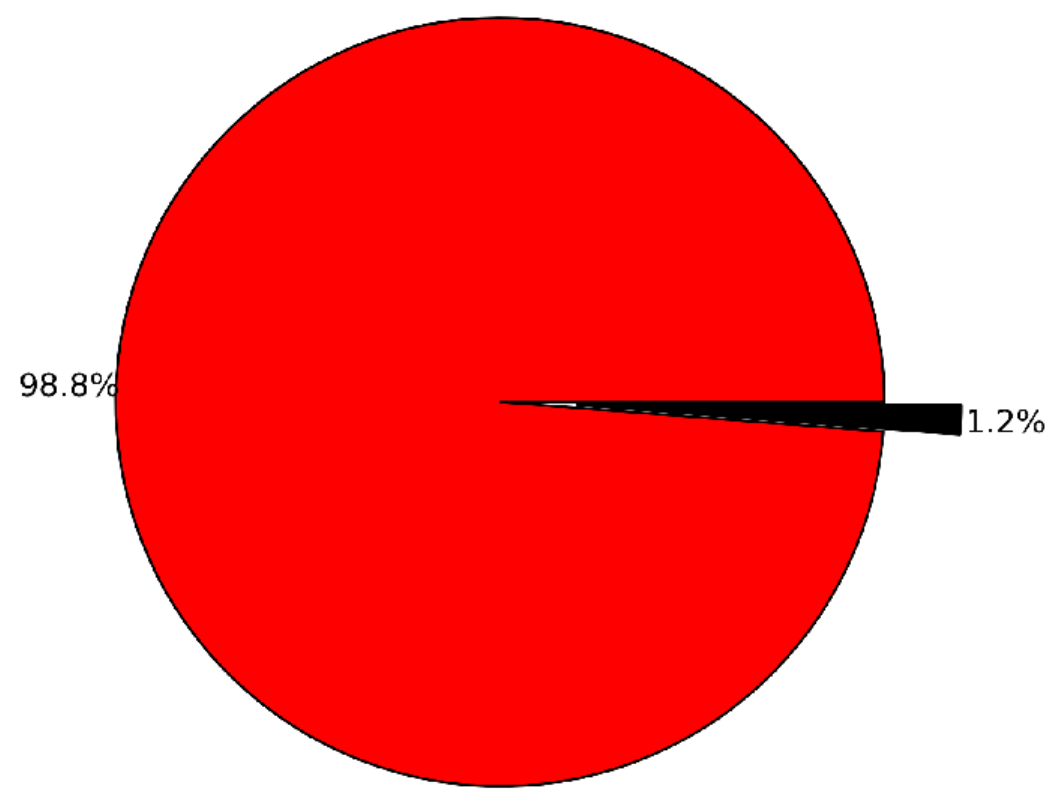
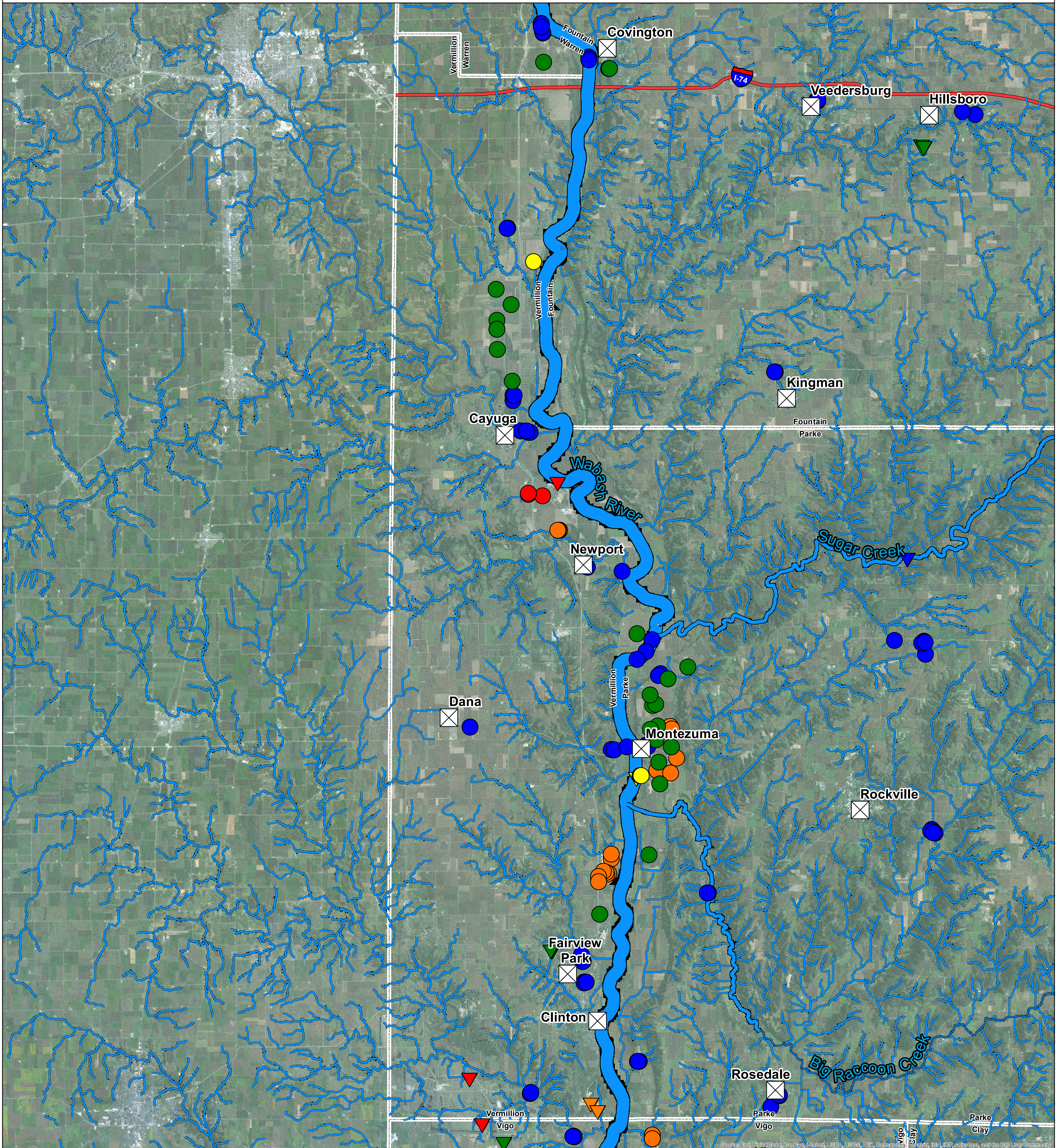
