Master of Public Health

Integrative Learning Experience Report

COMMUNICATING WASTEWATER SURVEILLANCE INFORMATION IN MONTANA

by

Beth Nicole Hopkins

MPH Candidate

submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

Graduate Committee:
A. Paige Adams, DVM, PhD
Deborah J. Briggs, PhD
Robert L. Larson, DVM, PhD

Public Health Agency Site:
Montana Department of Public Health and Human Services - Communicable Disease Epidemiology Section
September 4 - October 20, 2023

Site Preceptor:
Rachel Hinnenkamp, MPH

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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Abstract

On March 11, 2020, the World Health Organization declared COVID-19 a pandemic. With this pandemic came many public health challenges, including how to capture accurate, timely data to determine the burden of COVID-19 in communities. In Montana, community members do not always seek medical care, have access to testing, nor report their at-home test results. Wastewater surveillance mitigates this lack of accurate data by collecting and testing for the concentration of SARS-CoV-2 in the wastewater. This process is independent of the healthcare and reporting systems and the data aides in the decision process for public health action. Public health action includes prioritizing the provision of supplies (test kits, personal protective equipment, staff, vaccines, etc.) and to recommend implementation of masking, social distancing, and other strategies to decrease disease transmission. Wastewater surveillance trends at two sites in Montana, Helena and East Helena, were compared to reported COVID-19 cases over a three-year period to determine if wastewater trends forecast reported COVID-19 cases. A forecast of COVID-19 cases could allow for more effective public health action to reduce disease transmission. Communication to the public is a significant part of the wastewater surveillance program. With a variety of participating stakeholders, different communications strategies were identified and implemented to relay pertinent wastewater surveillance information. During this APE/ILE, a Montana-based public facing web page and social media posts were created to communicate these data. A flow chart of Montana's wastewater surveillance program and associated stakeholders was also created to further examine the steps and communication that are needed to have an effective wastewater surveillance program.

Subject Keywords: Wastewater, surveillance, communication, public health, trends, SARS-CoV-2, COVID-19, Montana

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Chapter 1 - Literature Review

Introduction

Gathering accurate data of COVID-19 presence in a community presents a serious public health challenge. During the SARS-CoV-2 pandemic, many changes in case definitions, introduction of home tests, and lack of testing and reporting may have led to underestimates of cases in Montana. A re-emerging surveillance method, wastewater surveillance, is an effective tool to mitigate the inaccuracies of other data sources alone. The wastewater surveillance method was first implemented in the 1940s for monitoring of the polio eradication efforts (National, 2023). Fast forward to the early 2020s, the SARS-CoV-2 pandemic has "catalyzed innovation", and wastewater surveillance became an important measurement for trends of infections in the community (National, 2023, pg. *ix*).

History of Wastewater Surveillance

Wastewater surveillance for infectious diseases "detect and quantify the presence of pathogen biomarkers" such as microbial DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) that is shed by an infected person in their feces (National, 2023). This process collects community-level, aggregate data from anyone that uses the municipal wastewater system from their home, place of work, businesses, etc. (National, 2023). It is estimated that 80% of the US population uses the public wastewater system, thus their data is captured through this surveillance method (National, 2023). Wastewater surveillance testing is independent of the health care system, meaning that community members do not need to seek care and testing with a medical provider in order for public health to determine trends of pathogens present in the wastewater. For COVID-19, many individuals did not seek care or confirmation testing when home test kits became available, leaving case counts drastically deflated. To mitigate this data issue, Montana is expanding their wastewater surveillance program through the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases (ELC) grant.

Public Health Structure in Montana

Montana is a decentralized state where public health jurisdictions are led by local government employees (Centers, 2022a). In application, this means that the authority to make public health decisions primarily lies with the local and tribal health jurisdictions rather than the state. The state health department provides a supportive role in local and tribal public health

action. For this Integrated Learning Experience/Applied Practice Experience (ILE/APE), I worked in the Communicable Disease Epidemiology Section (CDEpi) located in Helena, the state Capital of Montana (see Figures 1.1 and 1.2). The CDEpi section is housed within the Epidemiology and Scientific Support Bureau in the Public Health and Safety Division of the Montana Department of Public Health and Human Services (DPHHS) (State of Montana, 2023).

CDEpi's mission is "to create, maintain, support, and strengthen routine surveillance and detection systems and epidemiological investigation processes, as well as to expand these systems and processes in response to incidents of public health significance" (Montana Department, n.d.). This section is comprised of nine staff members, including an administrative assistant, a nurse consultant, the section supervisor, a lead epidemiologist, and five additional epidemiologists. These staff work on a variety of communicable diseases including, but not limited to, respiratory, foodborne, vector-borne, waterborne, zoonotic, and vaccine-preventable diseases.

Rachel Hinnenkamp is the lead epidemiologist in the CDEpi section and preceptor for this ILE/APE. Hinnenkamp obtained her Master of Public Health from the Boston University School of Public Health in 2016 (Rachel Hinnenkamp, n.d.). She has been working at Montana DPHHS as an epidemiologist with CDEpi section since 2017 and was promoted to a lead in 2021 (Rachel Hinnenkamp, n.d.). In her position, she investigates all outbreaks of food and waterborne disease in the state of Montana (Rachel Hinnenkamp, n.d.).

