



Advancing CCUS in the Michigan Basin

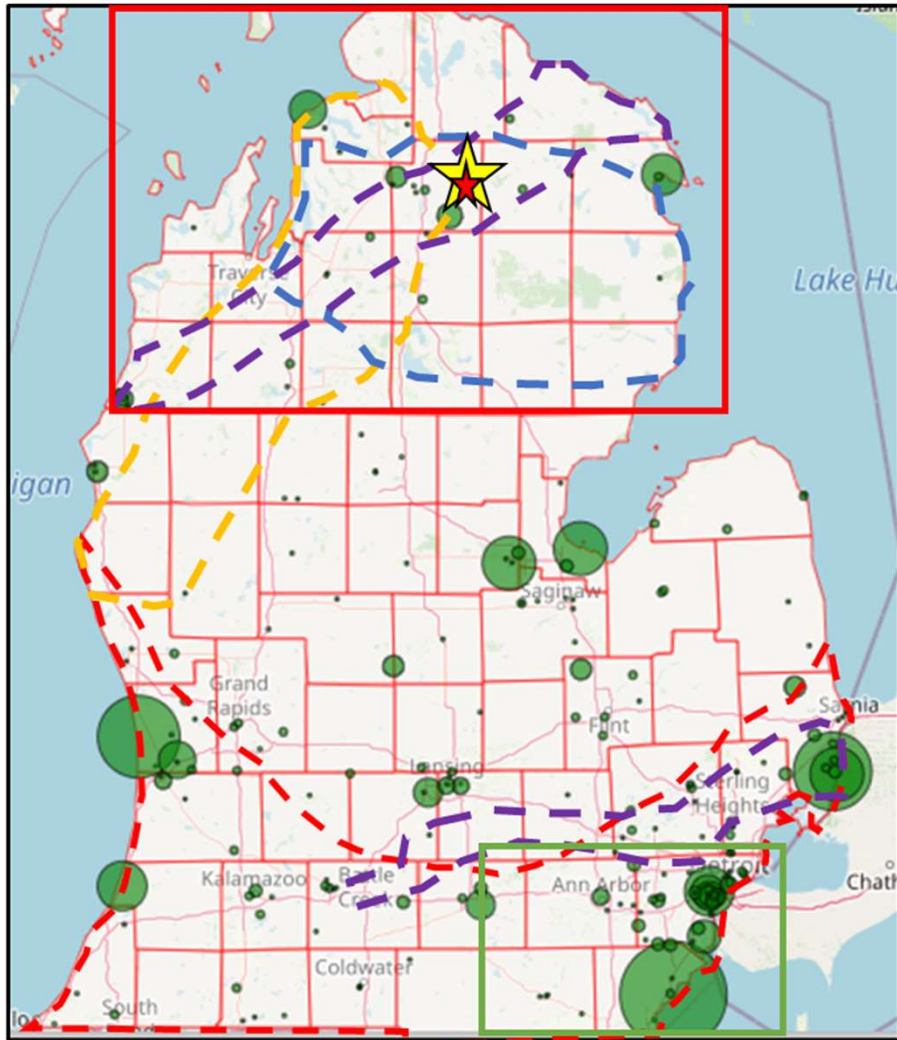
Dr. Autumn Haagsma

DE-FOA-0002799
DE-FE0032368

Project Goals

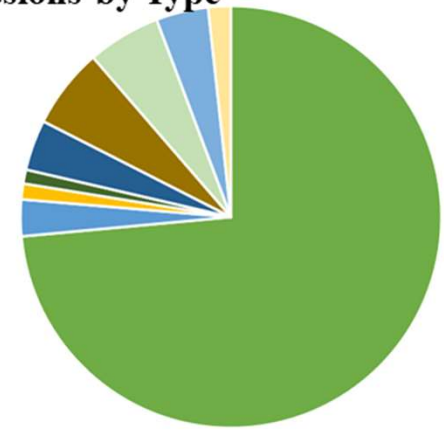
The proposed project aims to **reduce risks** by closing critical gaps in data and information, and **building strong relationships** with stakeholders and communities to **support public acceptance** of commercial deployment of CCUS

- **Validation** of key storage reservoirs through detailed mapping of reservoir properties and identification of regions suitable for commercial-scale to hub-scale storage
 - **Pressure management solutions** through mapping and evaluating brine disposal reservoirs which can be used to dispose of extracted brines from CCUS targets and control the pressure within those reservoirs
 - **Evaluating efficiency of confining units** through detailed mapping and characterization of immediately overlying seals for key reservoirs including extent, thickness, lithology, mineralogy, and geomechanical properties to reduce leakage risk and understand reaction potential
 - **Reducing leakage risks** by evaluating existing Michigan wellbores, developing a wellbore integrity assessment tool, and by integrating results with EGLE's well protection program
 - **Building relations with diverse communities** through engagement and education to provide benefits and/or allay adverse impacts from commercial CCUS deployment
- **Develop easy-to-use and publicly-available site selection tool which integrates geotechnical and societal considerations.**

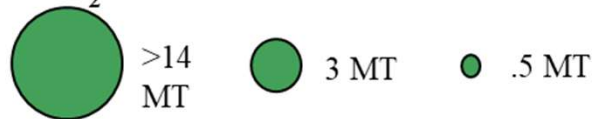


CO₂ Emissions by Type

- Power Plants
- Petro&Natural Gas
- Refineries
- Chemicals
- Other
- Minerals
- Waste
- Metals
- Pulp&Paper



