Go With the Flow:

Public Health Wastewater Monitoring in Michigan

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Executive Summary

(For videos of keynotes and panel discussions as well as other resources go to:
Go With The Flow: Public Health Wastewater Monitoring in Michigan | Office of Research and Innovation (msu.edu)**)**

The Michigan Network for Environmental Health & Technology (MiNet), a statewide network of laboratories, was established to use advanced PCR-based methods to assess recreational water quality, identify sources of fecal contamination in surface water, and early on in the COVID-19 pandemic, monitor SARS-CoV-2 in wastewater. MiNet established essential partnerships with local public health departments and utilities and has built a large and growing knowledge base, thus contributing to not only state but national disease monitoring efforts through wastewater surveillance.

The *Go with the Flow Conference* (May 17-18, 2023) was designed to bring together a variety of stakeholders involved in public health wastewater monitoring in Michigan for collaboration and networking. The goals of the conference were to share lessons learned, examples and best practices of wastewater-based monitoring for a variety of current and emerging targets, discuss advances and developments in the laboratory testing and applications of wastewater data, and highlight community connections and relationships necessary for successful monitoring efforts.

One hundred and fifty-eight (158) people attended the Go with the Flow Conference. Laboratories made up the majority (59%) of participants, followed by the local health departments (including those that operated laboratories, 29%) followed by utilities (5%). The "other" category included government agencies such as CDC, EGLE, and NIST, as well as the private sector.

Academia and students (32) made up a large majority of participants. Fifty-three posters were presented, of which 25 were prepared by students.

Senator Peters opened the conference via a taped video thanking the Michigan network for the work they have done. He particularly mentioned how MiNet has revolutionized wastewater monitoring and has built a broad coalition of public health and policy experts, business, and industry leaders. He concluded his remarks by addressing how innovative solutions were used here in Michigan, which will lead the nation in protecting public health and in fact are being extended to the protection of the Great Lakes.

Dr. Medema, the keynote speaker from the Netherlands, presented the work done on wastewater surveillance in the Netherlands, Europe and globally and particularly emphasized that:

- *Developing a vital, relevant, and sustainable wastewater monitoring program will benefit the water industry by increasing the monitoring infrastructure and knowledge of water quality. This will add value to the health sector at the local and national levels, presenting opportunities to strengthen disease monitoring programs. Finally, the private sector will be able to provide innovative and advanced technologies (new quantitative and multitarget platforms).*

The participants at the *Go with the Flow Conference* collectively found that there were four key lessons learned regarding the establishment of MiNet and the SARS-CoV-2 monitoring program.

Funding—Accessibility and building a sampling infrastructure for utilities, improving laboratory capacity for surveillance of emerging pathogens, and addressing prevention as well as responses, were critical for a robust network and maintaining collaborations for protecting public health.

Technical—Standardization was a key technical issue and meant creating common frameworks approaches for the complete data and results information chain, (from collection to reporting results).

Workforce—The training of new personnel to work at utilities, laboratories, and local health departments is a common concern. It has been learned that different ranges of skill sets are needed to conduct wastewater monitoring. MiNET has provided the perfect opening for institutions of higher education to support this need to promote work with laboratories, wastewater facilities, and public health by making students more aware of these opportunities.

Communication—Enhanced communication with the public and building trust are keys to validating data and using monitoring to serve public health. This means going beyond a dashboard to storytelling, addressing scientific results in real-time and developing public-focused educational tools that communicate what to do with information and data.

Key recommendations for the future for MiNET and environmental monitoring focused on five actionable efforts.

Building a stronger network- A strong network can be achieved by creating a more diverse program that is inclusive of more members with new, defined goals. One of the key areas to be addressed will be the further building of a sense of unity and participation toward a common purpose. To accomplish this, there needs to be a greater effort in communication internally within MiNet and externally to decision makers and the public. The network should be expanded and include a designated wastewater monitoring employee at the plants/utilities and a position for public health communication. There should also be programs that allow individuals to shadow the experts in utilities and in other laboratories to enhance the exchange of knowledge. The expansion of testing is also warranted. Expanding methods and surveillance to not only wastewater but also to other areas of public interest such as watersheds, drinking water, or stormwater, and could include livestock and wildlife health.

Using and testing innovative technologies- The network should look to the future and develop a roadmap for investment in research and development, balancing scientific advances and research within the monitoring program. One goal will be to have Michigan become a testbed for new instrumentation and new kits for an array of new targets, while also using more automation along the sampling and analysis data chain. This would include a focus on rapid sequencing. In addition, this will lead the way for new models that examine for example how gene copies can be turned into case counts and how to further understand pathogen shedding. The network could become a leader in geospatial intelligence and build the water metagenome for the State of Michigan.

Supporting the needs of wastewater facilities- Participation from more utilities is greatly desirable for the health of the network. Michigan can lead the U.S. in ensuring all wastewater facilities are on a pathway to becoming a *Utility of the Future.* Managing wastewater, combined sewer overflows, and septage (from septic tanks) will be changing as the state develops a Sanitary Code. Monitoring will be essential and likely mandatory for new emerging biologicals and chemicals (pathogens, microplastics, PFAS, sucralose, personal care products, pharmaceuticals, cortisol and other “stress” indicators, etc.). There will be a need

for advancements in treatment technology to improve effluent water quality. More automation, instrumentation, and mapping will all be needed. As mentioned above, new positions should include a designated wastewater monitoring employee at the plants/utilities; this would improve data accessibility, interpretation, and communication. If future growth of the network supports the needs of utility partners, it will lead the way for the modernization of utilities.

Educating and developing leadership- There is no doubt that there is a human resource crisis for a variety of disciplines, and the water and public health professions are beginning to face such a predicament. More water scientists, engineers, operators, laboratory technicians, analysts, epidemiologists, environmental health experts, and health-related microbiologists are needed. For the academic institutions that are a part of the network, clearly integrating wastewater monitoring into the classroom and course work should be a key goal. Some ideas that could be implemented include:

- Creating a for-credit laboratory course focused on methods used for surveillance
- Developing a summer workshop for community schools/high schoolers interested in STEM
- Producing an on-the-job training program for exposure to wastewater treatment plants and monitoring laboratories
- Developing a virtual module to share knowledge

Communicating with the public and decision makers- A broad communication program is needed to translate the science and ultimately result in improved public health policy. Audiences include decision makers, partners, and the public. It may be appropriate at some point to develop legislation to protect individual privacy and to define the purpose of wastewater monitoring. Perhaps a state-wide council for wastewater monitoring is needed.

App developers could explore if something similar to a weather app that shows ozone indicators, seasonal allergy risks, etc., could provide more immediate access to wastewater surveillance information in real time. There could be development of an adaptive dashboard for different clients (school, state, etc.). Finally, the network could lead the way in developing a standardized ethics program, including equitable and fair coverage for testing, as well as protecting the use of the data. All of these efforts need to be better communicated to decision makers.

