



MICHIGAN GEOLOGICAL SURVEY



Michigan Water!
What is known and needed after
years of nothing!

Michigan Geological Survey

EGLE Budget Committee Update

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269-387-8649

Michigan Statehood, **January 26, 1837**

Geological Survey, First Department **January 26, 1837**

Travel Promotions for Michigan

Water is Michigan – 1950's to present





What is Michigan Geology?

What is Michigan's most critical natural resource in the LP and UP for today and future generations?

Water!

Michigan glacial geology in the LP is:

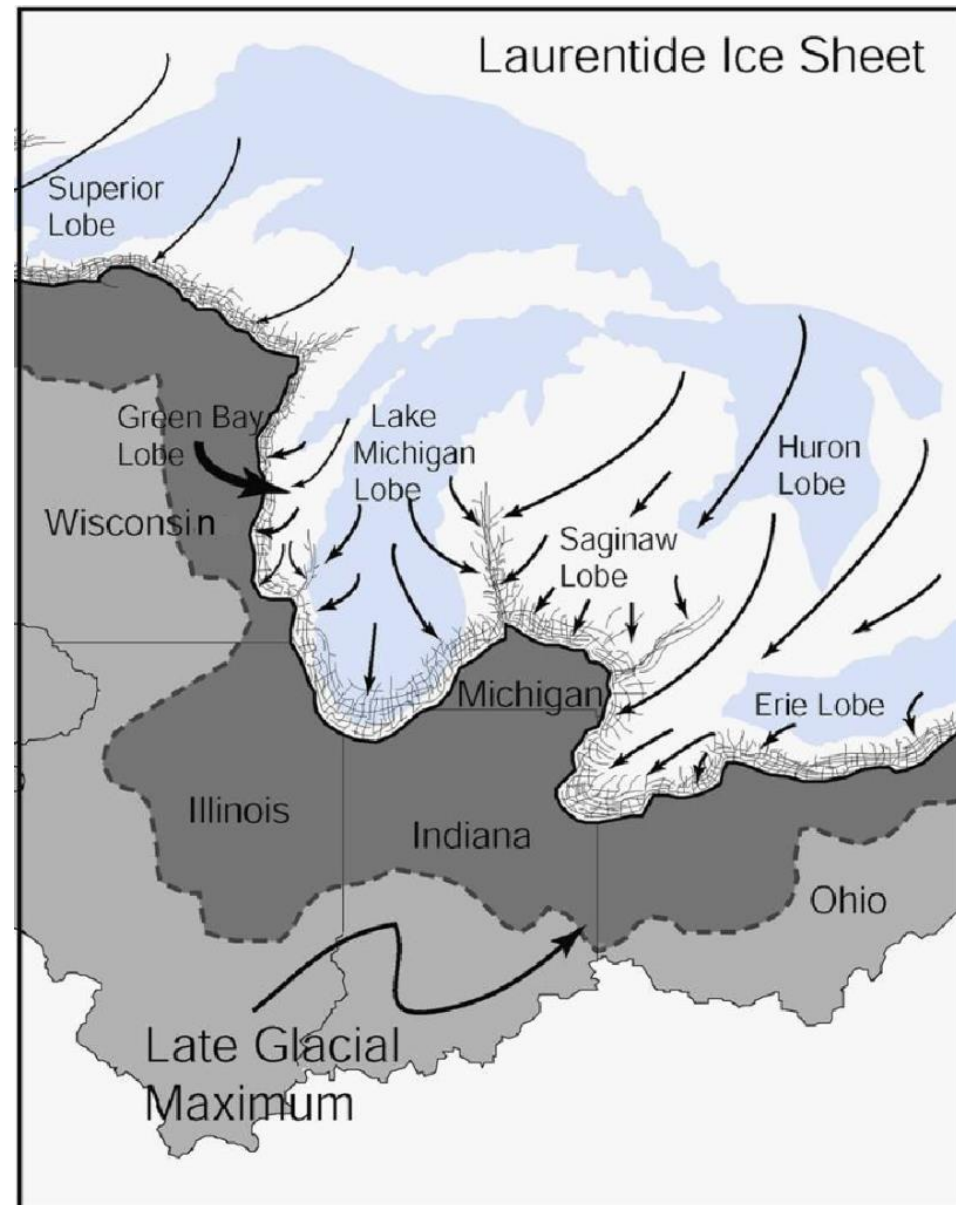
- Not uniform, vertically and laterally and what does it contain?
 - **Surface and subsurface geology contains these natural resources**
 - Groundwater
 - Surface water
 - Aggregates
 - Wetlands

What do we know about the geologic & water resource?

Almost NOTHING!

Michigan glacial geology is perhaps the most complicated discontinuous lithologic units that have been recorded.

- There are multiple stages of ice advances and retreats having crossed Michigan (200,000 to ~10,000 years ago).
- Glacial movement has resulted in the deposition of various glacial deposits and features and they include aggregates and water bearing sand zones, and
- Glacial moraines, which have the most important term, glacial till, it is not in the only database, Wellogic terminology table. Till - no economic aquifers or aggregates documented.



Michigan Geological Survey (MGS)- October 2011



PA- 167 - MGS to Western Michigan University with the Legislative mandate for the Michigan Geological Survey:

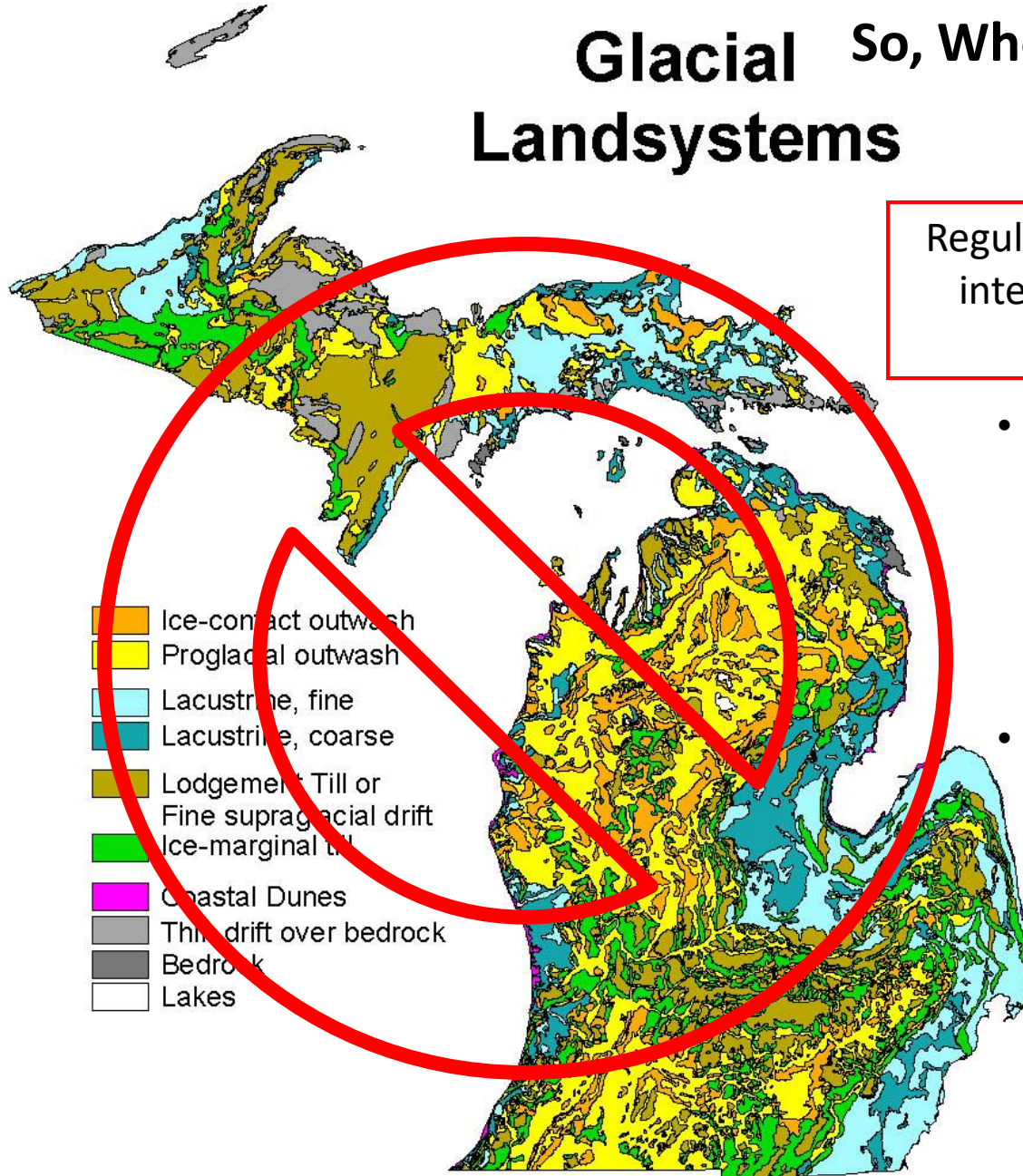
- Provide scientifically validated research and the data necessary for appropriate natural resource protection, discovery, assessment and management.
- Act as an independent, un-biased authority on geological matters underpinning Michigan's natural resource protection and management.
- Provide and preserve geologic records that can support the natural resource decision makers, public and private.
- **NOTE:** Michigan did not provide any funding to MGS in 2011!

