Upper Mississippi River Basin Association

Water Quality Executive Committee and Water Quality Task Force Joint Meeting

June 7-8, 2022

Agenda

with

Background

and

Supporting Materials

Upper Mississippi River Basin Association
Water Quality Executive Committee
Water Quality Task Force Meeting

June 7-8, 2022

Agenda

Connection Information

- Web, video conferencing, click on the following link:
  - June 7: https://umrba.my.webex.com/umrba.my/j.php?MTID=m117006a022a25845089a2863d9de6649
  - June 8: https://umrba.my.webex.com/umrba.my/j.php?MTID=m480ebc4ee8b22be82acde65286d524a6
- Dial-in number: (312) 535-8110
  - June 7 access code: 2555 034 5219
  - June 8 access code: 2551 807 7359
  - Passcode: 1234

June 7, 2022

Time	Topic	Presenter
1:00 p.m.	**Welcome and Introductions**	***Dana Vanderbosch**, MNPCA*
1:05	**Approval of the January 25-25, 2022 WQ Task Force Meeting Summary**	***All***
1:10	**UMRBA WQ Task Force Updates** • How Clean is the River? Report	***Lauren Salvato**, UMRBA*
1:25	**UMR Interstate WQ Monitoring** • Reaches 8-9 Pilot • Facilitated Discussion	 ***John Olson**, Contractor* ***All***
2:10	**CWA Program Updates** • 305(b) and 303(d) Consultation • Delisting Waters Discussion • TMDL Updates	***All***
2:45	**Break**	
3:15	**Emerging Contaminants** • The Effects on Environmental Quality of Raising Plants and Growing Animals • Facilitated Discussion	 ***Dana Kolpin,** USGS* ***All***
4:15	**Research** • Simulating Food-Energy-Water and Ecosystems in the UMRB	 ***Dr. Kelsie Ferin,** UW Madison*
5:00 p.m.	**Adjourn for the Day**	

June 8, 2022

Time	Topic	Presenter
8:00 a.m.	**Reflection**	***All***
8:05	**CWA Program** • 2022-2032 CWA 303(d) Program Vision • CWA 303(d) and Environmental Justice • Discussion	 ***Rosaura Conde,*** *USEPA* ***Sara Schwartz,*** *USEPA* ***All***
8:50	**Nutrients** • USEPA Nutrient Memo • State and Federal Updates	 ***Tom Wall,*** *USEPA* ***All***
9:40	**Administrative Items** • Future Meeting Schedule	***All***
9:45 a.m.	**Adjourn**	

ATTACHMENT A

January 25-26, 2022 WQ Task Force Meeting Summary

(A-1 to A-14)

Upper Mississippi River Basin Association
Water Quality Task Force Virtual Meeting

January 25-26, 2022

Draft Highlights and Action Items Summary

Tuesday, January 25

Approval of the WQEC-WQTF Draft September 28-29, 2021 Meeting Summary

The UMRBA Water Quality Task Force (WQTF) approved the September 28-29, 2021 draft highlights and action items summary.

UMRBA WQ Task Force Updates

How Clean is the River? Report

Lauren Salvato shared information about the investigation into lead trends calculated in the *How Clean is the River?* (HCR) Report update. Lead has a statistically significant increase in UMR Pools 15 and 17. Although the increase is relatively small (approximately 3 ppb), it will likely draw attention, and the WQTF has been discussing how to communicate the information to the public.

UMRBA staff have been conducting research to understand potential sources and contributions on the mainstem such as historic or on-going remediation projects near the UMR. The research has included outreach and conversations with USEPA regions, Army Corps Rock Island District staff, and USGS.

There was historic zinc and lead mining near Dubuque, Iowa and southwest Wisconsin (e.g., Platteville in Grant County), but it is unlikely that the historic mining is affecting Pools 15 and 17 as the metals are relatively immobile. The lead is potentially dissolved, rather than particulate given that the suspended sediments are not statistically significant in Pools 15 and 17. UMRBA staff also talked to Professor Colin Belby from UW La Crosse about his research, which has demonstrated that increasing discharge and climate change impacts are flushing historical metal contamination in sediment to the UMR mainstem. Belby's research is focused on historic mining areas, but his research can perhaps inform studies in other parts of the UMR.

Ultimately, the process has underscored the importance of the HCR report update and having the UMR Interstate WQ Monitoring Plan to provide more routine monitoring of metals on the river. Next steps include another report review before finalizing the report and GIS maps. Communications experts are also consulting UMRBA on messaging around the HCR report.

Karen Hagerty suggested evaluating the metals as percent change per year as a different way of presenting the information, rather than a percent increase across the time period. Albert Ettinger noted the 44 percent increase in arsenic in Pool 26 and said as a member of the public, he is concerned with the increase.

Reaches 8-9 Pilot

Salvato said the Reaches 8-9 planning committee is still working through data management before turning it over to John Olson (retired Iowa DNR) to write the condition assessment. The condition assessment will describe river conditions for each reach for the four use assessments: recreation, aquatic life, fish consumption, and drinking water. Salvato added that she has begun working on the evaluation report, which is a set of lessons learned from the pilot and outlines next steps.

Contaminants

Radium in Aquifers of North-Central Illinois

Walt Kelly introduced the two species of radium (Ra-226 and Ra-228) that come from thorium and uranium. Radium has relatively short half-lives of 1,600 years for Ra-226 and 5.75 years for Ra-228, which Kelly noted is quite short relative to the cycling of groundwater. A high concentration of Ra-228 requires a high amount of Thorium-222 because it will decay quickly. The two types of radium are different emitters –alpha and beta– which impact the health risks from ingestion. Radon is one of the elements produced from decayed Ra-228 which can be dissolved in water and has a half-life of only 4 days. The primary concern from Ra-226 and Ra-228 is ingestion, not exposure. Kelly notes that radium is deposited in tissues because it behaves similarly to calcium and has been linked to cancer, kidney damage and birth defects. Given these concerns, the maximum contaminant level for both radium species is 5 picocuries per liter. Kelly explained that elevated levels of radium in groundwater depends on having a supply of uranium and thorium mobile in the water and limited mechanisms by which uranium and thorium drop out of solution. These mechanisms include mineral precipitation, adsorption, and cation exchange.

Kelly noted that radium is only concerning in the deep bedrock aquifers in the northern part of the state. The deep bedrock aquifers are confined aquifers primarily in sandstone separated by low-permeability shale and carbonate which limit the flow between the layers. Early research indicated that all the deep bedrock aquifer units contributed to the radium concentrations.

Kelly explained how the underlying geology influences and complicates groundwater in the region. Bedrock layers get deeper heading south, which limits the amount of drilling into the aquifers in the central and southern portions of the state. All the water in the aquifers started as brines. During the last ice age, as glaciers advanced and retreated, melt water from the glaciers recharged and mixed and diluted the brine in the St. Peter aquifer.

Kelly and researchers have shown that the brines in the aquifer layers are not the main source of radium because high concentrations occur where the St. Peter aquifer is close to the surface and is being recharged. If the brines were the source of radium, one would not expect to see radium because of its short half-life. Because radium is present, the source must be in the geologic layers the water is passing through. Both Ra-226 and Ra-228 are present in the aquifers. The presence of Ra-228 indicates that the water is relatively close to the source. The radium is likely coming from shales rather than the St. Peter Sandstone unit which is very pure quartz. The shale units tend to have thorium and uranium, though there is not good sampling of those layers. Kelly noted the challenge of drawing conclusions from the water chemistry when water from different aquifers and geologies are mixed in the well.

The total dissolved solids (TDS) affect the capacity for adsorption and cation exchange which are two geochemical processes that remove radium from the water. At lower TDS concentrations, it is likely that radium is lower. Radium concentrations may also be controlled by adsorption to iron or manganese oxyhydroxides in the recharge zones where the St. Peters sandstone is close to the surface. He concluded that radium will continue to be a challenge in our water resources as it is found in many deep aquifers.

Treatment is very expensive and often blending will be the most cost-effective method to use high-radium water.

Hagerty recalled there was a watch manufacturer in Ottawa, Illinois and asked if that industry was responsible for some of the radium. Kelly replied that in the aquifers his team studied, the watch industry was not the source. The water sampled is older than 100 years, away from the recharge area. John Hoke said the St. Francis Mountains in Missouri have Precambrian volcanic rock with high levels of radium in the groundwater. A prison was located on the rim of the igneous intrusion. The water had to be transferred to a larger surface water body with a NPDES permit or discharged to a bigger river that has a larger dilutional capacity. Would that be an issue in Bloomington-Normal, or are flows high enough to meet water quality standards? Kelly is unsure but believes that they don't have to treat the water as radioactive waste. Salvato asked what the use of the water is being actively dewatered. Kelly replied in the Joliet region, the St. Peter aquifer is actively being dewatered and new wells are being put in the Ironton-Galesville aquifer which cannot support the demand of the growing urban area. The City of Joliet decided to move away from the deep sandstone aquifer and to Lake Michigan water. The water will be transported via pipeline and purchased from the City of Chicago. The pipeline will not be ready until 2030, and in the meantime, some of the wells will fail.

Salvato asked whether it is feasible for small PWS to take on the cost of treating water for radium, or whether small PWS are able to actively mix with another source of water. Is there an outreach component to the research? Kelly replied that a lot of small PWS blend the water. Radium can be removed via ion exchange but the waste byproduct must be disposed of. Small communities do not want to deal with that. Many small communities are moving to a regional system because of issues like this and are losing their independence. Ettinger recalled about 20 years ago he was looking at this in the wastewater context, which was impacting wildlife like otters, that were getting high exposure. There were two procedures being used: one procedure took the radium from a process and sent it to a low-level radioactive waste site and the second took the radium out of the drinking water and put it back in the surface water. Have there been any updates on radium once it is taken out of the drinking water? Kelly didn't have a clear answer but thought it was likely just being returned to the surface water.

Prioritizing Chemicals of Ecological Concern in the Great Lakes Tributaries

Steve Corsi said this work derived from the Great Lakes Focus Area 1 Goal 5 to identify emerging contaminants. Data were collected through passive samples as well as water and sediment samples from 354 sampling locations. The team monitored 629 compounds from 2010 to 2018. Some of the parameters monitored included plastics additives, flame retardants, pesticides, pharmaceuticals, and polycyclic aromatic hydrocarbons (PAHs). Of the 683 chemicals monitored, 444 were detected. Pharmaceuticals and pesticides were the bulk of the chemicals monitored due to the results of preliminary monitoring.

Corsi explained some of the challenges with environmental chemistry assessments. With the huge amount of chemicals detected there needs to be prioritization of chemicals. Researchers prioritized which chemicals to monitor by trying to understand the biological effects of the chemical compound and compared the sampled concentrations with the concentrations of concern. The team gathered biological effect information from water quality guidelines and screen values from agencies. Many of these chemicals do not have water quality guidelines or screening values. Where there are no guidelines or screening values, the team completed an extensive literature review and used USEPA's EcoTox to derive their own concentrations of concern. They also used the ToxCast database to understand the bio-active chemicals. An on-going effort is understanding pharmaceutical potency. The group also analyzed the toxicological effect of chemical mixtures based on the information on the biological pathway described in ToxCast.

Corsi explained the three primary objectives of the research: prioritization of biologically relevant chemicals (potency and human and ecological health), site prioritization that identifies where chemicals are occurring and if there are added effects from co-occurrence of multiple chemicals, and understanding the biological relevance. Bioeffect predictions are found using the Exposure Activity Ratio (EAR). This value can be used to prioritize chemicals and sites, predict mixture effects, and provide information on biological targets. This approach can help understand taxonomic relevance and help identify endpoints for targeted monitoring. He noted that these are screening level tests that can help guide but that field or lab tests will be needed to understand if the effect is observed.

Preliminary results of the water samples indicate that of the 629 chemicals monitored, 64 were identified as priority chemicals. The chemical classes that were determined to have the highest effect in the largest number of sites are fire retardants, herbicides, insecticides, PAHs, pharmaceuticals, and plastics components. Corsi noted that many of these like PAHs or pharmaceuticals come from similar sources, which can help with management (e.g., most pharmaceuticals come from wastewater and most PAHs come from coal-tar sealant on pavement). Corsi noted that these are screening-level assessments but there needs to be verification of the effects of these priority chemicals.