In conclusion, the intellectual capacity, resources, energy, and dedication of MiNET are impressive. The partnerships among wastewater utilities, laboratories, health departments, and community leaders have propelled environmental and wastewater monitoring forward into the future. The efforts have already produced important impacts protecting public health of Michiganders.

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1.0 Introduction

1.1 Workshop Goals

The World Health Organization (WHO) declared COVID-19 a pandemic in March 2020 based on the rapid spread and prevalence of SARS-CoV-2. The first patient in the United States was diagnosed with SARS-CoV-2 virus in the state of Washington and confirmed by the U.S. Centers for Disease Control and Prevention on January 20, 2020. By February 28, 2020, Governor Gretchen Whitmer of Michigan announced that the state would activate its emergency operations center to prepare for potential coronavirus cases. On March 10, 2020, Michigan confirmed its first two COVID-19 cases. Governor Whitmer declared a state of emergency in response to the first cases.

The Michigan qPCR Network Laboratories (a consortium of university, county, and private laboratories using advanced technologies for monitoring beaches) mobilized rapidly, partnering with the Michigan Department of Health and Human Services (MDHHS) and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and organizing a pilot study for monitoring the SARS-CoV-2 virus in wastewater. This $10 million pilot study implemented a standard ddPCR method for the network throughout the state. Thus MiNet, *The Michigan Network for Environmental Health & Technology*, a statewide network of laboratories that uses advanced PCR-based methods to assess recreational water quality, identify sources of fecal contamination in surface water, and monitor SARS-CoV-2 in wastewater, was established.

As the virus spread around the world, surveillance, prevention, and treatment methods arose as key needs to protect public health. Wastewater-based monitoring emerged as one tool for monitoring and assessing community spread of SARS-CoV-2. In early 2020, Dr. Gertjan Medema from the Netherlands led the implementation of the first application of wastewater monitoring, targeting nucleocapsid genes N1, N2, N3, and an envelope gene E of the SARS-CoV-2 virus.

The State of Michigan and MiNet then led the way to a robust system that created partnerships with local public health units and wastewater utilities. Now entering the fourth year after the first cases of COVID-19 were found in the U.S., Michigan's statewide network for monitoring SARS-CoV-2 in wastewater has built a large and growing knowledge base and contributes to national monitoring efforts.

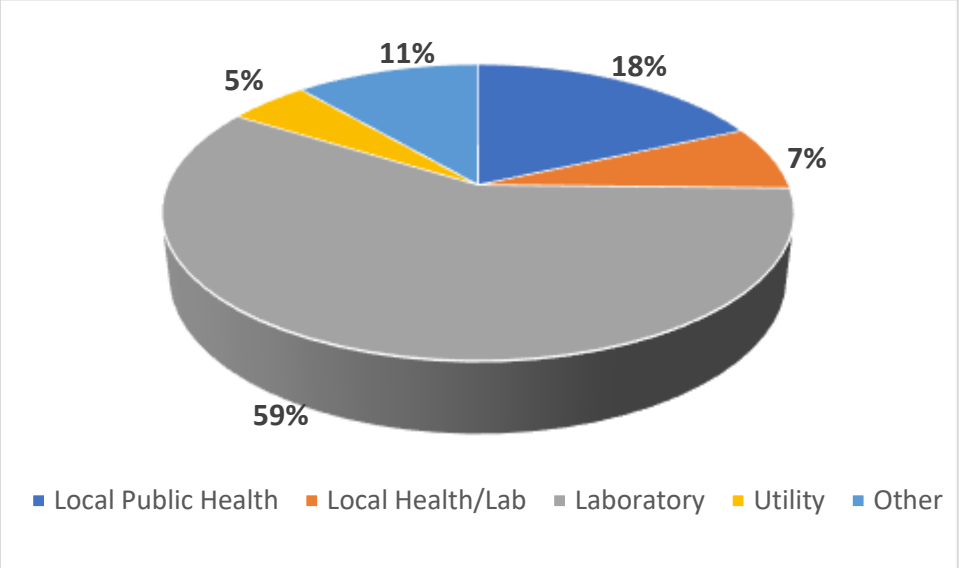
The *Go with the Flow Conference* was designed to bring together a variety of stakeholders involved in public health wastewater monitoring in Michigan for collaboration and networking. The goals of the conference were to share examples and best practices of wastewater-based monitoring for a variety of current and emerging targets, discuss advances and developments in the laboratory testing and applications of wastewater data, and highlight community connections and relationships necessary for successful monitoring efforts. Discussion of existing challenges for SARS-CoV-2 monitoring and considerations for future monitoring efforts were also discussed, and results were summarized for use for public health action. This report captures the knowledge of MiNet, as well as the outcomes and lessons learned surrounding wastewater monitoring. Finally, the goals for the future of advanced environmental testing to support public health for the State of Michigan were defined.

1.2 Demographics of Participant Affiliations

One hundred and fifty-eight people attended the Go with the Flow Conference. Figure 1 shows the sector affiliations of those who participated. Laboratories made up the majority (59%) of participants, followed by the local health departments (including those that operated laboratories, 29%) followed by utilities (5%). The "other" category included government agencies such as CDC, EGLE, and NIST, as well as the private sector.

Academia and students (32) made up a large majority of participants. Fifty-three posters were presented, of which 25 were prepared by students.

Figure 1: Participant Sectors Attending the *Michigan Go with the Flow Conference.*



2.0 Value of Wastewater Surveillance and Need for Partnerships

2.1 Opening remarks from Senator Gary Peters

Senator Peters opened the conference via a taped video thanking the Michigan network for the work they have done. He particularly mentioned how MiNet has revolutionized wastewater monitoring and has built a broad coalition of public health and policy experts, business, and industry leaders. He concluded his remarks by addressing how innovative solutions were used here in Michigan, which will lead the nation in protecting public health and in fact are being extended to the protection of the Great Lakes.

2.2 Dr. Gertjan Medema - Wastewater Gone Viral

Dr. Gertjan Medema (from KWR and Deft University of Technology in the Netherlands) provided a keynote presentation. He was the first to demonstrate that wastewater monitoring for SARS-CoV-2 could be used to monitor disease in the community early in 2020. He developed and shared key methods and lessons learned. Some of the recognized benefits of monitoring were early warning signs of increasing transmission, tracking spread throughout communities, and detecting variant emergences. He reported on how wastewater monitoring has proven useful for studying poliovirus worldwide and hepatitis A virus outbreaks in schools. Dr. Medema highlighted the need for the water and health sectors to come together. The water sector has wide experience in collecting water samples and analyzing these for a wide range of contaminants. Thus, they are the ones working with the laboratories that will be producing the data. However, it is the health sector that needs the data and needs to learn how to interpret the data for community health and public health action.

