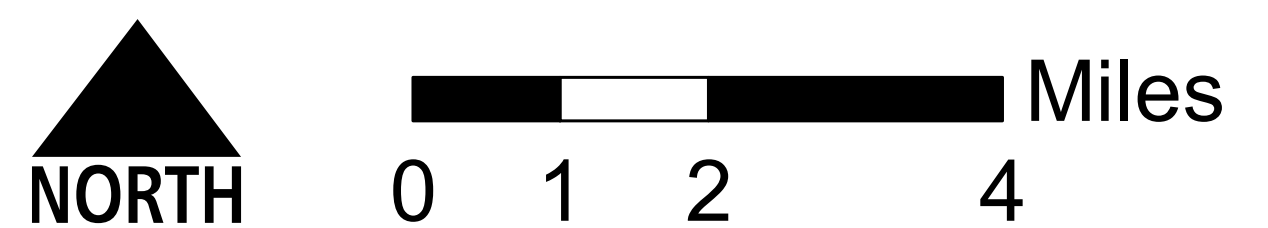
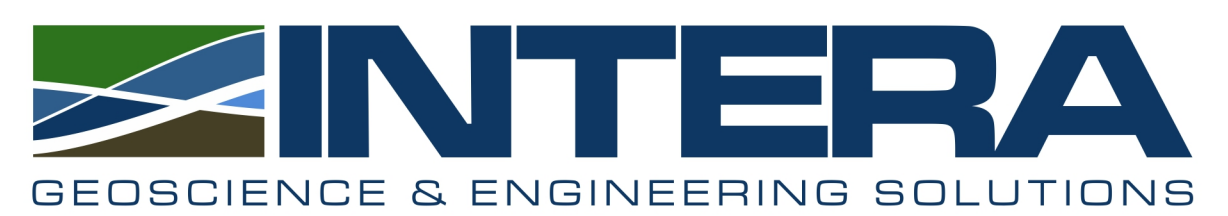
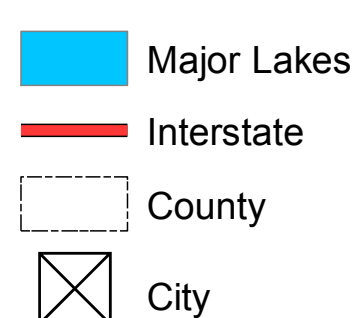
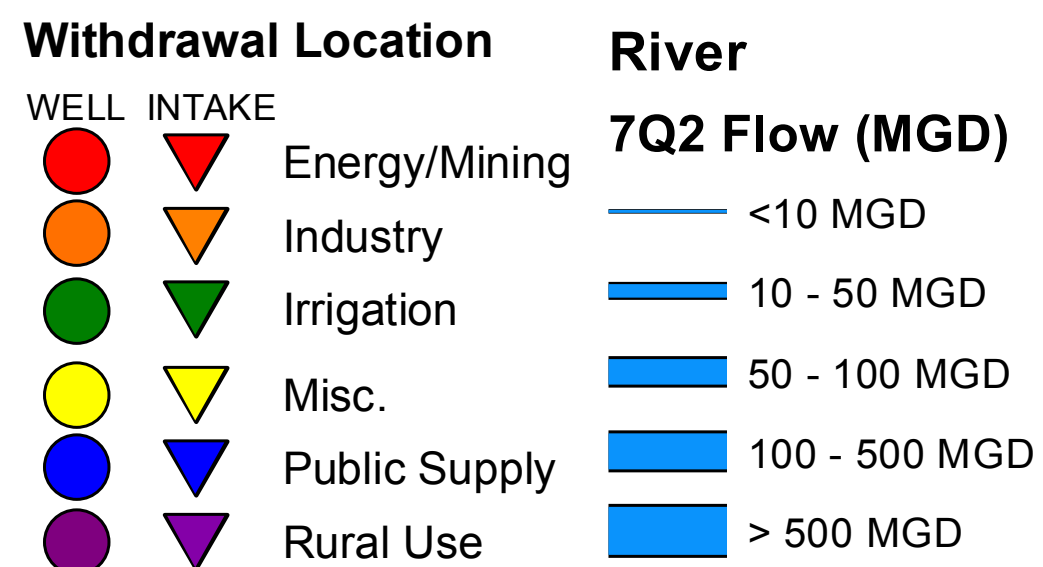
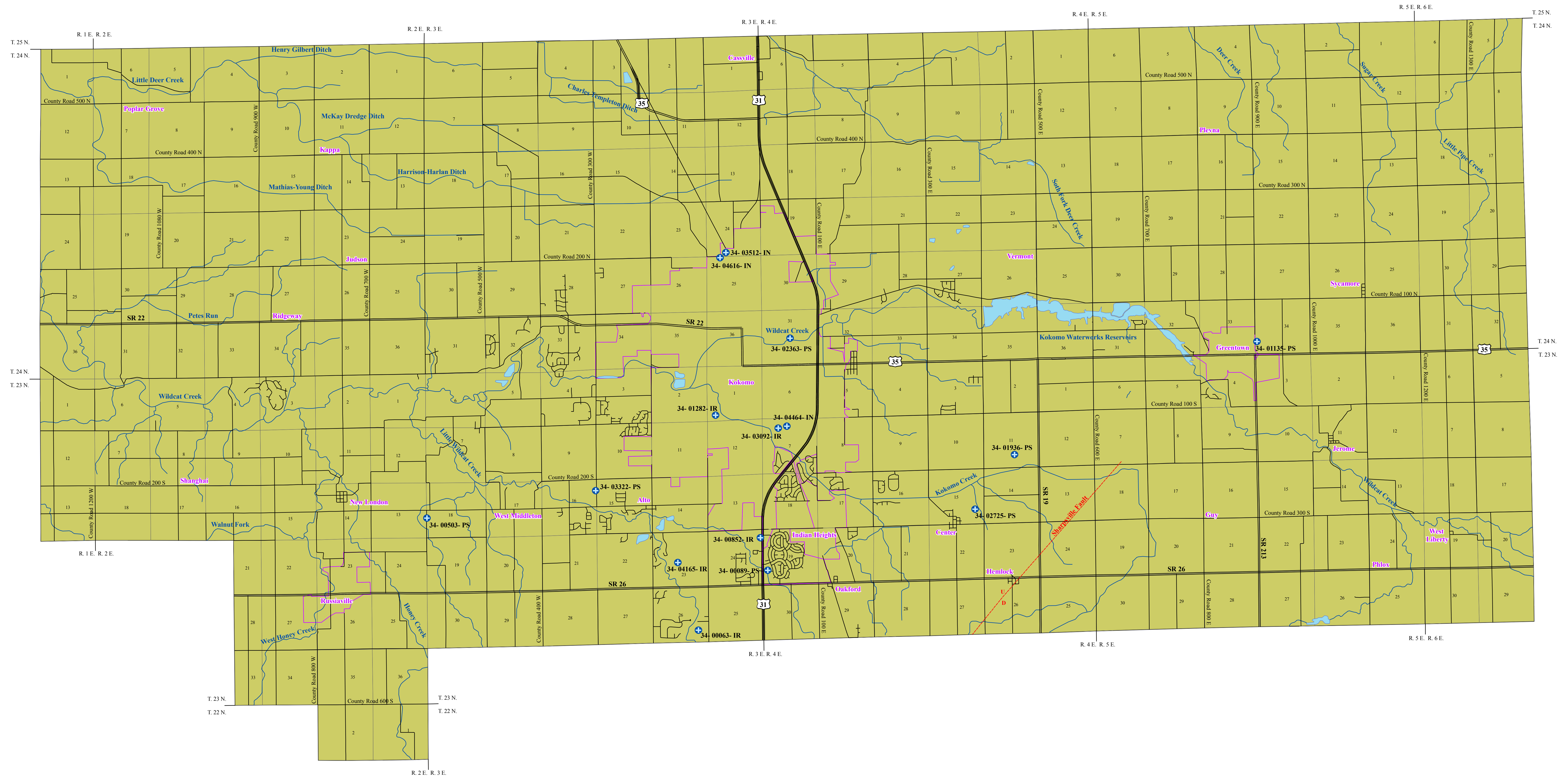


Water Resources and Use in Howard County

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



BEDROCK AQUIFER SYSTEMS OF HOWARD 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.

