GROUND WATER POLLUTION POTENTIAL OF MORROW COUNTY, OHIO

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GROUND WATER POLLUTION POTENTIAL REPORT NO. 69

OHIO DEPARTMENT OF NATURAL RESOURCES

DIVISION OF SOIL AND WATER RESOURCES

WATER RESOURCES SECTION

2013

ABSTRACT

A groundwater pollution potential map of Morrow 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 Morrow County resulted in a map with symbols and colors, which illustrate areas of varying ground water pollution potential indexes ranging from 65 to 175.

Morrow County lies entirely within the Glaciated Central hydrogeologic setting. Shales of the Devonian and Mississippian Systems compose the aquifer in the western third of the county. Yields from these shales typically average less than 5 gallons per minute (gpm) and are barely suitable for domestic needs. In central and eastern Morrow County, shales, sandstones, and interbedded sequences of shale, sandstone, and siltstone comprise the aquifer. The Berea Sandstone of the Devonian System in the eastern portion of the county yields 5 to 25 gpm. Sandstones and sandy shale of the Mississippian Logan and Cuyahoga Formations yield 3 to 10 gpm in the eastern portion of the county.

Sand and gravel lenses interbedded in the glacial till locally serve as aquifers throughout Morrow County where there is sufficient thickness of glacial drift. In some areas, the sand and gravel lenses may lie directly on top of the shale bedrock and serve as the aquifer or provide additional recharge to the underlying bedrock. Yields for these sand and gravel lenses range from 5 to 25 gpm. In central and eastern Morrow County, the sand and gravel units become much more common and are thicker and are more laterally extensive. Yields up to 50 gpm are common in these areas. Extensive outwash deposits underlie the till in the vicinity of Mt. Gilead and may have localized yields exceeding 100 gpm. Near Chesterville, outwash deposits adjacent to the Kokosing River overlie a buried valley and can produce yields up to 500 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 Morrow 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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ACKNOWLEDGEMENTS

The preparation of the Morrow County Ground Water Pollution Potential report and map involved the contribution and work of a number of individuals in the Division of Soil and Water Resources. Grateful acknowledgement is given to the following individuals for their technical review and map production, text authorship, report editing, and preparation:

Map preparation and review:	Kelly Barrett Michael P. Angle Kathy Sprowls
GIS coverage production and review:	Mark Steiner Michael P. Angle Kathryn Button Rachel Pohnan
Report production and review:	Michael P. Angle Kelly Barrett Kathy Sprowls
Report editing:	Kathy Sprowls Jim Raab

INTRODUCTION

The need for protection and management of ground water resources in Ohio has been clearly recognized. Approximately 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; 7090 of these wells exist in Morrow 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 (now Division of Soil and Water Resources) 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 Soil and Water Resources 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 Morrow 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 Morrow 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:

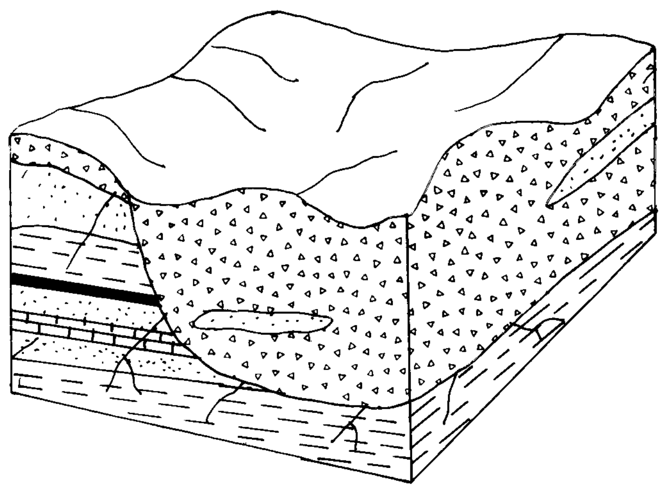
D – Depth to Water
R – Net Recharge
A – Aquifer Media
S – Soil Media
T – Topography
I – Impact of the Vadose Zone Media
C – Conductivity (Hydraulic) of the Aquifer

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.



7D Buried Valley

This hydrogeologic setting is found in eastern Morrow County. The buried valleys are typically overlain by modern streams such as Clear Fork, Cedar Fork, and the Kokosing River. The aquifer consists of sand and gravel deposits interbedded with glacial till. These sand and gravel deposits differ as to lateral extent and thickness and are found at varying depths. Yields range widely based on the thickness and extent of the sand and gravel deposits. The vadose zone is composed of loamy to clayey glacial till, or sand and gravel with significant silt and clay. The till may be fractured or jointed, particularly in areas where it is thin and weathered. Depth to water is variable and depends primarily upon how deep the underlying sand and gravel lenses are. Soils are predominantly sandy or silty loams. Recharge varies depending upon the thickness of till and depth to water.

GWPP index values for the hydrogeologic setting of Buried Valley range from 85 to 175, with the total number of GWPP index calculations equaling 40.

Figure 1. Format and description of the hydrogeologic setting - 7D Buried Valley.

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. Greater vulnerability to contamination is indicated by a higher DRASTIC index. 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	

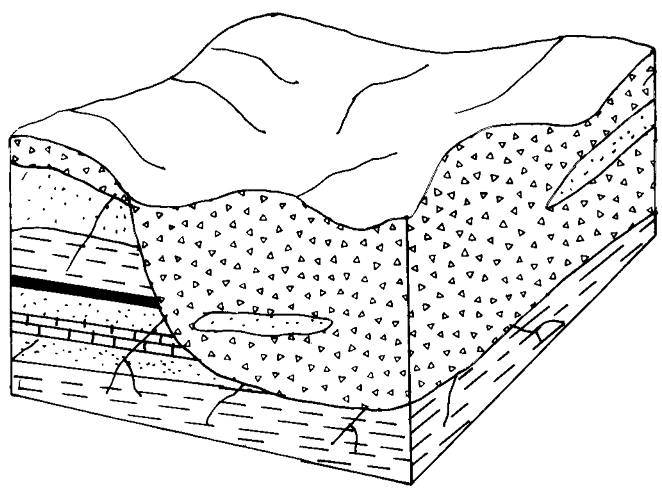
Table 8. Ranges and ratings for hydraulic conductivity

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 7D1, Buried Valley, identified in mapping Morrow 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 125. 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 Morrow County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the nine settings identified in the county range from 65 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 Morrow 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 Morrow County is included with this report.



SETTING 7D1		**GENERAL**		
FEATURE	**RANGE**	**WEIGHT**	**RATING**	**NUMBER**
Depth to Water	15-30	5	7	35
Net Recharge	4-7	4	6	24
Aquifer Media	Sand & Gravel	3	6	18
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	125

Figure 2. Description of the hydrogeologic setting - 7D1 Buried Valley.

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:

7D1 - defines the hydrogeologic region and setting
125 - defines the relative pollution potential

Here the first number (**7**) refers to the major hydrogeologic region and the upper case letter (**D**) 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 (**125**) 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.

GENERAL INFORMATION ABOUT MORROW COUNTY

Demographics

Morrow County occupies approximately 406 square miles in north central Ohio (Figure 3). Morrow County is bounded to the north by Crawford County, to the northeast by Richland County, to the southeast by Knox County, to the southwest by Delaware County, and to the west by Marion County.

The approximate population of Morrow County, based upon year 2010 census, is 34,827 (Department of Development, Ohio County Profiles, 2012). The village of Mt. Gilead is the largest community and the county seat. Agriculture accounts for roughly 66 percent of the land usage in Morrow County. Woodlands, residential, and open water are the other major land cover in the county. More specific information on land usage can be obtained from the Ohio Department of Development County Profiles website (www.odod.state.oh.us/research/).

Climate

The *Hydrologic Atlas for Ohio* (Harstine, 1991) reports an average annual temperature of approximately 50 degrees Fahrenheit for Morrow County. The average temperatures decrease slightly towards the northeast. Precipitation approximately averages 37 inches per year for the county, with precipitation decreasing towards the northwest (Harstine, 1991). The mean annual precipitation recorded at Mt. Gilead Lakes State Park is 39.5 inches per year based upon a thirty-year (1971-2000) period (National Oceanographic and Atmospheric Administration (NOAA), 2002). The mean annual temperature at the village of Centerburg in neighboring Knox County is 49.5 degrees Fahrenheit (NOAA, 2002).

Physiography and Topography

Morrow County lies within the Central Till Plains Lowland Province (Frost, 1931, Fenneman, 1938, and Bier, 1956). Brockman (1998) and Schiefer (2002) determined that western Morrow County belongs in the Central Ohio Clayey Till Plain and that most of eastern Morrow County is part of the Galion Glaciated Low Plateau. The extreme northeastern and southeastern corners of Morrow County lie just within the Killbuck-Glaciated Pittsburgh Plateau. Western Morrow County is characterized by flat to gently rolling ground moraine. In east-central and southeastern Morrow County, the topography takes the form of linear, hummocky end moraines, kames, and eskers combined with more steeply rolling areas of ground moraine. The topography in the northeast corner of the county is the result of a thin till cover over bedrock upland.

Figure 3. Location map of Morrow County, Ohio.

Modern Drainage

The divide between the headwaters of the Lake Erie Basin and the Ohio River Basin lies to the north of Morrow County in southern Crawford County and northwestern Richland County. The drainage of Morrow County lies to the south of this divide, entirely within the Ohio River Basin. The Olentangy River, Whetstone Creek, Alum Creek, and Big Walnut Creek and their tributaries drain the western half of Morrow County, while the eastern half of Morrow County is drained by the Kokosing River and Clear Fork and their tributaries. The Powell Moraine, which runs north-south through most of the county, acts as a drainage divide.

Pre- and Inter-Glacial Drainage Changes

The drainage patterns of Morrow County have changed significantly as a result of the multiple glaciations. The drainage changes are complex and not yet fully understood. More research and data are necessary in Morrow County and adjacent counties. Particularly, well log data for deeper wells that penetrate the entire drift thickness would be helpful in making interpretations. This would allow for a more accurate reconstruction of the system of buried valleys and former drainage channels for the county.

Prior to glaciation, the drainage in Ohio is referred to as the Teays Stage. The Teays River drained the southern and western two thirds of the state and was the master stream for what is now the upper Ohio River Valley. Stout et al. (1943) proposed that the Groveport River and a large unnamed tributary drained Morrow County (Figure 4). The Groveport River drained Morrow County to the east, and ultimately reached the Teays River. The unnamed tributary drained the western half of the county into the Teays River. Stout et al. (1943) speculated that the Groveport River originated near Wooster in Wayne County and flowed south to northeastern Fairfield County. Here the path of the Groveport River veered westward until it merged with the Teays River in Clark County. Schmidt and Goldthwait (1958) and Dove (1960) disagreed with this western path, suggesting that the Groveport River followed a more southwesterly course and merged with the Teays River further south in Madison County.