Similar sampling and prioritization occurred for sediment samples. The group sampled 71 stream sites in 26 tributaries to the Great Lakes. Of the 87 chemicals monitored, 21 were identified as level one or two chemicals and 38 percent could not be evaluated. Fourteen of the 21 chemicals were part of the PAHs chemical class. Corsi notes that like the water samples, there are a number of chemical classes that seem to be the most important. However, these screening-level assessments need validation. Corsi concluded that the effect of these chemicals is not well studied yet and that this work can guide future assessments beyond initial screening work to more definitive information about which of these chemicals really have effects. He outlined key questions for the future about where these chemicals are coming from, the timing of their presence in the water bodies, and what remedial action could look like.

Ettinger noted a lot of emerging pollutants have been around a while and asked if they are being observed in dredge spoils. Mercury settles to the bottom, and are there other contaminants that are being stirred up? What factors are causing the increase in emerging contaminants? Corsi said that his research has not measured contaminants in dredge material. Hagerty commented that dredged sand is tested and is generally not found to be contaminated. Shawn Giblin stated a study like Corsi's would be valuable for the Upper Mississippi River Basin. What are the recommendations of where to get started on a large river system to monitor emerging contaminants, given limited resources? Corsi said that UMRBA would want to distribute some sites in a logical fashion e.g., where there are major inputs or tributaries. There are a few chemical analysis schedules that various laboratories have that would cover multiple chemical classes. Corsi's study included over 600 compounds, with 5 to 7 chemical schedules, which is very expensive. There are some catch-all chemical schedules that you can choose that would flag primary issues for the UMRB. Hoke appreciated Shawn's question and added that USEPA is recognizing emerging contaminants in the latest Bipartisan Infrastructure Law and looking at making CWSRF monies available for remediating emerging contaminants.

Ecological Risk Assessments

Aquatic Life Water Quality Criteria for Toxics

Dr. Kathryn Gallagher's Ecological Risk Assessment Branch (ERAB) in the Office of Water/Office of Science and Technology at USEPA is responsible for developing 304(a) water quality criteria for toxic pollutants, developing and updating science, and developing tools and approaches to develop these criteria. Draft criteria are determined from the existing literature, which is then peer-reviewed and released to the public for scientific views before publishing the final criteria. Gallagher noted the length and complexity of the process, which means that the office needs to prioritize criteria.

ERAB considers input from states, tribes, and USEPA Regions to understand which criteria should be prioritized. The branch also considers the occurrence, toxicity, persistence, bioaccumulation, and the age of existing criteria when prioritizing which criteria to work on. Gallagher added that 48 criteria date to before the year 2000.

ERAB released the updated aluminum freshwater aquatic life criteria in 2018. The criteria were prioritized to incorporate new research to reflect the local water conditions that can influence the toxicity of aluminum, and the old criteria were published in the 1980's. ERAB has also been focusing on drafting PFOA and PFOS criteria for aquatic life, which has been a big lift because ERAB had to conduct a literature review of existing studies. The draft criteria have been peer reviewed and are currently undergoing USEPA review, with an anticipated release of the draft in the spring of 2022. The ERAB is looking at developing more aquatic life/aquatic-dependent wildlife values for other more data-limited PFAS chemicals that do not have enough peer-reviewed studies for ERAB to conduct their review.

The ERAB has also been working on updating criteria for ions such as chloride and sulfate. Gallagher noted that it has been complicated because the ions interact with each other to determine the toxicity so they cannot be isolated when developing criteria. The criteria have been prioritized because of the interest from states where road salt usage is prevalent during winter.

Gallagher noted that the chloride and sulfate criteria update has involved review of over 7,000 records and 509 references in the EcoTox database to understand elevated chloride and sulfate levels. USEPA Office of Research and Development is helping develop the model. The ERAB is considering what the criteria will look like but has not yet determined if it will be a combined chloride-sulfate criteria, as it will depend on the outcome of the modeling. She noted that the cations are causing the toxicity not the anion which is one complicating factor. ERAB is briefing the Association of Clean Water Agencies Monitoring Subcommittee in a few weeks about the work and the states are invited.

ERAB is working on gathering co-measured water chemistry data through a GIS mapping exercise to support modeling for water chemistry criteria like aluminum and copper in places that don't have water chemistry data. The development of this tool has been prioritized based on state demand for water chemistry in their modeling. Modeling occurs at the site, ecoregion, and ecoregion stream order level. The tool may also be able to display aluminum and copper criteria at the same scale for users that need assistance developing criteria that don't have ambient water quality data.

Gallagher also shared that the USEPA has entered into a cooperative agreement with eight metals organizations to accelerate the use of bioavailability approaches and update and develop metals criteria, including toxicity data. There is currently a phase one report that has already undergone external peer review. The report examines a regression model with three parameters rather than the existing ten parameter model. ERAB is interested in developing criteria that could be more user-friendly for states. The report will be released on the USEPA website with the external peer review. USEPA prioritized this action to update old criteria with the best available science e.g., metals criteria.

Gallagher reported that ERAB are also working on improving and expediting the systematic review process by creating a tool that will be an easily accessible database of toxicity data. The tool will help USEPA develop new criteria, and Gallagher is hopeful that the tool is useful to other USEPA offices and regions. The automated process has reduced the average time reviewing each study from approximately seven hours to approximately two and a half hours, which has been particularly useful in the most recent PFOS and PFAS work.

Other key prioritized projects are updating methods using pilot studies with the New Approach Methods for data-limited projects like PFAS. They are also working on updating criteria including nickel, zinc, and lead simultaneously.

Ettinger asked if USEPA is going to update the arsenic human health standard. He is aware that many states do not use the criterion, and arsenic is problematic with coal combustion waste. Gallagher replied that her group focuses only on aquatic life criteria.

Salvato asked if the criteria that are not being used by the states are prioritized by Gallagher's branch to be updated. Gallagher replied that they typically ask states for the information, but her branch must also balance emerging contaminants and older criteria. Bob Miltner commented that there is a considerable list of parameters and there have been significant strides in terms of biological recovery through the CWA and agriculture BMPs implemented on the landscape. One of the things that would help is being able to assess communities and watersheds on its trajectory of improvement. This could help identify where an improvement is expected but is not occurring. Is there a way to narrow down and assess which are having an impact? Gallagher said it is a complicated question. For some taxa, the chemicals are the driver, for others its land-use e.g., urbanization or construction. It would take a lot of monitoring to understand the drivers. Steve Corsi echoed Gallagher's comment that the question is complicated. Corsi has seen some studies that have a range of potential influences e.g., habitat, flow, DO, or chloride, but they all only explain a certain amount of the variability in biological responses. Miltner clarified that there is more in the biology that can lead practitioners to a direct and focused way of looking at a suite of contaminants that are potentially important. Some species in Ohio are declining and others are doing well. This is not necessarily enough to impair water, but there are some concerns. It seems that the absence of evidence lies in the areas not being monitored. PFAS, for example, has been around a while but yet biological improvements are still occurring. Gallagher said that she hopes that USEPA can continue to develop criteria that limit releases, instead of waiting until there is a biological effect. Gallagher said she would hear whether the participants have additional criteria to suggest. Suggestions included manganese, cobalt, and, Hoke reiterated, sulfate and chloride. Corsi thanked Gallagher for her work at USEPA.

Chloride

Impacts of Chloride and Sulfate Ions on Macroinvertebrate Communities

Robert Miltner with the Ohio EPA presented on the impacts of chloride and sulfate ions on biological monitoring. Increasing chloride concentrations are well-documented, nationwide trends by several notable organizations and peer-reviewed articles.

Chloride has both direct and indirect effects on biological organisms in streams. Direct effects arise from the toxicity of the chloride ion on biological organisms while indirect effects result from mobilization of nutrients and metals in the bed sediments. He noted that there are existing water quality criteria for chloride and sulfate, but they are being reexamined because the chronic level of 230 mg/L can be considered under-protective in many cases. Illinois developed a hardness-based standard for chloride and sulfate that Iowa and Indiana have also adopted. Michigan proposed a chronic level of 370 mg/L. There is not a national criterion for sulfate.

Milter's work examined the question of developing thresholds using a field-based approach. He modeled his approach after Cormier et al. who used field observed sensitivity measurement of conductivity and its impact on steam taxa. There is a similar approach used for toxicity studies but applies it to field data. The outcome identifies a Hazard Effect concentration. The other mechanism to identify thresholds is using biological attainment, with a passing or failing. This strategy is well suited to logistic regression and machine learning.

Miltner shared the chloride extirpation concentrations for different classes of macroinvertebrates. The hazard effect concentration (HC5) is about 54 mg/L but that is several orders of magnitude below the existing chronic criteria of 230 mg/L. He questions whether a permit level of 54 mg/L is a reasonable standard for a permitted facility like a wastewater treatment plant.

He also shared the individual taxon response graphs which displayed the taxa with increasing and decreasing responses as chloride concentrations increase. Using this data, Miltner generated heat maps from chloride concentrations and chloride tolerance values as expressed through macroinvertebrate species. The literature shows evidence that macroinvertebrates can adapt to increasing chloride concentrations as long as the change is slow. That is reflected in the individual taxon response graphs for chloride. That behavior is not seen in the individual taxon response graphs for sulfate. He noted that it models more similarly to a "traditional" toxicant than chloride.

Miltner also examined the data through a Bayesian logistic regression. Bayesian has an improved ability to visualize uncertainty in the predictions. This is important because there are many factors that impact macroinvertebrate response to chloride or sulfate.

Miltner shared the first difference, which identified the factors that have an impact when you hold each of the other stressors at its respective median. Chloride, TKN, sulfate, and manganese had a negative impact while habitat had a positive. He noted that TKN and Chloride had collinearity that showed in the results. The effect from TKN appears to be more evident in the eastern corn belt. One explanation is the challenge of collinearity. The eastern corn belt also has poorer habitat quality which may also be one reason for chloride trends and TKN to show the changes.

Miltner shared the relationship between chloride concentrations, manganese, and effect. As manganese concentrations and chloride concentrations increase, the effect increases. Even with a fairly high level of sulfate, the water can be attaining if manganese concentrations are low. The importance of these results is that treatment can be environmentally relevant since salt enrichment can exacerbate nutrient enrichment and release metals from the sediment. These factors all interact in a stream.

The average effects over the population help the user understand the range with confidence. For chloride, the range is roughly 51-83 mg/L and for sulfate is 140-500 mg/L. The sulfate appears to be in range with the Illinois model based on the average hardness of the stream.

Miltner discussed the importance of considering the environmental disturbance gradients and what different "endpoints" can tell us when applying water quality criteria. Many of the toxicity endpoints seem to prevent over-intensification while field-derived ones seem to fall at a less impacted part of the disturbance gradient. Miltner noted that there should be an awareness and paradigm shift away from a single value because the field-derived values may not be appropriate for all types of water.

Miltner advocates for a more comprehensive approach to managing ions because once they are in the waste stream, they are very difficult to remove. In an evaluation of 190 wastewater treatment plans, most plants would be able to meet a criterion of 230 mg/L and many more could be successful if there was a tiered approach to the criteria. Miltner finished by emphasizing that there should be a paradigm shift for the development of water quality standards. He advocates for field-derived endpoints to manage pollution from diffuse sources and emphasized the management of a non-traditional approach across a gradient of bio-conditions. One of the immediate focuses for chloride should be recently suburbanized but currently unenriched sources where there is an opportunity to get ahead of the problem.

Mike Shupryt asked what is the change in the probability of presence for the mixed-effects model? Miltner replied it is effectively the probability of attainment. Ettinger asked whether Miltner's research looked at the quality of biota below coal mines. He is aware that some waterbodies have high chloride levels. Miltner said in Ohio where coal mining occurred in rock bearing formations, sulfate and metals is a bigger problem. Ion levels in coal discharge are high. Treatment options to precipitate out the metals do tend to work when sulfate is the ion that is dominant in the water. Miltner acknowledged coal mining has an enormous impact and cited that Raccoon Creek watershed has recovered considerably from coal mining impacts. Robert Voss echoed the concerns about sulfate for Missouri. Sulfate concentrations have by far been higher than chloride. Voss has also seen some research on net alkaline mine drainage, which is in the realm of coal mining, describing the fixation of nitrogen and seeing increased nitrates in the water after the net alkaline mine drainage. Net alkaline drainage is usually a result of treating the acid mine drainage from the coal mines. Miltner said that they do see TKN in formerly mined areas.

