GROUND WATER POLLUTION POTENTIAL OF WYANDOT COUNTY, OHIO

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ABSTRACT

A groundwater pollution potential map of Wyandot County has been prepared using the DRASTIC mapping process. The DRASTIC system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system for pollution potential.

Hydrogeologic settings incorporate hydrogeologic factors that control ground water movement and occurrence including depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone media, and hydraulic conductivity of the aquifer. These factors, which form the acronym DRASTIC, are incorporated into a relative ranking scheme that uses a combination of weights and ratings to produce a numerical value called the ground water pollution potential index. Hydrogeologic settings are combined with the pollution potential indexes to create units that can be graphically displayed on a map.

Ground water pollution potential analysis in Wyandot County resulted in a map with symbols and colors, which illustrate areas of varying ground water pollution potential indexes ranging from 95 to 175.

Wyandot County lies entirely within the Glaciated Central hydrogeologic setting. Limestones and dolomites of the Silurian and Devonian Systems compose the aquifer in the county. Yields in the uppermost carbonate aquifers range from 5 to 25 gallons per minute (gpm) to 25 to 100 gpm. Yields over 100 gpm are possible from larger diameter wells drilled deeper into the limestone. Overall, yields are somewhat higher in the eastern part of the county.

Sand and gravel lenses interbedded in the glacial till locally serve as aquifers in limited areas of northern and western Wyandot County. Yields for these sand and gravel lenses range from 5 to 25 gpm.

The ground water pollution potential mapping program optimizes the use of existing data to rank areas with respect to relative vulnerability to contamination. The ground water pollution potential map of Wyandot County has been prepared to assist planners, managers, and local officials in evaluating the potential for contamination from various sources of pollution. This information can be used to help direct resources and land use activities to appropriate area, or to assist in protection, monitoring, and clean-up efforts.

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INTRODUCTION

The need for protection and management of ground water resources in Ohio has been clearly recognized. About 42 percent of Ohio citizens rely on ground water for drinking and household use from both municipal and private wells. Industry and agriculture also utilize significant quantities of ground water for processing and irrigation. In Ohio, approximately 750,000 rural households depend on private wells; 3,700 of these wells exist in Wyandot County.

The characteristics of the many aquifer systems in the state make ground water highly vulnerable to contamination. Measures to protect ground water from contamination usually cost less and create less impact on ground water users than remediation of a polluted aquifer. Based on these concerns for protection of the resource, staff of the Division of Water conducted a review of various mapping strategies useful for identifying vulnerable aquifer areas. They placed particular emphasis on reviewing mapping systems that would assist in state and local protection and management programs. Based on these factors and the quantity and quality of available data on ground water resources, the DRASTIC mapping process (Aller et al., 1987) was selected for application in the program.

Considerable interest in the mapping program followed successful production of a demonstration county map and led to the inclusion of the program as a recommended initiative in the Ohio Ground Water Protection and Management Strategy (Ohio EPA, 1986). Based on this recommendation, the Ohio General Assembly funded the mapping program. A dedicated mapping unit has been established in the Division of Water, Water Resources Section to implement the ground water pollution potential mapping program on a countywide basis in Ohio.

The purpose of this report and map is to aid in the protection of our ground water resources. This protection can be enhanced by understanding and implementing the results of this study, which utilizes the DRASTIC system of evaluating an area's potential for ground water pollution. The mapping program identifies areas that are vulnerable to contamination and displays this information graphically on maps. The system was not designed or intended to replace site-specific investigations, but rather to be used as a planning and management tool. The map and report can be combined with other information to assist in prioritizing local resources and in making land use decisions.

APPLICATIONS OF POLLUTION POTENTIAL MAPS

The pollution potential mapping program offers a wide variety of applications in many counties. The ground water pollution potential map of Wyandot County has been prepared to assist planners, managers, and state and local officials in evaluating the relative vulnerability of areas to ground water contamination from various sources of pollution. This information can be used to help direct resources and land use activities to appropriate areas, or to assist in protection, monitoring, and clean-up efforts.

An important application of the pollution potential maps for many areas will be assisting in county land use planning and resource expenditures related to solid waste disposal. A county may use the map to help identify areas that are suitable for disposal activities. Once these areas have been identified, a county can collect more site-specific information and combine this with other local factors to determine site suitability.

Pollution potential maps may be applied successfully where non-point source contamination is a concern. Non-point source contamination occurs where land use activities over large areas impact water quality. Maps providing information on relative vulnerability can be used to guide the selection and implementation of appropriate best management practices in different areas. Best management practices should be chosen based upon consideration of the chemical and physical processes that occur from the practice, and the effect these processes may have in areas of moderate to high vulnerability to contamination. For example, the use of agricultural best management practices that limit the infiltration of nitrates, or promote denitrification above the water table, would be beneficial to implement in areas of relatively high vulnerability to contamination.

A pollution potential map can assist in developing ground water protection strategies. By identifying areas more vulnerable to contamination, officials can direct resources to areas where special attention or protection efforts might be warranted. This information can be utilized effectively at the local level for integration into land use decisions and as an educational tool to promote public awareness of ground water resources. Pollution potential maps may be used to prioritize ground water monitoring and/or contamination clean-up efforts. Areas that are identified as being vulnerable to contamination may benefit from increased ground water monitoring for pollutants or from additional efforts to clean up an aquifer.

Individuals in the county who are familiar with specific land use and management problems will recognize other beneficial uses of the pollution potential maps. Planning commissions and zoning boards can use these maps to help make informed decisions about the development of areas within their jurisdiction. Developers proposing projects within ground water sensitive areas may be required to show how ground water will be protected.

Regardless of the application, emphasis must be placed on the fact that the system is not designed to replace a site-specific investigation. The strength of the system lies in its ability to make a "first-cut approximation" by identifying areas that are vulnerable to contamination. Any potential applications of the system should also recognize the assumptions inherent in the system.

SUMMARY OF THE DRASTIC MAPPING PROCESS

DRASTIC was developed by the National Ground Water Association for the United States Environmental Protection Agency. This system was chosen for implementation of a ground water pollution potential mapping program in Ohio. A detailed discussion of this system can be found in Aller et al. (1987).

The DRASTIC mapping system allows the pollution potential of any area to be evaluated systematically using existing information. Vulnerability to contamination is a combination of hydrogeologic factors, anthropogenic influences, and sources of contamination in any given area. The DRASTIC system focuses only on those hydrogeologic factors that influence ground water pollution potential. The system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system to determine pollution potential.

The application of DRASTIC to an area requires the recognition of a set of assumptions made in the development of the system. DRASTIC evaluates the pollution potential of an area under the assumption that a contaminant with the mobility of water is introduced at the surface and flushed into the ground water by precipitation. Most important, DRASTIC cannot be applied to areas smaller than 100 acres in size and is not intended or designed to replace site-specific investigations.

Hydrogeologic Settings and Factors

To facilitate the designation of mappable units, the DRASTIC system used the framework of an existing classification system developed by Heath (1984), which divides the United States into 15 ground water regions based on the factors in a ground water system that affect occurrence and availability.

Within each major hydrogeologic region, smaller units representing specific hydrogeologic settings are identified. Hydrogeologic settings form the basis of the system and represent a composite description of the major geologic and hydrogeologic factors that control ground water movement into, through, and out of an area. A hydrogeologic setting represents a mappable unit with common hydrogeologic characteristics and, as a consequence, common vulnerability to contamination (Aller et al., 1987).

Figure 1 illustrates the format and description of a typical hydrogeologic setting found within Wyandot County. Inherent within each hydrogeologic setting are the physical characteristics that affect the ground water pollution potential. These characteristics or factors identified during the development of the DRASTIC system include:

D – Depth to Water

R – Net Recharge

A – Aquifer Media

S – Soil Media

T – Topography

I – Impact of the Vadose Zone Media

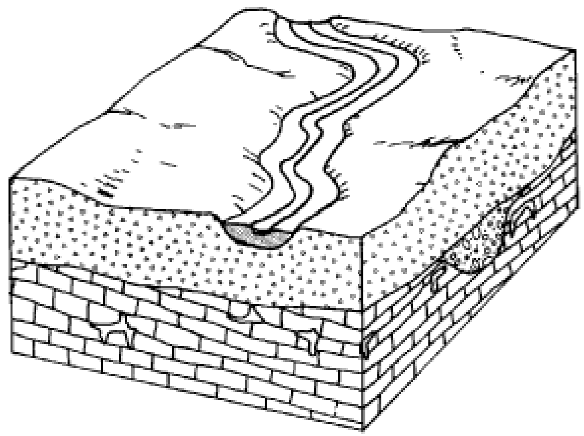
C – Conductivity (Hydraulic) of the Aquifer

These factors incorporate concepts and mechanisms such as attenuation, retardation, and time or distance of travel of a contaminant with respect to the physical characteristics of the hydrogeologic setting. Broad consideration of these factors and mechanisms coupled with existing conditions in a setting provide a basis for determination of the area's relative vulnerability to contamination.

Depth to water is considered to be the depth from the ground surface to the water table in unconfined aquifer conditions or the depth to the top of the aquifer under confined aquifer conditions. The depth to water determines the distance a contaminant would have to travel before reaching the aquifer. The greater the distance the contaminant has to travel, the greater the opportunity for attenuation to occur or restriction of movement by relatively impermeable layers.

Net recharge is the total amount of water reaching the land surface that infiltrates the aquifer measured in inches per year. Recharge water is available to transport a contaminant from the surface into the aquifer and affects the quantity of water available for dilution and dispersion of a contaminant. Factors to be included in the determination of net recharge include contributions due to infiltration of precipitation, in addition to infiltration from rivers, streams and lakes, irrigation, and artificial recharge.

Aquifer media represents consolidated or unconsolidated rock material capable of yielding sufficient quantities of water for use. Aquifer media accounts for the various physical characteristics of the rock that provide mechanisms of attenuation, retardation, and flow pathways that affect a contaminant reaching and moving through an aquifer.



7Ac-Glacial Till over Solution Limestone

This hydrogeologic setting is common in Wyandot County. It consists of fairly wide bands of ground moraine. The area is characterized by flat-lying topography and low relief. The vadose zone consists primarily of silty to clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. The aquifer is composed of fractured Silurian and/or Devonian limestones and dolomites. These carbonate rocks may contain significant solution features. Depth to water is typically moderate, ranging from 20 to 50 feet. Soils are typically clay loams derived from till. Maximum ground water yields greater than 100 gpm are possible from the Silurian Lockport, Tymochtee, Greenfield and Salina Groups. Yields range from 5 to 100 gpm for the Devonian carbonate units. Recharge is moderately low due to clayey nature of the soils and vadose zone.

GWPP index values for the hydrogeologic setting of Glacial Till over Solution Limestone range from 96 to 168, with the total number of GWPP index calculations equaling 33.

Figure 1. Format and description of the hydrogeologic setting – 7Ac Glacial Till over Solution Limestone.

Soil media refers to the upper six feet of the unsaturated zone that is characterized by significant biological activity. The type of soil media influences the amount of recharge that can move through the soil column due to variations in soil permeability. Various soil types also have the ability to attenuate or retard a contaminant as it moves throughout the soil profile. Soil media is based on textural classifications of soils and considers relative thicknesses and attenuation characteristics of each profile within the soil.

Topography refers to the slope of the land expressed as percent slope. The slope of an area affects the likelihood that a contaminant will run off or be ponded and ultimately infiltrate into the subsurface. Topography also affects soil development and often can be used to help determine the direction and gradient of ground water flow under water table conditions.

The impact of the vadose zone media refers to the attenuation and retardation processes that can occur as a contaminant moves through the unsaturated zone above the aquifer. The vadose zone represents that area below the soil horizon and above the aquifer that is unsaturated or discontinuously saturated. Various attenuation, travel time, and distance mechanisms related to the types of geologic materials present can affect the movement of contaminants in the vadose zone. Where an aquifer is unconfined, the vadose zone media represents the materials below the soil horizon and above the water table. Under confined aquifer conditions, the vadose zone is simply referred to as a confining layer. The presence of the confining layer in the unsaturated zone has a significant impact on the pollution potential of the ground water in an area.

