



Michigan Geological Survey

Filling Michigan geologic mapping data voids Providing a Sustainable Aggregate Supply for Michigan

An Overview of MGS geologic mapping techniques

House Local Government & Municipal Finance Committee
June 8, 2022

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Director

Michigan Geological Survey - History



- **1837—Michigan became a State and created the Michigan Geological Survey as it's first department to assess geological resources and their economic uses, on the same day.**
- **1840 to 1980's many surface geological maps prepared, but minimal subsurface geologic data developed**
- **1980's to 2011 no data compiled and no resource mapping**
- **2011 Geologic Survey transferred by PA 167 to Western Michigan University—no funding**
- **2011 to present MGS compiled data and mapped resources through grant funding and three \$500k Special appropriations (2016, 2018, 2019); but cannot hire full time staff**

Michigan Geological Survey

October 2011



PA- 167 transferred the MGS to Western Michigan University in 2011 with mandates to:

- **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.**
- **Acquire and preserve geologic records that can support natural resource decision makers, public and private.**
- **No funding was provided**

MGS is mandated to compile and preserve geologic data—yet it is the only Great Lakes state without an annually funded geological survey

Michigan is blessed with abundant Mineral Resources



- Michigan's annual non-fuel mineral value exceeds \$2.5 billion
- Michigan ranks 9th in the U.S, producing 3.4% of domestic minerals
- Michigan is 1st in the nation in production of Magnesium Compounds
- Michigan ranks 2nd in Iron Production
- Michigan ranks 5th in production of construction sand and gravel
- Michigan ranks 4th in sales of Peat
- Michigan Ranks 5th in production of Portland Cement
- Michigan is also an important producer of common clays, crushed stone, dimension stone, gypsum, industrial sand and gravel, lime, masonry cement, natural gemstones, and salt.
- Michigan has produced hydrocarbons for energy fuels for over 100 years. Michigan leads the nation in underground storage of natural gas.
- Historically Michigan has produced over \$550 billion in minerals valued in 2013 dollars

Providing a Sustainable Aggregate Supply for Michigan



What are aggregates?

Literally the foundation of our society—needed for roads, bridges, and buildings

Raw materials from geologic resources including gravel, crushed stone, and sand

- **The average American requires roughly 10,000 tons of aggregate per year**
- **Needed to make glass, computer parts, asphalt and concrete**
- **Construction of one mile of four-lane interstate highway requires 85,000 tons of aggregate**
- **The average six room house requires 90 tons.**

Finding local sources of aggregates saves money. A hauling distance of + 25 miles will double the cost of the delivered aggregate

Michigan has an abundance of aggregates—it is one of only 12 states that produced more than \$2 billion of aggregates last year

Yet only 10% of Michigan counties have been mapped for the location of aggregates.

We need to know where our aggregate resources are located to provide and manage a sustainable source of these essential building materials.

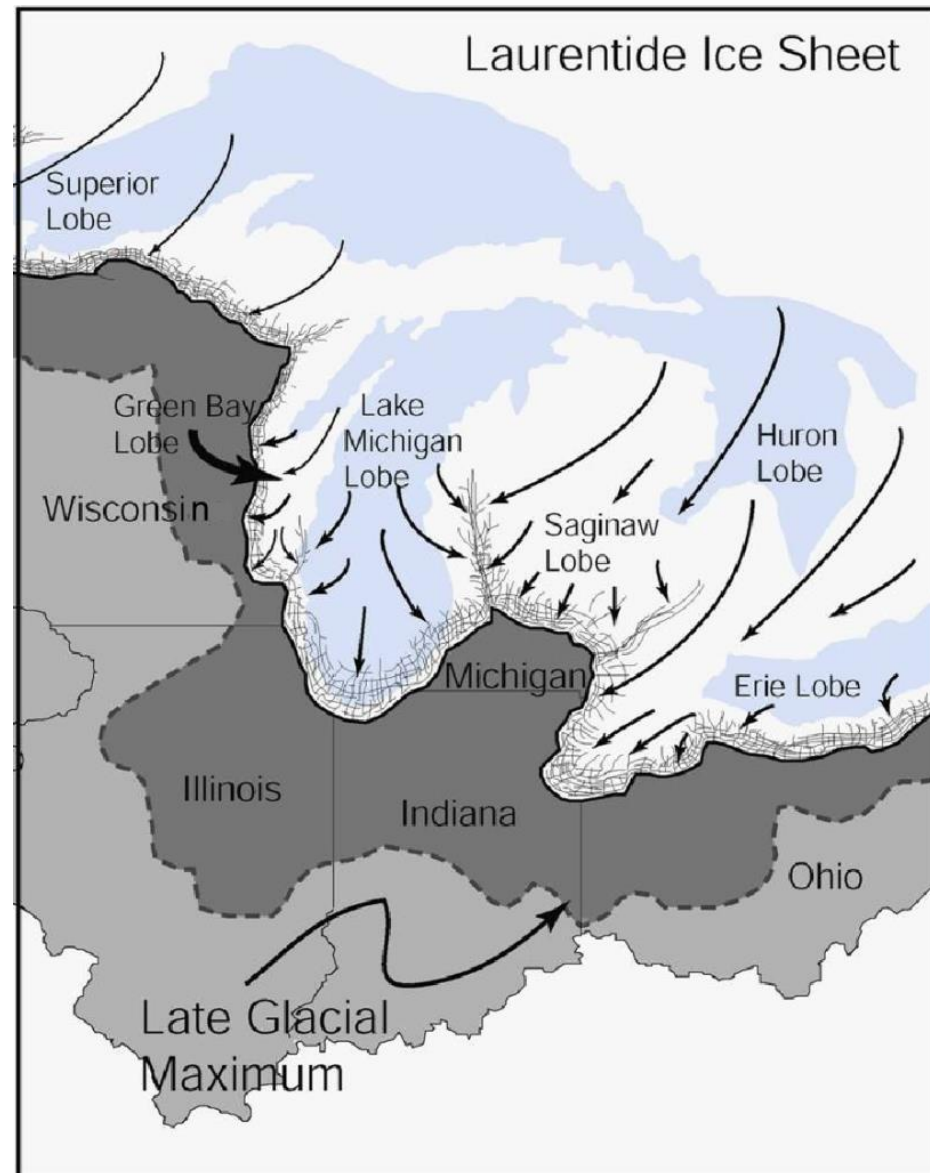
Mineral Resources are Geological Resources



- **What does Michigan know about the geology in the State?**
- **Less than 10% of Michigan has been mapped to understand the location of the natural resources of minerals and water.**
- **MGS has been petitioning for a mapping budget since 2011.**
- **2022, we are now petitioning for a budget to support the identification management of those natural resources (stone, sand, gravel, water).**
- **Let's look at where we know the resources are present.**
 - **We have vast data voids about future resources locations**