Stephen McCracken commented on whether the model considers the summer condition, trying to detangle winter peak chloride with the summer conditions. We would be comparing summer concentrations with summer macro populations. Miltner said both the water quality and macroinvertebrate samples were collected in the summer. That said, the streams are still salt enriched into the summer. The data are still meaningful and effective for use, but we should understand how winter concentrations carry into the following seasons. McCracken did not mean to suggest they are not related but notes that there might be an important management consideration from high winter peaks compared to summer peaks. McCracken noted that standards set for summer conditions may be challenging to meet in winter and that while there is a residual effect in the summer, peak winter concentrations may not be as harmful as summer concentrations. He noted that will be a management challenge.

UMRBA Resolution

Salvato said that the UMRBA Chloride Resolution was recently reviewed by the WQTF and WQEC. She appreciates everyone that provided input. The most notable recent changes were made to the language recommending that USEPA update its chloride criteria. UMRBA staff will be requesting endorsement of the resolution by the UMRBA Board at its upcoming February 22, 2022 quarterly meeting. Kirsten Wallace added that the completion of the resolution is timely with the How Clean is the River? report update and results showing increasing chloride trends on the UMR mainstem. The resolution can be used to guide the work of UMRBA WQ committees and continue to have the focus on chloride. The resolution underscores partnerships with UMRR and the UMRCC. Both groups have an interest in this work including outreach and science. We have the ability to expand efforts beyond the WQTF.

Wednesday, January 26

<u>Citizen Science</u>

Plastic Pollution Campaign

Jennifer Wendt shared that the Mississippi River Plastic Pollution Campaign is a joint effort with the Mississippi River Cities and Towns Initiative, University of Georgia, and United Nations Environment Programme with funding provided by National Geographic. In 2018, MRCTI committed to reducing plastic waste from land-based sources.

Many partners and local organizations made the pilot projects a success. The first pilot occurred in April 2021 in St. Paul, MN, St. Louis, MO and Baton Rouge, LA. About 100 organizations were involved and over 75,000 items collected. The top items collected were cigarette butts, food wrappers and beverage bottles. The volunteers collected trash in their own backyard, while some were asked to complete specified transects. Graduate students from Louisiana State University removed debris from trash traps and inventoried what was collected.

The second phase of pilot included the Quad Cities Area in October 2021. The top items of the 25,000 collected were cigarette butts, food wrappers, and paper and cardboard. One of the organizations involved was Partners of Scott County Watershed. Steve Gustafson, Vice Chair, said that the members of his organization promoted and recruited volunteers for the pilot. He is excited about the momentum and interest garnered and said that Partners of Scott County will be meeting in February 2022 to discuss next steps.

Wendt said that MRCTI's next steps for this initiative are to expand to the entire Mississippi River, with a focus on the delta area, explore funding opportunities, and expand partnerships e.g., manufacturers.

Salvato asked if trash traps are common in storm water systems? Wendt replied that trash traps are becoming more common and are effective if maintained consistently. Maintaining the traps is labor intensive and costly. The material is removed with heavy machinery, drained overnight, and transported to the landfill. Sorting the debris is labor intensive, as half of it is organic waste. Wendt thinks the focus should be on pollution reduction and prevention, however, trash traps serve a purpose. There is a project sponsored by the Commission for Cooperation installing trash traps in the Quad Cities, Canada and Mexico and pairing it with an educational campaign. Steve Schaff recalled that trash traps were placed in St. Louis as part of the Urban Waters program. Hoke confirmed that the Missouri Confluence Waterkeeper has placed traps in Deer Creek, Mackenzie Creek, and River Des Peres.

Nicole Vidales asked if the graduate students that sorted and counted trash trap materials in Baton Rouge will be a part of ongoing program? Wendt replied that the group at LSU was from the Coastal Sciences school. They are continuing the work and hiring a graduate student with the grant money. MRCTI is always eager to partner with universities.

WQ Citizen Science Programs

Minnesota – Shannon Martin, Volunteer Water Monitoring Program coordinator, said Minnesota PCA has had volunteer collected data for the past 49 years. The volunteer opportunities are monitoring lakes, streams, and lake ice. For lake and stream monitoring, volunteers are asked to monitor twice per month between May and September. They collect basic water quality parameters. The lake ice reporting program is a partnership with the State Climatology Office to collect ice on and off dates for monitoring climate change impacts on lakes. There is a specialized Boundary Waters Canoe Area volunteer monitoring option that can be completed on any lake when weather conditions are right.

Volunteer training is conducted online and hard copy materials are provided as well. Volunteers submit data at the end of the season, which is evaluated by program staff before being finalized in the state WQ database. Volunteers are important data collectors and local water advocates. The data are used to inform water management about water quality trends and whether the waterbody is meeting state standards.

One challenge Martin highlighted was recruiting the next generation of volunteers, after the majority of volunteers, retirees, age out.

Missouri – Laura Richardson said the volunteering monitoring program is a component of the Missouri Stream Team, which provides education and avenues for advocacy for improving water quality within Missouri. Physical, biological and chemical data are collected in streams. All data and resources can be found online at http://mostreamteam.org. Richardson and her colleagues QA/QC the data.

Richardson said DNR staff are working on a database upgrade to automate QA/QC procedures, automate site locations, and make the data more viewable for users. The data are used to provide information and education for the pubic, bridge monitoring gaps, provide baseline data on local streams, screen for potential problems, identify long-term trends, and assess changes in watersheds.

Cooperative Stream Investigation is a higher level of training to be useable by a Missouri State Agency and can be used in TMDLs, Clean Water Act/Integrated report Assessments, and permit evaluations. Finally, Richardson hopes to use macroinvertebrate data to qualify streams as assessed for aquatic life use designation.

Wisconsin – Shupryt said Wisconsin runs two programs separately for lake and stream monitoring. The first is the older Citizen Lake Monitoring Network (CLMN) and the Water Action Volunteers (WAV). Both DNR and UW Extension support the programs. CLMN monitor over 800 lakes per year for Secchi depth. Over 500 lakes are sampled for water chemistry from one to three visits per year. Secchi depth, phosphorus, and chl-a are collected and samples are analyzed by the Wisconsin State Hygienic Laboratory. Shupryt believes nitrogen series will be collected starting in 2022. Because Wisconsin DNR pays for the analyses out of the state monitoring budget, there is a limited amount of money for CLMN and a long wait list for volunteers to monitor water chemistry. The data are used for assessments if the index period is met (three visits over two years). The data collected by volunteers and DNR staff are treated the same. A user perception survey is used for CLMN to pair the survey with chl-a concentration data. Both were used to put together a rule package for chl-a criteria for recreation uses, currently being presented to the Wisconsin Natural Resources Board.

Lake volunteers also do AIS early detection surveys and ice on/ice off records. The ice program is more popular in the City of Madison lakes.

The WAV program has tiered volunteering for stream monitoring. There is introductory, focused on education and outreach. This component is solely run by UW Extension. The next level is chemistry sampling, which include six monthly visits between May and October for TP, TSS, and eventually N series sampling. A year of introductory monitoring work is required before moving up to the next tier. For this level, there is a program-specific quality assurance project plan (QAPP) and required trainings. These data are also analyzed by the Wisconsin State Hygienic Lab. Funds are also available for volunteers living in TMDL watersheds. WAV will request volunteer participation at specific locations for stream assessments. Shupryt said there is a 90-95 percent success rate for collecting planned samples with volunteers. The data are also used in 303(d) assessments. WAV piloted a family level IBI for macroinvertebrates. The time requirement is high and this program has begun to see less participation. WAV still has a coarse-level survey with simple math.

WAV also has a long-term temperature monitoring component, in which a temperature logger is placed in the stream. Sometimes the data are used for impaired waters, but there are challenges with justifying the use of the data when results are variable.

Finally, there was a winter road salt program that existed about six years ago. Sampling was focused in urban areas and four to five samples were collected in a 30-day period.

Shupryt shared the following links for participants to learn more: https://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/programs/clmn/default.aspx and https://wateractionvolunteers.org/. At the request of Richardson, Shupryt shared the IBI example: https://wateractionvolunteers.org/files/2019/10/Biotic-Index-Calculation.pdf.

Richardson said a PhD student ran a chloride monitoring program utilizing Missouri Stream Team volunteers. There was a lot of interest in the St. Louis area to understand how road salting techniques have influenced WQ.

Iowa – Kendall said that Iowa had a program to train volunteers. However, Iowa's credible data law has made it difficult to use volunteer data for regulatory purposes. The program shifted to local entities and counties and informing the public on what is happening with water quality in their backyard. Iowa DNR sent supplies to groups like the Izaak Walton League to conduct monitoring but does not have a staff person dedicated to working with volunteer monitoring groups. The volunteer monitoring program has to have a monitoring and QA/QC plan and be audited by Iowa DNR for the data to be used for regulatory purposes.

Shupryt asked what is credible data? Kendall replied that credible data have to meet certain standards, collected in a certain way and analyzed at a certified laboratory. The best way to be able to submit data is for the volunteer monitoring group to partner with Iowa DNR, rather than running independently. Before the impaired waters list is put together, volunteers can submit data for "waters in need of further investigation." If additional funding becomes available, Kendall said that DNR can target those locations for monitoring. Voss said Missouri has similar challenges when it comes to listing waters based on citizen science data. The CSI program has specific QAPPs and uses a certified laboratory. This increases confidence in the data if it is used to impair waters (i.e., proof negative). There is not usually much scrutiny to delist a water or demonstrate that a water is meeting a particular use (i.e., proof positive). Adding listings is open to more scrutiny.

Salvato asked if other states use their data for impairments. Kim Laing said that Minnesota PCA uses volunteer data in conjunction with the data PCA collects. There are protocols for the use of data in assessments, and often the data does not stand on its own. The agency is discussing new data collection methods and safeguards to ensure the data collected is accurate. For example, volunteer monitoring is limited to one person per site. PCA staff are considering opening it up to more volunteers per site but the agency would need to develop an app to accommodate more data.

Illinois – Vidales said Illinois EPA had a volunteer lake monitoring program from 1981 to 2018. With staff retirements, the positions were not backfilled. Vidales would like to bring back volunteer monitoring efforts and expand beyond lakes.

Gustafson shared a few comments about citizen science:

1. There are concerns about access and safety for sampling on the UMR. In the Quad Cities area, a good boat is needed

2. If the state does not consider volunteer data valid, it makes it harder to justify collecting data

3. Partners of Scott County Watershed (PSCW) can get many volunteers, but they are getting frustrated that despite having plenty of data, PSCW (and other organizations) cannot get any landowners or municipalities to act on the data or implement BMPs

4. PCSW publishes data on ArcGIS online: https://scottcountyiowa.maps.arcgis.com/apps/webappviewer/index.html?id=d84fd8ff83f249439599fc23d246df4d

5. The PSCW website can be found at the following link: https://www.partnersofscottcountywatersheds.org/

Clean Water Act Program Updates

State Updates

Minnesota – Laing reminded participants that Minnesota PCA goes through assessments every year based on the agency's watershed-based monitoring approach. Staff are currently working on the 2022 303(d) list. There are 66 delistings that are out for public comment. There are delistings on the UMR for ionized ammonia. From the 2020 list, USEPA Region 5 added sulfate. Minnesota PCA staff are using the USEPA methodology to select impairments and add more sites for monitoring. There are new PFAS impairments for fish tissue. In response to a question from Salvato, Laing replied that the 11 previous PFAS fish tissue listings were in the Twin Cities Metro Areas lakes and the UMR. The new listings are in the east Twin Cities, one on Lake St. Croix, and four other waterbodies outside of the metro area. Voss asked if the listings are based on particular congeners. Laing said there is site-specific criteria for PFOS, and more information can be found at the following link: https://www.pca.state.mn.us/water/site-specific-water-quality-criteria. She added that the HH-WQS was recently adopted, and PCA will move away from the Minnesota Department of Health fish consumption guidelines, which were 0.37 ng/g PFOS in fish tissue.

For TMDLs, two are on public notice and three are with USEPA Region 5 as drafts. A handful were approved by Region 5 in 2021. Laing added she would be interested to learn how states utilize delistings due to corrective action or delisting due to other reasons.

Illinois– Vidales said the 2018 list was submitted in February 2021. Illinois EPA staff are currently working on the combined 2020-2022 integrated report. Staff are hoping to make the deadline of Friday, January 28, 2022 to put the list on public notice. Vidales added that a lot of senior staff are retiring. Additionally, of the two staff working on the integrated report, one is leaving at the end of January 2022.