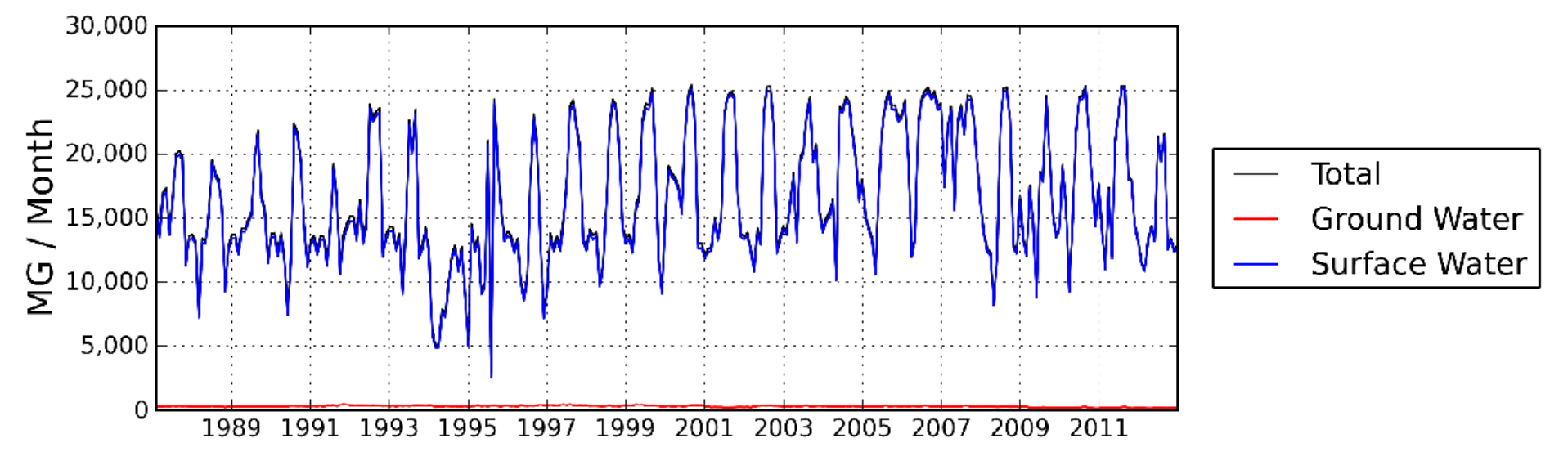
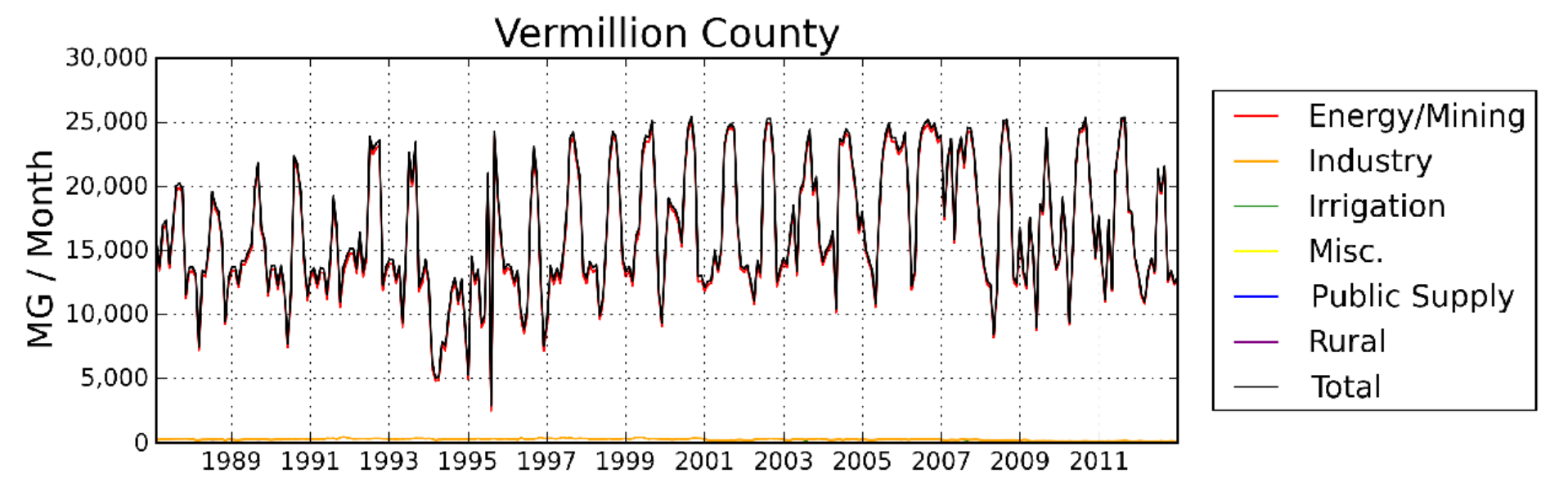