Hydraulic conductivity of an aquifer is a measure of the ability of the aquifer to transmit water, and is also related to ground water velocity and gradient. Hydraulic conductivity is dependent upon the amount and interconnectivity of void spaces and fractures within a consolidated or unconsolidated rock unit. Higher hydraulic conductivity typically corresponds to higher vulnerability to contamination. Hydraulic conductivity considers the capability for a contaminant that reaches an aquifer to be transported throughout that aquifer over time.

Weighting and Rating System

DRASTIC uses a numerical weighting and rating system that is combined with the DRASTIC factors to calculate a ground water pollution potential index or relative measure of vulnerability to contamination. The DRASTIC factors are weighted from 1 to 5 according to their relative importance to each other with regard to contamination potential (Table 1). Each factor is then divided into ranges or media types and assigned a rating from 1 to 10 based on their significance to pollution potential (Tables 2-8). The rating for each factor is selected based on available information and professional judgment. The selected rating for each factor is multiplied by the assigned weight for each factor. These numbers are summed to calculate the DRASTIC or pollution potential index.

Once a DRASTIC index has been calculated, it is possible to identify areas that are more likely to be susceptible to ground water contamination relative to other areas. The higher the

DRASTIC index, the greater the vulnerability to contamination. The index generated provides only a relative evaluation tool and is not designed to produce absolute answers or to represent units of vulnerability. Pollution potential indexes of various settings should be compared to each other only with consideration of the factors that were evaluated in determining the vulnerability of the area.

Pesticide DRASTIC

A special version of DRASTIC was developed for use where the application of pesticides is a concern. The weights assigned to the DRASTIC factors were changed to reflect the processes that affect pesticide movement into the subsurface with particular emphasis on soils. Where other agricultural practices, such as the application of fertilizers, are a concern, general DRASTIC should be used to evaluate relative vulnerability to contamination. The process for calculating the Pesticide DRASTIC index is identical to the process used for calculating the general DRASTIC index. However, general DRASTIC and Pesticide DRASTIC numbers should not be compared because the conceptual basis in factor weighting and evaluation differs significantly. Table 1 lists the weights used for general and pesticide DRASTIC.

Table 1. Assigned weights for DRASTIC features

Feature	**General DRASTIC Weight**	**Pesticide DRASTIC Weight**
Depth to Water	5	5
Net Recharge	4	4
Aquifer Media	3	3
Soil Media	2	5
Topography	1	3
Impact of the Vadose Zone Media	5	4
Hydraulic Conductivity of the Aquifer	3	2

Table 2. Ranges and ratings for depth to water

Depth to Water (feet)	
Range	**Rating**
0-5	10
5-15	9
15-30	7
30-50	5
50-75	3
75-100	2
100+	1
Weight: 5	Pesticide Weight: 5

Table 3. Ranges and ratings for net recharge

Net Recharge (inches)	
Range	**Rating**
0-2	1
2-4	3
4-7	6
7-10	8
10+	9
Weight: 4	Pesticide Weight: 4

Table 4. Ranges and ratings for aquifer media

Aquifer Media		
Range	**Rating**	**Typical Rating**
Shale	1-3	2
Glacial Till	4-6	5
Sandstone	4-9	6
Limestone	4-9	6
Sand and Gravel	4-9	8
Interbedded Ss/Sh/Ls/Coal	2-10	9
Karst Limestone	9-10	10
Weight: 3	Pesticide Weight: 3	

Table 5. Ranges and ratings for soil media

Soil Media	
Range	**Rating**
Thin or Absent	10
Gravel	10
Sand	9
Peat	8
Shrink/Swell Clay	7
Sandy Loam	6
Loam	5
Silty Loam	4
Clay Loam	3
Muck	2
Clay	1
Weight: 2	Pesticide Weight: 5

Table 6. Ranges and ratings for topography

Topography (percent slope)	
Range	**Rating**
0-2	10
2-6	9
6-12	5
12-18	3
18+	1
Weight: 1	Pesticide Weight: 3

Table 7. Ranges and ratings for impact of the vadose zone media

Impact of the Vadose Zone Media		
Range	**Rating**	**Typical Rating**
Confining Layer	1	1
Silt/Clay	2-6	3
Shale	2-5	3
Limestone	2-7	6
Sandstone	4-8	6
Interbedded Ss/Sh/Ls/Coal	4-8	6
Sand and Gravel with Silt and Clay	4-8	6
Glacial Till	2-6	4
Sand and Gravel	6-9	8
Karst Limestone	8-10	10
Weight: 5	Pesticide Weight: 4	

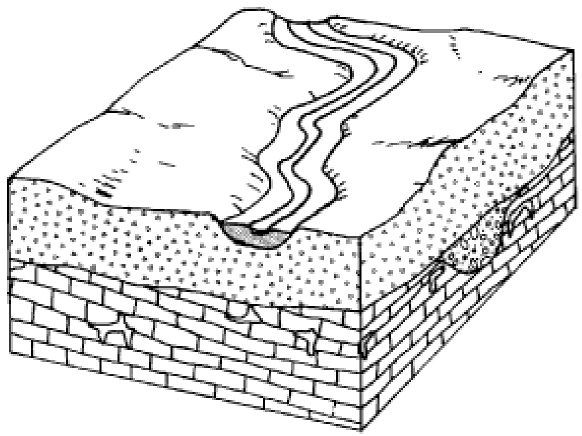
Table 8. Ranges and ratings for hydraulic conductivity

Hydraulic Conductivity (GPD/FT^2)	
Range	**Rating**
1-100	1
100-300	2
300-700	4
700-1000	6
1000-2000	8
2000+	10
Weight: 3	Pesticide Weight: 2

Integration of Hydrogeologic Settings and DRASTIC Factors

Figure 2 illustrates the hydrogeologic setting 7Ac1, Glacial Till over Solution Limestone, identified in mapping Wyandot County, and the pollution potential index calculated for the setting. Based on selected ratings for this setting, the pollution potential index is calculated to be 116. This numerical value has no intrinsic meaning, but can be readily compared to a value obtained for other settings in the county. DRASTIC indexes for typical hydrogeologic settings and values across the United States range from 45 to 223. The diversity of hydrogeologic conditions in Wyandot County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the ten settings identified in the county range from 95 to 175.

Hydrogeologic settings identified in an area are combined with the pollution potential indexes to create units that can be graphically displayed on maps. Pollution potential analysis in Wyandot County resulted in a map with symbols and colors that illustrate areas of ground water vulnerability. The map describing the ground water pollution potential of Wyandot County is included with this report.



SETTING 7Ac1		GENERAL		
FEATURE	**RANGE**	**WEIGHT**	**RATING**	**NUMBER**
Depth to Water	15-30	5	7	35
Net Recharge	2-4	4	3	12
Aquifer Media	Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	0-2%	1	10	10
Impact of Vadose Zone	Till	5	4	20
Hydraulic Conductivity	300-700	3	4	12
		DRASTIC	INDEX	116

Figure 2. Description of the hydrogeologic setting – 7Ac1 Glacial Till over Solution Limestone.

INTERPRETATION AND USE OF GROUND WATER POLLUTION POTENTIAL MAPS

The application of the DRASTIC system to evaluate an area's vulnerability to contamination produces hydrogeologic settings with corresponding pollution potential indexes. The susceptibility to contamination is greater as the pollution potential index increases. This numeric value determined for one area can be compared to the pollution potential index calculated for another area.

The map accompanying this report displays both the hydrogeologic settings identified in the county and the associated pollution potential indexes calculated in those hydrogeologic settings. The symbols on the map represent the following information:

7Ac1 - defines the hydrogeologic region and setting
116 - defines the relative pollution potential

Here the first number (**7**) refers to the major hydrogeologic region and the upper case letter (**Ac**) refers to a specific hydrogeologic setting. The following number (**1**) references a certain set of DRASTIC parameters that are unique to this setting and are described in the corresponding setting chart. The second number (**116**) is the calculated pollution potential index for this unique setting. The charts for each setting provide a reference to show how the pollution potential index was derived.

The maps are color-coded using ranges depicted on the map legend. The color codes used are part of a national color-coding scheme developed to assist the user in gaining a general insight into the vulnerability of the ground water in the area. The color codes were chosen to represent the colors of the spectrum, with warm colors (red, orange, and yellow) representing areas of higher vulnerability (higher pollution potential indexes), and cool colors (greens, blues, and violet) representing areas of lower vulnerability to contamination.

The map includes information on the locations of selected observation wells. Available information on these observation wells is referenced in Appendix A, Description of the Logic in Factor Selection. Large man-made features such as landfills, quarries, or strip mines have also been marked on the map for reference.

GENERAL INFORMATION ABOUT WYANDOT COUNTY

Demographics

Wyandot County occupies approximately 406 square miles in north central Ohio (Figure 3). Wyandot County is bounded to the north by Seneca County, to the east by Crawford County, to the south by Marion County, to the southwest by Hardin County, and to the northwest by Hancock County.

The approximate population of Wyandot County, based upon year 2000 census estimates, is 22,908 (Department of Development, Ohio County Profiles, 2005). Upper Sandusky is the largest community and the county seat. Agriculture accounts for roughly 80 percent of the land usage in Wyandot County. Row crops are the primary agricultural land usage. Woodlands, industry, and residential are the other major land uses in the county. More specific information on land usage can be obtained from the Ohio Department of Natural Resources, Division of Real Estate and Land Management (REALM), Resource Analysis Program (formerly OCAP).

Climate

The *Hydrologic Atlas for Ohio* (Harstine, 1991) reports an average annual temperature of approximately 51 degrees Fahrenheit for Wyandot County. Harstine (1991) shows that precipitation approximately averages 35 inches per year for the county, with precipitation decreasing towards the southwest. The mean annual precipitation for Upper Sandusky is 36.19 inches per year based upon a thirty-year (1971-2000) period (National Oceanographic and Atmospheric Administration, 2002). The mean annual temperature at Upper Sandusky for the same thirty-year period is 51 degrees Fahrenheit (National Oceanographic and Atmospheric Administration, 2002).

Physiography and Topography

Wyandot County lies within the Central Till Plains Lowland Province (Frost, 1931; Fenneman, 1938, and Bier, 1956). Brockman (1998) and Schiefer (2002) determined that Wyandot County belongs in the Central Ohio Clayey Till Plain. Wyandot County is characterized by flat ground moraine and intermorainal lakes separated by linear, hummocky end moraines.

Figure 3. Location map of Wyandot County, Ohio.

Modern Drainage

With the exception of the extreme southeast corner of the county, Wyandot County lies entirely within the Lake Erie Basin drainage. Tributaries of the Blanchard River drain the western margin of the county. The Sandusky River and its tributaries drain the remainder of the county. Important tributaries of the Sandusky River include Sycamore Creek, Broken Sword Creek, and Tymochtee Creek.

Pre- and Inter-Glacial Drainage Changes

Little information is available on the pre-glacial drainage of Wyandot County. Stout et al. (1943) suggested that during pre-glacial (Teays Stage Drainage) times that Wyandot County contained the headwaters of the Tiffin River. The Tiffin River was an ancestor of and had a course similar to that of the modern Sandusky River. The modern drainage patterns of Wyandot County largely reflect the terrain resulting from the final Wisconsinan glacial advances.

Glacial Geology

During the Pleistocene Epoch (2 million to 10,000 years before present (Y.B.P.)) several episodes of ice advance occurred in northwestern Ohio. Older ice advances that predate the most recent (Brunhes) magnetic reversal (about 730,000 Y.B.P.) are now commonly referred to as pre-Illinoian (formerly Kansan). Goldthwait et al., (1961) and Pavey et al., (1999) report that the last advance, the Late Wisconsinan Ice Sheet, deposited the surficial till in Wyandot County. Evidence for the earlier glaciations is lacking or obscured.

