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March 26, 2019

Michigan Geological Survey Annual Report for 2018

The Michigan Geological Survey is pleased to present the 2018 Annual Report summarizing the activities and achievements to the State Geologist, Adam Wygant, per Senate Bill No. 507. Harold R. Fitch will be retiring from the Department of Environmental Quality (DEQ) April 2019 and this is a transition.

MISSION STATEMENT:

- ***The mission of the Michigan Geological Survey is to facilitate basic and applied geological research to promote the best use of Michigan's geological resources for their social and economic benefits while protecting associated resource values and the environment.***
    - *The safety, health, welfare, social and economic benefits of completing these functions will enhance the education and employment opportunities for Michigan residents while preserving the environment.*

OVERVIEW:

The restructured Michigan Geological Survey (MGS) has been active at the Western Michigan University Geological and Environmental Sciences Department for over seven years. The primary functions mandated for the survey by the October 11, 2011 legislation include: investigation of the state's geological natural resources, the collection and archival of geological samples, cores, cuttings, and the preservation and publication of these geological investigations. The purpose of the Michigan Geological Survey (MGS) is to serve the state's people, industry, and governmental agencies (the clients). The MGS activities in 2018 continued to operate on grant awards received through December 31, 2018.

In this 2018 Annual Report, MGS documents a number of geologic successes and challenges for Michigan, but three issues have the potential to influence the social and economic future of Michigan.

1. PFAS and PFOS are being identified at many locations in the State and yet Michigan still does not have a validated geologic data package of surface and subsurface geology in most of these areas to adequately track and monitor the pathways of these contaminants.

2. Recent climatic changes have caused impacts to bluffs on the Great Lakes and the water levels of many interior lakes of the state, all requiring a greater understanding of the local geology to assess a solution to shoreline stability and flooding homes.

3. MGS/MGRRE core repository was recognized by the USGS for our data preservation program, which had the core/data to assess and confirm the purest and one of the largest potash deposits (fertilizer) in the world having an estimated $65 Billion in place value for agriculture and the Michigan economy (Page 9).

MGS continues to operate on "soft" money from Federal and State grants, and until there is an annual budget, MGS cannot hire permanent full time staff to meet mandated geological investigation requirements, nor can it receive an increase in matching Federal funds for geological mapping programs. The total 2018 grant funds expended and new MGS grant funds total **$1,096,180.** From January 1, 2018 to December 31, 2018, MGS has been granted funds from the USGS, MDEQ, MDOT, GWREF, and the Michigan Legislature (USGS -$49,394, $68,800, $75,117, DEQ -$125,401, MDOT - $23,143, GWREF - $74,521, Legislature - $500,000), respectively, for a total of **$916,306** to be used for the period October 1, 2018 to September 30, 2019.Some grants will continue into 2020. A detailed breakdown of the grants and work products are in Appendix III. Please see our website (http://wmich.edu/geologysurvey) for a summary of the Department of Geological and Environmental Sciences (GES) resource centers to understand our capabilities. To see a list of those faculty scientists who are contributing their support to the MGS in Appendix VI below.

MGS continues to be invited to present to various organizations the need for updated geologic data in Michigan. MGS requires regular, annual funding to compile geologic data for agencies, organizations and individuals to make sound scientific decisions. During 2018, MGS has made 63 presentations at conferences, meetings and at specific discussions (Appendix I). Over 200 presentations were made in the last five (5) years to key legislative staff, legislators, associations, committees, symposiums, organizations, professionals, geologists and private citizen groups. The geologic information MGS can provide today will support groundwater issues related to PFAS, groundwater quantity and quality, aggregates, geo-hazards and regional flooding. All are founded on geology.

One primary goal of the MGS is to be recognized as the “Go To” resource for all of the relevant geologic information in the state, both for the Lower Peninsula (LP) and the Upper Peninsula (UP). The State of Michigan has committed very little funding for geological research or mapping or other geologic research on a continuing basis for many decades, over 30 years. In order to develop programs using proven and current scientific methods and technologies to assess and manage many of the valuable natural resources of this beautiful state, permanent, reliable funding is required. Without reliable funding sources the MGS mission is seriously compromised. Through the assessment of fees for the use of MGS data, the oil and gas industry has partially supported the management of this data resource. The geological natural resources of Michigan include but are not limited to subsurface water, minerals, soils, limestone and other building and construction materials, sand, salt, potash, oil, gas, and metallic and non-metallic ores. None of these resources has any direct funding provided to support capturing validated geologic or scientific data in order to identify,

manage or protect these natural resources. The State Oil, Gas, and Minerals Division maintains and updates factual data and compiles segments of geologic and other Michigan data bases on GeoWebFace, a single quality data resource.

There is not a directed budgeting effort to properly identify, assess, collect, and present new geologic data to support decision making in the management and use of Michigan's geological resources. A fully functional geological survey cannot occur until permanent, annually recurring appropriations and funding is provided in order to hire permanent professional staff that can interact with state agencies and the legislature to conduct long needed, and prioritized, scientific geologic research and data collection.

The proper use, management and sustainability of our natural resources will or can provide economic and in many cases recreational benefits to Michigan. This cannot be done effectively without valid scientific data. The MGS is the most appropriate entity to provide unbiased scientific geologic documentation to support the management, the economic development, and the environmental and sustainable management of these natural resources by the public, citizen scientists, private stakeholders and the various state agencies. . In addition to the DEQ, the principal departments and agencies who are in need of unbiased geologic information are Natural Resources (MDNR);Agriculture and Re-development (MDARD); Transportation (MDOT). Also many local county and city planners and managers are decision makers in need of geologic data.

Michigan is now faced with a new threat to human health and the environment. Polyfluoroalkyl substances (PFAS) have been found in groundwater in many areas of Michigan. There are various concentrations of PFAS, some have been publicized as hazardous concentrations. Michigan does not have a useable data base of the geologic stratigraphy (surface to bedrock) in most areas impacted. The existing surficial geological map was developed in 1915, updated in 1955 and again with limited surficial information in 1982 with only new colors. Less than 10% of Michigan's Lower Peninsula has been mapped with any subsurface geologic data to support the compilation of a stratigraphic interpretation of many of the impacted areas.

Over the last 20 years, the MGS mapping amounted to compiling data in areas where limited budgets and priorities have allowed. A funded priority driven geologic data compilation process is what is needed in critical PFAS impacted areas, which is basically the subsurface geology.

MGS has a DEQ contract (Triage Data Compilation) to provide basic geologic and hydrogeologic data for specific locations identified by the State PFAS management team. MGS has completed six summaries in 2018 which presents data for a 2-5 mile radius of the reported contamination location/site. Data is compiled and presented in a user friendly format with a location data summary table, plates/figures or PowerPoint summary that presents surface and groundwater depth and flow directions, basic subsurface geology, bedrock depth and lithology, surface features, and any anomalous data features not readily known e.g. groundwater divides, lithology changes, etc.

The Special Allocation funds provided by the legislature in July 2016 have provided the opportunity to present documented evidence in support of annual funding for the MGS. Those investigations that were completed have identified functional technical and standardized programs, processes and results that have filled geologic data voids. MGS can present the capability to use practical geological methods, incorporating current techniques and technology, and integrating these data with Michigan geologic knowledge in format(s) useable by all stakeholders. MGS believes that it has presented sufficient examples to justify the establishment of an annual legislative budget for the geological survey in order to support the management of the state's natural resources with unbiased validated data. MGS met with state and local stakeholders, and identified and initiated select focused projects which were presented to MDEQ, MDNR, MDARD and MDOT staff. Attached are those projects that were compiled and completed by December 31, 2018. The technical results are summarized and presented in the attached table, Appendix II.

The United Tribes of Michigan (UTM), which is open to the twelve federally recognized tribes located in Michigan, passed a resolution to the Governor of the State of Michigan in support to annually fund a functional State Geological Survey. This is a petition to the Governor to support passage of legislation to annually fund a functioning geological Survey to allow applying for more federal grants to support geological identification, assessment and protection of our water and natural resource. This was passed unanimously on February 8, 2018 (Attachment III).

The following is a brief review with examples of recent requests for geologic information or interpretations not included in Appendix II. These were specific inquiries.

1. **Crooked Lake – Western Barry County, July 2018:** In reference to the flooding of lake front property in July 2018. The highest water levels in history were reported (up to three feet). At the request of the DEQ, MGS conducted a review of the geologic setting and data for western Barry County and presented the following: Crooked Lake and other NE-SW trending surficial features represent a glacial (10,000+ years) tunnel valley, which is a glacial age drainage system for a glacial melt water system that is bounded by glacial till material on the north and some glacial outwash on the south. It does not appear that property owners, county planners, engineers and developers considered the presence of these unique glacial features when they allowed houses to be built at the lake level, and in an area where groundwater levels historically can fluctuate up to ten's of feet. In addition, there have been various constructed features, culverts and check dams that have minimized the geologic function of wetlands and restricting the flows in the wetland feature located in section 11, T1N; R10W. by only installing one weir outfall from the lake, thus restricting the natural wetland flow of Crooked Lake water to the SW. E. Chatterson, DEQ projected the same result in an email on July 17. The community will now have a high cost to pump naturally occurring high water from the area. Other area land use and construction activities may also have contributed to flooding activities without considering the unique geology of the area.

2. **Texas Township, Kalamazoo County, July 2018 to Present;** High water levels in the summer July 2018 at Eagle lake. An unsolicited review of the setting has established the same geologic conditions as Barry County at Crooked Lake. A NE-SW trending glacial tunnel valley is capturing all the water, however, this area has a possible greater impact and longer period before equilibrium of the water level is reached. Eagle Lake is bounded by outwash sands and gravels, therefore the water table has high levels that extend out to the NW and SE, and there is a much greater volume in water storage than just the water in the lake. It will take longer for the water levels to be lowered. Again, no one contacted a qualified geologist or looked at the glacial geology before building houses in proximity to the lake. Again, pumping the water will just keep the groundwater system recharged and no water will effectively be removed, down gradient.

3. **Aggregate assessment demonstration- Are there sufficient aggregate resources available?:** – MGS reviewed recent MDOT aggregate resource data (October 2016, Michigan Aggregates, Market Study, Phase 1 Report). This overview presents the case that large portions of the southern Lower Peninsula does not have sufficient quality or quantity of aggregate materials with stone to meet the current needs after 10 to 15 years. More specifically, this aggregate resource will be greatly diminished when the prescribed Michigan infrastructure rebuilding program begins. Increased focus on rebuilding of infrastructure will put pressure on the remaining deposits and create shortages in less than 10 years. There is a current geographical high demand for aggregate supplies having clean sand and sufficient stone and rock in the glacial material in some areas. MGS recently published the Calhoun County surficial map, which displays a geologically favorable area for potential aggregate resources along the I-94 and I-69 area. This assessment outlined those potential resource areas. MGS applied a calculation for reasonable setbacks or restrictions for wetlands, streams, city borders, housing developments, etc., to determine what remained as potential areas for currently ungraded aggregate resources. This resource area went from 147 Sq. mi. to 66 Sq mi. Approximately 45% of the original resource areas are unavailable (Attached summary). This reduced resource is ungraded at this time, however the projection was shared with the Michigan Aggregate Association and was recently updated and attached below in Appendix IV. While this sort of initial assessment is necessary, even more ground truthing and drilling should be completed for an accurate assessment of available resources.

