THE WHY AND HOW OF SOIL EVALUATION FOR SEPTIC SYSTEMS IN GLACIATED OHIO: WEARING MANY HATS

Nathan A. Wright[1]

ABSTRACT

Soil evaluations for onsite sewage treatment and dispersal can be challenging in glaciated regions. Ohio has many of these challenges due to the diverse nature of how soils have formed from glacial times to present. It is important to know local geology, local soils, soil forming factors, man's influence on developed and developing soils, geospatial mapping techniques, local regulations, and site safety protocols. Local geology knowledge can help the soil evaluator predict the soil types that formed from glacial deposits during the Wisconsin and Illinois age glaciers in Ohio. Maps of general soil types in a region overlain with topographic data can also guide a soil evaluator in selecting the best areas for onsite residential septic effluent treatment. A soil evaluator needs to know the many soil limits to septic effluent treatment. Identification of these limits helps the septic system designer meet all regulations. Soil evaluations can be performed by many methods to view and collect soil layer information. These include digging a pit, use of a soil bucket auger, or a hollow tube soil probe. We use a large diameter (1.25-inch dia.) hollow tube probe to collect an intact core that is trayed and taken back to our lab to get a clearer, more comprehensive soil profile description. A complete site/soil map and soil profile is prepared to assist a septic system designer identify limits to septic effluent treatment and meet local septic regulations.

INTRODUCTION

To properly evaluate soils for onsite sewage treatment, a soil evaluator must wear many hats that represent the bank of knowledge involved in this process. This person must know local geology, soils, geospatial mapping, site safety, and local regulations.

A soil evaluator must know local geology of the earth's surface in their area of practice. For this presentation, I am focusing on the glaciated regions of Ohio. Figure 1 shows the surficial geology of the entire state that includes both Wisconsin and Illinois age glacial deposits as well as unglaciated areas. It shows the diversity of glacially deposited materials that have developed into soils across Ohio. The map is limited to 13 different major types of soil parent materials. A more detailed map of my area of work can be seen in Figure 2. This area is all Wisconsin age glacial deposited materials. It includes 7 different major groups of parent materials. These major groups can be subdivided into more detailed zones that affect soil formation. A look at these more detailed parent material zones can be seen in Figure 3. It is a zoomed in view to where this conference is being held, Erie County, Ohio. The county contains 8 subgroups of glacial parent material as seen in the Ohio Geological Survey Interactive Map.

[1]Certified Professional Soil Scientist, Geophyta, Inc.