One bedrock aquifer system is identified for Howard County: the Silurian and Devonian Carbonates. Rock types exposed at the bedrock surface include moderately productive to prolific limestones and dolomites with varying amounts of interbedded shale. Bedrock wells represent about 70 percent of all wells completed in this county. Most of the bedrock aquifers in Howard 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 Silurian and Devonian Carbonates Aquifer System in Howard County is overlain by unconsolidated deposits of varying thickness, ranging from 25 feet to over 250 feet. In general, the thickness of unconsolidated deposits increases from northeast to southwest. However, segments of the Wildcat Creek Valley are cut into bedrock.

The yield of a bedrock aquifer depends on its hydraulic characteristics and the nature of the overlying deposits. Shale and clay 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 extremely variable.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. However, because bedrock aquifer systems may have complex fracturing systems, once a contaminant has been introduced into a bedrock aquifer system, it will be difficult to track and remediate.

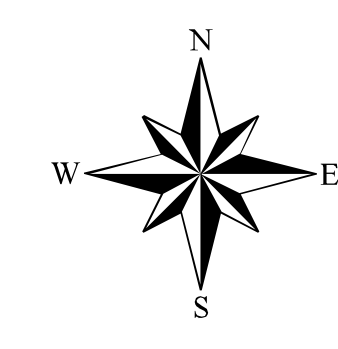
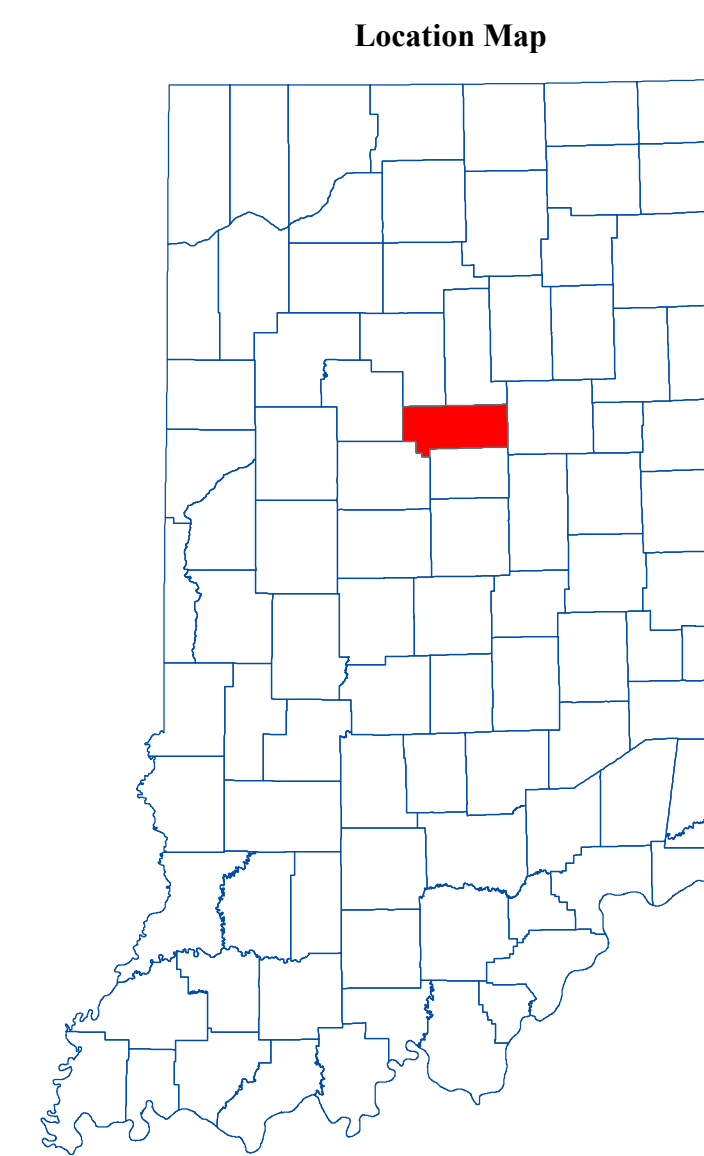
Silurian and Devonian Carbonates Aquifer System

The Silurian and Devonian Carbonates Aquifer System includes carbonate rock units (limestone and dolomite) with some interbedded shale units. In Howard County, the system consists of the Wabash formation of Silurian age and the Muscatatuck group of Devonian age. The total thickness of the Silurian and Devonian Carbonates Aquifer System in the county is over 850 feet.

Wells penetrating the Silurian and Devonian Carbonates Aquifer System in this county have reported depths ranging from 35 to over 500 feet, but are commonly 100 to 180 feet deep. The amount of rock penetrated in this system typically ranges from 5 to 10 feet.

Wells completed in the Silurian and Devonian Carbonates Aquifer System are capable of meeting the needs of domestic and some high-capacity users in this county. Domestic well yields commonly range from 15 to 50 gallons per minute (gpm). Static water levels typically range from 15 to 35 feet below the land surface. There are 15 registered significant ground-water withdrawal facilities (37 wells) using the Silurian and Devonian Carbonates Aquifer System in Howard County. Reported well yields for these facilities range from 70 to 1000 gpm. The uses are for public water supply, industry, and irrigation.

This aquifer system has a low susceptibility to surface contamination due to thick clay deposits over most of the county. However, the Silurian and Devonian Carbonate Aquifer System is moderately to highly susceptible to contamination where overlying clays are thin or absent.