Wastewater Surveillance in Montana

As of October 16, 2023, Montana has seven active wastewater surveillance sites in six jurisdictions including Missoula, Rocky Boy's Indian Reservation, Teton, Park, Gallatin, and Lewis and Clark Counties that have collected and analyzed at least one wastewater sample in the past six weeks. Multiple jurisdictions are in the onboarding process including the Crow Indian Reservation, and Hill and Silver Bow countries. Figure 1.1 depicts the location of the Montana Indian Reservations (Montana State, 2023). Figure 1.2 depicts the location of the counties (Montana County, 2023). Each of these sites will send up to two samples per week to a partnering laboratory for testing. Of all these testing sites, the longest participating sites are Helena and East Helena in Lewis and Clark County that both began testing in August 2020 (Centers, 2023b).

Literature Review

To determine if the Montana wastewater surveillance data is a helpful data source for COVID-19 in the local communities, a literature review was done on wastewater surveillance's forecasting nature in other jurisdictions. Wastewater surveillance can be analyzed and compared to case, hospitalization, and death data to determine its effectiveness in identifying and forecasting trend changes in clinical cases.

Multiple jurisdictions have published their analyses on wastewater surveillance data for SARS-CoV-2 and compared its trends to change in case and hospitalization trends. In New Haven, Connecticut, researchers found a six-to-eight-day lead in wastewater trends ahead of SARS-CoV-2 positive test results by the report date (Peccia et al, 2020). Researchers also found a zero-to-two-day lead of wastewater data ahead of percent positive tests from specimen collection date and one to four days ahead of local hospital admissions (Peccia et al, 2020). In Wisconsin, during their retrospective analysis of data over 12 locations, that no lead time was present in wastewater surveillance data when comparing wastewater sample and clinical specimen collection dates (National, 2023).

Analyses were also conducted in other countries where wastewater trends also demonstrated a forecast to other COVID-19 trends. In Sweden, their wastewater surveillance data for SARS-CoV-2 demonstrated a nineteen-to-twenty-one-day lead compared to hospitalizations during 2020 (Saguti et al., 2021). In Attica, Greece, researchers found that their wastewater data demonstrated a five-day lead compared to positive COVID-19 cases, an eight-day lead to new hospitalizations, and a nine-day lead to admissions into the Intensive Care Unit (ICU) Galani et al., 2022).

The wastewater surveillance forecasting trends can be important information to help inform public health officials in their decisions to implement public health strategies early to mitigate further disease transmission. Increased trends of COVID-19 in the wastewater could prompt public health officials to deliver additional vaccinations, testing supplies, and therapeutics to higher impacted communities. Other public health strategies could include advocating for increased masking, social distancing, better testing strategies, and communicating data to medical providers etc.

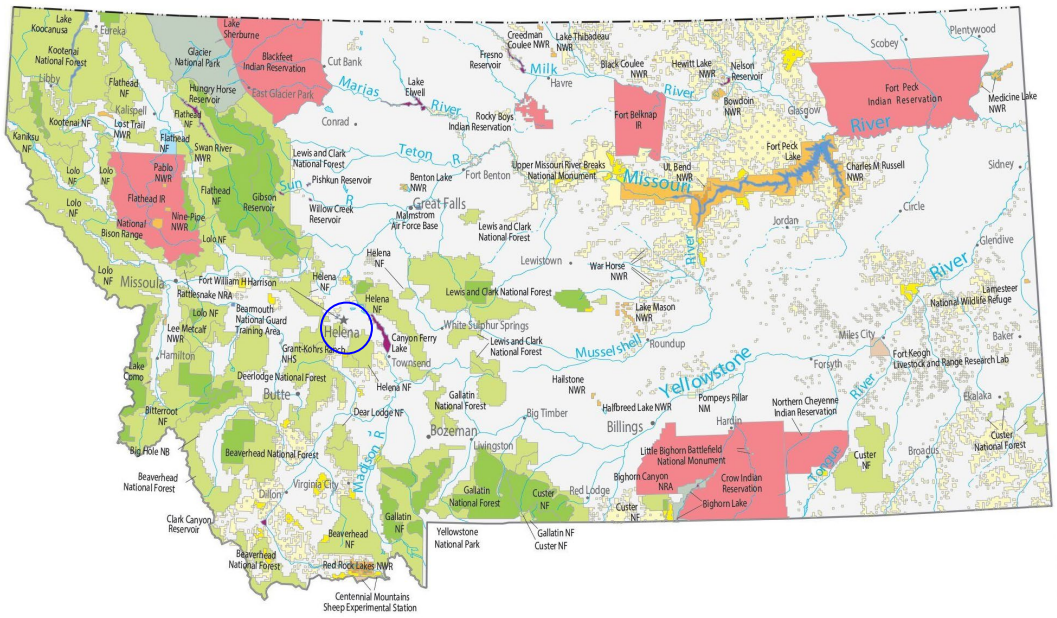
While wastewater surveillance data alone has demonstrated its effectiveness at prewarning reported cases in other jurisdictions, this data demonstrates that it is most useful when used in combination with other data sources (Centers, 2023d). Additionally, widespread recommendations for public health interventions are only recommended by the Centers for

Disease Control and Prevention (CDC) when multiple data sources are taken into account rather than solely relying on wastewater surveillance data (Centers, 2023d).

Use of Wastewater Surveillance Data for Public Health Action

Not only can wastewater surveillance detect pathogens, but when analyzed using the expertise of data scientists, these data can help determine what areas of the United States and globe are experiencing the wicked problem of health disparities. Generally, trends detected in wastewater samples occurred multiple days prior to case reports and hospitalization data (National, 2023). This prewarning system informs public health to implement or remove transmission mitigation strategies (e.g., masking and social distancing), health care providers to pivot their testing strategies of prevalent diseases, immunocompromised community members to take extra precautions, etc.

Figure 1.1 Map of Montana including Indian Reservations



Note. This map of Montana includes the seven in Indian reservations depicted in red. The blue circle indicates where Helena and East Helena are located.