Iowa – Dan Kendall said Iowa DNR staff are finished with assessments for the 2022 cycle. He hopes the list will be out for public comment by the end of February 2022. Kendall tracked the percent change from integrated report categories 4 and 5, and this is the first year where there is a zero percent change i.e., the same number of waters are being delisted and listed. Kendall hopes DNR can hit the April 1, 2023 deadline. The top pollutants for river segments are indicator bacteria, biological impairments, fish kills, fish consumption advisories, and DO.

Wisconsin – Giblin said the 2020 303(d) list was approved in October 2021, and the 2022 list will be submitted by April 1, 2022. He hopes that Region 5 approves the list in May 2022.

For the UMRB there are 64 new pollutants listed. The majority are for phosphorus and most of the impairment will be addressed in the Wisconsin River TMDL. The commend period for the TDML recently ended on January 7, 2022.

The 305(b) will also be submitted by April 1, 2022. In addition to the 50th anniversary of the CWA, the report will highlight Water Action Volunteer program's 25th anniversary in October 2022. In specific Mississippi River sections of the 305(b) report will highlight HABs and cyanobacteria research and monitoring, chloride and sodium freshwater salinization work, and new research related to aquatic vegetation and monitoring. Giblin added that DNR staff contributed to a chapter of the climate change status and adaption report for the Wisconsin climate change initiative.

Shupryt said staff are currently working on the modeling for a watershed outside of the UMRB. The Fox/Des Plaines River TMDL, in southeast Wisconsin is still in the monitoring phase until summer 2022. Staff will then move into the modeling phase. Shupryt updated participants that the Wisconsin Natural Resources Board approved the chl-a criteria. There are many steps to go; however, Shupryt believes this will be a powerful way to look at chl-a data.

Missouri – Voss reviewed that Missouri DNR's 2020 list was contentious, but are now able to use the lake nutrient criteria. That was completed in September 2021, and now staff have begun to work on the 2022 assessment. Missouri statute requires a 90-day public notice period after the list is complete. The Missouri Clean Water Commission has to approve the list as well. Voss noted there are a lot of moving parts before the 2022 assessment is submitted to USEPA Region 7.

The current list of TMDLs addresses 15 waterbody impairments. The focus has been revision of consent decree TMDLs. Missouri DNR staff are using models to derive new wasteload allocations and permits. The permitting team has become efficient at using the QUAL2k model; if anyone has questions. TMDL updates also include metals. Staff have not revised metal TMDLs in over 10 years, so there will be a big learning curve. The TMDLs are from primarily historic mining, although some mining still occurs in the state.

Finally, the top pollutants for 303d list include bacteria, chl-a, DO, mercury in fish, metals, and chloride.

UMRR Science Meeting

Dr. Kathi Jo Jankowski said the Upper Mississippi River Restoration (UMRR) science meeting occurs every two years with the purpose of developing a set of research projects in support of the restoration and management of the UMRS. The intent is to have restoration professionals, scientists, and other participants with extensive river knowledge and experience participate in the development of the project proposals. The expected result of this collaborative approach is that the resulting projects will improve our understanding of the UMRS, inform and improve river restoration and management, and will effectively incorporate the UMRR program's unique strengths. Jankowski coordinates the nutrients, phytoplankton, and harmful algal blooms WQ focal team. Some potential focal areas for this working group will include the following questions relevant to phytoplankton communities in the river:

— What is the current frequency of occurrence/risk of HABs? What factors are linked to risks for toxin production and how are they distributed across the river?

— How have phytoplankton communities responded to potential regime shifts in the UMRS, such as the invasion of bighead carp or the resurgence of submersed aquatic vegetation?

— What factors have affected long-term dynamics in phytoplankton communities in the UMRS and will they be sensitive to shifts in climate?

This working group will also include discussions of how LTRM can best utilize its 20+ year phytoplankton sample archive. Jankowski encouraged participants to reach out to her if they have research and management priorities for the WQ focal area to discuss.

Administrative Items

Future Meetings

- The next WQEC-WQTF meeting will be convened June 7-8, 2022 in Davenport, Iowa

Attendance

Ryan Sparks	Illinois Environmental Protection Agency
Nicole Vidales	Illinois Environmental Protection Agency
Daniel Kendall	Iowa Department of Natural Resources
Kim Laing	Minnesota Pollution Control Agency
Shannon Martin	Minnesota Pollution Control Agency
Waverly Reibel	Minnesota Pollution Control Agency
Ashley Grupe	Missouri Department of Natural Resources
John Hoke	Missouri Department of Natural Resources
Michael Kruse	Missouri Department of Natural Resources
Erin Petty	Missouri Department of Natural Resources
Laura Richardson	Missouri Department of Natural Resources
Robert Voss	Missouri Department of Natural Resources
Shawn Giblin	Wisconsin Department of Natural Resources
Shannon Haydin	Wisconsin Department of Natural Resources
Mike Shupryt	Wisconsin Department of Natural Resources
Sara Strassman	Wisconsin Department of Natural Resources
Bob Miltner	Ohio Environmental Protection Agency
Karen Hagerty	U.S. Army Corps of Engineers, Rock Island District
Leo Keller	U.S. Army Corps of Engineers, Rock Island District
Nicole Manasco	U.S. Army Corps of Engineers, Rock Island District
Micah Bennett	U.S. Environmental Protection Agency, Region 5
Kathryn Gallagher	U.S. Environmental Protection Agency, Office of Science and Technology
Jennifer Kissel	U.S. Environmental Protection Agency, Region 7
Chelsea Paxson	U.S. Environmental Protection Agency, Region 7
Steve Schaff	U.S. Environmental Protection Agency, Region 7
Jared Schmalstieg	U.S. Environmental Protection Agency, Region 7
Sydney Weiss	U.S. Environmental Protection Agency, Region 5
Aleshia Kenney	U.S. Fish and Wildlife Service, Iowa-Illinois Field Office
Steve Corsi	U.S. Geological Survey, Upper Midwest Water Science Center
Jim Duncker	U.S. Geological Survey, Central Midwest Water Science Center
Kelly Warner	U.S. Geological Survey, Central Midwest Water Science Center
Kathi Jo Jankowski	U.S. Geological Survey, Upper Midwest Environmental Science Center
Rebecca Kauten	Iowa Lakeside Laboratory
Steve Gustafon	Partners of Scott County Watershed
Jennifer Wendt	Mississippi River Cities and Towns Initiative
Stephen McCracken	The Conservation Foundation
Ingrid Gronstal	Iowa Environmental Council
Albert Ettinger	Mississippi River Collaborative
Doug Daigle	Lower Mississippi River Sub-Basin Committee
Walt Kelly	Illinois State Water Survey
Lauren Salvato	Upper Mississippi River Basin Association
Kirsten Wallace	Upper Mississippi River Basin Association

ATTACHMENT B

How Clean is the River? Report Executive Summary

(B-1 to B-2)


Jeff Janvrin, Wisconsin DNR

UMRBA
Upper Mississippi River Basin Association

How Clean is the River?

A 30-YEAR EVALUATION OF WATER QUALITY IN THE UPPER MISSISSIPPI RIVER BASIN

EXECUTIVE SUMMARY

The Upper Mississippi River Basin is a nationally significant economic, environmental, social, and cultural resource that requires balanced, integrated, and collaborative management. **How Clean is the River?** provides valuable insights for those who manage this resource and all who rely upon it.

A product of the Upper Mississippi River Basin Association (UMRBA), **How Clean is the River?** is the result of a second, collective effort to understand water quality trends in the Basin, which includes Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The first report was published in 1989 and led UMRBA to focus its work on heavy metals and sediment. This new analysis includes water quality data from 1989 to 2018 and supports UMRBA's current focus on nutrients and chloride.

Based on review of 23 water quality parameters grouped into four categories—nutrients, heavy metals, salts and pathogens, and physical—the new analysis finds that **water quality between 1989 and 2018 has generally improved, while there are pollutants of concern that have varying trends**.

Decreases in legacy heavy metals, sediment, and phosphorus, for example, show that **public and private investments in managing water quality are beneficial and that the approaches taken have been effective**.

Nitrogen, chloride, and contemporary or emerging pollutants of concern, however, are rising and require a five-state approach to develop effective solutions.

How Clean is the River? underscores the value of coordinated and comprehensive water quality monitoring for the Basin. In combination with UMRBA's Interstate Water Quality Monitoring Program, the report's findings will allow the five Basin states to more effectively identify problem areas, target management actions, and measure progress in protecting water quality.

See the report at umrba.org/howcleanriver.
To learn more, contact **Lauren Salvato,** *UMRBA's Policy and Programs Director, at lsalvato@umrba.org*

The **Upper Mississippi River Basin Association** is the Governor-established forum for discussion, study, and evaluation of Upper Mississippi River-related issues of common concern to the Basin's states.

Representing its member states of Illinois, Iowa, Minnesota, Missouri and Wisconsin, UMRBA:

- **Facilitates cooperative planning and coordinated management** of the region's water and related land resources.
- **Creates opportunities** for the Basin states and federal agencies to exchange information.
- **Develops regional positions** on river resource issues and serves as an advocate of the Basin states' collective interests before Congress and the federal agencies.

KEY FINDINGS:

What's in the Report?

How Clean is the River? suggests progress in the Upper Mississippi River Basin—and frames challenges and questions for the future.

Nutrients (Total Phosphorus, Total Nitrogen, Nitrate & Nitrite, Ammonia, Chlorophyll-a)

Although phosphorus reduction goals are yet to be met, phosphorus continues to decline in the Basin due to successes of the Clean Water Act. Ammonia, a fraction of total nitrogen, is also generally decreasing. Ammonia can be toxic to aquatic life.

These are important improvements in water quality because excess nutrients cause algae overgrowth, which can harm water quality, food resources, habitat, and decrease oxygen concentrations, all which have an effect on aquatic life and outdoor recreation opportunities.

Excess nutrients in the river originate from various sources, including agriculture, stormwater runoff, and wastewater. Achieving nutrient reductions requires a multifaceted approach.

Even with these successes, there are some concerns. Despite efforts to reduce nitrogen and phosphorus pollution to the Gulf of Mexico Hypoxic Zone, total nitrogen is increasing. Nitrogen originates from nonpoint sources, such as urban and agricultural runoff, or pollution runoff from a broad area. The Hypoxic Zone receives attention nationwide because of its low oxygen levels—conditions that are not suitable for aquatic life to survive. Local problems with excess nutrients cause the overgrowth of algae and result in diminished recreational opportunities.

Heavy Metals (Aluminum, Arsenic, Lead, Zinc, Copper, Mercury, Cadmium)

Significant successes have resulted from implementation of pollution reduction efforts under the Clean Water Act. There has been a general decrease in heavy metals, which are both naturally occurring from underlying geology and human-made from manufacturing and industrial processes.

Still, while well below the maximum contaminant level set by the federal Safe Drinking Water Act, lead is increasing in Pools 15 and 17 near the Quad Cities in Illinois and Iowa and New Boston, Illinois, respectively. The reasons for this are not completely understood and warrant investigation and research.

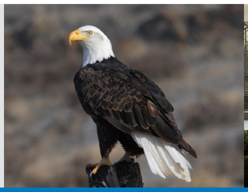
Salts and Pathogens (Chloride, Sulfate, *E. coli*, Fecal Coliform)

Chloride increased at least 35% in the Basin. The primary source is salt used to de-ice roads during winter. While road salt makes transit safer for people, too much of it is toxic to aquatic life that live in water bodies. Other dominant chloride sources include household water softeners and fertilizers.

Physical (Temperature, Conductivity, Total Suspended Solids, pH, Turbidity, Dissolved Oxygen)

There have been decreases in total suspended solids of at least 40% across the Basin. Turbidity and dissolved oxygen have also decreased. These reductions allow for light to reach aquatic vegetation, increasing its growth and thereby providing habitat and food for aquatic organisms.