As ice advanced through Ohio during the pre-Illinoian (Kansan) glaciations, northerly and western drainage ways were blocked, including the Teays Drainage System. Flow backed-up these numerous tributaries, forming several large lakes. These lakes over-topped, creating spillways and cutting new channels. New drainage systems began to evolve (Stout et al., 1943). The downcutting by these new streams was believed to be relatively rapid and, in many places, the new channels were cut over 100 feet deeper than the previous Teays River System valleys. The new drainage system is referred to as the Deep Stage due to this increased downcutting. Stout et al. (1943) suggested that Morrow County drained to the west and south into the Columbus River (Figure 5). The Columbus River had a course somewhat

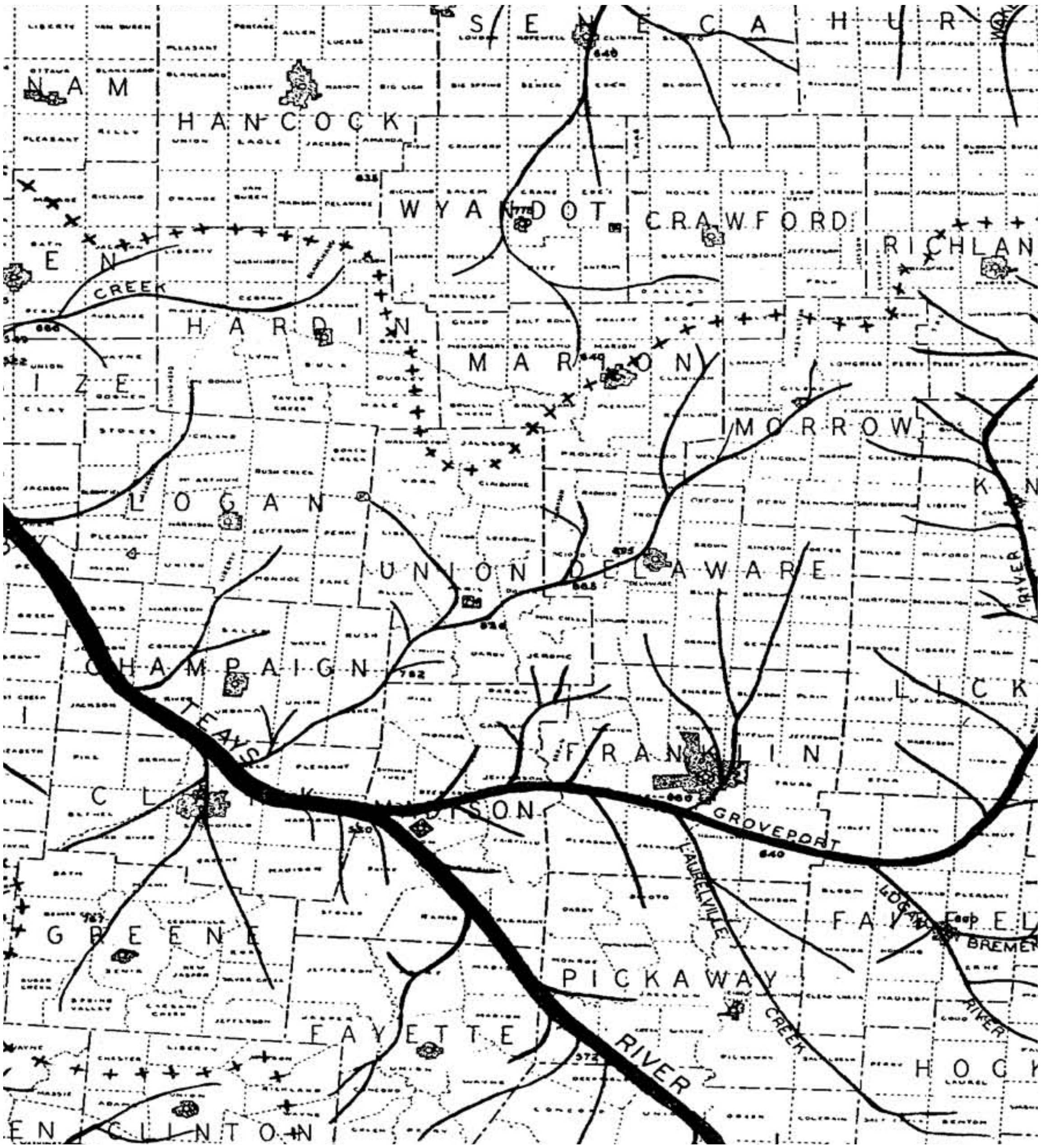


Figure 4. Teays Stage drainage in Morrow County (after Stout et al., 1943).

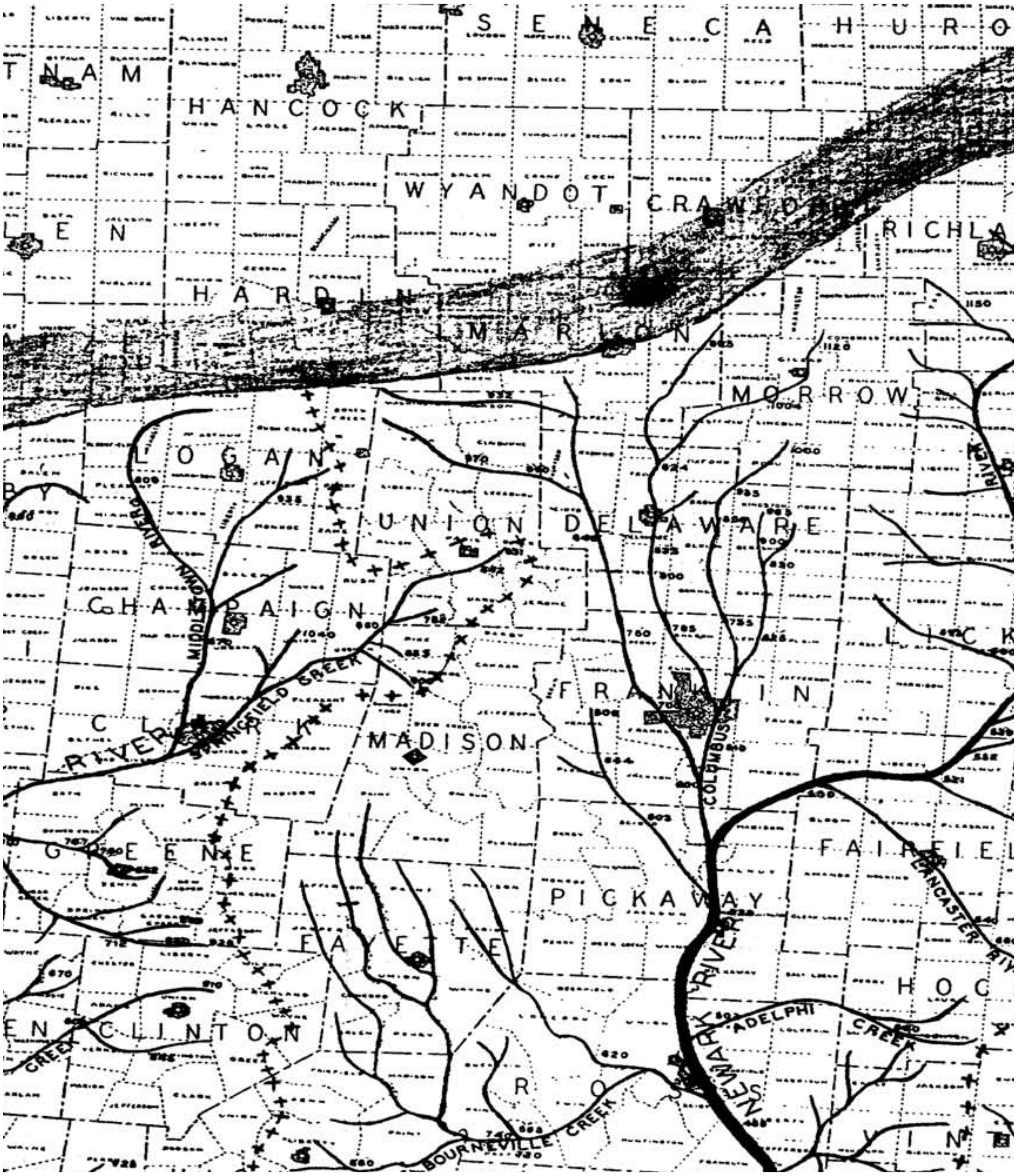


Figure 5. Deep Stage drainage in Morrow County (after Stout et al., 1943).

similar to the present Scioto River. It was a major tributary of the Newark River that flowed south into the Cincinnati River, a precursor of the Ohio River. Stout et al. (1943) postulated that Morrow County was drained to the east and south by the Utica River, which was also a tributary of the Newark River.

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). Evidence for these earlier glaciations is lacking or obscured. The last glacial advance, the Late Wisconsinan Ice Sheet, deposited the surficial till in Morrow County (Goldthwait et al., 1961; Pavey et al., 1999).

The glacial deposits in Morrow County fall into two main types: (glacial) till and ice-contact sand and gravel (kames, eskers) deposits. Drift is an older term that collectively refers to the entire sequence of glacial deposits. 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.

Till has a relatively low inherent permeability. Permeability in till is in part dependent upon the primary porosity of the till, which reflects the texture (fineness or coarseness) of the particular till. 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). 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 Broadway, Powell, and Johnstown end moraines (Goldthwait et al., 1961) trend north-south through the eastern half of Morrow County.

Kames and eskers are ice contact features. They are generally composed of masses of 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. Kame terraces are a linear belt of kames that have a similar appearance and a fairly uniform elevation. They represent deposition of materials between the melting ice sheet and the bedrock and till slopes flanking the ice-filled valleys. Eskers are elongate, sinuous deposits that marked deposition by drainage channels beneath the ice sheet. Crevasse fills are similar except that they occurred at the top of the ice sheet or within the ice sheet. The best examples of ice contact deposits are found along the Kokosing River in eastern Morrow County.

Bedrock Geology

Bedrock underlying the surface of Morrow County belongs to the Devonian and Mississippian Systems. Carbonate (limestone and dolomite) bedrock underlies the southwestern corner of Morrow County; the western third is underlain by shale, and the rest of the county is underlain by interbedded sandstones and shales. Table 9 summarizes the bedrock stratigraphy found in Morrow County. The ODNR, Division of Geological Survey, has Open-File Reconnaissance Bedrock Geological Maps completed at a 1:24,000 scale available for the entire county. The ODNR, Division of Soil and Water Resources, has Open File Bedrock State Aquifer maps available for the county also.

Devonian carbonates are found in the southwestern corner of Morrow County underlying the Devonian Ohio and Olentangy Shales. The uppermost carbonate units are the fossiliferous Columbus and Delaware Limestones. These rocks were deposited in warm, high-energy seas and reef areas.

Devonian-age Ohio and Olentangy Shale underlies the western third of Morrow County. These thick, dark brown to black fissile shales were deposited in deep oceans that had limited circulation of fresher waters and sediments. These shales are rich in organic matter, pyrite, and locally, natural gas.

The Bedford Shale and Berea Sandstone, which are Devonian in age, and the Mississippian-age rocks that overlie them, show a shift to deltaic, fluvial, and shoreline deposits. The Bedford Shale and the Berea Sandstone formations are found in central Morrow County. The Bedford Shale is comprised of very fine-grained silt and clay particles deposited in the outer (distal) margins of a delta. The Berea Sandstone consists of fine-grained, tightly cemented sand particles derived from river sediments that were re-deposited along adjacent shorelines. The Mississippian Sunbury Shale overlies the Berea Sandstone and is similar to the Devonian Ohio Shale. This unit may indicate the localized return to a low circulation environment. The Mississippian Logan and Cuyahoga Formations are found in the eastern third of Morrow County. This unit is composed of interbedded fine-grained sandstones, shales, and siltstones and represents deltaic to fluvial sediments deposited in a rapidly fluctuating, shoreline environment.