Figure 1.2 Map of Montana Counties

Note. This map of Montana includes its 56 counties. The blue circle indicates where Helena and East Helena are located within Lewis and Clark County.

Chapter 2 - Learning Objectives and Project Description

My responsibilities included attending triweekly CDEpi and adjacent section calls, weekly Public Health and Safety Division meetings, two monthly meetings of the National Wastewater Surveillance System (NWSS) Community of Practice and Regional. It was also my responsibility to gather wastewater surveillance data from two laboratories in Montana and report to NWSS. Additionally, I coordinated the onboarding of new sites for wastewater surveillance testing with a variety of stakeholders and reported weekly laboratory results of active sites to the CDC NWSS team. I also attended the Water Environment Federation's Wastewater Surveillance Disease Summit. During my APE, I designed the Montana Wastewater Surveillance web page (see Appendix A), created social media posts (see Appendix B), provided analysis of SARS-CoV-2 trends in wastewater to that of reported cases for two sites in Montana (see Appendix C), and created a flow chart of the wastewater surveillance process and stakeholders involved (see Appendix D).

CDEpi Triweekly Meetings

I attended and contributed to triweekly meetings with the CDEpi section and other related teams (the Surveillance and Informatics section and the Infection Prevention and Healthcare Associated Infection section). During these meetings, we discussed reportable conditions, outbreaks, cases under investigation, changes to Administrative Rules of Montana, upcoming conferences, educational trainings, grant management, etc.
Weekly Disease Meetings

Weekly Disease Meetings

I attended the weekly disease meetings that additional sections across the Public Health and Safety Division at Montana DPHHS.

Report Wastewater Surveillance Data

I collected weekly wastewater data from participating laboratories. I used Statistical Analysis System (SAS) program code to combine files accurately. Combined files were then reported to the NWSS through the Data Collation and Integration for Public Health Event Response (DCIPHER) portal platform with CDC.

Onboard Wastewater Surveillance Sites

I onboarded additional sites for testing with three different laboratories: Archer Biologicals in Bozeman, Carroll College in Helena, and the Montana Environmental Laboratory in Helena. Onboarding sites included extensive conversations with the participating laboratory, local or tribal health jurisdiction, wastewater plant operators, fiscal staff, CDEpi internal staff (lead and supervisor), and grant management to ensure coordination. Task Orders (similar to a contract) between MT DPHHS and the local or tribal health jurisdiction, coordinating was drafted and worked through the workflow to be approved by the fiscal and division administrator staff.

Attended the Wastewater Disease Surveillance Summit

I virtually attended the Wastewater Disease Surveillance Summit hosted by Water Environment Federation (WEF) on October 1st, 2023. This summit gathered water professionals, public health staff, medical providers, and policymakers together to share lessons learned and other ideas related to wastewater surveillance (Wastewater, n.d.).

Attend the Monthly NWSS Public Health Community of Practice Meetings

I attended the NWSS hosted monthly Public Health Community of Practice calls for public health staff participating in wastewater surveillance. These meetings include updates of federal wastewater surveillance contracts, federal funding, best practices, and presentations to progress the field of wastewater surveillance.

Attend the Monthly NWSS Regional Meetings

NWSS also hosts region specific calls. I attended these monthly meetings under the region hosted by NWSS's Colorado Center of Excellence. During these meetings, jurisdictions in this region share experiences and lessons in their wastewater surveillance programs.

Chapter 3 - Results

Montana Wastewater Surveillance Web Page

I designed Montana's Wastewater Surveillance web page (see Appendix A), and it is viewable to the public on the Montana Department of Public Health and Human Services main website. The website includes information about what wastewater surveillance is, how it works, its importance in public health action, our MT data, contact section, and frequently asked questions. The website is ADA compliant, and vocabulary used is easily understood by the general public.

Wastewater Surveillance Social Media Posts

Public health social media posts were created for local and tribal health jurisdictions to inform the public about COVID-19 trends (increasing or decreasing, significantly or slightly, or remaining the same) in the community (see Appendix B). There are eleven posts total divided into three sets: one set for jurisdictions to use for COVID-19, one set for a fill-in-the-blank disease, and one set of examples with logos, links, and QR codes for reference. In each set, there will be at least three posts that include slightly or significantly increasing, slightly or significantly decreasing, and stable levels of the disease in their community. These social media posts are ADA compliant, and vocabulary used is easily understood by the general public.

Chapter 4 - Discussion

CDEpi Triweekly Meetings

Attending these triweekly meetings allowed me to better understand how a decentralized state works in action with the local and tribal health jurisdictions at the forefront of patient care and disease investigation. Discussions with different disease groups (such as enteric illnesses, vaccine preventative disease, and antimicrobial resistant organisms) has allowed me to understand what prevalence and impact of diseases in Montana. I was able to recognize additional pathogens or other health targets that are negatively impacting communities and assemble a priority list of future wastewater surveillance targets. Discussing Administrative Rules of Montana (ARMs) and reportable conditions shaped my understanding of case definitions, applying disease progression and mechanisms, and the logistics of government and scope of practice.

Weekly Disease Meetings

During these meetings, I learned from other sections in the division how to understand how different sections work together in a multidisciplinary approach to public health. These calls also frame how public health is conducted in a decentralized, rural state. For example, hearing about what new vaccines will become available for the flu and RSV (Respiratory Syncytial Virus) season, potential shortages of therapeutics, and increase in disease trends. These calls helped me understand the interconnected nature of public health and its different sections. With this exposure to information, I can provide helpful ideas to mitigate current problems, learn new health concepts, or better understand the impact one subject area may have on others.