House (1985) discusses the glacial deposits of Wyandot County at length. In a recent study, Russell (2002) reevaluated the lacustrine deposits related to the intermorainal lakes found in neighboring Crawford County. The *Soil Survey of Wyandot County* (Steiger and Hendershot, 1982) was used to make the delineations between the lakebeds and ground moraine. The exceptional flatness of these features and characteristics of poor drainage also proved useful in delineating the intermorainal lakes.

The majority of the glacial deposits in Wyandot County fall into four main types: (glacial) till, alluvial deposits, lacustrine deposits, and ice-contact sand and gravel (kames, eskers) deposits. Drift is an older term that collectively refers to the entire sequence of glacial deposits. Overall, drift is thinner in areas of ground moraine and thickens somewhat in end moraines. The drift overall thins toward the northwest and southwest corners (ODNR, Division of Geological Survey, Open File Bedrock Topography and ODNR, Division of Water, Glacial State Aquifer Map). The thickest drift is located in the east central portion of the county.

Till is an unsorted, non-stratified (non-bedded), mixture of sand, gravel, silt, and clay deposited directly by the ice sheet. There are two main types or facies of glacial till. Lodgement till is "plastered-down" or "bulldozed" at the base of an actively moving ice sheet. Lodgement till tends to be relatively dense and compacted and pebbles typically are angular, broken, and have a preferred direction or orientation. "Hardpan" and "boulder-clay" are two common terms used for lodgement till. Ablation or "melt-out" till occurs as the ice sheet melts or stagnates away. Debris bands are laid down or stacked as the ice between the bands melts. Ablation till tends to be less dense, less compacted, and slightly coarser as meltwater commonly washes away some of the fine silt and clay. There is evidence that some of the tills were deposited in a water-rich environment in Wyandot County. These types of tills would be deposited when a relatively thin ice sheet would alternately float and ground depending on the water level of the lake and thickness of the ice sheet. Such tills may more closely resemble lacustrine deposits.

Till has relatively low inherent permeability. Permeability in till is in part dependent upon the primary porosity of the till, which reflects how fine-textured the particular till is. Vertical permeability in till is controlled largely by factors influencing the secondary porosity such as fractures (joints), worm burrows, root channels, sand seams, etc. (Brockman and Szabo, 2000 and Haefner, 2000). Of importance in the end moraines of Wyandot County is the somewhat higher proportion of sand and gravel units interbedded in the till. These units may overlap enough (“stack”) to help aid in permeability. Fractures may also interconnect the sand and gravel lenses.

At the land surface, till accounts for two primary landforms: ground moraine and end moraine. Ground moraine (till plain) is relatively flat to gently rolling. End moraines are ridge-like, with terrain that is steeper and more rolling or hummocky. End moraines commonly serve as a local drainage divide due to their ridge-like nature. The Fort Wayne Moraine extends roughly in an east-west line across southern Wyandot County before turning sharply northeastward from Harpster toward Deunquat. The Wabash End Moraine occupies the southeastern corner of Wyandot County.

Alluvial deposits are sediments deposited near the floodplain or channel of rivers and streams. As modern streams downcut, the older, now higher elevation remnants of the original valley floor are called terraces. Terraces in Wyandot County tend to be at elevations just above the current floodplain. Alluvium will vary in nature from fine sand to silty-sand to clayey silt. In Wyandot County, coarser alluvium is more common in the larger streams and finer alluvium is more common in the smaller tributaries or headwaters of streams. The largest terraces overall are associated with the Sandusky River in central Wyandot County.

Kames and eskers are ice contact features. They are composed of masses of generally poorly sorted sand and gravel with minor till, deposited in depressions, holes, tunnels, or other cavities in the ice. As the surrounding ice melts, a mound of sediment remains behind. Typically, these deposits may collapse or flow as the surrounding ice melts. These deposits may display high angle, distorted or tilted beds, faults, and folds. Two narrow, elongate eskers are present in eastern Wyandot County. The one esker is located along the border of Crane and Eden Townships, and the second esker is almost directly due south in Pitt

Township. Sand and gravel pits located in both eskers are indicative of the coarse nature of these deposits.

Wyandot County contains abundant kettles. Melting blocks of ice formed these small, circular to elongate depressional features. As the ice block melted, it left behind a hole or low area surrounded by either till or outwash. Kettles may also reflect lows or "swales" in an end moraine which are flanked by highs or "swells". Larger kettles are found in the northwestern part of the county. Abundant, smaller kettles are located in central Wyandot County. Kettles commonly contain standing water. The water may reflect the local water table conditions or may collect and perch local runoff. Kettles also contain peat and muck. Peat and muck are organic-rich deposits associated with low-lying depression areas, bogs, kettles, and swamps. Muck is dense, fine silt with a high content of organics and a dark black color. Peat is typically brownish and contains pieces of plant fibers, decaying wood, and mosses. The two deposits commonly occur together; the *Soil Survey of Wyandot County* (Steiger and Hendershot, 1982) shows numerous organic deposits that have filled kettles. The kettles are typically underlain by either highly permeable sand and gravel or by low permeability lacustrine silt and clay or till.

Lacustrine deposits are composed of silty to clayey material. These lakes are referred to as intermorainal lakes as they occupy low areas of ground moraine between end moraines. The lakes tend to become somewhat finer-grained near the center of the deposit or lake (House, 1985 and Russell, 2002). Lacustrine deposits tend to be laminated (or varved) and contain various proportions of silts and clays. Thin layers of fine sand may reflect storm or flood events. Permeability is preferentially horizontal due to the laminations and water-laid nature of these sediments. The inherent vertical permeability is slow; however, secondary porosity features such as fractures, joints, root channels, etc. help increase the vertical permeability. Thin layers of sand typically occupy the margins of the lakes. These sands may reflect minor deltas that started to prograde into the lake, or they may mark the rough beginnings of a shoreline.

The thickness of the lacustrine deposits varies throughout the county. In some areas, lacustrine clays and silts or fine sands may accumulate up to 20 feet (House, 1985). Along the margins of these lakes, till is commonly found at the land surface. In these areas, minor wave action may have eroded away any lacustrine sediment and exposed the till. Some of these lakes may have been very short-lived and lacustrine deposits may not have had time to adequately accumulate. Another possibility is that thin lacustrine deposits have slowly been lost over time due to soil erosion and farming activities, leaving the underlying till exposed at the surface.

House (1985) identified four main lakes in Wyandot County. Glacial Lake Killdeer occupied much of southern Wyandot County. Glacial Lake Wharton covered large portions of central Wyandot County. Over time, Glacial Lake Vanlue and Glacial Lake Carey overlapped and occupied north central Wyandot County.

The lakes were created during the recession of the ice sheets. Meltwater was trapped between the receding ice sheet and end moraines. In some areas, meltwater may have been trapped between two end moraines forming a lake. Additional ponding may have resulted from northerly-flowing, run-off fed streams that were blocked by the ice sheets. Run-off in general helped to fill these ponds. Eventually, some of these ponds may have overflowed their margins and began to cut an outlet. House (1985) and Russell (2002) theorized that as one lake overflowed, it would progressively cause the next lower elevation lake to overflow. Alternatively, the headwaters of emerging streams may have cutback and created an outlet for the lakes. As the modern drainage system slowly developed, streams downcut through the series of end moraines, draining the lakes over time. Swampy bog and kettle areas replaced many of the lakes. Many of these features persist to today or were recently drained for agriculture.

Bedrock Geology

Bedrock underlying the surface of Wyandot County belongs to the Silurian and Devonian Systems. Carbonate (limestone and dolomite) bedrock underlies the entire county. Table 9 summarizes the bedrock stratigraphy found in Wyandot County. The ODNR, Division of Geological Survey has Open-File Reconnaissance Bedrock Geological Maps completed at a 1:24,000 scale on USGS topographic map bases available for the entire county. The ODNR, Division of Water has Open File Bedrock State Aquifer maps available for the county also.

The uppermost carbonate units are the fossiliferous Devonian Columbus and Delaware Limestones. These rocks were deposited in warm, high-energy seas and reef areas. These units are limited to the extreme eastern edge of Wyandot County.

Underlying the Columbus and Delaware Limestones is the Salina Undifferentiated Group, which consists of dolomites, fine-grained limestones, and some minor evaporite deposits such as gypsum. These rocks were deposited in warm, shallow tidal areas. Units of the Salina Undifferentiated Group are encountered in the eastern portion of Wyandot County. They are the uppermost units in areas of eastern Wyandot County where the Devonian Columbus and Delaware Limestones are absent.

Underlying the Salina Undifferentiated Group are rocks of the Silurian Tymochtee and Greenfield Formations, which were also deposited in warm, shallow seas. The Tymochtee and Greenfield Formations are found across most of Wyandot County. They are the uppermost units in much of the central and western parts of the county.

The oldest unit typically encountered by water wells is the Silurian Lockport Group. Rocks of the Lockport are commonly found in the subsurface in eastern and central Wyandot County, and are the uppermost bedrock unit in some areas of western Wyandot County. The Lockport Group rocks were associated with tidal reefs deposited in warm, high-energy shallow seas.

Table 9. Bedrock stratigraphy of Wyandot County

System	Group/Formation (Symbol)	Lithologic Description
Devonian	Delaware and Columbus Limestones (Ddc)	The Delaware is a gray to brown thin-bedded to massive, argillaceous, carbonaceous limestone. The Columbus is a gray to brown, fossiliferous, massive-bedded limestone and dolomite. Karst features are common in the Columbus. In Wyandot County, these units are <100 feet in thickness. Yields are usually 5-100 gpm. These units are limited to the eastern edge of the county.
Silurian	Undifferentiated Salina Dolomite (Sus)	Gray to brown, thin-bedded, argillaceous dolomite. Thin evaporite zones common. Thickness >100 feet along the eastern edge of the county. This formation thins markedly westward in the county. Yields may exceed 100 gpm when fractures or solution features are encountered.
	Tymochtee and Greenfield Dolomites (Stg)	Thin- to massive-bedded, olive-gray to yellowish-brown. The Tymochtee contains shale partings. The Greenfield has a laminated dolomite lithology. Combined thickness exceeds 100 feet in eastern and central Wyandot County. Thickness decreases towards the western part of the county. Yields can be >100 gpm, especially in the Tymochtee.
	Lockport Dolomite (Sl)	White to medium gray, medium to massive-bedded dolomite. Commonly contains cavernous solution zones. Thickness >100 feet across Wyandot County. Yields can exceed 100 gpm, especially in cavernous or solution zones.

Ground Water Resources

Ground water in Wyandot County is obtained primarily from consolidated (bedrock) aquifers. A very limited number of wells are completed in unconsolidated (glacial) aquifers. The glacial aquifers are limited to thin lenses of sand and gravel interbedded with till. Such deposits are limited to the northern and western fringes of the county. Shallow sand and gravel wells may also be found in areas associated with end moraines and the two eskers (ice-contact features). Sand and gravel aquifers are commonly associated with end moraine deposits. Yields from these sand and gravel lenses are from 5 to 25 gpm, and are suitable for limited domestic and small farm usage. In some areas of the county, a thin layer of sand and gravel directly overlies the limestone bedrock. Wells may be completed just into the underlying limestone to take advantage of the extra recharge provided by the sand and gravel.

