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Michigan Geological Survey Annual Report for 2019

The Michigan Geological Survey is pleased to present the 2019 Annual Report summarizing the activities and achievements to the State Geologist, Adam Wygant, per Senate Bill No. 507.

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), a state department, has been located at Western Michigan University Geological and Environmental Sciences Department for over eight years. The primary functions mandated for the State survey by the October 11, 2011 legislation (PA 167) 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 continued to operate on grant awards received through December 31, 2019.

MGS continues to operate on "soft" money from Federal and State grants. The total 2019 grant funds expended and new MGS grant funds total **$1,709,899.** From January 1, 2019 to December 31, 2019, MGS has been granted funds from the USGS, MEGLE, and the Michigan Legislature (USGS -$68,800, $75,117, $89,835, $76,239, $99,908, EGLE $500,000, EGLE $300,000 Legislature December 2018- $500,000), respectively, for a total of **$1,709,899** to be used for the period October 1, 2018 to June 30, 2021. One of the grants will continue into 2022. 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 and scientists who are contributing their support to the MGS in Appendix VI below.

MGS Is not going to review the project details of the past year, but presents the summary of current financial conditions in this text and has attached the summary of MGS projects ongoing and completed

along with the contacts, presentations and meetings where MGS presented results or the rationale for annual funding. Funding was there twice and was deleted by the Governor's office. Current conditions indicated, the Director position will not be funded after June 30, 2021, if not before.

Now, MGS, Michigan and the nation have been put on hold because of the Pandemic and projected future economic changes at WMU. This is a total unknown for all Michigan programs and MGS has also been impacted. MGS has sufficient funds to employ the Director until June 30, 2021, but no more. It could be less if something unforeseen happens. For review, MGS is employing over 18 students on the Triage-Wellogic data correction project having health and welfare benefits, validating where the water wells are located in a State database, Wellogic. We have funding for nearly two years at the current rate. MGS has received two USGS mapping grants and because WMU laid off all Term Appointment (Yearly contract) staff, MGS does not have any WMU geologists to support the two awarded grants. Until MGS has an annual budget, MGS cannot hire permanent full-time staff to meet State mandated geological investigation requirements, nor can it receive an increase in matching Federal funds for geological mapping programs. MGS has not seen any annual funding from the Michigan Legislature nor has there been monetary support from WMU for MGS operations since mid-2015.

MGS continues to be invited to present to various organizations the need for updated geologic data in Michigan. MGS requires annual funding to compile geologic data for agencies, organizations and individuals to make sound scientific decisions. During 2019, MGS has made 66 presentations at conferences, meetings and at specific table top discussions (Appendix I). Over 250 presentations have been made in the last six (6) 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 the health and welfare related to PFAS in the subsurface, groundwater quantity and quality, aggregate locations, geo-hazards-bluff failures and regional flooding, all are founded on geology.

MGS is presenting this overview to inform the MGS stakeholders of the WMU priorities that have now been changed to respond to Covid 19. However, the need for geologic understanding of where is PFAS/PFOA going and where are the aggregate resources are two primary goals and they have not been reduced in importance. MGS has now been asked by WMU to provide a summary of how MGS can be supported by the existing grants as well as how MGS can support MGRRE, having over 30% of the core belonging to the State of Michigan.

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 EGLE 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.

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 public and private stakeholders and the various state agencies. In addition to EGLE, the principal departments and agencies who are in need of unbiased geologic information are Natural Resources (MDNR);Agriculture and Re-development (MDARD); and Transportation (MDOT) MGS has specific letters of support in 2019 from EGLE – Water Resource Division, EGLE- MPART, MDARD – Agriculture, DNR Minerals and Michigan Farm Bureau, all in support of mapping to support the location and protection of the water and aggregate resources. 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 geologic database of the 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 contract (Triage Data Compilation) to provide basic geologic and hydrogeologic data for specific locations identified by the State PFAS management team. MGS has completed eleven summaries in 2019 (Table 1,d below) 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 data summary table, plates/figures, cross sections and a PowerPoint summary of this information and data. MGS has corrected the well location data to present a corrected surface and groundwater depth and flow directions, down gradient well locations, basic subsurface geology, bedrock depth and lithology, surface features, and any anomalous data features not readily known e.g. groundwater or surface water divides, lithology changes, etc. MGS has completed seventeen of these locations since June 2018. The presentation of the inaccuracy of the majority of the Wellogic well locations not

being within the two mile radius is the basis for MGS capturing the Wellogic Triage database correction grant.

Table 1: Triage summary of Data Compilation, 2-5 mile radius (2018 and 2019-11 Locations)

Summary of Michigan Geological Survey (MGS) Triage Sites submitted to MEGLE/MPART