Table 9. Bedrock stratigraphy of Morrow County

System	Group/Formation (*Symbol*)	Lithologic Description
Mississippian	Logan and Cuyahoga Formations (*Mlc*)	Logan Formation consists of gray, yellow and brown sandstone and siltstone. Sandstone fine- to medium-grained, locally contains lenses and beds of coarse-grained sand to fine pebble conglomerate. Siltstone is clayey to sandy, locally contains shale interbeds and partings. Cuyahoga Formation consists of sandstone, siltstone, and shale in shades of gray, olive, brown and yellow. Sandstone is silty to conglomeratic in thin to thick beds, siltstone and shale occur in thick to thin beds, shale black in northern portion of state.
	Sunbury Shale (*Ms*)	Black to brownish-black, carbonaceous, and pyritic shale.
Devonian	Berea Sandstone and Bedford Shale, undivided (*Dbb*)	Berea is gray to brown sandstone, medium-grained to silty. Bedford is shale that ranges in color from gray to red to brown, is silty to clayey, and locally contains abundant siltstone and sandstone interbeds.
	Ohio Shale (*Doh*)	Consists of three members: Cleveland, Chagrin, and Huron. Cleveland is black shale, thickest in north-central portion of state. Chagrin consists of shale, siltstone, and very fine-grained sandstone, gray to greenish-gray. Huron is black, carbonaceous, shale with calcareous concretions common in the lower portion.
	Olentangy Shale (*Do*)	Greenish-gray to gray clayey, pyritic shale that locally contains lenses and nodules of limestone. Contains thin, brownish-black shale beds in upper portion.
	Delaware Limestone (*Dd*)	Bluish-gray dolomitic limestone, thin- to medium-bedded with argillaceous partings, contains nodules and layers of chert.
	Columbus Limestone (*Dc*)	The Columbus is a gray to brown, fossiliferous, massive-bedded limestone and dolomite, consists of four members of regional extent. Karst features are common. The water quality deteriorates in areas where these units are overlain by thick Ohio Shale.

Ground Water Resources

Ground water in Morrow County is obtained from both unconsolidated (glacial-alluvial) and consolidated (bedrock) aquifers. Glacial aquifers are primarily associated with layers of sand and gravel of varying thickness and extent interbedded with till. Sand and gravel deposits are more commonly utilized in areas with underlying shale bedrock in the western third of the county. Yields from shales are typically low and are marginal for supplying even domestic needs. In the southwestern corner of the county, some wells are drilled through the shales to reach the carbonate aquifer below. Sand and gravel is also utilized as an aquifer in the eastern two-thirds of the county in areas of moraines and buried valleys. Interbedded sandstone and shale aquifers in the eastern two-thirds of the county underlie the glacial deposits and provide ample yields for domestic and farm needs. Completed water wells typically penetrate multiple bedrock units.

Yields for the Devonian Columbus and Delaware Limestones vary from 5-100+ gpm in southwestern Morrow County (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000, and Kostelnick, 1981). In Westfield Township, some wells penetrate the Ohio and Olentangy Shales to reach the carbonate units beneath. Typically, the shale ranges from 130 to 150 feet in thickness, and total depths of the wells can reach 300 feet. Water from the limestone formations underlying the shale tends to be very high in sulfur, hydrogen sulfide, and iron (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000).

The Devonian Ohio and Olentangy Shales in western Morrow County are a poor source of ground water. Yields are typically less than 5 gpm (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000 and Kostelnick, 1981). Typically, the uppermost 10 to 15 feet of the shale is weathered and broken and provides the most water. Wells drilled deeper into the shale provide increased well storage, but little additional water. The water quality becomes more objectionable with depth. Yields from the Devonian Bedford Shale in west central Morrow County and the Mississippian Sunbury Shale in east central Morrow County are also typically less than 5 gpm (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000 and Kostelnick, 1981).

Wells drilled into the Devonian Berea Sandstone beneath the Sunbury Shale in east central Morrow County yield from 5 to 25 gpm (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000 and Kostelnick, 1981). Yields obtained from the interbedded fine-grained sandstones, shales, and siltstones of the Logan and Cuyahoga Formations in the eastern third of the county also yield 5 to 25 gpm (ODNR, Division of Soil and Water Resources, Open File, Bedrock State Aquifer Map, 2000 and Kostelnick, 1981).

Yields from sand and gravel lenses interbedded with the fine-grained till averages 5 to 25 gpm in western Morrow County where glacial deposits overlie the shale. Coarser sand and gravel deposits are found in the area of the buried valleys and outwash deposits in eastern Morrow County, such as the area of the present-day Kokosing River. Yields in these areas range from 10 to 100 gpm to properly constructed and developed wells. Coarse sand and gravel deposits of significant thickness are also found in areas of morainal and buried valley deposits exceeding 100 feet in thickness. Yields in these areas, found near the city of Mount

Gilead and Candlewood Lake, can exceed 300 gpm (ODNR, Division of Soil and Water Resources, Glacial State Aquifer Map, 2000 and Kostelnick, 1981).

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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 Soil and Water Resources. Approximately 7090 water well log records are on file for Morrow County. Data from roughly 2,800 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 Morrow County* (Kostelnick, 1981) provided generalized depth to water information throughout the county. Depth to water trends mapped in adjoining Knox County (Aller and Ballou, 1990), Marion County (Angle, 2003), Crawford County (Angle and Russell, 2003), Richland County (Angle, 2003), and Delaware County (Angle, Barrett, and Jones, 2005) were used as a guideline. Topographic and geomorphic trends were utilized in areas where other sources of data were lacking.

Depths to water of 0 to 5 (10) and 5 to 15 feet (9) were selected for most of the alluvial settings and in areas of ground moraine with thin till. Depths of 15 to 30 feet (7) were used for the majority of Morrow County for ground moraine with moderate thickness of till and some of the more subdued end moraines. Depths of 30 to 50 feet (5) were utilized for the uplands between streams particularly and for the higher relief end moraines. Depths to water of 50 to 75 feet (3) and 75 to 100 feet (2) were utilized for higher relief uplands and areas in the eastern part of the county with greater thickness of glacial deposits.

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 Knox County (Aller and Ballou, 1990), Marion County (Angle, 2003), Crawford County (Angle and Russell, 2003), Richland County (Angle, 2003), and Delaware County (Angle, Barrett, and Jones, 2005) were used as a guideline.

Values of 7 to 10 inches per year (8) were assigned to areas adjacent to the Lucerne Well Field and the Kokosing River. These areas have outwash soils and sand and gravel deposits extensive enough to support commercially viable gravel pits. Values of 4 to 7 inches per year (6) were used for areas with moderate recharge. These areas include the majority of the settings in the county. Values of 2 to 4 inches per year (3) were utilized for areas where the depth to the aquifer was greater than 50 feet and/or there was a significant thickness of clay in the vadose zone.

Aquifer Media

Information on evaluating aquifer media was obtained from the *Ground Water Resources of Morrow County* (Kostelnick, 1981). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps from the ODNR, Division of Geological Survey proved helpful. Aquifer ratings from neighboring Knox County (Aller and Ballou, 1990), Marion County (Angle, 2003), Crawford County (Angle and Russell, 2003), Richland County (Angle, 2003), and Delaware County (Angle, Barrett, and Jones, 2005) were used as a guideline. The ODNR, Division of Soil and Water Resources, Glacial State Aquifer Map and Bedrock State Aquifer Map were an important source of aquifer data. Water well log and drilling reports on file at the ODNR, Division of Soil and Water, were the primary source of aquifer information.

Most of the bedrock and most of the 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). An aquifer rating of (4) was used for interbedded sandstone and shale aquifers of the Logan and Cuyahoga Formations in eastern Morrow County. An aquifer rating of (4) or (5) was selected for sandstone and fine sandstone aquifers in the south-central and northeastern sections of the county. Sandstone aquifers with greater depths to the aquifer and lower yields were rated (4), while shallower sandstone aquifers with higher yields were rated (5). Aquifer ratings of (2) or (3) were utilized for shale aquifers of the Ohio and Olentangy Shale in western Morrow County. A rating of (2) was given to shale aquifers with minimal yield; a rating of (3) was given to areas where yields average 5 gpm or more.

Sand and gravel aquifers were given ratings ranging from (5) to (8) based on the thickness and extent of the sand and gravel, the thickness of the clay in the vadose zone above it, and yields to wells developed in these aquifers. Areas of lower yields (from less than 5 up to 25 gpm) with greater thicknesses of clay were assigned values of (5). Areas with yields ranging from 5 to 100 gpm and with less clay were assigned values of (6). Most of the sand and gravel aquifers in Morrow County received this rating. Sand and gravel aquifers around Mt. Gilead and in the southeast corner of the county were assigned a value of (7) due to greater thicknesses of sand and gravel and the presence of many high-yielding wells. Sand and gravel aquifers in and around the buried valley running from Chesterville to Lucerne in Knox County were given a rating of (8) due to the thickness of the outwash deposits and data from the high-yielding wells developed in the Lucerne well field.

Soils

Soils were mapped using the data obtained from the *Soil Survey of Morrow County* (Gehring et al., 1993). 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 Morrow 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 Morrow County.

Table 10. Morrow County soils

Soil Name	Parent Material/ Setting	DRASTIC Rating	Soil Media
Amanda	Till	3	Clay loam
Bennington	Till	3	Clay loam
Blount	Till	3	Clay loam
Canfield*	Loamy to sandy till	4	Silty loam
Carlisle	Bogs, depressions	8	Peat
Centerburg	Till	3	Clay loam
Chili	Outwash/kame	6	Sandy loam
Colyer Variant	Till over shale	10	Thin/Absent
Condit	Till	3	Clay loam
Gallman	Outwash	6	Sandy loam
Glynwood	Till	3	Clay loam
Lobdell	Coarse alluvium	5	Loam
Milford	Lacustrine	3	Clay loam
Millgrove	Outwash	6	Sandy loam
Morley	Till	3	Clay loam
Ockley	Outwash	6	Sandy loam
Pewamo	Till	3	Clay loam
Rittman*	Silty till	3	Clay loam
Shoals	Alluvium	4	Silt loam
Sleeth	Coarse alluvium	5	Loam
Sloan	Alluvium	4	Silt loam
Tioga	Fine outwash	5	Loam
Wadsworth*	Silty till	3	Clay loam
Wooster*	Loamy till	4	Silt loam

* denotes soils containing fragipan

Soils were considered to be sandy loam (6) for a limited number of exposures of outwash/kame sand and gravel primarily found along the Kokosing River, North Branch Kokosing River, and Cedar Fork. Loam (5) soils and silt loams (4) were designated for alluvial and floodplain deposits. These occur adjacent to the major drainages of Morrow County. Clay loam (3) soils were evaluated for the majority of the county including till overlying ground moraine and end moraine. Thin/absent (10) was designated for a limited area along Alum Creek southwest of West Liberty where shale outcrops or is near the surface on the stream valley walls.