CO₂ Emissions



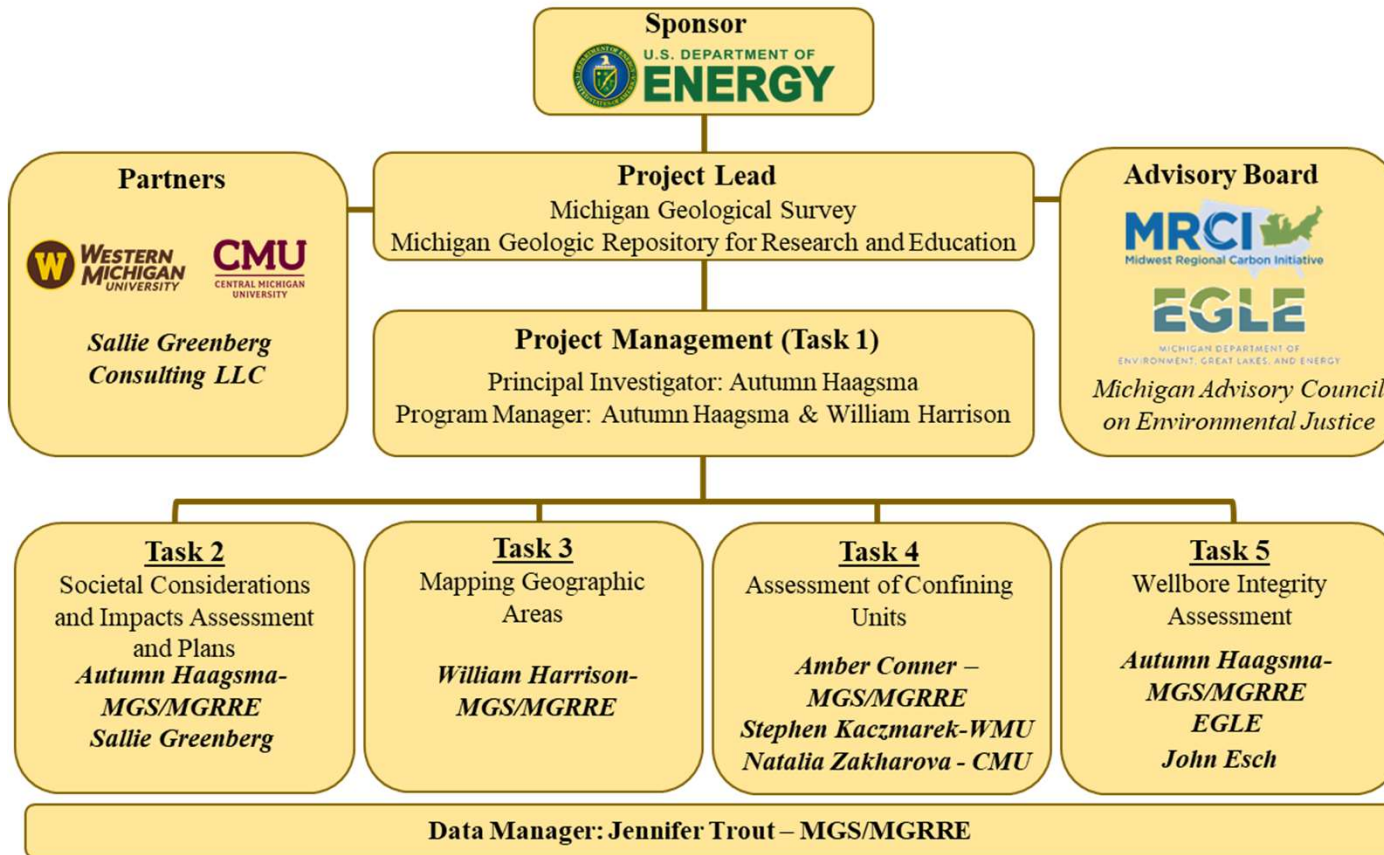
Reservoirs

- Niagaran Reefs
- Bass Islands
- St. Peter
- Mt. Simon

Key Projects

- ★ MRCSP Phase III Large-Scale Test
- ★ MRCSP Phase II Test
- CarbonSAFE Phase I
- CarbonSAFE Phase II