Quarter	#	Submittal Date	Site name	County	City	RRD Office	Submitted to:	CC to	Notes:
3rd - 2018	1	27-Jun-18	North 34th Street	Kalamazoo	Richland	Lansing	Mike Jury	Mike Sweat Amy Peterson	Preliminary data
	2	13-Aug-18	North 34th Street	Kalamazoo	Richland	Lansing	Mike Jury	Mike Sweat Amy Peterson	PPT, Data summary table & data table
	3	13-Aug-18	Cherry Capital Airport	Grand Traverse	Traverse City	Lansing	Mike Jury	Mike Sweat Amy Peterson	PPT, Data summary table & data table
	4	13-Aug-18	Kellogg-Battle Creek Airport	Calhoun	Battle Creek	Lansing	Mike Jury	Mike Sweat Amy Peterson	PPT, Data summary table & data table
4th-2018	5	29-Oct-18	Robinson Elementary School	Ottawa	Robinson Twp	Grand Rapids	Abigail Hendershott	Mike Sweat Amy Peterson	Data summary table, Summ Report and Single set of PDF files
4th-2018	6	12-Dec-18	Ashley Avenue	Kent	Grattan Twp	Grand Rapids	Abigail Hendershott	Mike Sweat Amy Peterson	Data summary table, Summ Report and Single set of PDF files
1st - 2019	7	11-Jan	Muskegon Airport	Muskegon	Muskegon	Grand Rapids	Abigail Hendershott Peter Van Heest	Mike Sweat Amy Peterson	Data summary table, Summary Report, Single PDF files (12 files)
1st - 2019	8	8-Feb	Flint Bishop Airport - Landfill	Genesee	Flint	Lansing	Paul Bucholtz, Dennis Eagle	Mike Sweat Amy Peterson	Data summary Table, Summary PPT- 18 Figures, Transmittal Summary Repot
1st - 2019	9	9-Mar	Evergreen MHC	Ionia	Easton	Grand Rapids	Aaron Assmann Abigail Hendershott	Mike Sweat Amy Peterson	Data summary Table, Summary PPT- 12 Figures, Transmittal Summary Report
2nd- 2019	10	16-May	Ionia Biosolids	Ionia	Ronald/ City of Paleo	Lansing	Stephanie Kammer Sydney Ruhala	Mike Sweat Amy Peterson Mike Jury	Data Summary table, Summary PPT 10 figures, Transmittal Summary Report
2nd- 2019	11	21-May	IAC Mendon	St. Joseph	Mendon	Kalamazoo	Michael Baranoski Ray Spaulding	Mike Sweat Amy Peterson Mike Jury	Data Summary Table, Summary PPT 8 figures, Transmittal report
3nd- 2019	12	10-Aug	MI Milk Producers	St. Joseph	Constantine	Kalamazoo	David Heywood Erica Bays David Harn	Mike Sweat Amy Peterson Mike Jury	Data Summary Table, Summary PPT 9 figures, Transmittal report
3nd- 2019	13	25-Sep	Watson Township Dump	Allegan	Watson	Kalamazoo	David Heywood Ray Spaulding David Harn	Mike Sweat Amy Peterson Mike Jury	Data summary table, Summary PPT, 18 figures, Transmittal Report.
4th - 2019	14	21-Oct	Grayling Army Depot	Crawford	Grayling	Gaylord	Christiaan Bon Randy Rothe	Mike Sweat Amy Peterson Mike Jury	T25-26N R3-4W Data summary table, Summary PPT, 18 figures, Transmittal Report.
4th - 2019	15	21-Oct	Grayling Airport	Crawford	Grayling	Gaylord	Christiaan Bon Randy Rothe	Mike Sweat Amy Peterson Mike Jury	T25-26N R3-4W Data summary table, Summary PPT, 18 figures, Transmittal Report.
4th - 2019	16	21-Oct	Grayling MATES-Tank Training	Crawford	Grayling	Gaylord	Christiaan Bon Randy Rothe	Mike Sweat Amy Peterson Mike Jury	T25-26N R3-4W Data summary table, Summary PPT, 18 figures, Transmittal Report.
4th - 2019	17	11-Nov	Michner Plating	Jackson	Jackson	Jackson	Gerald Tiernan Jayamani Indumathy	Mike Sweat Amy Peterson Mike Jury	T2S; R1W; Sect 22 Data summary table, Summary PPT, 19 figures, Transmittal Report.
	18								

Denotes Federal Facilities or there is an airport and/or Federal training area at the location.

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 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 with 52 in 2019, 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.

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.***

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.

Attached in Appendix VIII is a summary of all 2019 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.

The following is a summary of MGS 2019 meetings and functions, the Annual Summary:

- **5 - Michigan legislator meetings**
- **48- Meetings with Michigan agencies and the public**
- **5- PPT Presentations**
- **2 -TV interviews-Ottawa water and Michigan bluff deterioration and stability**
- **1 Radio interview- Bluff stability**
- **AASG DC Liaison sessions, Spring and Fall 2019 representing State Geological Surveys**
- **28 Agency meetings**
- **40 Legislative staff mtgs**
- **19 days drilling, Cass Co**

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 doll ars for geologic mapping. This past year, the USGS mapping program awarded funding to map areas in the Lower Peninsula, (Cass County, Edwardsburg and Nile East 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 and subsurface thickness 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).

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 EGLE, completed a two-year review of water resource issues in the state in 2014. 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.

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 example, many of the 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.

Respectably submitted,
John A. Yellich

CC: MGS Website

Attachments:
Appendix I – MGS 2019 summary of meetings and presentations (53), plus AASG DC Liaison 28 Agency & 40 Legislative staff
Appendix II - MGS Summary of demonstration tasks, projects & publications 6-2016-December 31, 2019
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 2019 Michigan geology publications and presentations
Appendix IX – MGS Advisory Council members

Appendix I
2019 - Summary of meetings and presentations (4 pages)

Q1 2019 Summary of significant MGS meetings and presentations-Mapping, Projects, data - Special Appropriations

Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
16-Jan	Lansing, Constitution hall	1:00 to 4:00 PM	MDEQ- WRD, MDARD, SW Farmers, consultants	Technical Advisory Committee: Review data collection and modeling of the water withdrawals from SW Michigan, Cass and St. Joseph counties.	
18-Jan	Senate Office Bldg	2:30 to 3:30	Staff members for Senator Ruth Johnson	Discuss the geologic mapping in Michigan and what is the possible source for Arsenic in water in District. Also presented the case for minimal mapping in areas associated with known PFAS impacts.	
5-Feb	Firekeepers, Michigan Agg Assoc. annual mtg	12-2:00	Doug Needham, Executive Director of Michigan Aggregates Association (MAA).	Review MGS Calhoun county mapping results. Presenting multiple areas having aggregate potential. Prepare an outline of resulting aggregates that may be available after home construction, environmental restrictions and easements have been applied, what is left.	MGS prepared a summary document of results.
6-Feb	Firekeepers, Michigan Agg Assoc. annual mtg	8-5:00	MGS presentation at MAA annual meeting, Poster session after presentation	"Kicking the geology can down the road" Then an open discussion with attendees about need for mapping aggregates in critical areas of Michigan.	
22-Feb	Grand Rapids, Marriott, MGWA Annual mtg	8-5:00	Presentation to membership on the need for quality data by drillers into Wellogic system.	Discussed the fact training of new and existing drillers on the merits of quality data to the Wellogic program is needed by all drillers. Update on mapping and support from MGWA for funding.	
25 Feb to 28 Feb	Washington DC	4 days	Meetings with DOI, USGS, DOE, NGWA, BOEM, AGI, NAS	American Association of State Geologists (AASG) spring Liaison meetings with Federal agencies and selective meetings with congressional staff to review the benefits of mapping in their respective states. 21 Agency, 18 Legislator	
Feb-29	Alma, Michigan	8- 5:00	Michigan Academy of Sciences Annual meeting	MGS presentation of lack of mapping data to meet societal objectives.	
8-Mar	Kalamazoo, Mich	8-5:00	Kalamazoo, Van Buren, St. Joseph County staff, Local Health staff, water well drillers, DEQ WRD state regulators	Presentation to ~ 50 attendees, "Kicking the geology can down the road".	
15-Mar	Augusta, Michigan	12-2:00	Steve Allen, consultant and Jon Scott, owner of Stoatin Golf Course.	Discuss presenting a summary of the geologic features along the Kalamazoo River, that can be seen from the club house deck. MGS will outline a plan, present a Hillshade summary of LiDAR images.	
26-Mar	Ottawa County offices	10-12:00	Joe Bush, Ottawa county drain commissioner	Discuss recharging shallow groundwater, stormwater discharges and reuse of stormwater for irrigation.	
27-Mar	Ottawa County offices	9:00-12:00	Groundwater Executive committee	Review strategy(s) for presenting conservation plans and action items to be considered	**1- MI legislative staff 8- Meetings 2- PPT AASG DC Liaison 21 Agency 18 Legislative staff**

Q2 2019 Summary of significant MGS meetings and presentations-Mapping, Projects, data - Special Appropriations					
Date(s)	**Location**	**Time/ Duration**	**Contact(s)**	**0**	**Notes**
11-Apr	Lansing, Constitution hall	10:00 to 3:00		Retirement function for Hal Fitch, State Geologist; Met with EGLE Director Liesl Eichler Clark , Erin McDonnaugh-MOGS, Doug Needham- MI Aggregate Assoc.; Short presentation by MGS commending Mr. Fitch for his 27 years of service to Michigan.	
April 17 - 18	PTTC Traverse City	Wednesday & Thursday	Petroleum Technology Transfer Conference (PTTC) MGRRE/MGS - 20 + years MOGA, Mi energy industry	Discuss funding for MGS and need for support from industry, booth at open vendor exhibits	
April 22-25	Denver, Co, Federal Center	4 days paid by USGS	USGS	Review State proposals for funding by USGS, National Geologic and Geophysical Data Preservation Program (NGGDPP)	
26-Apr	Denver, Co; Federal Center	Full day	USGS, Chuck Blome, FEDMAP Project Mgr, Paul Bedrosian; Berke Minsley;	Review USGS FEDMAP project, Michigan and Great Lakes states project, bluff stability, mapping & geophysical data collaboration and funding by GLGMC.	
3-May	Lansing, Constitution hall	9:30 to 12	Matt Gamble, Anita Ladouceur; Mike Sweat, John Esch- EGLE managers and staff	EGLE Proposal discussion: Review Wellogic data entry (5300 well logs 2017-18), plus 700,000 scanned logs not in Wellogic, correct locations of Wellogic well locations	
17-May	Conference call	9-10:30	USGS Director, Dr. James Reilley and 10 USGS Mission directors & AASG officers	Monthly conference call with USGS Director and Mission directors, role of state geological surveys in mapping and data compilation for US	
18-May	Portage, MI Water treatment plant	Saturday, 9-12	Larry Shaffer-Portage City Manager, Pat Randall-Mayor	Discuss Portage water issues as a panel with Kazo County, City and EGLE representatives for Portage Public television.	
22-May	Lansing - MDOT	1- 4:00	Richard Endres, Chris Johnecheck; Steve Kahl	Dr. Upul Attanayaka, WMU Eng Dpt & JAY, MGS review geology of Michigan and Geo-Hazards to expect during MDOT construction	
23-May	Ottawa County offices	8:00 to 10	Joe Bush, Ottawa county drain commissioner	Review areas of Ottawa Co for possible infiltration of surface water to shallow sand/gravel systems.	
23-May	Ottawa County offices	10:00 to 12	Al Vandenburg, Paul Sachs and staff	Review the Ottawa Co water strategy for promotion and advertising to present how and why shortages and Cl in water.	
29-May	Kalamazoo, Mich		Submit Earth MRI proposal	MGS and MTU collaborative Earth MRI proposal, surficial geologic mapping for rare earth elements in Dickinson Co, $100,000.	
May 29-30	Escanaba, Hannaville Tribal Hdqtrs	Wed night, Thursday mtg	Aaran Payment, Sault Ste Marie-United Tribes Chair; Ken Meshigaud, Hannaville; Jamie Stuck, Nottawaseppi; Frank Ettawageshik, UTM Executive Dir.	United Tribes of Michigan (UTM) support geologic mapping for identification and protection of water resources. United Tribes, Meeting review of tribal issues in MI including mining proposal, Back Forty. MGS presentation of need for science to study mining, water and PFAS.	**12 - meetings** **1 - PPT**