Topography

Topography, or percent slope, was evaluated using U.S.G.S. 7-1/2 minute quadrangle maps and the *Soil Survey of Morrow County* (Gehring et al., 1993). Slopes of 0 to 2 percent (10) were selected for almost all of the settings in Morrow County due to the overall flat lying to gently rolling topography and low relief. Slopes of 0 to 2 percent (10) were used for most areas of ground moraine or alluvial deposits. Slopes of 2 to 6 percent (9) were assigned to most end moraines exhibiting hummocky terrain, as well as areas of stream-dissected ground moraine. Slopes of 6 to 12 percent (5) and 12 to 18 percent (3) were selected for steep, highly dissected uplands adjacent to major streams.

Impact of the Vadose Zone Media

Information on evaluating vadose zone media was obtained from the *Ground Water Resources of Morrow County* (Kostelnick, 1981). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps from the ODNR, Division of Geological Survey proved helpful. Vadose zone media ratings from Knox County (Aller and Ballou, 1990), Marion County (Angle, 2003), Crawford County (Angle and Russell, 2003), Richland County (Angle, 2003), and Delaware County (Angle, Barrett, and Jones, 2005) were used as a guideline. The ODNR, Division of Soil and Water Resources, Glacial State Aquifer Map and Bedrock State Aquifer Map were an important source of vadose zone media data. The *Soil Survey of Morrow County* (Gehring et al., 1993) 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. Water well log and drilling reports on file at the ODNR, Division of Soil and Water Resources, were the primary source of vadose zone media information.

The vadose zone media is a critical component of the overall DRASTIC rating in Morrow 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.

Sand and gravel with silt and clay that has a rating ranging from (6) to (8) was selected as the vadose zone material for kame/outwash deposits near the Kokosing River in southeastern Morrow County. A rating of (8) indicates less silt and clay content, while a rating of (6) indicates more. Till with a vadose zone media rating of (4) or (5) was selected for most areas of ground moraine, end moraine, and buried valley in the county. Till with a vadose zone media rating of (4) was assigned to till with greater clay content and greater depth to water. Silt and clay with a rating of (4) or (5) was applied to alluvial settings throughout Morrow County. The ratings varied depending upon how relatively fine-grained the alluvium was and in the content of silt and clay.

In areas with thin till cover, the bedrock or bedrock and till combination was rated as the vadose media. Interbedded sandstone and shale in the northeast corner of the county was rated a (5), while a sandstone vadose media in the same area was also rated (5). The vadose media in western Morrow County consisting of shale and till was assigned a value of (5).

Hydraulic Conductivity

Water well log and drilling reports on file at the ODNR, Division of Soil and Water Resources, were the primary source of hydraulic conductivity information. The *Ground Water Resources of Morrow County* (Kostelnick, 1981) and Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps from the ODNR, Division of Geological Survey also proved helpful. Hydraulic conductivity ratings from Knox County (Aller and Ballou, 1990), Marion County (Angle, 2003), Crawford County (Angle and Russell, 2003), Richland County (Angle, 2003), and Delaware County (Angle, Barrett, and Jones, 2005) were used as a guideline. The ODNR, Division of Soil and Water Resources, Glacial State Aquifer Map and Bedrock State Aquifer Map were an additional important source of hydraulic conductivity data. 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. Hydraulic conductivity ratings of 1000-2000 gallons per day per square foot (gpd/ft^2) (8) and 700-1000 gpd/ft^2 (6) were selected for clean outwash deposits along the Kokosing River between Chesterville and Lucerne. A rating of (6) was also assigned to selected alluvial deposits (7Ed) and glacial complex deposits (7J) between Chesterville and Sparta. The remaining sand and gravel aquifers were given hydraulic conductivity ratings of 300-700 gpd/ft^2 (4) or 100-300 gpd/ft^2 (2). The hydraulic conductivity rating depended upon how clean and well-sorted the sand and gravel deposits were. Typically, well yields are used to infer the properties of the sand and gravel deposits.

Interbedded sandstone and shale was given a rating of 1-100 gpd/ft^2 (1) for most areas of the Logan and Cuyahoga Formations because of moderate to low well yields. All shale aquifers were assigned a hydraulic conductivity rating of 1-100 gpd/ft^2 (1). Sandstone aquifers were also given a rating of 1-100 gpd/ft^2 (1) due to relatively low well yields.

APPENDIX B

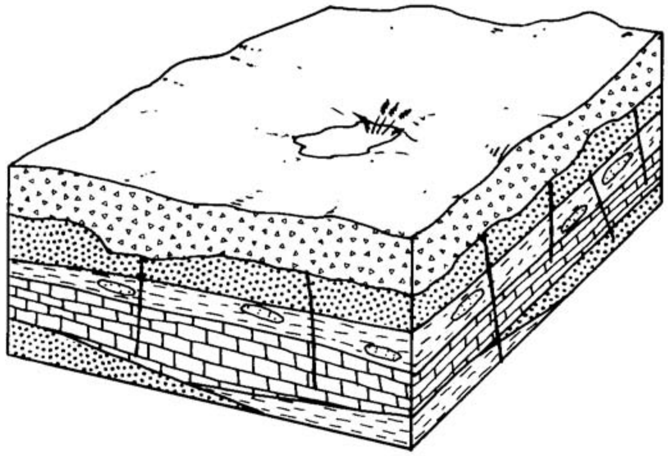
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

Ground water pollution potential mapping in Morrow County resulted in the identification of nine 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. Pollution potential indexes computed for Morrow County range from 65 to 175.

Table 11. Hydrogeologic settings mapped in Morrow County, Ohio

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7 Aa-Glacial till over bedded sedimentary rocks	65-128	83
7Ad-Glacial till over sandstone	68-121	13
7 Ae-Glacial till over shale	105-122	19
7Af-Sand and gravel interbedded in glacial till	109-146	32
7 C-Moraine	73-140	63
7 D-Buried valleys	85-175	40
7 Ec-Alluvium over sedimentary rock	92-132	52
7 Ed-Alluvium over glacial till	89-146	50
7 J-Glacial complex	73-139	65

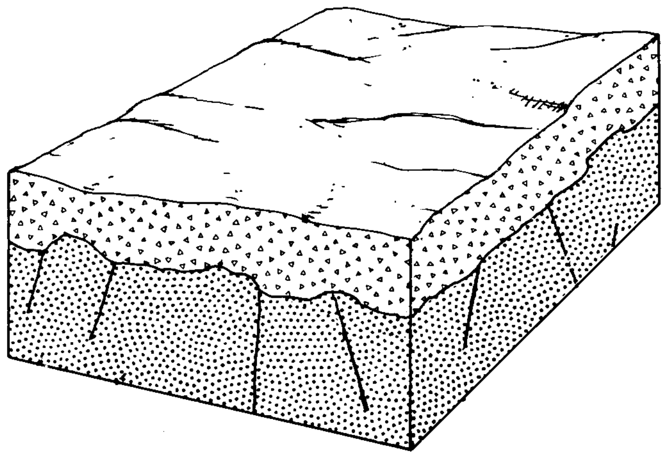
The following information provides a description of each hydrogeologic setting identified in the county, a block diagram illustrating the characteristics of the setting, and a listing of the charts for each unique combination of pollution potential indexes calculated for each setting. The charts provide 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.



7Aa-Glacial Till over Bedded Sedimentary Rocks

Thin glacial till overlies the interbedded sandstones, siltstones, and shales of the Mississippian Logan and Cuyahoga Formations. The vadose zone is composed of clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. Where the till is very thin the interbedded sandstone and shale may function as the vadose. Depth to water varies widely across the county. Soils are generally clay loams or silty loams. The aquifer is usually fractured, interbedded, Mississippian fine-grained sandstones and shales. Yields from the bedrock typically range from 5 to 25 gpm. Recharge is moderately low due to clayey nature of the soils and vadose zone.

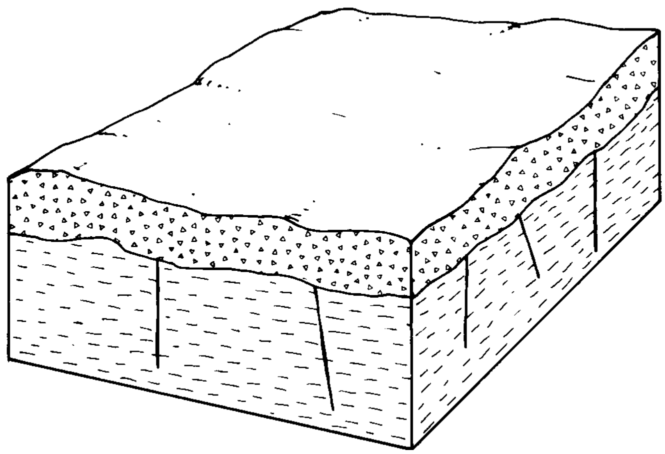
GWPP index values for the hydrogeologic setting of Glacial Till over Bedded Sedimentary Rocks range from 65 to 128, with the total number of GWPP index calculations equaling 83.



7Ad Glacial Till over Sandstone

This hydrogeologic setting is found in limited areas of south-central and northeastern Morrow County. Wells completed in this area are shallow and completed in sandstone; shale is not encountered in this vicinity. This setting is generally characterized by flat-lying to gently rolling topography. The aquifer commonly consists of fractured, fine-grained sandstone. Depths to water range from moderate to deep. Soils are clay loams derived from the underlying tills. The vadose zone is typically fractured till. In areas were the till is very thin, fractured sandstone is the vadose zone media. Yields usually average 5 to 25 gpm. Recharge is low to moderate due to the greater depths to water and relatively low permeability of the sandstone.

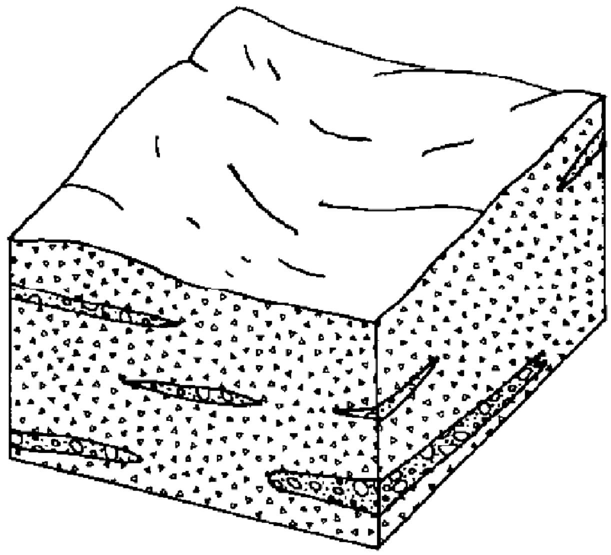
GWPP index values for the hydrogeologic setting of Glacial Till over Sandstone ranges from 68 to 121, with the total number of GWPP index calculations equaling 13.



7Ae-Glacial Till over Shale

This hydrogeologic setting is widespread in the western third of Morrow County. The area is characterized by flat-lying topography and very low relief. The vadose zone is composed of clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. Where the till is very thin, shale may function as the vadose. Depth to water is typically shallow, averaging less than 20 feet in most areas. Soils are generally clay loams. The aquifer is usually fractured, massive black Devonian-age shale. Yields from the shale are typically less than 5 gpm. Recharge is moderately low due to the clayey vadose zone and soils and the impermeable nature of the shale bedrock.