MGS is mandated to compile geologic data and is the only Great Lakes state without an annually funded geological survey!

Glacial Landsystems

So, Where do we begin?

Regulatory, Consulting and Mi WWAT interpretations and decisions are made using this map.



- This 1982 surficial geology map is based on 1915 (Leverett & Taylor) data, with minimal changes in 1955 (Helen Martin), 1982 (Farrand & Bell). This is **ONLY** a surficial geology map.
- No subsurface validation.

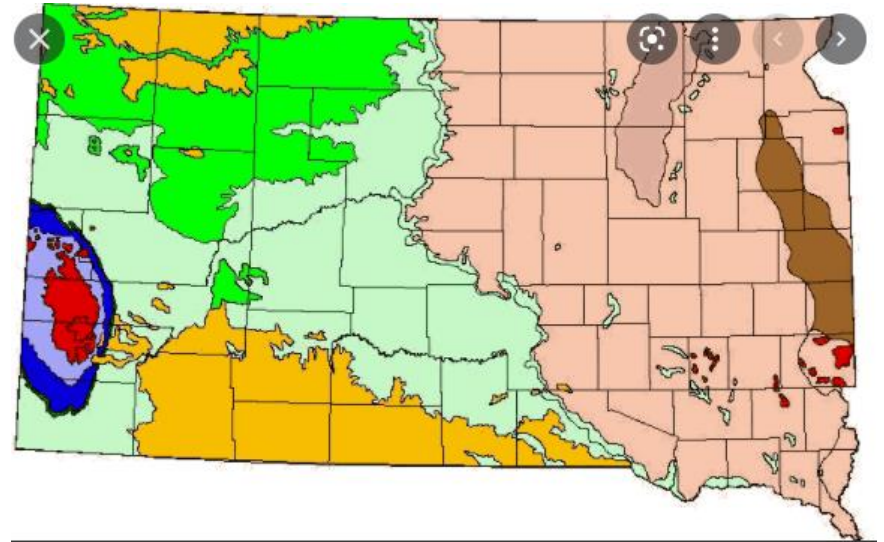
The role of the Survey is to provide updated subsurface geology in priority areas.

Where is the Water?

Western US-South Dakota watershed drainage Map, a comparison



Figure 1. Hydrologic Subbasins in South Dakota

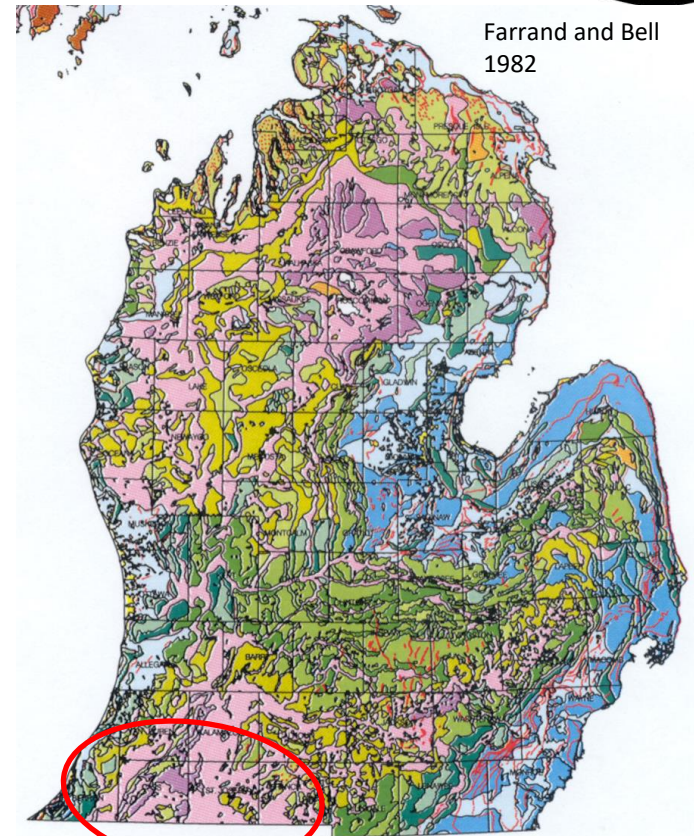


South Dakota the entire state.
~70+ watershed/basins that can contain water

Entire State has eight to 20 geologic units/formations that can contain water in the entire state of South Dakota

~30 basins may only have 1 – 3 formation aquifers that need to be mapped- you can do large multi-basin modeling.

Michigan Watersheds, geology NOT the same

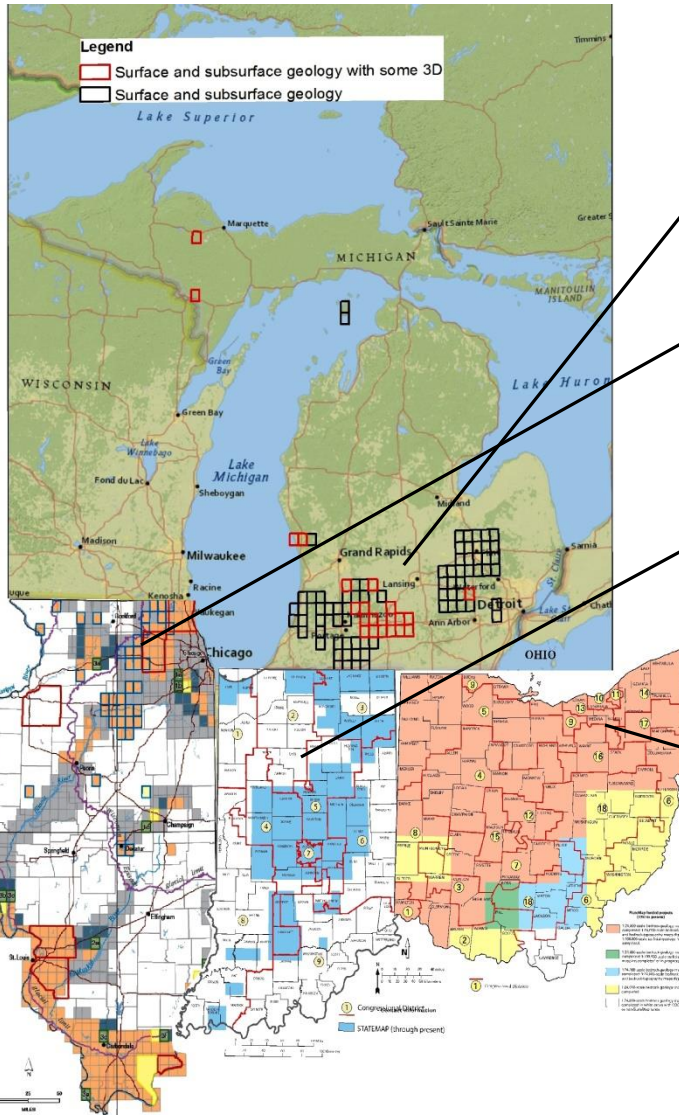


86 major water sheds in Michigan

Groundwater modeling in Michigan needs **validated geology for subsurface data** for each watershed – NOT statewide models.

Michigan glacial geology is NOT continuous.
Hundreds of glacial formations, not the same!
One Water shed can have 5->10 formations and multiple aquifers

Mapping-Michigan versus adjoining states!



Federal matching dollars in the last 25 years

- ✘ **Michigan**, no dedicated funds in 25 years, not until 2014, \$44,000 to support mapping in Cass County, < 10% mapped. (\$1.751 M = **\$72.9 K/yr**).
- ✘ **Illinois**, mapping in high impact and use areas, many priority areas for 3D mapping, ~ 30% mapped. (\$4.987M=**\$207.8 K/yr**).
- ✘ **Indiana**, mapping in high impact areas, some priority 3D mapping, ~ 40% mapped. (\$4.276 M=**\$178.2 K/yr**).
- ✘ **Ohio**, funding from energy and minerals, geo-hazards for mapping in addition to Fed funds ~ 80% mapped (\$3.069 M=**\$127.9 K/yr**).
- ✘ **Wisconsin**, mapping impact areas, \$3.762 M = **\$156.7k/ year**
- ✘ **Minnesota**, State funding (~\$2M/yr) map the entire state, \$2.834 M = **\$118.3k/year**.