Q3 2019 Summary of significant MGS meetings and presentations-Mapping, Projects, data - Special Appropriations

Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
3-Jun	Hudsonville	9-11 am	Ottawa Co Al Vandenburg and Senator Roger Victory	Review MGS support for Ottawa Co water and the need for funding for MGS, currently funding in Senate budget.	
Jun 8-15	Butte MT	5 days	AASG Annual meeting of State Geologists (35 present)	Yellich VP of AASG and organized all the prof breakout sessions/speakers, Mtg times and open sessions Water, PFAS, Critical Minerals, Infrastructure, Wildfire, Geohazards, Mapping priorities,	
17-Jun	Ann Arbor	10-1 PM	Pat Crowley-Kazo Drn Comm; Kendra - Portage stormwater mgr; Brandon Wong, Branko Kurkee, UofM	Surface water monitoring of stormwater systems with realtime data.	
Jun 18 - 28	Cass Co Drlg	9 days	Core drilling three holes	Twin Lakes and Adamsville quads, three core holes drilled and sampled for STATEMAP and GLGMC program, Cass Co	
July 8 to 12	St. Joseph, Miami Park South, Pentwater	4 days	UGSS, MGS and WMU Students, Richard Becker	Drone research assessment St. Joseph, Miami Park South, Pentwater, initial drone flight for research project	Drilling 10 days
16-Jul	Ottawa County offices	2.5 hours 9:00 - 11:30	Al Vandenburg, Paul Sachs and staff	Ottawa Co Water Excutive committee, draft County water plan.	
19-Jul	County Road Association Lansing	2 hours 1:00 to 3:00	Ed Noyala, Deputy Director	Discuss aggregates and 2016 Report. Where are the aggregates and need to map their locations	
22-Jul	Constitution hall WUAC mtg	3 hours 2:00-5:00	Members	Review old WUAC notes and recommend re-establishing the policy groups. MGS noted there needs to be science I the recommendations	
29-Jul	Allegan Co Commissioner mtg	2 hours 5:00 - 7:00	Allegan Co, Commissioners, water issues	D. Zach Carter, MSU chloride study. MGS presented geology section, also, Allegan is not the same as Ottawa Co.	
2-Aug	Conference call	2-3:00 pm	Dr. Jame Reilly, Kevin	Monthly conference call with USGS Director and Mission	
5-Aug	MGRRE	9-12:00	Anita Ladoucer, WRD Wellogic training	Training program for MGS staff/students at MGRRE. Wellogic and scanned well logs	
7-Aug	GVSU-Allendale	11;00 - 5:00	Paul Center, GVSU, public television,	Interview on Ottawa Co geology, conservation, local housing area and farmers fields	
10-Aug	South Haven	8:00 to 5;00	Doug Nickerson, bluff failure	Miami Park south, bluff failure, taking pictures and going to Beethoven, south of Miami park, Jody Brott	
3-Sep	Lansing, mtg	3:00 - 4:30	Adam Wygant, Sarah Howes meeting at Rep Jack Omalley offices, aggregate resources	Discuss what Michigan does not know about aggregates.	
Sept 9-12	DC, Meeting with Congressional staff	Tues to Thursday	AASG Fall Liaison mtgs Cosmos club, DC	7 agency meetings, 22 congressional staff meetings	
17-Sep	Lansing - MDOT	staff	meetings with staff, Mike Fredericks		
18-Sep	Lansing	Staff	Discuss mapping and budgets		
19-Sep	Lansing	Staff	Discuss mapping and budgets		
22 Sep to 26	Phoenix	GSA national mtg	Meet with geologists from across US	Attend presentations and talk with USGS. AASG mid year meeting.	
26-Sep	Conf call	8:00 to 9:00	Mark Cascarrelli, Public Sector Consultants	Discuss MICHIGAN aggregates and 2016 Report. Presented AZ legislation on mapping by survey. Where are the aggregates and need to map their locations in MI. **He did not know anything about aggregates.**	**2 - MI Leg Staff-Rep Omalley & Roger Victory 1- TV Ottawa Co water AASG Ann Mtg AASG Liason mtgs 7 Agency 22 - Legislative staff 14 - Meetings 19 - Drilling days**