4. **Ottawa County Aggregates:** MGS has initiated an assessment of the aggregate resources of Ottawa County to support population growth and development. MGS will develop outlines of those aggregate locations, so county zoning can be appropriately assigned for potential approval of extractive functions going forward. The purpose is to minimize the statements of not knowing there was an extraction potential for aggregates “in my backyard”. The second benefit of noting the aggregate locations is a potential to demonstrate groundwater recharge in those areas having geologic conditions favorable for near surface groundwater recharge.

5. **Geo-Hazards – City of St Joseph, City Manager (John Hodgson) called for some assistance in June 2018:** His question was, why are the lakeshore slopes failing in the City near the local park at

Hawthorne and Lakeshore (Bus 94)? This is an area that has been relatively stable since the late 1960's when major bluff failures occurred, causing many houses to be condemned and foundations fell off the bluffs to the beach below. There is a commemorative plaque at this location, summarizing this event. A field visit and compiling remote sensing Interferometry data for the area confirms the locations of the bluff movement, which is over 1200 feet from north to south. Anecdotally, there is recent condominium and hotel construction activity at Hawthorne immediately to the east of the park with no vegetation. The failure is immediately west of Hawthorne and Business 94 to the north. At this time, there is no cause identified for the slope failure. No further communication has occurred.

6. **Proof of Concept- Bedrock valley mapping:** MGS initiated a Bedrock valley mapping "Proof of Concept" project funded by the Groundwater Research and Education Foundation (GWREF), a foundation of the Ground Water Protection Council (GWPC) in May 2018. MGS was successful in data compilation and interpretation, identifying a potential additional water resource buried below in bedrock valleys. This project is a collaborative research effort with the energy industry that donated geophysical data (seismic profiles) that can help focus subsurface bedrock mapping with an inexpensive geophysical tool known as a Tromino passive seismic detection device. This technology allows for the rapid mapping of buried bedrock valleys, bedrock versus glacial material. The Tromino can validate potential valleys from 150 to 800 feet below the surface within a few weeks, and do so at a greatly reduced cost. MGS confirmed these results with minimum additional drilling to confirm that the Tromino "proof of concept" does work. This data process package can then support the identification and protection of newly found water resources. This mapping would support protection of these newly identified water resources from surface impacts or proposed surface or subsurface activities that cannot be done in an environmentally safe manner. Success of the program can be extrapolated to many areas of Michigan and to other adjoining Great Lakes states having glacial sediments. .

MGS continues to use established surface mapping techniques in addition to sophisticated airborne tools, LiDAR (Light detection and Ranging) and GIS data output, to assist in the mapping and data processing procedures to support the identification and presentation of the locations of favorable near surface geology that may contain aggregate resources previously not identified or extensions of the resource. Secondary geophysical tools such as Ground Penetrating Radar (GPR) have shown promise in some areas looking for the higher concentrations of the quality aggregates, reducing the need for exploration with backhoe trenches or excessive drilling.

Associated with the assessment of aggregate need, many Michigan residents may not be aware of the direct increased cost of construction that results from restricting aggregate operations. This affects possible future county or local tax increases and all other associated cost impacts for future construction projects. Note: The hauling of aggregates more than 30 miles can double the cost of that material. This is the monetary impact of not having a nearby source for aggregates. Local

aggregate resources can support infrastructure installation and rebuilding required to maintain a county's current and future life style. Aggregates are a geological resource, located where they were deposited thousands of years ago.

The MGS Director, John A. Yellich, has continued to both introduce and to update interested stakeholders to the progress the restructured survey has made across the state. The primary focus of many meetings has been to present an overview of Michigan geology and the benefits that can accrue from a fully funded, functional geological survey supporting the evaluation of Michigan's mineral, energy, and water resources. The meetings not only present Michigan geology, natural and energy resources, but highlight the importance of public access to the Michigan Geological Repository for Research and Education (MGRRE) core and data repository at WMU/MGS to the state. MGS has made approximately 200 presentations, meetings and discussions in the last five plus years to various associations, committees and organizations that included: Michigan Manufacturers Association; Environmental and Mining Policy Committees; Michigan Association of Counties; Michigan Groundwater Association; representatives of the Michigan Chamber of Commerce; Michigan Oil and Gas Association; Michigan Environmental Health Association; Michigan Aggregates Association; Michigan Communities Association of Mapping Professionals (MI CAMP) professionals; American Institute of Professional Geologist (AIPG); Ottawa County Planning Department; Michigan Departments of Natural Resources, Environmental Quality, Agriculture and Redevelopment, Office of Great Lakes, officers, chiefs, Directors and staff; members of the Michigan sovereign tribes; and private individuals. All these contacts are associated with aspects of agriculture, industry, municipal and rural growth, water resources, regulatory issues, resource development, aggregate industry, and data management.

The MGS continues to underscore the benefit and the need for state funding if the MGS is to provide the science needed to address critical geological issues. MGS and Michigan Technological University (MTU) have a formal Memorandum of Understanding (MoU) and MGS has a second MoU with Wayne State in place. An MOU allows MGS to contact and perhaps contract with the University to provide faculty and students to conduct and support MGS geologic objectives in their local area. In addition, they may provide expertise not available to a geological survey for a specific project which would then result in validated geologic data that can be used to manage our resources. MGS is also discussing similar MoU agreements with Central Michigan University and Grand Valley State University. MGS has met with stakeholders in the UP and the priorities recommended include state funding for core storage and coordinated data management between the MGS/MGRRE facility and the UP facility to support sustainable environment, natural resources and economic development in the UP utilizing the scientists of MTU, Lake Superior State University, and MGS and the MGS-MGRRE repository data sharing systems.

Michigan is the only Great Lakes state that has not committed to any recurring annual funding for either statewide or specific geologic mapping. Capturing geological information would support future continued geologic, natural resource and environmental management, and potential economic development in the state. ***NOTE: MGS cannot maximize the application for Federal USGS National Cooperative Geologic Mapping Program (NCGMP) matching funds, until there are direct monies or full time staff to use for increasing the matching dollars.***

MGS has presented significant documentation in support of completing high quality LiDAR (Light Detection and Ranging) mapping programs in most areas of the State. Completion of this program in

selective areas has shown high quality expedited geologic mapping products in recently published areas of the Lower Peninsula. LiDAR also supports all facets of Michigan's economic and business entities including agriculture, municipal development, drain commissioners, forestry, flood issues, transportation, aggregates, and water resources. The LiDAR program, has finally garnered additional interest by many parties for implementation and completion using federal, state and local funding.

Quality airborne data collection associated with natural resources using airborne geophysics, the indirect measuring of earth's physical properties, has not been done in most areas of Michigan. A USGS demonstration program was supported by MGS and many Michigan geoscientists. It was initiated in late spring, 2016 and completed in August 2018. This was located in areas of the Upper Peninsula that have complex Precambrian geologic terranes buried under Paleozoic and glacial rock cover. The area surveyed goes from Menominee to Gwinn and Iron Mountain to Escanaba. This program can potentially lead to the mapping and definition of geologic units and structure that is conducive to identifying water, minerals or other buried resources.

The Michigan Geological Repository for Research and Education (MGRRE) core and data repository is the cornerstone of available Michigan geologic data. Much of this is basin scientific data, and it represents an estimated $20 billion that need not be spent to replace the data and samples. The MGRRE facility houses over 560,000 feet of core and cuttings from over 20,000 oil and gas wells, more than 2,000 water well cuttings, and digital versions of all the electric logs and analytical data that is compiled and stored open filed on the MGRRE/MGS data systems. Furthermore, there are now over 90 MGS rotosonic, Geoprobe and wireline core samples from the surficial geologic mapping program using Federal matching funds to support glacial and shallow bedrock mapping.

Over 30% of the MGRRE samples are from state land and there is a documented return on investment (ROI) of hundreds of millions of dollars of Michigan revenues in the last 20 years, yet there is no continuing state funded support for the operation and maintenance of MGS/MGRRE. WMU/MGRRE receives a nominal amount of funds to store some of the state water well cuttings that were going to be discarded, had MGRRE/MGS not offered to hold them.

MGRRE has rescued numerous core, sample and data collections that were destined to be discarded in landfills, but their value to future Michigan geologic research has been captured, stored and retained at MGRRE. MGS is in need of sustainable annual state legislative funding for survey staffing, and for core and data repositories that will combine the geologic data resources of MGRRE, and would support data compilation programs and procedures that can be used at a repository in the UP as a collaborative data facility.

The National Geological Geophysical Data Preservation Program (NGGDPP) recognized the MGRRE facility as the prime example for data preservation, and determined that the potential return on investment of hundreds of millions of dollars to Michigan that would support the agricultural community of Michigan and the nation. This recognition was associated with the resurgence of the potash resource in Mecosta County having a potential in-place value of $65 billion. The USGS and the NGGDPP program summarized the benefits of the national data and core storage program having a high social and economic value to Michigan and the agricultural community in the following USGS link (https://www.usgs.gov/news/mineral-discovery-could-mean-billions-michigan) Yet, the State of Michigan is not providing annual funding for the operation of this state data repository.

Attached in Appendix VIII is a summary of all 2018 published Michigan geologic research, all submitted proposals and awards, publications, map products, presentation abstracts, and reports completed by MGS, WMU, and student researchers, a testament to having ongoing research and to the ensuing economic benefits of a functional geological survey.

The MGS has an Advisory Council (Appendix IX) that was established at the time of the transfer of geological research and mapping functions from the DEQ to MGS in 2011. The members of the Council represent a cross section of interests for Michigan geology, and they have been kept apprised of all the MGS initiatives and programs to date. The members have provided guidance and input to these programs to seek state annual funding for MGS, MGRRE and our overall collaborative programs and MGS appreciates their volunteer efforts to support these initiatives and programs.

GENERAL - MICHIGAN GEOLOGICAL SURVEY ACTIVITIES AND ACHIEVEMENTS:

RESOURCE CENTERS – See Appendix V

MGRRE: The Michigan Geological Repository for Research and Education (MGRRE) has served Michigan for over 30 years under the direction of Dr. William Harrison III. MGRRE remains the primary asset of the MGS, and continues to request funding from the State for this economic asset to assess and manage Michigan's Natural Resources. For nearly 30 years, MGRRE has conducted collaborative student and industry research workshops that have supported not just natural gas storage and energy industry, but glacial geologic research on water and aggregate resources.