Left: USFWS; right: Preston Keres, USDA



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ATTACHMENT C

Emerging Contaminants

(C-1 to C-8)

- **A Comprehensive Statewide Spatiotemporal Stream Assessment of Per- and Polyfluoroalkyl Substances (PFAS) in an Agricultural Region of the United States (Kolpin et al., 2021)**

- **USGS Food Resources Lifecycle Integrated Science Team**
  Web link: Food Resources Lifecycle Integrated Science Team | U.S. Geological Survey (usgs.gov)

Environmental Science & Technology LETTERS

pubs.acs.org/journal/estlcu Letter

A Comprehensive Statewide Spatiotemporal Stream Assessment of Per- and Polyfluoroalkyl Substances (PFAS) in an Agricultural Region of the United States

Dana W. Kolpin,* Laura E. Hubbard, David M. Cwiertny, Shannon M. Meppelink, Darrin A. Thompson, and James L. Gray

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ABSTRACT: Public concern regarding per- and polyfluoroalkyl substances (PFAS) has grown substantially in recent years. In addition, research has documented multiple potential agriculture-related release pathways for PFAS (e.g., biosolids and livestock manure). Nevertheless, little research on the environmental prevalence of PFAS has been conducted in agricultural regions of the United States. To fill this gap, we conducted the first statewide spatiotemporal assessment of PFAS in Iowa streams across a region of intense agricultural activity. At least one PFAS was detected at 19 of the 60 stream sites sampled (32%) with 10 different PFAS detected statewide. The number of PFAS detected in the stream samples ranged from one to nine. While PFAS were detected in agricultural streams, sites with the most PFAS detected and in the highest concentration were small, effluent-affected streams where wastewater treatment plant discharge is driving stream PFAS concentrations. No individual PFAS had an exposure:activity ratio (EAR) of >1.0 (exposure concentration shown to trigger observed adverse biological activity). Five stream locations, however, had at least one EAR of >0.001, a precautionary effect screening threshold. Additional targeted temporal sampling would be beneficial to specifically capture potential agricultural source applications and corresponding runoff conditions to fully characterize the prevalence of PFAS in such agricultural systems.

INTRODUCTION

Per- and polyfluoroalkyl substances (PFAS) make up a class of more than 4700 anthropogenic compounds[1] with extremely strong C−F bonds that were first synthesized in the 1930s. Due to their unique properties (e.g., oil and water repellency, temperature and acid resistance, and friction reduction), they have been frequently used in many household and industrial products globally for decades.[2] Because the C−F bonds are extremely resistant to degradation, many PFAS have been shown either to persist in the environment or to degrade to other forms of PFAS.[3,4] PFAS are also subject to long-range transport through environmental pathways such as volatilization, atmospheric deposition, and surface water,[5−7] causing transport to remote regions far removed from the location of their initial use or manufacturing.[8,9]

Initial environmental PFAS research was hindered due to analytical challenges derived from their unique surface-active properties.[10] Since the 2000s, however, substantial research has taken place, and PFAS have now been detected in numerous environmental compartments, including drinking water.[6,11−14] In addition, their bioaccumulation potential has led to their detection in a variety of aquatic and terrestrial organisms, including humans.[15−18] The long half-lives of some PFAS in humans indicate the potential to bioaccumulate following repeated exposures and/or longer times for PFAS to be eliminated from the body after exposure.[19] PFAS exposure is associated with a variety of potential effects on humans, including cancer and immune dysfunction.[20,21]

Historically, the anions derived from longer-chain perfluoroalkyl acids (PFAAs), perfluorooctanoate (PFOA), and perfluorooctanesulfonate (PFOS) have been investigated the most. Both PFOS and PFOA have been voluntarily phased out by the major United States (U.S.) manufacturers in the early 2000s because of their bioaccumulation potential, toxicity, and environmental prevalence.[3,20] U.S. manufacturers initially replaced PFOA and PFOS with shorter-chain PFAAs and more recently with perfluoroether carboxylates (i.e., GenX and ADONA). While the exposure and effects of these replacement PFAS are currently not well understood, research has documented that these newer PFAS are of global concern[7,22,23]

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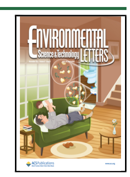

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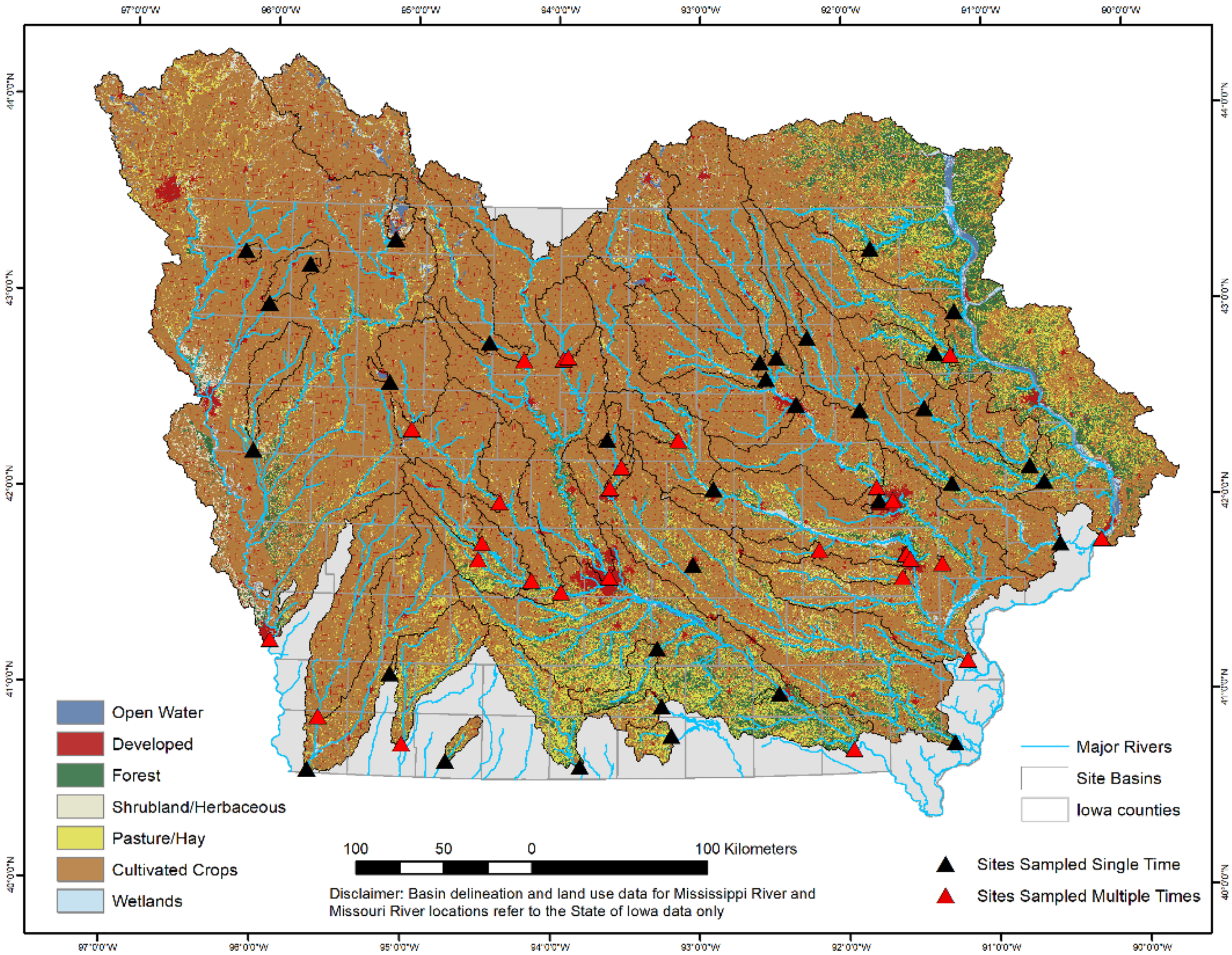

Figure 1. Sixty stream locations and corresponding land cover[39] across Iowa where PFAS samples were collected (June 2019 to January 2020).

as they are more toxic and resistant to treatment than previously anticipated.[24] Between 2013 and 2015, the U.S. Environmental Protection Agency's (USEPA) third Unregulated Contaminant Monitoring Rule (UCMR 3) required the monitoring of six PFAS with PFOS and PFOA being detected in roughly 1% of the public water supplies sampled.[25] In 2016, the USEPA set a non-enforceable lifetime drinking water health advisory level of 70 ng/L for the individual and combined concentrations of PFOS and PFOA. The USEPA's fifth UCMR (UCMR 5) includes 29 PFAS.[26] Guidelines stricter than those set by the USEPA for select PFAS have been established in some states (e.g., Michigan and New Jersey) with enacted or proposed maximum contaminant limits in the range of 10 ng/L.[27,28] Currently, there are no ecological criteria or guideline values in the United States for PFAS.

To date, most environmental research has been conducted proximal to potential PFAS sources such as wastewater treatment plants (WWTPs), airports, and military bases[12] or in surveys of groundwater.[29] While UCMR 3 did collect PFAS data from 39 drinking water sources across Iowa,[25] 28 (72%) were from aquifers. Only 11 surface water sources were monitored, and all were from large water systems such as the Mississippi and Missouri rivers. No smaller agriculturally affected streams that dominate Midwestern landscapes such as those in Iowa were sampled. Thus, while research has documented multiple potential agriculture-related pathways for PFAS, including land application of municipal biosolids, livestock waste, fertilizers, and pesticides,[30−37] little environmental research of streams that are not used as drinking water sources has been conducted in rural regions of the United States to assess the prevalence of PFAS exposure resulting from such agricultural activities. To fill this research gap, this study conducted a statewide spatiotemporal stream sampling across Iowa to provide the most comprehensive assessment of PFAS concentrations in Iowa streams to date. As a vast majority of Iowa's landscape is devoted to agriculture (leading the nation in corn, swine, and egg production), Iowa is an ideal area for determining the prevalence of PFAS in rural, agricultural streams and providing critical baseline data on PFAS exposure in such streams.

■ MATERIALS AND METHODS

Site Selection. Sixty stream sites were sampled for this study, with 88% of the basin area within Iowa covered by the sampling network (Figure 1 and Table S1).[38] The sampling network contained a range of basin sizes (0.85−36301 km^2), urban land uses (2−72%), cultivated land uses (12−93%), human populations (0−835 people/km^2), and livestock production (0−516 animal units/km^2). All sites sampled for this study were part of ongoing water quality or water quantity

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investigations being conducted by the U.S. Geological Survey (USGS) Central Midwest Water Science Center.

Sample Collection. A spatiotemporal set of 119 stream-water samples from 60 stream sites were collected across Iowa from June 2019 to January 2020 (Tables S2 and S3). To confirm that treated wastewater is a potential source of PFAS to streams as previously documented,[30] two wastewater effluents (one from a municipal WWTP and one from an ethanol processing plant) were both sampled over two separate time points (Table S1). In addition, longitudinal sampling along a 5.1 km reach of Muddy Creek was conducted using four sampling sites: (1) 0.1 km upstream from the WWTP outfall (US1, 05454050), (2) WWTP outfall (effluent, 05454051), (3) 0.1 km downstream from the WWTP outfall (DS1, 05454052), and (4) 5.1 km downstream from the WWTP outfall (DS2, USGS gaging station, 05454090).

To determine whether a relation exists between PFAS concentration and streamflow at the time of sample collection, 10 sites had the combination of (1) multiple PFAS samples collected, (2) PFAS detected in at least one of the samples collected, and (3) corresponding flow information during the time of sampling (Table S3). Previous research has documented streamflow as an important driver of chemical concentrations in streams.[40]

Unfiltered water samples were collected from below the water surface in two, 2 mL centrifuge tubes and immediately chilled at 4 °C for transport back to the various offices. Each tube was filled halfway (approximately 1 mL) to accommodate addition of an equal volume of methanol during laboratory analysis. Archival was switched partway through the study from chilled to frozen storage. To avoid contact with surface water sampling equipment that could contain materials such as Teflon and Teflon-coated components that could cause sampling contamination, samples were collected using a direct dip approach at the centroid of flow (for wadable situations) or by filling a high-density polyethylene bottle using a weighted sampler at the centroid of flow and immediately transferring water to the centrifuge tubes.