Q4 2019 Summary of significant MGS meetings and presentations-Mapping, Projects, data - Special Appropriations					
Date(s)	Location	Time/ Duration	Contact(s)	Discussion topics	Notes
7-Oct	Ottawa County	9-4:00 PM PBS-GVSU TV	PBS video on water conservation	Video and discussion of conservation in populated areas, Allendale area.	
8-Oct	Ottawa County	9-11:00 am	Executive Water	Executive Committee review water strategy and subsequent meetings with Joe Bush, Drain Commissioner	
10-Oct	Allegan Co Commissioner mtg	1:00-3:00	Commissioner meeting,	Presentation of need to understand water demands, growth projections needed to know where to look for water potential. MSU presentation to do survey using faulty data.	
15-Oct	Senate /Com hrg Lansing,	11-3:00	Senate Comm SB 403 Outman, Brinks, Ananich	Senate B 403, MGS presentation of mapping needs for Michigan, $1.3 M/ county, 15-20 counties. $3.0M/yr	
17-Oct	MTU - Conf Call	2-4;00 PM	Jim DeGraff	EDMAP discussion of results of Keweenaw peninsula mapping program.	
24-Oct	WKZO Radio interview	6:30 AM 15 min	Tony Cuthbert, interview	Discuss bluff failures and MGS research program.	
25-Oct	Ottawa County Water Exc Committee	9-11:00	Al Vandenburg, Paul Sachs and staff	Review water and recharge program.	
29-Oct	MGWA-Sebastiens Drilling office	12:-3:00	Everett, Feenstra, Frederick, Laura Campbell	Discuss future of Aason Miller legislation being accepted by WRD and USGS, Reeves.	
30-Oct	Lansing	1:00-1:30	Review Rep KahleHB 4745	Meeting with Frederick, future of HB 4745	
7-Nov	Lansing, Conf Call	9-11:00	Review WUA, WWAT modeling	WUAC Modeling sub committee, review modeling needs.	
12-Nov	Conf Call	10-11:00	STATEMAP Advisry committee	Review STATEMAP proposal and vote on proposal, Ottawa and Allegan Co mapping for two year program.	
21-Nov	Ottawa County Water Forum	8:30-4:30	80 Ottawa, Allegan Muskegon Co staff and Commissioners	MGS presenting need for mapping and bluff research drone photos, requesting MGS funding.	
25-Nov	WUAC-New Topics, conf Call	9-11:00	WUAC New Topics Committee	Review high priority topics needing funding and direction	
5-Dec	EGLE WRD Lansing	9-12:00	WRD, Matt Gamble, Anita Ladauceur, Mike Sweat, John Esch, Gage,	Review Wellogic location validation, paper log inputs, QA/QC of data entry	
10-Dec	WUAC Modeling committee Conf Call	10-12:00	Dave Hamilton, others	Review data for modeling and discussion of Hydrologic Framework proposal, not recommended by MGS	
12-Dec	Allegan Co Commissioner mtg	9-1:00	Commissioners review MSU and MGS proposals	MGS PPT, Allegan no ArcGIS staff, need others to do data, this is the wrong proposal, MSU, non-validated logs.	
17-Dec	Man Assoc Mining committee	9-12:00	MMA attendees,	MGS PPT, presenting need for mapping and bluff research drone photos, requesting MGS funding.	
23-Dec	Lansing	10-12:00	Dave Hamilton, MGS	Review Hydrostragraphic framework and the limitations of Wellogic data, bedrock data and need for validated info.	
30-Dec	Conf call	10-12:00	Ottawa Co proposal for reuse of water	Call with driller (Hecksel) and consultant to discuss agriculture program, water reuse.	**Q4- Summary** **1- MI Legislative- Sen Outman PPT** **1 - Kahle staff** **14 - meetings** **4-PPT** **==========** **2019 Annual Sum:** **5 - MI legislators** **48- Meetings** **5- PPT Presentations** **2 -TV interviews-Ottawa water and bluffs** **1 Radio- Bluff stability** **AASG DC Liaison** **28 Agency** **40 Legislative staff mtgs** **19 days drilling Cass Co**

Appendix II

Michigan Geological Survey
MGS demonstrations, publications & ongoing & completed projects and tasks
Examples of proposed Michigan functions providing scientific data from a funded Survey.
July 1, 2016 to December 31, 2019

SOCIETAL TASKS INITIATED & COMPLETED	SCIENTIFIC RESULTS	BENEFITS OR BENEFICIARY
PFAS Data Triage – Geologic & hydrogeologic data compilation for identified locations having a PFAS impact. EGLE/MPART presents location!	EGLE requested MGS compile 59+ locations (2-5 mi radius) 6-27-18 to 12-31-22. Surface & groundwater flow directions, nearest receptors, bedrock depth/type, basic glacial subsurface geology.	Basic geologic setting and data to assist sampling and interpretation of groundwater flow and 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, a demonstration.	Confirmed bedrock valley > 50 feet deeper than current water production, potential additional water resources. Bedrock valley is over 1 mile wide and more than 5 miles long,	**Ms. Patricia Randall- Mayor.** Confirmed potential additional water resources for the Cities of Portage & Kalamazoo for 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. **Prof. Public February 2020, Remote Sensing**	Modeling can monitor changes in water storage over 15 year period throughout the state. **MDARD** has expressed interest. Modeling has shown changes to increased water levels in the two demonstration areas and the rest of the LP.
Drill hole data validation in Wellogic **560,000** validation of water well locations in database **700,000** Scanned well logs, 1968 to 2003 to be Input **5300** paper logs 2017-2018 input **Triage Grant to 12-31-22, $125,401**	7/2019 Wellogic water well locations have never been validated for location (X-Y). Many can be in another section, township or county. This is the ONLY subsurface database at this time and regrettably this is being used to manage MI water use and compliance with the Great Lakes compact. This data represents water levels at the time of water well completion	Upon completing each county, MGS will prepare a county water well data summary to determine groundwater flow directions in a standard format for EGLE and public use to support tracking water contamination. **MPART- 47 county priority list, WRD 13 County priority list.**
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? **Al Vandenberg**, County Planner	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). **PBS TV groundwater Video, October 2019**	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. How can water users make better use of surface waters, MGS Is proposing a demonstration program with the agricultural community.
Mapping of bedrock valleys, glacial features 10's to hundreds of feet below the surface. **A Proof of Concept, utilizing oil industry seismic geophysical methods to map water bearing zones and Tromino data. 800+ feet LP**	MGS received a grant from the Groundwater Research Education Foundation (GWREF) as a **Proof of Concept** to assess geophysical methods to map buried bedrock valleys, a source of additional water resources beneath existing water bearing zones.	This mapping presents the case where Michigan needs to protect the water resources from potential contaminants, also to assess if these zones have been impacted by contaminants.
Shoreline bluff failures Vast areas of Michigan coastlines are deteriorating and slumping into the lakes as a	MGS has proposed a joint study with the USGS to assess initially three areas of bluff geologic structure and settings, City of St. Joseph, Miami Park South (North of South	Using remote sensing techniques (Interferometry, 3D photography, LiDAR, Drone surveys with infra red sensing), determine the responses of slope failures in various geologic, weather periods and