Report Wastewater Surveillance Data

The main limitation present when I started doing the wastewater uploads to DCIPHER was that they operate on a “kill and replace” system meaning that each file accepted by their system replaces the old file. Thus, the data files uploaded must include all historical data for each site in addition to the new data. Additionally, the DCIPHER platform only accepted one submission per week. Thus, if the results are not ready for reporting at a certain time due to a sample did not arriving on time to be tested, or it had to be re-run due to an anomalous result or control issue, it may not get reported until the following week’s upload. With the prewarning system that wastewater data can provide as seen in multiple sources from the literature review, a timely reporting system is important to get the data to the community as soon as possible.

Thus, a more efficient reporting process is needed such as DCIPHER accepting multiple uploads a week and removing or modifying the “kill and replace” system.

Onboard Wastewater Surveillance Sites

One of the limitations of onboarding sites was that not all jurisdictions in Montana are able to participate due to lack of funding, staff capacity, and/or interest. The process from early discussions with the stakeholders to signing the task order to testing is incredibly lengthy. Longer than I originally anticipated due to bidding (receiving quotes from multiple business), presenting to commissions on the local level, etc. Onboarding new sites inherently moves the subject area forward as more sites are testing, providing data, and able to have their data analyzed for trends. To make onboarding new sites more efficient, I would recommend creating an onboarding packet and include an easy-to-follow flow chart for onboarding jurisdictions. With the onboarding packet, I would also resending frequent updates on the process.

Attended the Wastewater Disease Surveillance Summit

The WEF summit is moving the subject area forward by bringing in members of many different parts of the wastewater surveillance world to work more effectively as a multidisciplinary team. As a person working in a smaller jurisdiction in population, it is often hard to connect and apply what larger jurisdictions are doing as they would not work in a smaller area due to lack of staff, lack of funding, lack of community or governmental participation, etc. While WEF did have many presentations from larger communities, they also had smaller communities present, which was much more applicable and impactful to Montana’s program.

Attend the Monthly NWSS Public Health Community of Practice Meetings

The most significant finding that I have taken away from attending the CoP calls is that participating states are at all different stages in their programs and Montana’s program, while still new, can grow tremendously just as other state programs have. The most interesting thing that I learned was that one jurisdiction can test wastewater from individual schools and provide data directly to impacted people. Parents and staff can opt in to receive text messages about what is in the wastewater. This data collection and information sharing more directly with those impacted is a great way to move the subject area forward and encourage community members to take public health action in their own lives, for the health of their own families.

Attend the Monthly NWSS Regional Meetings

This meeting pushes the subject area of wastewater forward by bringing together jurisdictions that are in the same region that may have similar population sizes, political climates, and other similar challenges to navigate and learn from each other to propel all programs forward. The most significant finding that I have taken away from attending the regional calls is that other jurisdictions around me are facing similar challenges but have also overcome them. This call is important as these regions may have similar experiences and communities (e.g. rural population, geography, political climate, public health structure etc.). Given this, we may be able to relate and learn better from each other.

Montana Wastewater Surveillance Web Page

This is relevant to public health as this communicates data about local wastewater data for COVID-19 to provide community members with more information about what is circulating in their community and their potential risk of illness. Prior to my ILE/APE, the state of Montana did not have a state specific wastewater surveillance web page. The information on the website is concise as to not overwhelm the public with too much information. As CDEpi receives questions through the question and comment link, additional sections and frequently asked questions will be updated. Having this webpage foundation will allow for expansion such as adding in a Montana-based Tableau dashboard to display wastewater trends in conjunction with CDEpi's new dashboard for respiratory viruses. This display of data together will allow for a better understanding of the impact of COVID-19 and other respiratory diseases currently circulating in the community and facilitate more effective public health action.

Wastewater Surveillance Social Media Posts

Social media is a common way in Montana for local and tribal health jurisdictions to communicate public health information to community members. Communicating wastewater data to community members is important for community members to aid in their own risk analysis for their likelihood of infection and take appropriate health precautions.

When creating the posts, they had to be concise and use language that the average community member could understand. A benefit of this is that they will get the overall information they need in a few seconds as they scroll through a sea of social media posts. However, a limitation is that it will take additional engagement from the community member to scan the QR code or click the website link to see a fuller picture of what is in the wastewater. Additionally, each jurisdiction has certain workflows to get social media and other content

approved for distribution to the public. This process can take a significant amount of time. Since the posts are already prepared and the content on the posts itself is not changing, only which post is used for that week, this will mitigate any approval process roadblock with this time sensitive data.

By jurisdictions using social media posts to communicate changes in disease levels in the wastewater, it is meeting community members where they are at and opening up the conversation about the information wastewater brings us. The QR code and website url will lead community members to websites, and, in the future, an interactive dashboard where they can engage with the data and take health precautions as they see fit.

Analysis of the Trends of SARS-CoV-2 in Wastewater to Case Data for Two Sites in Montana

When analyzing, I learned that even though the towns are close together in distance, the results can look drastically different. Thus, when communicating data to the public, it is important to not lump locations together as their data is unique. A large limitation that is present not just in this analysis but also nationally in the wastewater surveillance program as a whole is that there is no specific level of disease that would trigger public health action for most diseases. Analysis like these provide important information about what is circulating the community when other data sources are not always accurate. As more analyses like this around the nation are being done, and the national wastewater program expands its knowledge, we will have more concrete guidance.