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

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

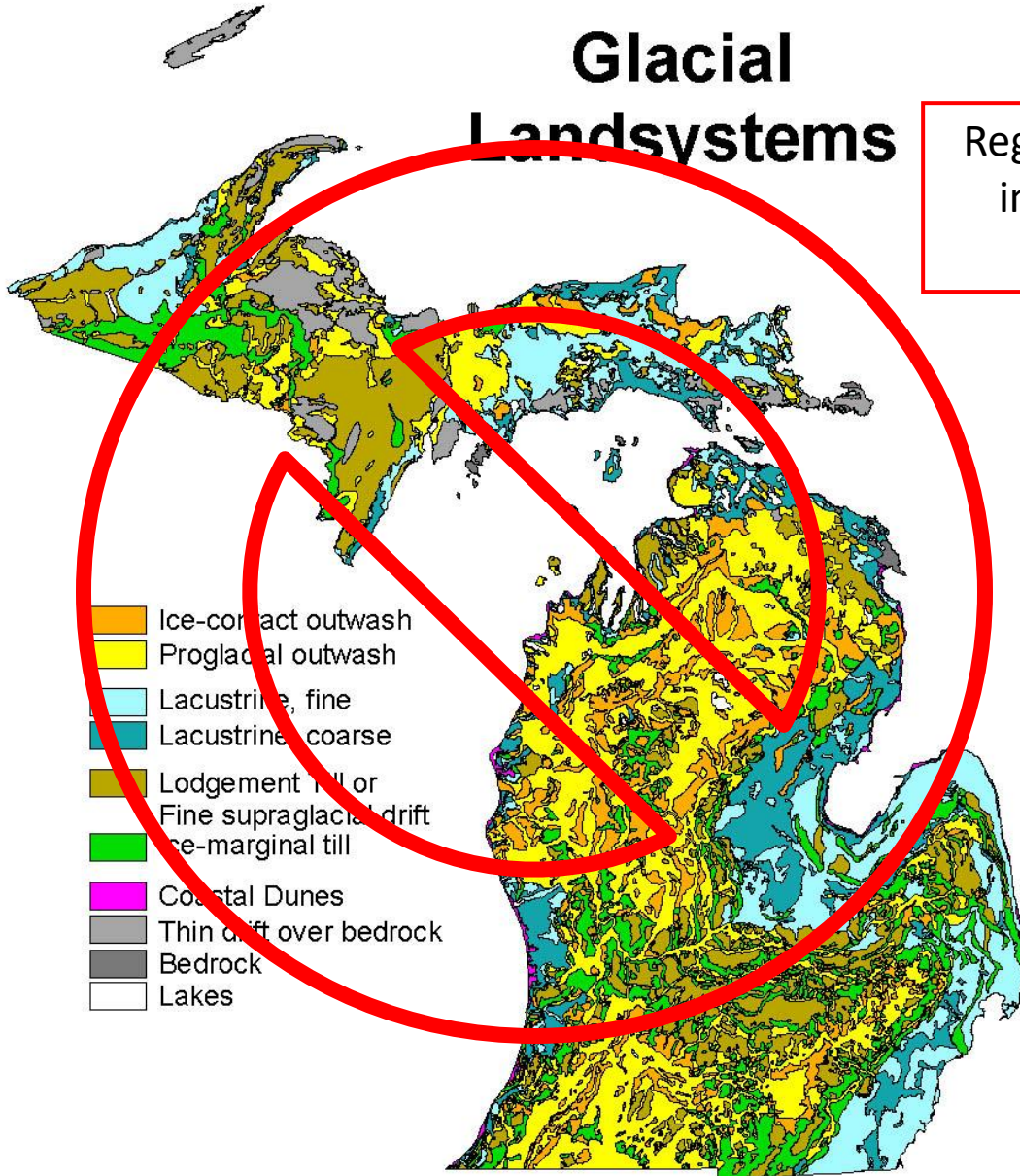




So, Where do we begin?

Glacial Landsystems

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

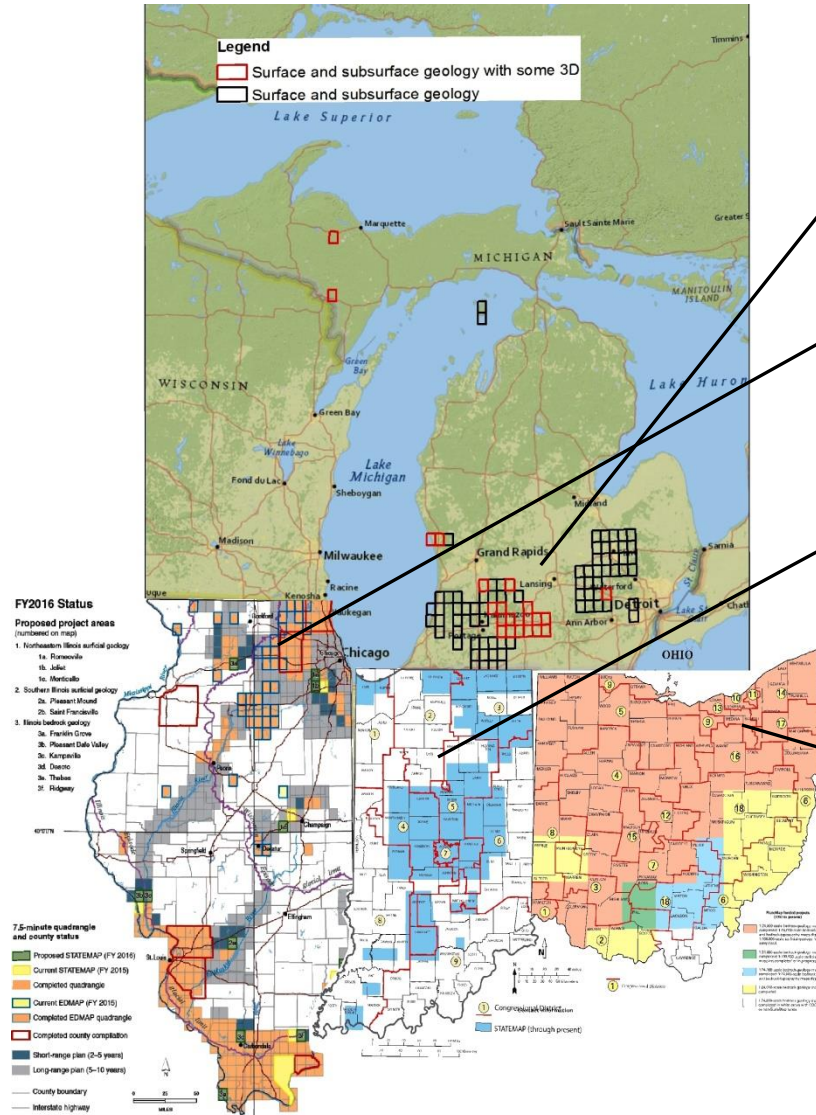


- This 1982 surficial geology map is based on 1915 (Leverett & Taylor) data, with minimal changes in 1955 (Helen Martin), 1982 (Farrand & Bell). This is **ONLY** a surficial geology map.
- No subsurface validation.

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

Where is the Water and Aggregates?

Mapping-Michigan versus adjoining states!

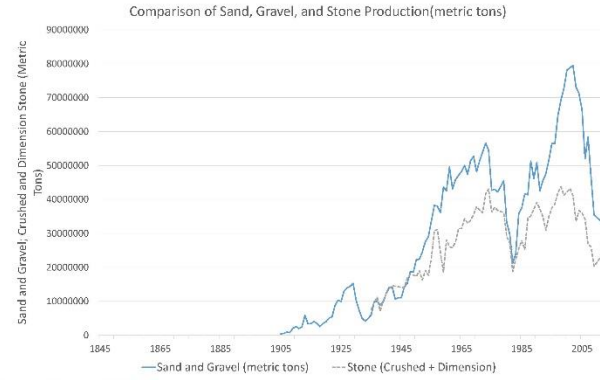
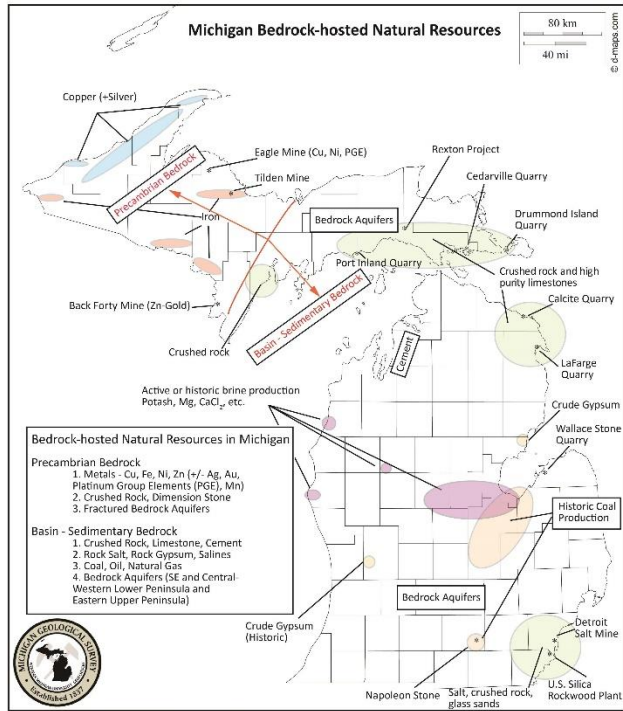


Federal matching dollars in the last 25 years

- ✘ **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 production, 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

Michigan Historic Mineral Production – Aggregate and Other Industrial Materials - Statewide