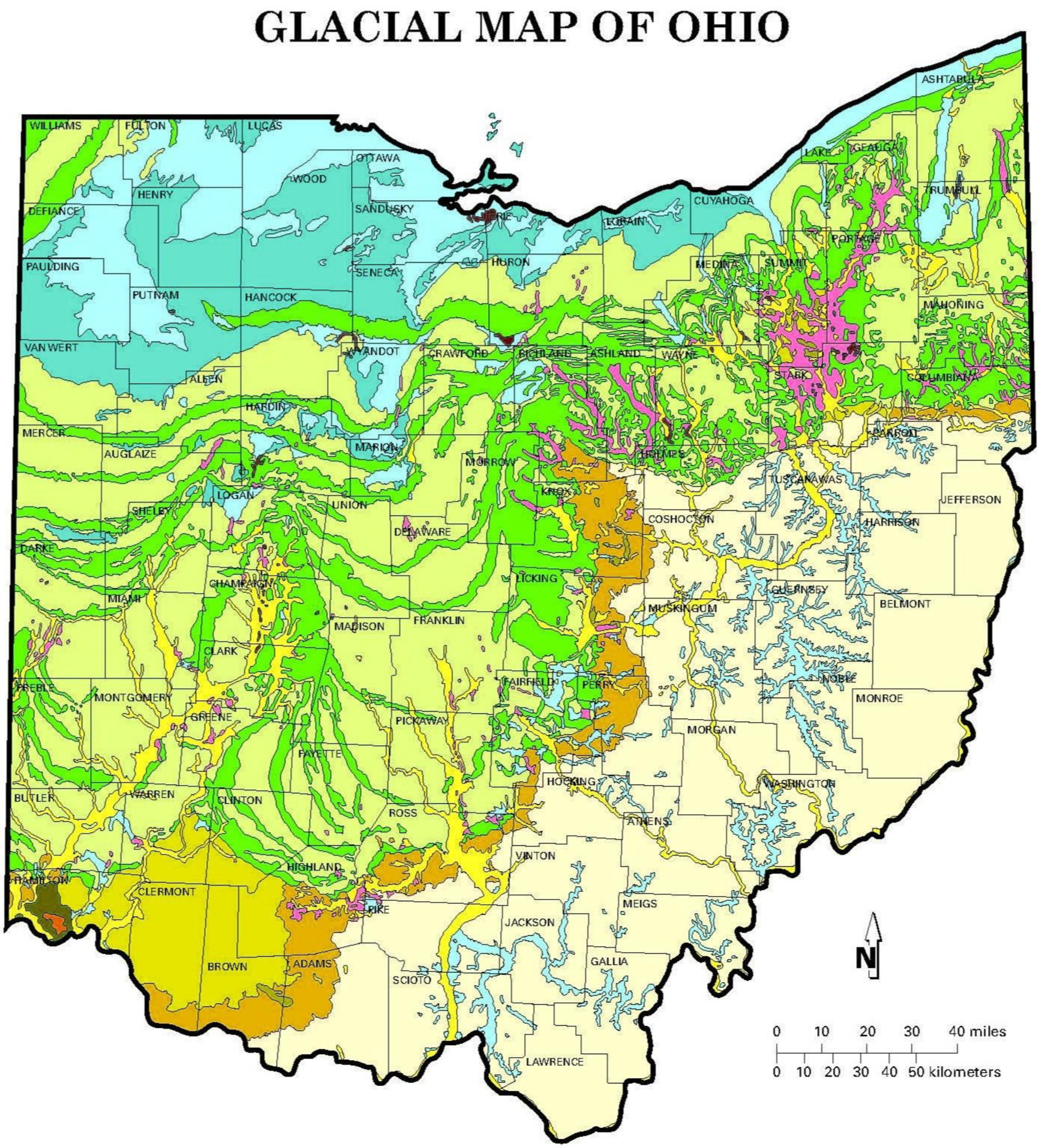

Figure 1: Surficial Geology of Ohio - Overall. State of Ohio, Dept. of Nat. Res., Geological Survey.

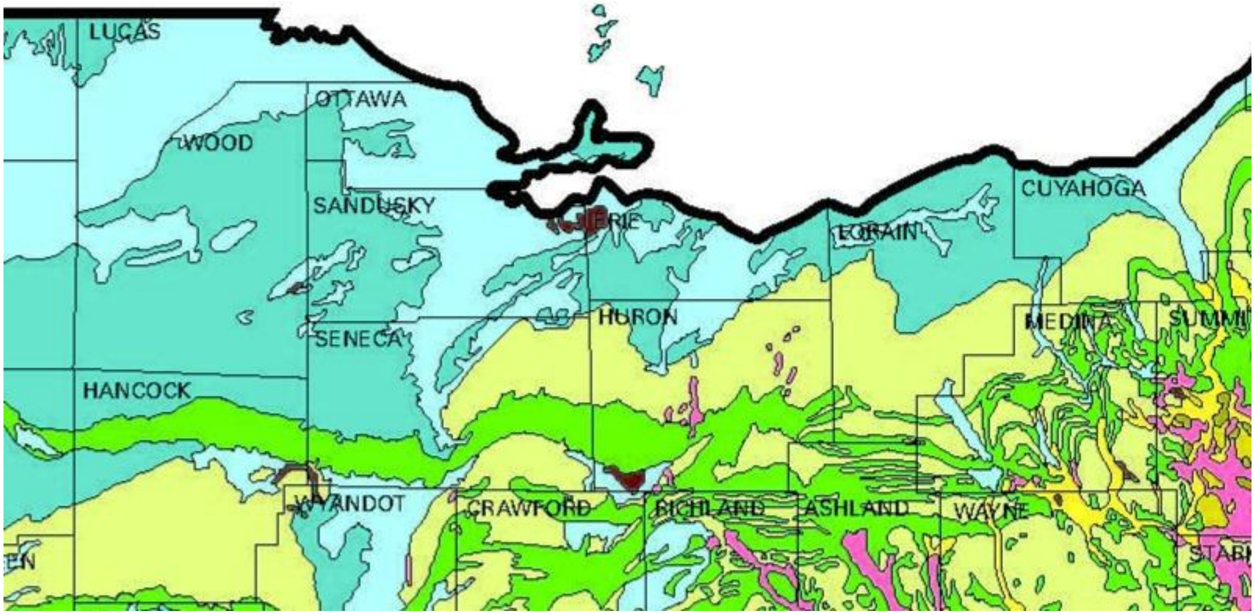

Figure 2: Surficial Geology of Ohio – North Central Ohio. State of Ohio, Dept. of Nat. Res., Geological Survey.