- **Developing a vital, relevant, and sustainable wastewater monitoring program will benefit the water industry by increasing the monitoring infrastructure and knowledge of water quality. This will add value to the health sector at the local and national levels, presenting opportunities to strengthen disease monitoring programs. Finally, the private sector will be able to provide innovative and advanced technologies (new quantitative and multitarget platforms).**

2.3 Lessons Learned and Best Practices

MiNet first started wastewater monitoring through the pilot study in the summer of 2020, which then transitioned into the SARS-CoV-2 Epidemiology – Wastewater Evaluation and Reporting (SEWER) Network program. The SEWER Network, coordinated and funded through MDHHS, utilizes MiNet laboratories to support 19 locally-based wastewater monitoring projects across Michigan. The Network quickly developed monitoring strategies, methods, training, and began reporting to MDHHS, EGLE, and CDC. Based on these past experiences, the goal of the discussion was to share the lessons learned and discuss best practices.

The participants were divided into three groups based on their expertise and/or interest: 1) collection and testing methods, 2) broadening wastewater utility roles and engagement, and 3) interpretation of results and action.

2.3.1 Common themes across all groups

There were several common themes among the groups. These fell into financial, technical, workforce, and communications subjects.

Funding—This was a major concern for all groups and focused on how the network will be supported for the next phase. It has been learned that accessibility and building a sampling infrastructure for utilities, improving laboratory capacity for surveillance of emerging pathogens, and addressing prevention as well as responses, were critical for a robust network and maintaining collaborations for protecting public

health. While commercialization of some of the monitoring may be a benefit, there is uncertainty on who will provide funding. Understanding the limitations ofresources will help to provide a sustainable system and reduce the uncertainty. Supporting the students (scholarships) and the operators was seen as critical. Continued uninterrupted funding is also needed for the retention of experienced personnel.

Technical—Standardization was brought up by all groups. This means not just producing a standard method but creating common frameworks for the complete data and results chain, from collection to reporting results. This also includes feedback including feedback and improving collaborations between facilities and partners. Many groups in Michigan have shown that it is the team environment (laboratories, utilities, and local health departments) that has led to a successful program.

Workforce—The training of new personnel to work at utilities, laboratories, and local health departments is a common concern. It has been learned that different ranges of skill sets are needed to conduct wastewater monitoring. With low staff support, shortages, and burnout, the flow of qualified individuals requires a concerted effort. MiNET has provided the perfect opening for institutions of higher education to support this need to promote work with laboratories, wastewater facilities, and public health by making students more aware of these opportunities. ,also considered to be Importance was placed on supporting wastewater workers and creating a team environment.

Communication—Given the current divisive political climate, enhanced communication with the public and building trust are key to validating data and using monitoring to serve public health. This means going beyond a dashboard to storytelling, addressing scientific results in real-time and developing public-focused educational tools that communicate what to do with information and data.

2.3.2 Themes from each discussion group

2.3.2.1 Collection and Testing Methods

- Use and test new techniques, staying on the leading edge of technology
- Expand testing for other diseases, storing samples to test later for other pathogens
- Invest in disease and prediction modelling for the future
- Understand normalization methods
- Develop automation and collecting composite samples more consistently
- Produce clear and simple protocols to follow
- Standardize procedures for sample storage (whereby samples can be transferred between labs)
- Communicate with internal partners and obtaining feedback
- Plan early and ongoing communication to the public

2.3.2.2 Broadening Wastewater Utility Roles and Engagement

- Build a monitoring infrastructure
- Improve and optimize efficient protocols for sample collection
- Understand infiltration and exfiltration to support sampling
- Develop a team environment with academic and public health partners
- Improve transparency and clearly defining project goals
- Train operators

- Develop a better plan for the data chain from collection to sharing and interpreting results (what does the health department do with the data)
- Work directly with utility partners to understand how sample results are being used so they can also communicate effectively

2.3.2.3 Interpretation of Results and Action

- Acknowledge the critical importance of working on good relationships and partnerships
- Develop better, regular interaction strategies tailored to specific communities and stakeholders (i.e. lab community, public health community, Utility and additional project partners)
- Standardize the protocol for reporting data out to the public, not just via the dashboard
- Communicate results internally to address collection practices and data use
- Communicate results externally, what should the public or health department do with the results ("What do we do now?")
- Determine what flexibility and resilience looks like for the data/results chain
- Prove the usefulness of the data; developing more discussion on the data so that it is valuable, actionable, and fundable
- Build a better decision-making framework for actionable efforts on communicating risk and mobilizing resources on clinical testing and vaccination, especially for vulnerable groups

2.4 Wastewater Surveillance Opportunities and Challenges for Utilities (Anna Mehrotra)

Anna Mehrotra is the director of the Wastewater Water Surveillance program for the Water Environment Federation and has helped establish a Community of Practice for utilities participating in the National Wastewater Surveillance System (NWSS). She reported that only 1,246 sites track SARS-CoV-2 data and 98% of these are at a wastewater facility and not upstream in the sewer system. The median population served is 34,100 persons. Eleven states are participating (CA, CO, MI, MO, NC, NE, NY, OH, OR, UT and WI) and only 13.3% of 4440 U.S. wastewater treatment plants are participating. It is clear while there is room to expand, there is a need to do so strategically.

Anna presented some key findings from WEF's work with the wastewater industry. First, there are challenges for utilities not participating in the program:

- Not knowing where to start or who to contact
- Not having enough time/staff/resources
- Not being able to convince leadership of the value of participating

Secondly, for those utilities currently participating, there were another set of issues:

- Understanding how all the programs nationally fit together
- Communicating data and interpreting data to the public
- Addressing questions about long-term funding and value beyond COVID
- Managing concerns about archived samples being tested without the utility's knowledge

There are many benefits for utilities when joining a wastewater monitoring program. This is certainly in support of a utility's mission of protecting public health. Wastewater systems and treatment plants often

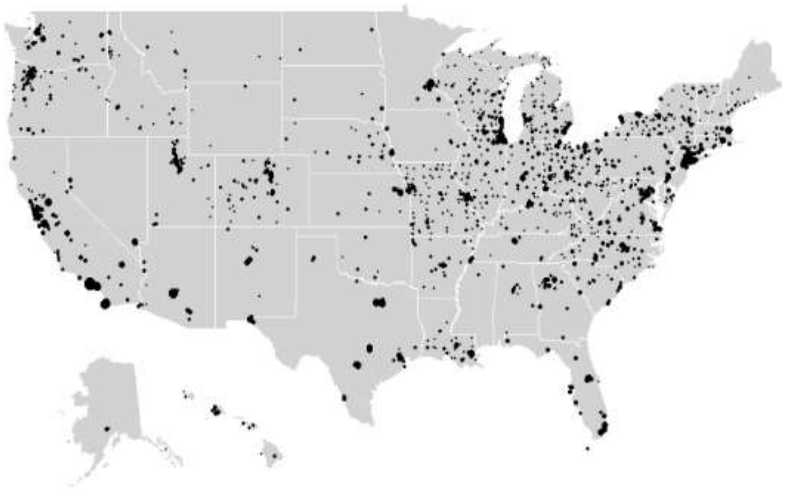
seem hidden from the public, and there is little awareness of what a utility is doing; this provides an opportunity for a utility to engage with the community. Ultimately, a wastewater utility will be able to expand collaborations and communications, which is beneficial for producing an improved monitoring infrastructure for emerging chemicals and pathogens in the future.