- Production of 3.5 Bil tons, stone, sand and gravel



Glass Sand Quarry, Monroe Co., MI



Cement Quarry, Charlevoix Co., MI



Crushed Rock, Calhoun Co., MI



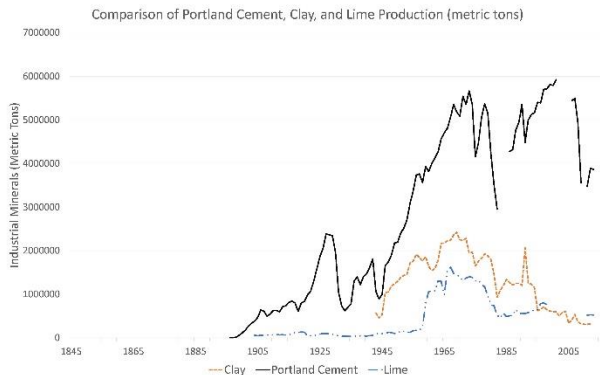
Crushed Stone, Chippewa Co., MI



Brick Factory Ruins Eaton Co., MI



Gravel Quarry, Kalamazoo Co., MI



Sand Mining Cass Co., MI

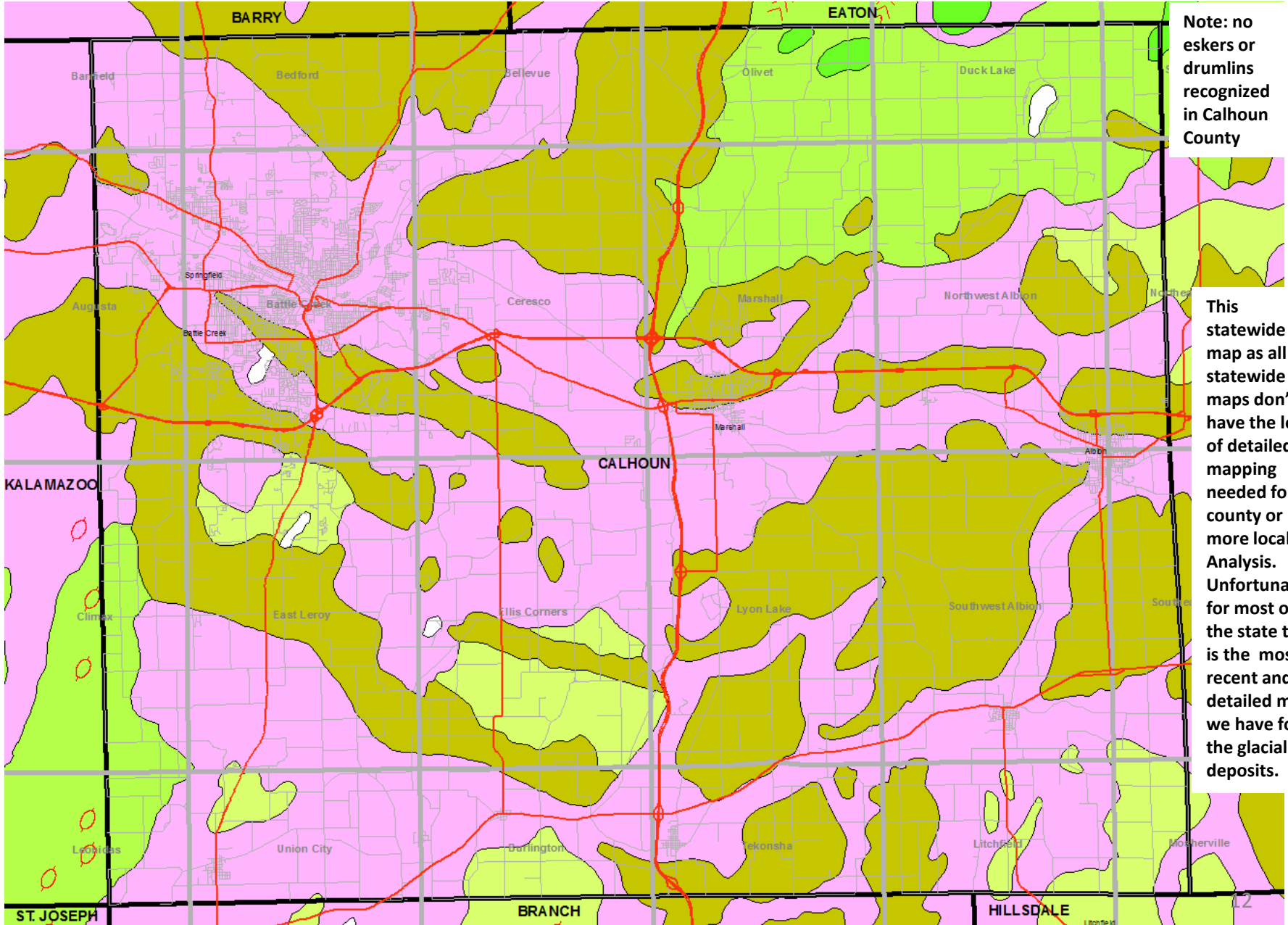
Resource	Amount Produced (metric tons)	Value in 2013 US \$
Portland Cement	300 million	\$28 billion
Clay	91 million	\$1 billion
Lime	45 million	\$5.5 billion
Marl	4 million	\$18 million
Stone (crushed and dimension)	2.2 billion	\$10.4 billion
Sand and Gravel	3.3 billion	\$25 billion
Peat	10 million	\$260 million



So how does MGS produce the maps?

- **MGS has a process/plan to map a county's geology for regulatory and public use as soon as practicable.**
- **Mapping each county will require 1.5 to 2 years.**
 - Not all counties will need the same data compilation, some less.
- **Multiple counties will be mapped each year (At least two, if not three ongoing).**
- **Apply county geologic mapping techniques used by Minnesota for almost 10 years, modified for Michigan.**
 - No re-invention of the mapping program or method is needed.
 - Will take at least one full-time geologist per county, but will team support multiple counties.
- **Illinois Estimates the cost at \$1.3 M per County (for staff, field drilling, analytical/ technical data, and map production) Note: Inflation costs and access to drill rigs.**
- **MGS will pursue Federal - USGS support- STATEMAP, which will allow for more funding available beginning in 2021.**
- **Publication of open file data to meet USGS map production standards.**
- **Estimate 20-25 counties to require at least 10 years.**
- **Need to start now!**

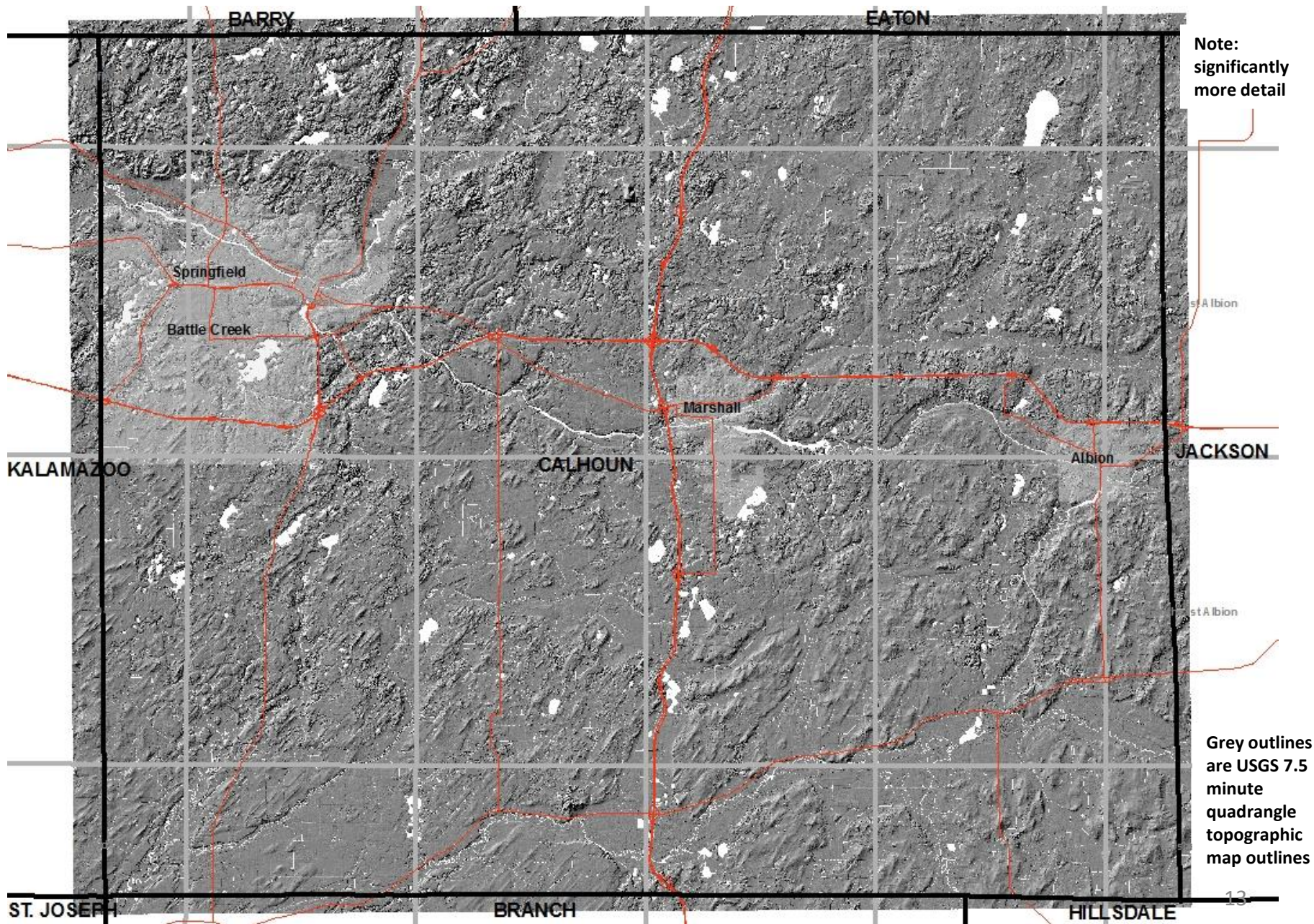
This is the 1982 Quaternary Geology Map of Michigan 1:500,000 – based mostly on earlier maps from 1915 and 1955