The carbonate aquifer is an important regional aquifer for most of northwestern and north central Ohio and underlies all of Wyandot County (ODNR, Div. of Water, 1970, ODNR, Division of Water, Bedrock State Aquifer Map, 2000, and Schmidt, 1983). Completed water wells typically penetrate multiple bedrock units. Yields for the Devonian Columbus and Delaware Limestones vary from 5-25 gpm (ODNR, Div. of Water, Open File, Bedrock State Aquifer Map, 2000, ODNR, Div. of Water, 1970, and Schmidt, 1983) due to the thin nature of these formations along the eastern edge of Wyandot County. Yields exceeding 100 gpm are available from deep, large diameter wells drilled into the Silurian Salina Undifferentiated Group in eastern Wyandot County; these yields decrease to the west as this unit thins. Yields exceeding 100 gpm are available from deep, large diameter wells drilled into the Silurian Tymochtee and Greenfield Dolomites in eastern Wyandot County; the yields decrease to the west as these units thin. Yields exceeding 100 gpm are possible from the Silurian Lockport Dolomite throughout most of the county (ODNR, Div. of Water, Open File, Bedrock State Aquifer Map, 2000, ODNR, Div. of Water, 1970, and Schmidt, 1983). Maximum yields of 25 to 100 gpm are available from the Silurian Lockport Dolomite in isolated areas of southwestern and northwestern Wyandot County. In these areas, the Silurian Lockport Dolomite is the uppermost unit and is not quite as productive (ODNR, Div. of Water, Open File, Bedrock State Aquifer Map, 2000 and Schmidt, 1983). The amount of fracturing, solution, and vuggy (porous) zones has great local importance. Deeper wells are more likely to contain highly mineralized water and have objectionable water quality.

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APPENDIX A
DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

This factor was primarily evaluated using information from water well log records on file at the Ohio Department of Natural Resources (ODNR), Division of Water, Water Resources Section (WRS). Approximately 3,700 water well log records are on file for Wyandot County. Data from roughly 1,300 located water well log records were analyzed and plotted on U.S.G.S. 7-1/2 minute topographic maps during the course of the project. Static water levels and information as to the depths at which water was encountered were taken from these records. The *Ground Water Resources of Wyandot County* (Schmidt, 1983) provided generalized depth to water information throughout the county. Depth to water trends mapped in adjoining Seneca County (Smith and Voytek, 1994), Hancock County (Smith, 1994), Crawford County (Angle and Russell, 2003), and Marion County (Angle, 2003) were used as a guideline. Topographic and geomorphic trends were utilized in areas where other sources of data were lacking.

A depth to water of 0 to 5 feet (DRASTIC rating of 10) was used for a limited floodplain area in south central Wyandot County. Depths of 5 to 15 feet (9) were selected for most of the alluvial settings, intermorainal lakes and areas with shallow limestone bedrock. Depths of 15 to 30 feet (7) were used for alluvial settings in the eastern part of the county and for some of the more subdued end moraines. Depths of 15 to 30 feet (7) were also utilized for most areas of ground moraine and some areas of intermorainal lakes. Depths of 30 to 50 feet (5) were utilized for some areas of ground moraine, most areas of end moraine, and some areas of intermorainal lakes. Depths to water of 50 to 75 feet (3) were used for some higher elevation areas of end moraine and for some areas with deeper limestone aquifers.

Net Recharge

Net recharge is the precipitation that reaches the aquifer after evapotranspiration and run-off. This factor was evaluated using many criteria, including depth to water, topography, soil type, surface drainage, vadose zone material, aquifer type, and annual precipitation. General estimates of recharge provided by Pettyjohn and Henning (1979) and Dumouchelle and Schiefer (2002) proved to be helpful. Recharge ratings from adjoining Seneca County (Smith and Voytek, 1994), Hancock County (Smith, 1994), Crawford County (Angle and Russell, 2003), and Marion County (Angle, 2003) were used as a guideline.

Values of 7 to 10 inches per year (8) were used for areas of moderately high recharge. These areas were limited to areas where fractured limestone was very close to the ground surface in northern Wyandot County. Values of 4 to 7 inches per year (6) were used for areas with moderate recharge. These areas include all of the alluvial settings in the county and all of the end moraines. Values of 4 to 7 inches per year (6) were also used for areas with sand and gravel aquifers for the 7Af-Sand and Gravel Interbedded in Glacial Till setting, for the

7Bc-Outwash over Limestone setting, for areas of the 7Gb-Thin Glacial Till over limestone with a moderate thickness of till, and most alluvial settings. Values of 2 to 4 inches per year (3) were utilized for areas with moderately low recharge associated with ground moraine, intermorainal lakes and for deeper bedrock aquifers.

Aquifer Media

Information on evaluating aquifer media was obtained from the *Ground Water Resources of Wyandot County* (Schmidt, 1983). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps, based upon U.S.G.S. 7-1/2 minute topographic maps from the ODNR, Division of Geological Survey proved helpful. Aquifer ratings from neighboring Seneca County (Smith and Voytek, 1994), Hancock County (Smith, 1994), Crawford County (Angle and Russell, 2003), and Marion County (Angle, 2003) were used as a guideline. The ODNR, Division of Water, Glacial State Aquifer Map and Bedrock State Aquifer Map were an important source of aquifer data. Water quality studies in the vicinity of Lime Ridge and Carey (Stein, 1966 and Richards, 1992) provided background information on the carbonate aquifers. Water well log records on file at the ODNR, Division of Water, were the primary source of aquifer information.

All of the bedrock and interbedded lenses of sand and gravel are semi-confined or leaky; however for the purposes of DRASTIC, they have been evaluated as being unconfined (Aller et al., 1987). A limited number of areas along the border of Seneca County were evaluated as having karst limestone for an aquifer and given an aquifer rating of (9). These rocks were evaluated as having some solution features and higher secondary porosity (Smith and Voytek, 1994). Relatively thin glacial drift in the vicinity may have contributed to the solution in the limestone. Massive limestone was evaluated as the aquifer and given a rating of (7) for the Silurian and Devonian carbonates throughout the remainder of Wyandot County.

Sand and gravel aquifers were given a rating of (8) for a limited area in the northeastern part of the county where a stream had downcut into the sand and gravel aquifer. Sand and gravel aquifers elsewhere in northern and western Wyandot County were assigned a rating of (7), (6) or (5) depending upon how clean, coarse and thick the deposits were.

Soils

Soils were mapped using the data obtained from the *Soil Survey of Wyandot County* (Steiger and Hendershot, 1982). Each soil type was evaluated and given a rating for soil media. Evaluations were based upon the texture, permeability, and shrink-swell potential for each soil material. Special emphasis is placed upon determining the most restrictive layer. The soils of Wyandot County showed a high degree of variability. This is a reflection of the parent material. Table 10 is a list of the soils, parent materials, setting, and corresponding DRASTIC values for Wyandot County.

Table 10. Wyandot County soils

Soil Name	Parent Material/ Setting	DRASTIC Rating	Soil Media
Belmore	Beach ridge, outwash	6	Sandy loam
Bennington	Clayey till	3	Clay loam
Blount	Loamy till	3	Clay loam
Bono	Lacustrine	7	Shrink-swell clay
Cardington	Clayey till	3	Clay loam
Carlisle	Kettle, bogs	8	Peat
Chagrin	Alluvium, floodplain	4	Silt loam
Colwood	Deltaic, shoreline	6	Sandy loam
Del Rey	Lacustrine	3	Clay loam
Digby	Outwash, shoreline, deltaic	5	Loam
Elliot	Clayey till	3	Clay loam
Fitchville	Deltaic, lacustrine	4	Silt loam
Fulton	Clayey lacustrine	7	Shrink-swell clay
Genesee	Alluvial, floodplain	4	Silt loam
Glenford	Silty lacustrine, deltaic	4	Silt loam
Glynwood	Loamy till	3	Clay loam
Haney	Outwash, shoreline	6	Sandy loam
Haskins	Thin sand over till, ablation	3	Clay loam
Kibbie	Outwash, kame	6	Sandy loam
Kibbie-Blount	Thin sand over till	3	Clay loam
Latty	Clayey lacustrine	7	Shrink-swell clay
Lindside	Coarse alluvium	5	Loam
Luray	Lacustrine	3	Clay loam
Lykens	Lacustrine	3	Clay loam
Lykens-Milton	Lacustrine over clayey till	3	Clay loam
Martinsville	Shoreline	6	Sandy loam
Medway	Alluvium	4	Silt loam
Mermil	Outwash/beach over till/lacustrine	3	Clay loam
Milford	Lacustrine depressions, lows	3	Clay loam
Milgrove	Lacustrine depressions, lows	3	Clay loam
Millsdale	Thin to limestone	10	Thin or absent
Milton	Thin to limestone	10	Thin or absent
Morley	Clayey till	3	Clay loam
Nappanee	Wave-planed till	3	Clay loam
Olentangy	Depressions, lacustrine	2	Muck
Oshtemo	Outwash, coarse alluvium, deltaic	6	Sandy loam
Pandora	Till, depressions on moraines	3	Clay loam
Paulding	Clayey lacustrine	7	Shrink-swell clay
Pewamo	Clayey till	3	Clay loam
Randolph	Thin to limestone	7	Shrink-swell clay
Ritchey	Thin to limestone	10	Thin or absent
Shinrock	Lacustrine, fine deltaic	4	Silt loam
Shinrock-Martinsville	Fine lacustrine over sand	6	Sandy loam
Shoals	Alluvium, floodplain	4	Silt loam
Sloan	Alluvium, floodplain	4	Silt loam
Tiro	Lacustrine over till, ablation	3	Clay loam
Tuscola	Shoreline, beach	6	Sandy loam

Soils were evaluated as thin or absent (10) for limited areas in northwestern Wyandot County where limestone bedrock was at or within a few feet of the ground surface. Shrink-swell (aggregated) clay was selected as the soil media in areas of some very high-clay lacustrine deposits associated with the intermorainal lakes. Shrink-swell clay (7) was also used for a limited number of areas in northwestern Wyandot County where thin, clayey residuum overlies limestone bedrock that is close to the ground surface. Soils were considered to be sandy loam (6) or loam (5) for areas of relatively sandy shoreline or deltaic deposits associated with the intermorainal lakes or for coarser-grained alluvial terraces flanking the major rivers. Silt loams (4) were designated for alluvial and floodplain deposits as well as for silty lacustrine and deltaic deposits associated with the intermorainal lakes. Clay loam (3) soils were evaluated for the majority of the county including till overlying ground moraine and end moraine and moderately clayey lacustrine deposits associated with the intermorainal lakes. For the purposes of determining the hydrogeologic setting, clay loam soils were differentiated as to whether they overly ground moraine versus intermorainal lakes. Muck (2) and peat (8) were evaluated for soils associated with some kettles and depressions.

Topography

Topography, or percent slope, was evaluated using U.S.G.S. 7-1/2 minute quadrangle maps and the *Soil Survey of Wyandot County* (Steiger and Hendershot, 1982). Slopes of 0 to 2 percent (10) were selected for intermorainal lakes, alluvial, and most ground moraine settings in Wyandot County. Slopes of 2 to 6 percent (9) were assigned to most end moraines exhibiting hummocky terrain. Slopes of 6 to 12 percent (5) were selected for limited areas where modern rivers had steeply downcut surrounding terrain or in areas of past erosion.

Impact of the Vadose Zone Media

Information on evaluating vadose zone media was obtained from the *Ground Water Resources of Wyandot County* (Schmidt, 1983). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps, based upon U.S.G.S. 7-1/2 minute topographic maps from the ODNR, Division of Geological Survey proved helpful. Vadose zone media ratings from neighboring Seneca County (Smith and Voytek, 1994), Hancock County (Smith, 1994), Crawford County (Angle and Russell, 2003), and Marion County (Angle, 2003) were used as a guideline. The ODNR, Division of Water, Glacial State Aquifer Map and Bedrock State Aquifer Map were an important source of vadose zone media data. The *Soil Survey of Wyandot County* (Steiger and Hendershot, 1982) provided valuable information on parent materials. The *Glacial Map of Ohio* and *Quaternary Geology of Ohio* (Goldthwait et al., 1961 and Pavey et al., 1999) were useful in delineating vadose zone media. The *Pleistocene Geology of Wyandot County, Ohio* (House, 1985) proved to be valuable for determining vadose zone media through the county. Water well log records on file at the ODNR, Division of Water, were the primary source of aquifer information.