2012 Water Use



Average Daily Use: 488.2 MGD



Water Resources and Use in Vermillion County

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

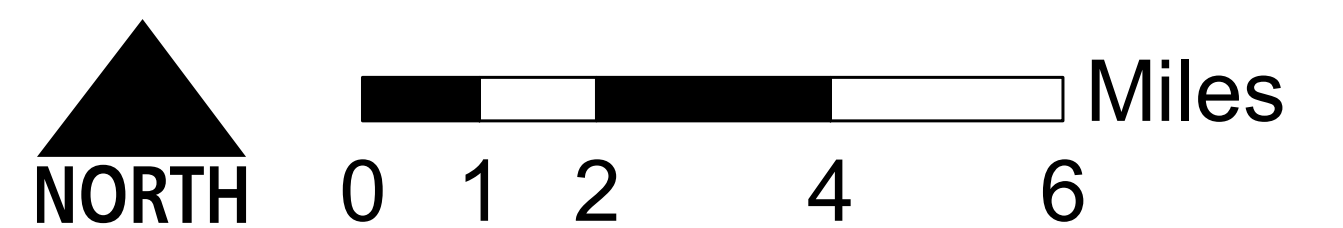
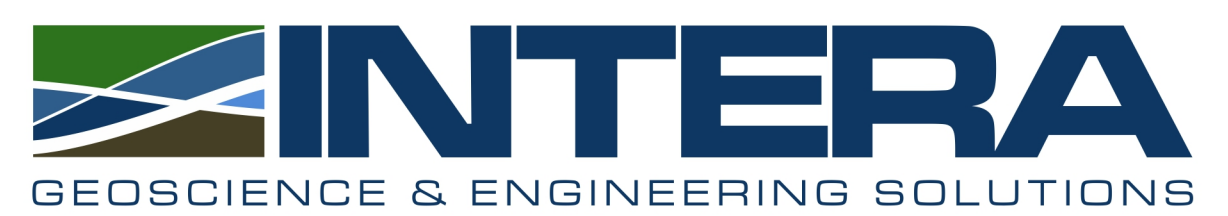
Withdrawal Location

- | | | |
|-------------|---|---------------|
| WELL INTAKE | ▼ | Energy/Mining |
| ● | ▼ | Industry |
| ● | ▼ | Irrigation |
| ● | ▼ | Misc. |
| ● | ▼ | Public Supply |
| ● | ▼ | Rural Use |

River

- | | | |
|----------------|---|---------------|
| 7Q2 Flow (MGD) | — | <10 MGD |
| 7Q2 Flow (MGD) | — | 10 - 50 MGD |
| 7Q2 Flow (MGD) | — | 50 - 100 MGD |
| 7Q2 Flow (MGD) | — | 100 - 500 MGD |
| 7Q2 Flow (MGD) | — | > 500 MGD |

- | | |
|---|-------------|
| ■ | Major Lakes |
| — | Interstate |
| □ | County |
| ⊗ | City |



BEDROCK AQUIFER SYSTEMS OF VERMILLION 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 ranging from less than 50 feet thick to more than 250 feet thick overlie bedrock aquifer systems in Vermillion 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.

Three bedrock aquifer systems are identified for Vermillion County. They are, from youngest to oldest: the McLeansboro Group of Pennsylvanian age; the Carbonate Group of Pennsylvanian age; and the Raccoon Creek Group of Pennsylvanian age.

Pennsylvanian -- McLeansboro Group Aquifer System

The McLeansboro Group subarea is located in the southwestern corner of the county. Thickness of the McLeansboro Group ranges from 50 to 200 feet. This aquifer system consists in ascending order of the Shelburn, Patoka, Bond, and Mattson Formations. However, in Vermillion County only the Shelburn and Patoka Formations are present.

The Patoka Formation consists primarily of shale and sandstone with clay, limestone, and coal. The underlying Shelburn Formation consists of shale, siltstone, sandstone, coal, and limestone. Two important members of the Shelburn Formation include the West Franklin Limestone at the top of the formation and the Basseron Sandstone at the base. These are the primary aquifer units within the McLeansboro Group Aquifer System.

Few wells are reported in this system in Vermillion County. The depth to the bedrock surface ranges from 10 to 30 feet with total well depths typically ranging from 50 to 90 feet. The amount of rock penetrated generally ranges from 5 to 35 feet. Most domestic wells produce less than 10 gallons per minute (gpm) with a few (pumped) dry holes reported. Static water levels range from 10 to 30 feet below surface.

Most of the McLeansboro Group Aquifer System contains fine-grained materials that limit the movement of groundwater. However, in some areas alluvial materials directly overlie the bedrock surface. Therefore, the aquifer system is considered at moderate risk from surface contamination.

Pennsylvanian -- Carbonate Group Aquifer System

The Carbonate Group Aquifer System subsurfaces throughout much of Vermillion County. The group consists in ascending order of the Petersburg, the Linton, and the Dugger Formations. Bedrock deposits include mostly shale and sandstone with some limestone and commercially important coal. Thickness of the Carbonate Group in Vermillion County ranges from 300 to 350 feet.

Depth to the bedrock surface is typically from 45 to 140 feet below surface. Well depths range from 35 to 300 feet with most completed at depths between 60 and 160 feet. The amount of rock penetrated ranges from 5 to 280 feet. The Carbonate Group is considered a minor groundwater source with domestic wells typically pumping less than 10 gpm. Static water levels in the wells vary from 7 to 75 feet below the land surface, but are typically between 20 and 55 feet below the surface.