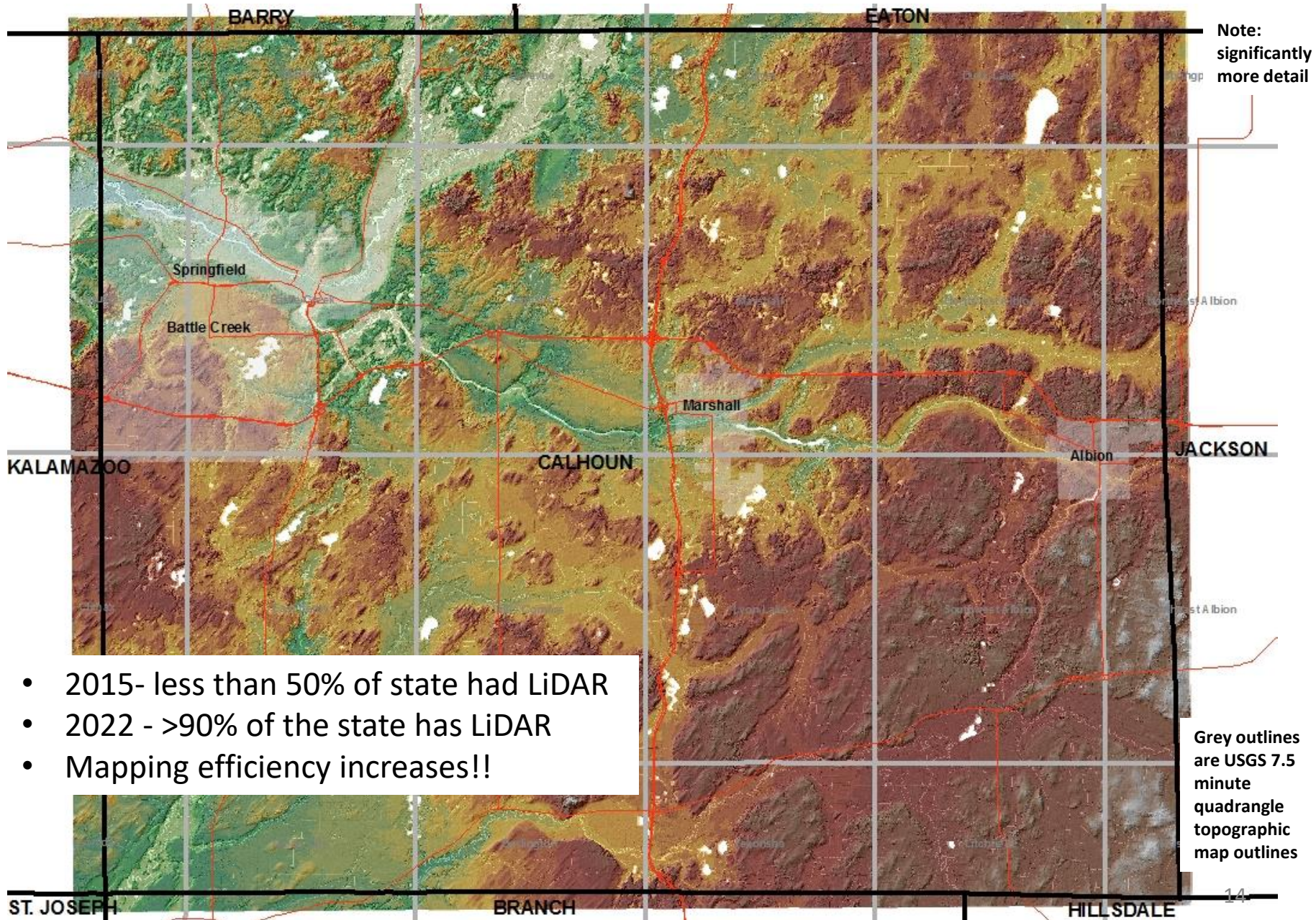
Note: no eskers or drumlins recognized in Calhoun County

This statewide map as all statewide maps don't have the level of detailed mapping needed for county or more local Analysis. Unfortunately for most of the state this is the most recent and detailed map we have for the glacial deposits.

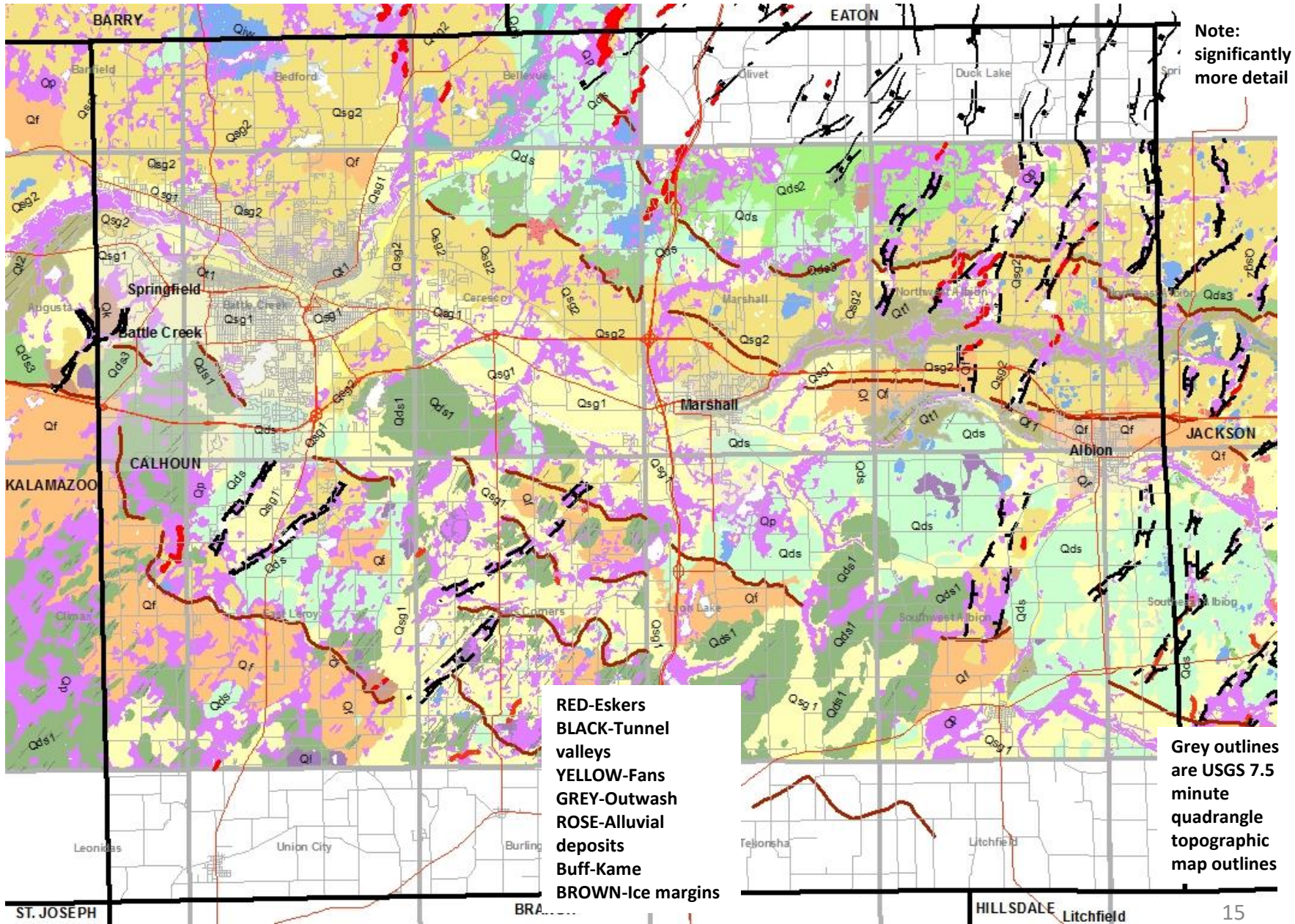
Calhoun County LIDAR elevation hillshade, Michigan Geological Survey (MGS)



