



On-Lot Septic Field Limiting Conditions: What are they? Where are they Found? Why Do They Matter?

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For The Association of Ohio Pedologists

March 28, 2019

AN ASSOCIATION OF OHIO PEDOLOGISTS EDUCATIONAL OUTREACH PROJECT

Recognizing contributions for illustrations and
concepts from AOP members:

Steve Hamilton

Duane Wood

Anna Michael

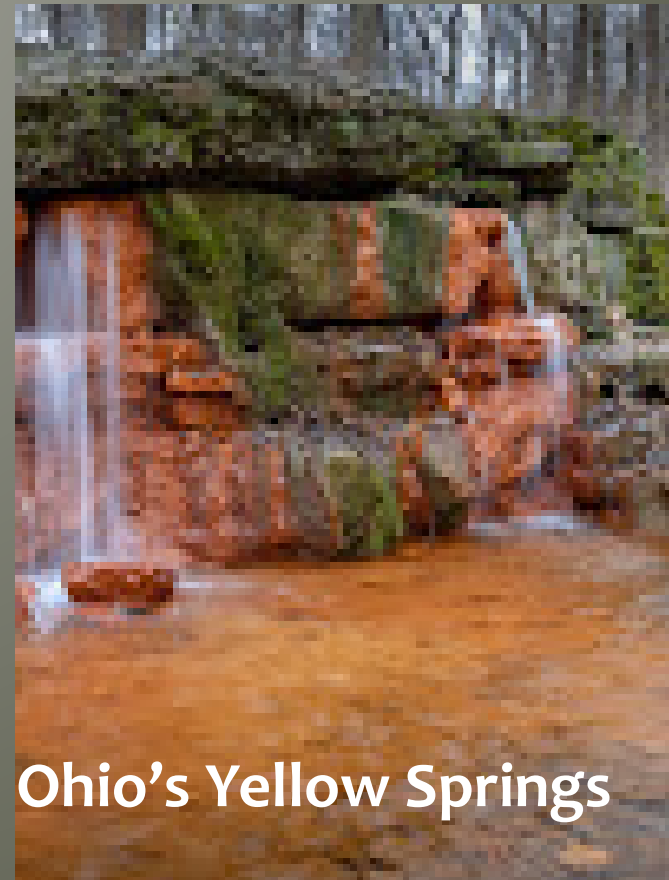
Larry Tornes

Susan Rice

ALL SOILS AND UNDERLYING GEOLOGY IN OHIO LEAK TO SOME EXTENT

We know this because although Ohio receives ~ 40" of precipitation each year

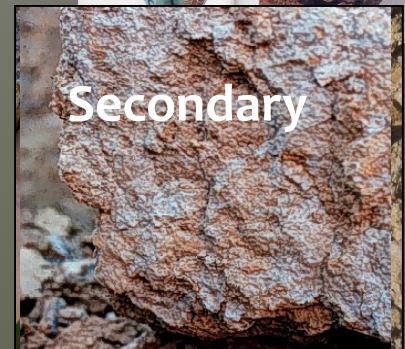
1. We are not building arks
2. Our water wells recharge each year
3. Some of our precipitation recharges the ground water each year but some areas leak more than others
4. Septic leach fields need to leak not too much but just enough to work – the Goldilocks zone



Ohio's Yellow Springs

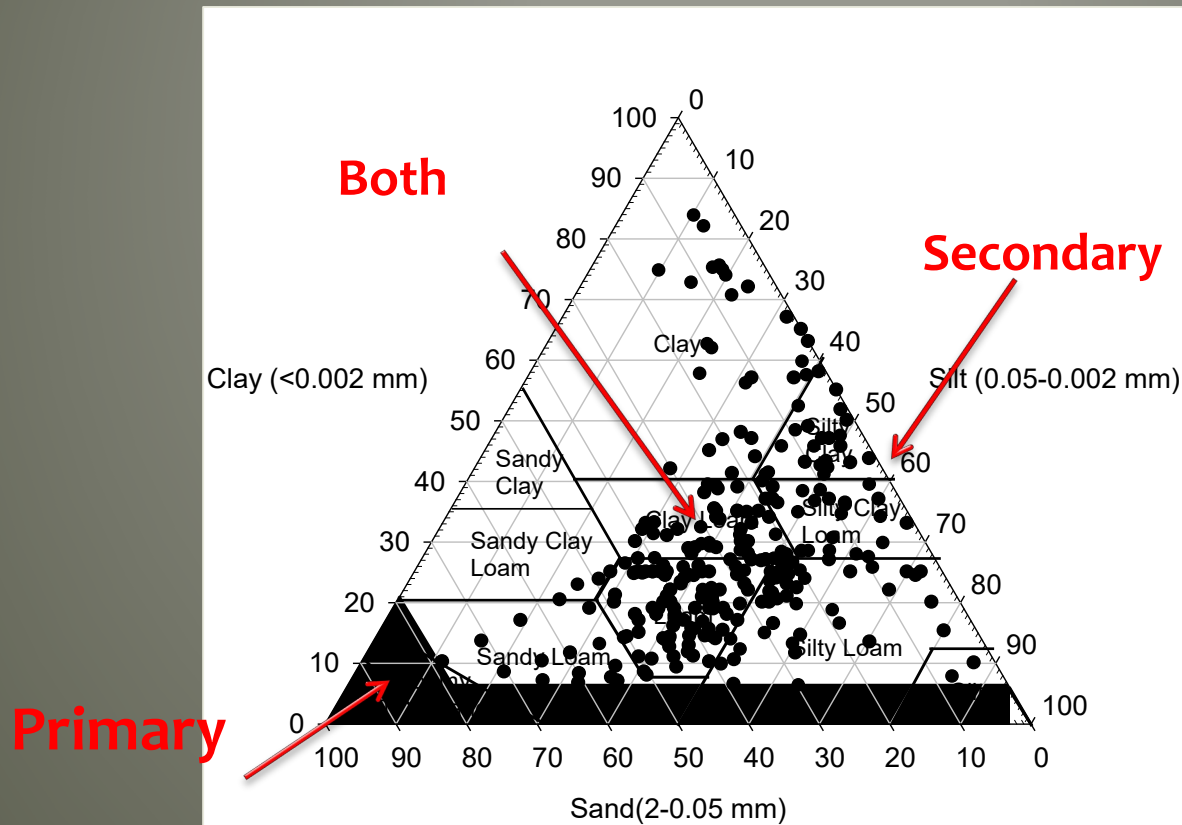
RECHARGE HAPPENS TWO WAYS

1. Through the soil (between the grains) or the underlying geology matrix... primary porosity
2. Around the matrix materials through “macropores” i.e. fractures, wormholes, animal tunnels, root channels and traces, etc....secondary porosity
3. If trying to determine how much recharge is happening at a given time, i.e. recharging a well field, looking for “effective porosity” which is often a combination of the two
4. If trying to prevent contamination, looking for the “fastest route”



HOW DO WE KNOW THIS?

25+ YEARS OF ORGANIZED RESEARCH IN OHIO



A Function of
grain sizes,
Ohio's
geologic
history and
clay
mineralogies

Combination of field and laboratory data
Kim & others, 2018, Jour Engineering Geology

JUST BECAUSE YOU CAN MEASURE BOTH PRIMARY & SECONDARY POROSITY DOESN'T MEAN THEY ARE BOTH WORKING AT A SITE



Ohio Academy of Science 1997
Summer Field Workshop on Joints and
Fractures in Ohio Tills: Site
Investigations Techniques & Field
Hydraulic Measurements

OSU's Molly Caren Agricultural Center
near London , Ohio (Farm Science
Review)

Measuring saturated hydraulic
conductivity of both fractured zones
and polygon matrix in Lewisburg silt
loam

Compact Constant Head Permeameter
(Amoozemeter)

Fausey & others, Ohio J Sci 100
(3/4):107-112, 2000

HOW DO WE KNOW THIS?

“FOUND” EXAMPLES OF ONLY SECONDARY POROSITY

Unstable *Green rust* colors were observed in the lowest, unconsolidated lacustrine unit in deep cores retrieved from the CECOS International Hazardous Waste Landfill in Clermont Co., OH.

The presence of *Green rust* colors implies minimal to no matrix flow of aerated water.