EXPLANATION

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

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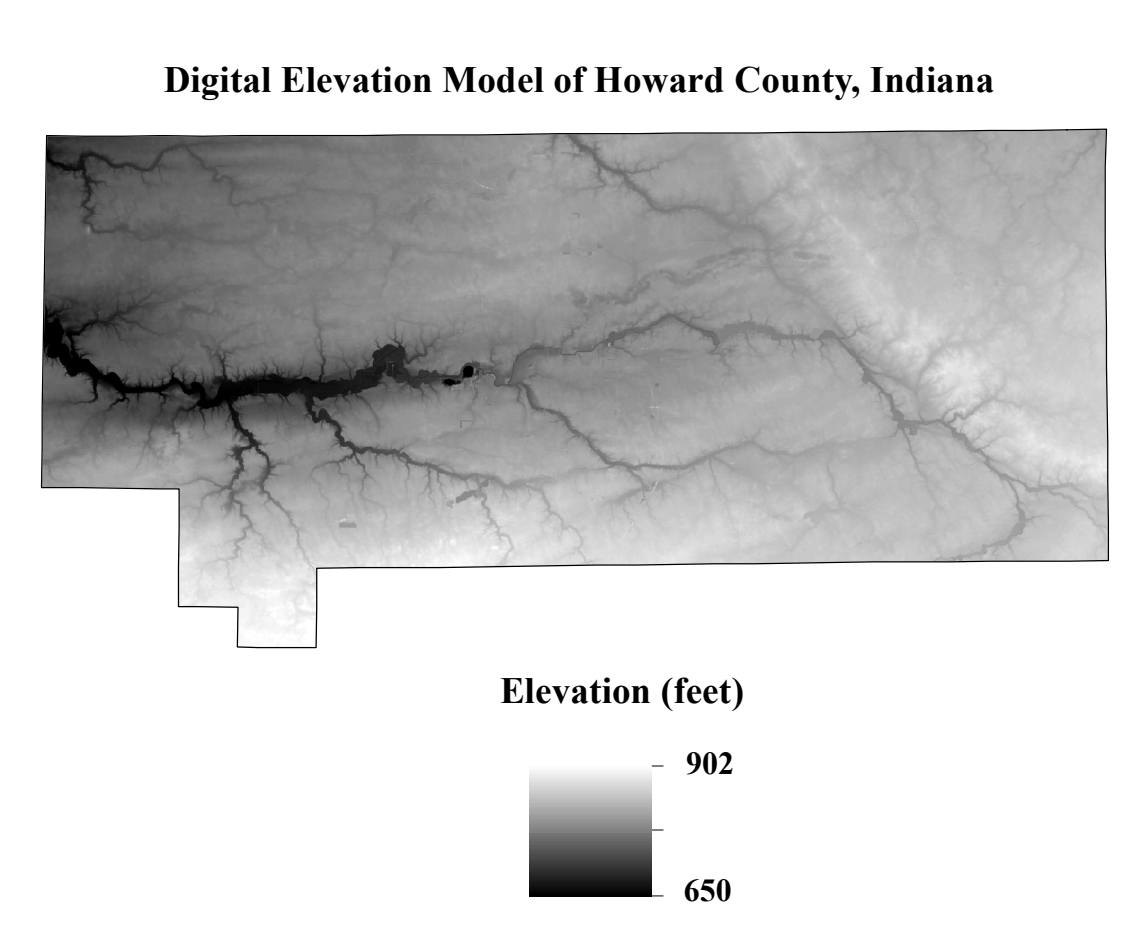
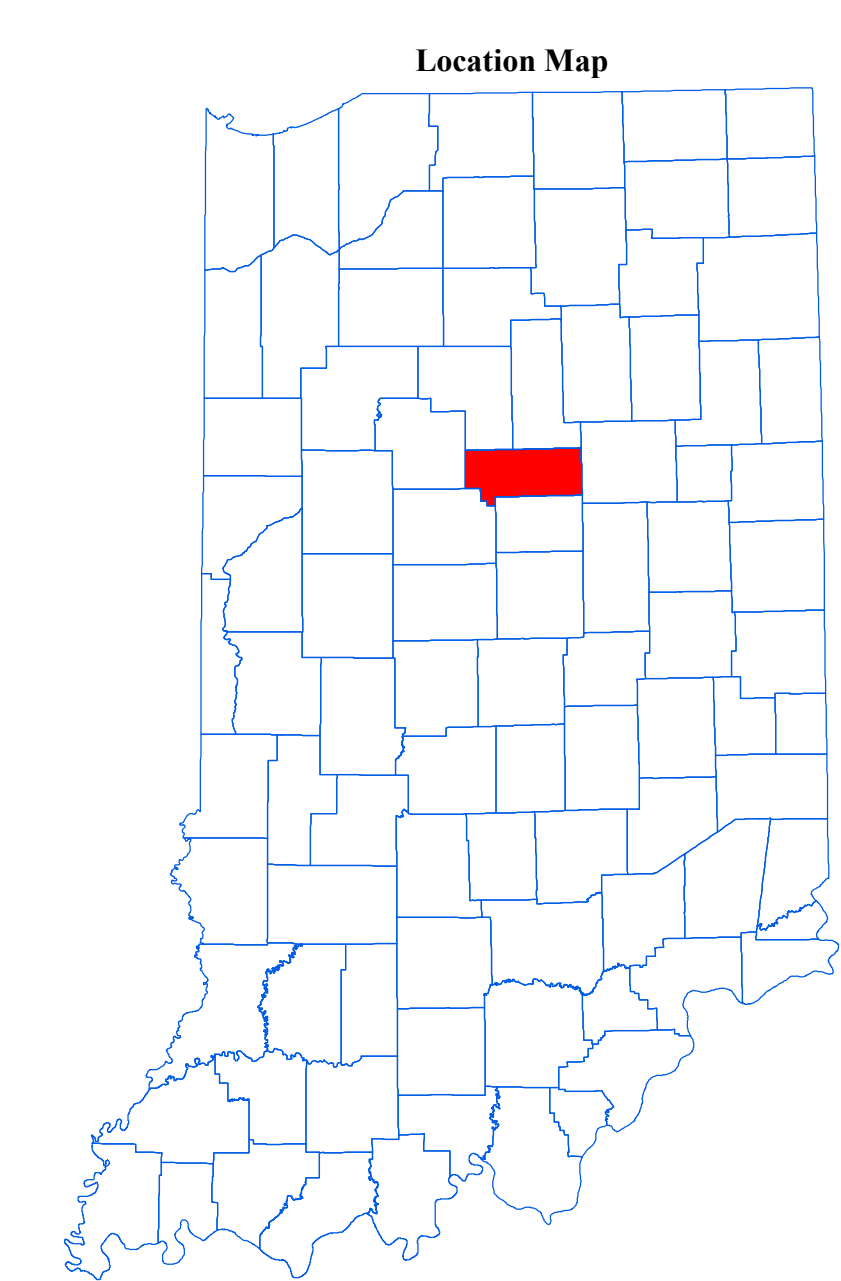
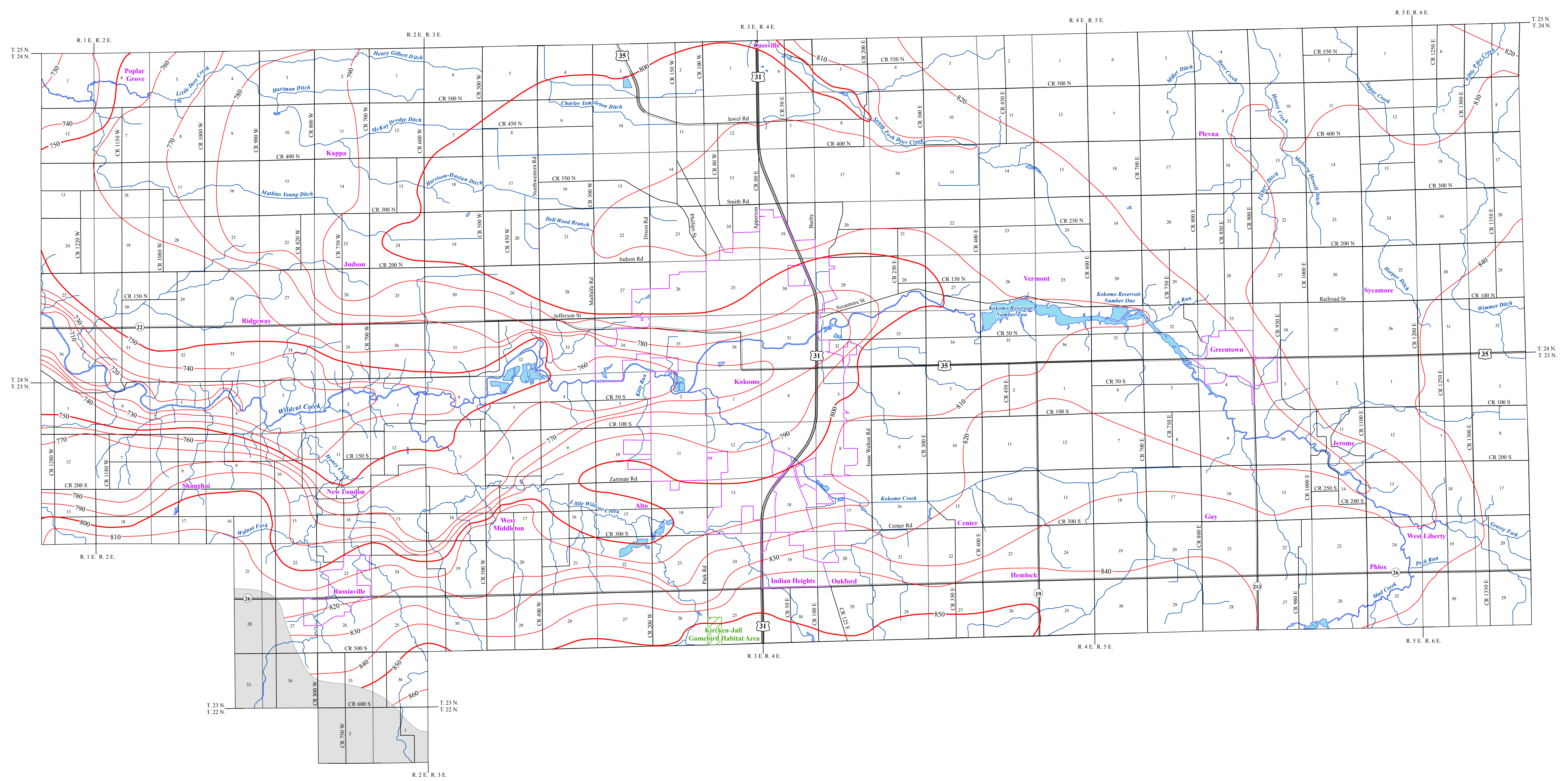
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Bedrock Aquifer Systems of Howard County, Indiana

