2018 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Characterize Unregulated Contaminants in Source Water and Drinking Water
PROJECT MANAGER: Stephen Robertson
AFFILIATION: Minnesota Department of Health
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WEBSITE: www.health.state.mn
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 04g

APPROPRIATION AMOUNT: $1,000,000
AMOUNT SPENT: $966,516
AMOUNT REMAINING: $33,483

Sound bite of Project Outcomes and Results
Analysis of drinking water resources reveals the presence of a range of unregulated contaminants at low levels. Most of these levels are below health-based guidance, if available. Results are being used to inform development of new health-based guidance and to perpetuate drinking water ambient monitoring.

Overall Project Outcome and Results
This project sampled water from 105 public water systems statewide for a wide spectrum of drinking water contaminants. Participating public water systems were organized into three groups: systems that use surface water, systems that use groundwater potentially influenced by wastewater, and systems that use groundwater potentially affected by agricultural land uses. Depending on the group, samples were analyzed for as many as 600 different contaminants, including pharmaceuticals, per- and polyfluoroalkyl substances (PFAS), organic wastewater indicators, and pesticides.
Results for individual systems showed that most contaminants analyzed were not detected in drinking water, but some contaminants were present at low levels. The detections included 84 pesticides, 51 pharmaceuticals, 43 wastewater indicators, 15 PFAS, eight benzotriazoles, and one inorganic compound. Some contaminants were detected at multiple systems. Results were compared against health-based guidance values, if available, although most contaminants analyzed lack health-based guidance values. A few results exceeded available guidance values. In those instances, MDH staff coordinated with the public water system to validate results and take action where appropriate.
There were detections of contaminants from most classes analyzed, but pesticides and PFAS were the most commonly detected. The most frequently detected contaminants across the study included lithium, pesticides (metolachlor, atrazine, deethylatrazine), PFAS (PFBA, PFHxS, PFOS, PFOA), and tribromomethane. Differences in occurrence or concentration were observed in source versus finished water samples for some groups (e.g., pharmaceuticals, benzotriazoles) but not for others (e.g., PFAS, pesticides). Samples collected in geologically vulnerable settings generally showed higher contaminant concentrations than those collected from non-vulnerable sites.
Results have been used to prioritize and nominate contaminants for the development of health-based guidance. Also, the project has led to creation of a permanent drinking water ambient monitoring program. This ongoing work will help mitigate and manage the exposure to unregulated contaminants through Minnesota's drinking water.

Project Results Use and Dissemination
The project and associated materials are described on the MDH website. This project has spurred creation of risk communication resources for public water systems and MDH staff.

A project summary report has been prepared and will be available on the MDH website by October 2022.

Preliminary results from the project have been presented at the University of Minnesota's Water Resource Conference (October 2020). A complete analysis of the results is forthcoming and will be prepared for publication.

A professional paper describing the ELISA methodology used in this project is in press for publication. (Krall, Aliesha L., et al, 2022)

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2018 ENRTF Work Plan Final Report (Main Document)

Today's Date: August 15, 2022

Final Report

Date of Work Plan Approval: 06/05/2018

Project Completion Date: June 30, 2022

PROJECT TITLE: Characterize Unregulated Contaminants in Source Water and Drinking Water

Project Manager: Steve Robertson

Organization: Minnesota Department of Health

College/Department/Division: Environmental Health Division

Mailing Address: 625 Robert Street North

City/State/Zip Code: Saint Paul, MN 55164-0975

Telephone Number: 651-201-4648

Email Address: steve.robertson@state.mn.us

Web Address: www.health.state.mn

Location: Statewide

Total Project Budget: $1,000,000

Amount Spent: $966,516.58

Balance: $33,483.42

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 04g

Appropriation Language: $1,000,000 the second year is from the trust fund to the commissioner of health to establish monitoring networks of public water-system wells and surface-water intakes to determine if contaminants persist after standard public water treatment. This appropriation is available until June 30, 2022, by which time the project must be completed and final products delivered.

I. PROJECT STATEMENT:

Unregulated contaminants are one of the 21st century threats to drinking water for which existing resources and regulatory approaches are insufficient. The Minnesota Department of Health (MDH) monitors all public water systems (approximately 7000 statewide) for conformance with federal monitoring requirements and water quality standards. EPA has established about 100 water quality standards for drinking water. Federal regulation requires that these standards be met in finished water – the product that a public water system delivers to its customers. For thousands of chemicals in use in modern society, little or no monitoring of drinking water is done because there is neither a federal regulatory mandate nor resources to test for them in drinking water sources. Some of our agency partners (MPCA, MDA, USGS, EPA) have conducted monitoring of lakes, rivers or ambient groundwater to better understand water quality conditions, but none of these efforts have been focused on drinking water sources.