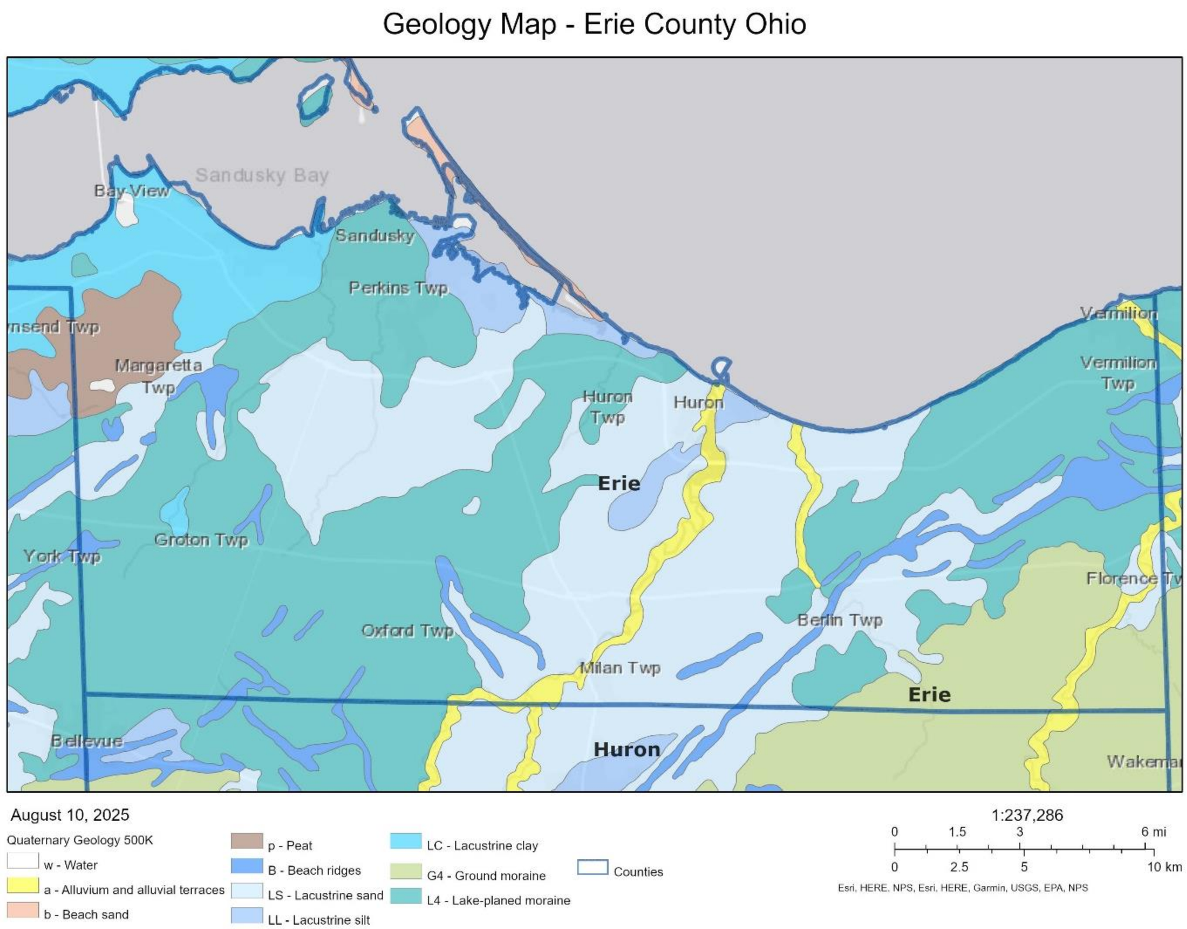

Figure 3. Ohio Geology Interactive Map. Surficial Glacial Geology of Erie County Ohio.