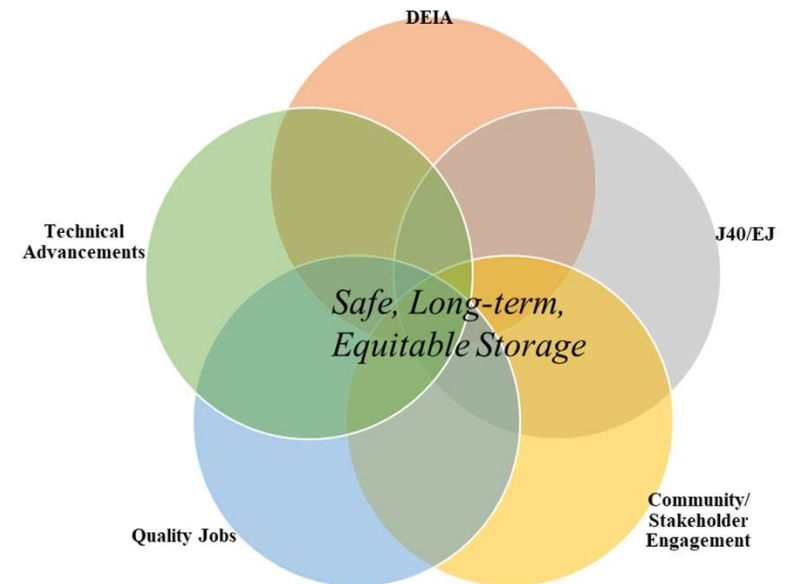
Team and Organization



Task 2 -Societal Considerations and Impacts (SCI) Assessment and Plans

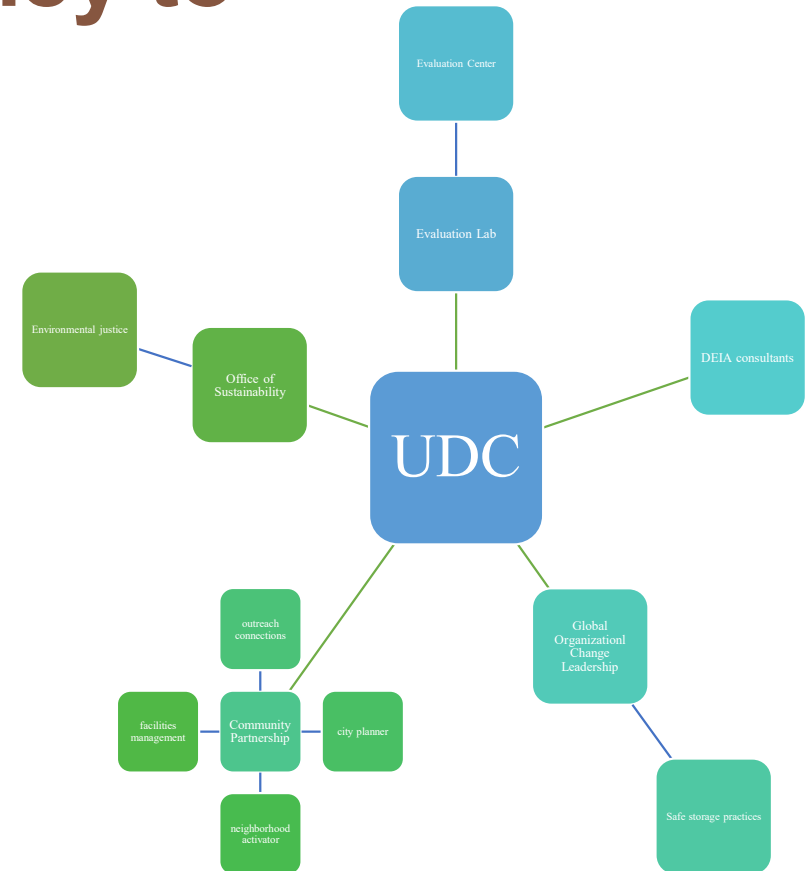
1. Diversity, Equity, Inclusion, and Accessibility Plans
2. Justice40 Initiative Plans
3. Community Engagement Plans

- Connected to task 1 – implement strategies and plans, conduct outreach and engagement
- Connected to task 5 – assessments incorporated into site selection tool
- *Utilize existing outreach mechanisms and social media platforms*



Task 2 – Networking Journey to Build Advisory Board

- Began with meeting WMU’s diversity committee (UDC)
 - Explained the project, goals, and community benefits plan
 - UDC aided in making connections within the University and adjacent communities
 - Groups provided reports and metrics used for DEIA
- Developed a diverse and multi-disciplinary advisory board to review the community benefits plan
 - Established questions and prompts for reviewers
 - Compiled results of reviews into a milestone report
- Upcoming work:
 - Stakeholder analysis – Fall 2024
 - Virtual meeting with advisory board – Fall 2024



Outreach, Engagement, and Education

- Panelist at NAPE discussing “Better Storage: Risk Metrics for Assessing CCUS Reservoirs”
- Testified to the Michigan Senate and their Energy and Environment Committee on CCUS in Michigan
(<https://cloud.castus.tv/vod/misenate/video/65ea1af49d94700008452b29?page=HOME>)
- Interviewed by local news channel WoodTV 8 on CCUS research in Michigan
(https://youtu.be/eqQI9VFZe_k?si=GscBgpDQi3PCNkSj)
- Chaired the CCUS 2024 conference which is hosted by multiple organizations and drew ~1,700 attendees from around the world. During the conference, Dr. Haagsma was interviewed by OGGN podcast, which will be available later this summer.
- Developed a 1-page project fact sheet, which has been shared with Michigan senators and their staff, and other stakeholders.
- Taught an introduction to CCUS to Western Michigan University geology students
- Presented a webinar to Illinois Sustainability Technology Center on Importance of Community Engagement, Outreach, and Education
- Abstracts submitted and accepted to GSA