The vadose zone media is a critical component of the overall DRASTIC rating in Wyandot County. The rating varies with the restrictive properties of the various glacial materials. The higher the proportion of silt and clay and the greater the compaction (density) of the sediments, the lower the permeability and the lower the vadose zone media are rated. Where the glacial drift was thin and limestone bedrock was close to the surface, limestone was determined to be the vadose zone media. Karst limestone was given a vadose zone media rating of (8) due to the occurrence of solution features. Limestone was given a vadose zone media rating of (6) or (7) depending upon how close the limestone was to the ground surface and how weathered and fractured the limestone was.

Sand and gravel was assigned vadose zone media ratings of (7) and were utilized for limited areas of eskers containing thick sequences of sand and gravel. Sand and gravel with vadose zone media ratings of (6) or (5) were selected depending upon the degree of sorting and how clean and coarse these deposits were. Typically, these coarse-grained materials were associated with near surface shoreline, beach, and terrace deposits. Sand and gravel with silt and clay was assigned a vadose zone media rating of (7) for the 7Bc-Outwash over Limestone setting that consists of sand and gravel rich eskers capped by till. Sand and gravel with silt and clay was given a vadose zone media rating of (8) or (6) for a limited number of streams in the county that had downcut into a relatively thick sequence of sand and gravel underlying finer alluvium. Sand and gravel with silt and clay was assigned a vadose zone media rating of (5) for alluvial settings associated with major streams including the Sandusky River and Tymochtee Creek. Sand and gravel with silt and clay was also assigned a vadose zone media rating of (5) for areas of till bordering portions of Seneca County (Smith and Voytek, 1994) and Hancock County (Smith, 1994). Till was not evaluated as a separate vadose zone media material for these counties at the time they were mapped, and sand and gravel with silt and clay was utilized for these areas.

Till with a vadose zone media rating of (5) was selected for most areas of ground moraine and end moraine. Till with a vadose zone media rating of (4) was assigned to the fine-grained till deposits associated with the 7Fd-Wave-eroded Lake Plain setting. Till with a vadose zone media rating of (4) was also utilized for some fine-grained tills along the Crawford County boundary. Silt and clay with vadose zone media ratings of (4) or (5) were applied to areas occupied by intermorainal lakes and areas of alluvial settings. Silt and clay with a rating of (3) was selected for areas of fine-grained lacustrine sediments that had weathered into shrink-swell clay soils. Silt and clay with a vadose zone media rating of (2) was utilized for very fine sediments that had accumulated in kettles and other depression areas.

Hydraulic Conductivity

Information on evaluating the hydraulic conductivity was obtained from the maps and report of the ODNR, Div. of Water, (1970) and the *Ground Water Resources of Wyandot County* (Schmidt, 1983). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps, based upon U.S.G.S. 7-1/2 minute topographic maps from the ODNR, Division of Geological Survey proved helpful. Hydraulic conductivity ratings from neighboring Seneca County (Smith and Voytek, 1994), Hancock County (Smith, 1994), Crawford County (Angle and Russell, 2003), and Marion County (Angle, 2003) were used as a guideline. The ODNR, Division of Water, Glacial State Aquifer Map and Bedrock State Aquifer Map were an important source of hydraulic conductivity data. Water well log records on file at the ODNR, Division of Water, were the primary source of aquifer information. Textbook tables (Freeze and Cherry, 1979, Fetter, 1980, and Driscoll, 1986) were useful in obtaining estimated values for hydraulic conductivity in a variety of sediments.

Values for hydraulic conductivity correspond to aquifer ratings; i.e., the more highly rated aquifers have higher values for hydraulic conductivity. Karst limestone was given a range of hydraulic conductivity of 1,000 to 2,000 gallons per day per square foot (gpd/ft^2) (8) due to the presence of large solution features. Limestone aquifers were assigned a range of hydraulic conductivity of 300 to 700 gpd/ft^2 (4) for the vast majority of Wyandot County. Limestone along the boundary of Seneca County were given a range of hydraulic conductivity of 100 to 300 gpd/ft^2 due to a number of low-yielding wells completed in the limestone in this area.

Sand and gravel aquifers have been given a hydraulic conductivity rating of 300-700 gpd/ft^2 (4) throughout most of Wyandot County. Sand and gravel aquifers were assigned a hydraulic conductivity range of 100-300 gpd/ft^2 (2) for sand and gravel aquifers bordering Seneca County. These ratings reflect a number of low-yielding wells completed in sand and gravel in this area.

APPENDIX B

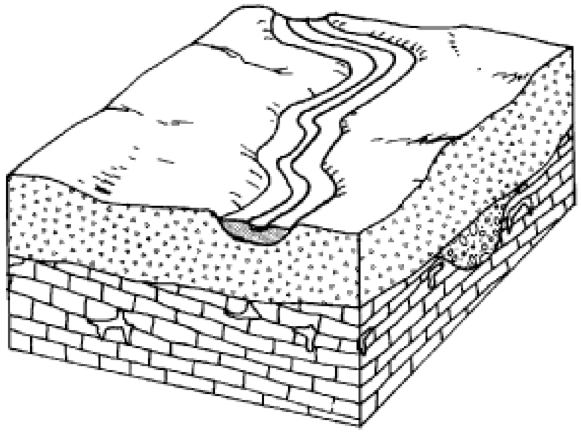
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

Ground water pollution potential mapping in Wyandot County resulted in the identification of ten hydrogeologic settings within the Glaciated Central Region. The list of these settings, the range of pollution potential index calculations, and the number of index calculations for each setting are provided in Table 11. Computed pollution potential indexes for Wyandot County range from 95 to 175.

Table 11. Hydrogeologic settings mapped in Wyandot County, Ohio

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7 Ac-Glacial till over solution limestone	96-168	33
7Af-Sand and gravel interbedded in glacial till	106-144	21
7Bc-Outwash over Limestone	118-135	6
7 C-Moraine	112-135	9
7 Ec-Alluvium over sedimentary rock	120-164	13
7 Ed-Alluvium over glacial till	155	1
7 Fc-Intermorainal lake deposits	95-129	25
7Fd-Wave-eroded Lake Plain	105-126	6
7Gb-Thin Till over Limestone	132-175	33
7I-Marshes and Swamp	108-138	4

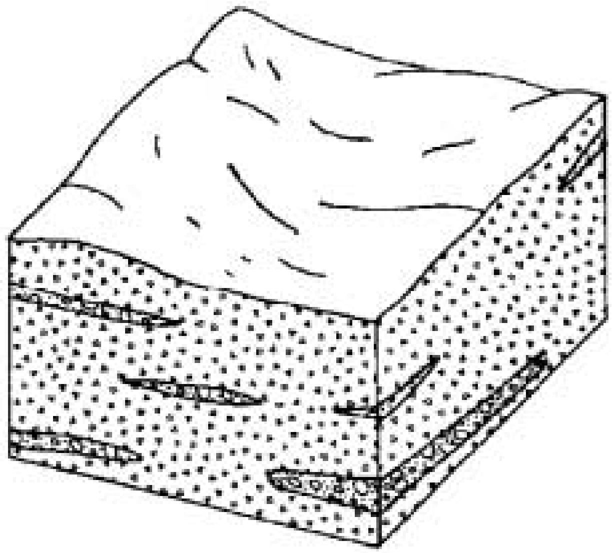
The following information provides a description of each hydrogeologic setting identified in the county, a block diagram illustrating the characteristics of the setting, and a listing of the charts for each unique combination of pollution potential indexes calculated for each setting. The charts provide information on how the ground water pollution potential index was derived and are a quick and easy reference for the accompanying ground water pollution potential map. A complete discussion of the rating and evaluation of each factor in the hydrogeologic settings is provided in Appendix A, Description of the Logic in Factor Selection.



7Ac-Glacial Till over Solution Limestone

This hydrogeologic setting is common in Wyandot County. It consists of fairly wide areas of ground moraine. The setting is characterized by flat-lying topography and low relief. The vadose zone consists primarily of silty to clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. The aquifer is composed of fractured Silurian and/or Devonian limestones and dolomites. These carbonate rocks may contain significant karst solution features in the northern part of the county. Depth to water is typically moderate, ranging from 20 to 50 feet. Soils are typically clay loams derived from till. Maximum ground water yields greater than 100 gpm are possible from the Silurian Lockport, Tymochtee, Greenfield and Salina Groups. Yields range from 5 to 100 gpm for the Devonian carbonate units. Recharge is moderately low due to clayey nature of the soils and vadose zone.

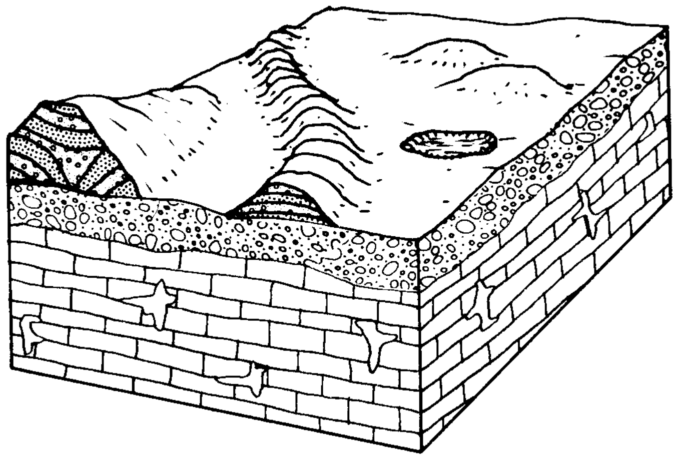
GWPP index values for the hydrogeologic setting of Glacial Till over Solution Limestone range from 96 to 168, with the total number of GWPP index calculations equaling 33.



7Af-Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is found along the western and northern fringe of Wyandot County. The area is characterized by flat lying to slightly rolling topography. The setting is commonly associated with areas of ground moraine. The vadose zone is composed of silty to clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. Depth to water is usually shallow, averaging less than 30 feet. Soils are generally clay loams. The aquifer consists of thin lenses of sand and gravel interbedded in the glacial till. Ground water yields range from 5 to 25 gpm. Recharge is moderate due to the relatively low permeability of the clayey soils and vadose and the overall shallow depth of the aquifers.

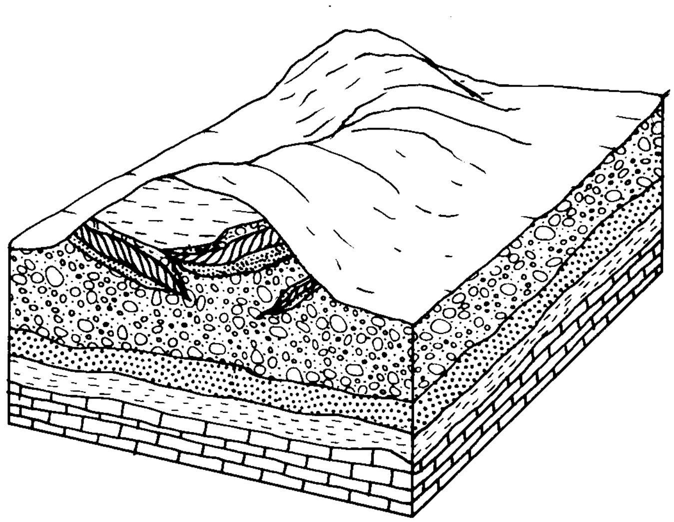
GWPP index values for the hydrogeologic setting of Sand and Gravel Interbedded in Glacial Till range from 106 to 144, with the total number of GWPP index calculations equaling 21.



7Bc Outwash over Limestone

This hydrogeologic setting is limited to east central Wyandot County where low eskers capped by sandy till overlie the limestone bedrock. Topography is hummocky to gently rolling. The sand and gravel is too thin to comprise the aquifer; therefore, ground water is obtained from the underlying limestone bedrock. Sand and gravel with silt and clay composes the vadose zone. Precipitation moving through the drift recharges the bedrock. Yields up to 100 gpm may be obtained from the underlying limestone. The number of fractures and solution features encountered within the limestone help to determine the yield. Depth to water is generally moderate, averaging 40 to 50 feet. Soils are usually clay loams derived from the weathered till capping the eskers. Recharge is moderate due to the permeable soils and vadose and the moderate depth to water.