3.0 Future Directions for Wastewater

3.1 The Future of NWSS (National Wastewater Surveillance System (John Person, CDC))

John Person (State, Territorial, Local, and Tribal Support Lead, National Wastewater Surveillance System, Waterborne Disease Prevention Branch, Division of Foodborne, Waterborne and Environmental Diseases, CDC) presented data on the NWSS program. The NWSS program represents 152,000 samples from 1,400 sites in 50 states which monitors 138 million people. There are two Centers of Excellence in Colorado and Houston. The data are presented to the public through the DCIPHER dashboard, which also includes the dominant variants of concern. Michigan is a proud part of this national program and has served as one of its leaders.

Figure 2. National Wastewater Surveillance System map indicating U.S. zip codes with wastewater sampling reported to DCIPHER as of December 6, 2022.



In addition to routine disease monitoring, the goal of the program is to use these data for:

- Emergency Response
- Local or regional activations in the wake of natural disasters to detect outbreaks
- Emerging infections
- Short-term activations to assess the prevalence and distribution of emerging threats
- Pandemic preparedness
- Rapid activation and increased sampling frequency to detect pandemic spread into communities to target mitigation efforts

- Rapid local or regional activation with increased sampling frequency to detect and track bioterrorism threats

New targets will be added, and the NWSS program has developed a set of criteria to assist in prioritizing various types of new pathogens and antibiotic resistance genes. These include:

1) Are there meaningful public health actions at the community level?
2) Is the pathogen shed into wastewater? Fecal shedding prevalence, magnitude, duration, and infectivity?
3) Can clinical assays be adapted for wastewater? Can the pathogen be recovered and quantified reliably? Are other, non-specific targets detected (false positives)?
4) What is the geographic distribution of cases? Are there enough cases in a sewershed to be detectable? What is the case ascertainment rate and timing?

The initial core group of new targets include:

Normalization and Process Controls	**Antibiotic resistance genes**	**Pathogen targets**
Pepper Mild Mottle Virus	Carbapenemases	SARS-CoV-2
Crassphage	ESBLs	Influenza A and B
Bovine Coronavirus	Colistin resistance	Respiratory Syncytial Virus
	Vancomycin resistance	Adenovirus 40/41
		Shiga-toxin-producing *E. coli*
		Campylobacter
		Norovirus

Finally, future goals for NWSS are broad and include:

- Extending coverage, 20% to unsewered populations
- Improved metrics, including estimating disease prevalence
- Optimal geographic and temporal sampling frame for multiple targets
- Improved methods, streamlined workflow
- Impact of vaccination and variants
- Improved data submission, dissemination, and messaging
- Ethical transparency, especially around sample archiving

3.2 Thinking Collectively about the Future of Michigan Wastewater Monitoring (World Café Session)

Participants at the conference worked together to envision the future for the Michigan Network for Environmental Health and Technology and the SEWER Network program.

- The five-year vision is that Michigan will be a major leader integral to a national network providing cutting-edge technology, approaches for innovative wastewater monitoring, support for *Utilities of the Future*, education for multiple stakeholders, and contributions to public health policy.

Achieving such a goal will mean investment in 1) continuing to build the network; 2) using and testing innovative technologies; 3) supporting the needs of wastewater facilities; 4) providing broad educational programs; and 5) communicating with the public and decisionmakers.

3.2.1 Building a stronger network

A strong network can be achieved by creating a more diverse program that is inclusive of more members with new, defined goals. One of the key areas to be addressed will be the further building of a sense of unity and participation toward a common purpose. To accomplish this, there needs to be a greater effort in communication internally within MiNet and externally to decision makers and the public. All partners need to be a part of meetings, with open exchange of ideas allowing for bottom-up input and flexibility to try new ideas. The network should be expanded and include a designated wastewater monitoring employee at the plants/utilities and a position for public health communication. This expansion should bring in more disciplines including statistics, computer science, geology, and chemistry. Students should be seen as essential to the network. There should also be programs that allow individuals to shadow the experts in utilities and in other laboratories to enhance the exchange of knowledge.

The expansion of testing is also warranted. Expanding methods and surveillance to not only wastewater but also to other areas of public interest such as watersheds, drinking water, or stormwater. There should be an explicit goal to narrow the knowledge gap between testing of environmental issues compared to public health issues (including livestock and wildlife health).

3.2.2 Using and testing innovative technologies

While the development of a standardized approach and methods are of value, the network will need to look to the future and develop a roadmap for investment in research and development, balancing scientific advances and research within the monitoring program. One goal will be to have Michigan become a testbed for new instrumentation and new kits for an array of new targets, while also using more automation along the sampling and analysis data chain. This would include a focus on rapid sequencing. In addition, this will lead the way for new models that examine for example how gene copies can be turned into case counts and how to further understand pathogen shedding. The network could become a leader in geospatial intelligence and build the metagenome for the State of Michigan.

3.2.3 Supporting the needs of wastewater facilities

Participation from more utilities is greatly desirable for the health of the network. Michigan can lead the U.S. in ensuring all wastewater facilities are on a pathway to becoming a *Utility of the Future.* Managing wastewater, combined sewer overflows, and septage (from septic tanks) will be changing as the state develops a Sanitary Code. Monitoring will be essential and likely mandatory for new emerging biologicals and chemicals (pathogens, microplastics, PFAS, sucralose, personal care products, pharmaceuticals, cortisol and other “stress” indicators, etc.). There will be a need for advancements in treatment technology to improve effluent water quality. More automation, instrumentation, and mapping will all be needed. As mentioned above, new positions should include a designated wastewater monitoring employee at the plants/utilities; this would improve data accessibility, interpretation, and

communication. If future growth of the network supports the needs of utility partners, it will lead the way for the modernization of utilities.

3.2.4 Educating and developing leadership

There is no doubt that there is a human resource crisis for a variety of disciplines, and the water and public health professions are beginning to face such a predicament. More water scientists, engineers, operators, laboratory technicians, analysts, epidemiologists, environmental health experts, and health-related microbiologists are needed. For the academic institutions that are a part of the network, clearly integrating wastewater monitoring into the classroom and course work should be a key goal. Some ideas that could be implemented include:

- Creating a for-credit laboratory course focused on methods used for surveillance
- Developing a summer workshop for community schools/high schoolers interested in STEM
- Producing an on-the-job training program for exposure to wastewater treatment plants and monitoring laboratories
- Developing a virtual module to share knowledge

3.2.5 Communicating with the public and decision makers

A broad communication program is needed to translate the science and ultimately result in improved public health policy. Audiences include with decisionmakers, partners, and the public. It may be appropriate at some point to develop legislation to protect individual privacy and to define the purpose of wastewater monitoring. Perhaps a state-wide council for wastewater monitoring is needed.

A better dashboard for all to use should be developed with stakeholders. An initial review of what is currently on the project dashboard and the use of new information technology approaches could provide an improved system that could be used for a variety of apps. App developers could explore if something similar to a weather app that shows ozone indicators, seasonal allergy risks, etc., could provide more immediate access to wastewater surveillance information in real time. There should also be thought of developing an adaptive dashboard for different clients (school, state, etc.).