Drinking water sources vary across the state of Minnesota. While most of the state's residents drink groundwater (mostly from wells), many of the largest public water systems in the state (serving about 20 percent of the population), rely on rivers, lakes or other surface water. Land use is a factor that determines groundwater and surface water quality where precipitation onto contaminant sources soaks into the ground or runs off into streams or lakes. Prior work established that land uses involving wastewater disposal and agricultural chemical storage/use on the land can cause unregulated contaminants to occur in water supplies. Industrial and municipal wastewater effluent contains pharmaceuticals, personal care products and other endocrine-active substances, while runoff and infiltration from agricultural lands can contain various types of pesticides, as well as nutrients. Additionally, natural events like algal blooms can produce cyanotoxins that are acutely toxic to human health.

In Minnesota, the distribution of drinking water is seldom directly from the source without some degree of handling and treatment. Sometimes this handling and treatment is to satisfy regulatory requirements that protect public health, and sometimes it is to provide some aesthetic value, like softening or removal of iron. Due to the cost and lack of a regulatory mandate, it is very unusual for public water systems to design for the removal of unregulated contaminants. However, research indicates that existing treatment processes sometimes provide incidental removal of some unregulated contaminants. Consequently, in addition to characterizing unregulated contaminants present in selected high risk drinking water sources, this project will evaluate the degree to which contaminants present in raw source water may persist to finished drinking water.

The goals of this project are to 1) characterize the presence of selected unregulated contaminants in drinking water sources and associated samples of treated drinking water in Minnesota, and 2) identify screening approaches to simplify and target future monitoring efforts. Also, the information will be of value in MDH efforts to assist public water systems statewide in the areas of source water protection, water treatment, health based guidance, and risk communication. Currently, the lack of data to drive these efforts undermines the integrity of future drinking water protection efforts. As a result, achieving project goals pertaining to drinking water source characterization will provide data and knowledge that state and local officials can use to prioritize future interventions in a way that minimizes risk and maximizes public health benefits.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2019

MDH created an internal working team for the project. Additionally, MDH created a technical advisory team (TAT) comprised of internal and external stakeholders. This team has met four times since project inception to discuss project goals, interim work products and to advise the MDH working team on the development of the overall monitoring plan for the project. Much of the analytical work will be done by USGS under the auspices of a work order as part of an existing Joint Funding Arrangement (JFA), which has already been established with USGS. Execution of the work order is pending; USGS staff were affected by the partial federal government shutdown. If the shutdown resumes, schedules for this project may be affected.

Second Update June 30, 2019
Overall project work moved forward since January, 2019 in the following areas: 1) Activity 1 site and parameter selection were concluded and a monitoring plan finalized as described in the Activity 1 status update, 2) preparations were made to initiate Activity 2, as described below, and 3) communications materials were developed to describe project goals, objectives and outcomes to project participants, MDH staff, and partners.
Third Update January 31, 2020
Field staff were hired in July to conduct the statewide sampling per the monitoring plan (this plan is available here: https://www.health.state.mn.us/communities/environment/water/unregcontam.html). Coordination and training with USGS staff were conducted in July and early August. 30 PWS wells were sampled in agriculturally sensitive areas, 30 PWS wells vulnerable to wastewater were sampled, and 16 surface water systems were sampled twice. All site visits included a sample at both the source and entry point. Sampling was conducted between August-November 2019.
In total samples are being analyzed for about 12 different parameter groups, including pesticides, pharmaceuticals personal care products, and PFAS. The capabilities of three separate contracted laboratories were enlisted to conduct the analytical work. All results will not be received by MDH until about May, 2020.
Fourth Update June 30, 2020 (July 17, 2020)
After the conclusion of field activities late in the fall of 2019, most of the time period associated with this update has been spent awaiting the delivery of results from the analytical laboratories. As of the time of this update, we are in receipt of all results from AXYS Analytical, and the MDH public health lab. We have partial results from the USGS. Their analytical capabilities have been significantly impacted by the COVID pandemic. Results from USGS are expected in the next update period for this grant. MDH staff are preparing interim results memos that will be sent to participating public water systems in August.
Fifth Update January 31, 2021
All results from the MDH, AXYS Analytical and USGS laboratory analytical work has been received. Data have been compiled and preliminary assessments made relative to known public health protection criteria. Interim results reports have been distributed to participating public water systems. MDH and USGS staff presented early results assessments to Water Resources Conference. Budgets have been updated and evaluated. Sufficient budget remains to plan additional field activities to provide additional insight within bounds of overall study design.
AMENDMENT REQUEST March 10, 2021 (Approved by LCCMR 3/15/2021)
We are requesting a shift from the personnel budget to Professional/Technical/Service Contracts. Specifically, this transfer will address a negative balance on the line item for MDH Public Health Laboratory.