Now we switch from glacial parent material areas to soil types within each surficial subgroup. Figure 4 is a map of the Kalahari Resort and surrounding lands with USDA maps of soil types within the lacustrine sand glacial subgroup. There are approximately 10 different soil types within this region around the resort. Also keep in mind that these soil type areas may have small inclusions of other soil types due to the limits of mapping performed in the late 1970s. This illustrates the amazing diversity of soils that can result from glacial activity. It can take a lifetime of study in the soil sciences to just begin to understand the diversity of soils within a small region of 15 counties within north central Ohio.

Each soil has its own unique capabilities to treat and disperse septic effluent. So, why do we use soil to treat septic effluent? We use soil for its ability to "clean up" septic effluent. Soil has an amazing diversity of microorganisms. Hoorman and Islam (2010), plus Vieira and Nahas (2005), and many others have reported the quantity of organisms by type.

Figure 4. Geographic Information System Map of Kalahari Resort and Surrounding Land with Soil Type Overlay with Soil Codes.

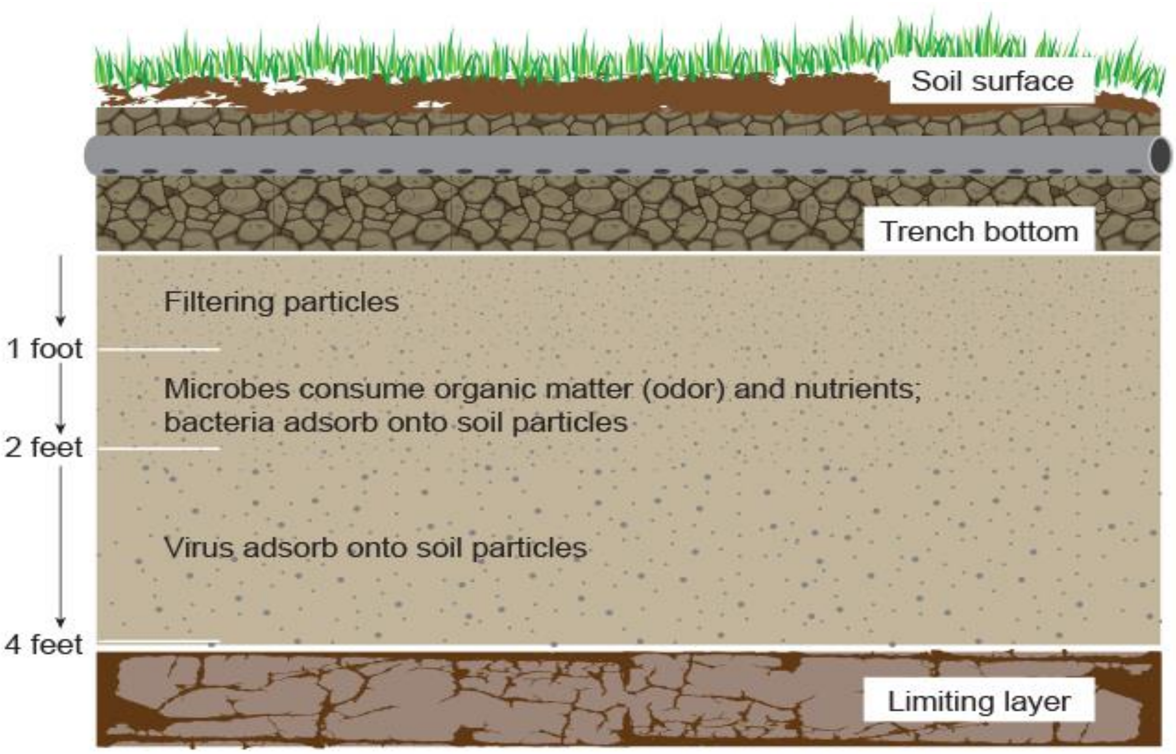

Figure 5: Wastewater Treatment Depths in Unsaturated Soil. Mancl and Slater, 2016.

In general, one teaspoon of soil may contain 1 billion bacteria, 100 million actinomycetes, and 1 million fungi. These microorganisms serve as the “treatment factory” to remove contaminants in sewage.

A look at the amount of unsaturated soil to achieve full treatment of sewage is presented in figure 5, as presented by Mancl and Slater (2106). The first foot of soil can filter most organic particles from effluent as well as some phosphorus adsorption. The second foot of soil will allow for removal of organic chemicals and pathogenic bacteria. The third and fourth foot of soil can assist in adsorption and destruction of pathogenic viruses. All these activities are the result of native soil microorganisms in association with the soil matrix of sand, silt, and clay. The exact amounts of wastewater removal within the soil profile depends on soil texture, structure, moisture content, and temperature, as well as method of effluent application. Keep in mind that this is unsaturated soil; a soil with good aeration. Long term, saturated soil loses its ability to treat septic effluent due to a shift in the types of microorganisms that cannot treat contaminants.