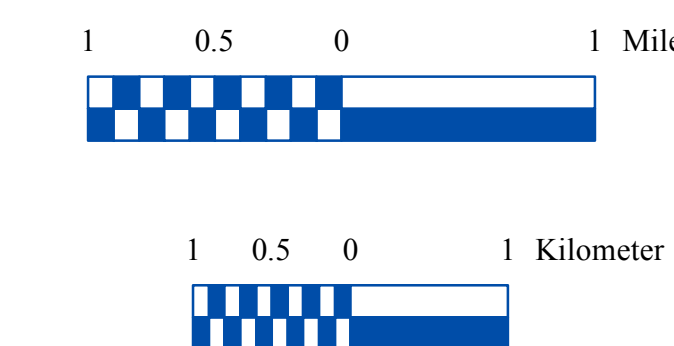
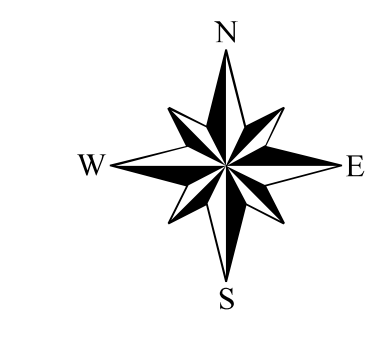
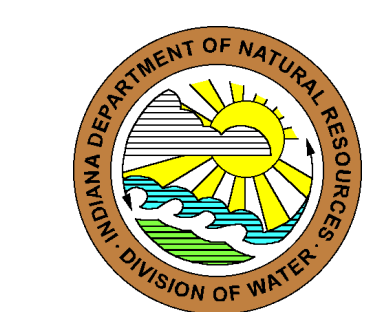
by
Robert A. Scott
Division of Water, Resource Assessment Section

July 2008

POTENTIOMETRIC SURFACE MAP OF THE BEDROCK AQUIFERS OF HOWARD COUNTY, INDIANA



- EXPLANATION**
- 800 — Line of equal elevation, in feet above mean sea level
 - Potentiometric Contour interval 10 feet
 - Stream
 - County Road
 - State Road
 - US Highway
 - Municipal Boundary
 - Lake & River
 - State Managed Property
 - No Aquifer Material or Limited Data



Howard County, Indiana is located in the north-central section of the state and lies within the Upper Wabash River Basin.

The Potentiometric Surface Map (PSM) of the bedrock aquifers of Howard County was mapped by contouring the elevations of 1286 static water-levels reported on well records received primarily over a 50 year period. These wells are completed in aquifers at various depths, and typically, under confined conditions (bounded by impermeable layers above and below the water bearing formation). However, some wells were completed under unconfined (not bounded by impermeable layers) settings.

The potentiometric surface is a measure of the pressure on water in a water bearing formation. Water in an unconfined aquifer is at atmospheric pressure and will not rise in a well above the top of the aquifer, in contrast to groundwater in a confined aquifer which is under hydrostatic pressure and will rise in a well above the top of the water bearing formation.

Static water-level measurements in individual wells used to construct county PSM's are indicative of the water-level at the time of well completion. The groundwater level within an aquifer constantly fluctuates in response to rainfall, evapotranspiration, groundwater movement and pumping. Therefore, measured static water-levels in an area may differ due to local or seasonal variations. Because fluctuations in groundwater are typically small, static water-levels can be used to construct a generalized PSM. As a general rule, but certainly not always, groundwater flow approximates the overlying topography and intersects the land surface at major streams.

Universal Transverse Mercator (UTM) coordinates for the water wells were either physically obtained in the field, determined through address geocoding, or reported on water well records. The location of the majority of the water well records used to make the PSM were field verified. Elevation data were obtained from a digital elevation model. Quality control/quality assurance procedures were utilized to refine or remove data where errors were readily apparent.

Potentiometric surface elevations range from a high of 860 feet mean sea level (msl) in the southwestern portion of the county, to a low of 710 feet msl in the west-central section. The potentiometric contour line crossing through Kokomo Waterworks Reservoir No. 2 represents the potentiometric surface of the groundwater in the immediate area, not the water level of the reservoir, which is a man-made feature. Groundwater flow direction in the central and southern portions of the county is generally towards Wilkett Creek and westward. In the northwestern part of the county, groundwater flow direction is generally to the west-northwest toward Little Deer Creek, and in the north-central portion, groundwater flow is northward toward South Fork Deer Creek. Bedrock potentiometric surface elevation contours have not been determined through the southwestern portion of the county. This area is lacking in data and/or covered by more prolific unconsolidated deposits that limit the necessity to complete wells in bedrock.