Conclusion

Overall, the process was very eye opening of the benefits and limitations of the program. Moving forward to make this process as efficient as possible, I would recommend creating an onboarding packet and include an easy-to-follow flow chart for onboarding jurisdictions. With that, sending frequent updates on the process. To further engage with the community, I would also recommend that a Montana-based Tableau dashboard be created to display wastewater trends in conjunction with CDEpi's new dashboard for respiratory viruses. This display of data together will allow for a better understanding of the impact of COVID-19 and other respiratory diseases currently circulating in the community and facilitate more effective public health action.

Chapter 5 - Competencies

Student Attainment of MPH Foundational Competencies

Table 5.1 Summary of MPH Foundational Competencies

Number and Competency		Description
3	***Evidence-based Approaches to Public Health***	Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate
8	***Planning and Management to Promote Health***	Apply awareness of cultural values and practices to the design or implementation of public health policies or programs
18	***Communication***	Select communication strategies for different audiences and sectors
19	***Communication***	Communicate audience-appropriate public health content, both in writing and through oral presentation
21	***Interprofessional and/or Intersectional Practice***	Integrate perspectives from other sectors and/or professionals to promote and advance population health.
22	***Systems Thinking***	Apply systems thinking tools to a public health issue - Process Mapping - using graphics to understand the process for solving public health problems

Competency 3 Evidence-based Approaches to Public Health

Researchers across multiple jurisdictions have analyzed their wastewater trends compared to case, hospitalization, and death trends to determine if wastewater surveillance trends forecast clinical cases, hospitalizations, and deaths (National, 2023). To determine if Montana's wastewater surveillance program also demonstrates a forecast for COVID-19 cases in the community, a comparison of trends was performed (see Appendix C). This comparison was between trends of COVID-19 concentrations in the wastewater to the trends of reported COVID-19 cases in Helena and East Helena, Montana, from August 18, 2020, through August 18, 2023. Wastewater data of COVID-19 are based on concentrations of viral copies of SARS-CoV-2 per liter of wastewater analyzed as reported by the Carroll College laboratory. The COVID-19 reported cases were extracted from the Montana Infectious Disease Information System (MIDIS). The analysis showed that based on the collection date of the wastewater samples and the investigation state date of reported cases, both trends increased during the same week thus the wastewater data in Helena and East Helena did not forecast reported cases. This information highlighted multiple different areas needed for improvement in

Montana's wastewater surveillance program to better capture changes in trends of COVID-19 cases in the community as well as to inform public health action. These findings were presented to the CDEpi and adjacent sections at their October 16th, 2023, meeting.

Competency 8 Planning and Management to Promote Health

There are multiple ways that this ILE/APE project applied this competency. Many Montanans value both physical privacy and privacy with their health data. The wastewater samples, both past and present samples, are from a community rather than from an individual, thus their individual privacy is protected while still providing important community-based information to public health (Centers, 2023). When sites were onboarded for testing, it was imperative to include the tribal nations. Montana is home to twelve tribal nations and seven reservations (Division, 2015). Tribal nations are a large part of Montana's history and culture and need to be represented in the wastewater surveillance program. Additionally, social media posts were selected to distribute weekly wastewater data directly to affected communities. A 2019 survey was conducted by the Greater Montana Foundation to understand Montanans usage and interaction with news and media. These researchers found that 76% of surveyed Montanans reported using social media daily (Greater, 2019). Facebook was also reported as the most used (40%) social media platform for news and other information followed by Instagram (10%) (Greater, 2019). Thus, the eleven created social media posts during the APE/ILE project provided a way for community members to receive pertinent COVID-19 data from their wastewater where they were already viewing other information (see Appendix B). As for the website, since privacy is important to Montanans, that value was mentioned by and reassured based on information provided by the website (see Appendix A).

Competency 18 & 19 Communications

The audiences to communicate wastewater surveillance data include, but are not limited to, wastewater treatment plant operators, health departments (state, local, tribal, and territorial), community members, laboratorians, computer scientists, news and social media correspondents, and government officials (National, 2023). A multidisciplinary approach is required for wastewater surveillance to be implemented efficiently. Direct and frequent communication is needed from all parties, especially health departments and the wastewater treatment plant operators (National, 2023). Therefore, a quarterly report and virtual meetings for wastewater treatment plant operators, laboratorians, and local and tribal health jurisdictions hosted by the state health department was identified through this ILE/APE project as an

important communication strategy for these audiences. Future quarterly reports and virtual meetings will be created and implemented separately from this ILE/APE project. These quarterly reports and meetings will allow for these disciplines to engage with each other to delve into in-depth communication about trends, lessons learned, and best practices.

To accomplish effective communication with all audiences in Montana, a public facing web page on Montana's Department of Public Health and Human Services website was designed, published, and updated frequently to provide timely information (see Appendix A). For weekly communications with the community members, social media posts were created during this ILE/APE project with the intent for the local and tribal health jurisdictions to post this information on their social media pages (e.g., Facebook) with weekly updates on the COVID-19 wastewater surveillance trends (see Appendix B). Both the website and social media posts were ADA (Accessibility and Disability Act) compliant and used common language to be easily understood by the general public.

Competency 21 Interprofessional and/or Intersectional Practice

Many different methods used in Montana's wastewater surveillance program were integrated from other disciplines. Wastewater sample collection methods for this surveillance program were used from already established collection techniques from the wastewater treatment plants. The testing method, polymerase chain reaction (PCR), that was used was an established laboratory method for the detection of biomarkers from other sample collection sources. The method to compare disease trends in wastewater using excel and pivot tables was applied from epidemiologic methods used to compare other disease trends. Additionally, trends can be communicated using already established social media platforms.