- Personnel budget will be reduced by $5165 to a revised budget of $47,235 ($7797 remaining balance).
- Professional/Technical/Service Contracts will increase by $5165 to $26,400 ($0 remaining balance).

This change is being requested because the actual costs charged to MDH for laboratory analysis differed from those estimated at project outset. To offset this change, MDH will cover personnel costs as an additional in-kind contribution to the project.
Sixth Update June 30, 2021
Preliminary data compilation and assessments complete. Professional paper prepared describing subset of monitoring work. Review of budget revealed first phase of field activities was completed below forecasted cost estimates. Supplemental monitoring plans created for second phase of monitoring.
Amendment Request (Approved by LCCMR 10/5/2021)

1. Extend project end date to June 30, 2022 from December 31, 2021. This will allow phase two follow sampling as described in Activity 1, Task 4 and Activity 2, Task 3.
2. Adjust budget to direct remaining funds for phase two sample analysis and ongoing USGS professional/technical services. Specifically, re-allocate funds originally designated for MDH payroll ($7797), travel ($15,123), USGS professional/technical services ($24,993) and supply expenses ($3941) to analytical laboratory. This action will zero out budget in the MDG personnel, travel, and expenses

categories. Remaining project expenditures will be in the following categories: private analytical laboratory (approx. $193,000) and USGS professional/technical services (approx. $44,802).

Final Update January 31, 2022
Phase 2 of sampling is complete. Laboratory analysis pending. Data analysis plan is under development and is being reviewed by project partners.

Overall Project Outcomes and Results
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There were detections of contaminants from most classes analyzed, but pesticides and PFAS were the most commonly detected. The most frequently detected contaminants across the study included lithium, pesticides (metolachlor, atrazine, deethylatrazine), PFAS (PFBA, PFHxS, PFOS, PFOA), and tribromomethane. Differences in occurrence or concentration were observed in source versus finished water samples for some groups (e.g., pharmaceuticals, benzotriazoles) but not for others (e.g., PFAS, pesticides). Samples collected in geologically vulnerable settings generally showed higher contaminant concentrations than those collected from non-vulnerable sites.
Results have been used to prioritize and nominate contaminants for the development of health-based guidance. Also, the project has led to creation of a permanent drinking water ambient monitoring program. This ongoing work will help mitigate and manage the exposure to unregulated contaminants through Minnesota's drinking water.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Develop detailed monitoring plan
Description: Analyze land use adjacent to public water system wells and upstream of intakes. Identify wells and intakes at risk from wastewater disposal and agricultural chemicals. Develop monitoring networks comprised of public water system wells and intakes at which the water quality effects of wastewater and agricultural chemicals can be sampled and evaluated.
Review previous state and national water monitoring information to establish a list of laboratory analytical parameters (i.e., specific compounds) targeted to Minnesota conditions. Parameters will be grouped into classes (e.g., pharmaceuticals, personal care products, pesticides, wastewater indicators, etc.). Further analysis will establish specific indicators for each class for which semi-quantitative pre-screening may provide information to guide rigorous and quantitative laboratory analysis. Develop formal strategy to use combination of screening approach and laboratory analysis to maximize the information received on the presence of unregulated contaminants while minimizing costs.
Create statewide monitoring networks for public water systems at risk from the following land uses: 1) wastewater disposal and 2) agricultural chemical storage and uses. Networks will consist of systems using both groundwater and surface water. Establish sampling schedule.

ENRTF BUDGET: $ 59,341

Outcome	Completion Date
1. *Analyze land uses near public water system wells and intakes. Identify separate ranked lists of vulnerable public water system wells ranked relative to the degree of exposure to wastewater disposal and agricultural chemicals. Prospective sites are expected all over the state.*	January 2019
2. *Develop targeted list of parameters of concern in Minnesota due to wastewater disposal and agricultural chemical use. Employ both screening tools and quantitative laboratory analysis to evaluate drinking water sources.*	January 2019
3. *Create specific monitoring plan that lists wells, parameters and sampling schedule for 2019 and 2020.*	March 2019
4. *Update monitoring plan to include sites and parameters not included in 2019 sampling due to budget concerns*	September 2021