The county PSM can be used to define the regional groundwater flow path and to identify significant areas of groundwater recharge and discharge. County PSM's represent overall regional characteristics and are not intended to be a substitute for site-specific studies.

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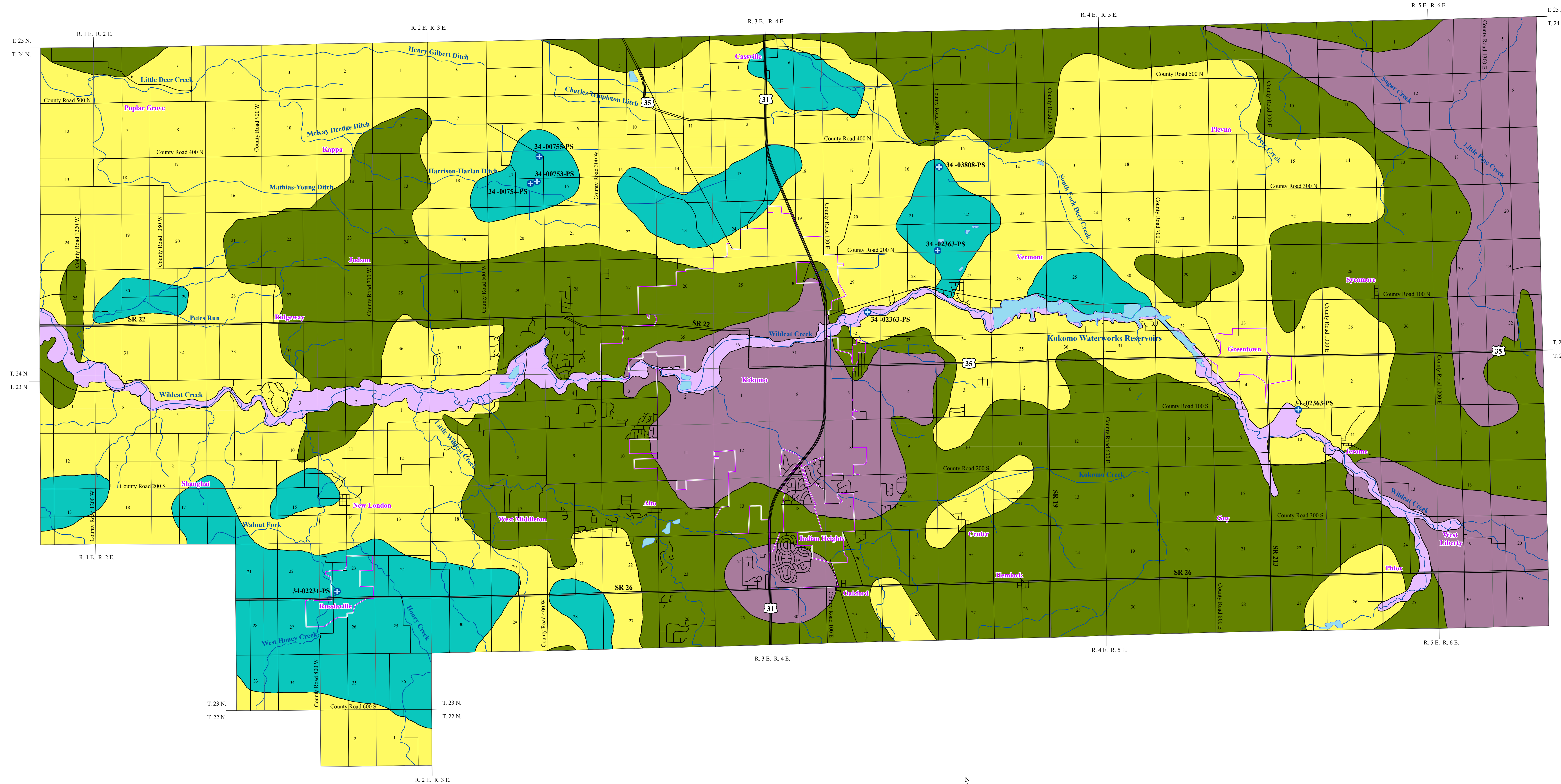
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Potentiometric Surface Map of the Bedrock Aquifers of Howard County, Indiana
by
Robert K. Schmidt
Division of Water, Resource Assessment Section
November 2013

UNCONSOLIDATED AQUIFER SYSTEMS OF HOWARD COUNTY, INDIANA



Five unconsolidated aquifer systems have been mapped in Howard County: the Tipton Veneer, the Bluffton / Tipton Till, the Bluffton / Tipton Till Subsystem, the Tipton Complex, and the Wabash River and Tributaries Outwash Subsystem. Boundaries of all aquifer systems described are commonly gradational, and individual aquifers may extend across aquifer system boundaries.

The thickness of unconsolidated deposits in Howard County is quite variable, because glacial material has been deposited over an uneven bedrock surface. The thickness of unconsolidated deposits ranges from about 25 feet in the eastern portion of Howard County to over 250 feet in the western portion of Howard County.

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.

Tipton Veneer Aquifer System

In Howard County, the Tipton Veneer Aquifer System encompasses areas where the unconsolidated material is predominantly thin till overlying an eroded bedrock surface. This system has the most limited ground-water resources of the unconsolidated aquifer systems in the county and is mapped around the Kokomo area and near the eastern edge of Howard County. Total thickness of the Tipton Veneer Aquifer System generally ranges from about 25 to 50 feet.

There is little potential for ground-water production in the Tipton Veneer Aquifer System in Howard County. Potential aquifer materials include thin isolated sand and/or gravel layers. However, none of the reported domestic wells penetrating this aquifer system are completed in unconsolidated materials, which are bypassed in favor of the underlying bedrock. The Tipton Veneer Aquifer System is not very susceptible to contamination from surface sources because the near-surface materials generally have low permeability.

Bluffton / Tipton Till Aquifer System

In Howard County, this aquifer system ranges in thickness from about 75 feet in the eastern portion of the county to over 225 feet in the western portion of the county. Wells completed in the Bluffton / Tipton Till Aquifer System are capable of meeting the needs of most domestic and some high-capacity users in Howard County. However, approximately 65 percent of wells started in this system utilize the underlying bedrock aquifer. Saturated aquifer materials include sand and/or gravel deposits that are commonly 5 to 20 feet thick and are generally overlain by 45 to 85 feet of silt. Silt produced from the Bluffton / Tipton Till Aquifer System are typically 60 to 105 feet deep. Domestic well capacities are commonly 10 to 50 gallons per minute (gpm). Static water levels generally range from 10 to 30 feet below the surface. There are no registered significant ground-water withdrawal facilities in this system in Howard County.

The Bluffton / Tipton 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 because surficial clay deposits are thin in some areas.

Bluffton / Tipton Till Aquifer Subsystem

Areas where unconsolidated materials are generally greater than 50 feet in thickness, yet have limited aquifer potential, are mapped as the Bluffton / Tipton Till Aquifer Subsystem in the county. The unconsolidated material in this subsystem ranges from about 50 to 175 feet thick in Howard County. Potential aquifer materials include intratill sand and gravel deposits. Where present, aquifer materials are typically capped by till that is commonly 45 to 85 feet thick.