Most wells produce from the thicker sandstone and coal units in the upper formations of the Carbonate Group. Localized yields are greater in areas where outwash and alluvial sands and gravels directly overlie bedrock. A few (pumped) dry holes have been reported. Water quality from the deeper bedrock units is highly mineralized.

In areas where overlying clay materials are present, the Carbonate Group Aquifer System is at low risk to contamination. However, in some areas outwash and alluvial materials directly overlie the bedrock surface. These areas are at moderate to high risk from surface contamination.

Pennsylvanian -- Raccoon Creek Group Aquifer System

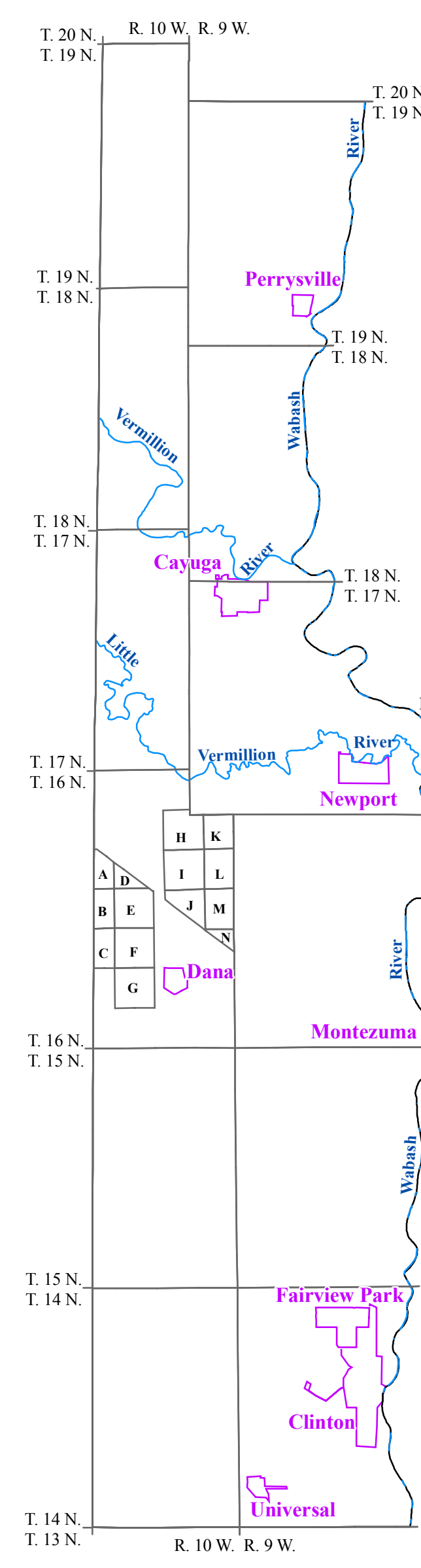
In Vermillion County the Raccoon Creek Group Aquifer System subsurfaces primarily in the northeastern, south-central, and eastern parts of the county. The group consists in ascending order of the Mansfield, Brazil, and Staunton formations. The basal formation of the group, the Mansfield Formation, rests unconformably on Mississippian rocks. Bedrock consists of mostly sandstone and shale with minor amounts of mudstone, coal, and limestone. Thickness of the Raccoon Creek Group in Vermillion County ranges from about 100 to 500 feet as it dips beneath younger strata.

Few well records are available in the Raccoon Creek Group Aquifer System in Vermillion County. Most wells produce from the upper formations of the Raccoon Creek Group. However, the Mansfield Formation is considered a moderately dependable groundwater resource. The upper contact of the Mansfield Formation ranges from less than 50 feet to over 250 feet below surface. Completed wells range from 70 to 200 feet below surface. Domestic well production ranges from 5 to 15 gpm with a few (pumped) dry holes reported. Static water levels are generally 20 to 70 feet below surface. In general, water quality from deeper bedrock units is more mineralized than upper units. There is 1 registered significant groundwater withdrawal facility (1 well) with a reported capacity of 150 gpm.

In areas where overlying clay materials are present, the Raccoon Creek Group Aquifer System is at low risk to contamination from the surface or near surface. However, in some areas outwash and alluvial materials directly overlie the bedrock surface. These areas are at moderate to high risk from surface contamination.

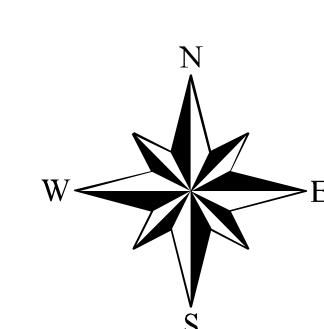
Underground Mine Areas

In Vermillion County various coal seams within the Carbonate Group have been removed by underground mining methods. In underground mines, approximately 50 percent of the coal seam has been removed, leaving the potential for storage of substantial amounts of water in the larger mines. Although the Division has no records of wells drilled into these mines, yields of a few hundred gallons per minute are possible. A limitation on use of the water could be its more mineralized nature.