Finally, the network would lead the way in developing a standardized ethics program, including equitable and fair coverage for testing, as well as protecting the use of the data. All of these efforts need to be better communicated to decision makers.

4.0 Closing Observations and Conclusions: Now What?

The future of wastewater monitoring is bright and full of opportunities. There is the emergence of a collective vision. However, there is much work to be done.

First, MiNET and the State of Michigan need to develop a plan to expand, strategically developing a roadmap to prioritize future efforts. The 5 “C”s should guide these efforts:

- Capacity

- Cash
- Community
- Collaboration
- Communication

There has not been a discussion yet on how to implement such an effort; one idea was to form a board and formalize the network. Ongoing consultations will continue.

The intellectual capacity, resources, energy, and dedication of MiNET are impressive. The partnerships among wastewater utilities, laboratories, health departments, and community leaders have propelled environmental and wastewater monitoring forward into the future. The efforts have already produced important impacts protecting public health of Michiganders.

List of Appendices

Appendix 1: Full Conference Agenda (includes speaker & panelist bios)

Go with the Flow: Public Health Wastewater Monitoring in Michigan Agenda

May 17-18, 2023
Michigan State University Union

Day 1 – May 17, 2023

10:00am-6:30pm

TIME AND LOCATION	ACTIVITY	PRESENTER/SESSION LEAD(S)
9:00 – 10:00 **Ballroom, 2nd Floor**	**Registration opens** **Continental Breakfast**	
10:00 – 10:05 **Ballroom**	**Welcome** **Video from Senator Peters**	**Joan Rose**, Michigan State University **Doug Gage**, Vice President for Research and Innovation, Michigan State University
10:05 – 10:15	**Opening Remarks**	**Sarah Lyon-Callo**, State Epidemiologist & Interim Sr. Deputy Director, Public Health Administration, MDHHS **Shannon Briggs**, Toxicologist, Water Resources Division EGLE
10:15 – 10:30	**Group Introductions**	
10:30 -11:15	**Keynote:** Value of Wastewater Surveillance and Need for Partnerships	**Gertjan Medema**, Principal Microbiologist at KWR
11:15 – 11:30	**BREAK**	
11:30 – 12:30	**Panel: Lessons Learned** - Use and Value of Wastewater Data	Moderator: **Chuanwu Xi**, University of Michigan Panelists: **Sara Heathman,** Western Upper Peninsula Health Department **Kevin Polston,** Kentwood Public Schools **Irene Xagoraraki**, Michigan State University
12:30 – 12:45	**Poster Teasers**	
12:45 – 1:45	**LUNCH**	

1:45 – 2:45 **Ballroom, 2nd Floor Ontario, Superior & MSU Rooms, 3rd Floor**	**Breakout Sessions**: **Best Practices/Challenges** 1. Collection & Testing Methods 2. Broadening Wastewater Utility Roles and Engagement 3. Interpretation of Results and Action	
2:45 – 3:00	**BREAK**	
3:00 – 3:20 **Ballroom**	**Poster Teasers**	
3:20 – 3:40	**Keynote:** Wastewater Surveillance Opportunities and Challenges for Utilities	**Anna Mehrotra**, Director, Wastewater Surveillance Program, Water Environment Federation
3:40 – 4:15	**Share Breakout Results**	
4:15 – 4:25	**Closing Remarks for Day 1**	**Susan Peters**, Waterborne Disease Epidemiologist, MDHHS
4:25 – 4:30	**BREAK**	
4:30 – 6:30 **Lake Huron & Erie Rooms, 3rd Floor**	**Poster Session, Vendor Tables and Reception**	

Day 2 - May 18, 2023

9:00am-3:00pm

TIME AND LOCATION	ACTIVITY	PRESENTER/SESSION LEAD(S)
8:30 – 9:30 **Lake Erie, 3rd Floor** **Lake Huron 3rd Floor**	**Registration opens** **Continental Breakfast** **Pre-award Poster Review and Vendor Tables**	
9:30 – 9:45 **Ballroom**	**Day Two Welcome** **Poster Award Announcements**	**Joan Rose,** MSU **Shannon Briggs**, Toxicologist, Water Resources Division EGLE
9:45 – 10:15	**Keynote:** Future Directions	**John Person**, State, Territorial, Local, and Tribal Support Lead, National Wastewater Surveillance System, Centers for Disease Control and Prevention
10:15 – 10:30	**BREAK**	
10:30 – 11:30	**Panel** – New Directions	Moderator: **Jeffery Ram**, Wayne State University Panelists: **Aaron Best**, Hope College **Marisa Eisenberg**, University of Michigan **Jaime Fleming**, City of Wyoming **Keith Sanders**, City of Ann Arbor
11:30 – 12:30	**LUNCH**	

12:30 – 1:45 **Ballroom**	**World Café Session -** Thinking Together about the Future of Michigan Wastewater Monitoring	
1:45 – 2:15	**World Café Feedback**	
2:15 – 2:30	**Closing Observations: Now What?** Remarks from keynote speakers about moving into the future	**Gertjan Medema**, KWR **Anna Mehrotra**, WEF **John Person**, CDC
2:30 – 3:00	**Closing Remarks**	**Joan Rose**, MSU **Susan Peters**, MDHHS
3:00	**Adjourn**	

Keynote Speaker Biographies

Gertjan Medema

Gertjan Medema is Principal Microbiologist at KWR. He is also a part-time professor of Water & Health at Delft University of Technology and a Distinguished Hannah Visiting Professor at Michigan State University. His research focuses on understanding the transmission of infectious diseases and antimicrobial resistance via water systems and how this can be prevented through technical and non-technical management measures. His research forms the scientific basis for the design of safe water systems. Gertjan is an internationally recognized expert and scientific coordinator of the WHO Collaborating Centre on Water Quality and Health. He advises WHO on the microbial safety of water and the European Union DG Environment on drinking water and water reuse guidelines. Gertjan is also a member of the International Water Association Strategic Council and of the Specialist Group on Health-Related Water Microbiology.

Anna Mehrotra

Anna Mehrotra is a wastewater specialist with 20 years of experience as an engineer and researcher. She is currently the Director of the Water Environment Federation's Wastewater Surveillance Program, where she oversees training, pilot testing, and other activities focused on advancing the practice of wastewater surveillance and expanding participation in the CDC's National Wastewater Surveillance System. Anna is a licensed professional engineer with a Ph.D. in civil and environmental engineering from the University of California Berkeley.

John Person

John Person is currently the State, Territorial, Local, and Tribal Support Lead for the CDC's National Wastewater Surveillance System (NWSS). He has been involved with NWSS since late 2020, where he has helped develop many aspects of the program including establishing the STLT support team. Previously, John has worked for the Waterborne Disease Prevention Branch and the Louisiana Department of Health as an epidemiologist. John earned his MPH from the Louisiana State University School of Public Health.