During the onboarding of new sites to participate in the wastewater surveillance program, a variety of stakeholders were involved in the process. This multidisciplinary approach was depicted in the progress mapping flow chart (see Appendix D). Initially, I worked with the CDEpi section lead epidemiologist (my preceptor) and the section supervisor, the fiscal staff, and grant manager to understand the scope of the funds awarded by federal partners under the Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases (ELC) grant. I then connected interested local or tribal health jurisdictions and their utility partner to a participating testing laboratory. After drafting and distributing the Task Orders (similar to contracts) to the appropriate jurisdiction, I kept the lines of communication open through email and phone calls to ensure that questions or concerns were addressed promptly. Throughout this process I was able to successfully onboard four testing sites under the currently

awarded grant funds (Helena, East Helena, Livingston, and Rocky Boy) and began onboarding additional sites. Once sites were ready to report laboratory results, I worked with the jurisdiction, laboratory, federal partners, and other epidemiologists within our division to ensure effective and prompt data reporting of the wastewater data.

Competence 22 Systems Thinking - Progress Mapping

As a public health practice, wastewater surveillance is multidisciplinary in nature. These different disciplines and stakeholders include, but are not limited to, federal partners, epidemiologists, fiscal staff, grant management staff, wastewater treatment plant operators, local and tribal health jurisdictions, laboratorians, courier and shipping staff, computer scientists, community members, news and social media correspondents, and local government officials and tribal councils (National, 2023). Process mapping, through the creation of a flow chart, will help the epidemiologists in CDEpi to understand and effectively communicate the sequence of actions and responses in wastewater surveillance (see Appendix D). CDEpi can use this tool to determine stakeholders that may need to be contacted to participate in their quarterly wastewater meetings and receive the quarterly reports. This flow chart will also help identify where bottlenecks and inefficient steps are present between onboarding a new wastewater surveillance site through reporting the data.

Table 5.2 MPH Foundational Competencies and Course Taught In

22 Public Health Foundational Competencies Course Mapping	MPH 701	MPH 720	MPH 754	MPH 802	MPH 818
Evidence-based Approaches to Public Health					
1. Apply epidemiological methods to the breadth of settings and situations in public health practice	x		x		
2. Select quantitative and qualitative data collection methods appropriate for a given public health context	x	x	x		
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	x	x	x		
4. Interpret results of data analysis for public health research, policy or practice	x		x		
Public Health and Health Care Systems					
5. Compare the organization, structure and function of health care, public health and regulatory systems across national and international settings		x			
6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to					x

22 Public Health Foundational Competencies Course Mapping	MPH 701	MPH 720	MPH 754	MPH 802	MPH 818
achieving health equity at organizational, community and societal levels					
Planning and Management to Promote Health					
7. Assess population needs, assets and capacities that affect communities' health		x		x	
8. Apply awareness of cultural values and practices to the design or implementation of public health policies or programs					x
9. Design a population-based policy, program, project or intervention			x		
10. Explain basic principles and tools of budget and resource management		x	x		
11. Select methods to evaluate public health programs	x	x	x		
Policy in Public Health					
12. Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence		x	x	x	
13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes		x		x	
14. Advocate for political, social or economic policies and programs that will improve health in diverse populations		x			x
15. Evaluate policies for their impact on public health and health equity		x		x	
Leadership					
16. Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making		x			x
17. Apply negotiation and mediation skills to address organizational or community challenges		x			
Communication					
18. Select communication strategies for different audiences and sectors	AAI 801				
19. Communicate audience-appropriate public health content, both in writing and through oral presentation	AAI 801				
20. Describe the importance of cultural competence in communicating public health content		x			x
Interprofessional Practice					
21. Perform effectively on interprofessional teams		x			x
Systems Thinking					
22. Apply systems thinking tools to a public health issue			x	x	

Student Attainment of MPH Emphasis Area Competencies

Table 5.3 Summary of MPH Emphasis Area Competencies

MPH Emphasis Area: IDZ Emphasis Area Competency			
Number and Competency		**Description**	**Required Course**
1	***Pathogens/pathogenic mechanisms***	Evaluate modes of disease causation of infectious agents.	DMP 850 / ASI 540
2	***Host response to pathogens/immunology***	Investigate the host response to infection.	DMP 850 / ASI 540
3	***Environmental/ecological influences***	Examine the influence of environmental and ecological forces on infectious diseases.	DMP 710
4	***Disease surveillance***	Analyze disease risk factors and select appropriate surveillance.	DMP 710
5	***Disease vectors***	Investigate the role of vectors, toxic plants and other toxins in infectious diseases.	DMP 710

The MPH infectious diseases and zoonoses emphasis area competencies were primarily attained during the required courses listed in table 5.3. Competency four, disease surveillance, was specifically applied during this ILE project.

Competency 4 - Disease Surveillance

During the SARS-CoV-2 pandemic, there were many health disparities and lack of disease testing and reporting, especially when at-home test kits were acquired and shipped to local jurisdictions in Montana starting in June 2021 (S. Saycich, personal communication, 10/10/2023). Additionally, many Montanans value privacy which may have been a contributing factor to the lack of Home-Test result reporting to public health. To fill the knowledge gap of accurate case data, wastewater surveillance was implemented. This surveillance method tests viral levels of its target, in this case SARS-CoV-2. These data are independent from case data and health systems while upholding individual community members privacy due to its population-based data (Centers, 2023c).