First Update January 31, 2019

Outcome 1, developing lists of prospective sampling sites, is well underway. Three different sets of monitoring sites are under development. The first is comprised of public water systems that use surface water as a drinking water source. Surface water resources are among the most vulnerable in the state. There are 23 community systems that use surface water in Minnesota, and nearly all will be included (multiple systems use Lake Superior as a source of supply – due to cost concerns, some will not be sampled because the additional information provided by multiple sampling sites on the lake will likely be negligible). The second set of sampling sites consists of systems that use groundwater as a drinking water source and are located in areas that might make them vulnerable to wastewater discharges. Prospective sites are being evaluated based on some of the following criteria: vulnerable geologic setting, multiple water quality criteria (e.g., chloride/bromide ratios, general wastewater indicators), preliminary results from ongoing Virus Study, proximity to wastewater disposal or conveyance infrastructure, and other land use considerations. The third set of sampling sites is of systems that use groundwater as a drinking water source and are located in areas that are subject to agricultural land uses. Prospective sites are being evaluated based on some of the following criteria: vulnerable geologic setting, existing water quality indicators (e.g., nitrate-nitrogen, results from 2015 Pesticide Occurrence Study), biological indicators of agricultural impact from ongoing Virus Study, land use (e.g. number of acres of cultivated lands in drinking water supply management areas), identification of agricultural response actions in wellhead protection plans.

Outcome 2 relates to parameter selection. The principal drivers for parameter selection are prior results from sampling efforts in Minnesota, cost and availability of suitable analytical techniques, stakeholder nominations, association of specific parameters to land use target (i.e., pesticides for agricultural sites), and results from national studies. Selected parameters vary for each of the three sets of monitoring sites, as described above for Outcome 1, because the parameters of interest differ depending on land use and drinking water source.

Outcome 3, development of formal monitoring plan. Creating the three separate monitoring networks, identifying the sampling sites for each, and selecting relevant parameters will be a balancing act. The more sampling sites, the more geographic representation we can obtain with the results. The more parameter schedules we add will provide a more comprehensive assessment of unregulated contaminants. Increasing either sampling sites or parameter schedules will increase cost, so the final monitoring plan will necessarily represent a balancing act.

Second Update June 30, 2019

Technical advisory team (TAT) completed its activity 1 work regarding candidate site selection criteria and parameter selection criteria. These were used to identify sampling sites for each of three sampling networks. Approximately 30-35 candidate sites were identified for both of the groundwater networks – one network of wells in or near wastewater sources and the other near agricultural land uses. The third network is comprised of 17 sites representing surface water sites. The monitoring plan for the project describes the results of this work. It is not yet posted to the MDH web site describing the project, but will be soon.

Third Update January 31, 2020
Outcomes 1, 2 and 3 were completed as of the last update. Monitoring plan is available at: https://www.health.state.mn.us/communities/environment/water/unregcontam.html
No further updates.
Fourth Update June 30, 2020 (July 17, 2020)
No further update.
Fifth Update January 31, 2021
No further update.
Sixth Update June 30, 2021
Monitoring plan update in preparation. Overall sampling objectives are the same. Updated plan will include sites and parameters not included in first round of sampling due to budget concerns. Second phase of sampling will allow more robust characterization of the occurrence and distribution of parameters of concern based on phase one results and the ability to investigate settings that were not prioritized on phase one sampling efforts.
Final Update January 31, 2022
Monitoring plan completed and distributed to partners for feedback. Plan was implemented as will be described in next activity update.
Final Report Summary
This project used existing capacity within MDH's Drinking Water Protection program to identify, assess, and prioritize sources of supply used by public water systems in the state in order to establish a system or group of sampling sites. These sampling sites were categorized based on their vulnerability (i.e., sensitivity to contamination from activities at the land surface) and their potential to be affected by 1) land uses dominated by agricultural land uses, 2) sources of contamination that include wastewater disposal, or general surface water conditions. Sites meeting these separate criteria were grouped into, respectively, an agricultural monitoring system, a wastewater monitoring system, and a surface water monitoring system.
Parameter selection varied depending on the potential for usage or occurrence in the recharge area for the well or the intake. For example, samples collected at agricultural sites were subject to analysis for a comprehensive list of pesticides, including herbicides, insecticides and fungicides. Wastewater sites were analyzed for a wide range of pharmaceuticals. Samples from surface water sites were analyzed for the widest range of parameters, including pharmaceuticals, organic wastewater compounds, PFAS, and pesticides, among other things.
Results of the sample site and parameter selection processes were reviewed with a technical advisory team comprised of experts from other state and federal agencies, as well as public water systems. Monitoring plans documenting this work were published on the MDH web site.