Following are some of the activities and achievements of MGS/MGRRE during 2018:

April - MGRRE held a Petroleum Technology Transfer Council (PTTC) workshop was held at the Grand Traverse Resort with 100 attendees from all over Michigan and the US. This was a joint event with the Michigan Oil and Gas Association (MOGA), where an additional 100 attendees could talk with the researchers, presenters and students who had posters at the social events. This year's event was focused on the Traverse formation where industry could examine cores from some of the producing fields and ask questions of the students that have conducted research on this formation or on other Michigan projects. Speakers included Bill Harrison, Peter Voice, John Fowler, Mike Barratt, Chuck Knox, Adam Wygant, Murray Matson and Allan Modroo.

May – Dr. Edward Montgomery, the new WMU President was joined by the new VP of Research, Dr. Terry Kinzy, Interim Provost, Dr. Susan Stapleton, and College of Arts and SciencesDean Dr. Carla Koretsky. MGS and MGRRE presented their current operational functions and recent project (PTTC, mapping, etc.) successes that have benefitted the State of Michigan.

May - Dr. Christopher Stafano, Director of the A. E. Seaman Mineral Museum, Houghton, MI. Dr. Harrison presented the scientific and economic basis of the MGRRE repository as a Michigan resource and other discussions were focused on the WMU Lloyd Schmaltz Geology Museum at Rood Hall.

September and November – Review of the Brock Gas Storage training program. MGRRE has become the go to location for training engineering and geological professionals in the new national gas storage regulations and the associated compliance issues. The additional benefit is MGRRE has the

capability to both show geologic core/samples that will utilize the appropriate equipment, presenting actual examples of geologic core of the gas storage formations. Two training sessions were held in the fall. About 30 engineers and geologists attended each session. The attendees were from all over the US.

MGRRE continued with a Department of Energy (DOE) collaborative project with Battelle National Laboratories and Core Energy, member partners of the Midwest Regional Carbon Sequestration Partnership (MRCSP) that has been active for the last 16 years. This collaborative scientific program for carbon (CO2) sequestration research in oil and gas reservoirs continues with funding by the Department of Energy (DOE). As a result of this program, Dr. William Harrison, Dr. Stephen Kaczmarek and Dr. Andrew Caruthers are conducting research with a number of students on the development of new Niagaran reef reservoir models. The additional benefits include a greater understanding of suitable formations and areas favorable for gas storage. Michigan is number one in the US for gas storage capacity at more than a billion cubic feet. This research has supported a number of student/industry research projects.

As part of the MGS on-going data preservation program, MGRRE received 150 pallets of cores and cuttings from another Michigan university. Many of the cores are one of a kind from gas storage fields and will be used in our research and they will be available for industry. Before coming to MGRRE, that collection had suffered extensive damage from water and poor storage conditions. The MGRRE group plus several students have been working on organizing and compiling the samples from about 1000 wells. This has been supported by funding from the National Geological and Geophysical Data Preservation Program (NGGDPP).

The MGS and MGRRE are very pleased that industry has annually provided donations and paid services costs that can provide incremental support, which is well needed because this facility can not fully fund itself.

Ongoing Studies, publications, Outreach and Grants: Listed below are some of the ongoing and most recent achievements that have emerged from the numerous requests, onsite researcher visits and Outreach for data review at MGRRE. A summary of the value of the new 2018 grants, and ongoing grants and submittals can be found in Appendix IV.

MGRRE has hosted university faculty from state and private universities. Faculty bring their geology classes and use the MGRRE facility as an academic resource presenting the geology or sample logging techniques to students. This past year the following universities have visited MGRRE with students to review selective core as a segment of their geology classes. They include, Michigan State University, Grand Valley State University, Calvin College, Hope College and Central Michigan University.

The Geological Society of America (GSA) requested a memoir on Michigan Basin Geology and Drs. William Harrison, Dave Barnes, Michael Grammer and Peter Voice with support from Jenny Trout and several students submitted reports to be included in a Geological Society of America (GSA) Special Paper 551 published in April 2018. This special publication focuses on the geology and economic resources of the Michigan Basin and highlights much of the recent research that students, faculty and industry conducted during the past ten years.

MGS has noted in previous presentations and annual reports, MGRRE has been both an indirect and direct state economic benefit from this functioning facility. MGRRE, a functioning core repository and data source has provided Michigan with major economic benefits in the last 15-20 years to include: state tax revenue, huge contributions to the Natural Resources Trust Fund and state royalties. Specifically, there has been no state funding provided to MGRRE and MGS to cover the annual costs for providing these services. This research facility has resulted in hundreds of millions of dollars to Michigan through these documented natural resource benefits and the collaborative scientific work conducted by industry and other researchers at the MGRRE facility.

In addition, tens of successful collaborative student theses, industry and federal agency research studies, and other geological programs conducted over the last 30 years are also documented. Industry has graciously donated funds to show its appreciation. Yet as of this date, there has been no direct annual state funding for MGRRE or MGS to support this ongoing data resource, which has shown continuous scientific and economic benefits to the State of Michigan.

Surficial mapping cores and data: The MGRRE repository is also the location for all of the drilling and coring samples from surficial geologic mapping programs done in Michigan. There are MGS, USGS, MDOT and various engineering company cores and samples along with the supporting data. These are cataloged and available for research on glacial and shallow bedrock geology, critical to understanding the water and other near surface resources of Michigan.

MGS and MGRRE Websites: The number of contacts (hits) on a website is a measure of the importance of that information resource. The MGRRE and MGS website contacts indicate greater visibility with an increased public exposure and an increased number of data sets. The number of unique new visitor requests continue to increase.

In 2018, the summary of new users totals:

- MGS had 3,750 sessions with 80% new users 2,651
- MGRRE had 2,686 sessions with 71% new users 1,602
- Core Kids had 462 sessions with 67% new users 297

The MGS website has been fully functional for the last five years and the number of unique IP requests for 2018 was at 2,651, approximately 218 per month, ~54 per week, approximately the same rate as last year, which was 228 per month.

Geologic Mapping: John Yellich and Dr. Alan Kehew, direct the MGS submittals to participate in, and submit projects in both of the USGS Federal National Cooperative Geologic Mapping Programs (NCGMP), STATEMAP, and the Great Lakes Geologic Mapping Coalition (GLGMC) programs, which provide matching federal dollars for geologic mapping. This past year, the USGS mapping program awarded funding to map areas in the Lower Peninsula, (Cass County, Twin Lakes and Adamsville Quadrangles) under the direction of Dr. Alan Kehew and John Yellich with support from contractor, John Esch. The emphasis in the two USGS mapping programs is surficial geology concentrated in the areas favorable for water and aggregate mineral resources. The need for accurate geologic data and aquifer characterization in the LP cannot be underestimated. The LP studies are being conducted with a refined 3-D approach that includes a combination of surface geologic mapping with hand augering, trenching and confirmation of lithologies, and integrating the data with available LiDAR

imagery to prepare a documentation of the surface and subsurface geology. The data will then be combined with a limited wireline, rotosonic or Geoprobe drill coring program to bedrock, the full 3D. Finally, combining a refined subsurface geologic mapping approach that includes core samples and sieve analyses, down-hole geophysical logs and validated geologic logs from water well drillers completes the data set for a 3D mapping product. Sampling of core and outcroppings for age dating assists in the refinement of the glacial geologic history using Carbon 14 or optically stimulated luminescence (OSL) analysis. This allows a chronologic understanding of the glacial system(s).

MGS is limited in the Federal mapping projects because of the limited available matching funds. Therefore, MGS cannot conduct that additional surface/subsurface mapping in critical PFAS or other resource areas without State funding to conduct this mapping.
LiDAR increases the quality of the surficial geologic data when used in assessing potential areas for aggregate resources and when combined with the data from underlying water-bearing strata, which can also support locating potential water for high production users such as the agricultural community. Quality LiDAR also allows for a more rapid assessment of the geology of areas where physical access may be limited, and where field validation can then be focused on mapping the continuity of the surface geology.

Groundwater, Data Bases, Resource Assessments: MGS is compelled to restate issues of relevance that have not been clarified. For review, the governor's Water Use Advisory Council (WUAC), under the direction of the director of the DEQ, completed a two-year review of water resource issues in the state in 2015. The WUAC supports the objectives of the Great Lakes Compact that requires permitting of large capacity water wells, and quantifies their impact on local stream flows. Local requests have been made to the MGS for information on the quality and quantity of the groundwater in certain areas of the state, but many of the requests cannot be supported by MGS, because the local or personal request does not have funding to allow MGS to conduct a geological assessment associated with the specific permitting request.

One of the issues revealed by the WUAC was that validated geologic data is not available. The MGS recognizes that because of the paucity of mapping (<10%) in Michigan there is an abundance of geologic information that is not known or available for use in assessing and protecting our resources, which includes groundwater as well as aggregate locations. This situation was presented and is described below.

The State of Michigan has numerous data sets and documents that are either in paper or microfiche format, along with various electronic databases. None of these data sets communicate with each other, nor are they retrievable in a uniform electronic format. There could be up to a million data sets that represent geologic information having an estimated minimum value of over $10 million ($10.00/file) up to 1.0 billion.

Michigan risks the loss of a substantial portion of these data resources due to physical deterioration, mishandling, and to the expense of physical storage. This is called "orphan data". The inefficiency that is inherent in the use of non-communicating databases is substantial. The result is that state employees, and the public, each spend unproductive time each time this data is researched, both retrieving and sorting data before it can be effectively used if it is not in a compiled public data base.

It is obvious that there is a demand for a set of central electronic databases that could be used to archive standard geologic information into formats that are easily searchable and appropriate for the type of information requested. A centralized set of databases would make Michigan's agencies more functional and time responsive effecting a substantial cost savings. Properly prepared electronically formatted files would also provide the public with an expedited mechanism to fill FOIA requests, or to allow electronic inquiry rather than personally handling paper files. The files would be made available through three electronic steps: request, receive, and review. A searchable electronically formatted document program would encourage greater use of available data, and would save manpower and time for both state employees and public users. For examplefees are already being assessed for requesting data, many of the proposed databases could be supported by a multi-tiered fee structure, and users would have existing documents almost instantly available. Fees would cover the cost of continuing input and maintenance of electronic data.

Drillers Workshop and a DEQ Geologists Outreach Roscommon Stakeholder review: In multiple years of 2015, 2016, 2017 and 2018, the MGS proposed a format for drill hole data entry to the Michigan Groundwater Association (MGWA) representing all the water well drillers. This program concept has been embraced by MGWA to support more consistent, verifiable data for water resource studies. MGS has conducted training sessions for the drillers and a formal training workshop was again done in 2017. A collaborative effort is continually being proposed by MGS to have the professional geologic community and the MGWA drillers input "standard" formatted data into the same data base. Per discussions and feedback, MGS has confirmed that drillers and public users of water well data would appreciate a standardized approach to data notation and entry of drill cuttings information into a standard format.