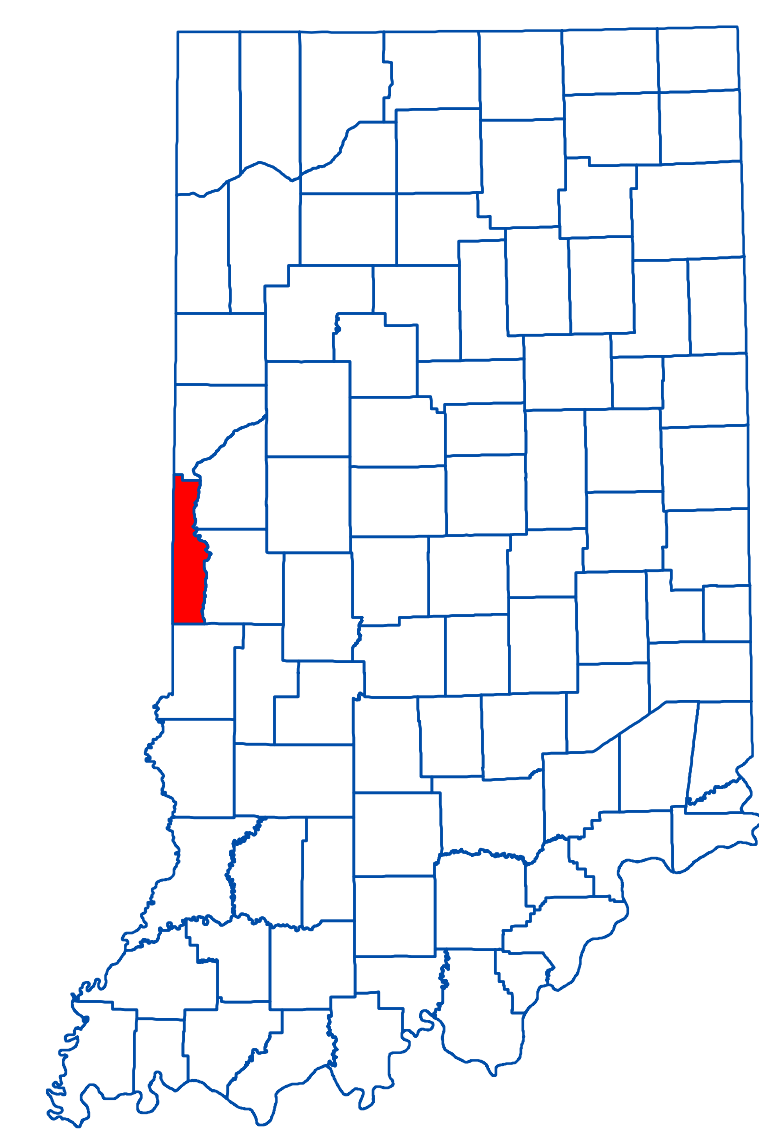


- A. 9 South of the Ten O'clock Line
- B. 16 South of the Ten O'clock Line
- C. 21 South of the Ten O'clock Line
- D. 10 South of the Ten O'clock Line
- E. 15 South of the Ten O'clock Line
- F. 22 South of the Ten O'clock Line
- G. 27 South of the Ten O'clock Line
- H. 9 North of the Ten O'clock Line
- I. 16 North of the Ten O'clock Line
- J. 21 North of the Ten O'clock Line
- K. 10 North of the Ten O'clock Line
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- N. 27 North of the Ten O'clock Line



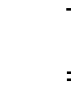





MAP SHOWING NAME AND LOCATION OF RESERVES IN VERMILLION COUNTY



Location Map



EXPLANATION

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

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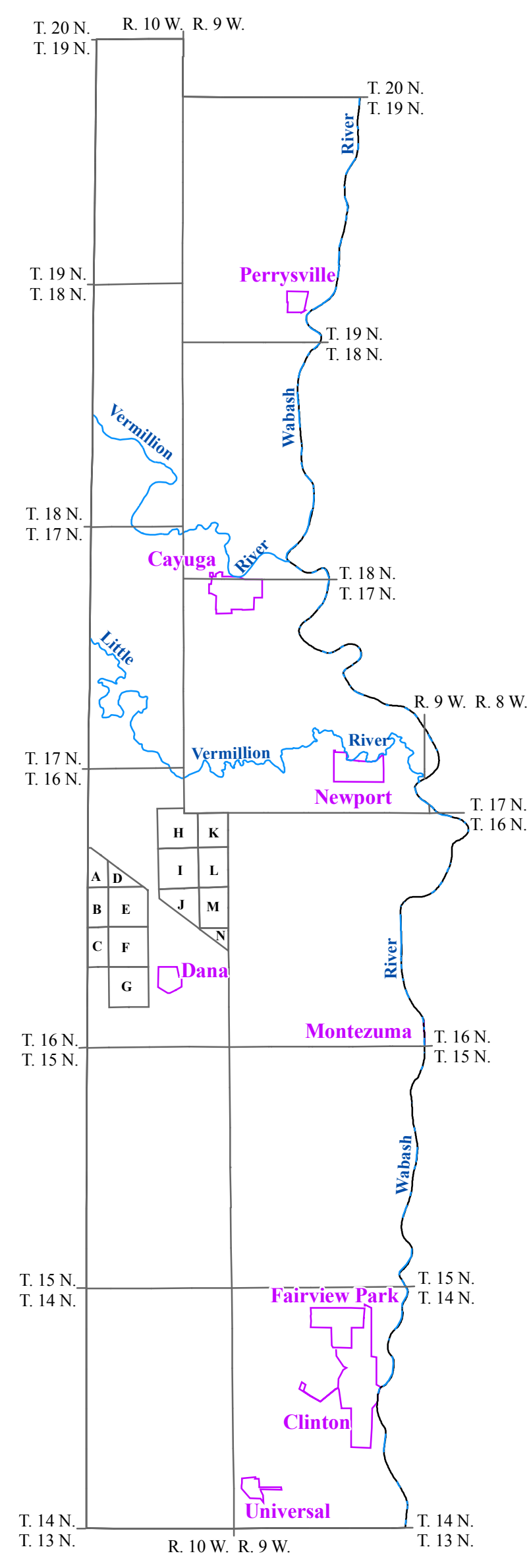
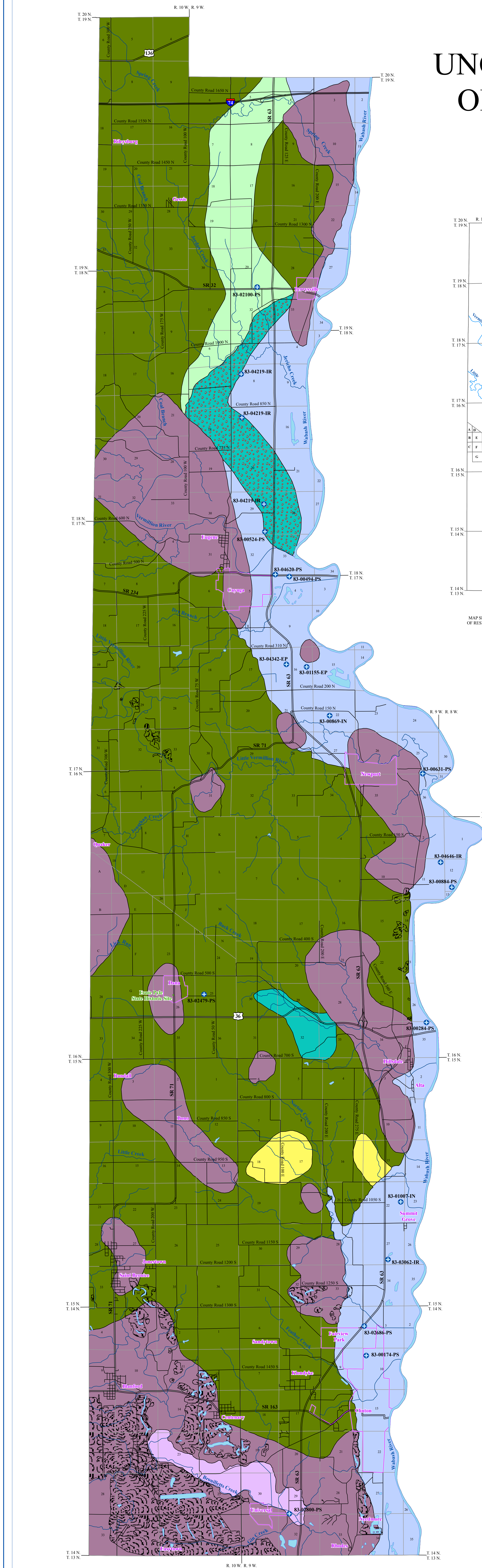
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This map was created from several existing shapefiles. Township and Range Lines of Indiana (line shapefile, 20020621), Land Survey Lines of Indiana (polygon shapefile, 20020621) and County Boundaries of Indiana (polygon shapefile, 20020621), Underground Coal Mines (polygon shapefile, 20081231), 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, System 1 and System 2 (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.