Lessons Learned Panelists Biographies

Sara Heathman

Sara Heathman is the Environmental Health Operations Supervisor at the Western UP Health Department. She worked in the wastewater industry for eight years before joining the Western UP Health Department as a Sanitarian in 2019. Sara is a Wisconsin Certified Soil Tester, Wisconsin Licensed Septage Operator, and Registered Environmental Health Sanitarian. She currently coordinates the Wastewater Monitoring program for the Western UP Health Department.

Kevin Polston, Ed.S.

Kevin has served as superintendent of Kentwood (MI) Public Schools since 2021. His previous superintendent experience included four years at Godfrey-Lee Public Schools in Wyoming, Michigan. Prior to becoming a superintendent, he served as a teacher, coach, and administrator at Grand Haven Area Public Schools (MI) for 15 years. His vision is to "change the world through opportunities for students."

In June, 2020, Kevin was appointed by Governor Gretchen Whitmer to the Return to School Advisory Council. Then again in February, 2021, he was appointed by Governor Whitmer to serve as the chairperson of the Student Recovery Advisory Council.

Polston currently serves as a trustee on the Board of Trustees of KConnect, a collective impact organization in Grand Rapids, MI, and on the Board of Trustees for Kent School Services Network, a community schools initiative in Kent County. He is also a 2020 alumnus of the Grand Rapids Chamber's Leadership Grand Rapids program.

Irene Xagorarki

Irene Xagoraraki is a Professor of Environmental Engineering at Michigan State University. She and her students have been studying the fate of viruses in natural and engineering systems. Since 2017, her research focuses on environmental surveillance approaches for identification and prediction of viral outbreaks. In 2020 her work on wastewater surveillance for early detection of viral outbreaks was featured in Women in Engineering and Science: Women in Water Quality - Investigations by Prominent Female Engineers, Springer Nature, Switzerland. She received awards by the US Environmental Protection Agency (2018) and by the American Society of Civil Engineers (2021 and 2022). In 2022 she was featured in the Smithsonian: Stories of Women in STEM: Biotechnology. In 2023 she received the William J. Beal Outstanding Faculty Award at Michigan State University.

Moderator: Chuanwu Xi

Dr. Chuanwu Xi is a professor of Environmental Health Sciences, professor of Global Public Health and director of Global Environmental Health in the Department of Environmental Health Sciences at the University of Michigan School of Public Health. Dr. Xi is a renowned expert in biofilm and water microbiology. Research in his laboratory focuses on biofilms/microbiome, water quality and treatment, and public health. He has published over 100 research articles, and received/filed 5 patents. Dr. Xi was a Scholar-in-Residence at US FDA and a chair and council of Division Q of American Society for

Microbiology. Dr. Xi currently serves as a board member of Council of Public Health of NSF Internationals and an associate editor for mLife.

New Directions Panelist Biographies

Aaron Best

Dr. Aaron Best is the Harrison C. and Mary L. Visscher Professor of Genetics and Co-Director of the Global Water Research Institute at Hope College (Holland, MI, USA) and is the President and founder of Aquora Research and Consulting (www.aquorarc.com). He has over 20 years of experience in academia with recent crossover into industry, having been awarded over $15 million in federal and private grants in support of microbial genomics/ecology research and application of research to public health problems stemming from water quality. He was selected to be an American Society for Microbiology Distinguished Lecturer and the Waksman Foundation Lecturer from 2018-2020. Dr. Best leads highly interdisciplinary teams of scientific experts that work closely with organizations and communities to help them tell data-driven stories of impact based on rigorous project design, implementation, and end-to-end evaluation.

Marisa Eisenberg

Marisa Eisenberg is an Associate Professor in the Department of Epidemiology, and in the Department of Mathematics. Her research revolves around mathematical epidemiology, focus on using and developing parameter estimation and identifiability techniques to model disease dynamics. Her group builds multi-scale models of infectious disease, including HPV, cholera and other environmentally driven diseases. She also jointly works on several projects related to wastewater monitoring for a range of pathogens, including SARS-CoV-2.

Keith Sanders

Keith Sanders, Ann Arbor Wastewater Treatment Services Unit Manager. Keith has over 25 years of experience in wastewater treatment. Keith is a member of the Water Environment Federation and the Michigan Water Environment Association. In addition, he is a graduate of Michigan State University.

Moderator: Jeffery Ram

Jeff Ram is a Professor of Physiology with an Associate Appointment in Biochemistry, Microbiology, and Immunology at the Wayne State University School of Medicine. An invertebrate physiologist by training with more than 150 publications, Dr. Ram was President of the International Society for Invertebrate Reproduction from 2013 until 2017. As an investigator of invasive invertebrates in the Great Lakes, Jeff started working on wastewater when a grad student in Civil and Environmental Engineering asked the question of whether zebra mussels could help detoxify wastewater and source track contamination of our rivers, streams, and beaches. And the rest, as they say, is history. Jeff says: “Wastewater has enormous complexity and information about society and our environment.”