All data from MGS mapping programs is OPEN FILES. National Cooperative Geologic Mapping Program



Kicking the geology can down the road!

1970's - Michigan legislature did not maintain survey funding

- 1970's- Legislature determined consultants and staff can provide the geologic data.
 - State could then compile the data, but no compilation dollars?
 - No urgency in doing subsurface or surface mapping.
- So where is the “geology can” now?
 - No funding for the state departments to compile the data.
 - “Use what we have”, “no time, no money” has been the mantra for geologic data.
 - Data costs money to compile and maintain so there were no staff costs attached to data compilation. Everyone must compile it themselves.
- What did Michigan do to stimulate a greater understanding of the natural resources for the economy for the last 30 years?
 - NOTHING!
- Only subsurface database in 2003, is Wellogic, it is not Validated
- Here are some examples of “kicking the geology can down the road”!!!

Michigan stakeholders were not told in 2000-03 they needed validated geologic data!



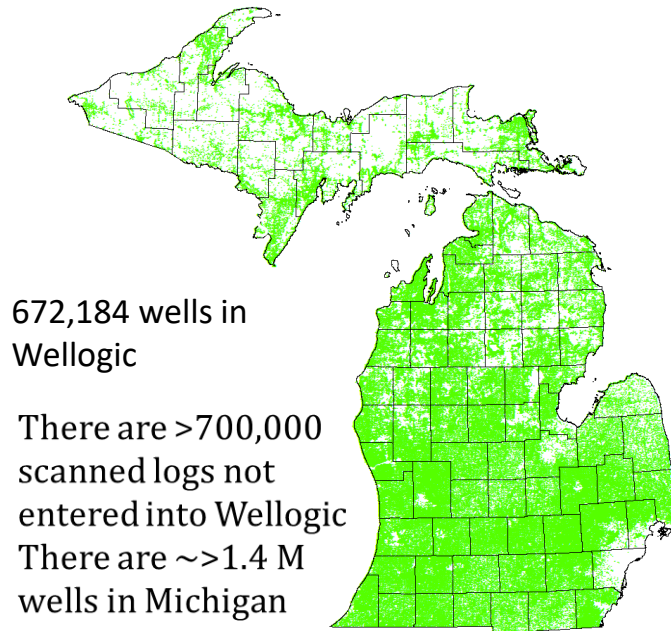
Michigan Lower Peninsula, ~ 60% of drinking water is from glacial sediments, what is important?

There is no scientific glacial or bedrock database that has validated and corrected data.

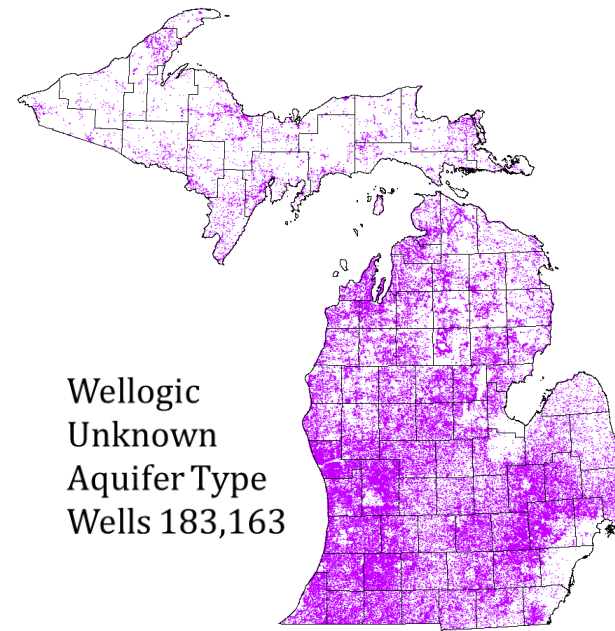
- **Many programs use Wellogic (water well) data, the only database, not geologic.**
 - Wellhead Protection,
 - Groundwater level,
 - Depth to bedrock,
 - WWAT, HC well program, etc.
- **Wellogic, 2003, was never location validated, until 2018-MGS.**
- **Drillers were never trained to input standard terms, 2015-MGS.**

Wellogig water well Summary # and Type

The only subsurface database



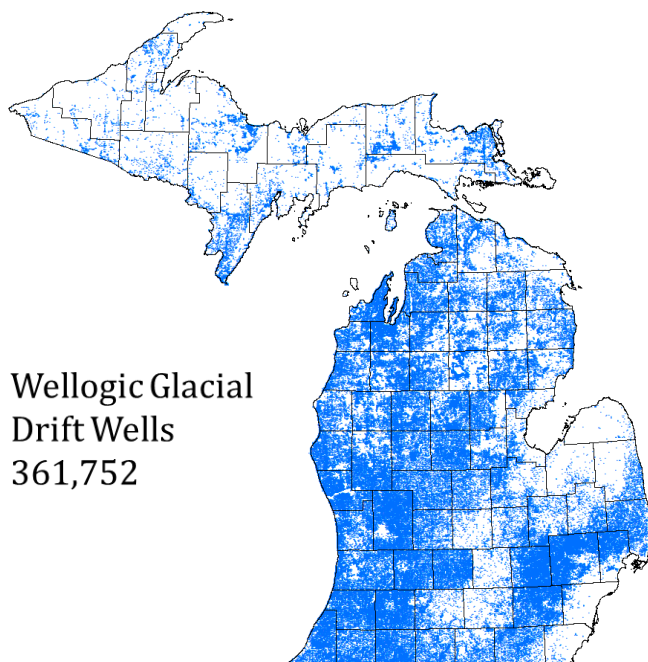
Wellogig well data update,
January 2021



Note Aquifer Type field in Wellogig
can often be unreliable

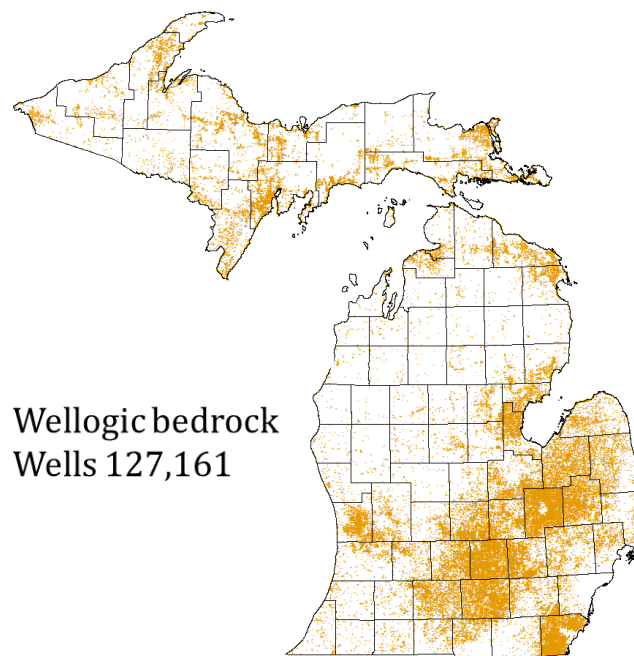
MGS has contract to validate and correct locations of all Wellogig wells-40% wrong
MGS inputting 700,000 scanned logs 1950's to 2003 to Wellogig

