestic and some high-capacity users. Typical domestic yields range from 10 to 50 gpm. Static water levels commonly range from 10 to 25 feet below surface. Five registered significant groundwater withdrawal facilities (10 wells) report pumping capacities that range from 100 gpm to 800 gpm.

Areas of this system overlie buried bedrock valleys with deposits that are nearly 330 feet thick in places. Although most wells completed in this system utilize sediments at shallower depths, deeper sand and gravel deposits are available with some wells producing at depths greater than 185 feet. Wells in the buried valley areas are typically 55 to 155 feet deep. Domestic wells are commonly 10 to 60 gpm with static water levels from 10 to 40 feet below surface. There are three registered significant groundwater withdrawal facilities (4 wells) with reported yields ranging from 100 to 600 gpm.

This aquifer system is not very susceptible to contamination where thick clay materials overlie aquifer materials. However, in some areas where outwash is present at or near the surface and clay deposits are thin, the system is a moderate risk.

White River and Tributaries Outwash Aquifer System

In Delaware County the White River and Tributaries Outwash Aquifer System is mapped along a part of the White River from the western county line to Yorktown. This system contains outwash valley train and alluvial deposits that filled portions of the White River Valley. Total thickness of unconsolidated deposits are as much as 135 feet with up to 110 feet of continuous sand and gravel in places. In some areas, however, clay deposits, generally less than 15 feet thick, disrupt the continuity of the sands and gravels. Well depths are typically 40 to 75 feet. Aquifer materials are commonly 15 to 40 feet thick and are capped by 10 to 20 feet of clay or silt.

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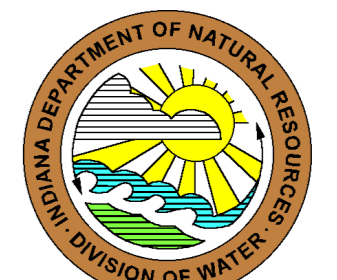
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Unconsolidated Aquifer Systems of Delaware County, Indiana

by
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November 2006

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Delaware County