ACTIVITY 2: Execute monitoring plan developed in Activity 1
Description: Collect and analyze water samples from public water system wells/intakes identified as at risk for wastewater disposal and agricultural chemicals. The work for this activity constitutes the primary data collection effort of the project. It will consist of coordinating the sampling needs for this project with other MDH sampling and inspection in support of compliance activities associated with federal Safe Drinking Water Act compliance. Assessments will need to be made each sampling round after evaluation of initial screening information to identify those samples associated with drinking water sources with the highest potential for presence of unregulated contaminants of concern. These assessments will be used to identify samples for laboratory analysis.

ENRTF BUDGET: $ 836,644

Outcome	Completion Date
1. *Collect water samples from drinking water sources identified in monitoring plan completed in activity 1 for ELISA analyses and in-depth quantitative laboratory analyses.*	November 2020
2. ELISA and quantitative laboratory analysis of source and finished water samples and data quality assurance	March 2021

3. Collect water samples from drinking water sources identified in supplemental monitoring plan completed in Activity1, Task 4 for in depth laboratory analyses.	December 2021

First Update January 31, 2019

No activity during this working period.

Second Update June 30, 2019

Activity 2 work activities did not formally commence, but preparations were made for initiating the work in July or August of 2019. This work consisted of 1) initiating hiring process for samplers who will travel statewide to collect and ship samples, 2) coordinating logistical support with project partners (USGS) to provide field and lab training for new staff, 3) communication and coordination with Community public water supply staff (MDH) re: roles and responsibilities relative to this new project, 4) outreach to key partners to secure engagement (city of Minneapolis, Water Utility Council, etc), 5) development of communication materials (factsheets, webpage, message blocks, etc) to help assure clear and consistent messaging relative to project goals and outcomes, 6) identification and purchase of field equipment and supplies, and 7) contracting with USGS and other laboratories.

Third Update January 31, 2020

Activity 2 work was initiated in July, 2019. MDH hired two temporary sampling staff in July 2019 to conduct the sampling. Training on field sample collection, handling, and shipping was conducted in conjunction with USGS staff in July and August 2019. Staff prepared scheduling plans to optimize travel and shipping needs. Formal sample collection began in August 2019 by starting on the first round of samples from surface water systems. Subsequently, thirty samples each were collected from each of the groundwater networks – the sites with potential wastewater influence and those with potential agricultural influence. The second round of surface water samples were collected by mid-November, when the sampling was complete. At all sites where it was possible, samples were collected from both the source (i.e., well or intake) and the entry point into the distribution system.

Full laboratory analytical results are not expected until mid 2020.

Fourth Update June 30, 2020 (July 17, 2020)

Analytical results from Fall 2019 sampling have been delivered piecemeal to MDH because the analytical work was distributed among three different laboratories. While results from MDH and AXYS are complete, results from specialized laboratories operated by the USGS are still pending. As results have been received, they are screened against known health-based guidance. Should results exceed threshold values, MDH staff will follow the Drinking Water Protection CEC Framework for guiding system response. Partial results are sorted into data systems for later analysis.

Fifth Update January 31, 2021

Based on remaining financial resources, additional sampling is being planned for the spring of 2021 to further evaluate the sampling locations and parameters omitted in the fall 2019 sampling because of budget concerns. We will be updating the monitoring plan in the spring of 2021 and commence additional sampling prior to next status report. This additional data collection stage will require extending the data analysis completion dates as described in Activity 3 (see fifth update for activity 3, below).

Sixth Update June 30, 2021

Execution of the supplemental monitoring plan will proceed in third quarter of 2021.

Final Update January 31, 2022

Phase 2 monitoring activities commenced and were completed since last update. Approximately 120 samples were collected at public water systems in vulnerable and non-vulnerable environments across the state. Per the monitoring plan and original study design, samples of both source water and finished drinking water were collected at each of these systems.

Final Report Summary

Prior to any actual sampling, much advance work needed to happen to prepare MDH staff and public water systems. Studies and research that examine the water quality conditions at real world operating drinking water systems is understandably sensitive for regulators and public water systems alike because the results might cause confusion and undermine trust in public drinking water systems. Studies of unregulated contaminants in drinking water is relatively new, is rapidly evolving, and necessarily involves areas of uncertainty, especially for