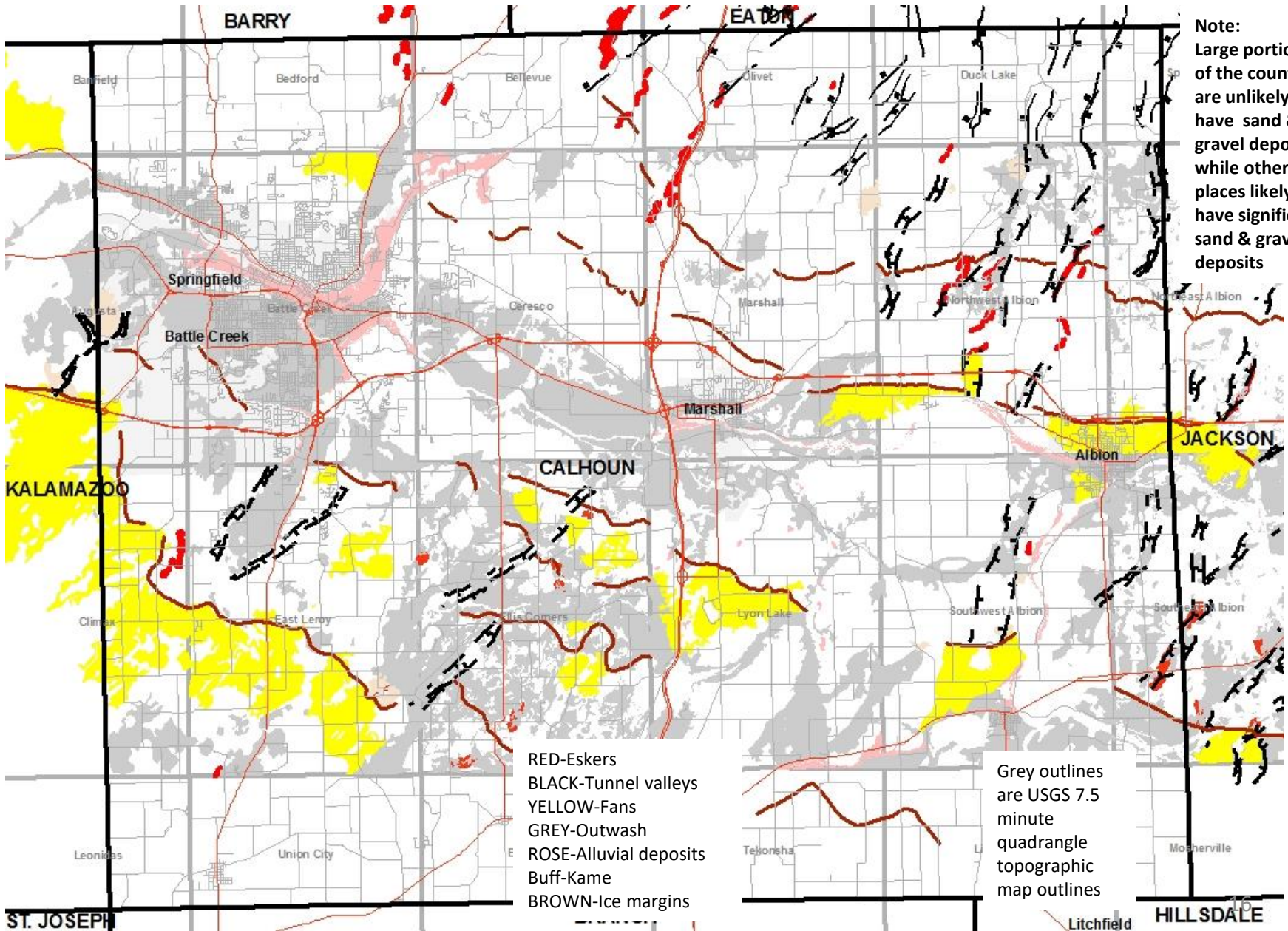
Calhoun County LIDAR elevation shaded relief, Michigan Geological Survey (MGS)



2015 Quaternary Geology Map of Calhoun County based on detailed mapping at 7.5 minute scale, Michigan Geological Survey (MGS)



2015 Quaternary Geology Map of Calhoun County – sand and gravel likely bearing glacial landforms



Note:
Large portions
of the county
are unlikely to
have sand &
gravel deposits,
while other
places likely
have significant
sand & gravel
deposits

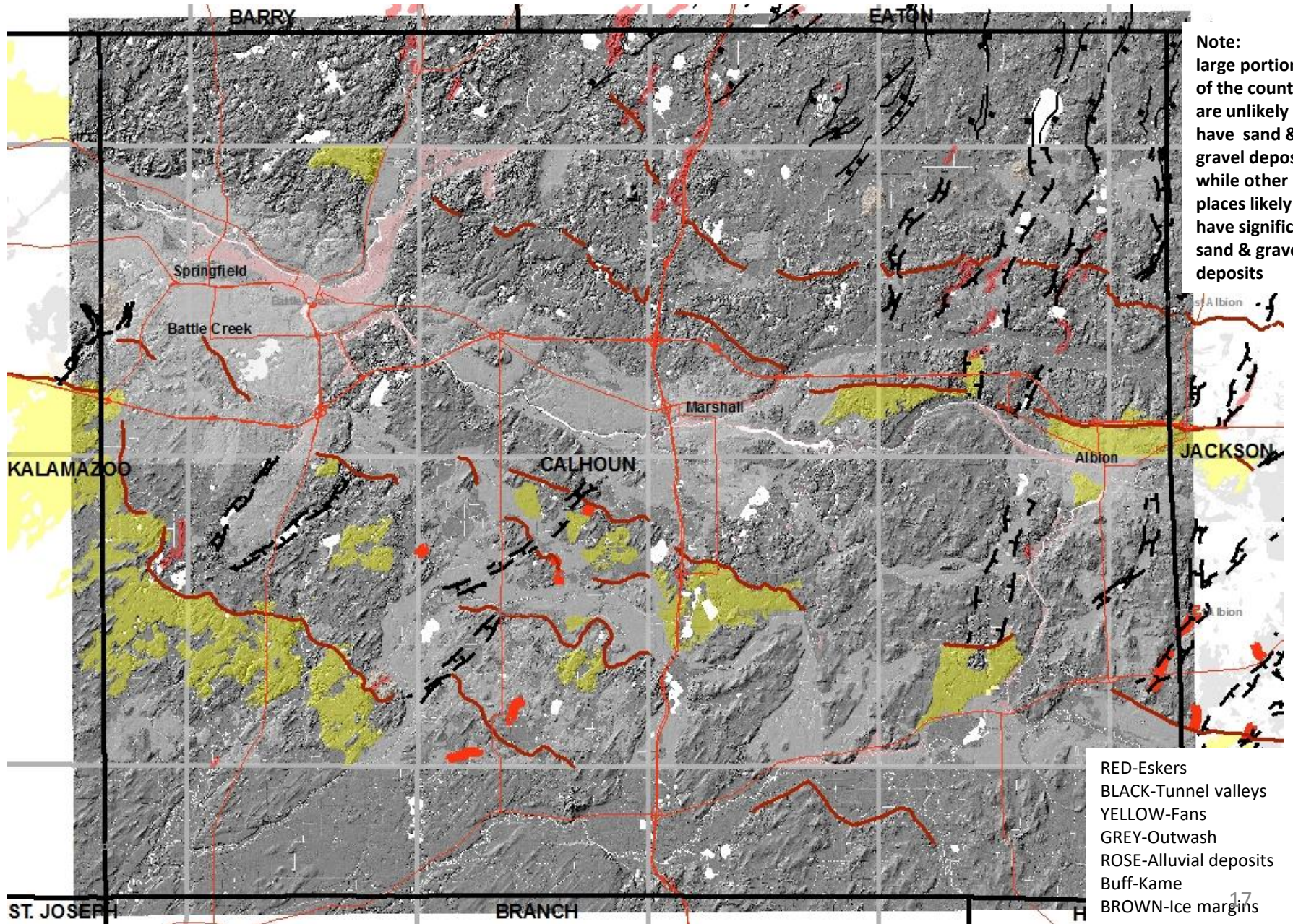
- RED-Eskers
- BLACK-Tunnel valleys
- YELLOW-Fans
- GREY-Outwash
- ROSE-Alluvial deposits
- Buff-Kame
- BROWN-Ice margins