Sample Processing and Analytical Methods. Concentrations of 34 PFAS compounds [11 perfluoroalkane carboxylates (PFCAs), nine perfluoroalkanesulfonates (PFSAs), four PFOS/PFOA replacements, and 10 PFSA/PFCA precursors] (Table S2) were determined in matrix-modified samples by direct aqueous injection-liquid chromatography/tandem mass spectrometry (DAI-LC/MS/MS) with isotope-dilution quantification. Additional details regarding sample processing and analysis are provided in the Supporting Information. To maximize the amount of data regarding PFAS exposure for this study, quantitative [at or above the limit of quantification (LOQ)] and semiquantitative (<LOQ) results were considered detections.[41−43] The method detection levels (MDLs) and LOQs were determined using a multiconcentration spiking approach with seven replicates at each concentration level and calculations being made with ASTM's DQCALC software.[44,43] MDLs were set at Currie's critical level (L_c); LOQs were set at twice the MDL for each compound, and the reporting level shown in tables was equal to the LOQ. The LOQs ranged from 3.0 to 42.7 ng/L (Table S2).

Quality Assurance/Quality Control. Field blanks were collected at three randomly selected sites to ensure that sample collection and handling procedures did not affect the corresponding PFAS results. These field blanks consisted of laboratory grade organic-free water that was collected and handled using the same field protocols as the environmental sample. No PFAS were detected in the three field blanks collected (Table S4). In addition, eight stream samples were randomly selected for laboratory duplicate analysis with no detections of PFAS compounds (Table S3). Details regarding the method validation experiments (recovery in reagent water, surface water, groundwater, and wastewater effluent) are provided in the Supporting Information.

Statistical and Exposure:Activity Ratio (EAR) Analysis. All statistical analyses were conducted in R statistical software.[45] Spearman's rho (ρ), a nonparametric test to determine significant monotonic relations between continuous variables,[46] was used to determine potentially significant relations between PFAS results (i.e., total number of PFAS detected and cumulative PFAS concentration) and the set of explanatory variables compiled (Table S1). For this statistical analysis, semiquantitative detections and concentrations coded with an "E" and a "V" were included. For sites having multiple PFAS samples collected, the greatest number of PFAS detected and the largest cumulative PFAS concentration observed were used. Correlations were considered significant when $p < 0.05$.

EARs were computed and plotted in R using toxEval (version 1.2.0; ToxCast database version 3.2).[47] Detected PFAS were compared with ToxCast high-throughput exposure effect data to determine potential biological effects. Individual chemical EARs [ratio of the detected concentration to the activity concentration at the cutoff (ACC) from ToxCast][48] of ≥1 reflect exposure concentrations shown to trigger the observed biological activity.[49,50] An EAR of ≥0.001 has been previously used to identify samples of potential environmental concern.[51,52]

RESULTS AND DISCUSSION

At least one PFAS was detected in 26 of the 119 stream samples (22%) and in all four (100%) of the effluent samples collected, with 10 PFAS detected overall (Table S3). All detected PFAS were PFAAs that are known to be environmentally stable.[53] The most frequently detected PFAS in streams were PFBS (11 detections, 9.2%), PFOA (11, 9.2%), and PFNA (10, 8.4%). When semiquantitative detections were excluded, the most frequently detected PFAS in streams were PFBS (8), PFOA (7), PFHxA (7), and PFPeA (7). The highest individual PFAS stream concentration measured was 134 ng/L (PFBA) in an agricultural stream, and the highest cumulative PFAS concentration measured in an individual stream sample was 197 ng/L in a municipal WWTP effluent-affected stream. Observed stream PFAS concentrations were similar to those from a study of a large river basin in the southeastern United States (Yadkin-Pee Dee River) having substantial urban and agricultural land use with no known industrial production or military-related PFAS sources[54] but substantially lower than those of streams in urban and industrialized settings from the United States and South Korea.[55−57]

Spatial Distribution. At least one PFAS was detected in 19 of the 60 streams sampled but in only 9 streams when semiquantitative detections were excluded (Figure S1 and Table S3). No obvious geographic or size distribution to the basins where PFAS were detected was observed. Sites, however, having the greatest number of PFAS detected were small, municipal WWTP effluent-affected streams (Table S3). Such streams are becoming increasingly common worldwide

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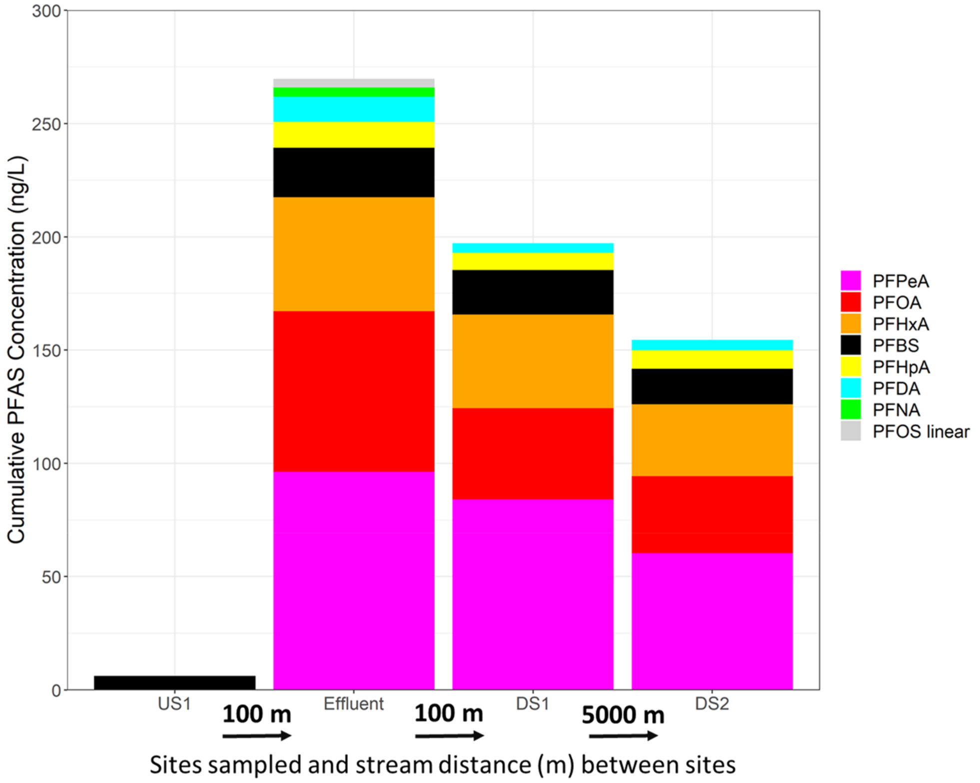

Figure 2. Individual per- and polyfluoroalkyl (PFAS) concentrations at four longitudinal sampling locations along a 5.1 km reach of Muddy Creek [US1, 100 m upstream from a wastewater treatment plant (WWTP) outfall, 0.014 m^3/s; effluent = at WWTP outfall, 0.076 m^3/s; DS1, 100 m downstream from a WWTP outfall, 0.09 m^3/s; and DS2, 5000 m downstream from a WWTP outfall, 0.061 m^3/s]. All samples were collected on July 16, 2019. On the basis of streamflow measurements at US1 and DS1, Muddy Creek was roughly 85% effluent at the time of sampling.

even in temperate areas such as Iowa.[58] Previous research has documented wastewater input to streams to be an important source of contaminants.[59] In particular, effluent-affected streams have been shown to have numerous water quality effects from WWTP effluent discharge,[60,61] including PFAS.[62] While PFAS exposures were more sporadic in basins dominated by agriculture, such exposures were observed (Table S3), indicating that agricultural activities may also be contributing to stream PFAS concentrations or there were other unidentified PFAS sources in these basins.

Three of the 20 available ancillary factors (Table S1) were significantly correlated with the PFAS results. The number of permitted "operations" outfalls (e.g., egg farms and wineries) was significantly related to the total number of PFAS detected ($\rho = 0.267$, and $p = 0.039$). In addition, the percentage of basin in developed land use ($\rho = 0.318$, and $p = 0.013$; $\rho = 0.311$, and $p = 0.015$) and number of permitted stormwater outfalls ($\rho = 0.470$, and $p < 0.001$; $\rho = 0.426$, and $p < 0.001$) were related to both the total number of PFAS detected and the total PFAS concentration. These results indicate the importance of urban sources of PFAS to streams even in intense agricultural regions.

The longitudinal sampling along a 5.1 km reach of Muddy Creek clearly documented the effect of WWTP effluent on stream PFAS concentrations similar to that in previous research.[59] An abrupt increase was observed in both the number of PFAS detections and the concentration between two longitudinal sites (US1 and DS1) due to the input of WWTP effluent (Figure 2). This dramatic change in stream PFAS concentrations was similar to that previously observed for pharmaceuticals in this stream reach.[61] Some attenuation did occur between the effluent and DS1 site (roughly 100 m of travel distance), in terms of both the number of individual PFAS detected and the total PFAS concentration (Figure 2 and Table S3). Two PFAS measured at low concentrations in the effluent (PFNA and $PFOS_{linear}$) were not detected at DS1. Interestingly, not all PFAS attenuation in this first 100 m of transport can be explained by dilution (i.e., mixing of the effluent with native streamwater containing substantially lower PFAS concentrations) as the amount of flow derived from upstream water (15%) translated to a 27% decrease in cumulative PFAS concentration. Additional potential attenuation processes occurring between the these two sites include volatilization,[6] sorption to bed sediment,[57] biodegradation via biofilms,[54] and foam formation.[63]

While there was additional PFAS attenuation observed in the 5 km travel distance between DS1 and DS2 (roughly 20% decrease in total PFAS concentration), there was no change in the individual PFAS detected (Table S3). This decrease in total PFAS concentration was from a roughly similar percentage concentration decrease for PFPeA, PFOA, PFHxA, and PFBS (Table S3). These four PFAS composed the vast majority of the total PFAS concentration (>90%) at both DS1 and DS2 (Figure 2). The PFAS attenuation between sites DS1 and DS2 was not likely due to dilution from additional surface water or groundwater input as streamflow was observed to be decreasing through this stream section (Table S3) and has been documented to be a losing reach during base-flow conditions.[38,61] Thus, this decrease in PFAS concentration between DS1 and DS2 was likely due to other potential attenuation processes such as sorption to sediment and biodegradation via biofilms. Previous research has

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documented that biofilms can rapidly degrade organic contaminants in surface waters.[64]

Temporal Distribution. Seven of 10 basins with available flow information and corresponding PFAS detections in at least one of the temporal samples collected (Table S3) provided preliminary evidence of an inverse relation between PFAS and streamflow, with six of these sites having PFAS detected only in the sample where the lowest flow was observed (Table S3). The three remaining basins had no obvious trend between PFAS results and streamflow at the time of sampling. Such inverse relations between stream concentrations and flow are indicative of a point source input that is increasingly diluted with increasing streamflow.[40] This hypothesis is best tested at the Muddy Creek sampling site (05454090) as this is an effluent-affected stream where four temporal PFAS samples were collected (Table S3). These results clearly document an inverse relation between cumulative PFAS concentration and streamflow (Figure S2). Conversely, nonpoint sources have been documented to have a general direct relation between streamflow and chemical concentration when there is a combination of (1) source applications at the land surface and (2) corresponding precipitation to drive chemical transport to the stream following land application.[65] Additional research would help document the importance of nonpoint sources as potential drivers of stream PFAS concentrations as (1) only 52% of the streams in this sampling network had more than one water sample collected for PFAS analysis and (2) temporal sampling was not specifically targeted to bracket known windows of application (e.g., municipal biosolids and livestock manure) in combination with corresponding precipitation events.

Environmental Implications. The detected PFAS were compared with ToxCast high-throughput effect data to determine their relative potential to elicit biological effects in exposed organisms (Figure S3 and Tables S6 and S7). Of the 10 PFAS detected, six had data available in ToxCast. These six PFAS comprised roughly 38% of the overall PFAS concentration measured (449 of 1189 ng/L). While no individual PFAS had an EAR of >1.0 (Figure S4), a level shown to trigger observed adverse biological activity, five stream sites did have at least one EAR of >0.001, the precautionary effect screening threshold.[51,52] These five stream locations had a wide range of basin sizes (3.87−35500 km^2) with three locations derived from WWTP effluent-affected streams. Both wastewater effluents sampled had at least one EAR of >0.01 (Figure S4), indicating that wastewater discharge is likely an influential source of PFAS at levels of potential environmental concern to the sampled streams during this spatiotemporal study.