people who lack the background and experience to interpret the results. Because the MDH could not compel participation in the study we had to earn the trust of participants. We did this in three principal ways: 1) we developed risk and project communications materials for participants and assured them that MDH would continue to help them with these needs depending on what the project outcomes were, 2) the drinking water program developed a response framework (e.g, CEC Framework) so that systems would know in advance how MDH would treat detections that might result during the study, and 3) MDH staffers connected personally with participating systems to invite their participation and to answer questions. In the end, only a few systems declined participation. The work products from items 1 and 2 in the list above represent true program innovations that will serve our needs well into the future.
Field sampling was conducted in two phases. Phase 1 occurred in 2019 and phase 2 occurred in 2021. As part of this work more that 230 sampling locations statewide were visited, some of them on multiple occasions, resulting in over 160 site visits. During each visit samplers needed to exercise strict QAQC to avoid inadvertent contamination and to assure safe and secure chain of custody from the sampling site to the laboratory. In the end, samples were collected from over 300 sites and were subject to hundreds of analyses.

ACTIVITY 3: Data analysis and report writing

Description: Upon receipt of quantitative data from the laboratory, data will be quality assured to ensure a robust dataset is available for data analysis. Once the dataset is finalized, different statistical methods will be explored to identify the appropriate method for determining differences between sample types (source and treated), among facilities, and between different types of risk (e.g. agriculture or wastewater). Results will be summarized in a peer-reviewed publication.

ENRTF BUDGET: $ 104,015

Outcome	Completion Date
1. *Statistical analyses and interpretation of quantitative data*	May 2021
2. *Report preparation*	June 2021

First Update January 31, 2019
No activity during this working period.
Second Update June 30, 2019
No activity during this working period.
Third Update January 31, 2020
No activity during this working period.
Fourth Update June 30, 2020
Analytical results received during this update period have been screened against known health based guidance and screening values for drinking water. Data have been compiled and organized for a later, more complete analysis.
Fifth Update January 31, 2021
Plans for full data analysis are underway. Analysis will take several months and will commence in the next reporting period. Analysis activities may extend beyond June 2021 because of phase II sampling planned for the spring of 2021.
Sixth Update June 30, 2021
Draft professional paper developed describing ELISA work.
Final Update January 31, 2022
Final data analysis plan, incorporating data from phase 1 and phase 2 is in development and is under review by project partners. Once all laboratory data are received from contractors, then the plan will be executed.
Final Report Summary
Results for individual systems showed that most contaminants analyzed were not detected in drinking water, but some contaminants were present at low levels. The detections included 84 pesticides, 51 pharmaceuticals, 43 wastewater indicators, 15 PFAS, eight benzotriazoles, and one inorganic compound. Some contaminants

were detected at multiple systems. Results were compared against health-based guidance values for contaminants with available guidance, although most contaminants analyzed lack health-based guidance values. A few results exceeded available guidance values. In those instances, MDH staff coordinated with the public water system to validate results and take action where appropriate.
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IV. DISSEMINATION:

Description: A report will be prepared at the conclusion of each project activity, as described above. Each report will contain key data and results generated by the work as well as an evaluation of the information relative to water quality and public health criteria. Reports will be submitted to the LCCMR, published on the MDH web site, and submitted to the Minnesota Water Research Digital Library. As appropriate, project data and results will be summarized and evaluated in peer-reviewed professional publications and presented at local and national conferences.

First Update January 31, 2019
No activity during this working period.
Second Update June 30, 2019
Activity 1 is complete and resulting report (monitoring plan) is complete and available upon request. Will be posted to website upon review and approval relative document accessibility.
Third Update January 31, 2020
No activity during this working period.
Fourth Update June 30, 2020
No activity during this working period.
Fifth Update January 31, 2021
USGS and MDH staff presented a summary of limited data analysis at the University of Minnesota's Water Resources Conference in October.
Sixth Update June 30, 2021
Draft professional paper prepared and distributed for comments.
Final Update January 31, 2022
No activity during this working period.
Final Report Summary
The project and associated materials are described on the MDH website. This project has spurred creation of risk communication resources for public water systems and MDH staff. Also a formal response action framework for unregulated contaminants, entitle the CEC Response Framework, was developed by MDH staff to guide departmental response expectations of public water systems in the event of CEC detections.

A project summary report has been prepared, is in review, and will be available on the MDH website by October 2022.

Preliminary results from the project have been presented at the University of Minnesota's Water Resource Conference (October 2020). A complete analysis of the results is forthcoming and will be prepared for publication.

A professional paper describing the ELISA methodology used in this project is in press for publication. (Krall, A.L., Elliott, S.M., de Lambert, J.R., and Robertson, S.W., in press, Comparison of the results of enzyme-linked

immunosorbent assay (ELISA) to mass-spectrometry based analytical methods for six unregulated contaminants in source water and finished drinking-water samples: U.S. Geological Survey Scientific Investigations Report 2022–5066, 29 p., https://doi.org/10.3133/sir20225066.)