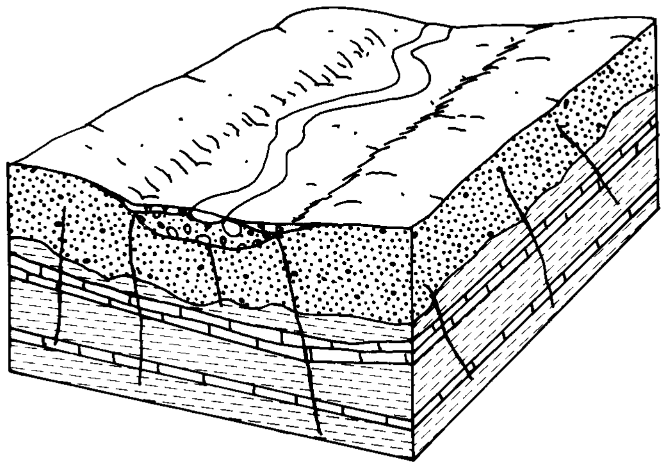
The GWPP index values for the hydrogeologic setting Outwash over Limestone range from 118 to 135, with the total number of calculations equaling 6.



7C-Moraine

This hydrogeologic setting consists of two broad belts of end moraines that extend across southern and eastern Wyandot County. This setting is characterized by hummocky to rolling topography. Relief tends to become steeper near the margins of the moraine, especially if enhanced by the downcutting of an adjacent stream. The majority of wells are completed in the underlying productive Silurian limestones and dolomites. Yields over 100 gpm are possible from large diameter wells completed in these bedrock units. Wells also may be completed in relatively thin sand and gravel lenses interbedded with glacial till within the moraine. These sand and gravel deposits differ as to lateral extent and thickness and are found at variable depths. Yields range from the 5 to 25 gpm. The vadose zone is composed of loamy to clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. Depth to water is variable and depends primarily upon how deep the underlying aquifer is. Soils are commonly clay loams. Recharge is moderately high due to the proximity of sand and gravel lenses to the surface and the amount of weathering and fracturing in the till. The end moraines are the primary local sources of recharge.

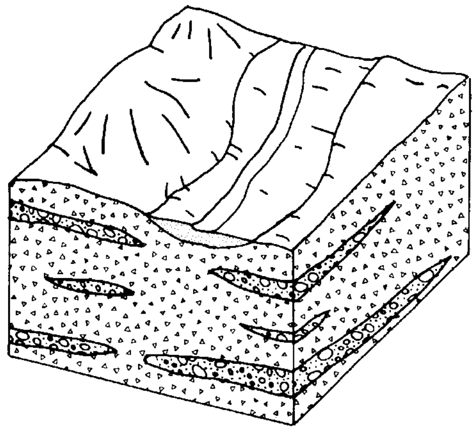
GWPP index values for the hydrogeologic setting of Moraine range from 112 to 135, with the total number of GWPP index calculations equaling 9.



7Ec-Alluvium over Sedimentary Rock

This hydrogeologic setting is common throughout Wyandot County. This hydrogeologic setting is comprised of flat-lying floodplains and stream terraces containing thin to moderate thicknesses of modern alluvium. The vadose zone consists of the silty to clayey alluvial deposits. Some of these deposits may also contain fine sand. Depth to water is commonly very shallow, averaging less than 20 feet. The alluvium typically overlies thin till or lacustrine deposits that in turn overlie the bedrock. Yields over 100 gpm are possible from large diameter wells completed in the underlying Silurian limestone and dolomite bedrock. Soils on the floodplain are typically silt loams derived from the alluvium. Recharge is typically moderately high due to the flat-lying topography, shallow depth to water, and the moderate permeability of the soils.

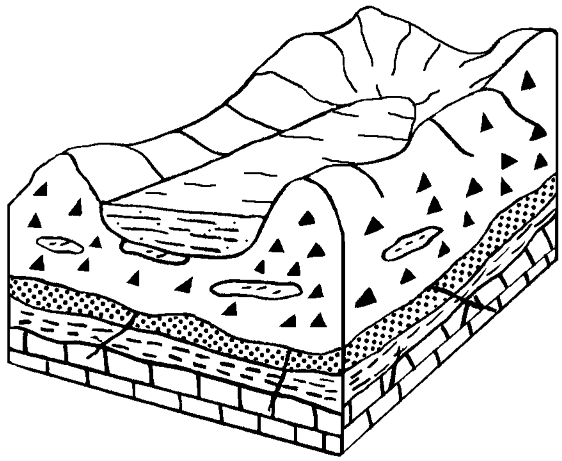
The GWPP index values for the hydrogeologic setting Alluvium over Sedimentary Rocks range from 120 to 164, with the total number of GWPP index calculations equaling 13.



7Ed-Alluvium Over Glacial Till

This hydrogeologic setting is comprised of flat-lying floodplains and stream terraces containing thin to moderate thicknesses of modern alluvium. The occurrence of this setting is limited to the northeastern corner of the county. This setting is similar to the 7Af–Sand and Gravel interbedded in Glacial Till setting except for the presence of the modern stream and related deposits. The setting is also similar to the 7Ec-Alluvium over Sedimentary Rock except that the underlying aquifer consists of shallow sand and gravel lenses instead of bedrock. The stream may or may not be in direct hydraulic connection with the underlying sand and gravel lenses, which constitute the aquifer. The surficial, silty alluvium is typically more permeable than the underlying till. The alluvium is too thin to be considered the aquifer. The vadose zone consists of the silty to clayey alluvial deposits. Soils are silt loams. Yields commonly range from 5 to 25 gpm from the sand and gravel lenses. Depth to water is typically shallow with depths averaging less than 20 feet. Recharge is moderately high due to the shallow depth to water, flat-lying topography, and the moderate permeability of the glacial till and alluvium.

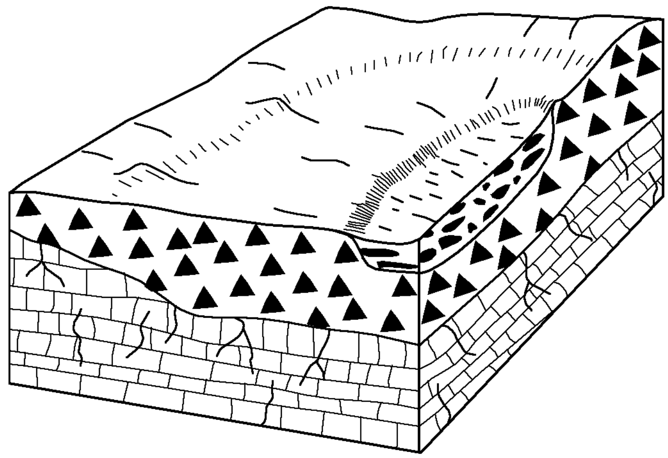
The GWPP index value for the hydrogeologic setting Alluvium Over Glacial Till is 155, with the total number of GWPP index calculations equaling 1.



7Fc-Intermorainal Lake Deposits

This hydrogeologic setting is characterized by flat-lying topography and varying thicknesses of fine-grained lacustrine sediments. Surficial drainage is typically very poor; ponding is very common after rains. These sediments were deposited in shallow lakes formed between end moraines and the retreating ice sheets before the modern drainage system evolved. This setting occupies many of the low-lying areas within central and eastern Wyandot County. The vadose zone media consists of silty to clayey lacustrine sediments that overlie glacial till. The aquifer consists of the underlying Silurian limestone and dolomite bedrock. Yields over 100 gpm are possible from large diameter wells completed in these formations. Depth to water is highly variable and is somewhat dependent upon the depth to the bedrock aquifer. Soils are highly variable ranging from clay loams and high shrink-swell clays derived from clayey lacustrine sediments to silt loams, loams, and sandy loams derived from thin, silty to fine sand deltaic and shoreline deposits bordering the lakes. Recharge in this setting is low due to the relatively low permeability of the soils and vadose and the depth to the bedrock aquifers.

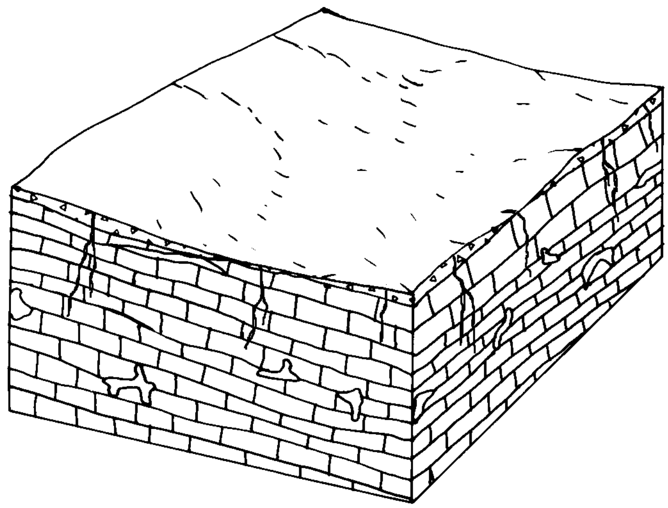
GWPP index values for the hydrogeologic setting of Intermorainal Lake Deposits range from 95 to 129, with the total number of GWPP index calculations equaling 25.



7Fd-Wave-eroded Lake Plain

This hydrogeologic setting is characterized by very flat-lying topography caused by wave-erosion occurring along the margins of the intermorainal lakes. The 7Fd setting is typically adjacent to the 7Fc-Intermorainal Lakes setting in central Wyandot County. The setting consists of wave-eroded, "water-modified" till. Any evidence for thin, fine-grained lacustrine sediments overlying the till has been eroded away over time. Surficial drainage is typically very poor; ponding is very common after rains. The vadose zone media consists of silty to clayey glacial till. The aquifer consists of the underlying limestone bedrock. Maximum ground water yields greater than 100 gpm are possible from the Silurian Lockport, Tymochtee, Greenfield and Salina Groups. Depth to water is commonly shallow. Soils are clay loams derived from the clayey till. Recharge in this setting is moderately low due to the relatively low permeability soils and vadose zone material and the relatively shallow depth to the water table and bedrock aquifer.

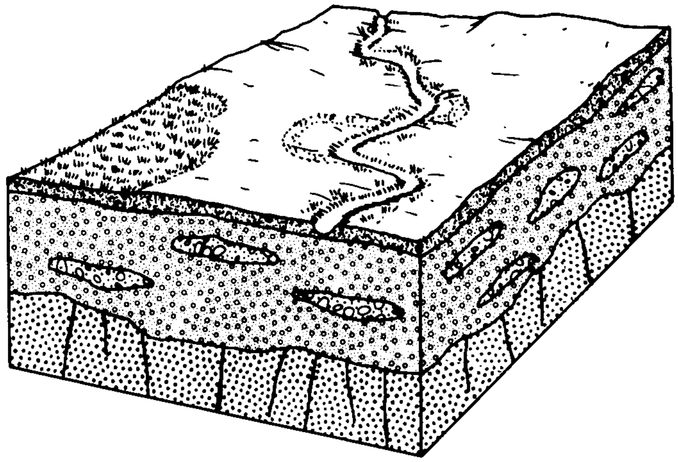
GWPP index values for the hydrogeologic setting of Intermorainal Lake Deposits range from 105 to 126, with the total number of GWPP index calculations equaling 6.