This study provides critical baseline PFAS stream data not previously available and documents that PFAS are present even in rural basins. While many of the PFAS detections observed during this study were below LOQs (i.e., semiquantitative), their affinity for bioaccumulation[54,66] makes the documentation of even such low concentrations an important endeavor. Thus, excluding confirmed detections below the LOQ would have provided an underestimation of both PFAS prevalence and the corresponding environmental exposures. In addition, a better understanding of the contributions of nonpoint, agricultural sources would be accomplished by stream sampling specifically targeted toward periods of use (i.e., land application of municipal biosolids) and corresponding precipitation events that drive chemical transport to streams. Furthermore, water concentrations likely underestimate stream exposures as bed sediment can also be an important exposure pathway to aquatic and terrestrial organisms. Previous research has documented that shorter-chain PFAS are more prevalent in streamwater with longer-chain PFAS being more prevalent in bed sediment.[57] Thus, future research of agricultural streams could include (1) simultaneous multimatrix sampling of water, bed sediment, and biota to better understand exposure and the corresponding propagation and effects of PFAS on the riparian food web[54,66,67] and (2) an analysis of both PFAS and total fluorine[68,69] to capture unidentified organic fluorine and to better evaluate the extent of potential organic fluorine contamination.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.estlett.1c00750.

Analytical method and Figures S1−S4 (PDF)

Tables S1−S7 (XLSX)

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Notes

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ATTACHMENT D

Research

(D-1 to D-3)

- **Fewscapes Discussion Brief**
- **A Quick Comparison of FEWscapes Models with Common Land and Water Management Models Web link:** https://fewscapes.wisc.edu/blog/a-quick-comparison-of-fewscapes-models-with-common-land-and-water-management-models/
- **What the FEWscapes Scenario Development Process Will Look Like Web link:** https://fewscapes.wisc.edu/blog/what-the-fewscapes-scenario-development-process-will-look-like/
- **Two Things to Know about SIMPLE-G, An Economic Model Designed to Pair with Ecological Models Web link:** https://fewscapes.wisc.edu/blog/two-things-to-know-about-simple-g-an-economic-model-designed-to-pair-with-ecological-models/

FEWscapes
FOOD ENERGY WATER

Discussion Brief | Issue 1 | Fall 2021

Over the course of three weeks at the end of August and beginning of September 2021, the FEWscapes project team hosted a set of four discussions with four different groups of engaged professionals from the food, energy, water, and conservation sectors in the Midwest. These individuals represented both the public and private sectors. Three of these discussion groups are state-based – representing Iowa, Minnesota, and Wisconsin – and one has a regional scope, consisting of the members of the Hypoxia Task Force Coordinating Committee and SERA-46. These were the first of a series of discussions that will take place over the next couple of years. Through the discussions, participants will provide input on scenarios for the Upper Mississippi River Basin to 2050 that will be developed and modeled, and they will help interpret the implications of those model results with the goal of identifying viable options for increasing food, energy, water, and ecosystem security in the region and beyond.

These first discussions provided an opportunity for participants to share their initial thoughts about the long-term trends and short-term "shocks" that are top of mind as threats (or opportunities) to food, energy, water, and ecosystem security. The trends and shocks they expressed will inform the development of the scenarios. The discussion also focused on modeling needs and pitfalls as a starting point for an exploration of how the FEWscapes models can be most useful to decision-making.

This Discussion Brief summarizes common ideas and themes that arose from these discussions and will inform FEWscapes research moving forward. Since this document is intended to provide a big-picture snapshot of the proceedings, the numerous unique ideas that participants also shared are not included. Despite their omission in this document, these unique insights are valuable and will also help inform the research and engagement process.

Common Trends of Concern

The following list includes long-term trends that participants frequently mentioned as concerns or curiosities for how they will influence FEWE security into the future.

- Nitrate contamination of groundwater and drinking water
- Drinking water threats, including those related to water quality (such as harmful algal blooms) and water quantity (such as drought)
- Agricultural intensification and consolidation within both commodity crop and livestock sectors
- Electrification of vehicles and how it could impact biofuel production and agriculture
- Cropland carbon sequestration, carbon markets, and their efficacy and profitability for farmers

- Consumer dietary changes toward lab-grown meats/veggie protein and the implications for crop production, land use, water quality, greenhouse gas emissions
- Increasing soil erosion due to extreme weather events
- Farmland conversion to solar energy generation

Common Shocks of Concern

The following list includes abrupt changes, or shocks, that participants frequently mentioned as concerns or curiosities for how they will influence FEWE security into the future.

- Variability in precipitation and more frequent extremes – both wet and dry – becoming the trend and impacts for food production, water resources
- Flooding and impacts to agriculture, infrastructure
- Drought and impacts to agriculture, drinking water, irrigation
- Big storms and impacts to agriculture, water quality
- Climate refugees to the Upper Midwest

Bridging Scenarios, Models, and Policy

The conversations were rich with questions and considerations for how to bridge the scenarios and models with policy effectively. A few themes emerged that are helpful considerations.

Several factors emerged as important to get right to ensure model outputs are accepted and useful to decision-making. These factors included the following:

- Credibility, trust, and confidence in the models and modelers
- Identifying and speaking to the right audience, and right-sizing model outputs to their scale of decision-making
- Getting input from policymakers and farmers on the scenarios
- Communicating the assumptions and uncertainties within the scenarios, models, and model results
- Identifying and communicating how FEWscapes' models can be helpful to small-scale or field-scale decision-making

Moreover, there was a general curiosity about how scenarios and models can influence the policy process and/or contribute to social change. Given that this is also a curiosity of the project team, this is a space ripe for more discussion and co-learning.

Modeling Gaps and Needs

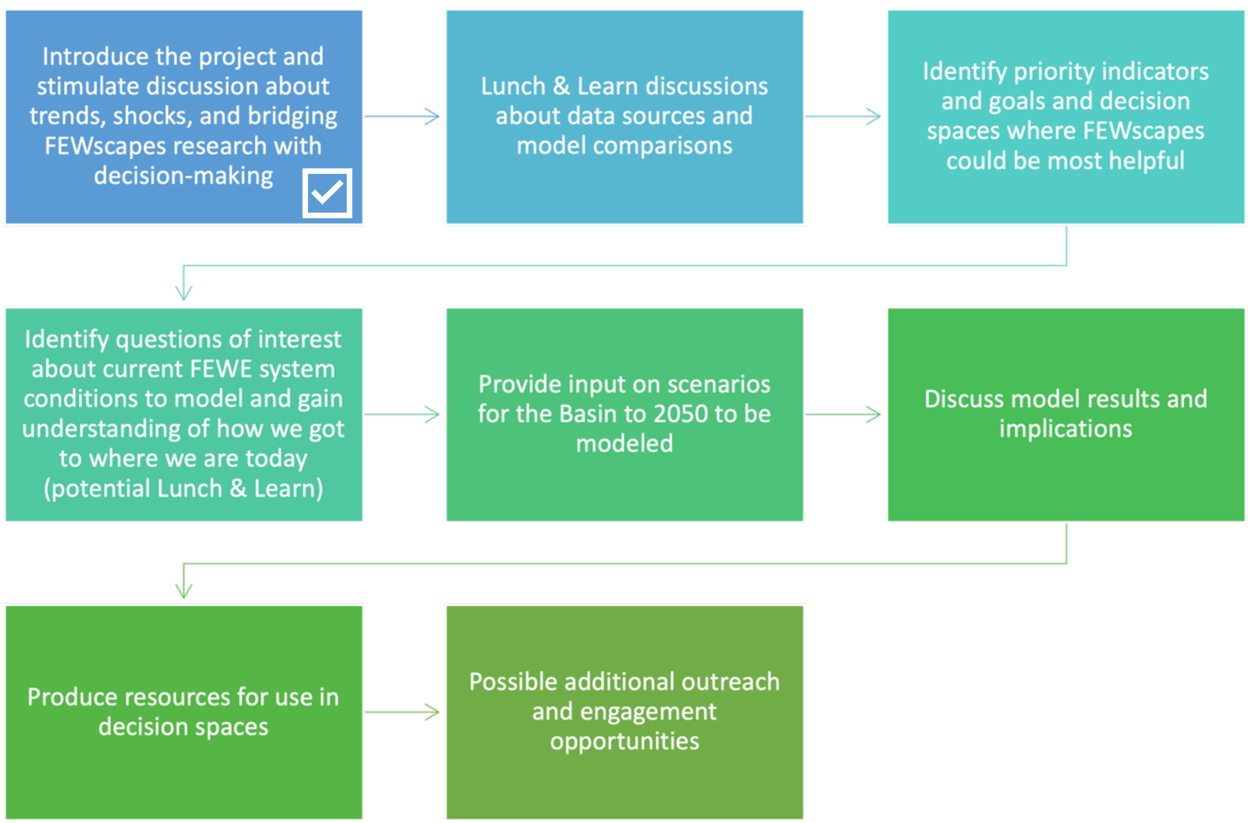
Participants expressed numerous needs related to model capabilities and the type of information they can provide to assist with decisions. A few themes emerged:

- There is interest in fine-scale data that can inform field-scale decisions and changes by farmers, including questions about how model outputs can cross scales effectively.
- There is a need for the capacity to update models with new information more quickly.

- There is curiosity about how to incorporate human dimensions into models – e.g., economics, human behaviors, risk tolerance, and other social and psychological factors that influence outcomes for food, energy, water, and natural systems.
- Components of FEWE systems that aren't currently represented adequately in either data sources or models include groundwater, drainage systems, conservation practice implementation on the landscape, and groundwater and surface water interactions.

Next Steps

The following diagram is the current understanding of the steps in this discussion series. This process is adaptable to accommodate unanticipated needs or opportunities and, thus, subject to change.



ATTACHMENT E

CWA Program

- **The 2022-2032 Vision for the Clean Water Act Section 303(d) Program (4-2022)** *(E-1 to E-13)*

- **EPA's Environmental Justice Collaborative Problem-Solving Model Web link:** EPA's EJ Collaborative Problem-Solving Model

- **Best Practices for Meaningful Community Engagement** Groundwork USA Tips for Meaningful Community Engagement

- **How to Involve Environmental Justice Communities Web link:** How to Involve Environmental Justice Communities

- **Confronting Disproportionate Impacts and Systemic Racism In Environmental Policy Web link:** Confronting Disproportionate Impacts and Systemic Racism in Environmental Policy

The 2022 - 2032 Vision for the Clean Water Act Section 303(d) Program

The Clean Water Act Section 303(d) program provides for effective integration of efforts to assess, restore, and protect the nation's aquatic resources.

The Vision identifies opportunities to effectively manage Clean Water Act (CWA) Section 303(d) program activities to achieve water quality goals for the Nation's aquatic resources such as streams, rivers, lakes, estuaries and wetlands. The purpose of this document is to articulate a long-term Vision and associated Goals for the CWA 303(d) program, as well as Focus Areas for growth in the national program. The Goals outline aspirations and highlight opportunities to implement CWA 303(d) program activities in the following areas – Planning and Prioritization, Restoration, Protection, Data and Analysis, and Partnerships. Focus Areas are intended to identify cross-cutting themes that EPA is emphasizing for growth at the national program level – Environmental Justice, Climate Change, Tribal Engagement and CWA Section 303(d) Program Capacity Building. This Vision outlines a framework to organize program activities; it does not constitute regulation, policy, or new mandates.

The Vision is designed to help coordinate and focus efforts to advance the effectiveness of CWA 303(d) program implementation in the coming decade. The 2022 Vision in this document builds on the experience gained from implementing the 2013 Vision outlined in "A New Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program." Like the 2013 Vision, the 2022 Vision is intended to encourage flexible and innovative approaches for states, territories, and authorized tribes[1] ("states, territories and tribes") to implement CWA Section 303(d), as well as in identifying ways to best use limited resources to lead to restoration and protection, leverage partnerships, and encourage development of solutions to emerging and difficult waters quality issues.

Vision Development Process

States and territories have been using the Goals outlined in the 2013 Vision to guide program management for the past ten years. The CWA 303(d) program had determined to revisit the Vision by 2022. A process of collective reflection on the successes and challenges of the 2013 Vision period started with the 2020 National CWA 303(d) Training Workshop (link). Following the workshop, the Association of Clean Water Administrators (ACWA) led a series of meetings with program representatives to further capture perspectives on the implementation of the 2013 Vision and provided recommendations to help shape the program discussions about a subsequent long-term Vision (link). In a parallel effort, EPA developed and distributed proposed principles to guide program management into the future and discussed them with state, territorial and tribal representatives. In October 2021, the Environmental Law Institute under cooperative agreement with EPA, hosted a writing Summit where state, tribal, and EPA staff worked together to develop language that would become the foundation for this memo.