V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview: See attached budget spreadsheet

Explanation of Capital Expenditures Greater Than $5,000: NA

Explanation of Use of Classified Staff: Classified staff will not be paid for with ENRTF.

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 986	Divide by 2,080 = TOTAL FTE: 0.47

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 1664	Divide by 2,080 = TOTAL FTE: 0.8

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period:			
EPA Section 106 Grant	$ 14,011	$ 12,402	Expended amounts are final as of June 30,2022
USGS match	$ 69,084	$129,150	Expended amounts are final as of June 30,2022
EPA DWRLF Set-aside	$ 91,700	$ 115,648	Expended amounts are final as of June 30,2022
Other State $ To Be Applied To Project During Project Period: *NA*			
Past and Current ENRTF Appropriation: *NA*			
Other Funding History: *NA*			

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Sarah Elliot, Mark Brigham	Scientists	US Geological Survey	Project partner/collaborator

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Mark Ferrey	Research Scientist	MPCA	Project Advisor
Bill van Rsywyk	Hydrologist 4	MDA	Project Advisor

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

The outcomes of this work will be used to inform work efforts involving source water protection, development of health-based guidance, drinking water treatment, as well as other means of managing unregulated contaminants in drinking water sources. Additionally, the results of this work will help to facilitate interagency coordination and cooperation to prioritize and target drinking water protection efforts. Our intent is to use the project to leverage other funding partners to support ongoing and permanent drinking water source characterization efforts. Lastly, the laboratory analytical techniques required for the work described in this proposal are, at present, cost-prohibitive to carry out routinely. Accordingly, this study will include the development of strategies (e.g., indicator parameter lists, simplified analytical protocols, use of new technology) that could be used in general practice by MDH, public water systems and other stakeholders to evaluate risks relative to unregulated contaminants.

As of August 2022, many of the expected outcomes of this project work have been achieved. Staff have used results from this project to prioritize and nominate contaminants for the development of health-based guidance. A Drinking Water Protection Section response action framework provides a predictable process for following up on detections above threshold values. Risk communication materials have been developed to assist public water systems and MDH staff in presenting information to others regarding the work. A data summary report will be posted to MDH website in the fall of 2022. MDH has requested ongoing funding for a Drinking Water Ambient Monitoring Program. Preliminary steps towards formal establishment of this program are underway now as the Drinking Water Protection Section is engaged in monitoring activities designed to ascertain the presence or absence of PFAS compounds in drinking water systems statewide. The more general program will be used to screen drinking water sources for CECs, to monitor drinking water sources where prior detections have been observed, and to characterize aquifer resources on a regional scale. This initiative will be housed in the Drinking Water Protection Section of MDH.

VIII. REPORTING REQUIREMENTS:

- **The project is for 4.0 years, will begin on July 1, 2018 and end on June 30, 2022.**
- **Periodic project status update reports will be submitted January 31 and June 30 of each year.**
- **A final report and associated products will be submitted between July 3 and August 15, 2022.**