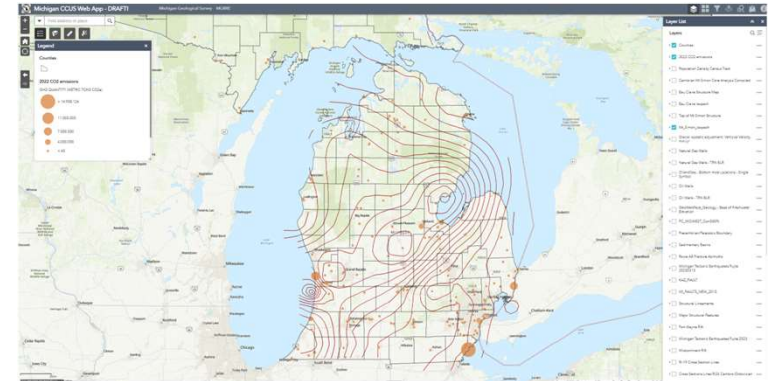
Task 3 – Mapping Geographic Areas

- 1) **Site Feasibility Map** – compilation of existing reservoir property data from previously identified key reservoirs (Mt. Simon, St. Peter, Niagaran, Bass Islands, Dundee). Polygon maps of locations, extents, and properties
- 2) **Evaluation of Unproven Reservoirs** – evaluate potential reservoirs, previously not studied, to assess the feasibility and quantity of CO₂ which could be stored. Could include regional Guelph and Lockport, Sylvania, Detroit River Group, etc.
- 3) **Evaluate Brine Disposal Reservoirs** – create comprehensive database of brine disposal zones, assess potential for co-location with CO₂ storage sites, and potential for use of reservoir for pressure management

* Goal is to build-on and expand existing knowledge base, compile data and information in accessible formats, and use as inputs into site selection tool

Task 3 – Building and Integrating Databases

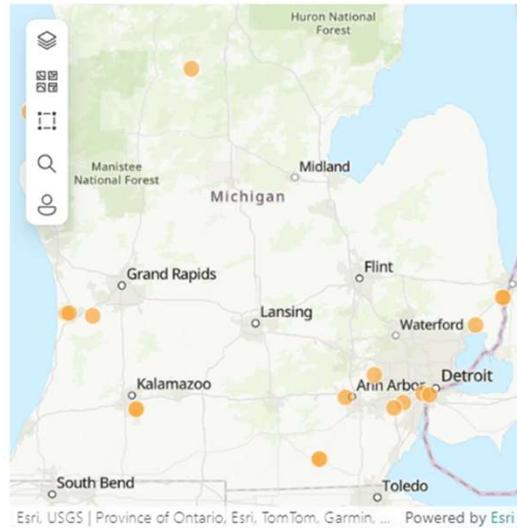
- Adapted and applied **MRCI** Carbon Systems approach:
 - Cambrian Mt. Simon
 - Cambrian – Ordovician
 - Silurian – Mississippian
 - Devonian
- Integrating multiple data types and building databases



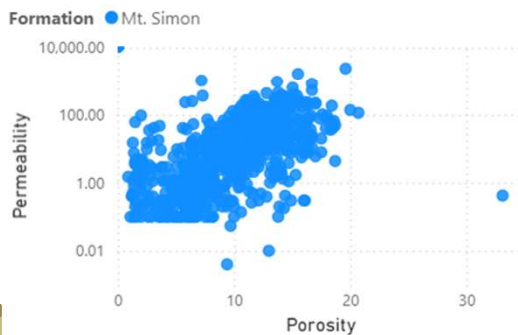
Information	Cambrian Mount Simon	Cambrian-Ordovician	Silurian-Mississippian
Reservoirs(s)	Mt. Simon	St. Peter	Niagaran Reefs, Bass Islands, Sylvania, Lucas, Dundee
Associated Confining Unit(s)	Eau Claire, Franconia, Trempealeau, Prairie du Chien	Glenwood, Trenton-Black River, Utica, Cincinnati	Salina Group, Amherstburg, internal baffles, Bell Shale
Key Region	Southern Michigan	Northern Michigan	Local sites, not extensive regions
Depth	X	X	X
Thickness	X	X	X
Rock Type	X	X	X
Pressure	X	X	X
Temperature	X	X	X
Salinity	X	X	X
Proximity to Faults	X	X	X
History of industrial activities	X	X	X
Produced maps	Structure/depth, thickness, porosity, permeability, net thickness, storage resources	Structure/depth, thickness, porosity, permeability, net thickness, storage resources	Bass Islands and Niagaran reefs extensively mapped, few maps of Sylvania, Lucas, and Dundee