Wellogig Summary, Drift vs Bedrock



Wellogig Glacial
Drift Wells
361,752

Wellogig well data update,
January 2021



Wellogig bedrock
Wells 127,161

Note Aquifer Type field in Wellogig
can often be unreliable

**MGS, 2015, training well drillers how to log consistently into Wellogig.
Never done before.**

Map comparison 1982 versus 2018

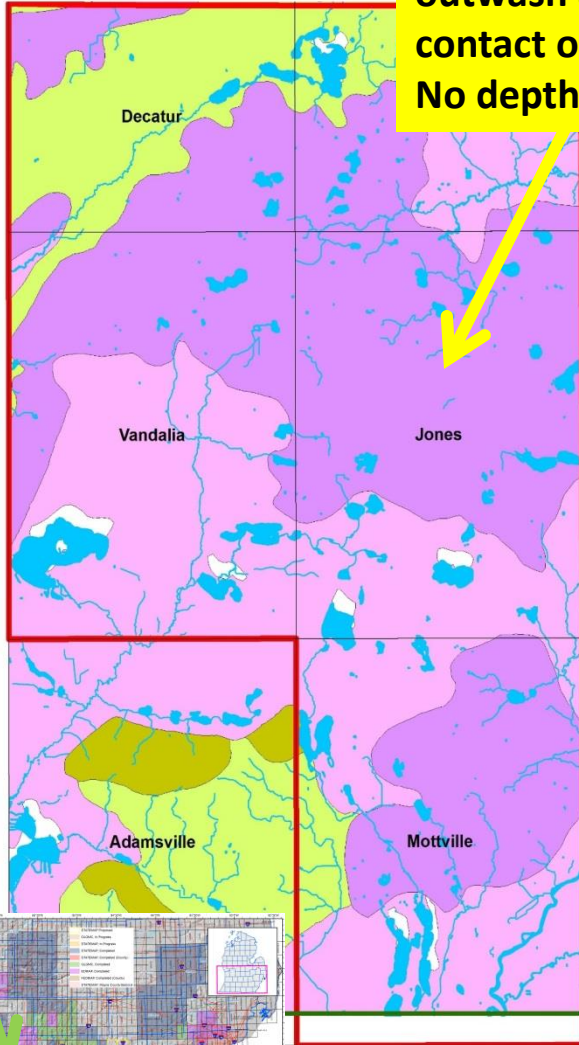


Cass County

Quaternary Geology of Michigan (F)

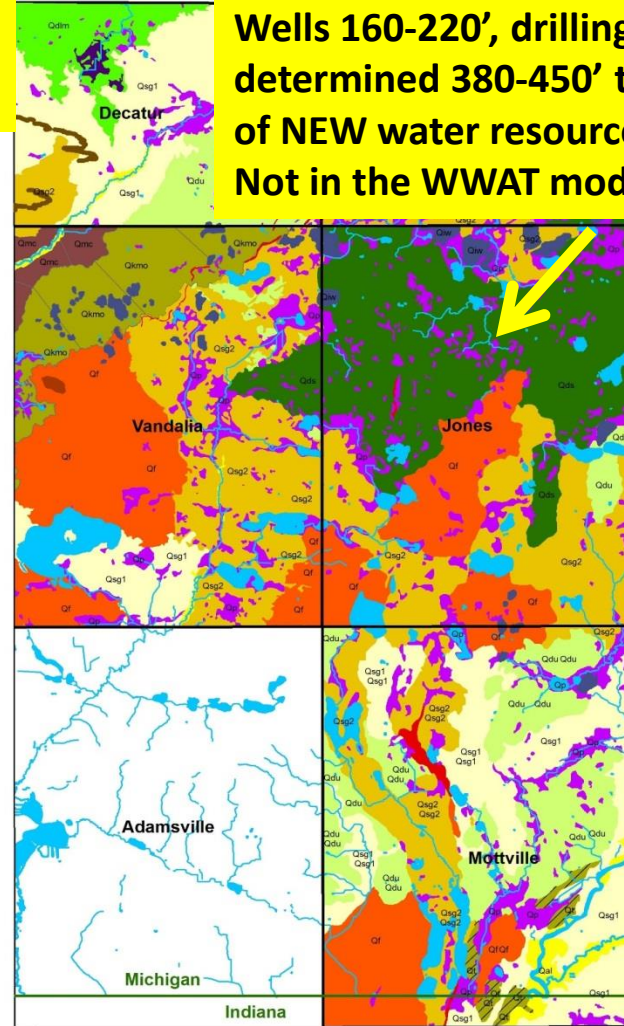
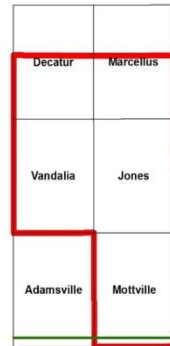
1982 interprets this as
outwash and ice
contact outwash.
No depth to bedrock.

2018 Diamicton/till at the surface,
outwash below, no recharge, clay.
Wells 160-220', drilling, mapping
determined 380-450' to Bedrock (>200'
of NEW water resource)
Not in the WWAT model

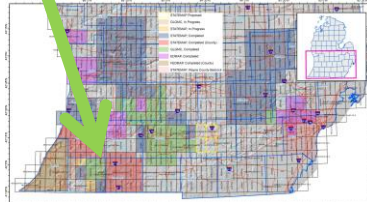
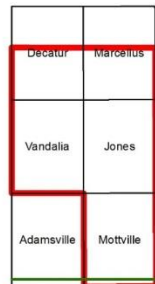


Legend

- Glacial outwash sand and gravel and postglacial alluvium
- Ice-contact outwash sand and gravel
- Coarse-textured glacial till
- End moraines of coarse-textured till



- Peat
Alluvium
- Qsg2 Outwash pitted
 - Qsg1 Outwash
 - Qe Esker
 - Qr Fan
 - Qsd Sand dunes
 - Qmc Glacial Lacustrine
 - Qdu Diamicton Undiff
 - Qds Diamicton Saginaw
 - Qk Kame field
 - Qdlm Diamicton Lake MI
 - Qkmo Outer Kalamazoo Mor
 - Qt Terrace
 - Qiw Ice Walled lake plain
 - Ql Lacustrine

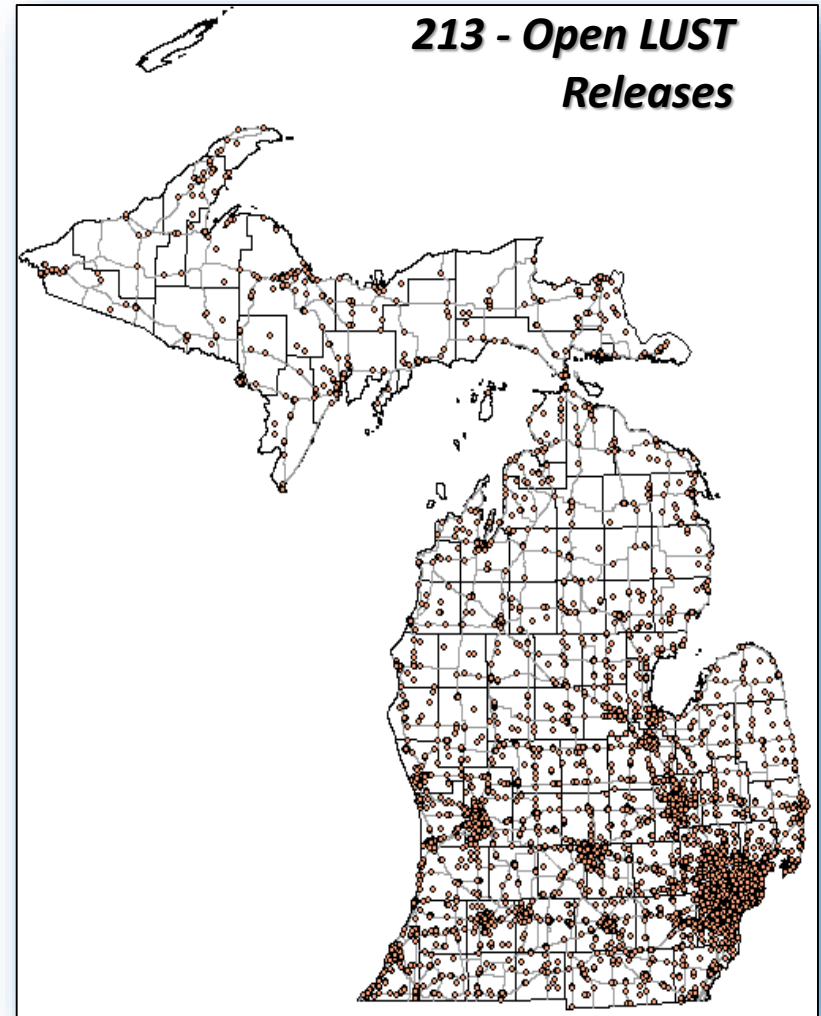
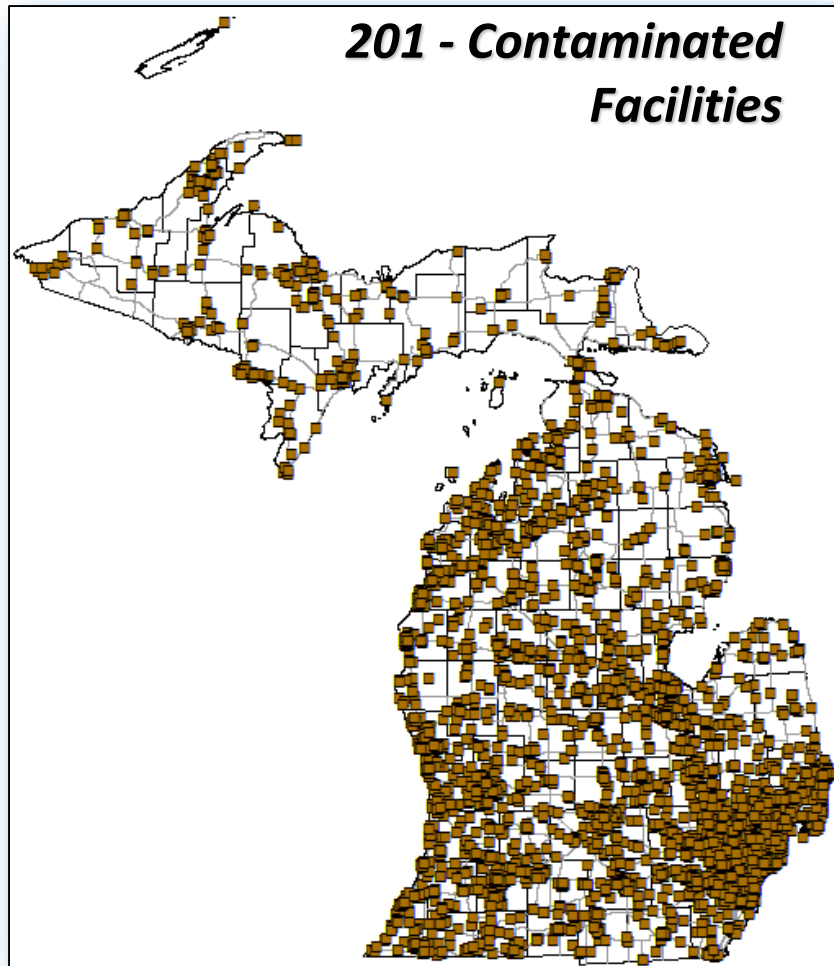