Approximately 86 percent of wells started in the Bluffton / Tipton Till Aquifer Subsystem are completed in the underlying bedrock aquifer system in Howard County. However, this subsystem is capable of meeting the needs of some domestic users in the county. The few wells producing from the Bluffton / Tipton Till Aquifer Subsystem are generally completed at depths of 60 to 95 feet. Intratill sand and gravel aquifer materials are typically 5 to 10 feet thick. Reported well yields generally range from 5 to 15 gpm and static water levels are commonly 10 to 35 feet below the surface.

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.

Tipton Complex Aquifer System

The Tipton Complex Aquifer System is characterized by unconsolidated deposits that are quite variable in materials and thickness. Aquifers within the system range from thin to thick and include single or multiple intratill sands and gravels. The aquifers are highly variable in depth and lateral extent and are typically confined by thick clay layers. Total thickness of the Tipton Complex Aquifer System generally ranges from about 125 to over 250 feet in Howard County.

This system is capable of meeting the needs of domestic and some high-capacity users in Howard County. Consequently, approximately 71 percent of wells started in this system are completed in the system. The most utilized aquifer layers in the Tipton Complex Aquifer System are generally 5 to 30 feet thick sands and/or gravels overlain by a till cap which is commonly 50 to 80 feet thick with thin intratill sand and gravel layers. Wells in this system are typically completed at depths ranging from 70 to 110 feet. Domestic well yields are commonly 10 to 60 gpm and static water levels are generally 10 to 25 feet below the surface. There are 6 registered significant ground-water withdrawal facilities (10 wells) in this system in Howard County. High-capacity well yields up to 350 gpm are reported.

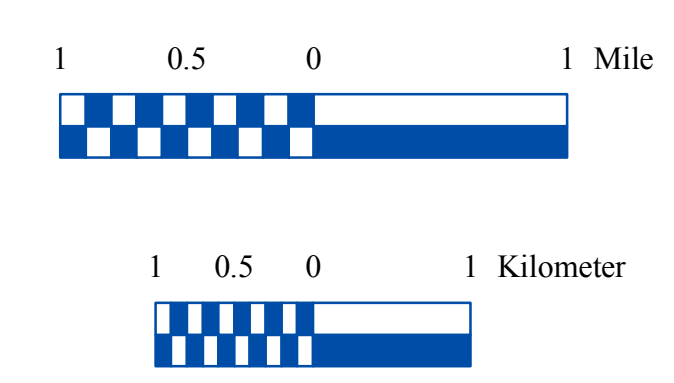
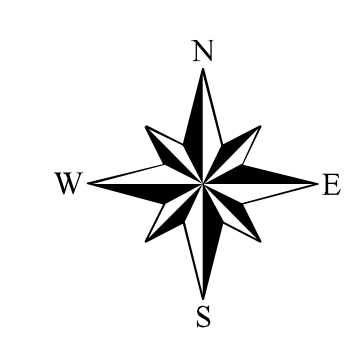
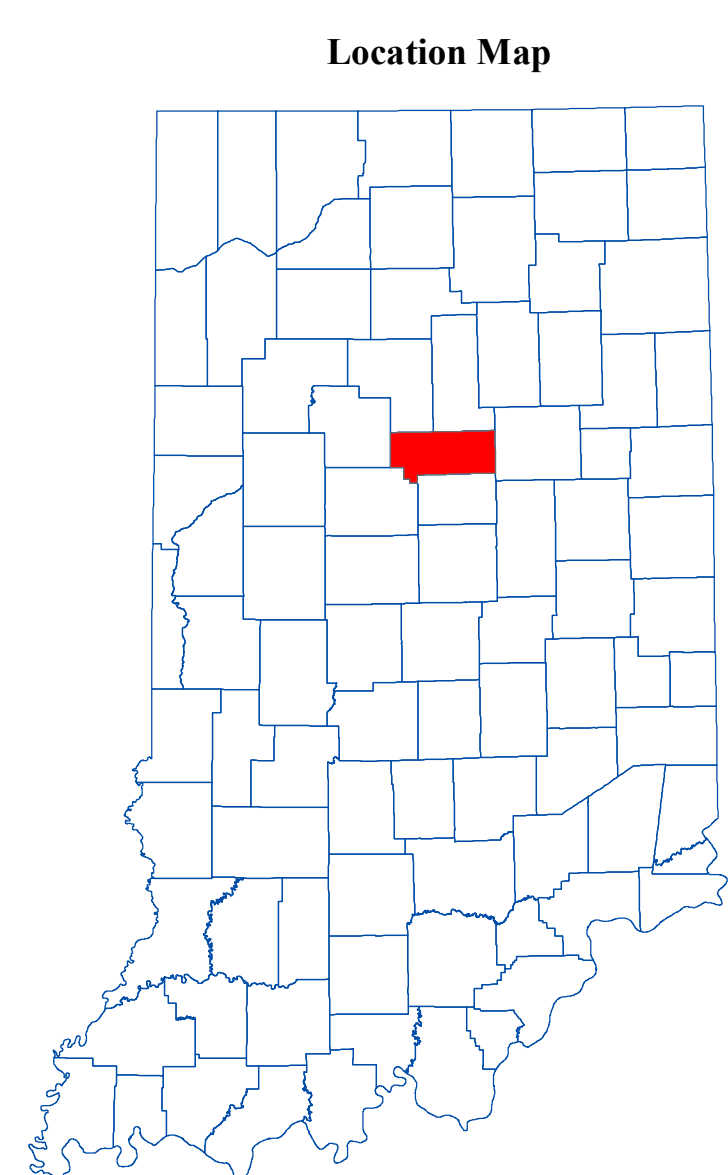
The Tipton Complex Aquifer System is not susceptible to contamination where overlain by thick clay deposits. However, in some areas where surficial clay deposits are thin, the shallow aquifer, if present, is at moderate to high risk.

Wabash and Tributaries Outwash Aquifer Subsystem

The Wabash River and Tributaries Outwash Aquifer Subsystem is mapped along portions of Wildcat Creek in Howard County. The system is made up of thick, glacially derived outwash deposits (sand and gravel).

Approximately 74 percent of wells started in the Wabash River and Tributaries Outwash Aquifer Subsystem are completed in the underlying bedrock aquifer system in Howard County. However, this subsystem is capable of meeting the needs of domestic and some high-capacity users in the county. The few wells producing from the Wabash River and Tributaries Outwash Aquifer Subsystem are generally completed at depths ranging from 55 to 85 feet below surface with up to 45 feet of continuous sand and gravel. In places, aquifer materials are capped by silt or sandy clay ranging from 5 to 30 feet thick. Domestic wells are typically 15 to 50 gpm with static water levels commonly 10 to 20 feet below surface. There is one registered significant ground-water withdrawal facility (10 wells) in the outwash subsystem in Howard County. Reported well yields range from 300 to 500 gpm.

Areas that lack overlying clay or silt deposits are highly susceptible to contamination. However, where overlying clay or silt deposits are present the system is moderately susceptible to surface contamination.