A standard approach to the logging of drill cuttings is also a way for MGWA members to add value to the non-standard datasets that exist today. This is currently an ongoing discussion with the State DEQ Water Resource Division which has not embraced this proposal at this time.

Economic Geology: Dr. Joyashish Thakurta, the Geosciences Department economic geologist / petrologist, has focused his research on the igneous and metamorphic rock suites of the Upper Peninsula of Michigan. His current UP research efforts are integrated into an overall program of sample collection, and the geochemical analysis of little known geologic environments. He has received a grant that will allow students to sample and analyze data for their respective theses.

MGS GIS Data Management and MGS Store: MGS continues to format new and historic maps and other documents to comply with ArcGIS standards. The MGS believes that there are many older Michigan publications and paper resources that need to be acquired and archived, in order that they can be made available to the scientific community and to the general public.

Outreach and CoreKids K-12 program: Dr. Peter Voice has coordinated and directed the CoreKids K-12 program at MGS/MGRRE for over five years which has had increasing interest by the Michigan education community with another successful year of contacts with fewer events. In 2018, CoreKids had contact with more than 16,000 students, teachers and parents. During the five years under Dr. Voice a total of more than 80,000 person contacts have been documented. Due to limited funding this year there was a reduction of in-school events and CoreKids has focused on reaching as many people as possible by providing educational content at mineral shows and science/STEM career days. The Michigan Earth

Science Teachers Association (MESTA) also hosted a STEM Career day and this was their 50th Anniversary. Western Michigan University Geological and Environmental Sciences Department was highlighted as it was instrumental in the formation of this teachers organization in the 1960's. This effort was initially spearheaded by Dr. Lloyd Schmaltz, former department chair and Dr. Richard Passero.

CoreKids has established an endowment that has reached the minimum for funding, and any donations that can assist in off-setting the cost to attend education functions is greatly appreciated.

Geohazards: MGS has initiated discussions with the USGS through the National Cooperative Geologic Mapping Program Director, John Brock; the Illinois State Geological Survey; and the Indiana Geological Survey to present a collaborative program for assessing the shoreline systems of Lake Michigan. These discussions have now evolved into drafting a USGS FEDMAP project having an estimated 10 year plan to study and publish data on the Lake Michigan bluffs, dunes and shoreline geology. This will be a collaboration with USGS, NOAA, CoNED and other National data compiling organizations, including the Canadian Geological Surveys and local and regional universities studying Great Lakes shorelines. MGS proposed to support emphasis on baseline data on the active shorelines of Michigan, Indiana and Illinois, particularly along Lake Michigan. The USGS has drafted the 10 year FEDMAP project to incorporate the USGS geological resources to support research along the shorelines, and is extrapolating this research to apply to all the Lake Michigan states and Great Lakes shorelines. At this time, all are waiting for the re-authorization of the federal mapping programs.

Recent slope failures along Lake Michigan has increased interest to map these areas in order to assess the failure potential. MGS suggests using airborne surveys, perhaps using current or research technology in radar, LiDAR or other remote sensing methods in aircraft or drones, and incorporating existing data, i.e., interferometry to assess and track slope movements in centimeters per year.

Remote Sensing: The MGS and the Earth Sciences Remote Sensing (ESRS) Laboratory under the direction of Dr. Mohamed Sultan has established remote sensing researchers and capabilities. The ESRS lab will also be used to assess the history of water resources in Michigan, using the NASA Gravity Recovery and Climate Experiment (GRACE) satellite data from 2002 to 2016. WMU research has demonstrated the ability to document Michigan's Lower Peninsula water storage in regional settings on an annual basis. This data set has been calibrated from a pixel representing 100 X 100 Km, and reduced it to 25 x 25 Km (~15 x 15 miles = 240 sq. mi.) to more accurately reflect water storage in the glacial system. Additional research using available data will provide a foundation for the USGS program going forward in the near surface glacial terrains of Michigan and the Great Lakes States using tested, and proven, remote sensing techniques.

Respectfully submitted,
John A. Yellich

CC: MGS Website

Attachments:
Appendix I – MGS 2018 summary of meetings and presentations (63)
Appendix II - MGS Summary of demonstration tasks, projects & publications 7-2016-December 31, 2018
Appendix III – United Tribes of Michigan, resolution to Governor to annually fund functional Geological Survey

Appendix IV - MGS/WMU/MGRRE Value of awarded and continuing Grants and Contracts
Appendix V – Aggregate Resource assessment
Appendix VI – Resource Centers
Appendix VII – Funded Professional Publications
Appendix VIII - MGS/WMU, Faculty, Staff and Student 2018 Michigan geology publications and presentations
Appendix IX – MGS Advisory Council members

Appendix I
2018 - Summary of meetings and presentations (4 pages)

Q1 2018 Summary of significant MGS meetings and presentations- Special Appropriations

Date(s)	Location	Time / Duration	Contact(s)	Discussion topics	Notes
11-Jan	DTW Army Corp of Engineers	9:00 - 3:00	James Selagean, COE	Coastal stability and future project funding for scientific studies, reference funding for MGS.	Follow up meeting summer 2018
Jan 12 & Feb 14	Lansing and Marshall	9-11:00 AM 10-12:00	Todd Feenstra, Technical Advisory Committee (TAC) WRD-DEQ	Multiple technical mtgs on groundwater data collection, modeling, use and recovery from SW MI, Farmers and DEQ project. $1.0 M 3 year program	Reviewing data and methods for gathering info.
24-Jan	MI Manufact Assoc (MMA) Lansing	9:30 to 11 AM	Andy Such, Env Policy Direct	MGS update to Mining and Extractive committee on projects and support for funding MGS.	
24-Jan	Lansing,	1-1:30	Rep Sue Allor, Alpena	PFAS at highest concentrations in limestone area. Presented the old data is all we have and we need mapping budget. She wrote a reply	Posted meeting to her website.
25-Jan	Ottawa Co Planning & Commissioners	10:30 to 12	Paul Sachs	MGS support to assess depleting water supplies and developing a Water Strategy for County and support for MGS funding.	Planning for future meetings
26-Jan	Webcast Presentor	12 to 1 PM	AGI, What is the future of geology in US.	MGS presented recent mapping products (Marcellus, Decatur, Mottville) and benefits recognized by DEQ and County.	On line and available.
13-Feb	Lansing Kellog Center	8:00 AM to 7 PM	MOGA,MAA, MMA	Governor Snyder's Extractive Industry summit meeting, MGS posters presenting results and MGS funding needed.	
20-Feb	Ottawa Co Offices	3:00 - 4:30	Ottawa Co County and Twp supervisors, update on Water	Presented water quality, shortages and proposed conservation programs needed, funding MGS.	Follow up meetings with all the Twp.
22-Feb	Lansing Comm Coll	8:00 to 5:00	American Water Works Association, MI, Annual meeting	MGS presentation with DEQ - RRD and DEQ Water, why we need a funded Geological Survey, PPT, funding MGS.	
Mar 2 - Mar 7	Denver USGS paid for trip	8:00 AM to 5 PM 3 days	Lindsey Powers, Director of NGGDPP, USGS Denver offices	USGS designated State Geologist, Data preservation proposal reviewer. 37 state proposals reviewed and graded for grants totaling $1.0 M.	
9-Mar	Denver	8:00 to 4:00 PM	USGS, Denver Geophysicists	Meetings with the USGS Minerals Geophysicists, USGS mapping in Michigan, past and future. UP area of interest.	
3/10/2018 to Mar 14	Wash DC, Mon to Wed	8 AM to 7:00PM 3 days	AASG State Geologists Annual Laision mtgs with US Senators, Represent and Fed Agencies	State Geologists lobbying for USGS and other funding to support studies in all the States. 15 to 30 minute meetings with Staff.	Presenting value of continuing Fed USGS funds at the same level. Met with USGS Director
15-Mar	Lansing	3-3:30 PM	MI Sen Mike Green, Sen Budg Chr Nat Res Approp	Proposed budget for MGS to support mapping in areas impacted by PFAS.	Sen Green inserted $500K, as an annual budget for mapping
23-Mar	Lansing	8- 10:00 AM	Rep Aaron Miller, Centerville	Meeting on HB 5638, revisions to WWAT tool to use geology in assessing impacts to surface water	Multiple mtgs to gain favor for WWAT corrections
26-Mar	Lansing	8 - 5 PM	MI Assoc of County Commissioners, Annual Mtg	MGS presentation on anthropogenic impacts and the need for changes in water use, conservation now, needing MGS Funding.	
Mar 27 to Mar 29	Minn St Paul	8-7:00 PM 3 days	National Coopertive Geologic Mapping Program, National mtg on mapping standards	Federal mapping program meeting to review current standards and where will mapping products evolve going forward.	Strategy on Fed Funding for shorelines/FEDMAP proposal, MI

Q2 2018 Summary of significant MGS meetings and presentations- Special Appropriations

Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
4-Apr	Lansing	1-3:00	Senate Legislative aide summarize mapping in Michigan	Present current map of PFAS locations and overview of lack of detailed geology for most of Michigan, 1915 Leverett & Taylor not changed in 100 years except for colors, 1955 Martin, 1982 Ferrand & Bell	
5-Apr	MGRRE/WMU	9-11:00	Todd Feenstra, Technical Advisory Committee (TAC) WRD-DEQ	Review Cass Co Farmers study data and drilling results.	
9-Apr	Lansing, HOB	8-11:00	Representative Aaron Miller HOB	Overview of HG 5638 and presenting the case for limited validated glacial geology in current WWAT tool, drillers data	
16-Apr	Lansing, HOB	10:00-10:30	Representative Mary Whiteford	Review the lack of factual geologic data and the need for annual funding fo r MGS. Receptive to proposal.	
18-Apr	Lansing, SOB	4:15-5;00	Senator Thomas Casperson Senator Hansen	Review mapping voids throughout state and need for mapping State land and priority areas for PFAS information.	
20-Apr	Kazoo, WMU	PM	WMU Advisory Council	Review need for support from Michigan geologists for MGS funding.	
24-Apr	Lansing, Nature Conservancy	2:00 - 4:00	David Hamilton, Hydrogeologic Framework of Michigan	MGS, (Yellich and Dr. Alan Kehew) presented the value of quality validated geologic data was needed to develop a Hydrogeologic Framework of 3D. This proposal ignores the benefit of using valid geologic data and proposes to continue to use unvalidated well drilling data. "Use what we have" was the statement to proceed. In addition, the WUAC PPT presentation (6/4/18) does not propose to use a qualified glacial geologist in any of the process, only suggesting more mapping is needed.	This proposal has not been vetted by the geologic community.
30-Apr	Ottawa Co Planning & Commissioners	10:30-12:00	Al Vandenberg, Paul Sachs	Review proposal outline for presenting water resource issues for the County, proposing a conservation program by government and the public.	
9-May	Lansing Constituton Hall	1:00-3:00	Mike Sweat	Review summary of PFAS Triage proposal and how to implement the work products.	
May 15-17	Institute of Lake Superior Geology Iron Mountain,		ILSG meeting with presentation on May 17	PPT, **Six years after assignment to Western Michigan University, Where are we today?** Summarizes the lack of validated geologic data to assess the natural resources or to support the management of PFAS migration in the subsurface.	
June 3-7	AASG, Annual meeting Rehoboth, DE	Meetings	Association of American State Geologists (AASG).	Meetings with Asst Sect of Interior, USGS Director and Assoc. Directors. Support Federal funding for NCGMP re-authorization for mapping and 3DEEP geophysical program for US. Discussions with: Tim Petty, Assistant Director of Interior-Water & Science James Reilly- USGS Director Kevin Gallagher - Assoc Director, Core Sciences Geoffery Plumlee - Assoc. Director, Environmental Sciences Tom Crawford - Assoc. Director, Minerals	Yellich elected VP of AASG, 2018-2019
13-Jun	John Hodgen, Cithy Manager, St. Joseph, MI	Discussion of slope failure south of St. Joseph	John Hodgen, City manager, City Engineer and proposed contacting USCOE and MTU, slope statility issues.	Slopes failure in the month of June, 2 miles south of St. Joseph. MGS gathering Sentinal Interferometry data to assess possible detection of movement with Remote Sensing methods.	
18-Jun	GWPC, Meeting summary of Tunnel Valley Research	Summary Update	Submitted to Dan Yates, Executive Director, Summary of work completed to date.	GWPC wanted a summary of the work completed to date on the Tunnel Valley Grant, completed by Tyler Norris, MS candidate. Tromino data collection, plus interpretation of 2D seismic porfiles provided by West Bay Exploration and Wolverine Oil and Gas in the research area.	
20-Jun	Lansing HOB	1:00-2:00	Representative Aaron Miller HOB, Matt Smego-Farm Bureau, Michael Frederick, MGWA	Review current geologic mapping in State and need for mapping in critical areas associated with PFAS and water withdrawals.	
21-Jun	Lansing Capital	3:30	Governor Snyder signing the 2019 Michigan budget.	Discussions with legislative staff on benefits for annual budget for next budget for MGS.	

Q3 2018 Summary of significant MGS meetings and presentations- Special Appropriations

Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
6-Jul	Phone call	9-:30 AM	Amy Peterson, Mike Sweat	Notified, MGS will receive Triage sites.	
9-Jul	Meeting Lansing Frederick offices	1-2:30	Emily Carney, Senior Staff, Senator Greene	Review topics for mapping and data where PFAS or other water issues are present.	
10-Jul	Rockford	10-12:00	Meeting with Senator MacGregor, Rockford	Review status of mapping and data compilation in Michigan and the need for validated data to predict where PFAS is migrating and the need for MGS funding at $1.5M/year.	
11-Jul	Notified assigning Triage sites	10:00	Mike Sweat	Notified of the first three sites - N-34th- Richland; Traverse City Cherry Capital Airport; Battle Creek Airport.	
11-Jul	Ottawa Co Planning department	1:00 - 3:00	Al Vandenberg, Paul Sachs	Review straegegy of water use and conservation and marketing brochures.	
July 17-20	Dowagiac Core drilling	4 days	Yellich, Kehew, Students, Lowe Foundation,	USGS STATEMAP - CAS 18-01 Coring hole in tunnel valley,	
July 23-26	Dowagiac Core drilling	4 days	Yellich, Kehew, Students, Lowe Foundation,	USGS STATEMAP-CAS 18-01 Coring hole in tunnel valley, completed, TD 301' having gravel and sand, 125-295 (170' of water bearing resources).	
Aug 1-3	Dowagiac Core drilling	3 days	Yellich, Students, City of Dowagiac Airport site	USGS STATEMAP-CAS 18-02 Coring hole in tunnel valley	
7-Aug	Dowagiac Core drilling	1 day	Yellich, Students, City of Dowagiac Airport site	USGS STATEMAP-CAS 18-02 Coring hole in tunnel valley, completed, TD 210' having sand and gravel, 120-200' (80' of water bearing resources).	
14-Aug	TAC Field day, Cass County	All day	Yellich, Jim Milne, Leah Clark, Brian Burroughs, Todd Feenstra	SW Farmers-DEQ partnership: Field testing stream bed seepage and stream flow meter measuring	
17-Aug	City of Portage	10-12:00	Larry Schaffer, City Manager, City of Portage	How to develop additional water resources for City using the MGS study completed in August 2017?	
27-Aug	Lansing, Nature Conservancy	10-12:00	WUAC Members review draft language	HB, 6123 WUAC member discussed the components needed to make the WUAC function going forward.	
4-Sep	Rep Aaron Miller HOB 993	10-12:00	Representative Aaron Miller Discuss implementation of HB 5836, research	Members of the SW Farmers/DEQ study. Science/hydrogeologists and geologists, outline the implementation of the modeling program.	
5-Sep	Lansing	8:30 AM - 7 PM	MMA Lobby days,	Meeting with legislators to discuss recent legislation.	
Sept 10-13	Wash DC, Mon to Thurs	Four days	AASG, State Geologists, Liaison meetings in DC.	Support Federal funding for NCGMP re-authorization for mapping and 3DEEP geophyscial program for US. State geologists meet with USGS, legislative staff to present benefits of mapping programs. Discussions with: Tim Petty, Assistant Director of Interior-Water & Science James Reilly- USGS Director Kevin Gallagher - Assoc Director, Core Sciences Geoffery Plumlee - Assoc. Director, Environmental Sciences Tom Crawford - Assoc. Director, Minerals	
Sept 18-19	Calhoun Co	Two days	Drilling, Calhoun GWREF validation of bedrock mapping	Drilling validation of bedrock valleys. MI Oil and Gas Newletter published success of energy industry collaboration, seismic data to MGS	
20-Sep	Lansing HOB 993	8:00-10:00	Meeting with Rep Aaron Miller, review status of training	HB 5836, training and modeling program.	

Q4 2018 Summary of significant MGS meetings and presentations- Special Appropriations October 1- December 31, 2018					
Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
Oct 16-18	Roscommon, RAM Center	3 days, PPT	Mich DEQ, Geologist Outreach and training	Over 75 State employee professional geologists (DEQ, DNR) at the Bi-Annual Outreach. MGS PPT presentation, "Kicking the geology can down the road" . Poster session, presenting MGS products for the last two years.	
Oct 22-23	Kalamazoo, MGRRE, Rood hall	2 days	USGS FEDMAP Project Manager, Chuck Bloom and geologist Scott Lundstrum	USGS and MGS are initiating the start of a 10 year FEDMAP project to assess variations in near shore geology and testing indirect methods that quantify and monitor changes in near shore bluff and shoreline changes to natural and anthropogenic impacts. (IN, IL, WI also participating)	Developing the USGS project plan with USGS, Denver Office
25-Oct	Lansing, MMA Offices	9-12, PPT	MMA Mining subcommittee meeting, Update by MGS	Quarterly update to MMA Mining subCommittee . Status of MGS funding	
26-Oct	Lansing, Constitution Hall	9-12:00 day	DEQ, USGS, DNR, University representatives	Groundwater Quality Monitoring - Quartery meeting wth DEQ, USGS, DNR, University representatives to discuss water quality monitoring for MI.	
31-Oct	Kalamazoo, MGRRE	9-12:00 day	Qtrly Meeting, SW Mich Groundwater Pilot study	SW Michigan farmers pilot study, Tech Advisory Committee Qtrly meeting to review results of drilling, ground and surface water sampling and data reduction.	
Nov 3-8	GSA National meeting Indianapolis	3.5 days	USGS Washington staff and directors. AASG State geologists, regional and national geologists	GSA National meeting, meetings with USGS on Mapping programs (NCGMP), national mapping strategies, critical minerals, 3DEEP national airborne geophysical, regional mapping programs meetings with regional state geologists, IN, IL, WI, OH, PA, NY, MN	
9-Nov	Kalamazoo	PPT 6-9:00 PM	Local community citizens requested a PPT on the water issues in Michigan	A Portage citizens group requested MGS present a summary of MI water issues and where we are today and asked why are we having issues. The group of about 18 present feel that letters need to be written to the new Governor and all the local legislators to initiate water/geologic research in MI.	
12-Nov	Ottawa Co Planning department, Filmore offices	1-3:00	Planning exec Committee on Water Conservation projects	Review stragegy of water use and conservation and marketing brochures and outline GVSU proposal for marketing.	
Nov 12-13,2019	Drilling last hole(s) Sumnerville	9-12:00 12th 9-6:00 PM, 13th	Sumnerville Quad, Cass Co.	Logging drill cuttings and gamma, drilling last hole in Coalition mapping program, logging CAS 18-03, south of Dowagiac. Map published Dec 28.	
14-Nov	Kalamazoo, Bells	5-7:00 PM	James Clift, Nature Conservancy, Seminar - PFAS in Kalamazoo	James Clift outlined the need for more geologic data if we are to understand where the PFAS will appear next in the water supplies. Referenced MGS proposal and data base compilation of old geologic data was needed.	
15-Nov	Kazoo, WMU Fetzer	4-8:00 PM, PPT	MGS PPT, WMU departments presenting PFAS expertise	Geology, Biology, economics, marketing, summary of what expertise WMU has to support assessing PFAS impacts.	
19-Nov	Ottawa Co Planning department, Filmore offices	8 AM-4:00 PM, PPT	MGS PPT Shoreline impacts. Ottawa county coastal impacts symposium.	MGS PPT presents examples of anthropogenic impacts from poor surface and near surface activities, Septic, stormwater, high water lake levels, etc.	
6-Dec	Devos Center, Grand Rapids, GVSU	5-8:00 PM	GVSU, Capstone marketing presentations, 4 proposals	Four groups of GVSU students presented four quality proposals to market water conservation for the County. Parts of each proposal will be reviewed for merit and use going forward.	
13-Dec	GVSU, Grand Rapids	8 A-5:00pm	Interstate Technology & Regulatory Council, PFAS	Approximately 120 attendees heard multiple speakers discuss PFAS and what the US/Michigan needs to do to keep abreast of the issue.	
14-Dec	MSU- Schaetzl mtg	12-4:00 PM	MSU students, glacial till assessment, Central Michigan Area	Four groups of Dr. Randy Schaetzl MSU students were assessing over 200 till samples to verify their Canadian/Michigan source areas within the glacial history of MI. Samples taken from Roscommon to north of Lansing, east to Saginaw Bay and west to Grand Rapids.	