Bedrock Aquifer Systems of Vermillion County, Indiana

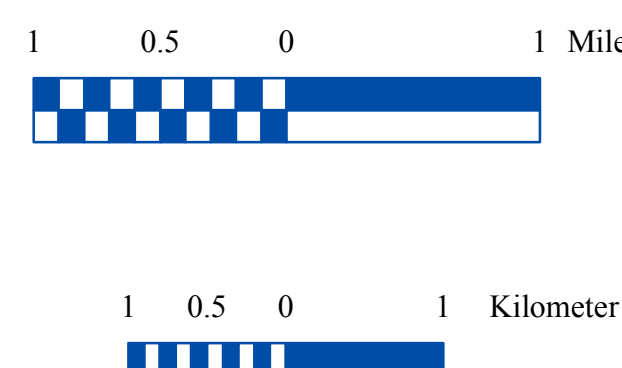
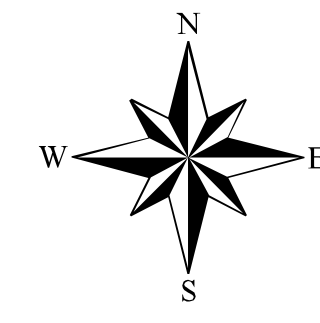
by
Robert A. Scott
Division of Water, Resource Assessment Section
September 2009

UNCONSOLIDATED AQUIFER SYSTEMS OF VERMILION COUNTY, INDIANA



- A. 9 South of the Ten O'Clock Line
- B. 16 South of the Ten O'Clock Line
- C. 21 South of the Ten O'Clock Line
- D. 10 South of the Ten O'Clock Line
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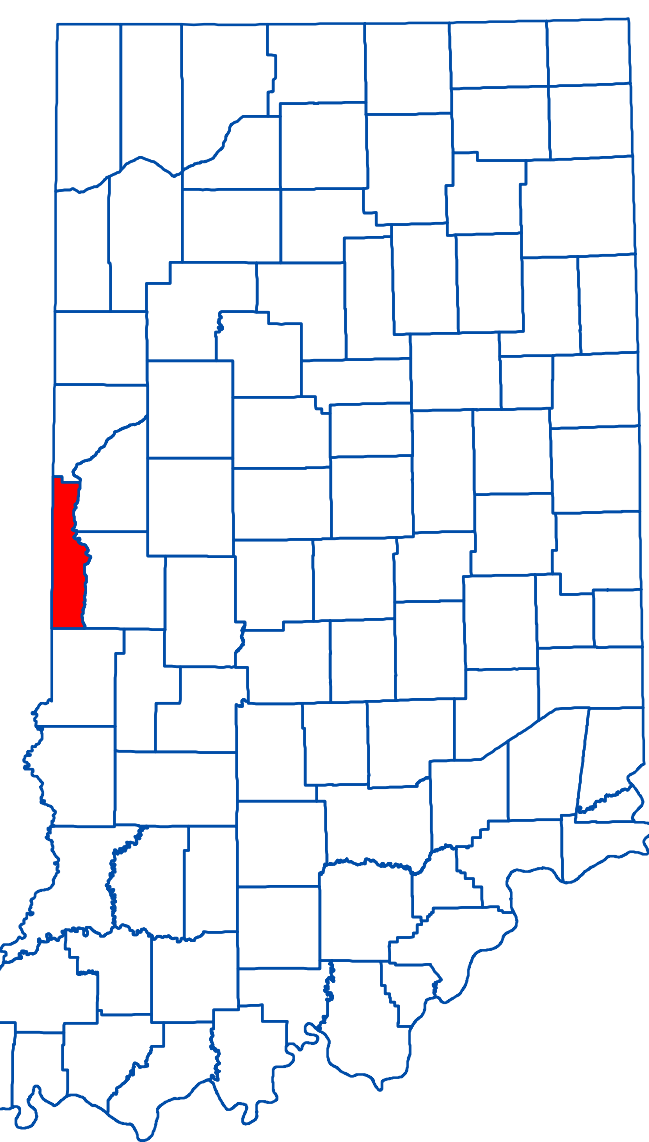
MAP SHOWING NAME AND LOCATION OF RESERVES IN VERMILION COUNTY