Appendix 2: Video Links

2.1 Senator Peters
2.2 Keynote Presentations
- 2.2.1 Gertjan Medema
- 2.2.2 Anna Mehrotra
- 2.2.3 John Person

2.3 Panel Discussions
2.3.1 Lessons Learned
2.3.2 Future Directions

Appendix 3: Keynote Speaker Slides

3.1 Gertjan Medema
3.2 Anna Mehrotra
3.3 John Person

Appendix 4: Poster Titles, Authors and link to Abstract Booklet

Poster Number	Authors	Speaker affiliation	Poster Title
1	**William Shuster**, James Hartrick, Carrie Turner, Jeffrey Ram	Wayne State University	In-pipe flow monitoring in the context of a wastewater-based epidemiology project: methods and applications
2S	**Renee Tardani**, Alexis Porter, Richard Rediske, Muskegon Resource Recovery Center	Grand Valley State University	Go With the Flow for Wastewater Data Normalization: Comparing Normalized and Non-Normalized SARs-CoV2 Viral Load and Physiochemical Parameters in Muskegon and Ottawa Counties
3S	**Qiuyang Zhang,** Anna Kilts, Gina Kittleson, Felipe de Paula Nogueira Cruz, Xavier Jenkins, Kevin Bakker, Michelle Ammerman, Steve Wright, Marisa Eisenberg, and Krista Wigginton	University of Michigan, School of Public Health	Determining Sampling Frequency in the Neighborhood Level Wastewater Surveillance of SARS-CoV-2
4	**Md Alamin**, Pelumi Oladipo, James Hartrick, Azadeh Bahmani, Carrie L. Turner, William Shuster, and Jeffrey L. Ram	Department of Physiology, Wayne State University	Which fecal marker should be used for fecal normalization of wastewater pathogens?
5S	**Taylor Segorski**, Ashley Thompson, Olatubosun Oyewole, Jack Ruhala, Zane Walters, Puneet Chowdary, Pei-Lan Tsou, Sheila Blackman	Cell and Molecular Biology Department, GVSU	Pepper Mild Mottled Virus as a Monitoring Tool in Wastewater Based Epidemiology
6S	**Nicholas Castle**, Josie Kuhlman, Michael Vu, John J. Hart, Megan Jamison, David C. Szlag	Oakland University	Can Fecal Indicator Targets and Flow Normalize Wastewater Insights?
7	**David Inman**	Aquasight	**No Title**
8	**Yabing Li**, Brijen Miyani, Liang Zhao, Maddie Spooner, Zach Gentry, Yangyang Zou, Geoff Rhodes, Hui Li, Andrew Kaye, John Norton, Irene Xagoraraki	Michigan State University	Surveillance of SARS-CoV-2 in nine neighborhood sewersheds in Detroit Tri-County area, United States: assessing per capita SARS-CoV-2 estimations and COVID-19 incidence
9S	**Hsinhui Hua**, Vanessa Slack, Julie Gilbert, Michelle Ammerman, Krista Wigginton, and Marisa Eisenberg	University of Michigan, School of Public Health	Comparing Normalization Methods for SARS-CoV-2 in Wastewater
10	**Jianfeng Wu**, Xin Li, Thu Le, Olivia Yancey, Christopher Breen, Yili Wang, Peter Song, Joseph Dvonch, Richard Neitzel, Alfred Franzblau, Julie Gilbert, Marisa Eisenberg, Chuanwu Xi*	School of Public Health at the University of Michigan	Wastewater Monitoring of SARS-CoV-2 at Building Level on a University Campus for COVID-19 Outbreak Assessment
11	**Daniel Wade**, Adam Slater1, Lauren Cribbs1, Celia Kun-Rodrigues1, Vanessa Kardian1, Dylan Gladysz1, Allaire Schneider1, Grace Goszkowicz1, Louis Kopp1, Benjamin G. Kopek1, Michael J.	Hope College	Processing more than 100 samples per week and delivering results the same day: an overview of Hope College's wastewater monitoring process

	Pikaart2, Brent P. Krueger2, Aaron A. Best1		
12S	**Cameron Priebe**, Heather LeFaivre, Ella Connors, Haley Berg, Bailey Copeland, Kassidy Vredeveld, Clifton Franklund, Mary Zimmer, Sky Pike	Ferris State University	A Nested Approach to Identifying Ferris Campus SARS CoV-2 Hotspots
13	**Alexis M. Porter**, John J. Hart, Richard R. Rediske, David C. Szlag	Grand Valley State University	SARS-CoV-2 Wastewater Monitoring on University Campuses: A Comparative Study on Effective Intervention Strategies for Public Health Guidance
14S	**Allison Patterson**, Kendra Hincka, Juliana Carey, Camryn Lowe, Rachel Smith, Kassidy Vredeveld, Clifton Franklund, Mary Zimmer, Sky Pike	Ferris State University	Ferris State Campus SARS CoV-2 Trends from November 2020 to April 2023
15S	**Tyler Chlystek**	Grand Valley State University Annis B. Water Resources Institute	SARS-CoV-2 Wastewater Surveillance
16	**Michael J. Conway**, Stephanie Kado, Breanna K. Kooienga, Jacklyn S. Sarette, Michael H. Kirby, Andrew D. Marten, Avery S. Ward, Jackson D. Abel, Steve King, Jacqueline Billette, Elizabeth Braddock, Maggie R. Williams, Rebecca L. Uzarski, and Elizabeth W. Alm	Central Michigan University College of Medicine	Effectiveness of SARS-CoV-2 Wastewater Monitoring in Rural and Small Metro Communities in Central Michigan
17S	**Louis Walter** ,Derick Chia ,Dan Adrian ,Sheila Blackman, Pei-Lan Tsou, Puneet Chowdhary,	Cell and Molecular Biology Dept., Grand Valley State University, Public Health Dept., Grand Valley State University.	Correlation of SARS-CoV-2 Wastewater Concentration and New COVID-19 Cases in Kent County, Michigan
18	**Puneet Chowdhary**, Sheila Blackman, Pei-Lan Tsou, Sara Simmonds and Andrew Salisbury	Molecular Monitoring for Health and Environment Lab, Cell and Molecular Biology Department, Grand Valley State University	Bridging Lab Science and Public Health with WBE: Partnership between KCHD and the Department of CMB at GVSU
19	**Matthew Flood**, Josh Sharp, Jennifer Bruggink, Molly Cormier, Bailey Gomes, Isabella Oldani, Lauren Zimmy, and Joan B. Rose	Michigan State University	Understanding the Efficacy of Wastewater Surveillance for SARS-CoV-2 in Two Diverse Communities
20	**Michelle M. Jarvie**, Moriah Reed, Benjamin Southwell, Derek Wright, Thu N.T. Nguyen	Lake Superior State University	Monitoring of COVID-19 in wastewater across the Eastern Upper Peninsula of Michigan
21S	**Abigail Proksch**, Alex E Guzman-Vargas, My Tran, Hannah Faber, Chandler Hendrickson, Kassidy Vredeveld, Clifton Franklund, Mary Zimmer, Sky Pike	Ferris State University	Wastewater SARS CoV-2 Spread in Rural Northern West Michigan
22S	**Liang Zhao**, Yangyang Zou, Randy E David, Scott Withington, Stacey McFarlane, Russell A Faust, John Norton, Irene Xagoraraki	Michigan State University	Simple methods for early warnings of COVID-19 surges: Lessons learned from 21 months of wastewater and clinical data collection in Detroit, Michigan, United States
23	**Lauren Cribbs**, Celia Kun-Rodrigues, Adam Slater, Daniel Wade, Vanessa Kardian, Dylan Gladysz, Allaire Schneider, Grace Goszkowicz, Louis Kopp, Benjamin	Hope College	Beta and Delta and Omicron, Oh My! : A look into the timeline of the emergence of SARS-CoV-2 variants in West Michigan