Grey outlines
are USGS 7.5
minute
quadrangle
topographic
map outlines

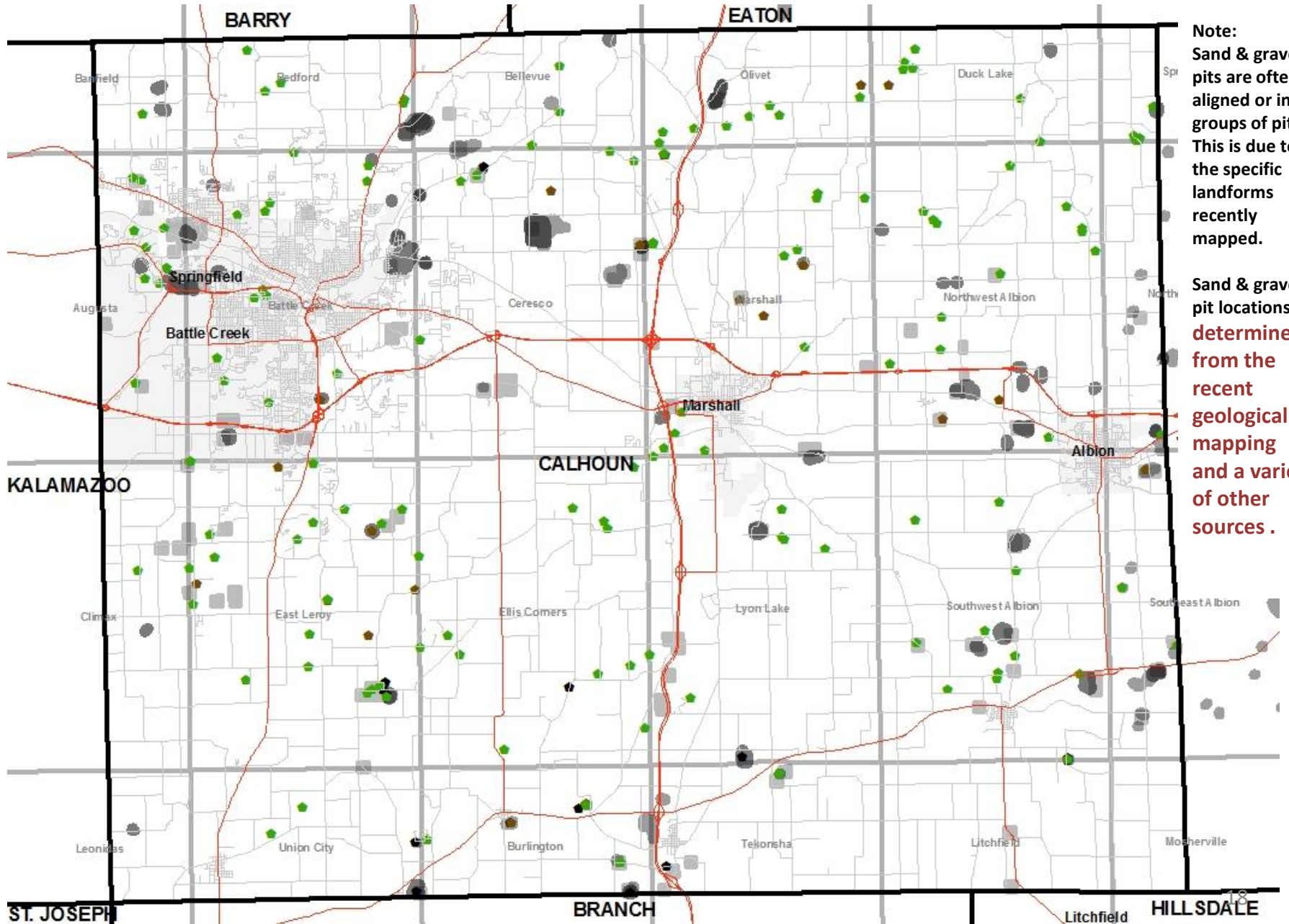
Litchfield

HILLSDALE

2015 Quaternary Geology Map of Calhoun County – sand and gravel likely bearing glacial landforms over LIDAR hillshade that can be mapped



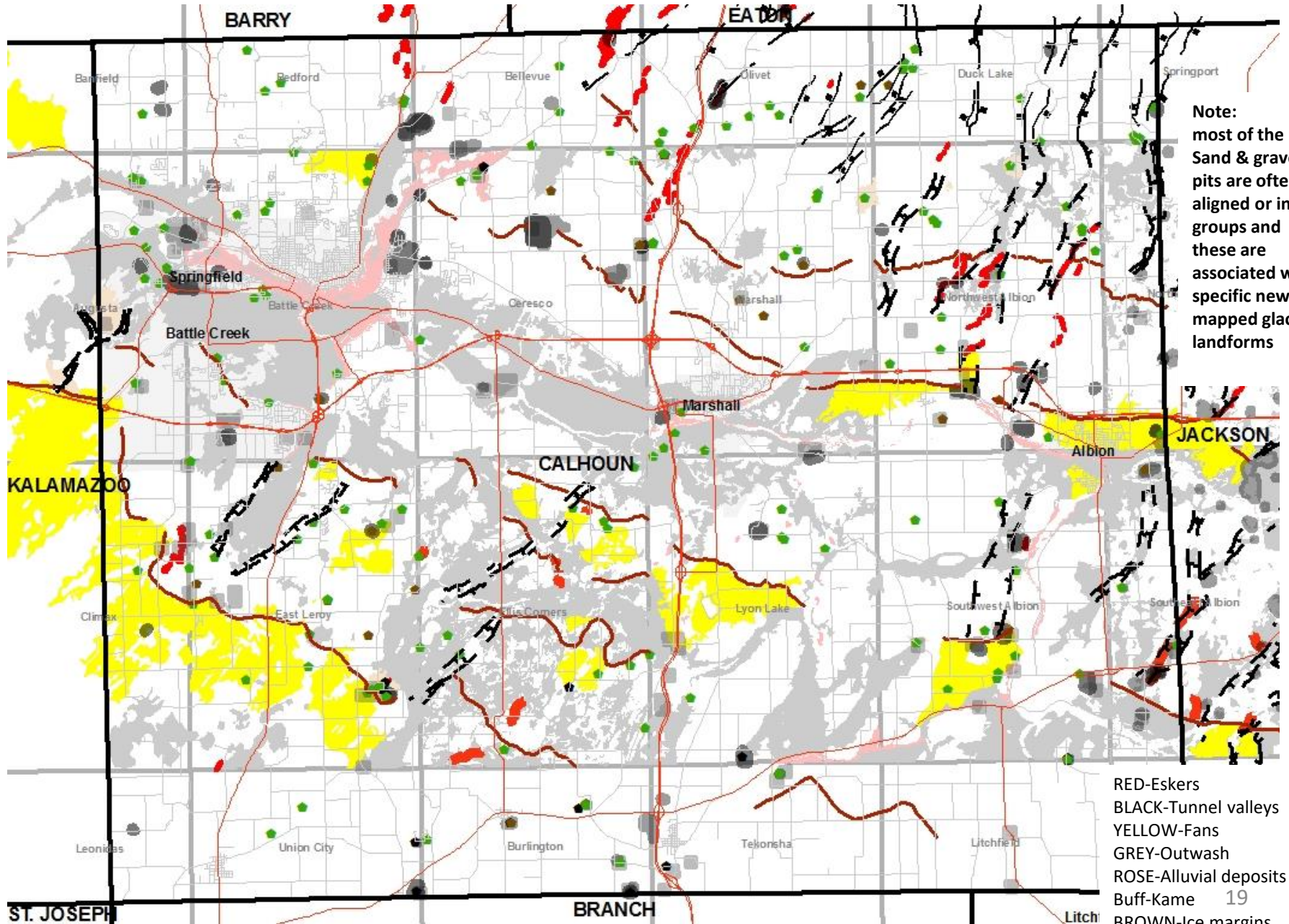
2015 Aggregate Inventory of Calhoun County



Note:
Sand & gravel pits are often aligned or in groups of pits. This is due to the specific landforms recently mapped.