Cambrian Mt. Simon Core Analysis

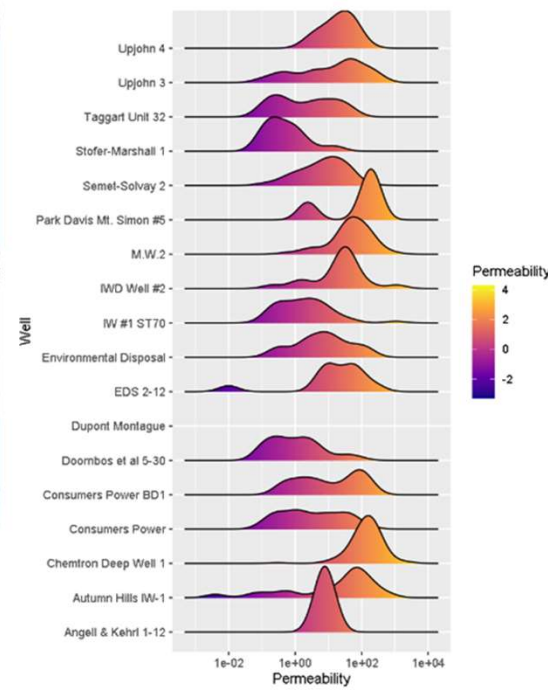
Well Coverage



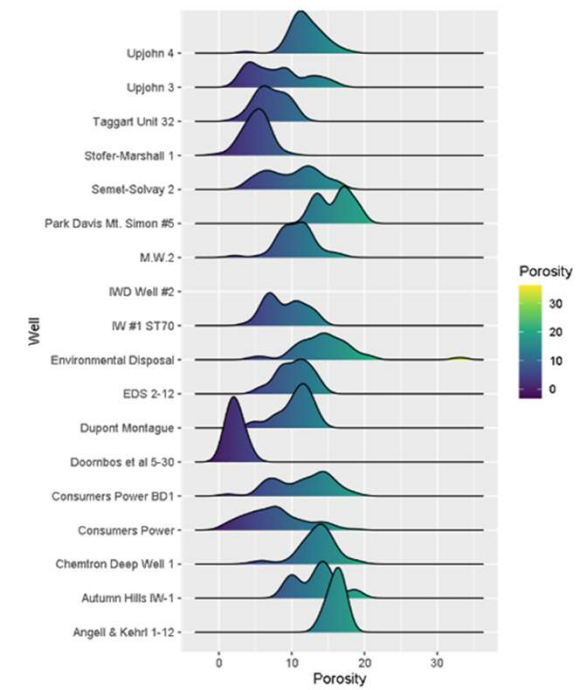
Porosity vs Permeability



Porosity Distribution



Permeability Distribution



Formation

--	Cincinnatian	Dresbach
Dundee-Detro...	Eau Claire	Franconia
Mt. Simon	Prairie du Chien	Salina Group

Average Por	Variance Por	STD Por
9.02	20.80	4.56
Average Perm	Variance Perm	STD Perm
53.62	21.87K	147.89

CambrianMtSimon_Data Variability, Core Analysis
Data updated on 6/20/24, 8:41 AM

Filters

Navigation icons: Home, Back, Forward, Refresh, Close



Task 4 – Assessment of Confining Units

- 1) **Lithological and Mineralogical Assessments** – Integrated analytical assessment of confining systems including lithological, mineralogical, and geochemical data from thin section petrography, SEM, XRD, and XRF. **Conducted by students via class experience**
- 2) **Geomechanical Assessments** – integrated analysis using scrape tests and velocity measurements to measure and compute geomechanical properties. Pore size distribution will also be measured. Results will be correlated with lithological/mineralogical/geomechanical data, and wireline logs for regional assessments.
- 3) **Confining Unit Mapping** – integrate existing and new data and information on major confining units to create first-of-a-kind detailed maps.

* Results will be used to identify potential risks, weaknesses, etc in confining systems. Outputs will be used to inform the site selection tool

Task 4 – Confining System Core Workshop

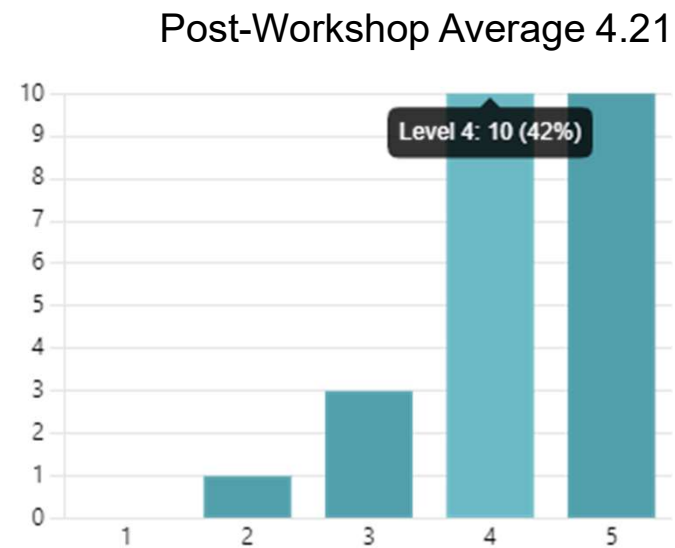
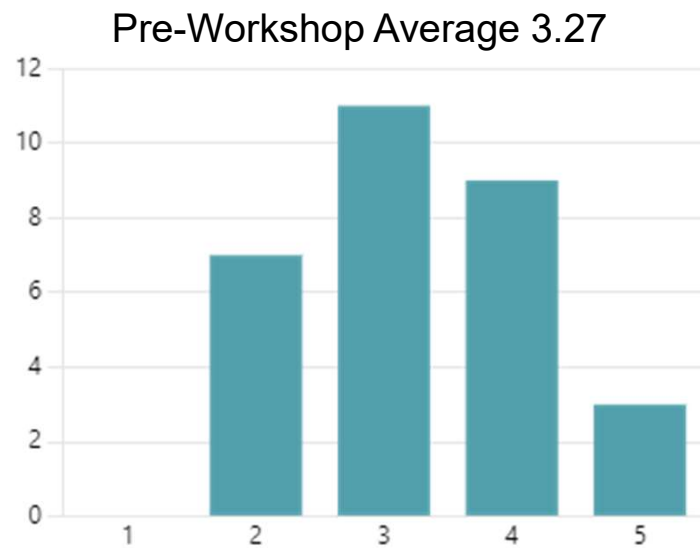
Hosted confining system workshop – May 14-16th

- ~40 people attended including project team, faculty and students, geological surveys, industry, research, and state
- Reviewed project scope, Carbon Systems, confining system characteristics, and observe cores from each system
- Created a workbook and flash drive of accompanying data
- Group discussions and exercises
- Pre and post-workshop surveys
- Following main workshop, project team met to discuss and develop our sample collection strategy



How comfortable are you with defining what elements make a good confining system?