Lets review the history of Data!

EGLE -Estimated 30,000 sites

Hazardous Substances

Released to the Environment



***1980's Pre – CERCLA
to present-geologic data***

***No geologic data compilation-
Until now!***

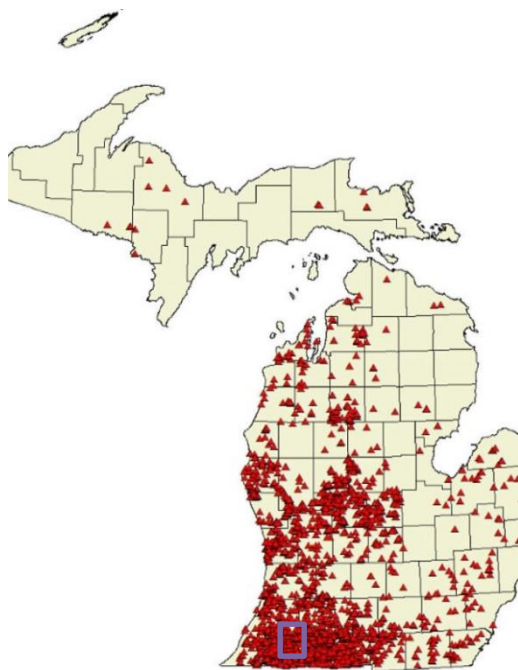


MI WWAT Applications vs detailed GEOLOGIC Map Products

Approximately 60% of the LP groundwater comes from glacial material

Mi WWAT Applications >70 GPM through 2019 for comparison

Beginning in ~2003 (Water Withdrawal Assessment Tool- well drillers logs, non-factual model)



This is a summary of mapping of the detailed combined surface and subsurface by MGS, USGS or others for Lower Peninsula.

Less than 10 % Detailed MGS mapping.

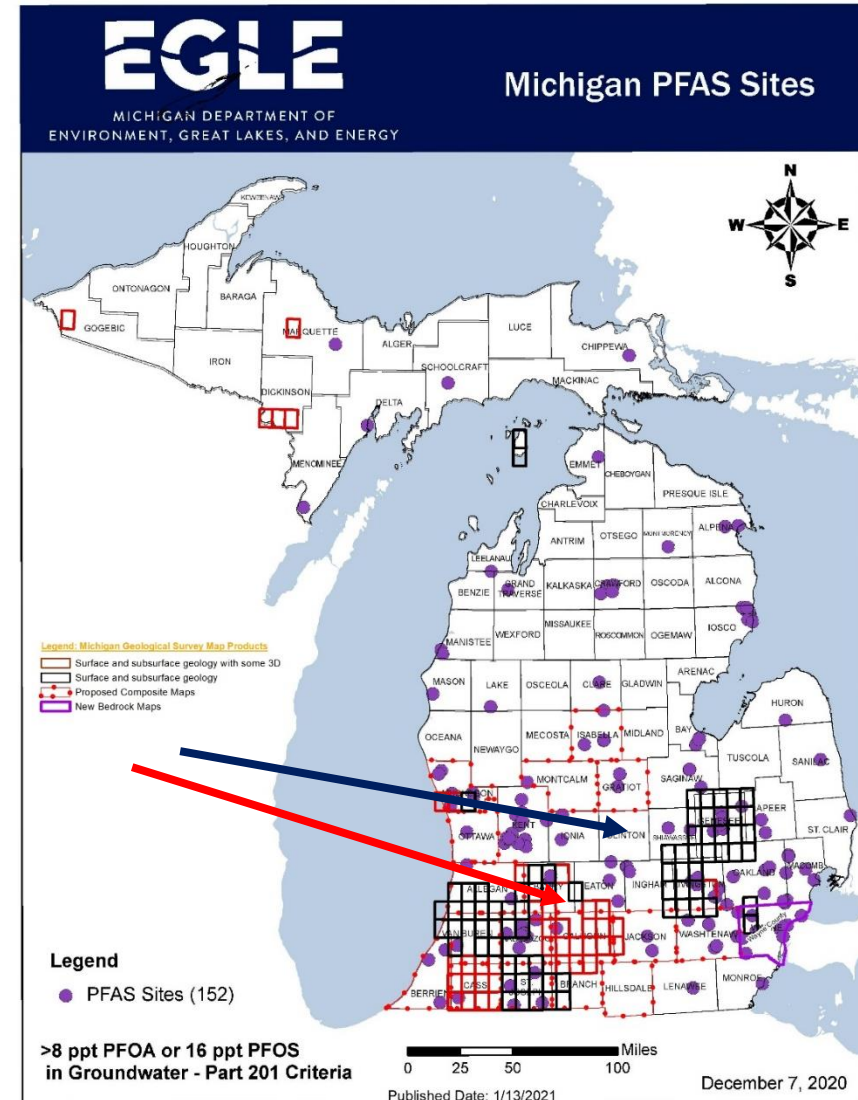
* **Quads** (~56 Sq Mi)

- Black - Surface only with validation of borings
- Red - surface + some subsurface drilling / geology 3D