EXPLANATION

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



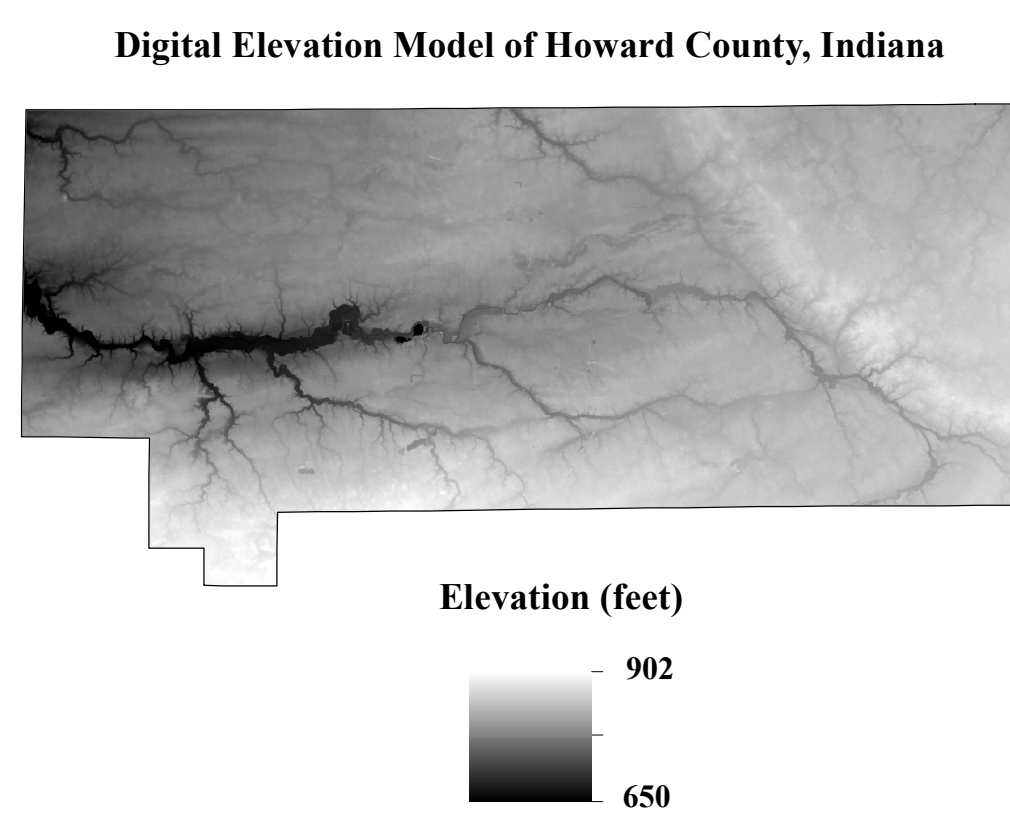
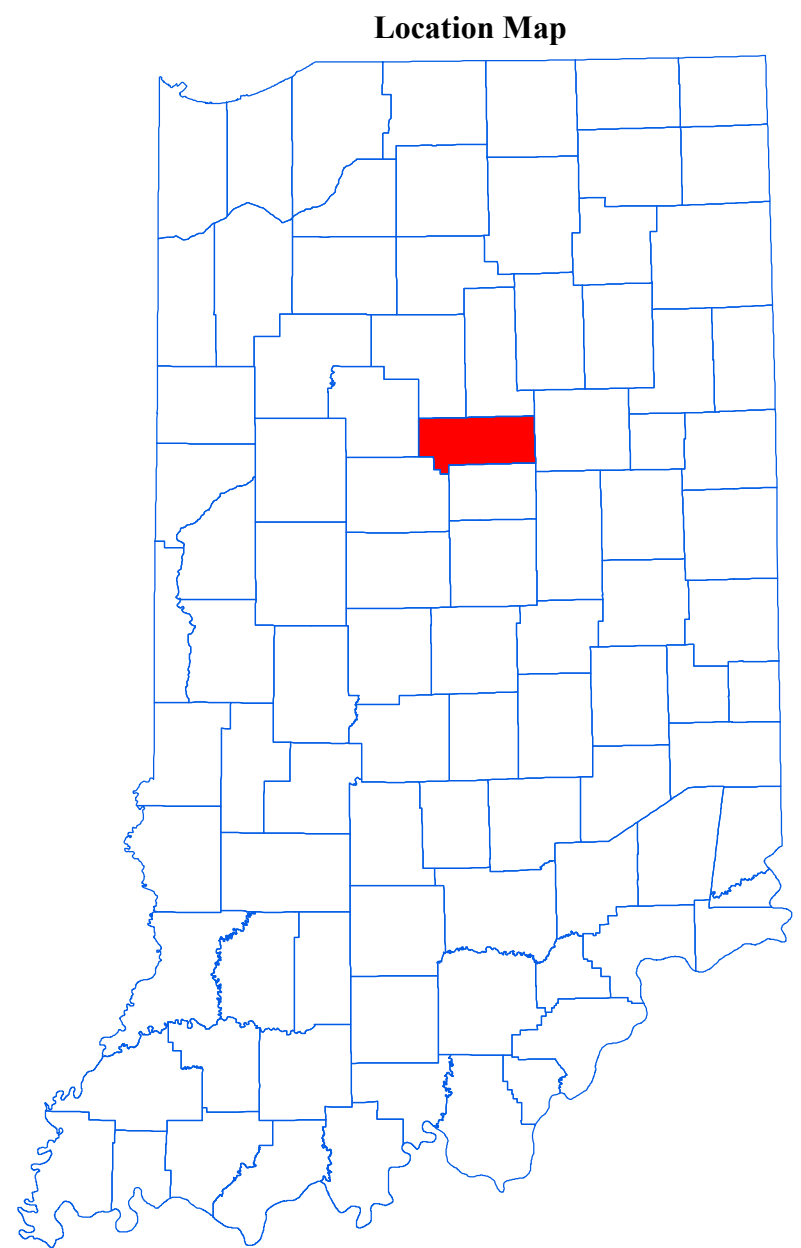
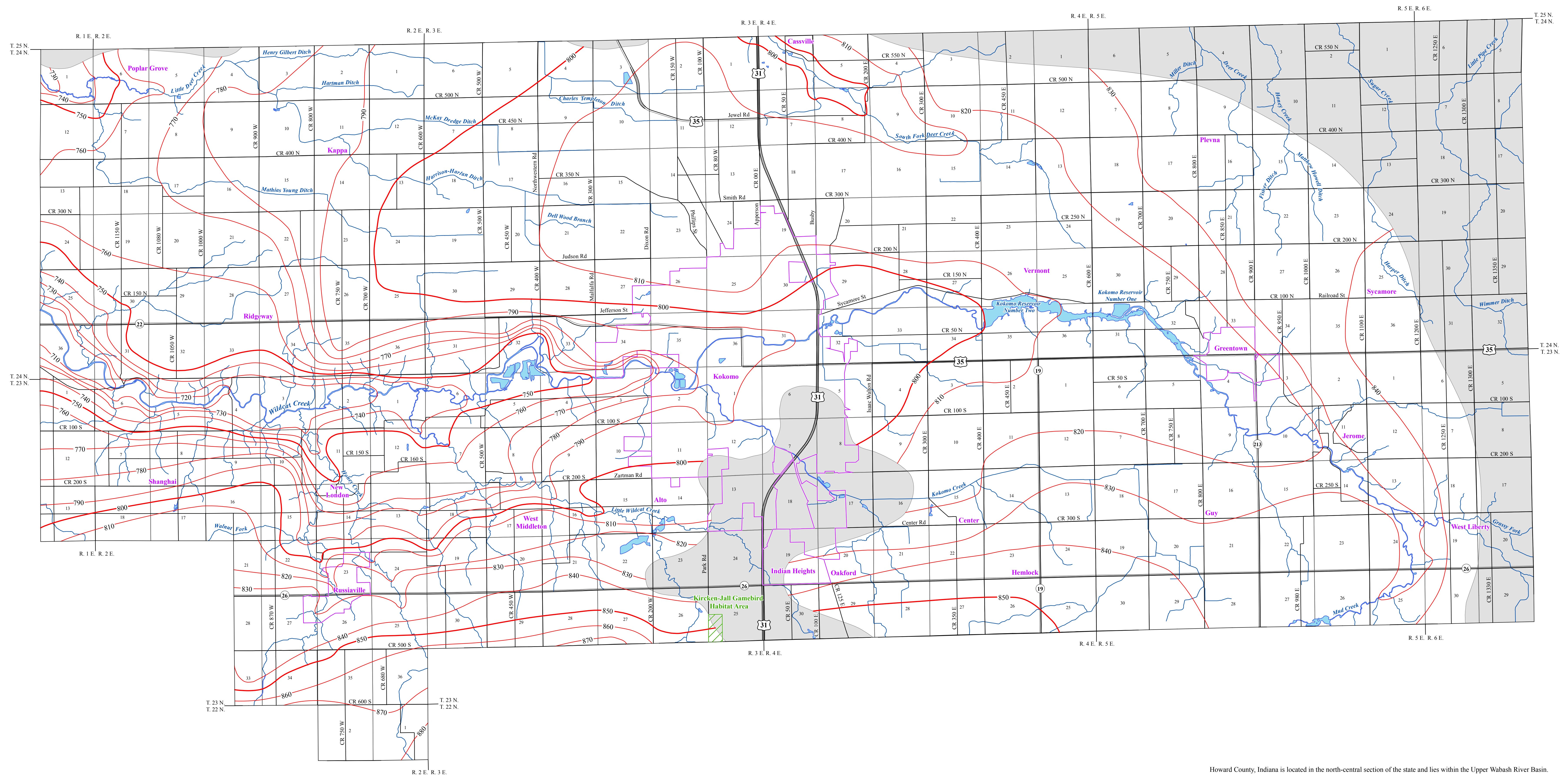
Map generated by Scott H. Dean and Robert A. Scott
DNR, Division of Water, Resource Assessment Section