Michigan Geological Survey
MGS demonstrations, publications & ongoing & completed projects and tasks
Examples of proposed Michigan functions providing scientific data from a funded Survey.
July 1, 2016 to December 31, 2019

result of high water and anthropogenic impacts	Haven)- rural weekend rentals and Pentwater- Consumers water storage electrical – no houses.	water levels in real time. **Allegan Co Emergency Response, MSP, County Comm meetings & presentations**
Geo-Hazards summary – MDOT Geo technical manual – Geology section May 2019 WMU Engineering Department Collaboration	Geo hazards are associated with Michigan geology and it's associated characteristics and physical changes and may include: Organic rich soils, Peat and muck/wetlands, bluffs, methane-natural gas pockets, clay deposits, karst-sinkholes, historic mining areas, artesian water systems.	Knowledge of the geology or where these hazards may develop can reduce the potential for death, injury or costly structural natural disasters that can be effectively remedied or avoided.
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 3+ years	MGS published five Surficial geologic maps, Jones, Vandalia, Mottville, Decatur, Marcellus, Adamsville, Sumnerville quads (~55 sq mi/quad), February, September & December 2017 & three Dowagiac& Sumnerville & Sister Lakes in 9 &12/2019. 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.	EGLE-WRD, MDARD, farmers and consultants are compiling a Cass-St. Joseph groundwater model. Using validated MGS geologic data in 3D to assist in WWAT applications. All users benefit from total mapping to bedrock which presents the true, greater thickness of favorable sands/gravels and the identification of bedrock valleys having concentrated areas for potential water resources, 100-250 below known existing water bearing zones.
Michigan Aggregates, How much IS available? The proposed example for aggregate resource availability, this is an un-graded resource. February 2019	MGS mapped Calhoun Co. in 2015 and this presents the potential geologic aggregate resources. This analysis projects setbacks, societal and natural restrictions and how much resource is now removed and unavailable.	**Summary for MI Aggregate Association:** Qualified resource: Potential ~147 sq. mi of minus ~81 sq. mi restricted = ~ 66 sq. mi (~45%) of ungraded potential resource available
USGS Airborne Geophysical data- UP Earth MRI, surface and bedrock mapping USGS, MGS, MTU collaboration.	Demonstration project by USGS to compile the surface and bedrock geology using airborne geophysics, LiDAR and geologic field verification, to quantify the bedrock geology in the UP. **(USGS Earth MRI $100,000 grant awarded - mapping demonstration- December 2019-21)**	MGS in collaboration with USGS Geophysical Research team and Michigan Tech University will map an area around Iron Mountain to validate the geology and geophysical data. Establish protocols and methods to expedite future bedrock mapping to define the geology.
United Tribes of Michigan – Resolution supporting budget for geologic mapping to assess and protect the water resources of Michigan	Sovereign tribes of Michigan unanimously supported a resolution to the Governor (Feb 2018) for annual funding for the MGS to assess the water resources of Michigan.	Geologic mapping in priority areas of high growth, known contamination or high water use, to better understand the location and protection of the water resources, which supports all well water resources.
Natural Gas Storage: Michigan is ranked #1 nationally in natural gas storage facilities. A funded geologic/core repository is required.	Current and new gas storage facilities are in need of upgrade and expansion. Mapping and 3D geology of gas storage zones using MGS/MGRRE core/data is required.	Additional research in gas storage is ongoing at MGS/MGRRE core repository, to support the natural gas industry.

Appendix III

United Tribes of Michigan
5453 Hughston Rd, Harbor Springs, Michigan 49740
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

2019, MGS,MGRRE and faculty new and continuing grants for a combined total of $$1,709,899 for 2019 until December 31, 2022.

MGS & MGRRE Current External Grant Funding

2019-2020. Yellich, John A., PI, Kehew, A. CoPI; Surficial Geologic mapping Cass County and Bedrock Geologic Mapping Jackson County. USGS/STATEMAP. $76,239.

2019-2020. Yellich, John A., PI. GLGMC #1 Geologic mapping Edwardsburg Cass Co & #2 FEDMAP Collaboration, shoreline studies. USGS/Great Lake Geologic Mapping Coalition. $89,835.