Fluids passing through these fine grained sediments must do so by preferential flow through fractures, sand stringers, etc.

“FOUND” EXAMPLES OF ONLY SECONDARY POROSITY



Lacustrine clays
estimated to be 0.78
MY from magnetic
polarity
measurements.




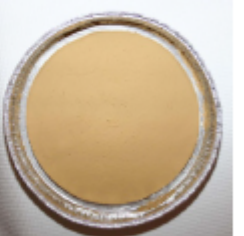

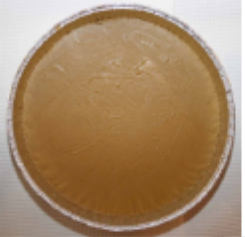
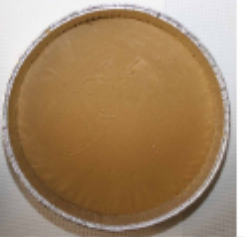
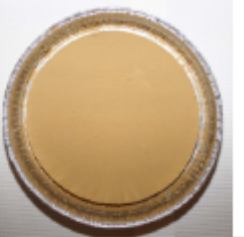




Weatherington-Rice and Bigham, Ohio J Sci 106 (2):35-44, 2006

LABORATORY STUDIES

EUN KYOUNG KIM'S CONTRIBUTION

OSU DISSERTATION 2006

Figure 7. Triplicate mud-pie tests for CECOS-A soil sample (leached) at 24.2 ± 2.1 °C and 51 ± 11 % relative humidity. The mixture contained 27.5 % sand, 38.5 % silt and 34.0 % clay.

	1 st Day	3 rd Day	4 th Day	26 th Day (Final day)	Result
Mud-pie #1					Volume shrinkage
Mud-pie #2					Volume shrinkage
Mud-pie #3					Crack

We will revisit these soils later

WHEN LOCATING A SITE FOR ON-LOT SEPTIC LEACH FIELD, LOOKING FOR THE GOLDILOCKS ZONE

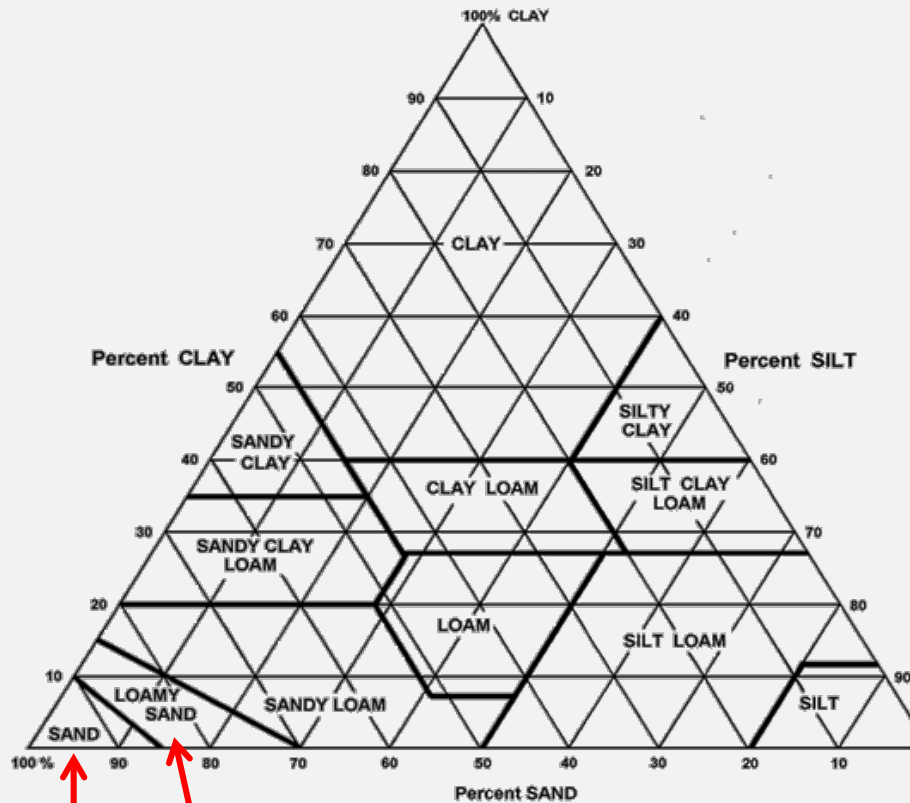
1. Papa Bear... soils are too tight (high water tables, low primary porosity, outbreaks of leachate to the surface, etc.)
Not adequate time for leachate treatment
2. Mama Bear....soils are too loose (sand and gravel, high primary porosity, rapid recharge to ground water, etc.) Not adequate time for leachate treatment
3. Baby Bear – The Goldilocks Zone...just right (drainage fast enough to allow leach fields to drain properly, slow enough not to allow rapid recharge to the ground water without treatment)
4. Ohio calls out the soils with limitations in OAC 3701-29-01(VV)(III) and OAC 3701-29-15(C) Table 2.... The Vertical Separation Distance and in situ soils requirements

OAC 3701-27-01 (VV)

“Highly permeable materials” means a layer through which effluent is expected to pass too quickly to provide adequate treatment, such as:

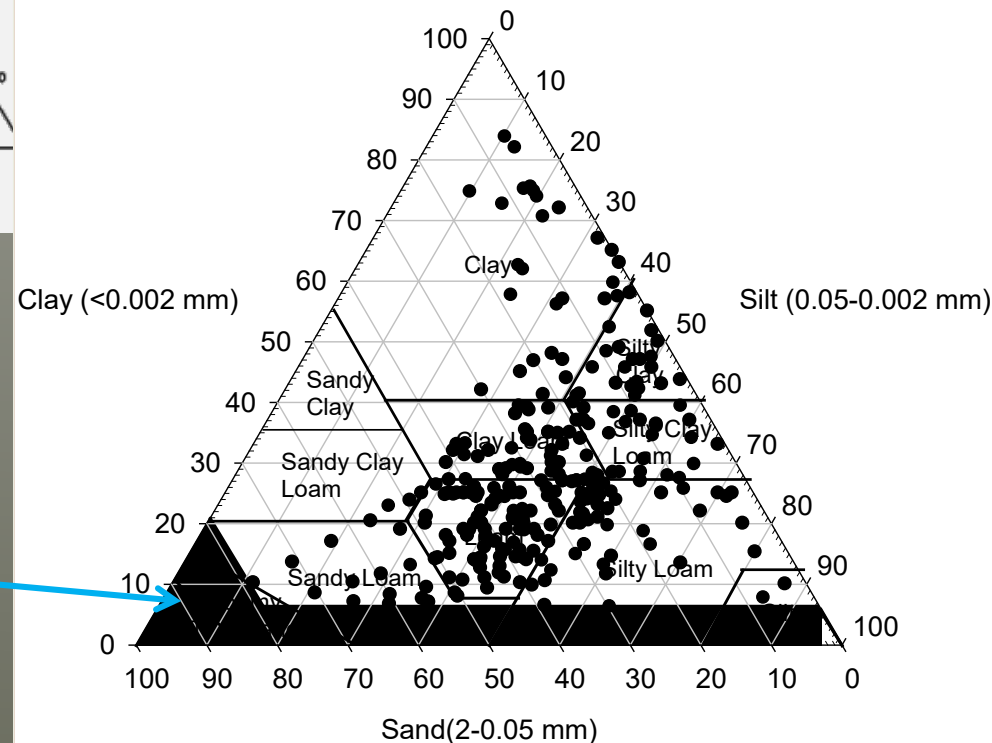
1. Soils with greater than 15% rock fragment size particles and a soil texture of : loamy sand, loamy course sand, coarse sand, sand, fine sand or very fine sand,
2. Soils with greater than 60% rock fragments size particles and the spaces between the rock fragments and the spaces between the rock fragments are filled with air, or soils other than fine textured soil, or
3. Any other layer deemed by the soil evaluator as highly permeable material

USDA Soil Textural Triangle



OAC 3701-27-01 (VV) calls out as highly permeable

Kim & Others, 2018, Jour. Eng Geol identifies as primary porosity flow



OAC 3701-29-01 (III)

“Limiting conditions” means a flow restrictive soil layer, bedrock, a water table, seasonal water table, groundwater or highly permeable material that limits or precludes the treatment or dispersal of effluent in the soil of a property where a sewage treatment system is located