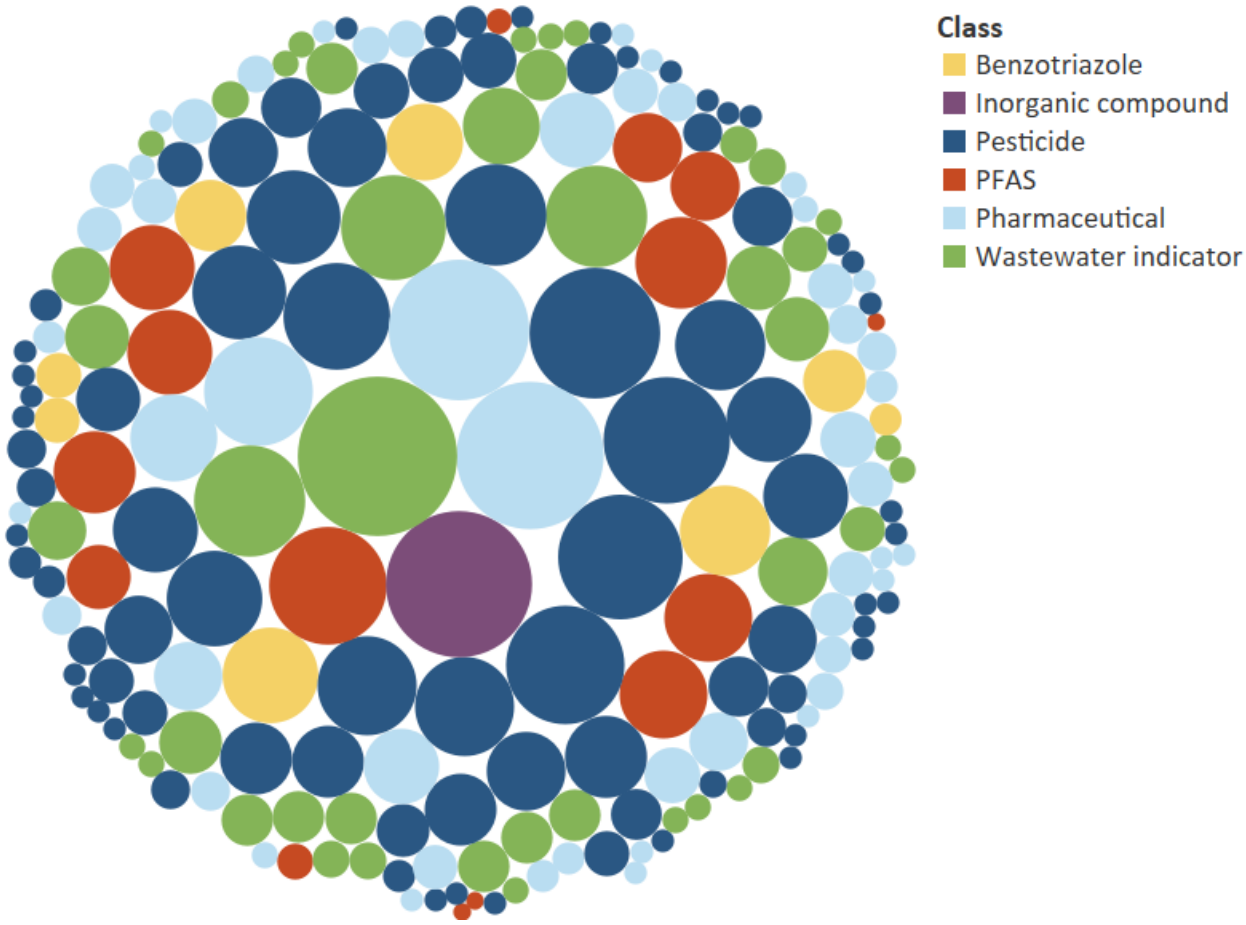
IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet (attached)
B. Visual Component (attached)

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2018 Budget Spreadsheet Final

Project Title: Characterize Unregulated Contaminants in Source Water and Drinking Water
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 04g
Project Manager: Steve Robertson
Organization: Minnesota Department of Health
College/Department/Division: Environmental Health
M.L. 2018 ENRTF Appropriation: $1,000,000
Project Length and Completion Date: 4 years; June 30, 2022
Date of Report: 8/11/2022

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	TOTAL (original) BUDGET	Revised Budget October 5, 2021	AMOUNT SPENT	TOTAL BALANCE
BUDGET ITEM				
Personnel (Wages and Benefits)				
Temporary samplers 0.25 FTE for years 1 and 2 and 0.276 in year 3, base cost is $40,000 per FTE plus 31% fringe, distributed over duration of project ($52,400)	~~$52,400~~	$39,438.25	$39,438	$0
Professional/Technical/Service Contracts				
Private analytical laboratory (Laboratory analytical services for pharmaceuticals, personal care products, pesticides (exact vendor not yet determined and will depend on monitoring plan developed in Activity 1)	~~$679,800~~	$731,653.41	$705,087	$26,566
U.S. Geological Survey (Professional and technical services related to monitoring plan design, sample collection, laboratory analytical services, data review and analysis, and report prepartion) ($214,915 not including USGS cost share)	~~$214,915~~	$189,922.00	$183,006	$6,917
MDH Public Health Laboratory (Routine water quality analysis in support of water chemistry and vulnerability characterizations) ($ ~~21,235~~ $26,400, not including EPA Section 106 cost share)	~~$21,235~~	$26,400.00	$26,400	$0
Equipment/Tools/Supplies				
Sampling equipment, supplies	$13,500	$9,559.08	$9,559	$0
Travel expenses in Minnesota				
Travel	$18,150	$3,027.26	$3,027	$0
COLUMN TOTAL	**$1,000,000**	**$1,000,000**	**$966,517**	**$33,483**



Attachment B. Visual summary of unregulated contaminants detected at all sites by class and relative frequency of detection. MDH Unregulated Contaminants Monitoring Project 2019-2022.

Size of dot represents frequency based on number of sites sampled for contaminant with detection.