Appendix II

Michigan Geological Survey

MGS demonstrations, publications & completed projects and tasks

Examples of proposed Michigan functions from a funded Survey.

July 1, 2016 to December 31, 2018

TASKS INITIATED & COMPLETED	RESULTS	BENEFITS OR BENEFICIARY
PFAS Data Triage – Geologic & hydrogeologic data compilation for identified locations having a PFAS impact.	MGS completed 6 locations (2-5 mi radius) 6/27 to 12/12/18. Surface & groundwater flow directions, nearest receptors, bedrock depth/type, basic glacial subsurface geology.	Basic geologic setting and data to assist sampling and interpretation of analytical data. Submit data summary table, PPT or usable data files, summary geologic setting.
City of Portage, Bedrock Valley assessment for deeper additional water resources.	Confirmed bedrock valley > 50 feet deeper than current production, potential additional water resources. Bedrock valley is over 1 mile wide and more than 5 miles long.	Confirmed potential additional water resources for the Cities of Portage & Kalamazoo, Pfizer or any new companies coming to Portage or Kalamazoo.
GRACE (Gravity Recovery and Climate Experiment) NASA terrestrial water storage data from 2002 to 2016 (15 years).	Validated GRACE modeling projected to a reduced pixel size of 25 KM (15 sq mi). Ability to monitor water storage changes with climatic changes. This is for Cass-St Joseph and Kent-Ottawa Counties and recent data for the entire LP.	Modeling can monitor changes in water storage over 15 year period throughout the state. Modeling has shown changes in the two demonstration areas and the rest of the LP.
Ottawa County Planning Department– Growth Projection to 2035. How will growth affect new water users with potential population growth and a potential water supply crisis in a complex geologic environment?	Ottawa County geologic and water storage data compiled and projected by MGS and MGWA (drillers) has shown in real time, there are limited water supplies available in many areas of the county. Without water use changes, projected growth will impact, both quantity and quality (Chloride impacts).	Ottawa County needs to consider population growth and a long term plan of water conservation and management of more wells and anthropogenic impacts (septics) to shallow water zones.
USGS Publications: Federal Funding of National Cooperative Geologic Mapping Program (NCGMP)- STATEMAP and the –Great Lakes Geologic Mapping Coalition. Eight Cass County map products in 2+ years	MGS published five Surficial geologic maps, Jones, Vandalia, Mottville, Decatur & Marcellus quads (~55 sq mi/quad), February, September & December 2017 & three Dowagiac& Sumnerville & Sister Lakes in 9 &12/2018. Identified new water resources 100 to 250 feet below existing published data over a 200 sq mi area at this time. The complex geologic data is presented in a 3D output allowing all users access to the new data.	DEQ-WRD, MDARD, farmers and consultants in the 3D mapping area now have validated geologic data to assist in WWAT applications using this new data. All users benefit from bedrock mapping to present bedrock valleys having concentrated areas of potential water resources, 100-250 below existing water bearing zones.
Michigan Aggregates, How much IS available? The proposed example for aggregate resource availability, this is an un-graded resource	MGS mapped the potential aggregate resources and projected how much is removed with setbacks and restrictions – New 2015 Calhoun Co MGS geologic map. Availability demonstration	Quanlified resource: Potential ~147 sq mi of minus ~81 sq mi restricted = ~ 66 sq mi (~45%) of potential resource available
Natural Gas Storage: Michigan is ranked #1 nationally in natural gas storage facilities. A geologic/core repository (MGRRE) is a must.	Current and new gas storage facilities are in need of upgrade and expansion. Mapping and 3D geology of gas storage zones using MGRRE core/data is a must.	Additional research in gas storage is ongoing at MGRRE, to support the natural gas industry.

Appendix III

United Tribes of Michigan

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Phone: 517-802-8650 --- Email: fettawa@charter.net

Frank Ettawageshik, Executive Director

RESOLUTION # 058 2-8-2018

United Tribes of Michigan support for Annual Funding for a functional State Geological Survey.

WHEREAS, the membership of United Tribes of Michigan (UTM) is open to all of the twelve federally recognized tribes located in Michigan; and

WHEREAS, the organization provides a forum for the Tribes in Michigan to address issues of common concern and is committed to join forces to advance, protect, preserve and enhance the mutual interests, treaty rights, sovereignty, and cultural way of life of the sovereign Indian Tribes of Michigan throughout the next seven generations; and

WHEREAS, the inherent sovereign rights of Tribal governments are advanced within their respective Constitutions and Laws, and are supported within provisions of the Constitution of the United States, and within the United Nations Declaration on the Rights of Indigenous Peoples and subsequent international actions; and

WHEREAS, UTM accepts the mission to engage, as a matter of mutual concern, issues that impact the health, security, safety, and general welfare of Native Americans; and

WHEREAS, the State of Michigan has significant groundwater resources that represent the primary source of all life for mother earth and the sovereign Indian Tribes of Michigan; and

WHEREAS, most of the population of Michigan living greater than 25 miles from the Great Lakes obtains their water supplies from wells, which is groundwater, which is known as the hydrogeology; and

WHEREAS, knowing where the groundwater is located and how the rock (geology) holds this liquid in the ground is the foundation for identifying the location of and protecting that water resource; and

WHEREAS, we all must continually strive to protect and conserve that precious water supply and knowing the characteristics of its buried geologic environment is pivotal to this goal; and

WHEREAS, less than 10% of Michigan has been adequately mapped and data published and available to assess and manage this precious resource suggests that Michigan has not had a

commitment to identify and support the protection of that water resource by qualified scientists/ geologists; and

WHEREAS, the current Geological Survey was transferred to Western Michigan University Geosciences Department in October 2011 with no funding; and

WHEREAS, the current Geological Survey has shown that quality geologic maps and reports can be done with a properly funded mapping and publishing program and that data can be used to identify, assess and protect those water resources; and

WHEREAS, the Tribes believe that the information developed in an expanded survey will assist Tribes in protecting our water resources from any potential activities that could cause harm to those resources: such as land-fills, legacy pollution sources, mining, excessive water withdrawals, etc.; and

WHEREAS, Federal mapping funds have been available for over 24 years and the State of Michigan has not taken advantage of these funds (1:1dollar match), yet the adjoining states, Illinois, Indiana and Ohio have been granted nearly three times ($3-5 Mill) the Federal funding from these programs than Michigan.

THEREFORE, BE IT RESOLVED, the United Tribes of Michigan petition the Governor to support the passage of legislation to annually fund a functioning Geological Survey that will allow applying for larger Federal grants to support the geological identification, assessment and protection of our water and other natural resources; and

BE IT FURTHER RESOLVED, UTM will collaborate with the functioning Survey to identify areas of Michigan and collaborate in applying for grants that will support geologic research and collect validated data to protect those resources; and

BE IT FINALLY RESOLVED, that this resolution shall be policy by UTM until it is withdrawn or modified by subsequent resolution.

Adopted by a vote of 10 in favor, 0 against, 0 abstaining, at a meeting of the United Tribes of Michigan held on February 8, 2018 at Lansing, , Michigan.

Chairman Aaron Payment
UTM President

United Tribes of Michigan, Resolution **# 058 2-8-2018**
Support for MI Geological Survey Funding
Page 2 of 2

Appendix IV
Michigan geology related research awarded grants, contracts

2018, MGS and faculty new and continuing grants for a combined total of $1,096,180 for 2019 until June 30, 2020.

Continuing grants total **$179,874** and NEW research grant funding of **$723,065** and Federal Grants of **$193,241** for a total of **$1,096,180**.

Continuing grants with products produced in 2018, $179,874

Yellich, J. A.; Kehew, A. E.; Great Lakes Geologic Mapping Coalition (GLGMC) Surficial Geologic Mapping Cass County, Michigan; Sister Lakes and Sumnerville 7.5 minute $75,462

Yellich, J.A.; Kehew, A. E.; Harrison, W.; Surficial Geologic Mapping: Dowagiac 7.5 Minute Quadrangle, Cass County, Michigan and Bedrock Geologic Mapping, SE Michigan: Bedrock Geologic Map, Wayne County, Michigan. $74,412

Michigan Geological Survey, a 2016 Michigan Legislative Special Appropriation funding ($500,000): "Identifying the programs to assess the Natural Resources of Michigan" managed through the MDEQ-Office of Oil Gas and Minerals for the period 2016 to 2019. There is approximately $30,000 remaining.

Barnes, David A. and William B. Harrison, III, 2014 to 2018, Reservoir Characterization and Petrophysical Studies in Niagaran-Silurian Northern Lower Michigan, Midwest Regional Carbon Sequestration Partnership, Phase III, Budget Period 5, funded by Battelle Memorial Corp. (approximately) This was last year to support student and faculty research with minimal future funding to be expected.

NEW State and other Grants ($723,065):
Michigan Geological Survey, a 2018 Michigan Special Appropriations funding ($500,000); Mapping, Projects and Data, a continuation of the 2016 grant to compile geologic data for the State of Michigan in priority areas related to PFAS, water and aggregates. October 2018- September 30, 2020, **$500,000**.

Yellich, J. A.; Sauck, W.; and Kehew, A. K.; Ground Water Research and Education Foundation of the Ground Water Protection Council of the National Ground Water Association awarded an unsolicited grant for a "Proof of concept/demonstration using geophysical methods to map water resources" 2016-2018 in the amount of **$74,521**. NOTE: The contract was signed in early 2018 and will carry through May 2019, funding at least one graduate student.

Yellich, J.A.; DEQ_RRD proposal, Data capture "Triage Data summary" for newly identified PFAS locations, through September 30, 2018, newly identified PFAS contaminated locations in Michigan. Final approval, April 2018 until September 30, 2019; **$125,401**.