It is the author’s belief that most environmental regulations wish to achieve a state of being “At One with Nature” to protect ground and surface waters from septic effluent contamination. Yet, many soils in north central Ohio contain limits that prevent full treatment of septic effluent. Consequently, the state of Ohio has performed an economic analysis of costs of onsite treatment versus environmental risk to set soil depth requirements based on type of soil limit. A few of these limits include bedrock depth, soil layers with a high percentage of rock fragments, soil layers with very coarse sand, soil layers with very firm consistence, soil layers with greater than 45% clay, and shallow seasonal high-water tables.

Depth to bedrock directly determines the total soil depth above the rock to treat effluent. We see areas of surfacing bedrock in a few areas in north central Ohio, followed by areas with a few inches to 12 inches of soil. Ohio regulations state that any new build, residential onsite septic absorption area needs at least 12 inches of soil above bedrock. The obvious limit is total depth of soil. There are special septic treatment components available to achieve soil depth credits needed for these areas.

Highly permeable soil layers are considered as limiting because septic effluent moves too quickly through these layers. A high percentage of rock fragments within the native soil may result in too little soil between the fragments to adequately treat effluent as it moves between the rock fragments. We generally see these layers on top of bedrock from decomposing, weathered bedrock. We also see these layers in highly water sorted glacial outwash because of melting glaciers. A special case of highly permeable soil is very coarse sand. Again, effluent passes through the soil too fast for treatment. We usually see this in north central Ohio in highly water worked sand from glacial outwash. A highly permeable soil layer cannot be counted in soil depths used for septic system design.

Soil layers which have very firm consistence refers to the compacted nature of the soil caused by glacier deposition of parent material. It has very little or no water infiltration capability. This same condition of firm consistence can result from agricultural tillage and equipment travel paths on construction sites. This limits water movement through these layers and is not a useable soil layer in septic system design.

Soil layers with greater than 45% clay content occur commonly in north central Ohio and are generally associated with the glacial lake deposited sediments. These high clay layers consist of very small soil particles that pack together and severely limit water movement through the soil. They exhibit a high degree of water saturation for periods exceeding four weeks out of every year. This degree of saturation restricts septic effluent treatment by aerobic microorganisms. These layers restrict septic effluent treatment and must be accounted for in a septic system design.

Lastly, some soil layers can exhibit a temporary and seasonal water saturation where septic effluent will move slowly when rainfall exceeds this soil layer's ability to drain fast enough. This is referred to as a perched, seasonal water table (PSWT). In north central Ohio, this limit is very common due to subsoil layers that are higher in clay content and have poorer structure development than the surface soil. Ohio's residential septic rules establish PSWT as a limit and must be considered in septic system design.

MATERIALS AND METHODS

There are many materials needed before a thorough site/soil evaluation. First, a detailed site map from the landowner/homeowner is necessary to locate the site and some of its limits such as existing utilities, a parcel identification number to use on most county auditor websites, and number of bedrooms. Next, we construct a site map with geographic information system software that overlays an aerial image with topographic contour lines, soil type polygons, designated wetlands, and flood zones. Finally, a call or online entry of site information is performed to have underground utilities marked through "Call Before You Dig", 811, Ohio Utilities Protection Service (OUPS). This provides OUPS the scope of excavation and location.

Soil samples can be collected by many methods to view and collect soil layer information. These include digging a pit, use of a soil bucket auger, or a hollow tube soil probe. We use a large diameter (1.25-inch dia.) hollow tube probe to collect an intact core that is trayed and taken back to our lab to get a clearer, more comprehensive soil profile description. A complete soil description is needed for a designer to identify limits to septic effluent treatment and meet local septic regulations. We utilize a small four-wheel all-terrain vehicle to carry our equipment that includes three depth increment heavy wall soil tubes that can be driven into the soil with a power fence post driver. A lever jack and/or rail jack is used to extract core samples. Four-foot-long soil core trays are used for sample core transport that are collected to 48 inches or until bedrock.