7Gb-Thin Glacial Till over Limestone

This hydrogeologic setting is limited to the northwest and southwest corners of Wyandot County. This setting is characterized by gently rolling to flat lying topography and deposits of thin, patchy glacial till overlying limestone bedrock. The till is usually less than 10 feet thick and consists of varying amounts of unsorted clay, silt, and sand with minor pebbles and cobbles. Ground water is obtained from the underlying, fractured Silurian limestone and dolomite. These carbonate rocks may contain significant karst solution features in the northern part of the county. Yields greater than 100 gpm are possible from the underlying bedrock. Depth to water is shallow to moderate, averaging less than 50 feet. Soils are highly variable and include high shrink-swell (aggregated) clays derived from weathered limestone and clay loams where the overlying till is a bit thicker. In some areas, soils are considered to be thin or absent, when limestone is less than 4 feet from the surface. Recharge is moderately high due to the close proximity of the limestone to the surface.

GWPP index values for the hydrogeologic setting of Thin Glacial Till over Limestone range from 132 to 175, with the total number of GWPP index calculations equaling 33.



7I-Marshes and Swamps

This hydrogeologic setting is characterized by extremely low topographic relief, high water table, poor drainage, and thin, organic-rich silt and clay deposits. This setting is limited to low, depressional areas flanked by coarser-grained deposits. In this setting, the soils and vadose zone media consist of thin peat and organic-rich silt and clay deposits that overlie silty to clayey lacustrine sediments. The aquifer is Silurian limestone and dolomite that can yield over 100 gpm from large diameter wells. Depth to water is very shallow due to the high water table. Recharge is moderate due to the shallow depth to water and moderately low permeability of the soils and vadose zone media.

GWPP index values for the hydrogeologic setting of Marshes and Swamps range from 108 to 138, with the total number of GWPP index calculations equaling 4.

Table 12. Hydrogeologic Settings, DRASTIC Factors, and Ratings

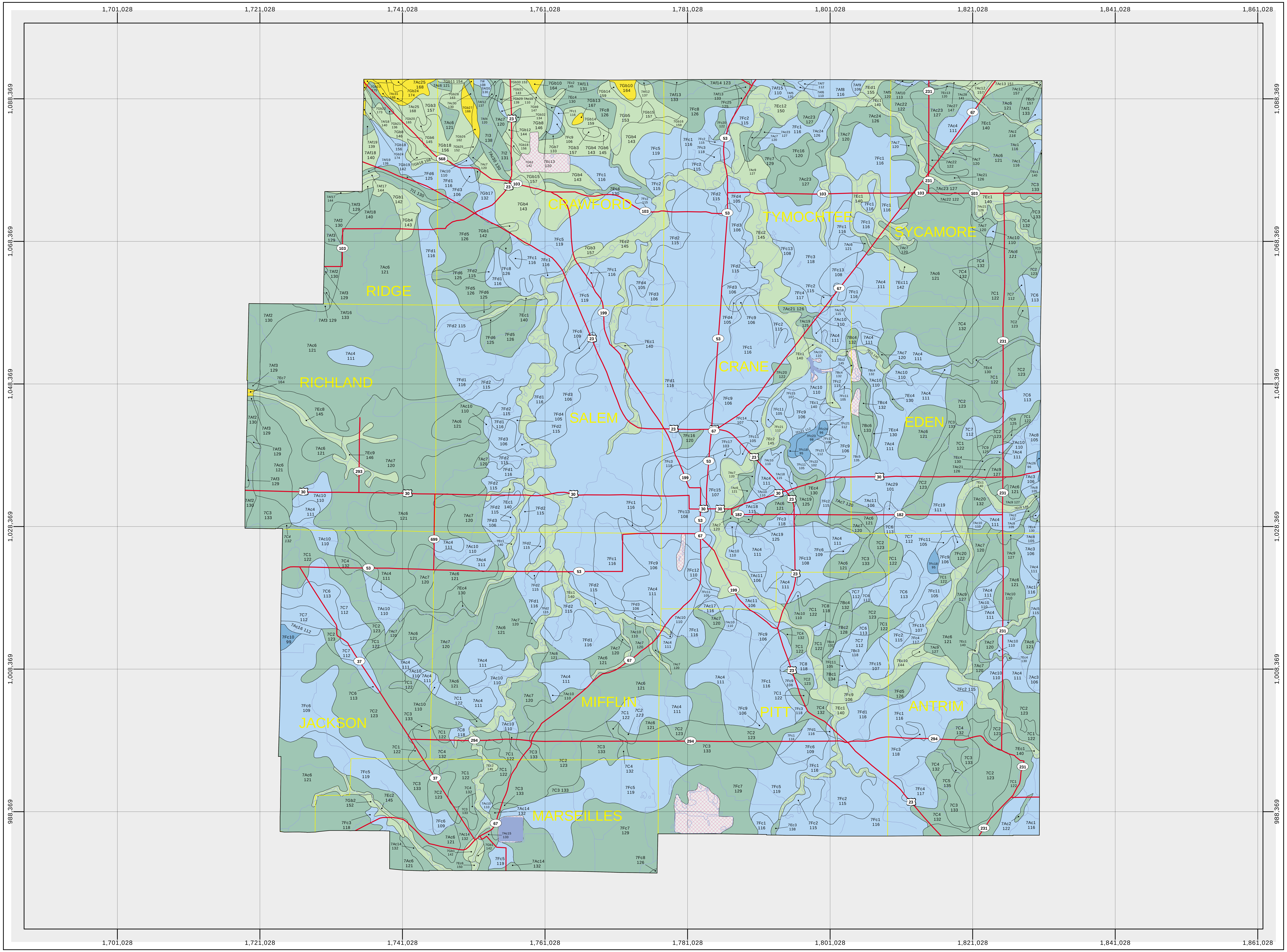
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating_
7Ac1	15-30	2-4	limestone	Clay Loam	0-2	till	300-700	116	137
7Ac2	15-30	2-4	limestone	Sandy Loam	0-2	till	300-700	122	152
7Ac3	30-50	2-4	limestone	Clay Loam	0-2	till	300-700	106	127
7Ac4	30-50	2-4	limestone	Clay Loam	0-2	till	300-700	111	131
7Ac5	15-30	2-4	limestone	Clay Loam	2-6	till	300-700	115	134
7Ac6	15-30	2-4	limestone	Clay Loam	0-2	till	300-700	121	141
7Ac7	15-30	2-4	limestone	Clay Loam	2-6	till	300-700	120	138
7Ac8	30-50	2-4	limestone	Clay Loam	2-6	till	300-700	105	124
7Ac9	15-30	2-4	limestone	Sandy Loam	0-2	till	300-700	127	156
7Ac10	30-50	2-4	limestone	Clay Loam	2-6	till	300-700	110	128
7Ac11	30-50	2-4	limestone	Clay Loam	6-12	till	300-700	106	116
7Ac12	15-30	4-7	karst limestone	Sandy Loam	0-2	sand and gravel with silt and clay	1000-2000	157	182
7Ac13	15-30	4-7	karst limestone	Clay Loam	0-2	sand and gravel with silt and clay	1000-2000	151	167
7Ac14	15-30	4-7	limestone	Clay Loam	2-6	till	300-700	132	150
7Ac15	15-30	4-7	limestone	Clay Loam	0-2	till	300-700	133	153
7Ac16	50-75	4-7	limestone	Clay Loam	2-6	till	300-700	112	130
7Ac17	15-30	2-4	limestone	Clay Loam	6-12	till	300-700	116	126
7Ac18	30-50	2-4	limestone	Loam	0-2	till	300-700	115	141
7Ac19	15-30	2-4	limestone	Loam	0-2	till	300-700	125	151
7Ac20	15-30	2-4	limestone	Sandy Loam	0-2	sand and gravel	300-700	132	160
7Ac21	15-30	2-4	limestone	Sandy Loam	2-6	till	300-700	126	153
7Ac22	15-30	2-4	limestone	Silty Loam	2-6	till	300-700	122	143
7Ac23	15-30	2-4	limestone	Sandy Loam	0-2	sand and gravel	300-700	127	156
7Ac24	15-30	2-4	limestone	Sandy Loam	2-6	sand and gravel	300-700	126	153
7Ac25	15-30	4-7	karst limestone	Silty Loam	0-2	karst limestone	1000-2000	168	184
7Ac26	50-75	2-4	limestone	Clay Loam	0-2	till	300-700	96	117
7Ac27	30-50	4-7	karst limestone	Sandy Loam	0-2	sand and gravel with silt and clay	1000-2000	147	172
7Ac28	30-50	4-7	karst limestone	Clay Loam	0-2	sand and gravel with silt and clay	1000-2000	141	157
7Ac29	50-75	2-4	limestone	Clay Loam	0-2	till	300-700	101	121
7Ac30	5-15	2-4	limestone	Clay Loam	2-6	till	300-700	130	148
7Ac31	15-30	4-7	karst limestone	Clay Loam	0-2	karst limestone	1000-2000	166	179
7Af1	15-30	4-7	sand and gravel	Clay Loam	0-2	sand and gravel	300-700	133	153
7Af2	15-30	4-7	sand and gravel	Clay Loam	0-2	sand and gravel with silt and clay	300-700	130	150

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating_
7Af3	15-30	4-7	sand and gravel	Clay Loam	2-6	sand and gravel with silt and clay	300-700	129	147
7Af4	15-30	4-7	sand and gravel	Clay Loam	2-6	sand and gravel with silt and clay	100-300	120	140
7Af5	30-50	4-7	sand and gravel	Loam	2-6	sand and gravel with silt and clay	300-700	120	144
7Af6	30-50	4-7	sand and gravel	Loam	6-12	sand and gravel with silt and clay	100-300	110	128
7Af7	30-50	4-7	sand and gravel	Sandy Loam	6-12	sand and gravel with silt and clay	100-300	112	133
7Af8	30-50	4-7	sand and gravel	Sandy Loam	2-6	sand and gravel with silt and clay	100-300	116	145
7Af9	30-50	4-7	sand and gravel	Clay Loam	6-12	sand and gravel with silt and clay	100-300	106	118
7Af10	30-50	4-7	sand and gravel	Silty Loam	0-2	sand and gravel with silt and clay	100-300	113	138
7Af11	5-15	4-7	sand and gravel	Clay Loam	0-2	sand and gravel with silt and clay	100-300	131	153
7Af12	5-15	4-7	sand and gravel	Sandy Loam	0-2	sand and gravel with silt and clay	100-300	137	168
7Af13	5-15	4-7	sand and gravel	Silty Loam	0-2	sand and gravel with silt and clay	100-300	133	158
7Af14	15-30	4-7	sand and gravel	Silty Loam	0-2	sand and gravel with silt and clay	100-300	123	148
7Af15	30-50	4-7	sand and gravel	Clay Loam	2-6	sand and gravel with silt and clay	100-300	110	130
7Af16	15-30	4-7	sand and gravel	Loam	2-6	sand and gravel with silt and clay	300-700	133	157
7Af17	5-15	4-7	sand and gravel	Loam	0-2	sand and gravel with silt and clay	300-700	144	170
7Af18	5-15	4-7	sand and gravel	Clay Loam	0-2	sand and gravel with silt and clay	300-700	140	160
7Af19	5-15	4-7	sand and gravel	Clay Loam	2-6	sand and gravel with silt and clay	300-700	139	157
7Af20	5-15	4-7	sand and gravel	Clay Loam	2-6	sand and gravel with silt and clay	100-300	130	150
7Bc1	30-50	4-7	limestone	Sandy Loam	6-12	sand and gravel with silt and clay	300-700	134	151
7Bc2	30-50	4-7	limestone	Clay Loam	6-12	sand and gravel with silt and clay	300-700	128	136
7Bc3	50-75	4-7	limestone	Clay Loam	6-12	sand and gravel with silt and clay	300-700	118	126
7Bc4	30-50	4-7	limestone	Clay Loam	2-6	sand and gravel with silt and clay	300-700	132	148
7Bc5	30-50	4-7	limestone	Silty Loam	0-2	sand and gravel	300-700	135	156
7Bc6	30-50	4-7	limestone	Clay Loam	0-2	sand and gravel	300-700	133	151
7C1	30-50	4-7	limestone	Clay Loam	2-6	till	300-700	122	140
7C2	30-50	4-7	limestone	Clay Loam	0-2	till	300-700	123	143
7C3	15-30	4-7	limestone	Clay Loam	0-2	till	300-700	133	153