EXPLANATION

- Registered Significant Groundwater Withdrawal Facility
- Stream
- County Road
- State Road & US Highway
- Interstate
- Municipal Boundary
- State Managed Property
- Lake & River

Location Map



Eight unconsolidated aquifer systems have been mapped in Vermillion County: Till Veneer; the Central Wabash Valley Till; the Central Wabash Valley Till Subsystem; the Buried Valley; the Central Wabash Valley Complex; the Wabash River and Tributaries Outwash; the Wabash River and Tributaries Outwash Subsystem; and the Coal Mine Spoil. Boundaries of all aquifer systems described are commonly gradational, and individual aquifers may extend across aquifer system boundaries.

The thickness of unconsolidated deposits in Vermillion County is quite variable because glacial material has been deposited over an uneven bedrock surface. Unconsolidated materials range from less than 50 feet thick in the eastern and southern portions of the county to more than 250 feet in the central portion of Vermillion County. However, throughout much of Vermillion County unconsolidated deposits are commonly 50 to 100 feet thick.

Regional estimates of potential contamination to aquifer systems from the surface can differ considerably by location. Variations within geologic environments can result in a wide range of susceptibility to these systems. 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 is mapped mostly along sections of the Wabash River, an unnamed tributary of Norton Creek, and Brouillets Creek. The system consists of thin till, generally less than 50 feet thick, which directly overlies an uneven bedrock surface. Potential aquifers within this system can include thin isolated sand and/or gravel layers. Along some of the major streams this system may include thin alluvium and surficial sands and gravels that directly overlie the bedrock surface. It is the most limited aquifer system mapped in Vermillion County.

There is little potential for groundwater production in this system in Vermillion County. Few wells have been completed in the Till Veneer Aquifer System because most wells have been completed in the underlying bedrock. Potential aquifer deposits would include thin, isolated sands and/or gravels with yields less than 5 gallons per minute (gpm). There are no registered significant groundwater withdrawal facilities utilizing this system.

This aquifer system is generally not very susceptible to surface contamination because intratill sand and gravel units are overlain by till deposits. However, some areas have surface sands and gravels, or thin to no clay deposits above the aquifer resource. These areas are considered at moderate to high risk to contamination.

Central Wabash Valley Till Aquifer System

The Central Wabash Valley Till Aquifer System primarily consists of thick clay with thin intratill sand and gravel layers. Wells completed in this system are capable of meeting the needs of most domestic users in Vermillion County. Saturated aquifer materials include sand and/or gravel deposits that are commonly 4 to 18 feet thick and are generally overlain by 75 to 150 feet of till.

Wells producing from this system are typically 75 to 175 feet deep. Domestic well capacities are commonly 5 to 15 gpm and static water levels generally range from 30 to 70 feet below the surface. There are no registered significant groundwater withdrawal facilities utilizing this system in Vermillion County.

The Central Wabash Valley Till Aquifer System typically has a low susceptibility to surface contamination because intratill sand and gravel units are commonly overlain by thick glacial till. Shallow wells completed in this system are moderately susceptible to contamination.

Central Wabash Valley Till Aquifer Subsystem

Areas where unconsolidated materials are generally greater than 50 feet in thickness, yet have limited aquifer potential, are mapped as the Central Wabash Valley Till Aquifer Subsystem. The unconsolidated material in this subsystem ranges from about 50 to 250 feet thick in Vermillion County. Potential aquifer materials include intratill sand and gravel deposits. Where present, aquifer materials are capped by till that is commonly 25 to 75 feet thick.

More than 45 percent of wells started in the Central Wabash Valley Till Aquifer Subsystem in this county are completed in the underlying bedrock aquifer system. However, this subsystem is capable of meeting the needs of some domestic users in the county. The wells producing from this subsystem are generally completed at depths of 55 to 120 feet. Intratill sand and gravel aquifer materials are typically 2 to 16 feet thick. Reported well yields generally range from 5 to 10 gpm and static water levels are commonly 20 to 65 feet below the surface. There is 1 registered significant groundwater withdrawal facility (4 wells) with yields from 35 to 50 gpm. However, available drawdown is limited.

This subsystem is generally not very susceptible to surface contamination because intratill sand and gravel units are overlain by thick till deposits. However, in some areas where aquifers are shallow and overlying clay deposits are thin, the system is at moderate risk.

Buried Valley Aquifer System

The Buried Valley Aquifer System consists of glacial materials deposited in deep stage bedrock valleys. The system is mapped from the northern county boundary and continues south to southeast for approximately eight miles. Typical deposits include a thick glacial till with isolated sands and gravels ranging from 25 to 125 feet thick that are generally not used as an aquifer resource. Aquifer sands and gravels are typically 120 to 180 feet deep and range from 5 to 25 feet thick. In places, the aquifer sands and gravels may directly overlie the bedrock surface.