OAC 3701-27-15 TABLE 2

Table 2. VSD and in situ soil requirements

Paragraph	Limiting Condition	Minimum VSD (inches)	Minimum unsaturated in situ soil within infiltrative distance (inches)
(D)	Limiting condition not specified in this table	18	8
(E)(1)	Fractured and/or Karst bedrock	36	12
(E) (2)	Ground water or aquifer	36	12
(E) (3)	Other limiting conditions identified in soil evaluation or by the board of health as having high risk of not meeting 3701-29-15 (A)	36	12
(F)	Highly weathered soils with weak structure or low to very low permeability developed on the low lime till plains are present	24	8
(G)	Perched seasonal water if not established by board of health	12	8
(G)	Perched seasonal water as established by a board of health	6	6

Page 73, definitions follow

BEFORE YOU SCHEDULE THE BACKHOE, PACK YOUR AUGERS OR READ THE SOILS REPORT – TAKE A FIELD TRIP

Why? Because soils form in/on the geologic landscape

If you know what the geomorphology (**study of the body of the earth**) of the area looks like, you will have major clues as to what site limitations you can expect

Make sure to bring your county Soil Survey and/or a tablet that provides access to the Web Soil Survey and the ODNR Div. Geological Survey maps along with you for references

WHY DOES IT MATTER?

Because you can get water through concrete in August but its what your site looks like in March that matters

What clues can you pick up from the landscape and the references?

WHAT DO YOU SEE?

Is the site on top of a hill, on the side slopes or in a flood plain next to a creek or river?

1. Top of hill may be shallow to bedrock (restricting layer)
2. Side slopes may be prone to leachate outbreaks
3. Flood plain soils may have high water tables, may have formed on alluvial or glacial outwash sand and gravel deposits



WHAT DO YOU SEE?

Is the site heavily wooded? In Ohio, if a site is heavily wooded with mature trees, it is probably too wet (**upland wooded swamp**) or too steep to farm

This lot in Worthington has been heavily wooded forever, cleared Oct. 2018 to encourage sale, standing water ever since

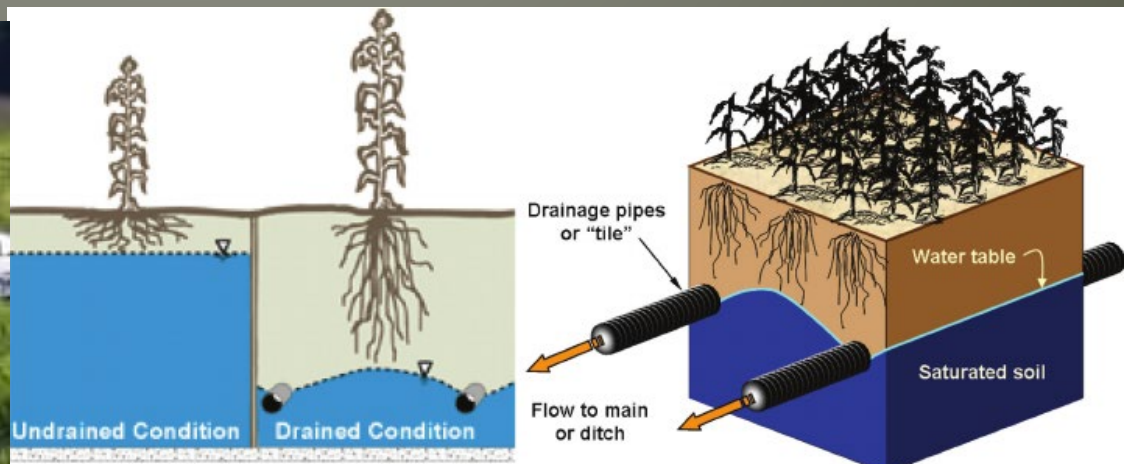


WHAT DO YOU SEE?

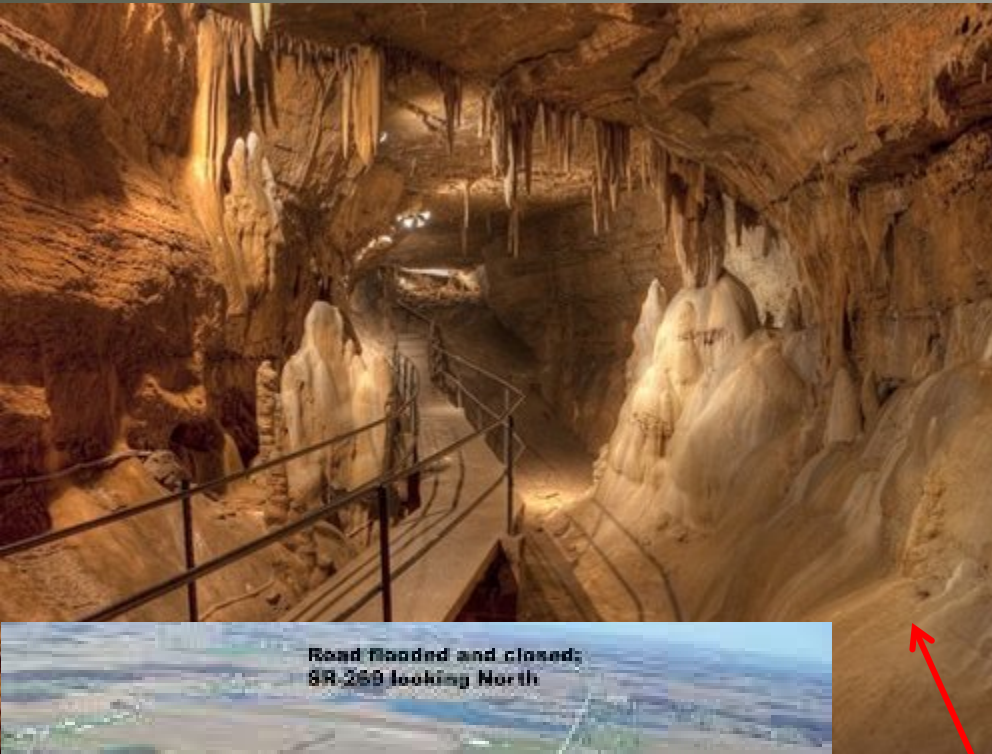
Is the site in agriculture? Does it have Agricultural Tile drainage?

Expect a high seasonal apparent or perched water table

Remember, we have drained 95% of Ohio's wetlands but some still remain



WHAT DO YOU SEE?



Seneca caves
Bellevue sink
holes
Springfield
Dolomite



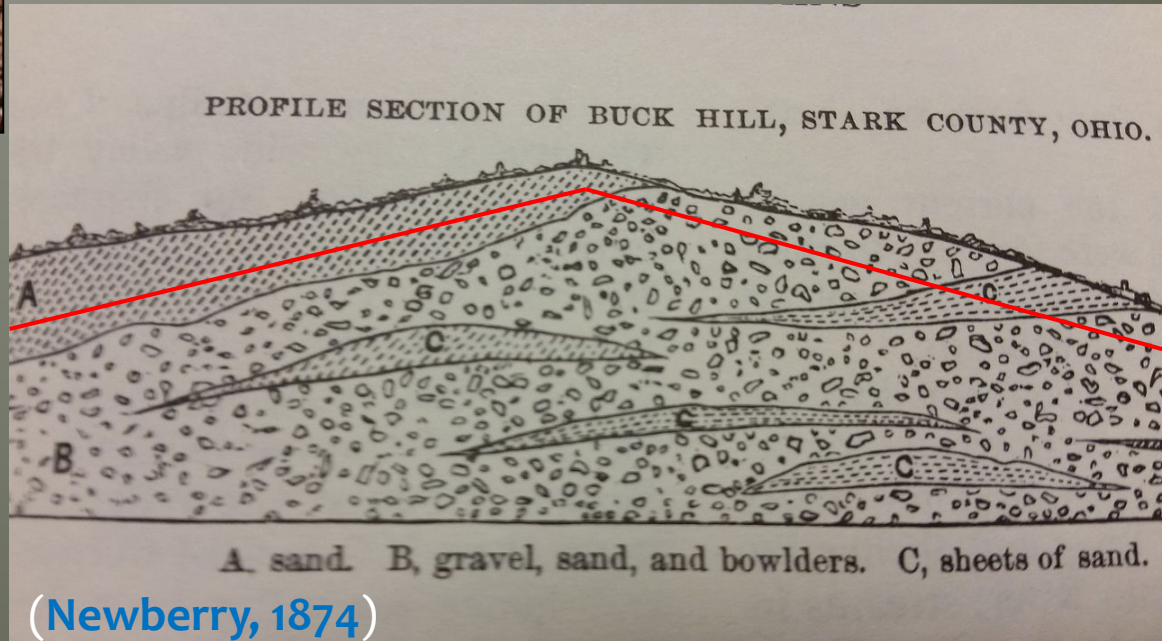
REVIEWING THE INDIVIDUAL SITE LIMITATIONS – A FLOW RESTRICTIVE SOIL LAYER

Can create a perched water table

Fragipan – a dense subsurface soils layer that perches water and roots, more common in Eastern low-lime tills, silica is involved – note fracture traces



A calcium carbonate cemented “C” Horizon in an Illinoian-aged Kame or kame terrace – common along the Hocking River south of Lancaster.