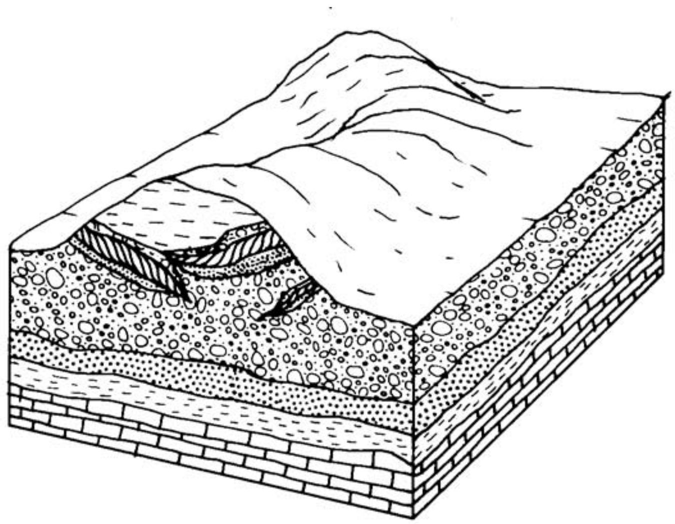
GWPP index values for the hydrogeologic setting of Glacial Till over Shale range from 105 to 122, with the total number of GWPP index calculations equaling 19.



7Af-Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is located in west-central Morrow 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 variable, typically averaging less than 50 feet. Soils are generally clay loams. The aquifer consists of thin lenses of sand and gravel interbedded in the glacial till. Groundwater yields range from 5 to 25 gpm. Recharge is moderate due to the moderate thickness of the overlying glacial till.

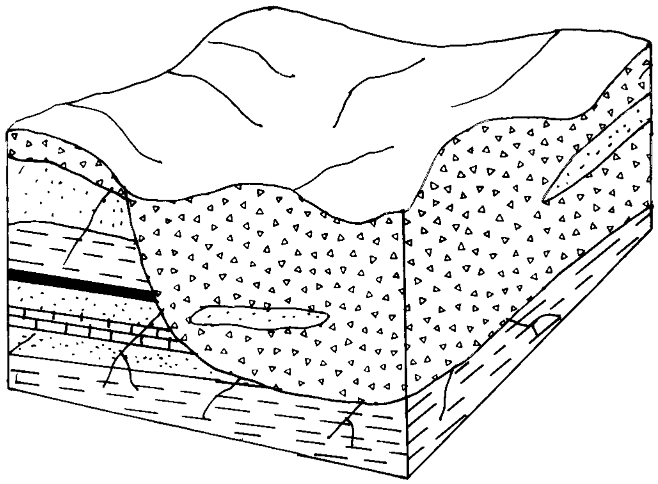
GWPP index values for the hydrogeologic setting of Sand and Gravel Interbedded in Glacial Till range from 109 to 146, with the total number of GWPP index calculations equaling 32.



7C-Moraine

This hydrogeologic setting consists of segments of the end moraines that cross Morrow 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 aquifer typically consists of 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 5 to 25 gpm. If sand and gravel lenses are not encountered or if they are too thin, wells are completed in the underlying bedrock. The bedrock aquifer may be sandstone, shale, or interbedded sandstone and shale. The yields vary and are typical for each rock type. The vadose zone is composed of clayey glacial till. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. In areas of thin till the bedrock may serve as part of the vadose zone. Depth to water is variable and depends primarily upon how deep the underlying aquifer is and how thick the till 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. As the till thickens and depth to water increases, the recharge becomes lower. The end moraines are the primary local sources of recharge.

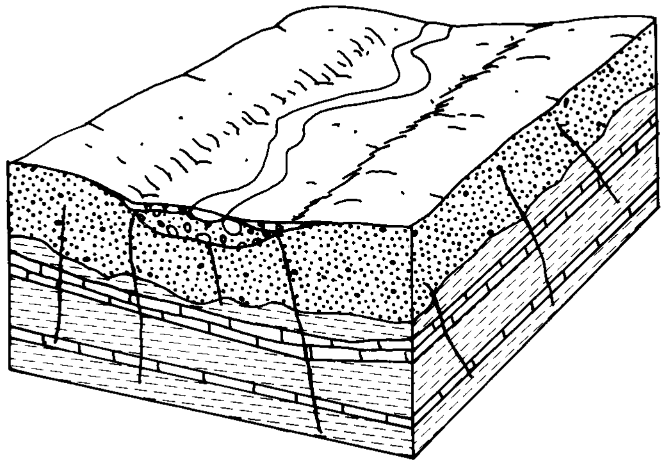
GWPP index values for the hydrogeologic setting of Moraine range from 73 to 140, with the total number of GWPP index calculations equaling 63.



7D-Buried Valley

This hydrogeologic setting is found in eastern Morrow County. The buried valleys are typically overlain by modern streams such as Clear Fork, Cedar Fork, and the Kokosing River. The aquifer consists of sand and gravel deposits interbedded with glacial till. These sand and gravel deposits differ as to lateral extent and thickness and are found at varying depths. Yields range widely based on the thickness and extent of the sand and gravel deposits. The vadose zone is composed of loamy to clayey glacial till, or sand and gravel with significant silt and clay. The till may be fractured or jointed, particularly in areas where it is thin and weathered. Depth to water is variable and depends primarily upon how deep the underlying sand and gravel lenses are. Soils are predominantly sandy or silty loams. Recharge varies depending upon the thickness of till and depth to water.

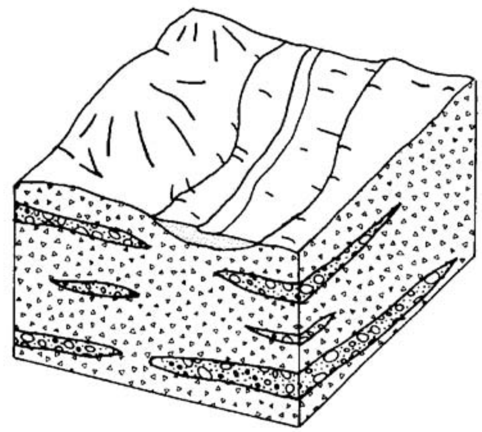
GWPP index values for the hydrogeologic setting of Buried Valley range from 85 to 175, with the total number of GWPP index calculations equaling 40.



7Ec-Alluvium over Sedimentary Rock

This hydrogeologic setting is common throughout Morrow County and is comprised of flat-lying floodplains and stream terraces containing thin to moderate thicknesses of modern alluvium. This setting is similar to the 7Ed-Alluvium over Glacial Till except that the underlying aquifers consist of bedrock. The vadose zone consists of the silty to clayey alluvial deposits. Bedrock may function as the vadose where the alluvium is thin. Depth to water is commonly very shallow, averaging less than 20 feet. The alluvium may be in direct hydraulic connection with the underlying bedrock or there may be thin till or lacustrine deposits in between. Yields vary depending upon the type of underlying bedrock. Soils on the floodplain vary depending on the nature of the alluvium. Recharge is typically moderately high due to the flat-lying topography, shallow depth to water, the moderate permeability of the soils, and the varying permeability of the underlying bedrock.

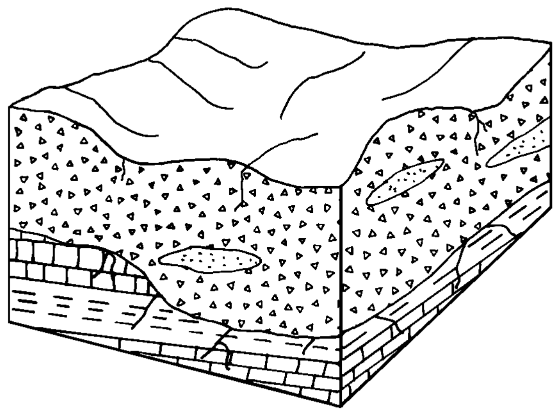
GWPP index values for the hydrogeologic setting of Alluvium over Sedimentary Rock range from 92 to 132, with the total number of GWPP index calculations equaling 52.



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. 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 that comprise the aquifer. The surficial, silty alluvium is typically more permeable than the underlying till, but is too thin to be considered the aquifer. The vadose zone consists of the silty to clayey alluvial deposits. Soils are silt loams or 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.

GWPP index values for the hydrogeologic setting of Alluvium over Glacial Till range from 89 to146, with the total number of GWPP index calculations equaling 50.



7J-Glacial Complex

This setting is found in southeastern and east-central portions of Morrow County. The surface topography is flat to rolling. The setting is characterized by a thick sequence of glacial till. The aquifer consists of thinner, less continuous lenses of sand and gravel interbedded with thicker sequences of fine-grained glacial till or the underlying bedrock. Yields vary from 5 to 25 gpm for wells completed in the sand and gravel lenses. Yields for bedrock vary according to the bedrock type. The setting is similar to the 7D-Buried Valley except that the sand and gravel lenses are less common, less continuous in lateral extent, and the overall thickness of drift is somewhat less. Soils are usually clay loams derived from the overlying glacial till. Depths to water are variable and depend on drift thickness and depth to the aquifer. Recharge is variable and depends upon drift thickness and depth to water.

GWPP index values for the hydrogeologic setting of Glacial Complex range from 73 to 139, with the total number of GWPP index calculations equaling 65.

Table 12. Hydrogeologic Settings, DRASTIC Factors, and Ratings

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa01	15-30	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	115	138
7Aa02	15-30	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	114	135
7Aa03	5-15	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	125	148
7Aa04	5-15	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	124	145
7Aa05	5-15	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	120	133
7Aa06	15-30	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	110	123
7Aa07	30-50	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	104	125
7Aa08	30-50	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	105	128
7Aa09	5-15	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	113	136
7Aa10	15-30	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	98	122
7Aa11	50-75	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	94	115
7Aa12	30-50	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	99	121
7Aa13	15-30	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	103	126
7Aa14	5-15	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	128	151
7Aa15	15-30	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	118	141
7Aa17	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	90	114
7Aa18	15-30	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	117	138
7Aa19	15-30	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	113	126
7Aa20	15-30	4-7	interbedded ss & sh	Silty loam	0-2	till	1-100	117	143
7Aa21	75-100	4-7	interbedded ss & sh	Silty loam	12-18	till	1-100	80	93
7Aa22	75-100	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	80	94
7Aa23	75-100	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	85	109
7Aa24	30-50	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	95	109
7Aa25	100+	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	79	101
7Aa26	100+	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	80	104
7Aa27	30-50	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	100	124
7Aa28	30-50	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	97	114