2019-2021. Yellich, John A., PI. and Michigan Technological University, Co-PI. Earth MRI-Geologic mapping with Aeromagnetic data. Upper Peninsula Precambrian bedrock Dickinson County., MI. USGS/NCGMP. $99,908.

2018-2022. Yellich, John A., PI. Triage-DEQ data compilation & Wellogic data base input and Validation. MDEQ/EGLE. $925,401.

2018-2021. Yellich, John A., PI. Special Appropriations. Mapping, projects, and data. MDEQ. $500,000.

2019-2021 Harrison, William B., PI. Preservation of unique drill cuttings and assembling geologic data for critical minerals. USGS/National Geological and Geophysical Data Presentation Program. $83,693.

2020-2021. Harrison, William B., PI. Preserving paper well records and thin sections by converting them to digital format and mapping the depth to bedrock in Michigan's Upper Peninsula. USGS/National Geological and Geophysical Data Presentation Program. $76,903.

2020-2021. Harrison, William B., PI. Regional Initiative to Accelerate Carbon Capture Utilization and Storage (CCUS) Development. USDOE/Battelle Memorial Institute. $61,279.

2020-2022. Harrison, William B., PI. Chemically Enabled CO2-EOR in Multi-Porosity, Hydrothermally Altered Carbonates in the Southern Michigan Basin. USDOE/Battelle Memorial Institute. $94,147.

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 expecded.

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**.

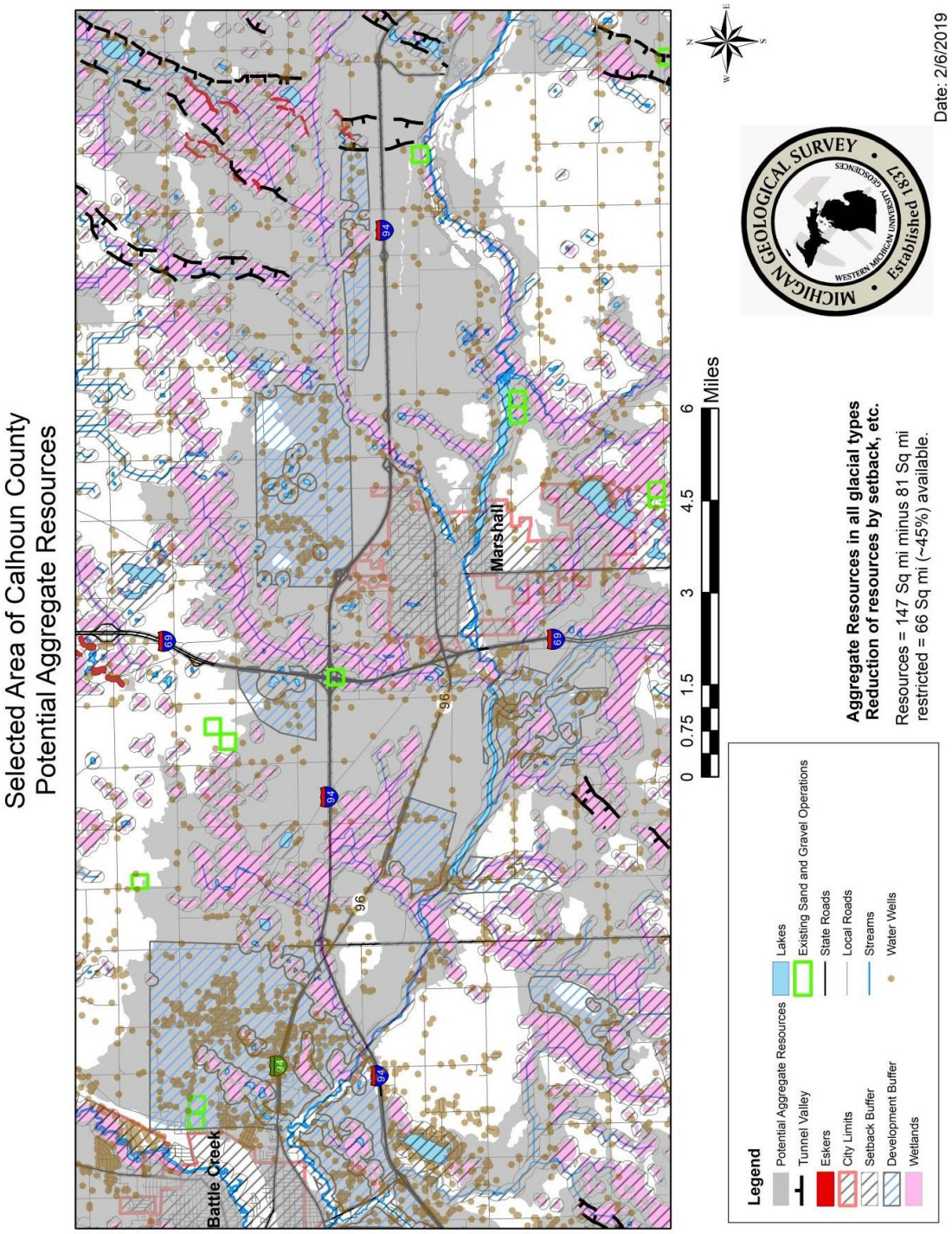
Yellich, J. A.; MDOT, Joint proposal with WMU- Engineering Excellence, Michigan Geology, a summary for the new MDOT Geotechnical manual. To include areas of geologic importance for construction and hazards. September 30, 2018 to December 31, 2019. **$23,143**.