Few wells are completed in the Buried Valley Aquifer System in Vermillion County. However, this aquifer system has the potential to meet the needs of domestic and some high-capacity users. Wells are generally 135 to 190 feet deep with yields that range from 8 to 30 gpm. Static water levels range from 85 to 115 feet below the surface. There is 1 registered significant groundwater withdrawal facility (2 wells) with yields of 300 gpm for each well.

This system typically has a low susceptibility to surface contamination because intratill sand and gravel units are commonly overlain by thick glacial till. Shallow wells completed in this system are moderately susceptible to contamination.

Central Wabash Valley Complex Aquifer System

The Central Wabash Valley Complex Aquifer System is mapped along a portion of Thick Creek in eastern Vermillion County and is characterized by unconsolidated deposits that are quite variable in materials and thickness. Sand and gravel aquifer deposits are commonly overlain by a thick till. This system generally exhibits alternating layers of outwash and till of variable thickness above the main aquifer. The unconsolidated material in this system ranges from about 100 to 200 feet thick in Vermillion County.

This system is capable of meeting the needs of domestic and some high-capacity users in Vermillion County. The most utilized aquifer layers in the Central Wabash Valley Complex Aquifer System are generally 10 to 55 feet thick sands and/or gravels overlain by a till cap which is commonly 45 to 140 feet thick. Wells in this system are typically completed at depths ranging from 160 to 225 feet. Domestic well yields are commonly 10 to 50 gpm and static water levels are about 100 feet below the surface. There are no registered significant groundwater withdrawal facilities utilizing this system.

The Central Wabash Valley Complex Aquifer System is not very susceptible to contamination where overlain by thick clay deposits.

Wabash River and Tributaries Outwash Aquifer System

The Wabash River and Tributaries Outwash Aquifer System is mapped along the Wabash River in eastern Vermillion County. The Wabash River and Tributaries Outwash Aquifer System has the potential to meet the needs of domestic and some high-capacity users. However, approximately 15 percent of wells started in this system utilize the underlying bedrock aquifer. The few wells utilizing this system in Vermillion County have been reported at depths of 60 to 115 feet. Saturated aquifer materials include sand and/or gravel deposits that are commonly 30 to 180 feet thick and are overlain by 4 to 22 feet of clay. Yields for these wells are 10 to 35 gpm with static water levels ranging from 25 to 60 feet below the surface. There are 14 registered significant groundwater withdrawal facilities (55 wells) with yields that range from 75 to 2,000 gpm. There is one significant groundwater withdrawal facility with 2 radial collector well systems. The reported capacities for these wells range from 3260 gpm and 9000 gpm.

In northeastern Vermillion County, this system overlies a bedrock valley system, which trends south from the area near Perryville toward the confluence of the Vermilion River with the Wabash River. The total unconsolidated thickness exceeds 200 feet, in places. Only a few wells that utilize the deeper aquifers within the buried bedrock valley have been reported. These wells include the deposits range in thickness from 15 to 105 feet and are overlain by 2 to 22 feet of clay. Reported domestic well yields are up to 50 gpm with static water levels ranging from 45 to 70 feet below the surface. There are 2 registered significant groundwater withdrawal facilities (6 wells) with yields that range from 70 to 1200 gpm.

Areas within this aquifer system that have overlying clay deposits are moderately susceptible to surface contamination; whereas, areas that lack overlying clay deposits are highly susceptible to contamination.

Wabash River and Tributaries Outwash Aquifer Subsystem

The Wabash River and Tributaries Outwash Aquifer Subsystem is mapped along Brouillets Creek in Vermillion County. The system is made up of thick, glacially derived outwash deposits.

Few wells have reportedly been completed in the Wabash River and Tributaries Outwash Aquifer Subsystem. The Wabash River and Tributaries Outwash Aquifer Subsystem has the potential to meet the needs of domestic and some high-capacity users. Potential aquifer deposits would include sands and/or gravels ranging in thickness from 5 to 50 feet. There is 1 registered significant groundwater withdrawal facility (2 wells) with yields of 58 and 72 gpm.

Where overlying clay deposits are present the system is moderately susceptible to surface contamination. However, the few areas that lack overlying clay deposits are highly susceptible to contamination.

Coal Mine Spoil Aquifer System

The Coal Mine Spoil Aquifer System covers about five percent of Vermillion County. This aquifer system was formed during the process of mining coal by surface-mining methods. The overburden was typically broken up by blasting and moved aside to uncover the desired coal seam. The overburden, most of which was originally solid rock, became a heterogeneous mixture of particles ranging in size from clay, silt, and sand up to gravel, cobbles, and boulders. Where extensive these spoil areas contain considerable amounts of groundwater. Although data are sorely lacking on permeability of these spoil materials, it is generally accepted that the spoil permeability is greater than most of the original rock layers above the coal seam mined.

The quality of groundwater in this system is generally much poorer than that in the overburden before mining took place. Typically a significant increase in total dissolved solids, especially calcium, magnesium, bicarbonate, and sulfate, occurs. High iron, and sometimes low pH, can also severely limit potential uses of groundwater from this system.

There are no well records reported in this aquifer system in Vermillion County. Very generally, it is expected that aquifers in old spoil areas that were not graded and capped with compacted soil are highly susceptible to surface contamination, whereas new spoil areas benefiting from modern reclamation methods are likely to be only moderately susceptible.



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Unconsolidated Aquifer Systems of Vermillion County, Indiana

by
Robert A. Scott
Division of Water, Resource Assessment Section
September 2009

Vermillion County