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa29	100+	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	81	106
7Aa30	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	95	118
7Aa31	30-50	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	102	118
7Aa32	30-50	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	106	130
7Aa33	100+	2-4	interbedded ss & sh	Clay Loam	2-6	till	1-100	67	89
7Aa34	100+	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	68	92
7Aa35	75-100	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	82	99
7Aa36	75-100	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	84	106
7Aa37	75-100	2-4	interbedded ss & sh	Sandy Loam	0-2	till	1-100	79	112
7Aa38	75-100	2-4	interbedded ss & sh	Clay Loam	2-6	till	1-100	72	94
7Aa39	75-100	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	90	113
7Aa40	30-50	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	100	113
7Aa41	30-50	4-7	interbedded ss & sh	Sandy Loam	0-2	till	1-100	111	143
7Aa42	50-75	2-4	interbedded ss & sh	Clay Loam	2-6	till	1-100	80	102
7Aa43	50-75	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	81	105
7Aa44	50-75	2-4	interbedded ss & sh	Clay Loam	6-12	till	1-100	76	90
7Aa45	50-75	2-4	interbedded ss & sh	Silty Loam	6-12	till	1-100	78	95
7Aa46	75-100	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	88	101
7Aa47	75-100	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	93	116
7Aa48	50-75	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	97	118
7Aa49	50-75	4-7	interbedded ss & sh	Sandy Loam	0-2	till	1-100	104	136
7Aa50	50-75	2-4	interbedded ss & sh	Silty Loam	2-6	interbedded ss & sh	1-100	87	111
7Aa51	50-75	2-4	interbedded ss & sh	Silty Loam	2-6	till	1-100	82	107
7Aa52	50-75	2-4	interbedded ss & sh	Silty Loam	6-12	interbedded ss & sh	1-100	83	99
7Aa53	50-75	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	90	103
7Aa54	30-50	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	88	112
7Aa55	50-75	2-4	interbedded ss & sh	Clay Loam	0-2	till	1-100	78	102

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa56	15-30	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	119	143
7Aa57	50-75	4-7	interbedded ss & sh	Sandy Loam	0-2	silt & clay	300-700	110	139
7Aa58	100+	0-2	interbedded ss & sh	Silty Loam	6-12	interbedded ss & sh	1-100	65	81
7Aa59	100+	2-4	interbedded ss & sh	Silty Loam	2-6	till	1-100	72	97
7Aa60	100+	2-4	interbedded ss & sh	Silty Loam	2-6	interbedded ss & sh	1-100	77	101
7Aa61	30-50	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	109	133
7Aa62	30-50	2-4	interbedded ss & sh	Silty Loam	6-12	till	1-100	88	105
7Aa63	30-50	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	100	117
7Aa64	30-50	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	104	129
7Aa65	75-100	2-4	interbedded ss & sh	Silty Loam	6-12	till	1-100	73	90
7Aa66	100+	2-4	interbedded ss & sh	Silty Loam	0-2	till	1-100	73	100
7Aa67	75-100	2-4	interbedded ss & sh	Silty Loam	0-2	till	1-100	78	105
7Aa68	75-100	4-7	interbedded ss & sh	Silty Loam	2-6	till	1-100	89	114
7Aa69	75-100	2-4	interbedded ss & sh	Silty Loam	2-6	till	1-100	77	102
7Aa70	50-75	4-7	interbedded ss & sh	Silty Loam	0-2	till	1-100	95	122
7Aa71	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	93	117
7Aa72	75-100	4-7	interbedded ss & sh	Silty Loam	0-2	till	1-100	90	117
7Aa73	15-30	4-7	interbedded ss & sh	Loam	0-2	till	1-100	122	151
7Aa74	15-30	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	115	131
7Aa75	30-50	4-7	interbedded ss & sh	Silty Loam	6-12	till	1-100	105	121
7Aa76	30-50	4-7	interbedded ss & sh	Silty Loam	0-2	till	1-100	110	136
7Aa77	15-30	4-7	interbedded ss & sh	Silty Loam	0-2	till	1-100	120	146
7Aa78	15-30	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	118	141
7Aa79	30-50	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	108	131
7Aa80	30-50	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	107	128
7Aa81	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	98	121
7Aa82	50-75	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	94	115

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa83	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	95	118
7Ad01	15-30	4-7	sandstone	Clay Loam	0-2	till	100-300	121	143
7Ad02	15-30	4-7	sandstone	Clay Loam	0-2	till	1-100	115	138
7Ad03	30-50	4-7	sandstone	Clay Loam	2-6	till	1-100	104	125
7Ad04	50-75	2-4	sandstone	Clay Loam	2-6	till	1-100	77	99
7Ad05	50-75	2-4	sandstone	Clay Loam	0-2	till	1-100	78	102
7Ad06	100+	2-4	sandstone	Clay Loam	0-2	till	1-100	68	92
7Ad07	30-50	2-4	sandstone	Clay Loam	0-2	till	1-100	88	112
7Ad08	75-100	4-7	sandstone	Clay Loam	2-6	till	1-100	89	110
7Ad09	75-100	4-7	sandstone	Clay Loam	0-2	till	1-100	90	113
7Ad10	50-75	4-7	sandstone	Clay Loam	0-2	till	1-100	95	118
7Ad11	50-75	4-7	sandstone	Clay Loam	2-6	till	1-100	94	115
7Ad12	50-75	2-4	sandstone	Silty Loam	6-12	till	100-300	81	97
7Ad13	50-75	2-4	sandstone	Silty Loam	6-12	sandstone	100-300	86	101
7Ae01	5-15	4-7	shale	Clay Loam	0-2	till	1-100	119	142
7Ae02	15-30	4-7	shale	Clay Loam	0-2	till	1-100	109	132
7Ae03	5-15	4-7	shale	Clay Loam	0-2	till	1-100	122	145
7Ae04	5-15	4-7	shale	Clay Loam	2-6	till	1-100	121	142
7Ae05	15-30	4-7	shale	Clay Loam	0-2	till	1-100	112	135
7Ae06	15-30	4-7	shale	Clay Loam	2-6	till	1-100	111	132
7Ae07	15-30	4-7	shale	Clay Loam	2-6	till	100-300	114	134
7Ae08	15-30	4-7	shale	Clay Loam	0-2	till	100-300	115	137
7Ae09	5-15	4-7	shale	Clay Loam	2-6	till	1-100	118	139
7Ae10	5-15	4-7	shale	Clay Loam	6-12	shale & till	1-100	117	130
7Ae11	5-15	4-7	shale	Clay Loam	6-12	till	1-100	117	130
7Ae12	15-30	4-7	shale	Clay Loam	2-6	shale & till	1-100	111	132
7Ae13	15-30	4-7	shale	Clay Loam	0-2	shale & till	1-100	112	135
7Ae14	5-15	4-7	clay shale	Clay Loam	0-2	till	1-100	119	142
7Ae15	15-30	4-7	shale	Clay Loam	2-6	till	1-100	108	129
7Ae16	5-15	2-4	shale	Clay Loam	0-2	till	1-100	105	129
7Ae17	5-15	2-4	shale	Clay Loam	0-2	till	1-100	110	133
7Ae18	5-15	2-4	shale	Clay Loam	2-6	till	1-100	109	130
7Ae19	5-15	2-4	shale	Clay Loam	0-2	till	1-100	107	130
7Af01	5-15	4-7	sand & gravel	Clay Loam	0-2	till	300-700	137	157
7Af02	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	126	144
7Af03	15-30	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	134	160

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Af04	5-15	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	144	170
7Af05	5-15	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	146	175
7Af06	5-15	4-7	sand & gravel	Clay Loam	0-2	till	300-700	140	160
7Af07	5-15	4-7	sand & gravel	Clay Loam	2-6	till	300-700	136	154
7Af08	5-15	4-7	sand & gravel	Clay Loam	2-6	till	300-700	139	157
7Af09	5-15	4-7	sand & gravel	Loam	0-2	till	300-700	141	167
7Af10	5-15	4-7	sand & gravel	Clay Loam	0-2	till	100-300	131	153
7Af11	5-15	4-7	sand & gravel	Clay Loam	2-6	till	100-300	127	147
7Af12	5-15	4-7	sand & gravel	Clay Loam	0-2	till	100-300	128	150
7Af13	15-30	4-7	sand & gravel	Clay Loam	2-6	till	100-300	117	137
7Af14	15-30	4-7	sand & gravel	Clay Loam	0-2	till	100-300	118	140
7Af15	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	130	150
7Af16	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	127	147
7Af17	5-15	4-7	sand & gravel	Clay Loam	2-6	till	300-700	133	151
7Af18	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	125	146
7Af19	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	129	147
7Af20	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	117	137
7Af21	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	115	136
7Af22	15-30	4-7	sand & gravel	Clay Loam	6-12	till	300-700	125	135
7Af23	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	120	140
7Af24	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	112	133
7Af25	5-15	4-7	sand & gravel	Clay Loam	6-12	till	300-700	135	145
7Af26	5-15	4-7	sand & gravel	Clay Loam	2-6	till	100-300	130	150
7Af27	15-30	2-4	sand & gravel	Clay Loam	2-6	till	300-700	109	128
7Af28	30-50	4-7	sand & gravel	Clay Loam	6-12	till	300-700	115	125
7Af29	30-50	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	129	147

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Af30	5-15	4-7	sand & gravel	Sandy Loam	0-2	till	300-700	146	175
7Af31	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	119	137
7Af32	15-30	4-7	sand & gravel	Clay Loam	0-2	till	100-300	121	143
7C01	15-30	4-7	shale	Clay Loam	0-2	till	1-100	112	135
7C02	15-30	4-7	shale	Clay Loam	2-6	shale & till	1-100	111	132
7C03	15-30	4-7	sandstone	Clay Loam	2-6	till	100-300	117	137
7C04	30-50	4-7	sandstone	Clay Loam	2-6	till	100-300	107	127
7C05	15-30	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	114	135
7C06	15-30	4-7	sandstone	Clay Loam	0-2	till	1-100	118	141
7C07	30-50	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	104	125
7C08	30-50	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	105	128
7C09	30-50	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	100	113
7C10	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	119	137
7C11	15-30	4-7	sand & gravel	Clay Loam	6-12	till	300-700	125	135
7C12	50-75	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	89	111
7C13	15-30	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	110	123
7C14	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	90	114
7C15	30-50	4-7	sand & gravel	Clay Loam	0-2	till	100-300	114	136
7C16	50-75	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	95	118
7C17	30-50	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	129	147
7C18	15-30	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	134	142
7C19	15-30	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	115	138
7C20	50-75	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	119	137
7C21	50-75	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	118	134
7C22	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	120	140
7C23	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	129	147
7C24	5-15	4-7	sand & gravel	Clay Loam	0-2	till	300-700	140	160
7C25	5-15	4-7	sand & gravel	Clay Loam	2-6	till	300-700	139	157

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7C26	75-100	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	89	110
7C27	50-75	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	109	118
7C28	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	130	150
7C29	30-50	4-7	sand & gravel	Clay Loam	6-12	till	300-700	110	121
7C30	30-50	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	124	132
7C31	30-50	4-7	sand & gravel	Clay Loam	6-12	till	300-700	115	125
7C32	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	114	133
7C33	15-30	4-7	sand & gravel	Clay Loam	2-6	till	100-300	115	136
7C34	30-50	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	128	144
7C35	75-100	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	109	117
7C36	75-100	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	109	128
7C37	50-75	4-7	sand & gravel	Clay Loam	0-2	till	300-700	108	129
7C38	5-15	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	124	145
7C39	50-75	4-7	interbedded ss & sh	Clay Loam	2-6	till	1-100	94	115
7C40	30-50	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	95	109
7C41	15-30	4-7	interbedded ss & sh	Clay Loam	6-12	till	1-100	105	119
7C42	5-15	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	125	148
7C43	5-15	4-7	shale	Clay Loam	0-2	till	1-100	122	145
7C44	15-30	4-7	sand & gravel	Clay Loam	6-12	till	300-700	128	138
7C45	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	132	150
7C46	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	122	140
7C47	30-50	4-7	sand & gravel	Loam	2-6	till	300-700	123	147
7C48	75-100	2-4	sand & gravel	Clay Loam	2-6	till	300-700	84	103
7C49	75-100	2-4	sand & gravel	Clay Loam	2-6	till	300-700	87	106
7C50	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	111	130
7C51	50-75	2-4	sand & gravel	Clay Loam	0-2	till	300-700	98	118
7C52	30-50	2-4	sand & gravel	Clay Loam	0-2	till	300-700	108	128
7C53	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	115	136