~30% increase in confidence



Data Collection Strategy



- ★ Biolab Inc. MW#2
- ★ Consumers BD#1-7
- ★ Consumers BD#2-7
- ★ Park Davis & Co. #5
- ★ Consumers BD#139

Well Selection and Data Review



Sampling Party



Data Collection, Analysis, and Mapping



Data and Results Review

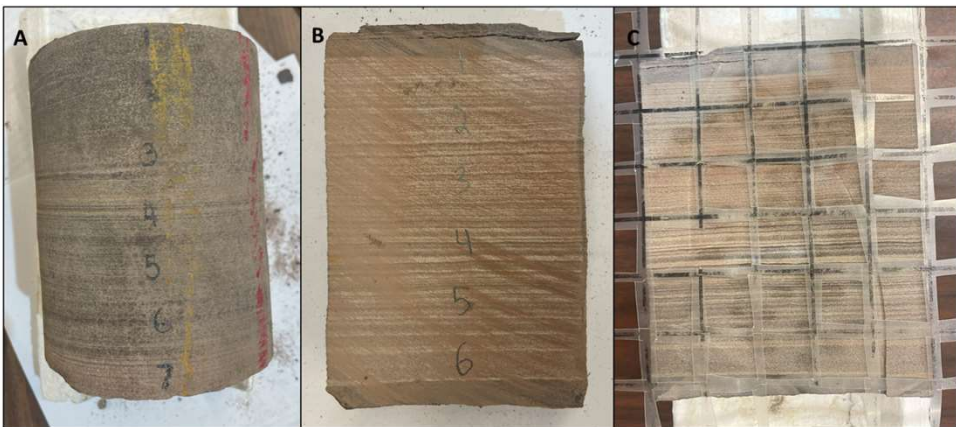
Mini-permeameter

N= 420

Thin Sections, SEM, XRD

N= 27 TS
N = 31 XRD

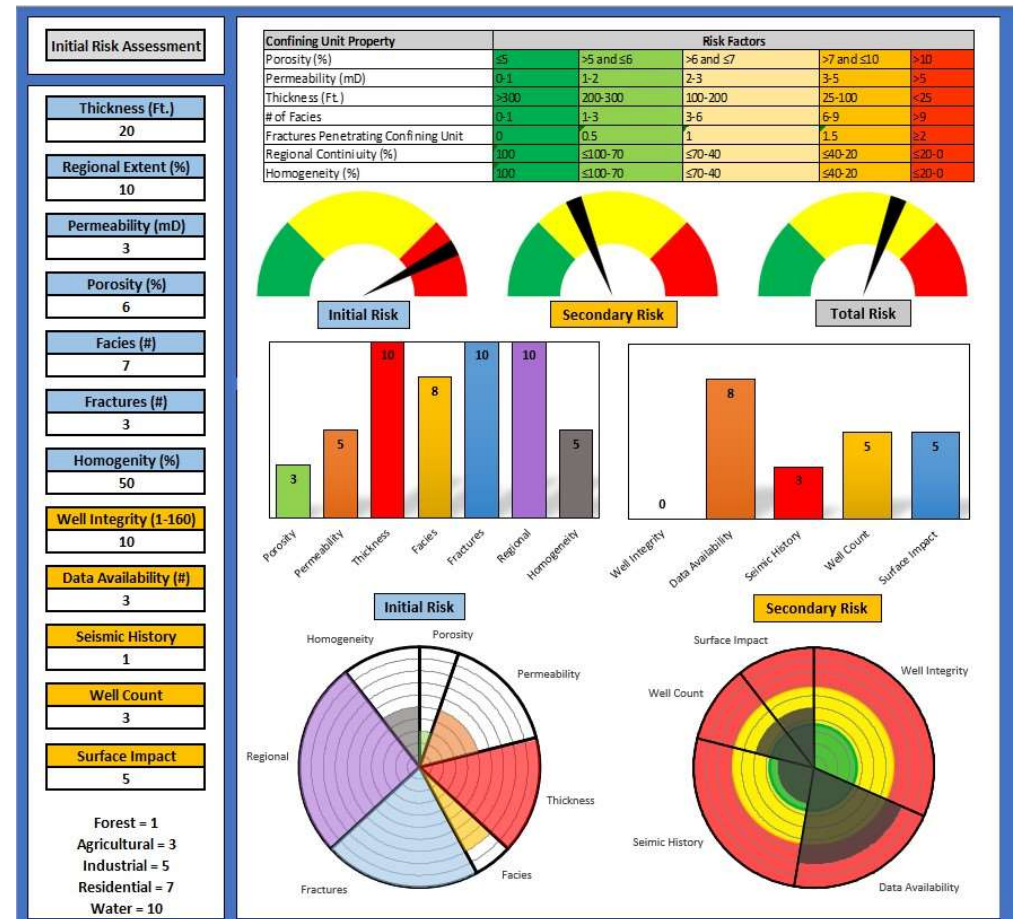
Geomechanics



- Focusing first on the Trempealeau and Eau Claire as confining systems for the Cambrian Mt. Simon
- Use to establish consistent workflow and timeline
- Selected intervals which represented end members and typical

Defining and Evaluating Confining Systems

- Based on workshop feedback and discussions, the team identified the need to develop consistent definitions for different types of confining units
 - Principal Confining Unit
 - Immediate Confining Unit
 - Seep Zone
 - Baffle
- Developing a dashboard to evaluate and score confining systems based on various metrics