Sand & gravel pit locations determined from the recent geological mapping and a variety of other sources .

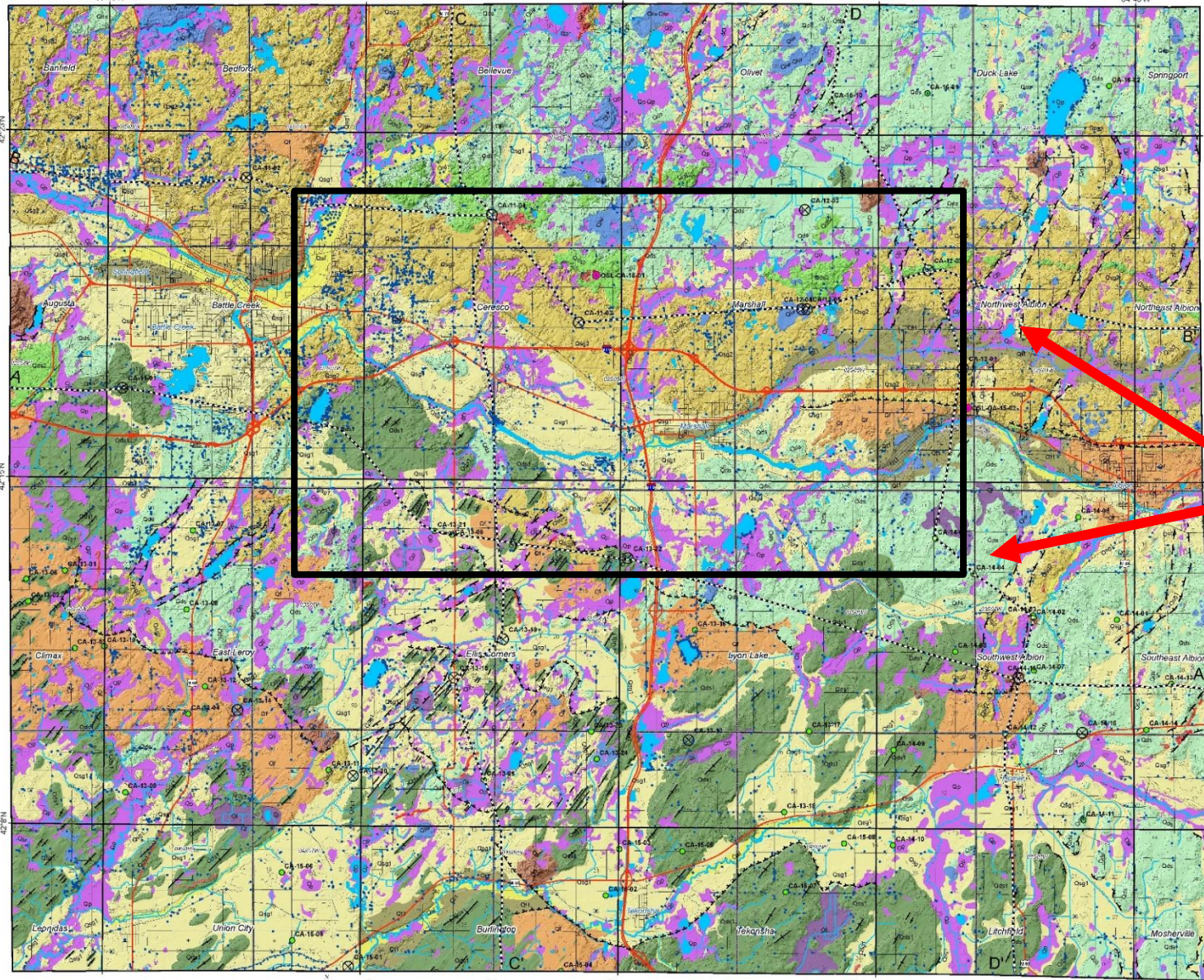
2015 Aggregate Inventory of Calhoun County and sand & gravel likely bearing glacial landforms



Note: most of the Sand & gravel pits are often aligned or in groups and these are associated with specific newly mapped glacial landforms

RED-Eskers
 BLACK-Tunnel valleys
 YELLOW-Fans
 GREY-Outwash
 ROSE-Alluvial deposits
 Buff-Kame
 BROWN-Ice margins

Calhoun County 2017 Map



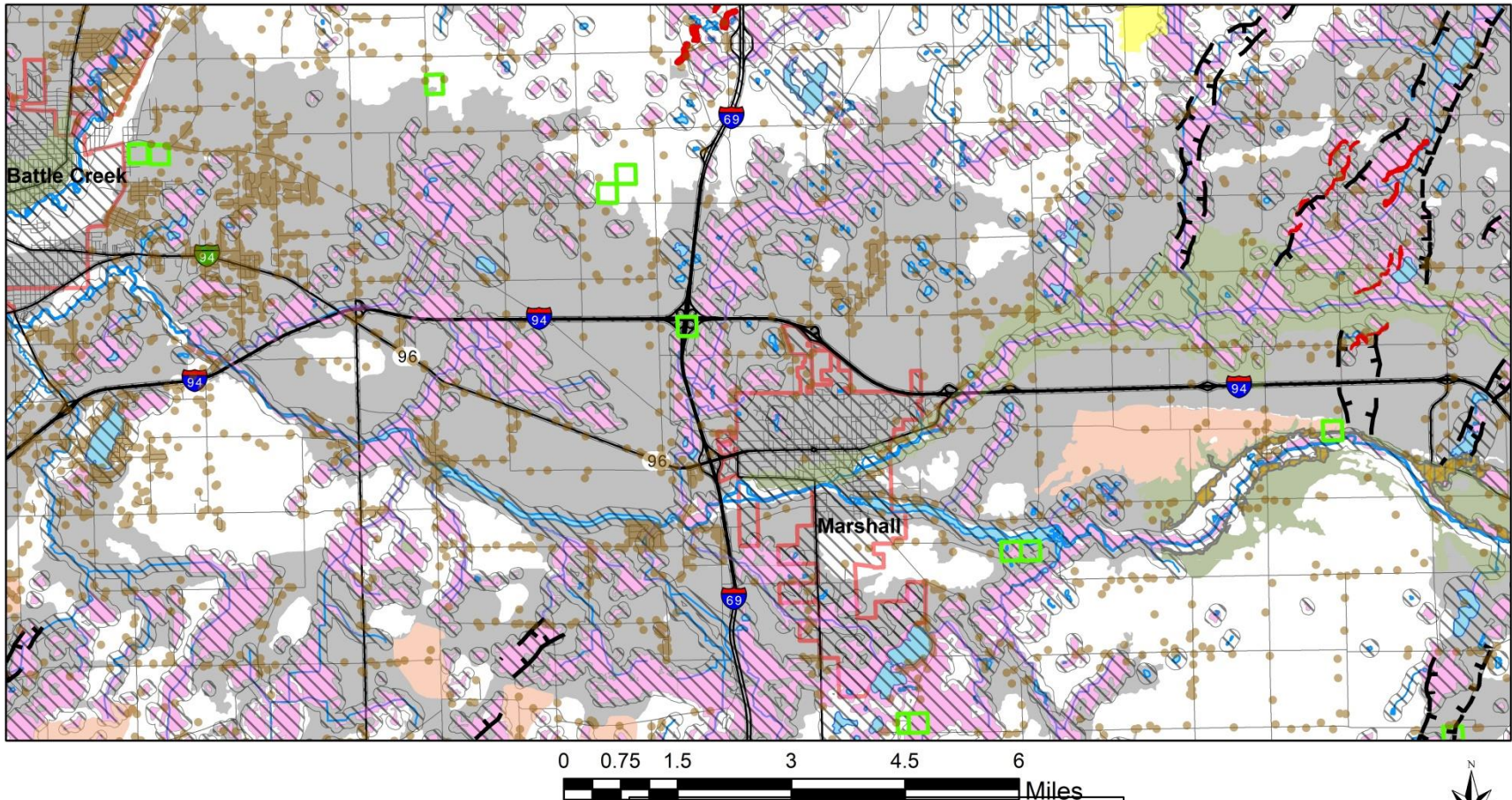
All can see the level of detail in new mapping.