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7C54	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	125	146
7C55	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	112	133
7C56	75-100	2-4	sand & gravel	Clay Loam	0-2	till	100-300	79	102
7C57	50-75	2-4	sand & gravel	Clay Loam	0-2	till	100-300	84	107
7C58	100+	2-4	sand & gravel	Clay Loam	0-2	till	100-300	74	97
7C59	50-75	2-4	sand & gravel	Clay Loam	6-12	till	100-300	79	92
7C60	50-75	2-4	sand & gravel	Clay Loam	2-6	till	100-300	83	104
7C61	50-75	4-7	sand & gravel	Clay Loam	2-6	till	300-700	104	123
7C62	100+	2-4	sand & gravel	Clay Loam	2-6	till	100-300	73	94
7C63	50-75	2-4	sand & gravel	Clay Loam	6-12	till	100-300	82	95
7D01	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	125	146
7D02	15-30	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	135	158
7D03	15-30	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	137	163
7D04	15-30	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	139	168
7D05	30-50	7-10	sand & gravel	Clay Loam	0-2	sand & gravel with silt & clay	1000-2000	151	166
7D06	15-30	7-10	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	1000-2000	167	191
7D07	30-50	7-10	sand & gravel	Sandy Loam	2-6	sand & gravel with silt & clay	1000-2000	161	182
7D08	15-30	7-10	sand & gravel	Loam	0-2	sand & gravel with silt & clay	1000-2000	175	194
7D09	15-30	7-10	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	1000-2000	168	185
7D10	30-50	7-10	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	1000-2000	155	172
7D11	30-50	7-10	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	1000-2000	162	185

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D12	15-30	7-10	sand & gravel	Sandy Loam	6-12	sand & gravel with silt & clay	1000-2000	167	180
7D13	15-30	7-10	sand & gravel	Sandy Loam	2-6	sand & gravel with silt & clay	1000-2000	171	192
7D14	5-15	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	700-1000	158	181
7D15	30-50	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	700-1000	138	161
7D16	30-50	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	700-1000	136	156
7D17	15-30	7-10	sand & gravel	Loam	0-2	sand & gravel with silt & clay	1000-2000	170	190
7D18	15-30	7-10	sand & gravel	Clay Loam	2-6	sand & gravel with silt & clay	1000-2000	165	177
7D19	15-30	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	133	162
7D20	15-30	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	129	152
7D21	15-30	4-7	sand & gravel	Sandy Loam	2-6	sand & gravel with silt & clay	300-700	132	159
7D22	15-30	4-7	sand & gravel	Clay Loam	2-6	sand & gravel with silt & clay	300-700	126	144
7D23	30-50	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	100-300	115	143
7D24	50-75	4-7	sand & gravel	Sandy Loam	6-12	sand & gravel with silt & clay	100-300	102	123
7D25	50-75	2-4	sand & gravel	Clay Loam	6-12	till	300-700	85	96
7D26	50-75	2-4	sand & gravel	Silty Loam	2-6	till	300-700	91	113
7D27	50-75	2-4	sand & gravel	Silty Loam	6-12	till	300-700	87	101
7D28	5-15	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	147	169
7D29	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	127	146
7D30	75-100	4-7	sand & gravel	Silty Loam	2-6	sand & gravel with silt & clay	300-700	111	131

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D31	15-30	4-7	sand & gravel	Silty Loam	2-6	sand & gravel with silt & clay	300-700	136	156
7D32	30-50	4-7	sand & gravel	Silty Loam	2-6	till	300-700	121	142
7D33	75-100	4-7	sand & gravel	Silty Loam	2-6	till	300-700	106	127
7D34	75-100	2-4	sand & gravel	Silty Loam	6-12	till	1-100	76	93
7D35	15-30	7-10	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	700-1000	158	184
7D36	15-30	7-10	sand & gravel	Loam	0-2	sand & gravel with silt & clay	700-1000	156	179
7D37	15-30	2-4	sand & gravel	Sandy Loam	0-2	till	300-700	122	152
7D38	50-75	4-7	sand & gravel	Silty Loam	6-12	till	300-700	102	116
7D39	5-15	4-7	sand & gravel	Sandy Loam	0-2	till	300-700	141	171
7D40	15-30	4-7	sand & gravel	Silty Loam	0-2	till	300-700	127	151
7Ec01	5-15	4-7	shale	Silty Loam	0-2	silt & clay	1-100	121	147
7Ec02	5-15	4-7	shale	Loam	0-2	silt & clay	1-100	126	155
7Ec03	5-15	4-7	shale	Silty Loam	0-2	silt & clay	1-100	124	150
7Ec04	15-30	4-7	shale	Loam	0-2	silt & clay	1-100	116	145
7Ec05	15-30	4-7	shale	Silty Loam	0-2	silt & clay	1-100	114	140
7Ec06	15-30	4-7	shale	Loam	0-2	silt & clay	1-100	113	142
7Ec07	5-15	4-7	shale	Loam	0-2	sand & gravel with silt & clay	1-100	126	155
7Ec08	15-30	4-7	shale	Silty Loam	0-2	sand & gravel with silt & clay	1-100	114	140
7Ec09	15-30	4-7	shale	Loam	0-2	sand & gravel with silt & clay	1-100	116	145
7Ec10	5-15	4-7	shale	Silty Loam	0-2	sand & gravel with silt & clay	1-100	124	150
7Ec11	15-30	4-7	shale	Sandy Loam	0-2	silt & clay	1-100	118	150
7Ec12	5-15	4-7	shale	Sandy Loam	0-2	silt & clay	1-100	128	160
7Ec13	5-15	4-7	shale	Clay Loam	0-2	silt & clay	1-100	119	142
7Ec14	5-15	4-7	sandstone	Silty Loam	0-2	silt & clay	100-300	130	155
7Ec15	15-30	4-7	sandstone	Loam	0-2	silt & clay	1-100	119	148
7Ec16	15-30	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	119	148

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ec17	15-30	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	117	143
7Ec18	5-15	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	127	153
7Ec19	30-50	4-7	interbedded ss & sh	Sandy Loam	0-2	silt & clay	1-100	111	143
7Ec20	15-30	4-7	shale	Silty Loam	0-2	silt & clay	1-100	106	133
7Ec21	15-30	4-7	shale	Sandy Loam	0-2	silt & clay	1-100	110	143
7Ec22	5-15	4-7	shale	Loam	0-2	silt & clay	1-100	118	148
7Ec23	15-30	4-7	shale	Loam	0-2	silt & clay	1-100	108	138
7Ec24	15-30	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	114	144
7Ec25	15-30	4-7	interbedded ss & sh	Silty Loam	2-6	silt & clay	1-100	111	136
7Ec26	15-30	4-7	interbedded ss & sh	Sandy Loam	0-2	silt & clay	1-100	121	153
7Ec27	5-15	4-7	shale	Sandy Loam	0-2	silt & clay	1-100	125	157
7Ec28	30-50	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	109	138
7Ec29	30-50	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	107	133
7Ec30	5-15	4-7	shale	Silty Loam	0-2	silt & clay	1-100	116	143
7Ec31	5-15	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	122	149
7Ec32	5-15	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	124	154
7Ec33	15-30	4-7	interbedded ss & sh	Loam	0-2	sand & gravel with silt & clay	1-100	114	144
7Ec34	15-30	4-7	interbedded ss & sh	Clay Loam	2-6	silt & clay	1-100	109	131
7Ec35	30-50	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	104	134
7Ec36	15-30	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	100-300	120	145
7Ec37	15-30	4-7	interbedded ss & sh	Loam	0-2	silt & clay	100-300	122	150
7Ec38	30-50	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	100-300	110	135
7Ec39	15-30	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	112	139
7Ec40	5-15	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	132	161
7Ec41	5-15	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	125	152
7Ec42	0-5	4-7	shale	Silty Loam	0-2	silt & clay	1-100	124	151
7Ec43	5-15	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	129	158
7Ec44	50-75	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	92	119

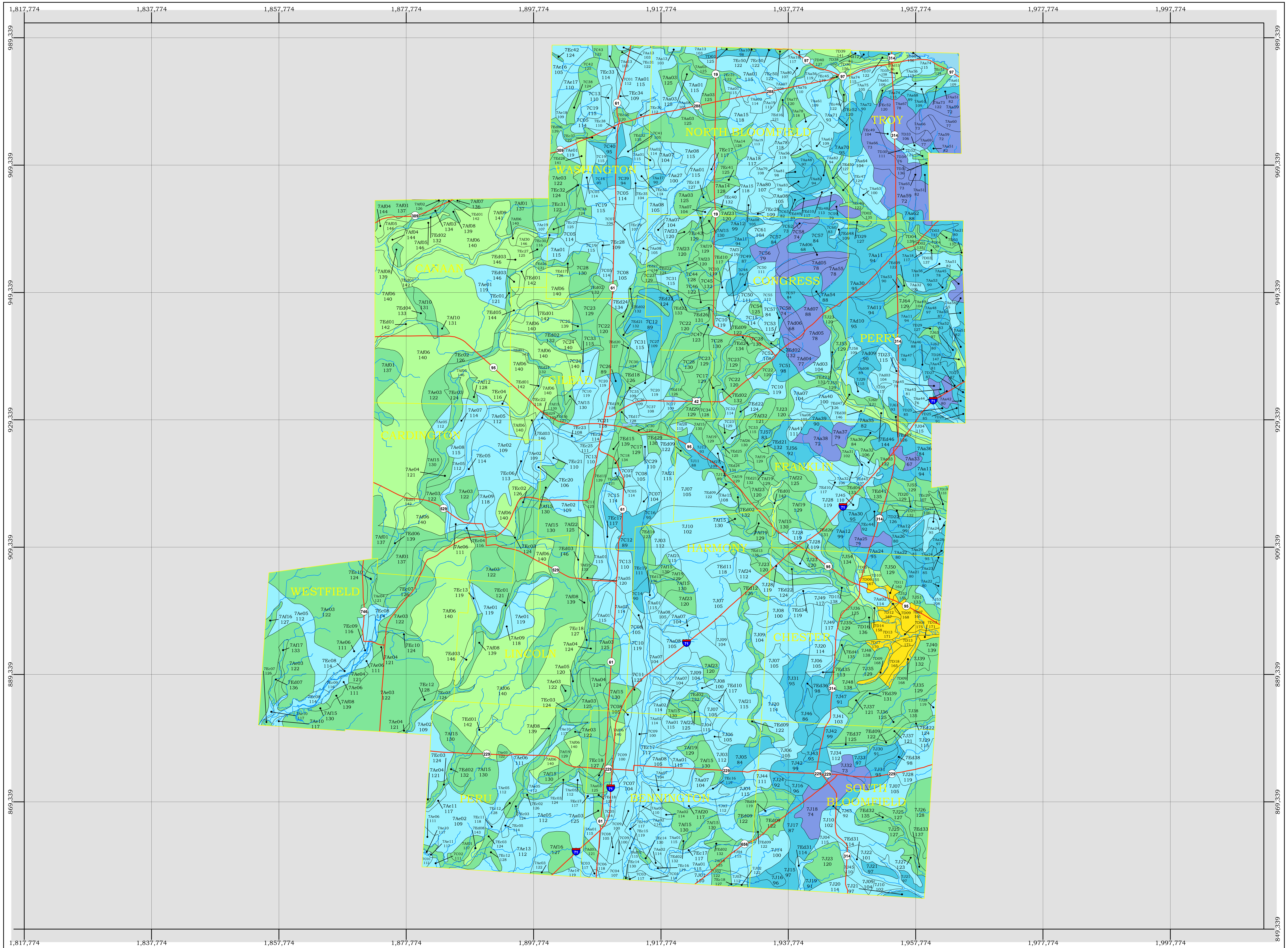
Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ec45	15-30	4-7	interbedded ss & sh	Silty Loam	2-6	silt & clay	1-100	119	143
7Ec46	15-30	4-7	interbedded ss & sh	Loam	0-2	silt & clay	1-100	122	151
7Ec47	15-30	4-7	interbedded ss & sh	Sandy Loam	0-2	silt & clay	1-100	124	156
7Ec48	30-50	4-7	interbedded ss & sh	Sandy Loam	2-6	silt & clay	1-100	113	143
7Ec49	75-100	4-7	interbedded ss & sh	Silty Loam	0-2	sand & gravel with silt & clay	300-700	104	127
7Ec50	5-15	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	122	149
7Ec51	15-30	4-7	interbedded ss & sh	Sandy Loam	0-2	sand & gravel with silt & clay	1-100	124	156
7Ec52	15-30	4-7	interbedded ss & sh	Silty Loam	0-2	silt & clay	1-100	120	146
7Ed01	5-15	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	142	165
7Ed02	15-30	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	132	155
7Ed03	5-15	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	146	175
7Ed04	5-15	4-7	sand & gravel	Silty Loam	0-2	silt & clay	100-300	133	158
7Ed05	5-15	4-7	sand & gravel	Loam	0-2	silt & clay	300-700	144	170
7Ed06	5-15	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	139	162
7Ed07	5-15	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	136	159
7Ed08	5-15	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	143	172
7Ed09	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	122	145
7Ed10	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	117	141
7Ed11	30-50	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	118	148
7Ed12	30-50	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	126	155
7Ed13	15-30	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	136	165
7Ed14	30-50	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	123	152
7Ed15	15-30	4-7	sand & gravel	Clay Loam	0-2	silt & clay	700-1000	139	157
7Ed16	15-30	4-7	sand & gravel	Silty Loam	0-2	silt & clay	100-300	121	147
7Ed17	30-50	4-7	sand & gravel	Loam	0-2	silt & clay	700-1000	128	153