	G. Kopek, Michael J. Pikaart, Brent P. Krueger, Aaron A. Best		
24S	**Ashlyn Smith**, Cassidy Cleary, Natasha Dagrella, Jannifer Tyrell, Tami Sivy	Saginaw Valley State University	A Timeline of Variant Distribution
25	**Michelle Ammerman**, Shreya Mullapudi, Julie Gilbert, Khaitlyn Figueroa, Felipe de Pula Nogueira Cruz, Kevin Bakker, Betsy Foxman, Marisa Eisenberg, and Krista Wigginton	University of Michigan, Civil and Environmental Engineering	Adding wastewater surveillance to the norovirus epidemiological toolbox
26	**N. D'Souza**, A. Porter, J.B. Rose, E. Dreelin, S.E. Peters, P.J. Nowlin, S. Carbonell, K. Cissell, Y. Wang, M.T. Flood, A.T. Rachmadi, C. Xi, P. Song, S. Briggs and the Michigan Network for Environmental Health and Technology (MiNET) consortium	Michigan State University	Lessons from a State-wide Wastewater surveillance program (MiNET) for SARS CoV-2 Public Heath use and beyond
27S	**Simran Singh**, Nishita D'Souza, Erin Dreelin, Alexis Porter, Kelly Geith, and the Michigan Network for Environmental Health and Technology (MiNET)	Michigan State University	Tracking Wastewater PCR Variant Trends Across Michigan from 2021 to 2022
28	**Julia Bazner**, Joan Rose, Nishita D'Souza, Colleen Naughton, Gertjan Medema, Panagis Katsivelis	Michigan State University	Present Challenges and Future Considerations for W-SPHERE: A Global Data Center for SARS-CoV-2 Wastewater Surveillance
29	**Alexis M. Porter**, Charlyn G. Partridge	Grand Valley State University	Changing Tides: West Michigan Based Genomic Analysis of SARS-CoV-2 Variants in Wastewater
30	**Celia Kun-Rodrigues**, Adam Slater, Lauren Cribbs, Daniel Wade, Vanessa Kardian, Dylan Gladysz, Allaire Schneider, Grace Goszkowicz, Louis Kopp, Benjamin Kopek, Michael Pikaart, Brent Krueger, Aaron Best	Hope College	Whole genome sequencing of SARS-COV-2 from wastewater using two different platforms
31S	**Elisabeth Hatfield**, Elizabeth Cazallis, Louis Walters, Pei-Lan Tsou, Sheila Blackman, Puneet Chowdhary	Grand Valley State University, Department of Cell and Molecular Biology	Variant identification by sequencing of SARS-CoV-2 spike protein receptor binding domain
32	**Lindsay Catlin**, Angela Minard-Smith, and Rachel R. Spurbeck	Battelle Memorial Institute	Method Development and Implementation of Genomic Wastewater Based Biosurveillance
33	**Yabing Li**, Brijen Miyani, Kevin Childs, Shin-Han Shiu, Irene Xagoraraki	Michigan State University	Methods to test for human virus diversity in wastewater: Towards a practical approach for identifying human viruses with metagenomics
34	**Ryan Julien**; Jade Mitchell	Michigan State University	Interpreting results of wastewater-based SARS-CoV-2 surveillance on a university campus
35S	**Peter J Arts**, Kevin M Bakker, Alexandria B. Boehm, Andrew F. Brouwer, Marisa C. Eisenberg, J Daniel Kelly, Sterling Knight, Krista R Wigginton	University of Michigan	Assessing representativeness of wastewater-based epidemiology measurements with dynamic models of fecal shedding
36S	**Leyao Zhang**, Yahui Zhang, Chuanwu Xi, Peter X.K. Song	Department of Biostatistics, University of Michigan-Ann Arbor	Selection of Sewage Manholes in Infectious Disease Surveillance
37S	**Yili Wang**, Peter Song, Chuanwu Xi	University of Michigan	Sewage-Based Surveillance: Using Machine Learning Methods to Address Under-Reporting of Covid Cases.
38S	**Zachary Gentry**, Liang Zhao, Irene Xagorarki, Russel A Faust, Randy E David, John Norton	Michigan State University Department of Civil and	Wastewater Surveillance Beyond COVID-19: A Ranking System for Communicable Disease Testing in Tri-County Detroit Area, Michigan, USA

		Environmental Engineering	
39S	**Yahui Zhang**; Chuanwu Xi; Peter X.K. Song et al.	University of Michigan	Wastewater-based estimation of the SARS-CoV-2 RNA shedding load distribution
40	**Julie Gilbert**, Michelle Ammerman, Krista Wigginton, Marisa Eisenberg	School of Public Health - Epidemiology	Visualizing Transmission Trends: Digital Dashboards in Wastewater-based Epidemiology
41	**Julie Gilbert**, Michelle Ammerman, Krista Wigginton, Marisa Eisenberg	University of Michigan School of Public Health - Epidemiology	Triangulating Transmission Trends: Comparing Google Trends and Wastewater Surveillance Data for Multiple Pathogens
42	**Julie Gilbert**, Michelle Ammerman, Kevin Bakker, Krista Wiggington, Marisa Eisenberg	University of Michigan School of Public Health - Epidemiology	Evaluating the changing relationship between wastewater surveillance, COVID-19 cases, and testing
43S	**Liang Zhao**, Yangyang Zou, Yabing Li, Brijen Miyani, Maddie Spooner, Zachary Gentry, Sydney Jacobi, Randy E David, Scott Withington, Stacey McFarlane, Russell Faust, Johnathon Sheets, Andrew Kaye, James Broz, Anil Gosine, Palencia Mobley, Andrea WU Busch, John Norton, Irene Xagoraraki	Michigan State University	Five-week warning of COVID-19 peaks prior to the Omicron surge in Detroit, Michigan using wastewater surveillance
44S	**Liang Zhao**, Qiudi Geng, Ryland Corchis-Scott, R. Michael McKay, John Norton, Irene Xagoraraki	Michigan State University	Targeting a free viral fraction enhances the early alert potential of wastewater surveillance for SARS-CoV-2: a methods comparison spanning the transition between Delta and Omicron Variants in a large urban center
45	**Rebecca Ives**, Nishita D'Souza, Joan Rose	Michigan State University	Point of Care Device as a SARS-CoV2 Wastewater Surveillance Screening Tool
46	**Spencer Kuehn**, Nishita D'Souza, Rebecca Ives, Julia Bazner, Joan B. Rose	Michigan State University	Optimizing Polyethylene glycol (PEG) Concentration Methods for SARS-CoV-2 Wastewater Analysis
47	**Jianfeng Wu**, Xin Li, Thu Le, Olivia Yancey, Christopher Breen, and Chuanwu Xi	Department of Environmental Health Sciences, University of Michigan School of Public Health. Ann Arbor, Michigan	Comparison of RT-qPCR and RT-Droplet Digital PCR platforms for Quantification of SA
48S	**Corrine Caponigro**, Joan Rose, Rebecca Ives, Nishita D'Souza	Michigan State University	3D Passive Sampling for SARS-CoV-2 Detection in Wastewater
49	**Jeffrey L. Ram**, Md Alamina, James Hartrick , Adrian A. Vasquez , Azadeh Bahmani, Carrie L. Turner , William Shuster , and Nicholas W. West	Wayne State University	Passive Swab Versus Grab Sampling for Detection of SARS-CoV-2 Markers in Wastewater
50	**Alshae' Logan-Jackson**, Nancy J. Lin, Ishi Keenum, Stephanie Servetas, Jason Kralj, Lisa Stabryla, and Scott Jackson	The National Institute of Standards and Technology	Mapping a Plan to Address Measurement Challenges in the Wastewater Surveillance
51S	**Katherine R. Harrison**, Delaney Snead, Anna Kilts, Michelle L. Ammerman, Krista R. Wigginton	University of Michigan, Ann Arbor	Virus genome degradation in untreated wastewater
52S	**Emily Zak,** Matthew Flood, Rebecca Ives, Nishita D'Souza, Joan Rose	Michigan State University	Examining Persistence of Coronavirus in Septage
53S	**Michael Vu**, John J. Hart, Nicholas Castle, Josie Kuhlman, Megan N. Jamison, Jim N. McNair, David C. Szlag	Oakland University	Frequency and Degradation of SARS-CoV-2 Markers N1, N2, and E in Sewage