REVIEWING THE INDIVIDUAL SITE LIMITATIONS – A FLOW RESTRICTIVE SOIL LAYER

Natural Conditions

Fragipan in Northeastern low-lime Wisconsin-
aged glacial till

Lake Plain soils in northwest Ohio

“C” Ca horizons in Illinoian-aged coarse sand and
gravel deposits, often beyond the edges of
glacial ice advances down meltwater outwash
kame and kame terrace formations

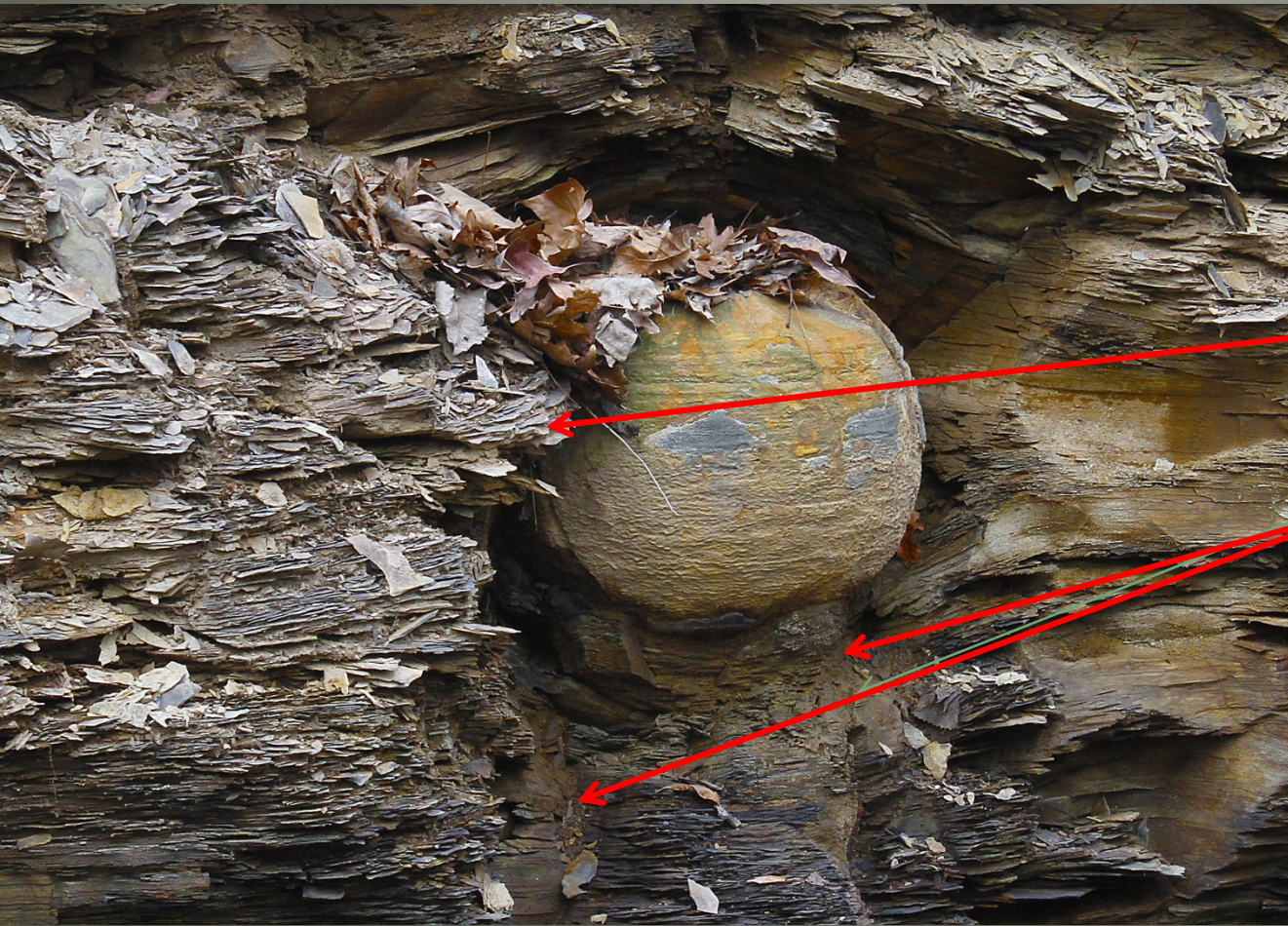
Manmade Conditions (agricultural & construction sites)

Using heavy equipment on soils that are too wet
will create a “hardpan” condition that perches
water moving from the surface to the underlying
aquifer.



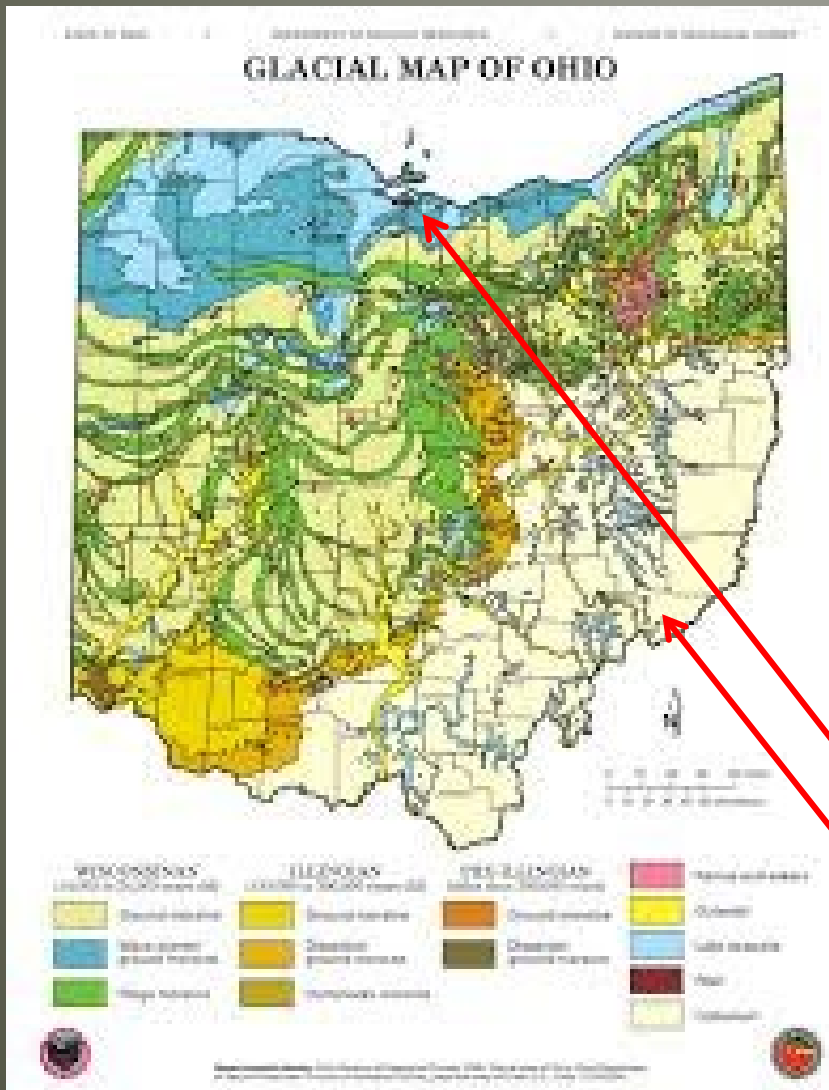
REVIEWING THE INDIVIDUAL SITE LIMITATIONS - BEDROCK

Can restrict leachate flow



Ohio Shale
(Highbanks
Metro Park),
flow is along the
shale layers and
down through
the fractures,
almost
completely
secondary
porosity