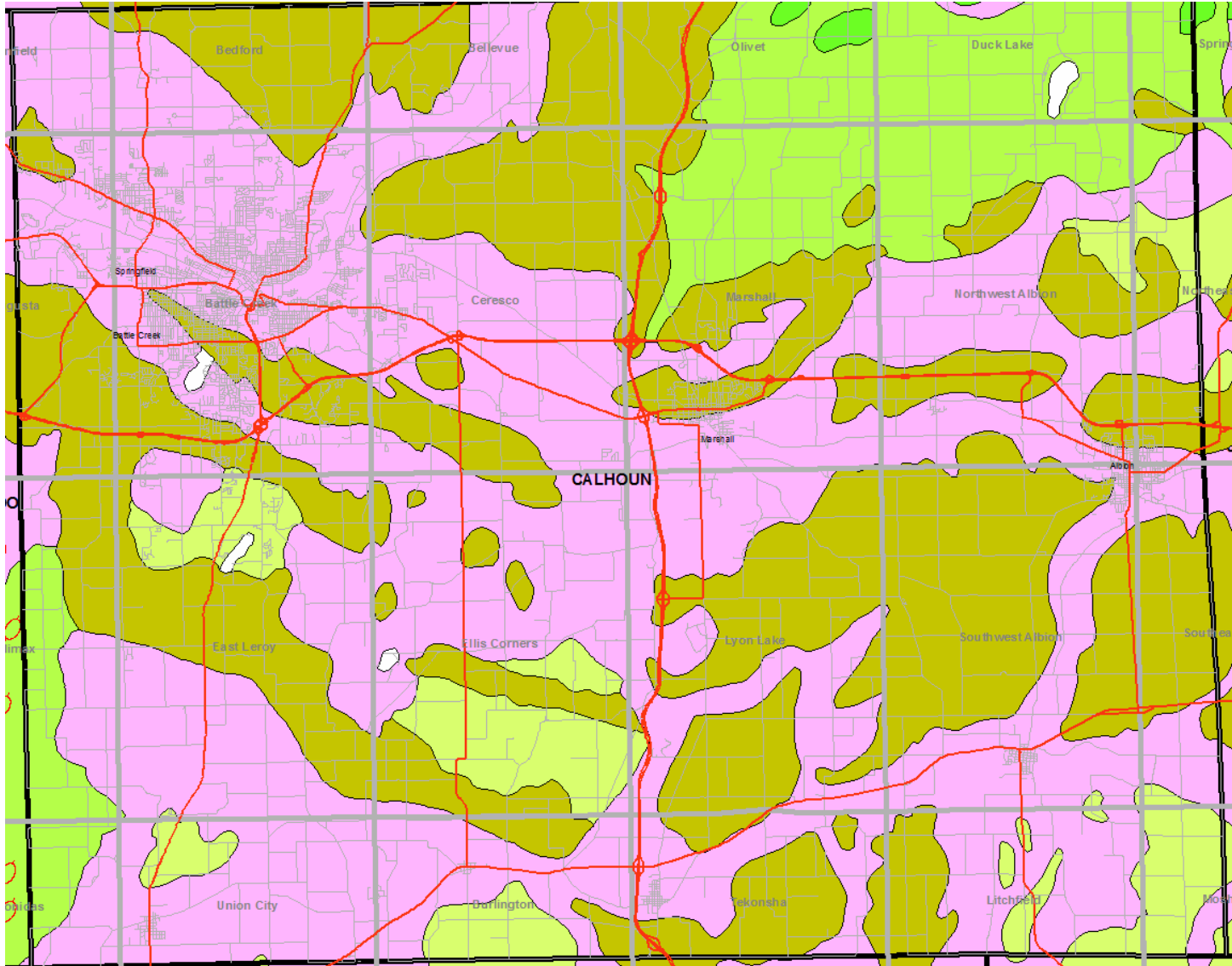
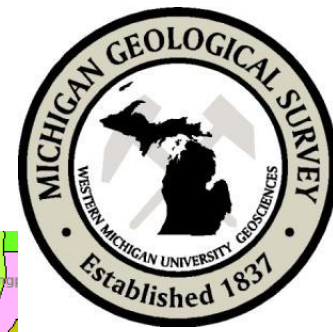
What is the new Michigan contaminant crisis?

Michigan – the Water Wonderland!

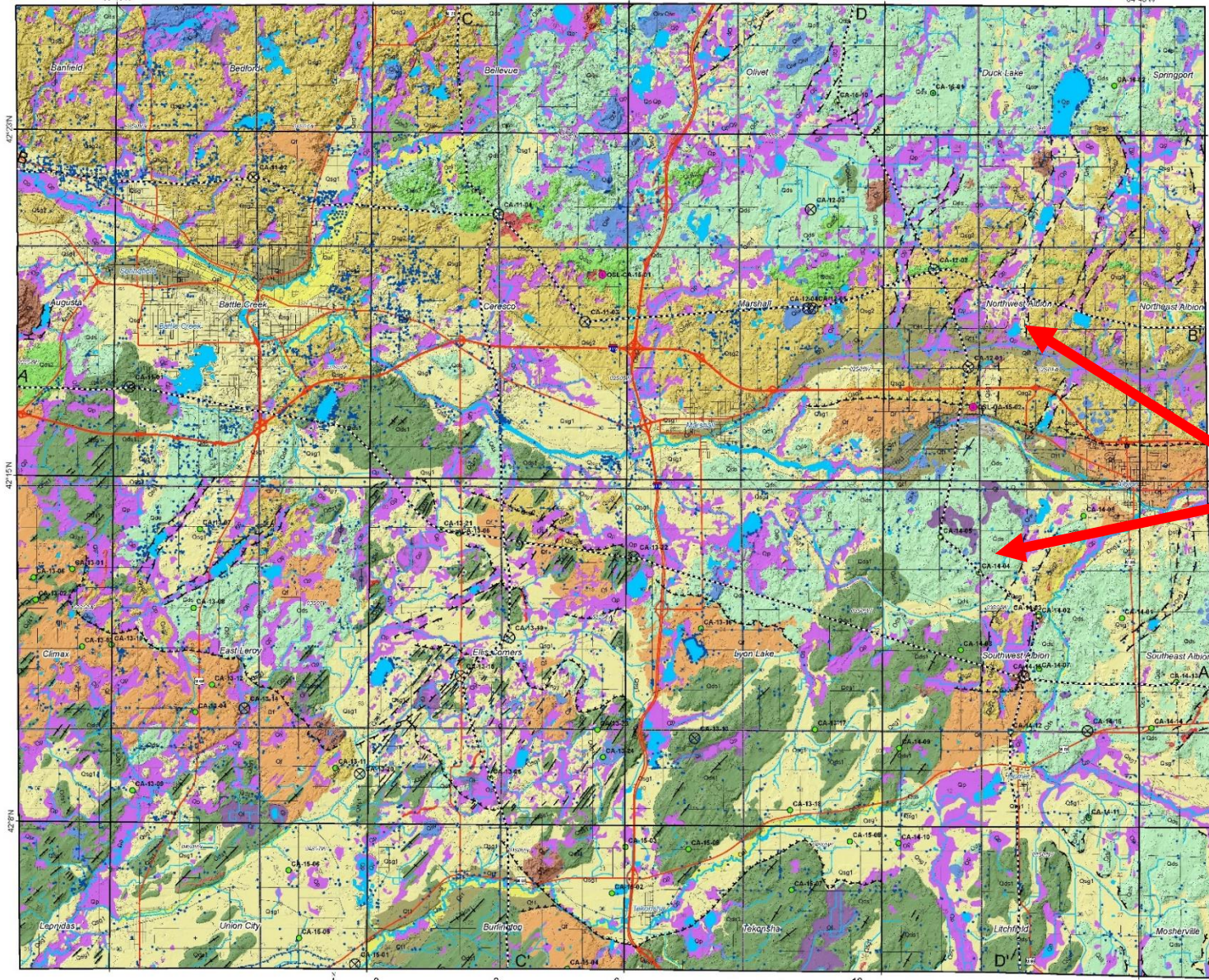
- Perfluorinated Alkyl Substances (PFAS) – Soils and water multiple locations and there may be more.
- Geologic mapping-completed counties Berrien, Cass, St. Joseph, Barry, Calhoun, Kent, Kalamazoo, Genesee, Van Buren.
- Where Michigan has open file subsurface geologic data (Red/Blk).
- What's wrong with this picture?
- Stop using just water well data.
- Mapping and drilling data is needed to define the full aquifer section for each watershed.
- Let's compare recent results.