RESULTS

Soil core samples are described at our laboratory under controlled lighting for accurate determination of soil colors, horizon designation, soil structure, soil texture, and consistence. These are all reported on a standard form required by the Ohio Department of Health. On this form we also identify limits to soil infiltration that include all the above-described soil limits. Figure 6 presents one these reports.

Site and Soil Evaluation for Sewage Treatment and Dispersal

County: Lorain
Township / Sec.: Brownhelm/Vermilion City
Property Address: [redacted]
OR Location: Parcel: [redacted]
Applicant Name: [redacted]
Address: [redacted]
Phone #:
Lot #:
Test Hole #: D
Latitude/Longitude: 82°19'35.555"W 41°24'45.348"N
Method: ____ Pit ___ Auger X Probe; 1 1/4" dia.

Land Use / Vegetation: Legacy Agric. Row Crop
Landform: Glacial Lake Plain
Position on Landform: Flat
Percent Slope: 0-1
Shape of Slope: Linear - Linear

Date: 6-May-13
Evaluator: Nathan Wright
Geophyta, Inc.
2685 C.R. 254
Vickery, OH 43464
Phone#: 419-547-8538

CPSS
Certified Professional Soil Scientist
Certification #: 19395
Signature: Nathan Wright

Soil Profile		Estimating Soil Saturation			Estimating Soil Permeability							
		Munsell Color (hue, value, chroma)										
			Redoximorphic Features		Texture			Structure				
Horizon	Depth (inches)	Matrix Color	Concentrations	Depletions	Class	Approx. % Clay	Approx. % Fragments	Grade	Size	Type (shape)	Consistence	Other Soil Features
A	0.0-7.0	10YR4/3	uniform	uniform	SiCL	30	0	2-mod	coarse	gr	friable	
B1t	7.0-9.0	10YR3/4	uniform	uniform	SiCL	35	0	2-mod	coarse	gr	friable	
B2t	9.0-14.0	10YR4/4	5%7.5YR4/6	15%10YR5/2	SiCL	40	0	2-mod	fine	sbk	friable	
Cg	14.0-32.0	10YR5/1	30%7.5YR4/6	matrix	SiC	45	0	1-weak	medium	sbk	firm	
R	32	-	-	-	-	-	-	-	-	-	-	soft shale layers

Limiting Conditions	Depth to (in.)	Descriptive Notes	Remarks / Risk Factors:
Perched Seasonal Water Table	9.0	Restricted in B2t & Cg	Tyler Table: A - B1t horizon (0.0 - 9.0) SiCL
Apparent Water Table	none		ILR(>30mg/L) = 0.4 gal/day/ft^2, ILR(<30mg/L) = 0.6 gal/day/ft^2
Highly Permeable Material	none		HLLR = 2.4 gal/day/ft
Bedrock	32.0	Soft shale layers	4 bedroom min. required absorption area = 1200 sq.ft.;
Restrictive Layer	14.0	SiC and weak structure	5xW Soil Absorption Box: 30'W x 200'L

Note : The evaluation shall include a complete site plan or site drawing including all requirements in paragraphs (B)(1) through (B)(4) of OAC 3701-29-08.

ODH - Dec 2006 - Revised Sept 2007 - Modified By Geophyta, Inc.

Figure 6. A typical Soil Profile Description from Geophyta, Inc.

We produce a final report that also includes a map of the site with all the features mentioned above, plus a new layer that shows the areas of soil represented by our soil cores. Figure 7 is an example of the type of map a customer will receive from us.

HSTS Site/Soil Evaluation - 921 CR 94
(Parcel 14-10-00-0001-00)