REVIEWING THE INDIVIDUAL SITE LIMITATIONS - BEDROCK



Thin spots in glaciated Ohio (Castalia Quarry Metropark, Erie County)

Beyond the glacial boundaries in south/southeast Ohio

REVIEWING THE INDIVIDUAL SITE LIMITATIONS – A HIGH WATER TABLE

Standing water all year long
Recharges the aquifer

Marshy area at
Pickerington Ponds
Metro Park

Marshes and wetlands
Apparent high water
table conditions

Saturated all the way to
the underlying aquifer

When Canal Winchester
or Groveport turn on
their wells, the pond
water levels fall



REVIEWING THE INDIVIDUAL SITE LIMITATIONS – A SEASONAL HIGH WATER TABLE

Virgin timber, vernal pools, marsh
marigolds, rare salamanders



© TrekOhio.com

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REVIEWING THE INDIVIDUAL SITE LIMITATIONS – A SEASONAL HIGH WATER TABLE

SOIL SURVEY OF FRANKLIN COUNTY, OHIO

Soil Surveys
on line
Descriptions
& tables

156

SOIL SURVEY

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MpC*: Milton----- Urban land.	Severe: depth to rock, percs slowly.	Severe: slope, depth to rock.	Severe: depth to rock, too clayey.	Moderate: depth to rock, slope.	Poor: area reclaim, thin layer.
MrB----- Mitiwanga	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: wetness.	Poor: wetness, area reclaim.
Ms----- Montgomery	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey hard to pack, ponding.
OcA, OcB----- Ockley	Slight-----	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too clayey.
OcC2----- Ockley	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope, too clayey.
Pm----- Pewamo	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
MoB, MoC2----- Milton	C	None-----	---	---	<u>Ft</u>	---	---	<u>In</u>	---	---	---	---
MpB*, MpC*: Milton----- Urban land.	C	None-----	---	---	>6.0	---	---	20-40	Hard	Moderate	High-----	Moderate.
MrB----- Mitiwanga	C	None-----	---	---	>6.0	---	---	20-40	Hard	Moderate	High-----	Moderate.
Ms**----- Montgomery	D	None-----	---	---	0.5-1.5	Perched	Nov-Jun	20-40	Hard	High-----	High-----	Moderate.
OcA, OcB, OcC2----- Ockley	B	None-----	---	---	+1-1.0	Apparent	Dec-May	>60	---	Moderate	High-----	Low.
Pm**----- Pewamo	B/D	None-----	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Pn*: Pewamo**----- Urban land.	B/D	None-----	---	---	+1-1.0	Apparent	Dec-May	>60	---	High-----	High-----	Low.

Once you know your soil name, be sure to check the tables in your soil survey

REVIEWING THE INDIVIDUAL SITE LIMITATIONS – GROUND WATER

Direct Connection

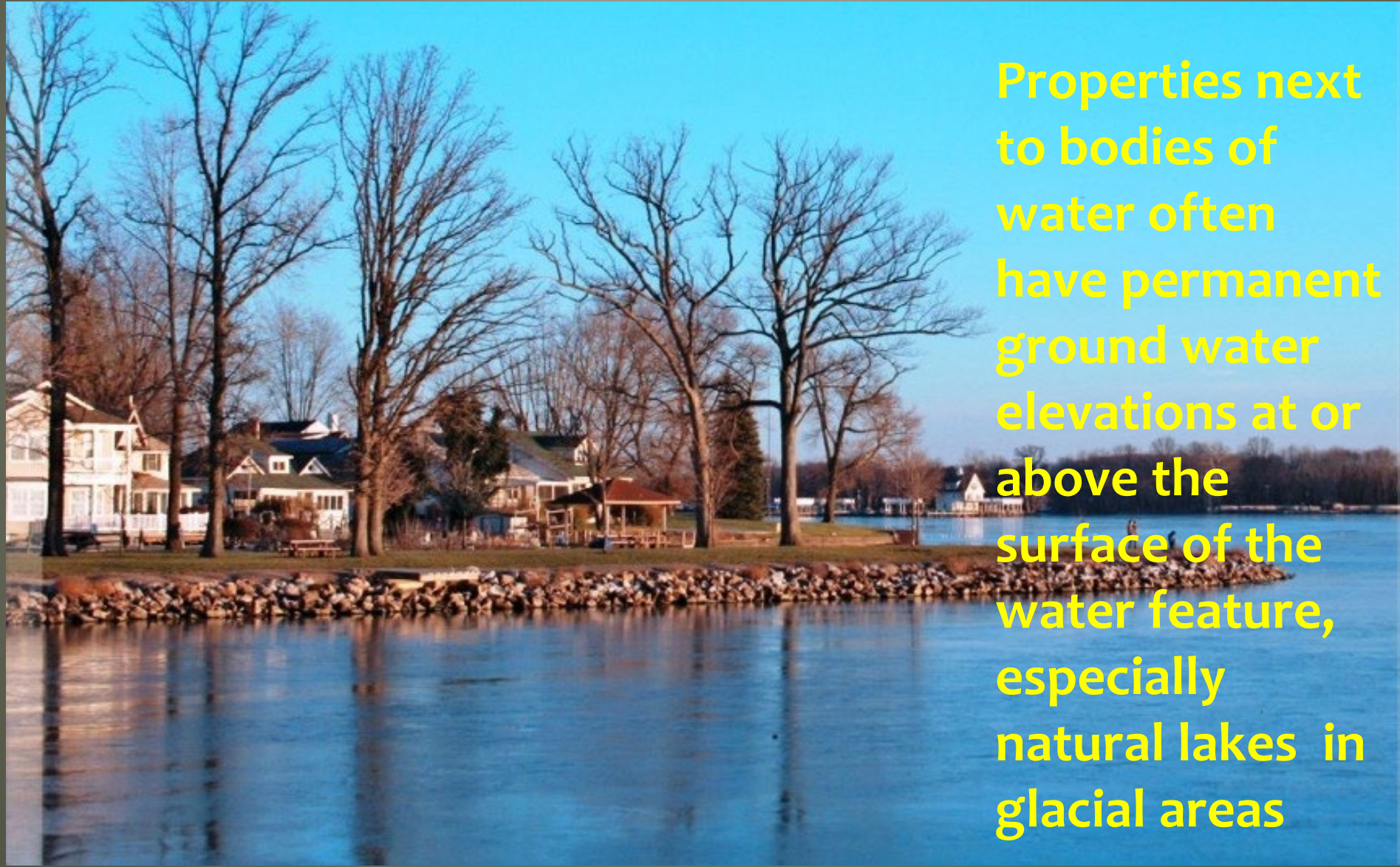
Glacial outwash buried valley sand & gravel pit, Licking River, Licking County



Glacial kettle lake,
Stage's Pond
Pickaway County



REVIEWING THE INDIVIDUAL SITE LIMITATIONS – GROUND WATER



Properties next to bodies of water often have permanent ground water elevations at or above the surface of the water feature, especially natural lakes in glacial areas

REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: > 15% ROCK FRAGMENTS & SANDY TEXTURE