Compare Calhoun County 1982 Map



Calhoun County 2017 Map

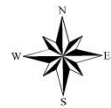
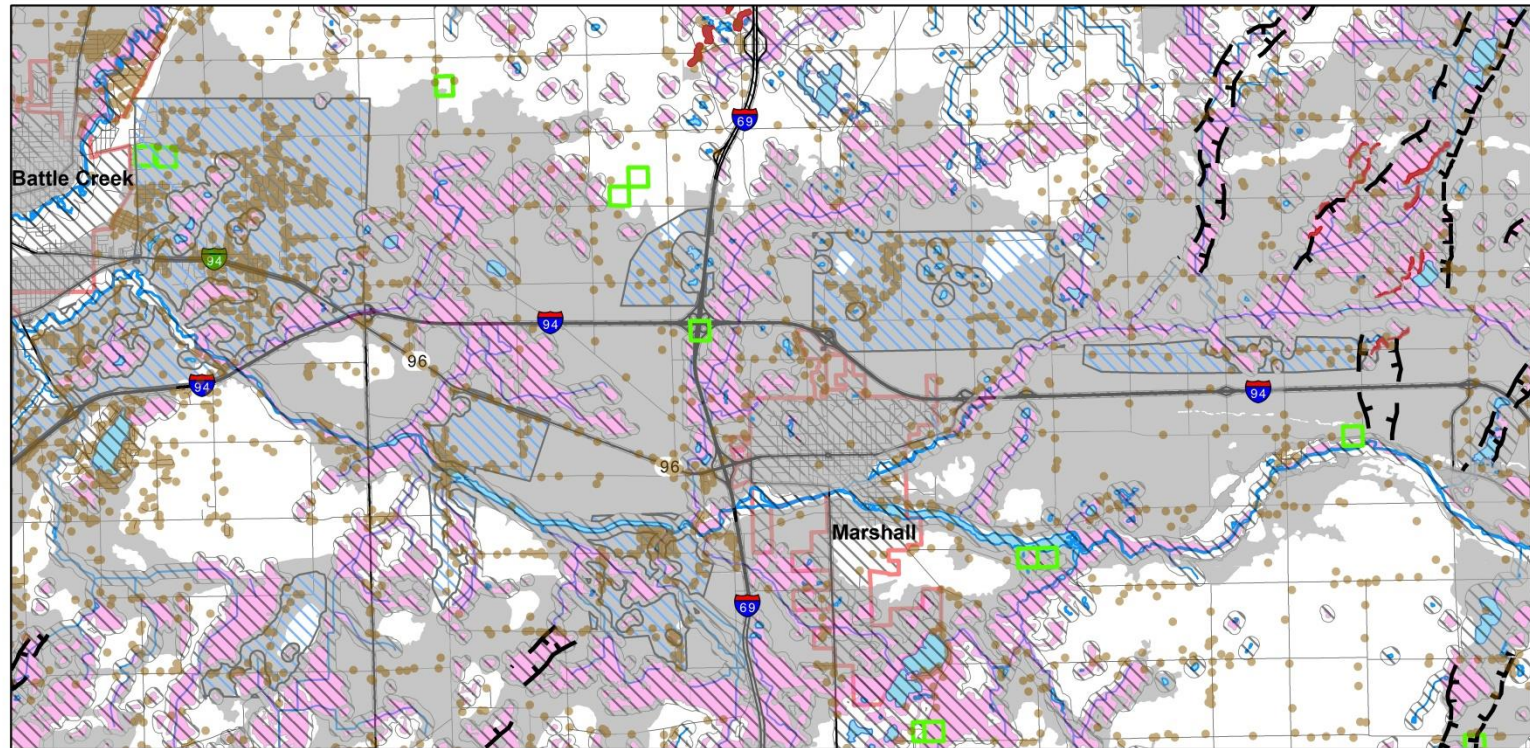


All can see the level of detail in new mapping.

This is where we have aggregates?

- Aggregates also mean water.
- Let's review a recent aggregate assessment for this area.

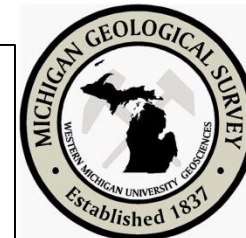
Selected Area of Calhoun County Potential Aggregate Resources



Legend

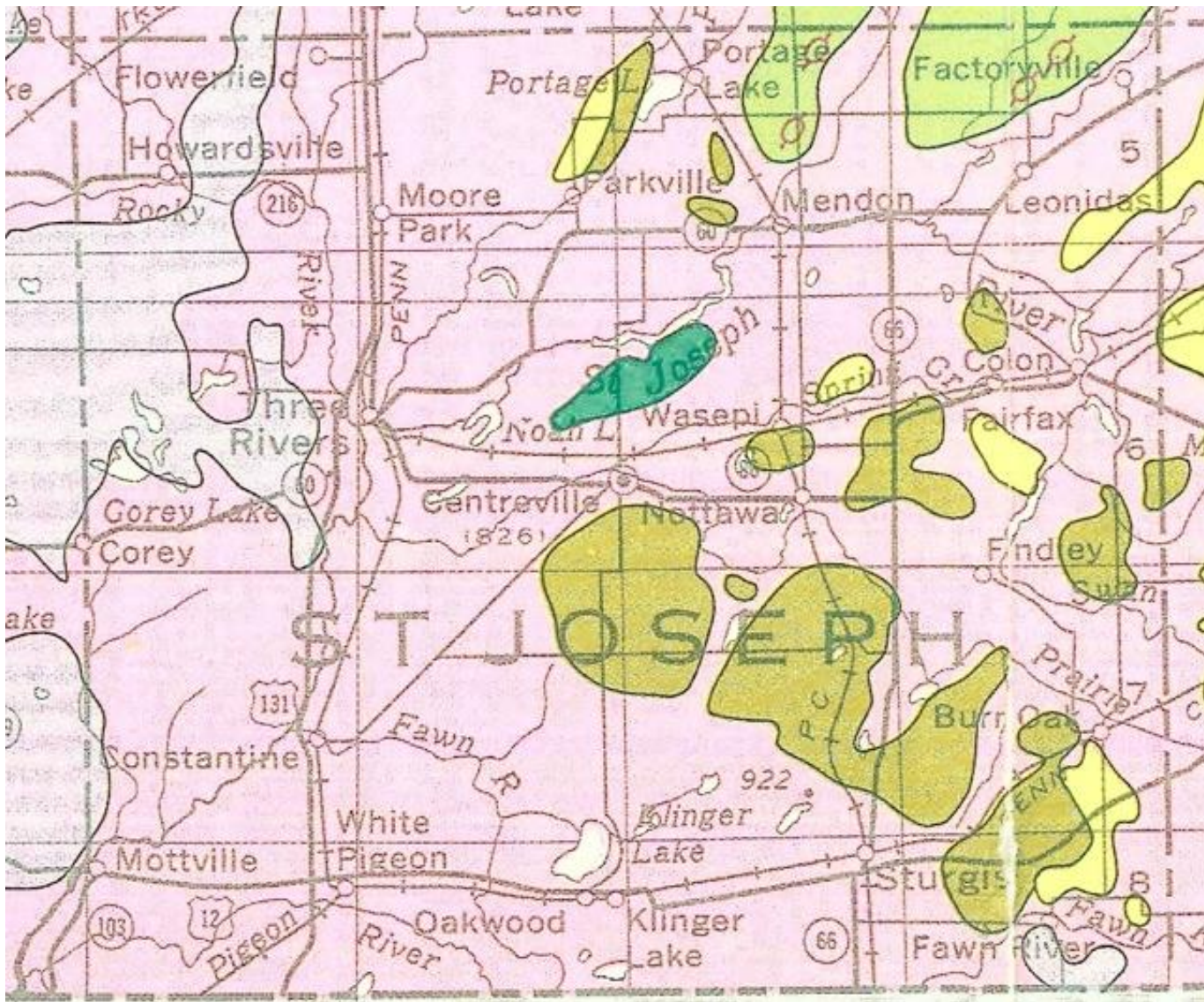
- | | |
|-------------------------------|-------------------------------------|
| Potential Aggregate Resources | Lakes |
| Tunnel Valley | Existing Sand and Gravel Operations |
| Eskers | State Roads |
| City Limits | Local Roads |
| Setback Buffer | Streams |
| Development Buffer | Water Wells |
| Wetlands | |

Aggregate Resources in all glacial types
Reduction of resources by setback, etc.
Resources = 147 Sq mi minus 81 Sq mi
restricted = 66 (~45%) Sq mi available.
Including residences in Un-graded
resources.