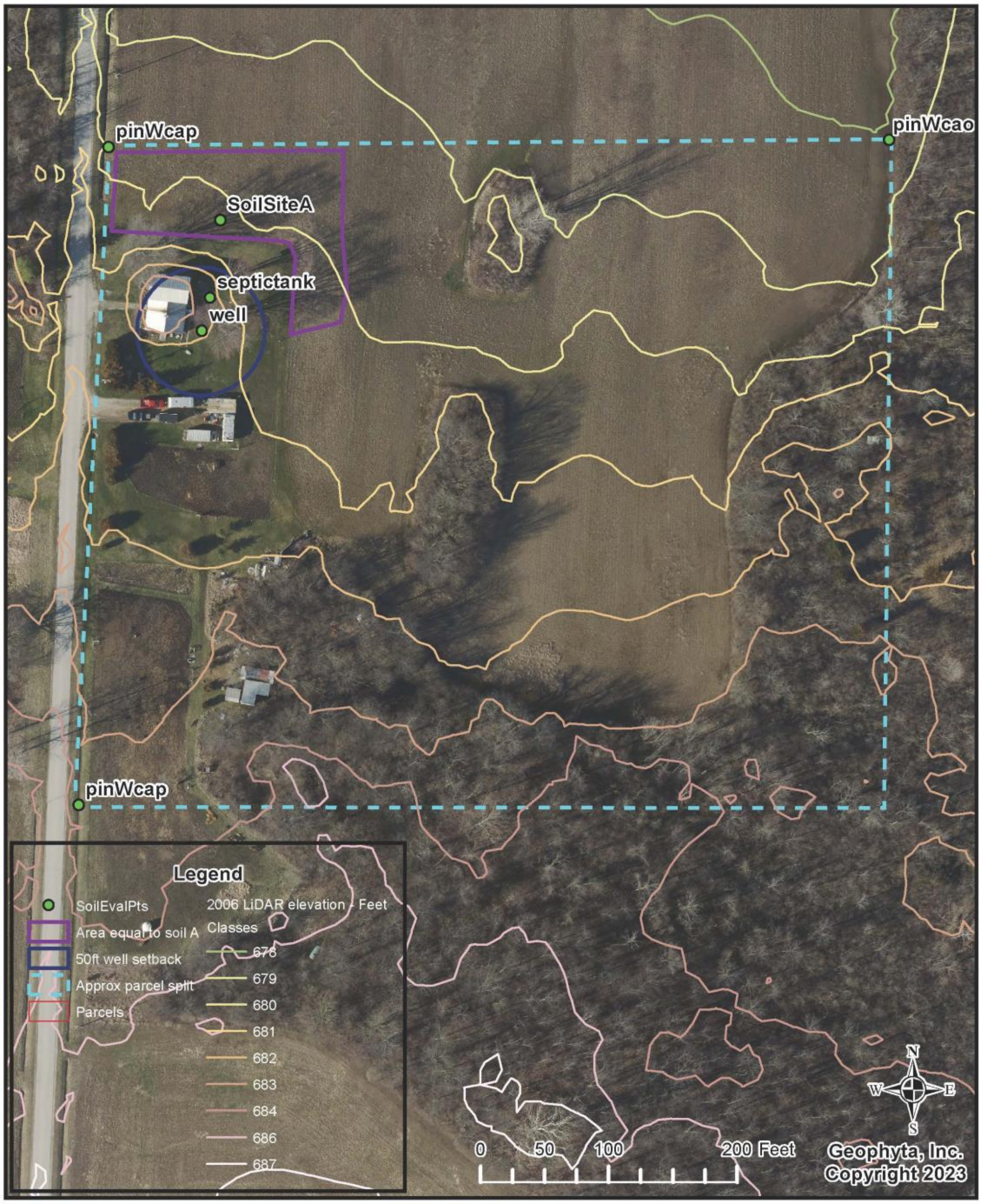

Figure 7. A site/soil evaluation map providing and aerial image, proposed parcel split, 1 foot elevation contours, a water well and its setback circle, and a soil polygon representative of the soil core collected.

LITERATURE CITED

Hoorman, J.J. and Islam, R. 2010. Understanding Soil Microbes and Nutrient Recycling. SAG-16. Ohio State University Extension. Agriculture and Natural Resources.

Mancl, K and Slater, B. 2016. Using Soil to Remove Pollutants from Wastewater. AEX-745, Ohio State University Extension, Agriculture and Natural Resources.

Ohio Geology Interactive Map. Surficial Glacial Geology of Erie County Ohio. https://gis.ohiodnr.gov/website/dgs/geologyviewer/#

Surficial Geology of Ohio. State of Ohio, Dept. of Nat. Res., Geological Survey. dam.assets.ohio.gov/image/upload/ohiodnr.gov/documents/geology/MiscMap_OhioGlacialMap_2005.pdf

The Ohio Department of Health Sewage Treatment Systems Regulations. 2015. https://codes.ohio.gov/ohio-administrative-code/chapter-3701-29.

Vieira, F.C.S. and Nahas. E. 2005. Comparison of microbial numbers in soils by using various culture media and temperatures. Microbiological Research. Volume 160, Issue 2, 25 April 2005, Pages 197-202

Presented at NOWRA 2025 Mega-Conference, October 19-22, 2025.