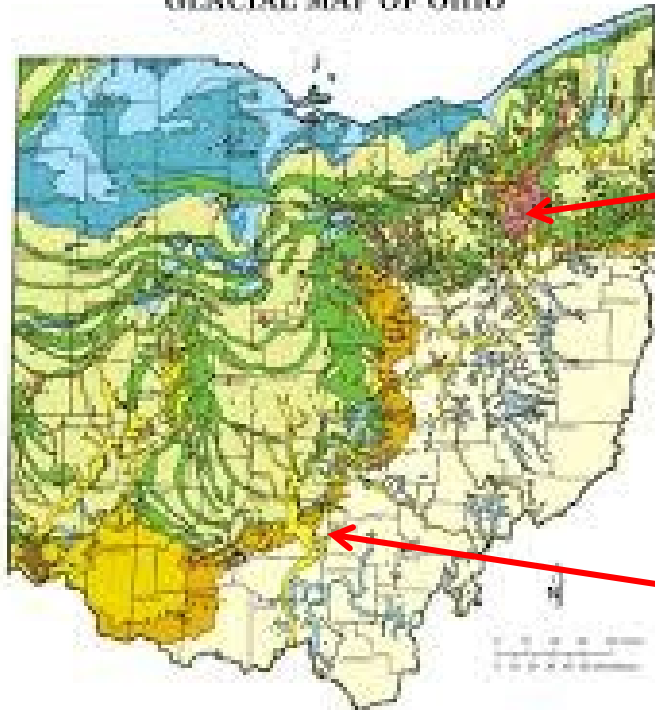


**Wisconsinan
kame terrace**

**This setting
develops
highly
permeable
soils like the
Chili Series of
northeastern
Ohio**

REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: > 15% ROCK FRAGMENTS & SANDY TEXTURE

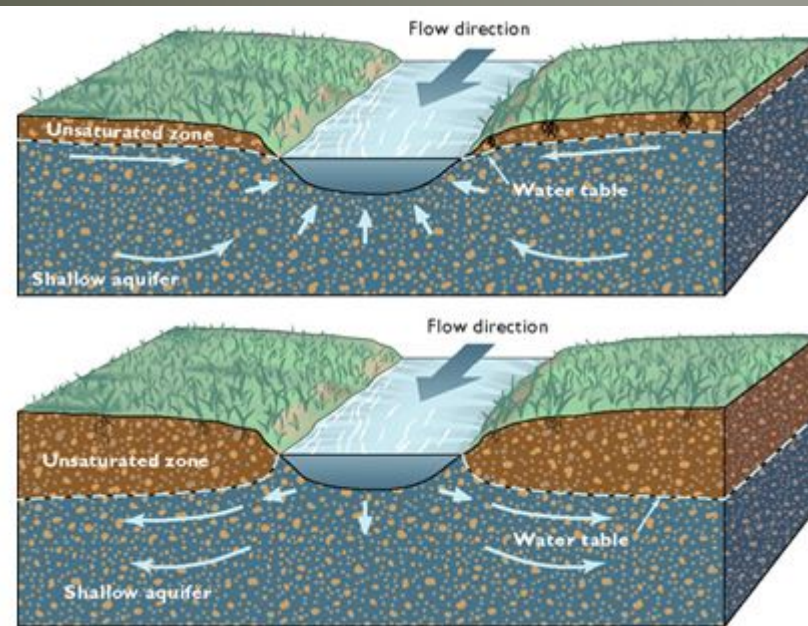
GLACIAL MAP OF OHIO



These conditions are typical of the large kame and kettle deposits in Portage, Geauga, Summit and Stark Counties and on kames and kame terraces along all the major south-flowing rivers that drained glaciated Ohio

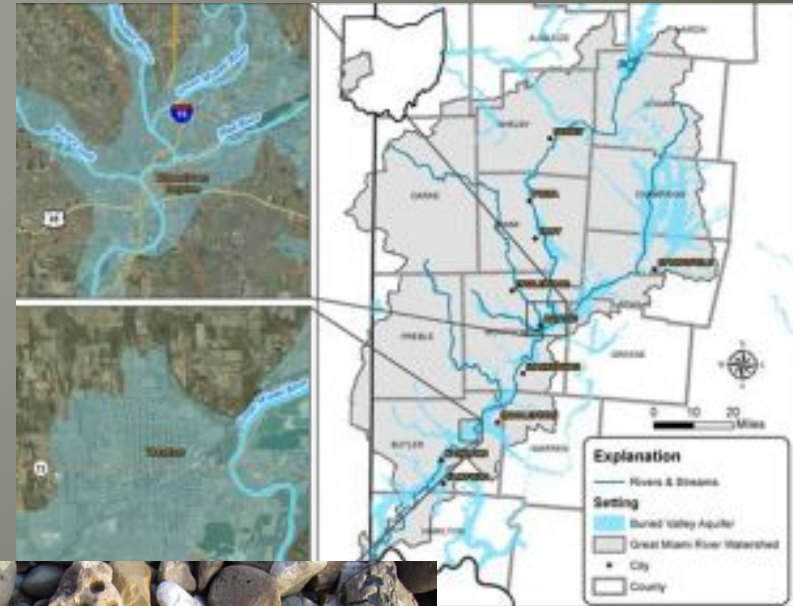
REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: > 60% ROCK FRAGMENTS, NO/COARSE FILL

Great Miami – Mad River System



From Winter and others, 1999

Relationship of a river and its buried valley aquifer



Gravels dredged from the Ohio River

REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: > 60% ROCK FRAGMENTS, NO/COARSE FILL