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating_
7C4	15-30	4-7	limestone	Clay Loam	2-6	till	300-700	132	150
7C5	15-30	4-7	limestone	Silty Loam	0-2	till	300-700	135	158
7C6	50-75	4-7	limestone	Clay Loam	0-2	till	300-700	113	133
7C7	50-75	4-7	limestone	Clay Loam	2-6	till	300-700	112	130
7C8	30-50	4-7	limestone	Clay Loam	6-12	till	300-700	118	128
7C9	30-50	4-7	limestone	Silty Loam	0-2	till	300-700	125	148
7Ec1	5-15	4-7	limestone	Silty Loam	0-2	silt and clay	300-700	140	164
7Ec2	5-15	4-7	limestone	Silty Loam	0-2	sand and gravel with silt and clay	300-700	145	168
7Ec3	5-15	4-7	limestone	Clay Loam	0-2	silt and clay	300-700	138	159
7Ec4	15-30	4-7	limestone	Silty Loam	0-2	silt and clay	300-700	130	154
7Ec5	15-30	4-7	karst limestone	Sandy Loam	0-2	sand and gravel	1000-2000	157	182
7Ec6	0-5	4-7	limestone	Silty Loam	0-2	silt and clay	300-700	150	173
7Ec7	5-15	7-10	limestone	Loam	0-2	sand and gravel with silt and clay	100-300	164	189
7Ec8	5-15	4-7	limestone	Silty Loam	0-2	sand and gravel	300-700	145	168
7Ec9	5-15	4-7	limestone	Shrink-swell clay	0-2	silt and clay	300-700	146	179
7Ec10	5-15	4-7	limestone	Sandy Loam	0-2	silt and clay	300-700	144	174
7Ec11	5-15	4-7	limestone	Loam	0-2	silt and clay	300-700	142	169
7Ec12	5-15	4-7	limestone	Silty Loam	0-2	sand and gravel with silt and clay	300-700	150	172
7Ec13	30-50	4-7	limestone	Silty Loam	0-2	silt and clay	300-700	120	144
7Ed1	5-15	7-10	sand and gravel	Silty Loam	0-2	sand and gravel with silt and clay	100-300	155	179
7Fc1	15-30	2-4	limestone	Clay Loam	0-2	silt and clay	300-700	116	137
7Fc2	15-30	2-4	limestone	Clay Loam	2-6	silt and clay	300-700	115	134
7Fc3	15-30	2-4	limestone	Silty Loam	0-2	silt and clay	300-700	118	142
7Fc4	15-30	2-4	limestone	Silty Loam	2-6	silt and clay	300-700	117	139
7Fc5	15-30	2-4	limestone	Shrink-swell clay	0-2	silt and clay	300-700	119	153
7Fc6	30-50	2-4	limestone	Shrink-swell clay	0-2	silt and clay	300-700	109	143
7Fc7	5-15	2-4	limestone	Shrink-swell clay	0-2	silt and clay	300-700	129	163
7Fc8	5-15	2-4	limestone	Clay Loam	0-2	silt and clay	300-700	126	147
7Fc9	30-50	2-4	limestone	Clay Loam	0-2	silt and clay	300-700	106	127
7Fc10	50-75	2-4	limestone	Shrink-swell clay	0-2	silt and clay	300-700	99	133
7Fc11	30-50	2-4	limestone	Clay Loam	2-6	silt and clay	300-700	105	124
7Fc12	30-50	2-4	limestone	Loam	0-2	silt and clay	300-700	110	137
7Fc13	30-50	2-4	limestone	Silty Loam	0-2	silt and clay	300-700	108	132

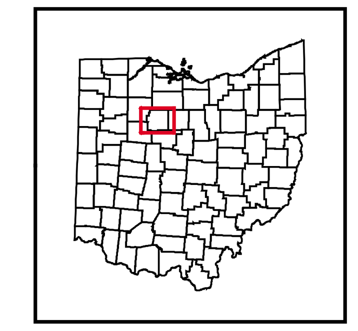
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating_
7Fc14	30-50	2-4	limestone	Sandy Loam	6-12	silt and clay	300-700	107	127
7Fc15	30-50	2-4	limestone	Silty Loam	2-6	silt and clay	300-700	107	129
7Fc16	15-30	2-4	limestone	Loam	0-2	silt and clay	300-700	120	147
7Fc17	30-50	2-4	limestone	Silty Loam	6-12	silt and clay	300-700	103	117
7Fc18	50-75	2-4	limestone	Clay Loam	2-6	silt and clay	300-700	95	114
7Fc19	30-50	2-4	limestone	Sandy Loam	2-6	silt and clay	300-700	111	139
7Fc20	15-30	2-4	limestone	Sandy Loam	0-2	silt and clay	300-700	122	152
7Fc21	30-50	2-4	limestone	Sandy Loam	0-2	silt and clay	300-700	112	142
7Fc22	50-75	2-4	limestone	Sandy Loam	0-2	silt and clay	300-700	102	132
7Fc23	50-75	2-4	limestone	Silty Loam	0-2	silt and clay	300-700	98	122
7Fc24	50-75	2-4	limestone	Clay Loam	0-2	silt and clay	300-700	96	117
7Fc25	5-15	2-4	limestone	Clay Loam	2-6	silt and clay	300-700	125	144
7Fd1	15-30	2-4	limestone	Clay Loam	0-2	till	300-700	116	137
7Fd2	15-30	2-4	limestone	Clay Loam	2-6	till	300-700	115	134
7Fd3	30-50	2-4	limestone	Clay Loam	0-2	till	300-700	106	127
7Fd4	30-50	2-4	limestone	Clay Loam	2-6	till	300-700	105	124
7Fd5	5-15	2-4	limestone	Clay Loam	0-2	till	300-700	126	147
7Fd6	5-15	2-4	limestone	Clay Loam	2-6	till	300-700	125	144
7Gb1	15-30	4-7	limestone	Clay Loam	2-6	limestone	300-700	142	158
7Gb2	15-30	4-7	limestone	Thin or Absent	0-2	limestone	300-700	152	192
7Gb3	15-30	4-7	limestone	Thin or Absent	0-2	limestone	300-700	157	196
7Gb4	15-30	4-7	limestone	Clay Loam	0-2	limestone	300-700	143	161
7Gb5	5-15	4-7	limestone	Clay Loam	0-2	limestone	300-700	153	171
7Gb6	15-30	4-7	limestone	Silty Loam	0-2	limestone	300-700	145	166
7Gb7	30-50	4-7	limestone	Clay Loam	0-2	limestone	300-700	133	151
7Gb8	30-50	4-7	limestone	Thin or Absent	2-6	limestone	300-700	146	183
7Gb9	30-50	4-7	limestone	Thin or Absent	0-2	limestone	300-700	147	186
7Gb10	5-15	7-10	limestone	Thin or Absent	0-2	limestone	100-300	164	206
7Gb11	15-30	7-10	limestone	Thin or Absent	0-2	limestone	100-300	154	196
7Gb12	15-30	4-7	limestone	Silty Loam	2-6	limestone	300-700	144	163
7Gb13	5-15	4-7	limestone	Thin or Absent	0-2	limestone	300-700	167	206
7Gb14	5-15	4-7	limestone	Silty Loam	0-2	limestone	300-700	159	180
7Gb15	5-15	4-7	limestone	Loam	0-2	limestone	300-700	157	181
7Gb16	5-15	4-7	limestone	Sandy Loam	0-2	limestone	300-700	159	186
7Gb17	30-50	4-7	limestone	Clay Loam	2-6	limestone	300-700	132	148

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating_
7Gb18	15-30	4-7	limestone	Thin or Absent	2-6	limestone	300-700	156	193
7Gb19	30-50	4-7	limestone	Thin or Absent	6-12	limestone	300-700	142	171
7Gb20	30-50	4-7	karst limestone	Thin or Absent	6-12	karst limestone	1000-2000	165	189
7Gb21	50-75	4-7	limestone	Thin or Absent	2-6	limestone	300-700	136	173
7Gb22	15-30	4-7	karst limestone	Shrink-swell clay	2-6	karst limestone	1000-2000	173	196
7Gb23	15-30	4-7	karst limestone	Thin or Absent	6-12	karst limestone	1000-2000	175	199
7Gb24	15-30	4-7	karst limestone	Shrink-swell clay	0-2	karst limestone	1000-2000	174	199
7Gb25	15-30	4-7	limestone	Thin or Absent	6-12	limestone	300-700	152	181
7Gb26	5-15	4-7	limestone	Thin or Absent	6-12	limestone	300-700	162	191
7Gb27	5-15	4-7	limestone	Thin or Absent	2-6	limestone	300-700	166	203
7Gb28	5-15	7-10	limestone	Thin or Absent	2-6	limestone	100-300	163	203
7Gb29	30-50	7-10	limestone	Thin or Absent	6-12	limestone	100-300	139	171
7Gb30	15-30	7-10	limestone	Thin or Absent	2-6	limestone	100-300	153	193
7Gb31	30-50	7-10	limestone	Thin or Absent	2-6	limestone	100-300	143	183
7Gb32	30-50	4-7	limestone	Silty Loam	2-6	limestone	300-700	134	153
7I1	5-15	4-7	limestone	Silty Loam	0-2	silt and clay	300-700	130	156
7I2	5-15	4-7	limestone	Muck	0-2	silt and clay	300-700	131	150
7I3	5-15	4-7	limestone	Peat	0-2	silt and clay	300-700	138	176
7I4	5-15	2-4	limestone	Muck	0-2	silt and clay	100-300	108	130



Ground Water Pollution Potential of Wyandot County

by Kelly Barrett and Mike Angle, Ohio Department of Natural Resources



Ground Water Pollution Potential maps are designed to evaluate the susceptibility of ground water to contamination from surface sources. These maps are based on the DRASTIC system developed for the USEPA (Aller et al., 1987). The DRASTIC system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and a relative rating system for determining the ground water pollution potential within a hydrogeologic setting. The application of DRASTIC to an area requires the recognition of a set of assumptions made in the development of the system. The evaluation of pollution potential of an area assumes that a contaminant with the mobility of water is introduced at the surface and is flushed into the ground water by precipitation. DRASTIC is not designed to replace specific on-site investigations.

In DRASTIC mapping, hydrogeologic settings form the basis of the system and incorporate the major hydrogeologic factors that affect and control ground water movement and occurrence. The relative rating system is based on seven hydrogeologic factors: Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone media, and hydraulic Conductivity. These factors form the acronym DRASTIC. The relative rating system uses a combination of weights and ratings to produce a numerical value called the ground water pollution potential index. Higher index values indicate higher susceptibility to ground water contamination. Polygons (outlined in black on the map at left) are regions where the hydrogeologic setting and the pollution potential index are combined to create a mappable unit with specific hydrogeologic characteristics, which determine the region's relative vulnerability to contamination. Additional information on the DRASTIC system, hydrogeologic settings, ratings, and weighting factors is included in the report.

Description of Map Symbols

Hydrogeologic Region → 7D24 ← Hydrogeologic Setting
170 ← Relative Pollution Potential

Legend

Colors are used to depict the ranges in the pollution potential indexes shown below. Warm colors (red, orange, yellow) represent areas of higher vulnerability (higher pollution potential indexes), while cool colors (green, blue, violet) represent areas of lower vulnerability to contamination (lower pollution potential indexes).

- Roads
- Streams
- Lakes
- Townships

Index Ranges

- Not Rated
- Less Than 79
- 80 - 99
- 100 - 119
- 120 - 139
- 140 - 159
- 160 - 179
- 180 - 199
- Greater Than 200

N

Black grid represents the State Plane South Coordinate System (NAD27, feet).

0 1 2 3 4 5
Miles

0 1 2 4 6 8
Kilometers

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