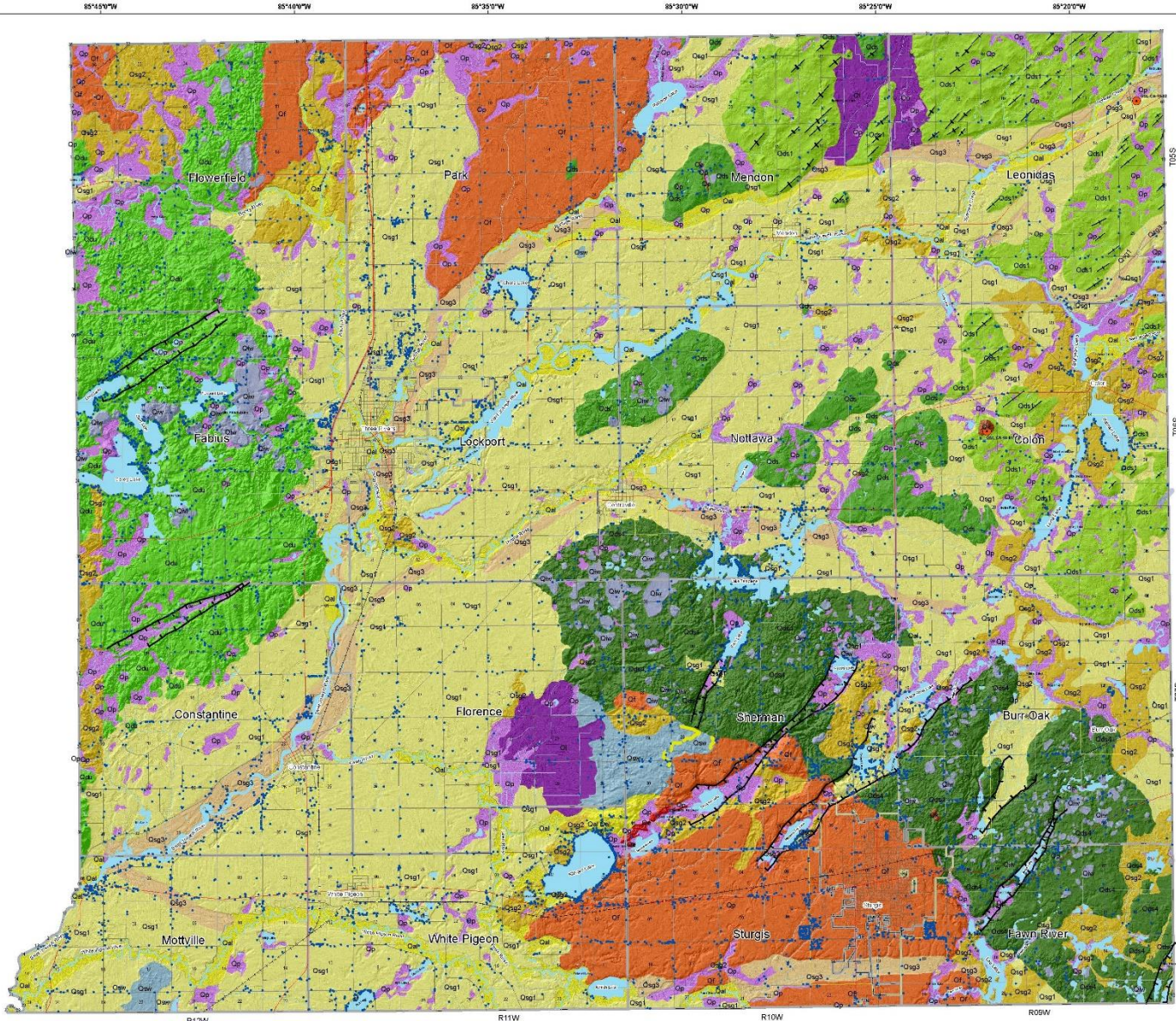


Date: 2/6/2019

St. Joseph County 1982 Map



St. Joseph County 2021 Map



- More details to define the shallow aquifers.
- Cross sections provide 3D.
- Examples of MGS recent mapping process.

Allendale & Olive Township locations Ottawa County



August 2021



Zeeland Township



August 2021

TD 185', 80 feet of Gypsum (White rock), **no glacial (Till) or bedrock aquifer**, Coldwater Shale.



Training students, Sara Hayes and Sophia White to log core.



Firestation, top of gravel pit, future home development below



Jamestown Fire Station

August 2021



- Two students learning how to log core, Sara Hayes and Yanni Philopoulos.
- Presenting core samples to Ottawa County Water administrator, Mathew Chappuies
- Two completed monitor wells at Jamestown Fire Station

MGS USGS mapping proposals 2014, 2019-2022



Cass, Ottawa, Allegan, Muskegon Counties- WRD, MPART, others

Combine new and proven technologies and methods

- MGS confirmed counties having growth and water quantity demands
- Localized geologically derived water quality issues
- 3D maps and reports are needed and developed with validated information, in real time.
- Data in formats (e.g. ArcGIS) accessed by phones, tablets, laptops, actively showing multi layers of data..... in seconds, in the field.
- Secondary MGS mapping products of surface and subsurface data include: Water tables, water bearing zones, surface drainage, aggregates, wetlands, recharge areas, deeper subsurface research and data, etc.
- Interactive electronic standard databases to capture existing and new data.



MGS mapping proposals 2019-2022

MGS products:

Combined new and proven technologies and methods

- **21st Users:** Citizen scientists, city and county planners & developers, geologists, earth scientists, engineers, consultants, industry representatives, regulators.
- **Where should you get your data, Wikipedia or the Geologic Survey?**



So what is the answer to scientific data?

- **Annual Funding for the Geological Survey!**
- **Priority driven areas!**
- **Use unbiased geological scientist, not data manipulators**
 - Scientists and public using data in open file format
- **What do we need to understand for today and future generations?**
 - **Geologic hydrostratigraphy,**
 - **3D geology of the entire stratigraphic section,**
 - **Water storage and recharge are defined,**
 - **Usage of resources, then**

Geologic mapping can support identification and protection of those resources which are associated with:

 - **PFAS, Water storage/availability, aggregates, wetlands.**
 - **WUAC Recommended Geologic mapping, 2014 & 2020**

So what is the answer to scientific data?



MICHIGAN GEOLOGICAL SURVEY
SUMMARY OF COUNTY MAPPING PRIORITIES
PRESENTING THE % OF VALIDATED GEOLOGIC MAPPING PRODUCTS



	Proposed Priority Counties (Mapping data needed)	EGLE County maps WRD Water Use Priority list	Estimate % Completed Maps	EGLE County Maps MPART PFAS Areas	Estimate % Completed Maps
1	Kalamazoo	Branch	20%	Kalamazoo	60%
2	Ottawa	Cass	95%	Muskegon	<10
3	Allegan	St. Joseph	60%	Oakland	<10
4	Montcalm	Calhoun	100%	Kent	60%
5	Muskegon	Van Buren	40%	Montcalm	<10
6	Kent	Ottawa	<10	Ottawa	<10
7	Oakland	Berrien	100%	Allegan	<10
8	Jackson	Allegan	<10	Calhoun	100%
9	Branch	Montcalm	<10	Ionia	<10
10	Washtenaw	Hillsdale	<10	Monroe	<10
11	St. Joseph	Jackson	<50	Livingston	60%
12	Hillsdale	Gratiot	<10	Lenawee	<10
13	Jackson	Isabella	<10	Marquette	50%
14	Livingston			Washtenaw	<10
15	Monroe			Barry	100%
16	Ionia			Berrien	100%
17	Lenawee			Charlevoix	<10
18	Marquette			Delta	<20
19	Charlevoix			Jackson	<50
20	Delta			Newaygo	<10
21	Gratiot				
22	Isabella				
		Top Priority			
		Second Priority			
		Done			

NOTE: This is a specific list of priority counties requiring validated geologic mapping. These two lists were provided by the EGLE departments of WRD and MPART in 2019. MGS has included a statement of % completion for each County. This list will be modified as needed after discussions and agreement with EGLE and DNR Departments. The United Tribes has endorsed mapping of water resources where needed in the State.

- **Prioritization by EGLE-WRD, EGLE – MPART and supported by United Tribes of Michigan, others (Priorities provided by 10-11-19).**
- **What counties are most important? 20-25 counties now identified**
- **Four Counties mapping 3D completed.**

Michigan Geological Survey



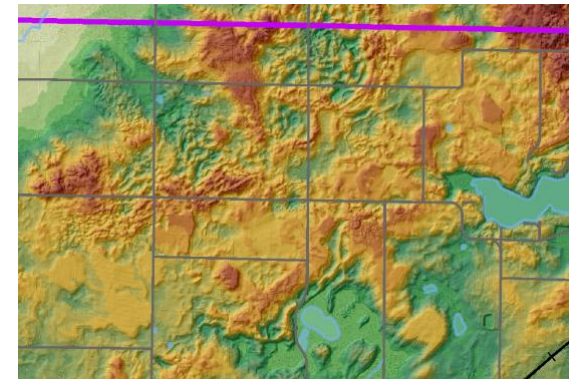
Summary as of May 1, 2015

MICHIGAN GEOLOGICAL SURVEY (MGS) - STATE DATA SUMMARY
WITH DATA LOCATION NOTED

County	Number of RRD site entries in Environmental Mapper	RRD Files	Oil and Gas (OOGM) permitted boreholes	Wellologic water wells	Number of O&G Wireline log files - MGRNE	Shallow bedrock cored wells at MGRNE - WML	Drill cuttings sets MGRNE
Alcona	108		334	3,300	755	0	73
Alger	56		0	2,286	4	0	1
Allegan	1,642		3,473	11,927	654	0	892
Alpena	321		1,469	2,877	1,367	2	116
Antrim	268		2,750	4,356	2,291	0	181
Arenac	362		1,076	2,498	437	0	731
	-		-	-	-	-	-



Thank you
Questions?



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