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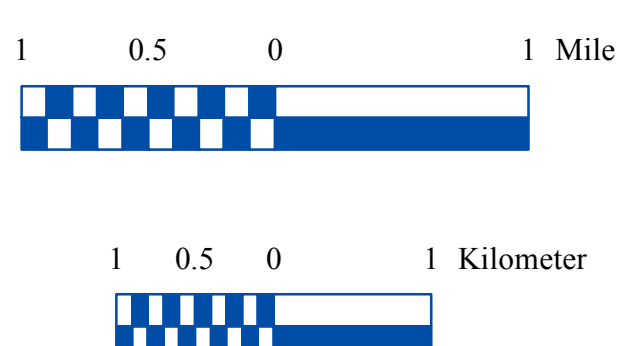
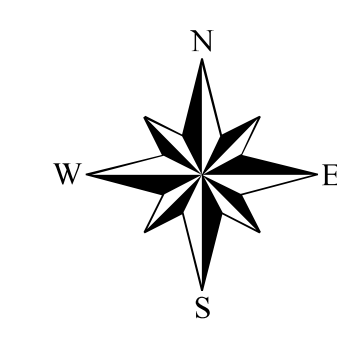
Unconsolidated Aquifer Systems of Howard County, Indiana
by
Robert A. Scott
Division of Water, Resource Assessment Section
July 2008

POTENTIOMETRIC SURFACE MAP OF THE UNCONSOLIDATED AQUIFERS OF HOWARD COUNTY, INDIANA



EXPLANATION

- Line of equal elevation, in feet above mean sea level
- Potentiometric Contour interval 10 feet
- Stream
- County Road
- State Road
- US Highway
- Municipal Boundary
- Lake & River
- State Managed Property
- No Aquifer Material or Limited Data



Howard County, Indiana is located in the north-central section of the state and lies within the Upper Wabash River Basin.

The Potentiometric Surface Map (PSM) of the unconsolidated aquifers of Howard County was mapped by contouring the elevations of 704 static water-levels reported on well records primarily over a 50 year period. These wells are completed in aquifers at various depths, and typically, under confined conditions (bounded by impermeable layers above and below the water bearing formation). However, some wells were completed under unconfined (not bounded by impermeable layers) settings. The mapped potentiometric surface contours are primarily for the upper 100 feet of the unconsolidated materials and utilize data for wells 100 feet or less in depth. If the shallow data was sparse or unavailable in an area, deeper wells were used to complement the mapping.

The potentiometric surface is a measure of the pressure on water in a water bearing formation. Water in an unconfined aquifer is at atmospheric pressure and will not rise in a well above the top of the aquifer, in contrast to groundwater in a confined aquifer which is under hydrostatic pressure and will rise in a well above the top of the water bearing formation.

Static water-level measurements in individual wells used to construct county PSM's are indicative of the water-level at the time of well completion. The groundwater level within an aquifer constantly fluctuates in response to rainfall, evapotranspiration, groundwater movement and pumping. Therefore, measured static water-levels in an area may differ due to local or seasonal variations. Because fluctuations in groundwater are typically small, static water-levels can be used to construct a generalized PSM. As a general rule, but certainly not always, groundwater flow approximates the overlying topography and intersects the land surface at major streams.

Universal Transverse Mercator (UTM) coordinates for the water wells were either physically obtained in the field, determined through address geocoding, or reported on water well records. The location of the majority of the water well records used to make the PSM were field verified. Elevation data were obtained from a digital elevation model. Quality control/assurance procedures were utilized to refine or remove data where errors were readily apparent.

Potentiometric surface elevations range from a high of 880 feet mean sea level (msl) in the southwestern section of the county, to a low of 710 feet msl in the west-central portion. The potentiometric contour line crossing through Kokomo Waterworks Reservoir No. 2 represents the potentiometric surface of the groundwater in the immediate area, not the water level of the reservoir, which is a man-made feature. Groundwater flow direction in the central and southern portions of the county is generally towards Wildcat Creek and westward. In the northwestern part of the county, groundwater flow direction is generally to the west-northwest toward Little Deer Creek, and in the north-central portion, groundwater flow is northward toward South Fork Deer Creek. In portions of the county, where data is lacking and/or covered by thin or unproductive deposits, potentiometric surface elevation contours have not been extended through these areas.

The county PSM can be used to define the regional groundwater flow path and to identify significant areas of groundwater recharge and discharge. County PSM's represent overall regional characteristics and are not intended to be a substitute for site-specific studies.

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Potentiometric Surface Map of the Unconsolidated Aquifers of Howard County, Indiana

by
Robert K. Schmidt
Division of Water, Resource Assessment Section

November 2013

Howard County