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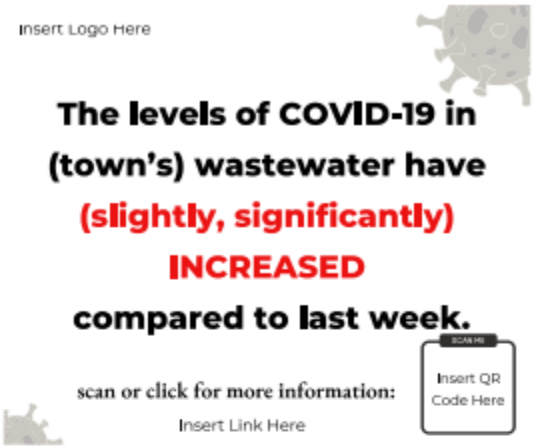
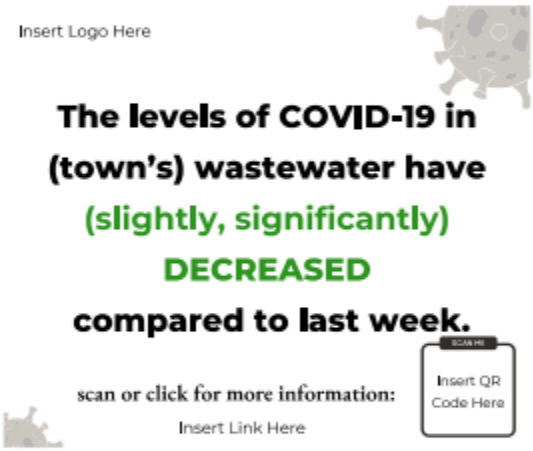
Appendix A - Montana Wastewater Surveillance Web Page

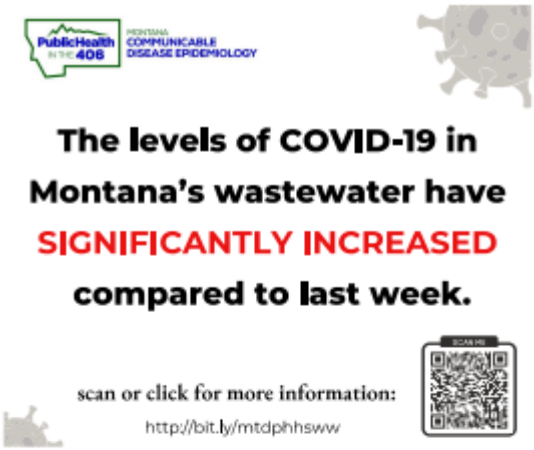
Website Link: https://dphhs.mt.gov/publichealth/cdepi/diseases/WastewaterSurveillance

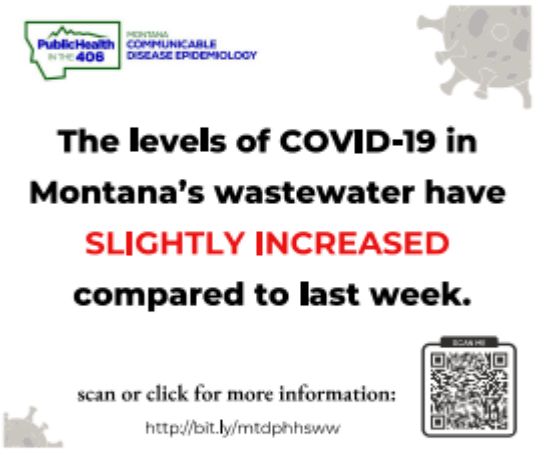
Image of the Webpage

Appendix B - Wastewater Surveillance Social Media Posts

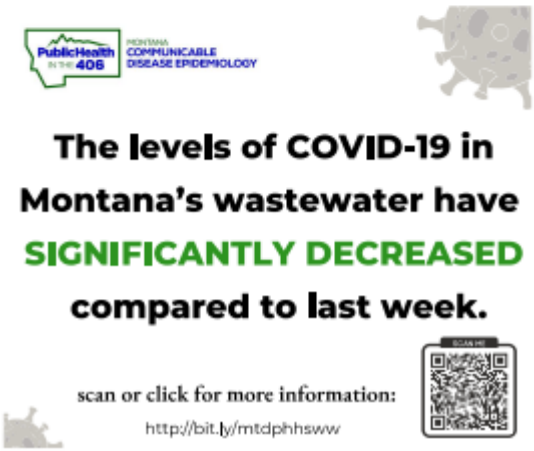


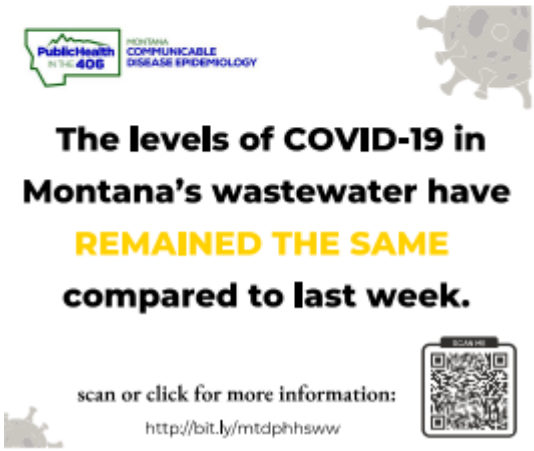



PublicHealth IN THE 406
MONTANA COMMUNICABLE DISEASE EPIDEMIOLOGY
The levels of COVID-19 in Montana's wastewater have SIGNIFICANTLY INCREASED compared to last week.
scan or click for more information:
http://bit.ly/mtdphhsww


PublicHealth IN THE 406
MONTANA COMMUNICABLE DISEASE EPIDEMIOLOGY
The levels of COVID-19 in Montana's wastewater have SLIGHTLY INCREASED compared to last week.
scan or click for more information:
http://bit.ly/mtdphhsww


PublicHealth IN THE 406
MONTANA COMMUNICABLE DISEASE EPIDEMIOLOGY
The levels of COVID-19 in Montana's wastewater have SLIGHTLY DECREASED compared to last week.
scan or click for more information:
http://bit.ly/mtdphhsww