Some of the major buried
valleys of Ohio

Great Miami-Mad Rivers

Scioto River

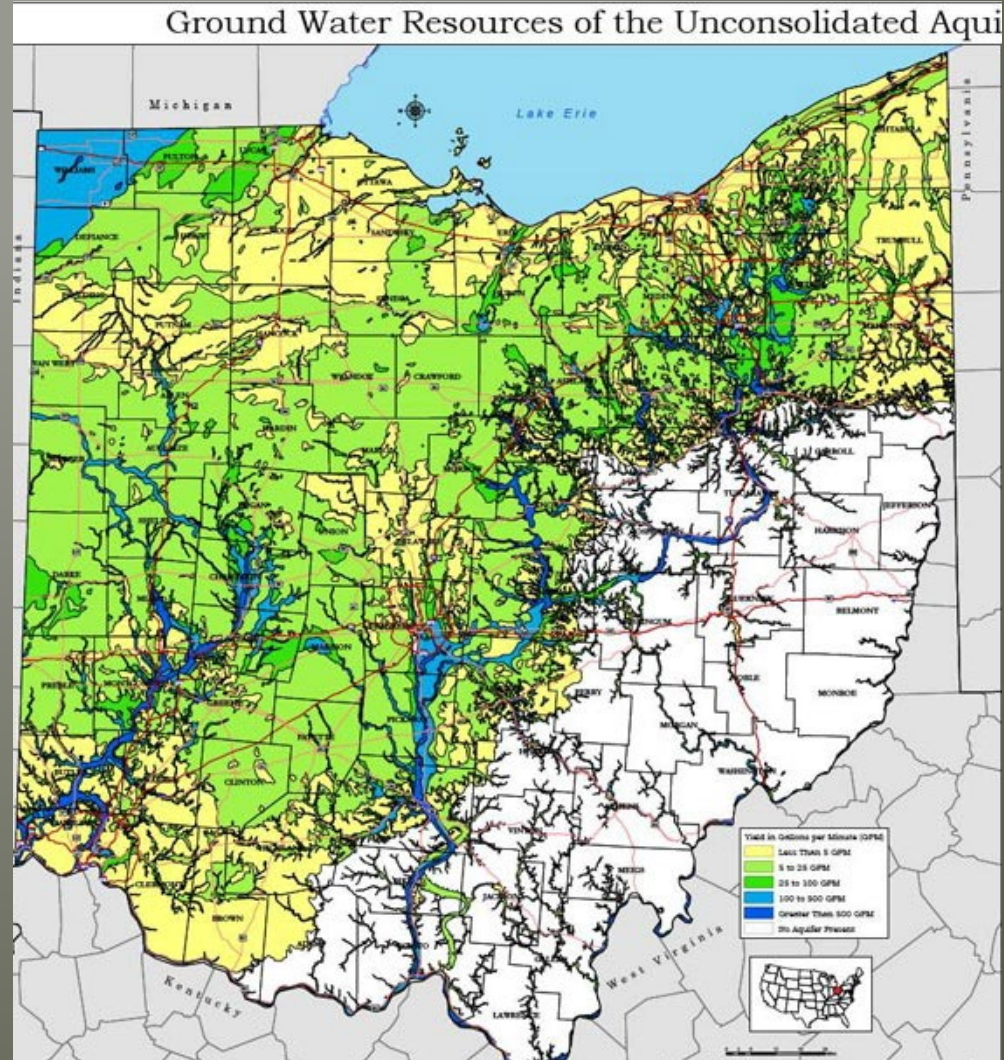
Hocking River

Tuscarawas River

Mahoning River

Muskingum River

Ohio River



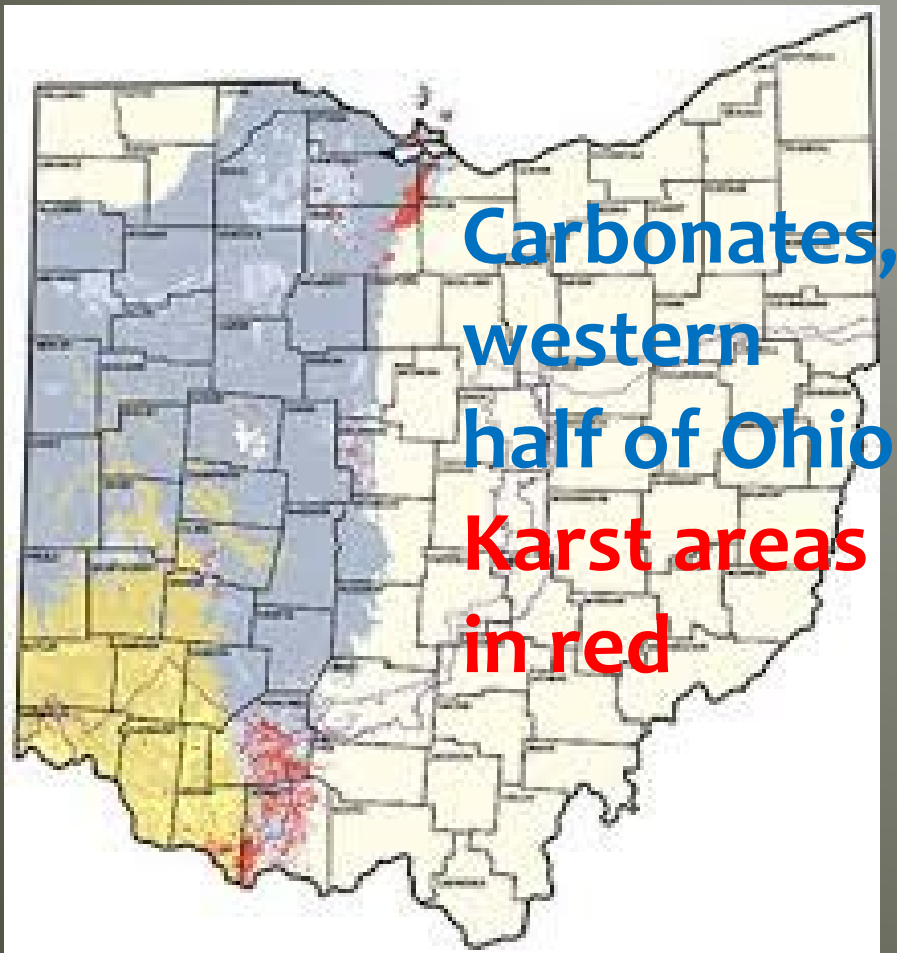
REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: ANY OTHER MATERIAL SO DEEMED

Karst Sinkhole in western
Delaware County

Black Hand Sandstone, Black
Hand Gorge, Licking County



REVIEWING THE INDIVIDUAL SITE LIMITATIONS – HIGHLY PERMEABLE MATERIALS: ANY OTHER MATERIAL SO DEEMED

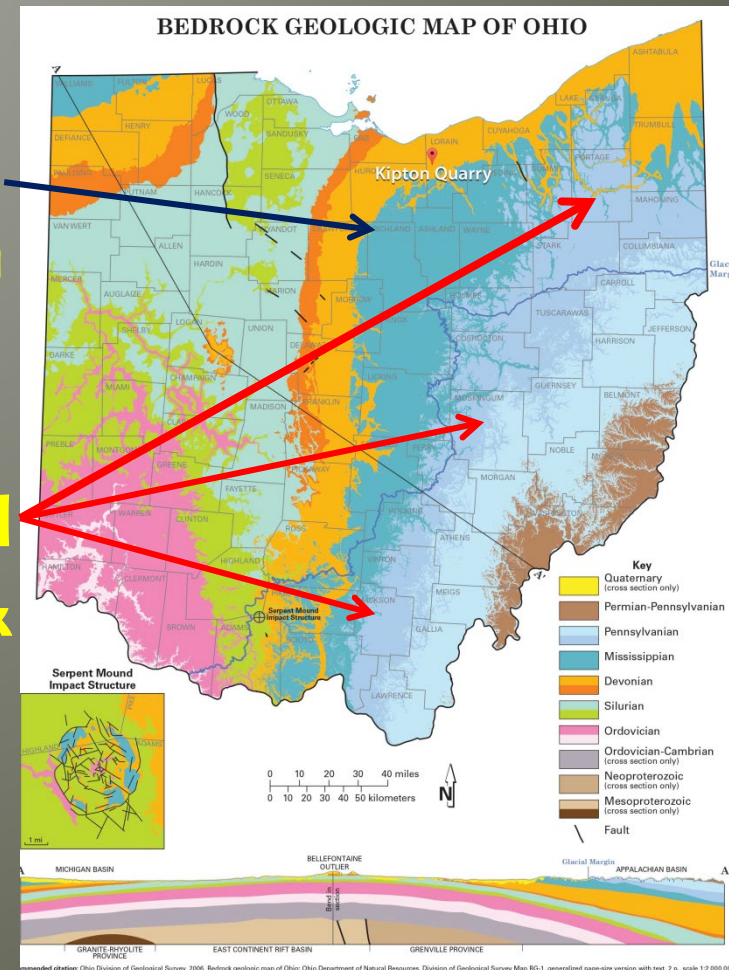


Sand-
stones,
eastern
half of
Ohio

Old coal
mines &
shafts

Blue to
brown

This text block provides additional context for the geological features shown in the maps. It highlights sandstones in the eastern half of Ohio, old coal mines and shafts, and a color gradient from blue to brown.



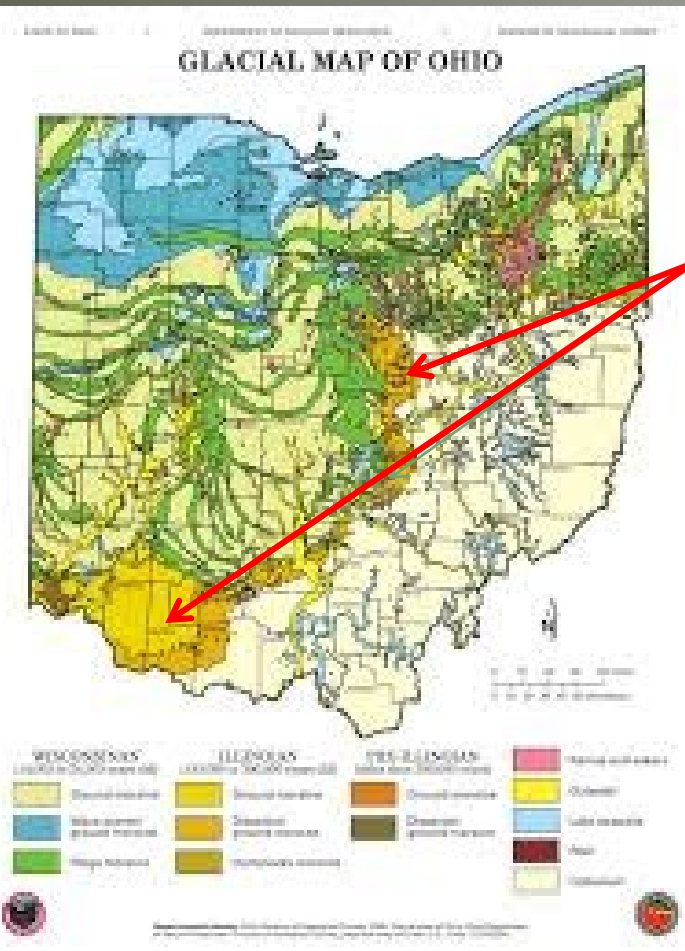
REVIEWING THE INDIVIDUAL SITE LIMITATIONS – TABLE 2 F: HIGHLY WEATHERED SOILS W/ WEAK STRUCTURE OR LOW TO VERY LOW PERMEABILITY DEVELOPED ON THE LOW LIME TILL PLAINS (THE ILLINOIAN- AGED SOILS)