Task 5 – Wellbore Integrity Assessment

- 1) **Wellbore Database** – update and expand the wellbore database to include all types of subsurface wells and information (age, depth, construction details, plugging details, etc.)
- 2) **Wellbore Integrity and Screening Tool** – development of scores/metrics to assign to wells based on construction and plugging parameters. Provide example applications of selected site
- 3) **Guidance** – collaborate with EGLE to develop guidance for remediation scenarios

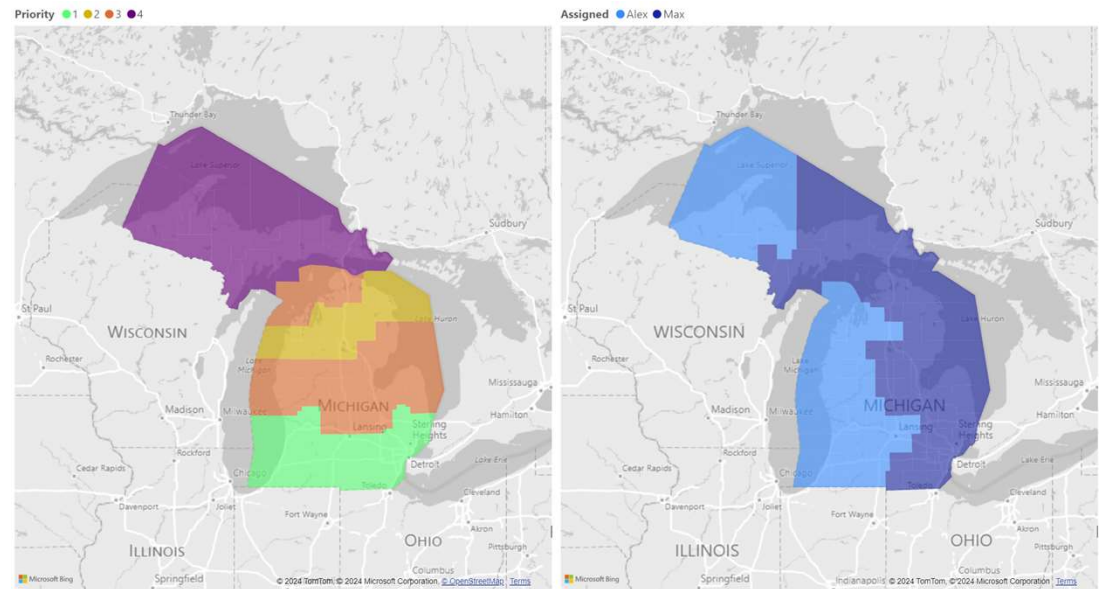
* **Outputs feed into site selection tool to inform potential risks and provide mitigation strategies**

Site Selection Tool (Task 5)

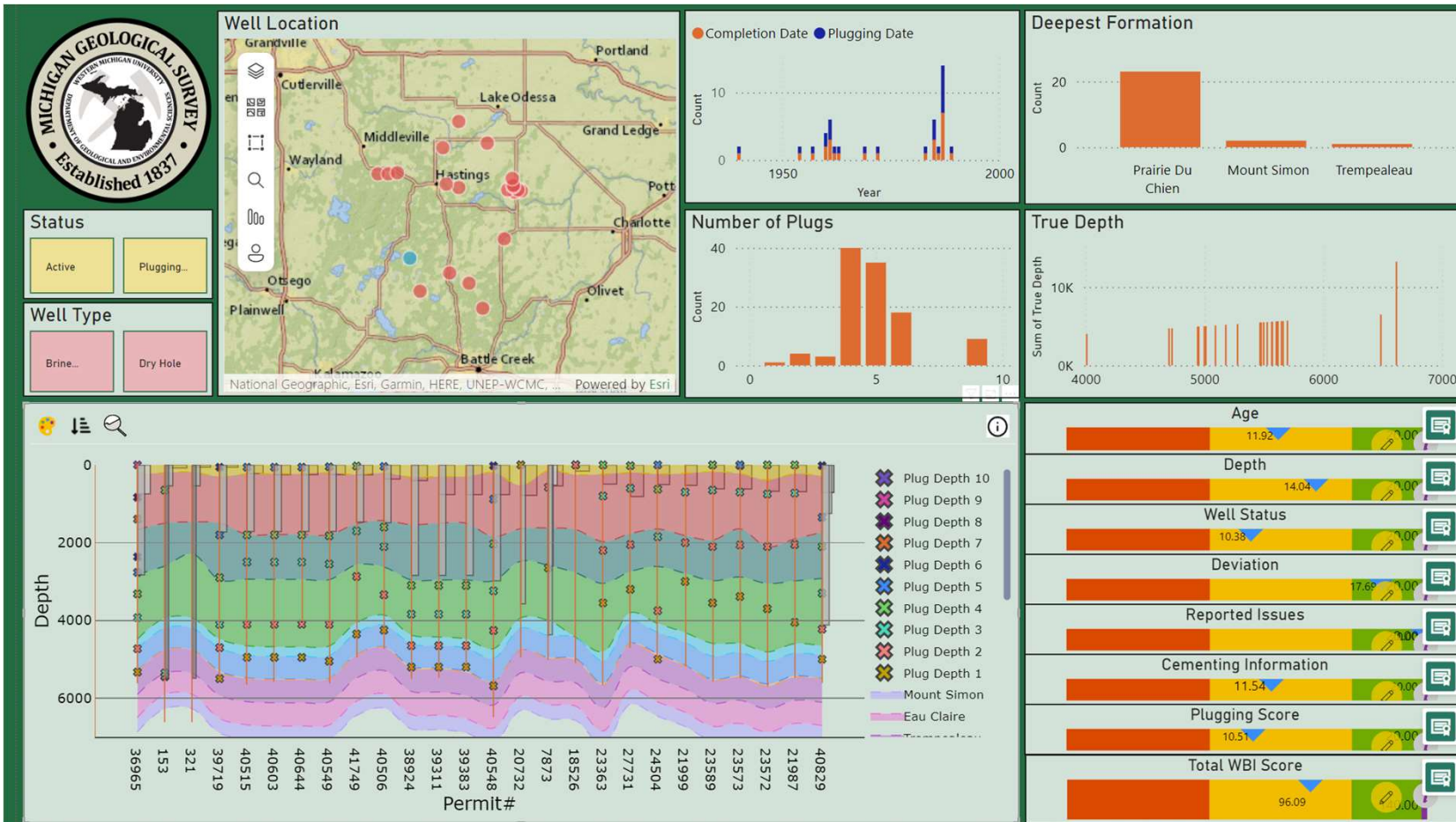
- Part of task 5 but will integrate all tasks, data, and information
- Goal is to create an easy-to-use site selection tool
 - Turn on/off layers
 - Descriptions of data type
 - Tutorials and accompanying materials
- Publicly available
 - For use by all stakeholders
 - Empower communities by providing information and tools for decision making
- Look to Triage project as a wonderful example of creating a public facing tool
- Engage with advisory board and other stakeholders to test the tool and seek feedback