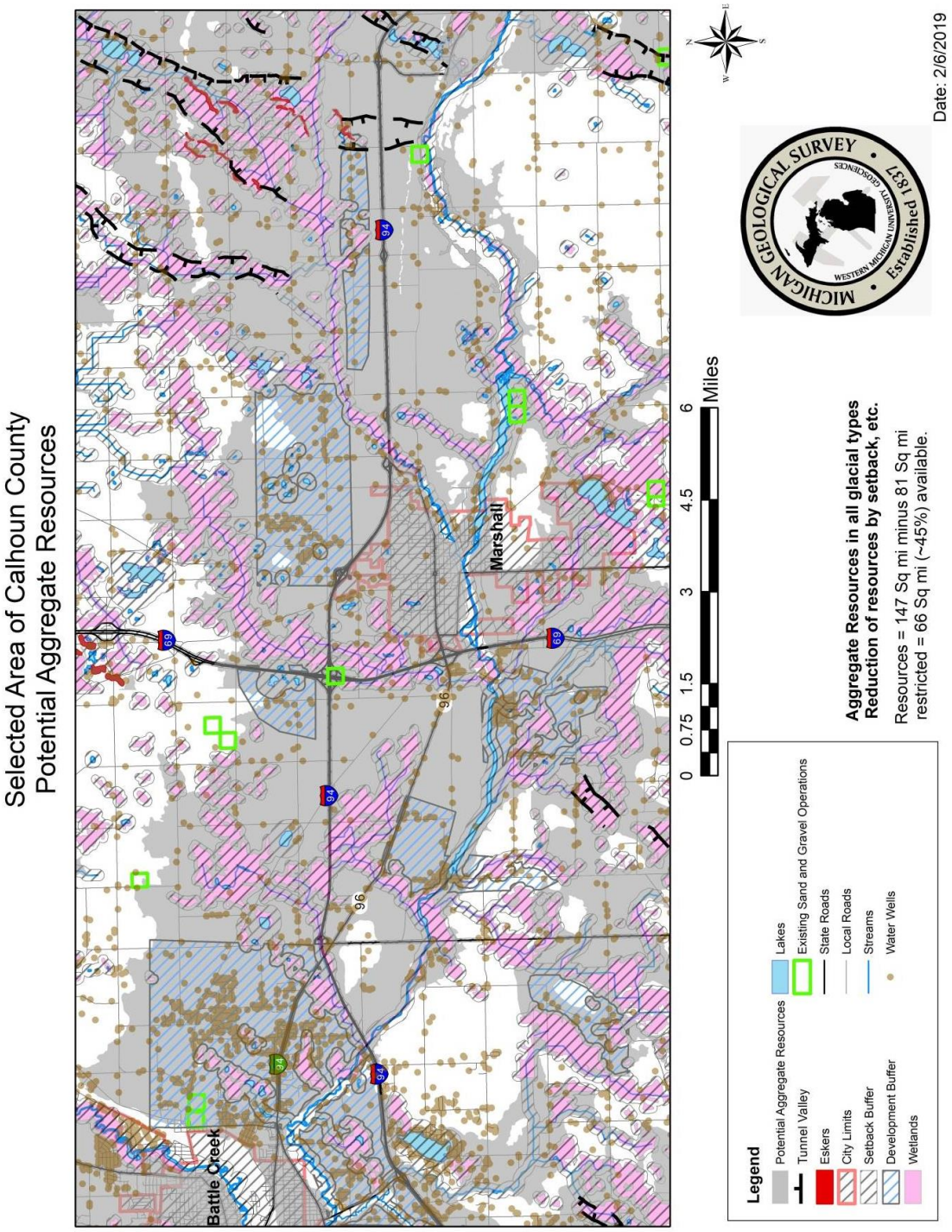
Yellich, J. A.; MDOT, Joint proposal with WMU- Engineering Excellence, Michigan Geology, a summary for the new MDOT Geotechnical manual. To include areas of geologic importance for construction and hazards. September 30, 2018 to December 31, 2019. **$23,143**.

NEW Federal grants and awards: $193,241, October 1, 2018 to September 30, 2019

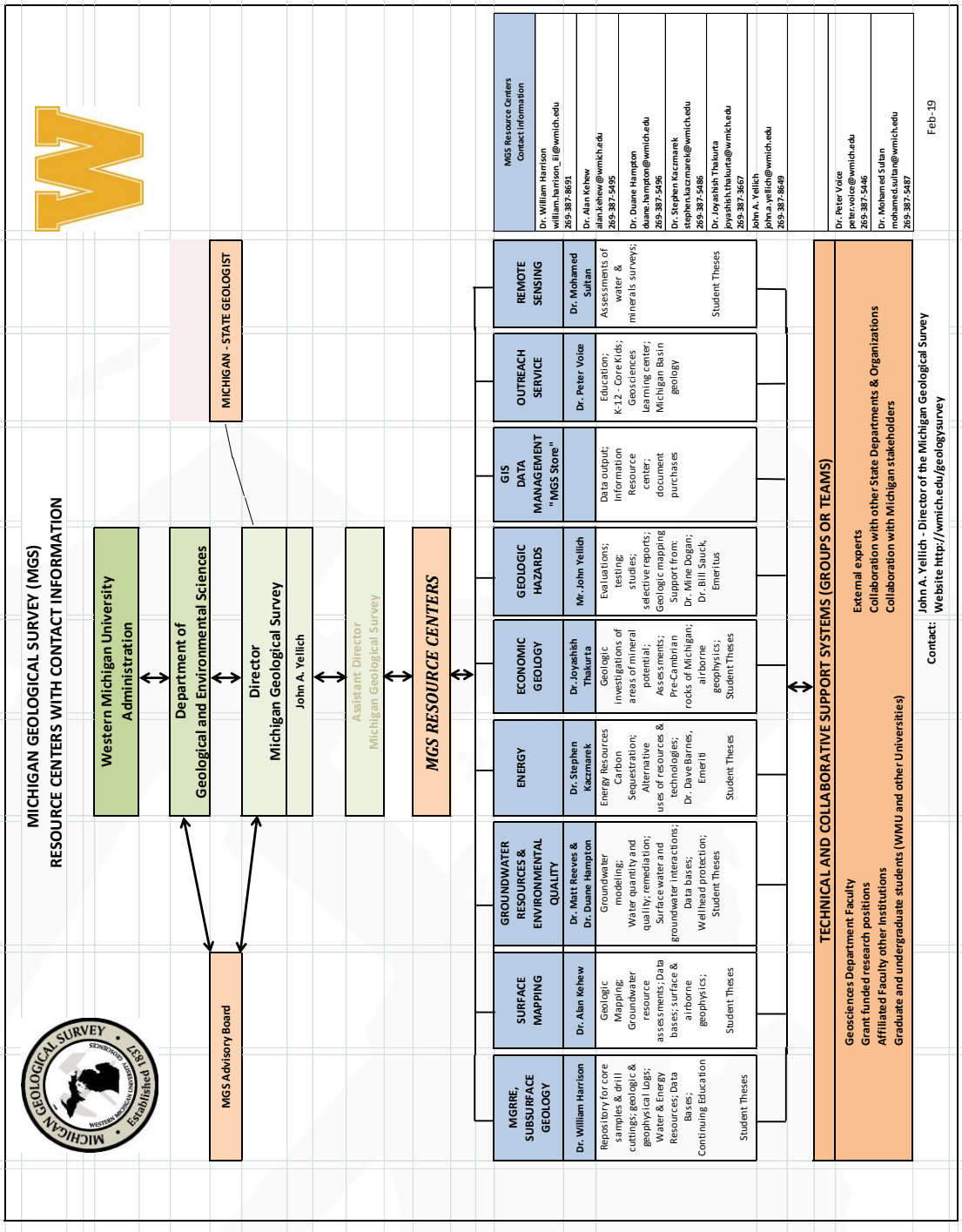
Yellich, J. A.; Kehew, A. E. USGS-GLGMC - Surficial Geologic Mapping Cass County, Michigan; Twin Lakes and continuation of county map compilations with adjoining Van Buren, St. Joseph and Berrien counties **$68,800.**

Yellich, J. A.; Kehew, A.E.; USGS STATEMAP Surficial Geologic Mapping: Edwardsburg 7.5 Minute Quadrangle, Cass County, Michigan and Project 2, Bedrock Geological Mapping in segments of Parma, Jackson North, Spring Arbor, and Jackson South 7.5 Minute Quadrangles in Jackson County, Michigan. **$75,117.** Harrison, William B., III, 2018, National Geological and Geophysical Data Preservation Program Funded by United States Geological Survey, **$49,394.**

Appendix V


Selected Area of Calhoun County
Potential Aggregate Resources
Battle Creek
Marshall
94
69
96
0 0.75 1.5 3 4.5 6 Miles
Legend
Potential Aggregate Resources
Tunnel Valley
Eskers
City Limits
Setback Buffer
Development Buffer
Wetlands
Lakes
Existing Sand and Gravel Operations
State Roads
Local Roads
Streams
Water Wells
Aggregate Resources in all glacial types
Reduction of resources by setback, etc.
Resources = 147 Sq mi minus 81 Sq mi
restricted = 66 Sq mi (~45%) available.
MICHIGAN GEOLOGICAL SURVEY
Established 1837
WESTERN MICHIGAN UNIVERSITY GEOSCIENCES
Date: 2/6/2019

Appendix VI


MICHIGAN GEOLOGICAL SURVEY (MGS)
RESOURCE CENTERS WITH CONTACT INFORMATION
Western Michigan University Administration
Department of Geological and Environmental Sciences
Director Michigan Geological Survey
John A. Yellich
Assistant Director Michigan Geological Survey
MGS RESOURCE CENTERS
MICHIGAN - STATE GEOLOGIST
MGS Advisory Board
MGRRE, SUBSURFACE GEOLOGY
Dr. William Harrison
Repository for core samples & drill cuttings; geologic & geophysical logs; Water & Energy Resources; Data Bases; Continuing Education
Student Theses
SURFACE MAPPING
Dr. Alan Kehew
Geologic Mapping; Groundwater resource assessments; Data bases; surface & airborne geophysics;
Student Theses
GROUNDWATER RESOURCES & ENVIRONMENTAL QUALITY
Dr. Matt Reeves & Dr. Duane Hampton
Groundwater modeling; Water quantity and quality; remediation; Surface water and groundwater interactions; Data bases; Wellhead protection; Student Theses
ENERGY
Dr. Stephen Kaczmarek
Energy Resources Carbon Sequestration; Alternative uses of resources & technologies; Dr. Dave Barnes, Emeriti
Student Theses
ECONOMIC GEOLOGY
Dr. Joyashish Thakurta
Geologic investigations of areas of mineral potential; Assessments; Pre-Cambrian rocks of Michigan; airborne geophysics; Student Theses
GEOLOGIC HAZARDS
Mr. John Yellich
Evaluations; testing; studies; selective reports; Geologic mapping Support from: Dr. Mine Dogan; Dr. Bill Sauck, Emeritus
GIS DATA MANAGEMENT "MGS Store"
Data output; Information Resource center; document purchases
OUTREACH SERVICE
Dr. Peter Voice
Education; K-12 - Core Kids; Geosciences Learning center; Michigan Basin geology
REMOTE SENSING
Dr. Mohamed Sultan
Assessments of water & minerals surveys;
Student Theses
MGS Resource Centers Contact information
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TECHNICAL AND COLLABORATIVE SUPPORT SYSTEMS (GROUPS OR TEAMS)
Geosciences Department Faculty
Grant funded research positions
Affiliated Faculty other Institutions
Graduate and undergraduate students (WMU and other Universities)
External experts
Collaboration with other State Departments & Organizations
Collaboration with Michigan stakeholders
Contact: John A. Yellich - Director of the Michigan Geological Survey
Website http://wmich.edu/geologysurvey
Feb-19

Appendix VII
Michigan Geological Survey, MGRRE, WMU Geosciences Michigan
Funded Professional Publications Summary Report for 2018

USGS Surficial and Bedrock Maps produced and published with matching Federal funds in 2018:

Kehew, A.E., Esch, J.M., **Yellich, J.A.**; Surficial Geologic Mapping: Dowagiac 7.5 Minute Quadrangle, Cass County, Michigan Surficial Geologic Map Series SGM-18-01, Scale 1:24,000.