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ed18	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	700-1000	126	148
7Ed19	30-50	4-7	sand & gravel	Loam	0-2	silt & clay	700-1000	128	153
7Ed20	30-50	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	127	153
7Ed21	15-30	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	132	155
7Ed22	30-50	4-7	sand & gravel	Loam	0-2	silt & clay	300-700	124	150
7Ed23	30-50	4-7	sand & gravel	Loam	0-2	silt & clay	700-1000	133	157
7Ed24	15-30	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	134	160
7Ed25	15-30	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	100-300	125	153
7Ed26	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	700-1000	131	152
7Ed27	15-30	4-7	sand & gravel	Loam	0-2	silt & clay	300-700	134	160
7Ed28	5-15	4-7	sand & gravel	Loam	0-2	silt & clay	300-700	141	167
7Ed29	15-30	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	100-300	130	161
7Ed30	5-15	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	146	175
7Ed31	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	114	138
7Ed32	15-30	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	135	158
7Ed33	15-30	4-7	sand & gravel	Loam	0-2	silt & clay	300-700	137	163
7Ed34	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	119	142
7Ed35	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	100-300	113	138
7Ed36	75-100	4-7	sand & gravel	Silty Loam	0-2	silt & clay	100-300	98	123
7Ed37	30-50	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	125	148
7Ed38	50-75	4-7	sand & gravel	Silty Loam	0-2	till	100-300	98	124
7Ed39	30-50	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	700-1000	131	152
7Ed40	50-75	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	112	135
7Ed41	15-30	4-7	sand & gravel	Silty Loam	0-2	silt & clay	700-1000	135	156

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ed42	15-30	4-7	sand & gravel	Sandy Loam	2-6	silt & clay	300-700	135	162
7Ed43	50-75	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	107	131
7Ed44	50-75	4-7	sand & gravel	Sandy Loam	0-2	silt & clay	300-700	111	141
7Ed45	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	130	150
7Ed46	5-15	4-7	sand & gravel	Loam	0-2	sand & gravel with silt & clay	300-700	144	170
7Ed47	30-50	4-7	sand & gravel	Sandy Loam	0-2	sand & gravel with silt & clay	300-700	126	155
7Ed48	50-75	4-7	sand & gravel	Silty Loam	0-2	sand & gravel with silt & clay	300-700	109	132
7Ed49	50-75	2-4	sand & gravel	Silty Loam	0-2	silt & clay	100-300	89	115
7Ed50	15-30	4-7	sand & gravel	Silty Loam	0-2	silt & clay	300-700	127	151
7J01	15-30	4-7	interbedded ss & sh	Clay Loam	0-2	till	1-100	110	134
7J02	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	122	143
7J03	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	112	133
7J04	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	115	136
7J05	50-75	2-4	sand & gravel	Clay Loam	0-2	till	100-300	84	107
7J06	30-50	4-7	sand & gravel	Clay Loam	2-6	till	100-300	105	126
7J07	50-75	4-7	sand & gravel	Clay Loam	0-2	till	300-700	105	126
7J08	50-75	4-7	sand & gravel	Clay Loam	6-12	till	300-700	100	111
7J09	50-75	4-7	sand & gravel	Clay Loam	2-6	till	300-700	104	123
7J10	50-75	4-7	sand & gravel	Clay Loam	0-2	till	300-700	102	123
7J11	50-75	2-4	sand & gravel	Clay Loam	6-12	till	300-700	88	99
7J12	50-75	2-4	sand & gravel	Clay Loam	2-6	till	300-700	89	108
7J13	50-75	2-4	sand & gravel	Clay Loam	0-2	till	300-700	93	114
7J14	75-100	4-7	sand & gravel	Clay Loam	0-2	till	300-700	100	121
7J15	75-100	4-7	sand & gravel	Clay Loam	0-2	till	300-700	97	118
7J16	75-100	4-7	sand & gravel	Clay Loam	2-6	till	300-700	96	115

Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7J17	100+	4-7	sand & gravel	Clay Loam	6-12	till	300-700	87	98
7J18	100+	2-4	sand & gravel	Clay Loam	0-2	till	100-300	74	97
7J19	100+	4-7	sand & gravel	Clay Loam	2-6	till	300-700	91	110
7J20	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	114	133
7J21	50-75	4-7	sand & gravel	Clay Loam	6-12	till	300-700	97	108
7J22	50-75	4-7	sand & gravel	Clay Loam	2-6	till	300-700	101	120
7J23	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	120	140
7J24	75-100	4-7	sand & gravel	Clay Loam	6-12	till	300-700	92	103
7J25	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	127	146
7J26	15-30	4-7	sand & gravel	Clay Loam	0-2	till	300-700	128	149
7J27	15-30	4-7	sand & gravel	Clay Loam	6-12	till	300-700	123	134
7J28	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	119	137
7J29	30-50	4-7	sand & gravel	Clay Loam	6-12	till	300-700	115	125
7J30	50-75	4-7	sand & gravel	Clay Loam	6-12	till	100-300	91	104
7J31	50-75	4-7	sand & gravel	Clay Loam	2-6	till	100-300	95	116
7J32	100+	2-4	sand & gravel	Clay Loam	2-6	till	100-300	73	94
7J33	50-75	4-7	sand & gravel	Clay Loam	6-12	till	100-300	97	110
7J34	30-50	4-7	sand & gravel	Clay Loam	6-12	till	100-300	112	124
7J35	30-50	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	129	147
7J36	30-50	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	125	141
7J37	30-50	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	121	129
7J38	15-30	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	135	151
7J39	15-30	4-7	sand & gravel	Clay Loam	12-18	till	700-1000	132	136
7J40	15-30	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	139	157
7J41	75-100	4-7	sand & gravel	Clay Loam	0-2	till	300-700	103	124
7J42	75-100	4-7	sand & gravel	Clay Loam	2-6	till	300-700	99	118
7J43	75-100	4-7	sand & gravel	Clay Loam	6-12	till	300-700	95	106

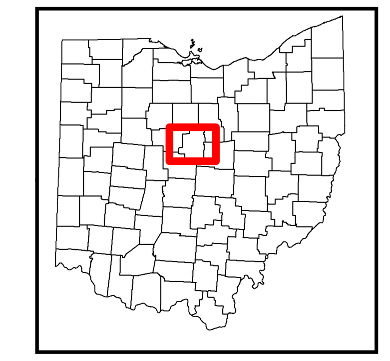
Setting	Depth to Water (Ft)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7J44	30-50	4-7	sand & gravel	Clay Loam	2-6	till	300-700	111	130
7J45	50-75	4-7	sand & gravel	Clay Loam	0-2	till	300-700	110	130
7J46	75-100	4-7	sand & gravel	Clay Loam	6-12	till	100-300	86	99
7J47	75-100	4-7	sand & gravel	Clay Loam	0-2	till	100-300	91	114
7J48	15-30	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	138	154
7J49	30-50	4-7	sand & gravel	Clay Loam	0-2	till	300-700	117	137
7J50	30-50	4-7	sand & gravel	Clay Loam	6-12	till	700-1000	129	136
7J51	30-50	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	133	148
7J52	30-50	4-7	sand & gravel	Silty Loam	0-2	till	700-1000	136	156
7J53	75-100	4-7	sand & gravel	Clay Loam	2-6	till	700-1000	108	125
7J54	30-50	4-7	sand & gravel	Clay Loam	0-2	till	700-1000	134	151
7J55	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	129	147
7J56	50-75	2-4	sand & gravel	Clay Loam	2-6	till	300-700	92	111
7J57	50-75	2-4	sand & gravel	Clay Loam	2-6	till	100-300	83	104
7J58	50-75	4-7	sand & gravel	Clay Loam	2-6	till	300-700	109	127
7J59	30-50	4-7	sand & gravel	Silty Loam	6-12	till	300-700	117	130
7J60	30-50	4-7	sand & gravel	Sandy Loam	6-12	till	300-700	121	140
7J61	30-50	2-4	sand & gravel	Clay Loam	2-6	till	100-300	93	114
7J62	100+	2-4	sand & gravel	Clay Loam	0-2	till	300-700	80	101
7J63	30-50	2-4	sand & gravel	Silty Loam	6-12	till	300-700	97	111
7J64	15-30	4-7	sand & gravel	Clay Loam	2-6	till	300-700	129	147
7J65	50-75	4-7	sand & gravel	Clay Loam	0-2	Till	300-700	92	123



Ground Water Pollution Potential of Morrow County

by

Kelly Barrett, Michael P. Angle, and Kathy Sprowls, 2013
Ohio Department of Natural Resources
Division of Soil and Water 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

N

Index Ranges

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

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

0 1 2 3 4 5
Miles

0 2 4 6 8
Kilometers

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