Task 5 – Wellbore Integrity Assessment

- 1) Developed WBI template to capture all information on construction, plugging, cementing, and location
- 2) Prioritized counties started
 - Second level of prioritization added to focus on key reservoirs
 - Higher priority to wells which penetrate confining systems
 - 17 counties complete for Priority 1 wells
- 3) Draft scoring based on various metrics

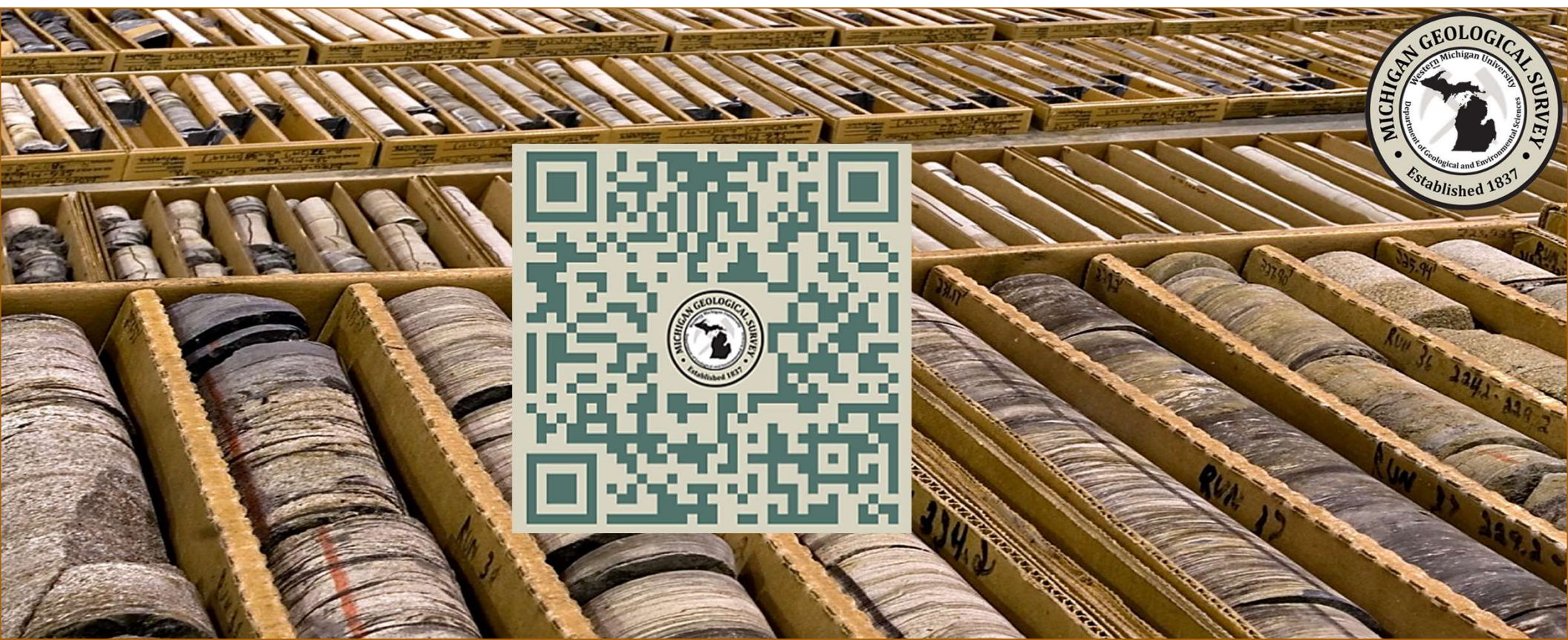


WBI Dashboard



Upcoming Work

- Continue to develop databases
- Continue to develop tools and dashboards
- Stakeholder analysis
- Advisory board meeting
- Interpretation and reporting on results of analyses
- Data collection and analysis on other Carbon Systems



Any Questions?

Autumn.Haagsma@wmich.edu