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

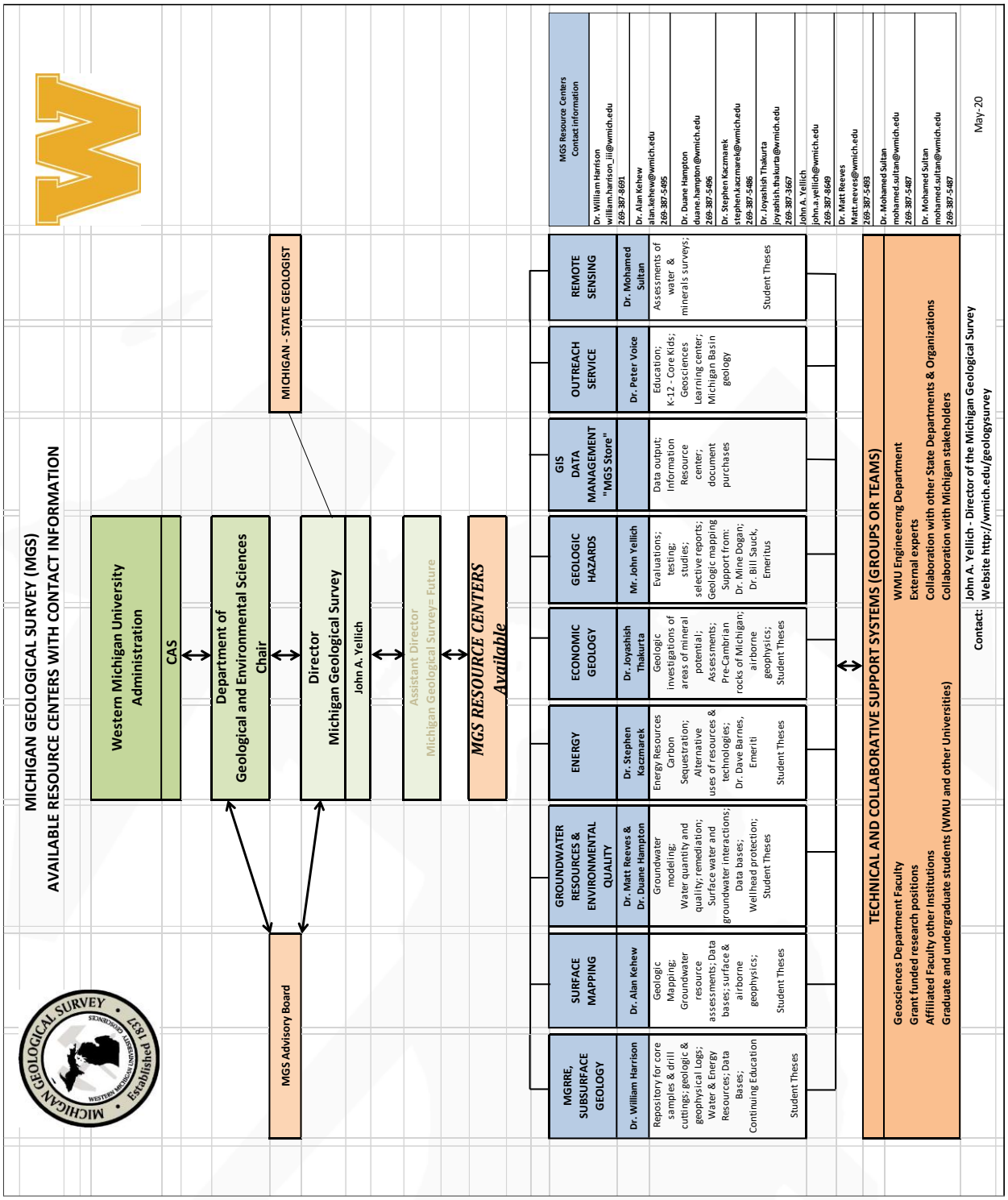
Yellich, J. A.; Kehew, A. E. USGS-GLGMC - Surficial Geologic Mapping Cass County, Michigan; Twin Lakes and continuation of county map compilations with adjoining Van Buren, St. Joseph and Berrien counties **$68,800.**

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
Date: 2/6/2019

Appendix VI


MICHIGAN GEOLOGICAL SURVEY (MGS)
AVAILABLE RESOURCE CENTERS WITH CONTACT INFORMATION
Western Michigan University Administration
CAS
Department of Geological and Environmental Sciences Chair
Director Michigan Geological Survey
John A. Yellich
Assistant Director Michigan Geological Survey= Future
MGS RESOURCE CENTERS Available
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
Dr. William Harrison
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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)
WMU Engineeemg Department
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
May-20

Appendix VII
Michigan Geological Survey, MGRRE, WMU Geosciences Michigan
Funded Professional Publications Summary Report for 2019

USGS Surficial and Bedrock Maps produced and published with matching Federal funds in 2019:

Kehew, A.E., Esch, J.M., **Yellich, J.A.**; Surficial Geologic Mapping: Adamsville 7.5 Minute Quadrangle, Cass County, Michigan Surficial Geologic Map Series SGM-19-01, Scale 1:24,000.

Westjohn, D. M.; Harrison, W. III, Voice, P. J.; Bedrock Geologic Mapping, Jackson County, Michigan: Bedrock Geologic Map of Quadrangles, Wayne County, Michigan. Bedrock Geologic Map Series BGM-19-01 Scale 1:100,000

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

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Appendix IX

Michigan Geological Survey, Advisory Council

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