PublicHealth IN THE 406
MONTANA COMMUNICABLE DISEASE EPIDEMIOLOGY
The levels of COVID-19 in Montana's wastewater have SIGNIFICANTLY DECREASED compared to last week.
scan or click for more information:
http://bit.ly/mtdphhsww


PublicHealth IN THE 406
MONTANA COMMUNICABLE DISEASE EPIDEMIOLOGY
The levels of COVID-19 in Montana's wastewater have REMAINED THE SAME compared to last week.
scan or click for more information:
http://bit.ly/mtdphhsww

Appendix C - Analysis of the Trends of SARS-CoV-2 in Wastewater to Case Data for Two Sites in Montana

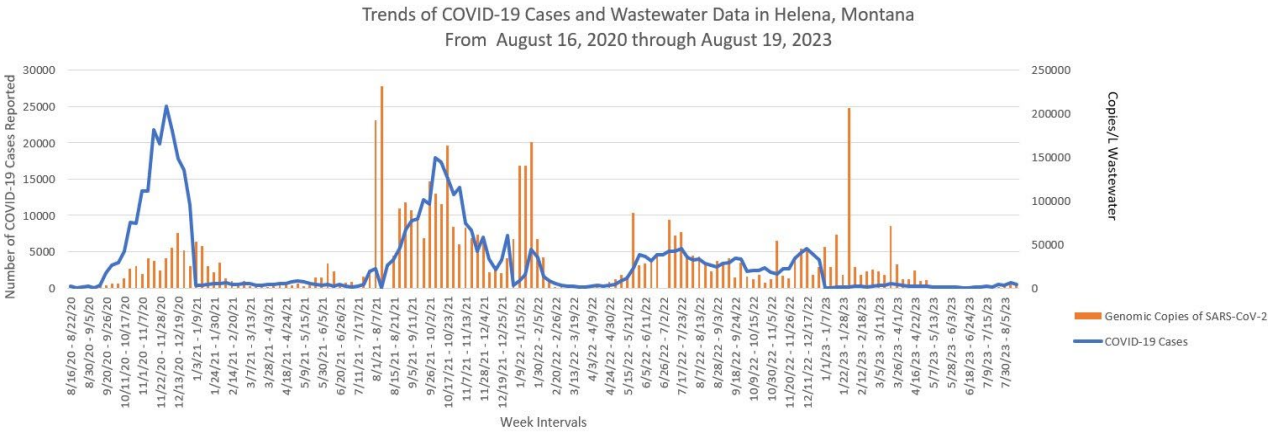


Figure A The trends of reported COVID-19 cases in Helena, Montana, and genomic copies of SARS-CoV-2 per liter of wastewater were graphed together for comparison from August 16, 2020, through August 19, 2023. The reported COVID-19 case data was collected from the Montana Infectious Disease Reporting System (MIDIS). The wastewater surveillance data was analyzed and reported to CDEpi from Carroll College. While the wastewater surveillance data demonstrated here does not forecast COVID-19 cases, it did demonstrate a continued presence of SARS-CoV-2 in the wastewater in January through March 2023 contrary to the minimal amounts of COVID-19 reported cases.

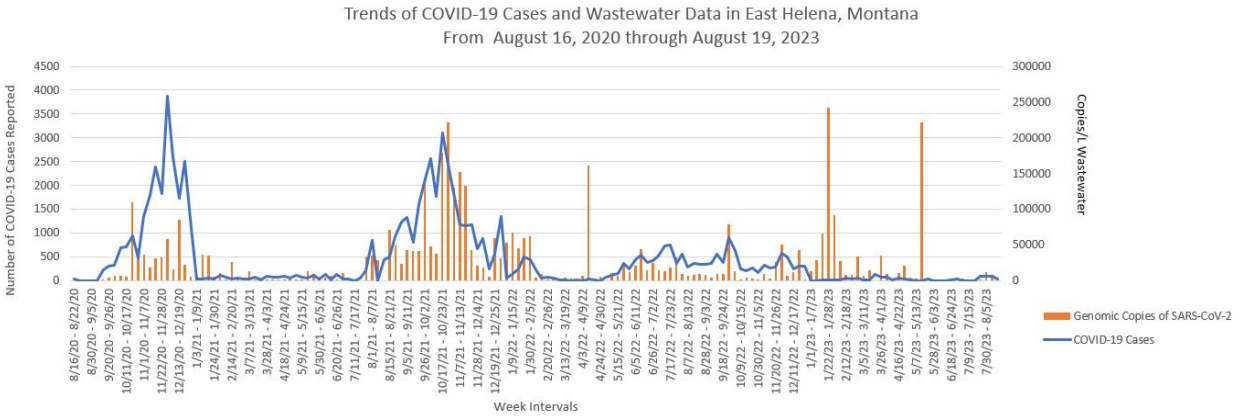


Figure B The trends of reported COVID-19 cases in East Helena, Montana, and genomic copies of SARS-CoV-2 per liter of wastewater were graphed together for comparison from August 16, 2020, through August 19, 2023. The reported COVID-19 case data was collected from the Montana Infectious Disease Reporting System (MIDIS). The wastewater surveillance data was analyzed and reported to CDEpi from Carroll College. While the wastewater surveillance data demonstrated here does not forecast COVID-19 cases, it did demonstrate a continued presence of SARS-CoV-2 in the wastewater in January through March 2023 contrary to the minimal amounts of COVID-19 reported cases.

Appendix D - Progress Mapping - Montana's Wastewater Surveillance Program Flow Chart