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

These are not MDOT graded resources



Legend

Qe	Qt2	Wetlands
Qf	Qt3	Lakes
Qk	Tunnel Valley	Existing Sand and Gravel Operations
Qsg1	Eskers	State Roads
Qsg2	City Limits	Local Roads
Qt1	Setback Buffer	Streams
		Water Wells

Aggregate Resources by all glacial types

Qe – Eskers
 Qf – Fans
 Qk – Kames
 Qsg 1&2 Outwash
 Qt 1, 2, 3 – Terraces

Resources = 147 Sq mi minus 63 Sq mi restricted = 84 (~55%) Sq mi available.
 Does not show home restrictions - Wells





MGS shows the need for validated geologic data to stakeholders

Since 2011, MGS has presented this need to Legislators, Associations, State Departments, Professional associations, industry members, governmental agencies and Tribal nations:

- 2014 Well drillers' training at MGRRE-Statewide, logging drill cuttings, Bi-Annual EGLE geologists training-Roscommon, WUAC review of need for geologic mapping, SW Michigan Farmers, Annual Tribal meetings, need for mapping, State DEQ/EGLE, DNR, OGL-\$44,000.**
- 2015-16 & 2019 MDOT, MI Aggregate Association & Mi Manufacturing Assoc. need for mapping location of aggregates and other resources.**
- 2015-2021 – presentations to annual and special meetings, County Commissioners, Planners, County (Ottawa, Allegan), City-St. Joseph, Allendale, City of Portage, Townships-Cosca-Bluffs, need for mapping, research and data collection, in real time.**

Michigan needs to acquire and maintain geologic data

MGRRE repository personnel have collected and preserved data and samples from Michigan's natural resources for 40 years, **renting** the current facility since 2006.

- **MGRRE Repository is NOW full and needs an expanded facility.**
- **>95% of all samples and data are from Michigan and belong to the State.**
- **MGRRE holds the largest data and sample archive in Michigan.**
- **\$20 Billion is the estimated cost to replace all the samples and data.**
- **MGRRE samples represent water, aggregates, energy, subsurface and energy/CO2 storage resources.**
- **Who uses MGRRE?**
 - **University researchers from WMU, UofM, MSU, CMU, GVSU, Wayne State, Ohio, Indiana, MI Junior Colleges, used for training professional geologists**
 - **Students conduct research learning how energy, water, chemical and engineering tests can support environmentally development.**
 - **Industry professionals share results with MGRRE and Public, e.g., potash.**
 - **MDOT samples stored and used to support current and past construction projects.**





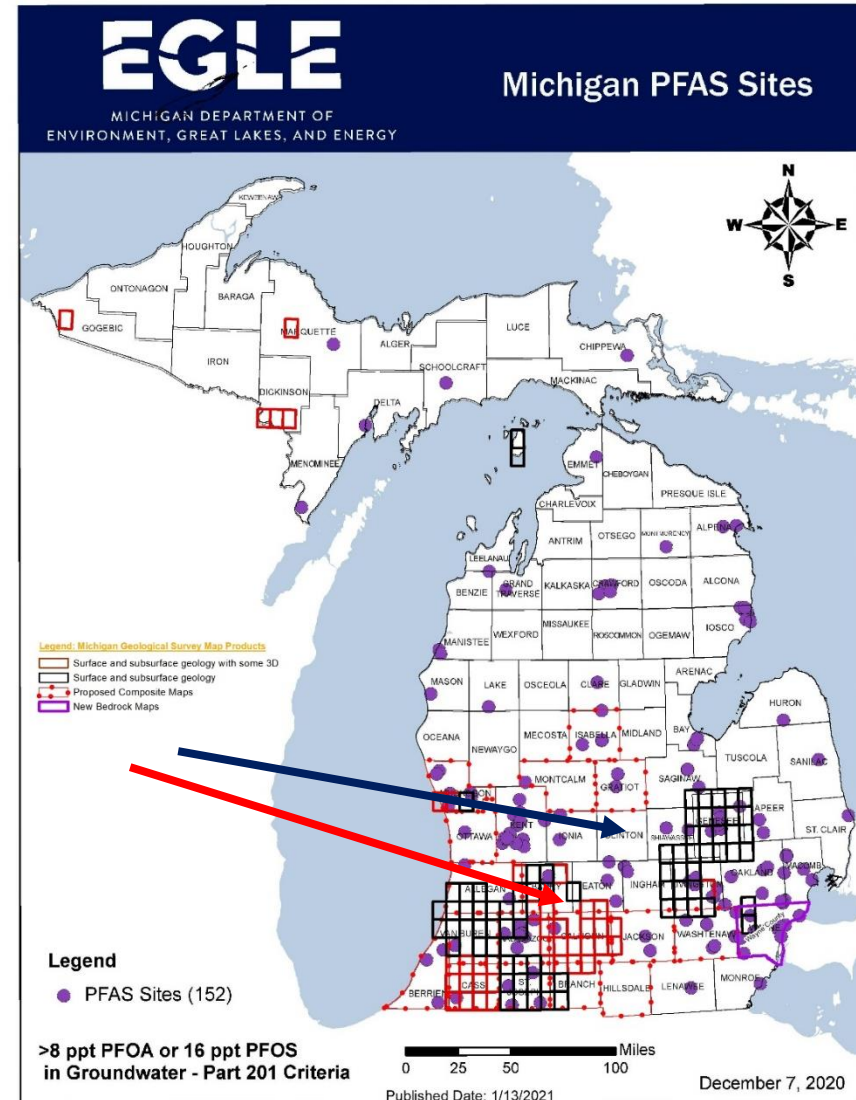
Since 2011, the Michigan Geological Survey has compiled data and maps for geologic resources:

- Ottawa County water resource support, now geologic mapping with USGS
- State of Michigan Welllog location validation (560,000 locations) **40% not on correct property** (project is 1/3rd done)
 - Input 700,000 scanned records totaling 1.3M water well logs
- UP – USGS Critical Minerals geologic mapping with MTU geologists
- WUAC recommended geologic mapping (2014 & 2020) for WWAT tool
 - Recommend State funding for 20 to 25 counties
- Ottawa County monitor well network with MGS drilling
- Gladwin County Dam break, mapping groundwater changes
- Publishing USGS grant, 1:1 matching funds mapping in Calhoun, Barry, Cass and now Ottawa and Allegan Counties.
 - Water and Aggregates occur in the geologic units.
- City of Portage, MS student research new mapping “New” lower aquifer
- Bluff research studies since 2017, St. Joseph, Cosca Twp, Ludington
- Allegan County drilling and monitor well program
- USFS mapping for aggregates, Wexford County

What is the new Michigan contaminant crisis?

Michigan – the Water Wonderland!

- Per fluorinated 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 MGS 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 and will support aggregate locations.



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	Hillsdale	<10	Allegan	<10	
8	Jackson	Jackson	<10	Calhoun	100%	
9	Branch	Berrien	<10	Ionia	<10	
10	Washtenaw	Allegan	<10	Monroe	<10	
11	St. Joseph	Montcalm	<50	Livingston	60%	
12	Hillsdale	Gratiot	<10	Lenawee	<10	
13	Livingston	Jackson	<10	Marquette	50%	
14	Monroe	Isabella	<10	Washtenaw	<10	
15	Ionia	Oceana	<10	Barry	100%	
16	Lenawee			Berrien	100%	
17	Marquette			Charlevoix	<10	
18	Charlevoix			Delta	<20	
19	Delta			Jackson	<50	
20	Gratiot			Newaygo	<10	
21	Isabella					
22	Oceana					
		Top Priority				
		Second Priority				
		Done				16-Mar-22

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.**



So what is the answer to scientific data?

- Annual Funding for the Geological Survey
- Priority driven areas
- Use unbiased geological scientists, 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

Michigan Geological Survey



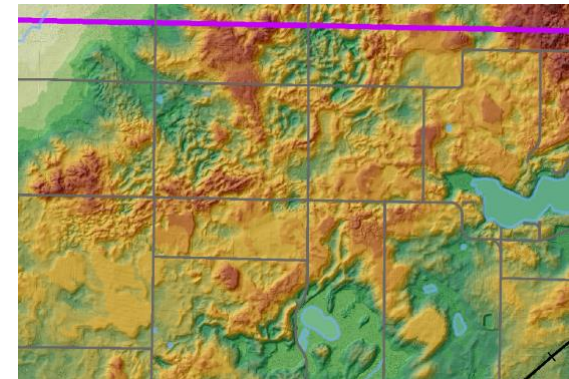
Summary as of May 1, 2015

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

County	Number of RRD	RRD Files	Oil and Gas		Number of O&G	Shallow bedrock	Drill cuttings	B
	site entries in Environmental Mapping		(OOGM) permitted bonholes	Wellologic water wells				
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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