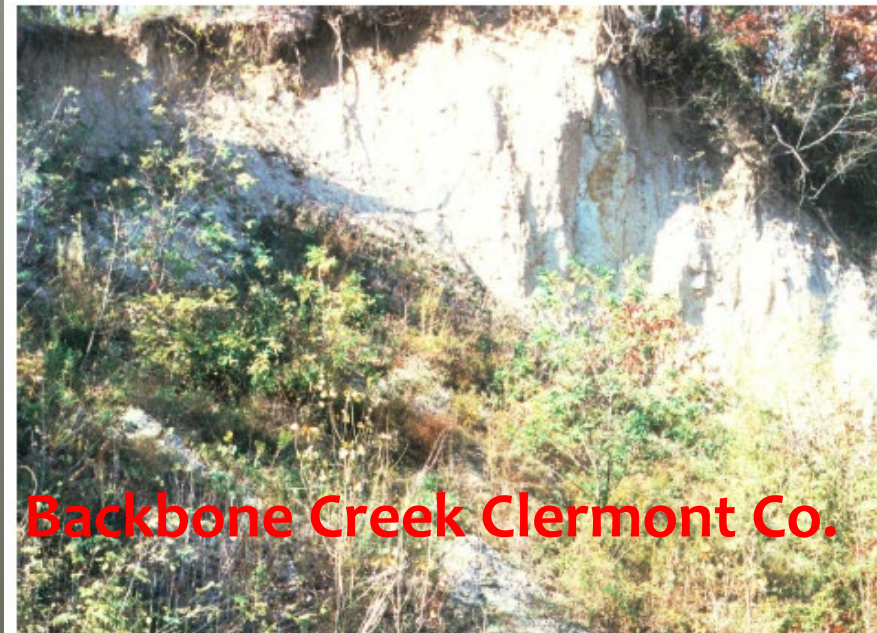
Grey mottles
at 8 in depth
These are the
soils from Eun
Kyoung Kim's
mud pie study
photo



REVIEWING THE INDIVIDUAL SITE LIMITATIONS – TABLE 2 F: HIGHLY WEATHERED SOILS W/ WEAK STRUCTURE OR LOW TO VERY LOW PERMEABILITY DEVELOPED ON THE LOW LIME TILL PLAINS (THE ILLINOIAN- AGED SOILS)



Illinoian-aged glacial deposits
mapped in brown and tan



HOW TO IDENTIFY HIGHLY WEATHERED SOIL ON REPORTS:

[illegible]

Limiting Conditions	Depth to (in.)	Descriptive notes	Remarks/Risk Factors:
Perched Seasonal Water Table	12in.		Avoid the area on the steeper side slope, it is very heavy and shallow to high clay content. This is due to severe
Ground Water/Aquifer	>50 in.		erosion.
Highly Permeable Material (range)	>50 in.		
Bedrock	>50 in.	Fractured - Karst (circle one)	
Flow Restrictive Layer	24in.	>45% Clay	
Highly Weathered Soil	24in.		
Fractured Glacial Till	>50 in.		
Other High Risk Limiting Conditions	>50 in.	This soil area is within the area of Highly Weathered soils as designated by ODH rule 3701-29-15(F)	

IF ANY OF THESE LIMITATIONS ARE PRESENT, THEN THE DESIGN MUST BE MODIFIED TO TAKE THESE INTO CONSIDERATION &/OR AN ALTERNATIVE SITE &/OR AN ALTERNATIVE TREATMENT SYSTEM NEEDS TO BE IDENTIFIED

There is always some kind of a work around but the more complicated it is, the more it costs & at some point, the best choice is to find another building site

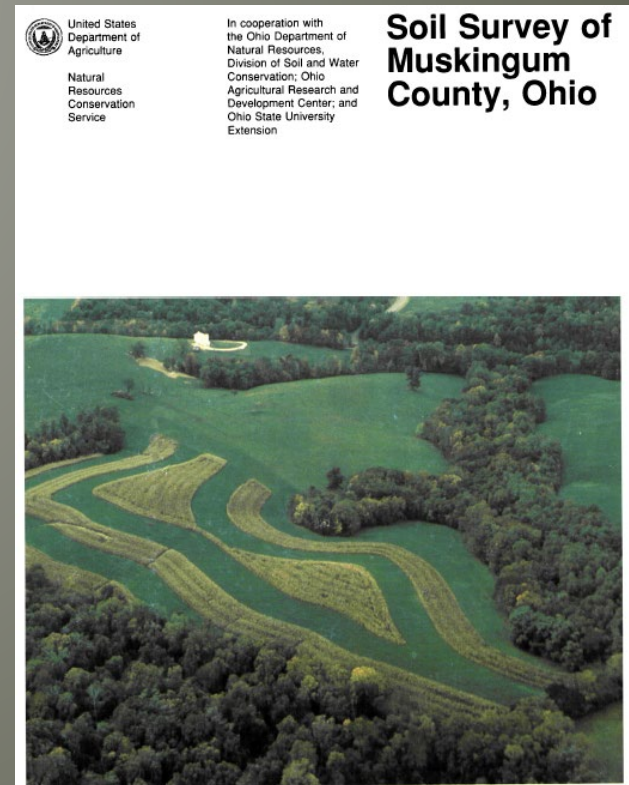
SO BEFORE YOU DIG OR REVIEW A REPORT

Curl up with your county Soil Survey

Read all about the soils and the included soils in the mapped units at your site

Read about the settings, the profile descriptions and check out the tables

Soil scientists will tell you that the surveys are 70-90% reliable but in 40+ years, I have never found one completely wrong – these guys were amazing – the rest of us should only be half as good



ODNR DIV GEOLOGICAL SURVEY CAN BE YOUR BEST FRIEND 175 YEARS OF OHIO MAPPING

[HTTP://GEOSURVEY.OHIODNR.GOV/](http://geosurvey.ohiodnr.gov/)

Maps

Bedrock Geology

Ohio Karst Areas

Environmental Geology

Industrial Geology

Surficial Geology

Glacial Map of Ohio

Drift Thickness Map

Interactive Maps

Oil & Gas

Lake Erosion

Mines

Earthquakes

Shale Map & Data

County Reports & Maps

Ground Water Pollution

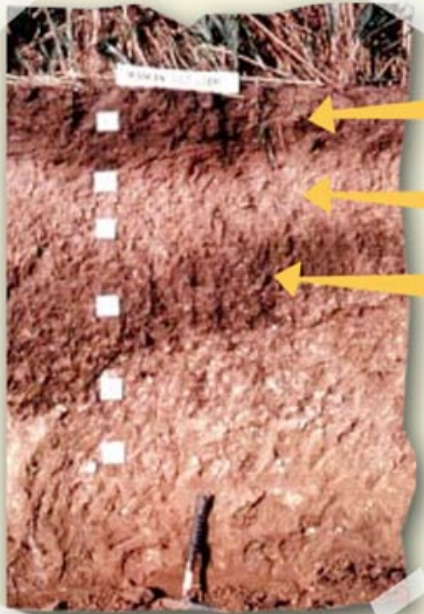
Potential (DRASTIC)

OHIO'S STATE SOIL

SEVERE LIMITATION FOR LEACH FIELDS, PERCOLATES SLOWLY BUT, IT DOESN'T FLOOD AND THE SEASONAL HIGH WATER TABLE IS MORE THAN 4' DOWN

Official State Soil: Miamian

What's in it?



MIAMIAN Clay-Rich, Forest Soils

Plowing mixes surface organic matter into the top six inches.

Seeping rain washes the reddish iron and clay out of this layer, leaving it pale.

Lower layers are rich in iron and clay. They accumulate minerals washed down from above.

Official State Soil: Miamian

Where is it?



Miamian soils are Ohio's most extensive soils. They occur on more than 750,000 acres in the state.

Ohio

Miamian



Contacts for this presentation

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Ohio Dept. Health Sewage Treatment Sstems,
<https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/sewage-treatment-systems>



Keeping Ohio's Water Clean
AOP/Ohio Fracture Flow Working Group