Harrison, W. III, Voice, P. J.; Bedrock Geologic Mapping, SE Michigan: Bedrock Geologic Map, Wayne County, Michigan. Bedrock Geologic Map Series BGM-18-01 Scale 1:500,000

Kehew, A. E., Esch, J. M., **Yellich, J. A**.; Great Lakes Geologic Mapping Coalition (GLGMC) Surficial Geologic Mapping Cass County, Michigan; Sister Lakes and Sumnerville 7.5 minute Quadrangle; Surficial Geologic Map Series SGM-18-02 Scale 1:24,000, 12/2018

Appendix VIII

Michigan 2018 Geologic Publications submitted or presented by Students, faculty and other researchers,

Published Abstracts or Professional Presentations -

(Student Authors are highlighted in Bold)

January 1, 2018 to December 31, 2018- Students with Faculty Staff

Caruthers, A.H., Grocke, D.R., Kaczmarek, S.E., †**Rine, M.J**., Kuglitsch, J., and Harrison, W.B. (2018) The utility of organic carbon isotope data from the Salina Group halite (Michigan Basin): a new tool for stratigraphic correlation and paleoclimate proxy resource, 9 p. doi.org/10.1130/B31972.1

Manche, C. and Kaczmarek, S.E. (2018) Evaluating dolomite stoichiometry as a proxy for the chemistry of dolomitizing fluids (oral), American Association of Petroleum Geologists Annual Conference, May 20-23, Salt lake City, UT, #2847232.

Al-Musawi, M. and Kaczmarek, S.E. (2018) Application of XRF, biostratigraphic, and carbon isotope data to establish a sequence stratigraphic framework and depositional facies model for the Burnt Bluff Group, Michigan Basin, USA (poster), American Association of Petroleum Geologists Annual Conference, May 20-23, Salt lake City, UT, #2855260.

Hemenway, M., Kaczmarek, S.E., and †Rose, K. (2018) Application of handheld ED-XRF for high-resolution chemostratigraphy in texturally homogeneous carbonate mudstones: Salina A-1 Carbonate (Silurian), Michigan Basin (poster), American Association of Petroleum Geologists Annual Conference, May 20-23, Salt lake City, UT, #2837835.

Pei Teoh, C., Laya, J.C., Whitaker, F., Gabellone, T., Tucker, M., **Manche, C.,** and Kaczmarek, S.E., Miller, B. (2018) Unravelling reflux dolomitization: why size matters (poster), American Association of Petroleum Geologists Annual Conference, May 20-23, Salt lake City, UT, #2857418.

Al-Musawi, M. and Kaczmarek, S.E. (2018) Application of high-resolution ED-XRF data to establish a sequence stratigraphic framework of homogeneous carbonate rocks, Michigan Basin, USA (poster), Geological Society of America – North-Central Meeting 52, April 16-17, Ames, IA, #313282.

Nadhim, Z.N., and Kaczmarek, S.E. (2018) (poster), A statistical approach for constraining facies volumes in the Niagaran pinnacle reefs, Michigan Basin, Geological Society of America – North-Central Meeting 52, April 16-17, Ames, IA, #313283.

Kaczmarek, S.E., *Voice, P.J., Petcovic, H.L., and Harrison III, W.B. (2018) Bridging the gap: using geochemical data to integrate geology and chemistry in K-12 education (oral), Geological Society of America – North-Central Meeting 52, April 16-17, Ames, IA, #312546.

Rupp, K. and Thakurta, J., 2018, Petrogenesis of the East Eagle intrusion and its relationship with the Eagle Ni-Cu-PGE magmatic sulfide deposit, Marquette County, Michigan, Geological Society of America Abstracts with Programs. Vol. 50, No. 6 doi: 10.1130/abs/2018AM-322738.

FACULTY AND STAFF (in Bold) PUBLICATIONS:

Kehew, A.E., Esch, J.M., **Yellich, J.A.**; Surficial Geologic Mapping: Dowagiac 7.5 Minute Quadrangle, Cass County, Michigan Surficial Geologic Map Series SGM-18-01

Harrison, W. III, Voice, P. J.; Bedrock Geologic Mapping, SE Michigan: Bedrock Geologic Map, Wayne County, Michigan. Bedrock Geologic Map Series BGM-18-01 Scale 1:500,000

Esch, J. M., **Kehew, A. E**., **Yellich, J. A**.; Great Lakes Geologic Mapping Coalition (GLGMC) Surficial Geologic Mapping Cass County, Michigan; Sister Lakes and Sumnerville 7.5 minute Quadrangle; Surficial Geologic Map Series SGM-18-02 Scale 1:24,000, 12/2018

Kehew, A.J.; Curry, B. Editors; Quaternary Glaciation of the Great Lakes Region: Process, Landforms, Sediments, and Chronology, GSA Special Paper 530, compilation of twelve chapters on Great Lakes Quaternary geology, February 2018

Appendix IX

Michigan Geological Survey, Advisory Council

	NAME	AFFILIATION, PROFESSIONAL INTEREST AND (OTHER)	PRIMARY PHONE CONTACT	EMAIL	ADDRESS
1	John A. Yellich	Director Michigan Geological Survey, Western Michigan University, Dept. of Geosciences	303-901-2886 (M) 269-387-8649	john.a.yellich@wmich.edu	1187 Rood Hall 1903 West Michigan Ave Kalamazoo, MI 49008-5241
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3	Mohamed Sultan	Department Chair, Geosciences Department, Western Michigan University Environmental Sciences & Remote Sensing	269-387-5451	mohamed.sultan@wmich.edu	1187 Rood Hall 1903 West Michigan Ave Kalamazoo, MI 49008-5241
4	William Harrison	MGRRE, Director of the MGS - MGRRE core repository at WMU, Emeritus Professor, WMU Geosciences Department	269-387-8691	william.harrisonIII@wmich.edu	1187 Rood Hall 1903 West Michigan Ave Kalamazoo, MI 49008-5241
5	Adam Wygant	Director, Office of Oil, Gas, and Minerals, Michigan Department of Environmental Quality (MDEQ), State Geologist (WMU Advisory Council)	517-897-4828	wyganta@michigan.gov	Office of Oil, Gas, and Minerals P.O. Box 30256 Lansing, MI 48909-7756
6	John Gierke	Chair - Department of Geolgical Engineering Michigan Technological University	906-487-2535	jsgierke@mtu.edu	712 Minerals and Materials Engineering Building 1400 Townsend Drive Houghton, MI 49931-1295
7	Tom Quigley	President - Great Lakes Exploration, Menominee, MI Menominee, long time Michigan Great lakes area Explor-Develop Geologist	906-352-4024	tquigley@glexploration.com	414 10th Avenue Menominee MI 49585-3028
8	Paul Daniels	Earth Resources International, Principal/Registered Professional Geologist, Oil, gas, potash, minerals, environmental, Michigan, US, So Americ, Europe, Russia	269-343-1181	paul.daniels@earth-resources.com	P.O. Box 20245 Kalamazoo MI 49019
9	David Preston	Varnum Law, Grand Rapids, Retired Senior Partner Environmental and property liability, mining projects, mine and powerplant development	616-336-6520 (Direct) 616 / 336-6000 (Office)	depreston@varnumlaw.com	333 Bridge Street, NW Grand Rapids, MI 49504
10	Jeff Hawkins	President, Envirologic Technologies, (Past Pres.- Kalamazoo Chamber, Member of Southwest Mich First) Brownfields development expertise, politically connected in Michigan	269-342-1100	jhawkins@envirologic.com	2960 Interstate Parkway Kalamazoo, MI 49048
11	Dan Balkema	Balkema Excavating - Michigan aggregates industry- Board of Directors	269-345-5289 517-381-1732 Ag Assoc	dan@balkemaexc.com	1500 River St, Kalamazoo, MI 49048
12	Bill Stelzer	Consultant Oil, gas, geophysics, production Michigan primary area	(517) 203-3385	stelzrb@aol.com	1500 Kendale Blvd, Suite 301 East Lansing, MI 48823
13	Robert G. Mannes	President, Core Energy Inc,	231-946-2419	rgmannes@coreenergyllc.com	1011 Nateware Drive Traverse City, Michigan 49646
14	Jill Bland	Executive VP; Southwest Michigan First	(269) 492-6375	jbland@southwestmichiganfirst.com	241 East Michigan Ave. Kalamazoo, MI 49007
15	Ralph Haefner	Director - USGS - Michigan and Ohio Water Science Center	(517) 599-4954 (517) 887-8927 (W)	rhaefner@usgs.gov	6520 Mercantile Way, Suite 5 Lansing, MI 48911-5991
16	Joe Van Wagnen	Van Wagnen Engineering Propane storage, Und Inject wells, permitting	(517) 331-1694	vwengr@wowway.com	849 W. Dansville Road Mason, MI 48854
17	Jerry L. Aiken	Consultant- Rare Earths, precious metals potash, Michigan, US, So America, Europe, Asia, Russia	520-293-9832 520-360-3572 (M)	j.l.aiken@att.net	6845 N. Magic Lane Tucson, AZ 85704
18	Dan Wiitala	North JacksonCompany, EnvironmentalScience and Engineering, Partner Environmental; Groundwater, permitting mining and development (Brownfields) UP - Eagle Mine	906-225-6787	dwiitala@northjacksonco.com;	307 South Front Street, Suite 105 ~ Marquette, Michigan 49855 ~ (906)225-6787
19	Tim Brock	Brock Engineering Geological Engineer - Oil, Gas, aggregates in Michigan	(231) 421-3001	brock.engineering@yahoo.com	170 Southeast Silver Lake Road Traverse City, MI 49685
	Ex- Officio Members				
20	Greg Rosine	WMU VP Government Affairs (State and Federal)	269-207-4484 (M) 269-387-2072 (W)	greg.rosine@wmich.edu	1903 West Michigan Ave Kalamazoo, MI 49008
21	Katie M. John	WMU Director of Government Affairs (State and Federal)	269-387-3606	katie.john@wmich.edu	1903 West Michigan Ave Kalamazoo, MI 49008