[Additional discussion of process will be added here before finalizing the memo]

[1] This document will discuss tribes both as potential entities to be authorized to implement CWA Section 303(d) (through Treatment in the Same Manner as State or TAS) and tribes that do not yet have TAS. When referring to entities that may implement CWA section 303(d) this document uses "states, territories, and tribes."

Relationship to EPA Performance Metrics for CWA 303(d) Program

EPA intends to meaningfully capture and share key program activities consistent with the Vision through a suite of metrics. Beginning in January 2021, EPA initiated a workgroup with a group of states to discuss creation of measures that would help track CWA 303(d) program's success in light of the forthcoming long-term Vision and Goals. The workgroup was tasked with identifying options for a set of metrics that would promote accountability by tracking development of plans over the period of long-term planning and provide additional opportunity for states to consider ways to tell their stories of overall program progress and success. EPA and states discussed the ideas arising from this workgroup and other ideas over a series of meetings and calls in 2021 and 2022.

In response to this work and discussion, EPA is developing, in coordination with states, territories and tribes, a metric that would be in place starting in Fiscal Year 2025. A leading candidate for that metric would measure the extent of state, territorial or tribal priority waters addressed by TMDLs and other restoration plans in impaired waters or by protection approaches in healthy waters. States, territories, and tribes would have the flexibility to begin and complete plans over the course of multiple metric reporting cycles. EPA is also working on a suite of additional metrics to communicate overall program progress.

The 2022 - 2032 Vision for the Clean Water Act Section 303(d) Program

Vision Statement

The Clean Water Act Section 303(d) program provides for effective integration of efforts to assess, restore, and protect the nation's aquatic resources.

Goals

Outline aspirations and highlight opportunities to implement CWA 303(d) program activities.

Planning and Prioritization Goal:
States, territories, tribes develop a holistic strategy for implementation of Vision Goals and systematically prioritize waters or watersheds for TMDL and other plan development (restoration and/or protection) and report on the progress towards development of plans for priority waters.

Restoration Goal:
States, territories, and tribes design TMDLs and other restoration plans to attain and maintain water quality standards, facilitate effective implementation, and drive restoration of impaired waters.

Protection Goal:
In addition to recognizing the protection benefits that TMDLs and other restoration plans can provide; states, territories, and tribes may develop protection plans to prevent impairments and improve water quality, as part of a holistic watershed approach.

Data and Analysis Goal:
The CWA 303(d) program coordinates with other government and non-governmental stakeholders to facilitate data production and sharing, and effectively analyzes data and information necessary to fulfill its multiple functions.

Partnerships Goal:
The CWA 303(d) program meaningfully communicates and collaborates with other government programs and non-governmental stakeholders to effectively and sustainably restore and protect water quality.

Focus Areas

Identify cross-cutting themes that EPA is emphasizing for growth at the national program level.

Environmental Justice: Actively consider environmental justice in assessment, listing, and TMDLs in order to address disproportionately high and adverse environmental, water quality, climate-related, and other relevant impacts on underserved communities.

Climate Change: Strategically consider how to account for the impacts of climate change, or address climate resiliency or vulnerability, in water quality assessment, impaired waters listing, and the development of TMDLs and other plans consistent with water quality standards.

Tribal Engagement: Help interested tribes administer the CWA 303(d) program, assess waters, and plan for restoration and protection of tribal waters, ensure meaningful consultation opportunities, and otherwise enable tribes to engage with EPA on CWA 303(d) program activities relevant to their interests.

Program Capacity Building: Expand and build upon the activities and materials developed to improve understanding of CWA 303(d) program foundations, familiarity with tools and various approaches to regular tasks and complex circumstances, and ability to accomplish statutory responsibilities and Vision Goals more efficiently and effectively.

Goals

The Goals outline aspirations and highlight opportunities to implement CWA 303(d) program activities. Goals are presented beginning with the cornerstone Goal of *Planning and Prioritization* as the foundation to guide organization and implementation of the other Goals. The next two Goals of *Restoration* and *Protection* recognize that CWA 303(d) programs may utilize different types of plans to advance their water quality objectives. The *Data and Analysis* Goal is a key means to inform water quality assessment and listing, TMDL development, and implementation activities. Finally, under the *Partnerships* Goal, coordination of CWA 303(d) and other water quality program objectives and involvement of stakeholders around mutually identified priorities are key themes to promote water quality restoration and protection.

Planning and Prioritization Goal

States, territories, and tribes develop a holistic strategy for implementation of Vision Goals and systematically prioritize waters or watersheds for TMDL and other plan development (restoration and/or protection) and report on the progress towards development of plans for priority waters.

The intent of the Planning and Prioritization Goal is to encourage states, territories, and tribes to coordinate program activities in the context of their broader water quality objectives and identify corresponding priorities that align with those objectives. The CWA 303(d) program has an inherent planning role because it applies water quality standards to develop pollutant loading targets for the point source permitting and nonpoint source management programs as well as other programs under and outside of the CWA. Coordinating CWA 303(d) program activities with those of other programs can aid in strategically focusing limited resources to address broader water quality objectives most effectively. Furthermore, implementation of the 2013 Vision has demonstrated that establishing long-term CWA 303(d) program priorities as part of this planning process can lead to more efficient and effective program management and yield thoughtful progress toward water quality restoration and protection.

Carrying out CWA 303(d) statutory and regulatory obligations through the lens of a state, territory, or tribe’s long-term priorities can help motivate partners and stakeholders to take the actions needed to implement TMDLs and improve water quality. Prioritization facilitates focusing the location and timing for developing and/or revising TMDLs and other restoration and protection plans in ways that are best suited to the broader water quality objectives of each state, territory, or tribe. The priorities also provide the foundation to guide the planning and implementation of the other CWA 303(d) Vision Goals. The EPA intends to continue to assist and collaborate with states, territories, and tribes in identifying their priorities. Important venues for such collaboration may include the Performance Partnership Agreement/Performance Partnership Grant (PPA/PPG) discussions and development of CWA Water Quality Management Plans and CWA Integrated Reports (IR).

Flexibility and adaptability are central to this Goal because each state, territory, or tribe is unique and subject to changing circumstances. Each state, territory, or tribe's planning objectives will be shaped by what is important to its public and stakeholders, and what resources and information are available, among many other factors. States, territories, and tribes can identify their long-term CWA 303(d) program priorities in their own unique manner, using any of a myriad of approaches, including but not limited to specific geographic areas, pollutants, designated uses, or pollutant-use combinations. States, territories, and tribes can express their priorities in a Prioritization Framework with as much detail as they deem appropriate, from just narrative explanations of the geographic priority area(s), pollutant(s), etc. to specific priority waters or watersheds for the entire Vision period. It is anticipated that states, territories, and tribes would identify and communicate specific waterbodies to be addressed over shorter increments. Each state, territory, and tribe is encouraged to involve an array of partners and stakeholders at all stages of the prioritization process that it finds beneficial. There are significant advantages in meaningfully engaging other CWA programs, other statutory programs, other government agencies, tribes, stakeholders, communities with environmental justice concerns, and the broader public, consistent with the Partnerships Goal.

A state, territory, or tribe's Prioritization Framework, including CWA 303(d) program long-term priorities and rationale for selecting those priorities, and its general strategy for implementing the Goals of the CWA 303(d) program Vision over the next decade should be transparent to its stakeholders. The Prioritization Framework for each state, territory, or tribe should be shared with the EPA by April 1, 2024, and updated as needed. States, territories, and tribes are encouraged to utilize the IR public process to share their respective Prioritization Frameworks or use an independent public process. Regardless of how states, territories, and tribes choose to communicate their Prioritization Frameworks, the use of IRs to report on the progress towards development of TMDLs and other restoration plans, and any protection plans for priority, or other, waters or watersheds is encouraged.

Restoration Goal

States, territories, and tribes design TMDLs and other restoration plans to attain and maintain water quality standards, facilitate effective implementation, and drive restoration of impaired waters.

The intent of the Restoration Goal is to encourage the identification, development, and implementation of the most effective approaches for restoring water quality. This Goal acknowledges how vital creativity and collaboration are for restoration plans to be successful in restoring waters. Restoration plans include TMDLs and other beneficial plans that address impaired waters. This includes, but is not limited to, waters assigned to Integrated Reporting Categories 5, 5r/5alt, 4b, and 4c.[2]

This Goal recognizes that TMDL development will continue to be a primary feature of the program. In addition to TMDLs, there are other types of plans that may be more immediately beneficial or practicable for restoring water quality in particular situations consistent with state,

[2] See EPA's Integrated Reporting Memoranda for discussion of EPA's reporting categories: https://www.epa.gov/tmdl/integrated-reporting-guidance-under-cwa-sections-303d-305b-and-314

territorial, or tribal water quality standards. EPA notes that while the CWA requirement to develop TMDLs remains for impaired waterbodies in Category 5, these waterbodies may be given a lower priority for TMDL development while other restoration plans are pursued.

The 2013 Vision highlighted that restoration plans have a greater likelihood of yielding successful implementation when they involve enhanced engagement, coordination with stakeholders, integration among programs, and greater overall buy-in. Successful implementation is also advanced when the approaches, plans, and implementation activities adapt to changing circumstances and new data (often referred to as adaptive management). TMDLs and, as appropriate, other restoration plans can guide implementation in many ways; for example, plans provide a target for restoring beneficial uses and identify pollutant sources with an appropriate level of detail, describe strategies or processes that can be used to best achieve that target, and/or present a structure for active review of implementation practices and monitoring data, allowing projects to adapt for the most effective outcome.

Another major focus of this Goal is to further explore and identify how principles of adaptive management can most effectively be applied to achieve water quality standards, regardless of the type of restoration plan used. An emphasis on adaptive management facilitates a more iterative approach to water quality restoration, promoting the monitoring of plan effectiveness, the incorporation of new data and information into plan implementation and revision, and building new opportunities and actions to pursue under the Partnerships Goal. The Water Quality Management Plan and Continuing Planning Processes are two possible tools that could be used to effectively track implementation activities and adjust implementation approaches, as well as inform revisions of TMDLs and other restoration plans, as needed.

Protection Goal

In addition to recognizing the protection benefits that TMDLs and other restoration plans can provide; states, territories, and tribes may develop protection plans to prevent impairments and improve water quality, as part of a holistic watershed approach.

The intent of the Protection Goal is to encourage a proactive and holistic consideration of management actions to protect healthy waters.[3] Protection of waters is a specific objective of the CWA – "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (CWA Section 101). Also, protection and restoration are interdependent goals regarding the "integrity of the Nation's waters." For example, protection of healthy headwaters and wetlands helps reduce downstream restoration challenges and costs, while restoration reduces risks to adjacent protected, healthy waters. Including protection in and alongside restoration planning and implementation contributes to a holistic watershed approach that uses resources efficiently.

[3] For a specific waterbody, protection as described in this Vision is the sustained minimization or avoidance of water quality degradation due to stressors and/or watershed alterations that would present threats to its current condition. Under the Vision, protection is oriented toward healthy waters, including, but not limited to, those of high quality, simply unimpaired, or with limited impairments (to uses other than those for which protection is being sought). See EPA's website for details.

Planning for protection can take many forms, independent from or in combination with restoration. For example, healthy waters at risk of degradation can benefit from protection plans designed to hasten implementation of actions that will keep the water from becoming impaired. For healthy waters not at risk of impairment, the thresholds necessary to maintain those higher quality characteristics can be identified, and plans designed to retain those thresholds. TMDLs and other restoration plans can aid the identification and protection of unimpaired or unassessed waters included within the broader geographic area by helping to ensure that segments do not degrade, as well as facilitating water quality improvements in impaired segments. Also, after restoration, TMDLs remain operative, helping to protect the waterbody from becoming impaired again.

Although not all States, territories, and tribes may ultimately choose to use protection approaches, opportunities for protection within the context of the state, territory, or tribe's water quality goals can be an important component to achieving water quality objectives. Protection can be less costly, both fiscally and ecologically, than restoration. Proactively protecting watersheds and waterbodies can help with future threats such as emerging water quality problems, loss and fragmentation of aquatic habitat, altered water flow and availability, invasive species, and climate change, and can protect the surrounding communities impacted by these threats. Examples of waters that could benefit from protection plans include, but are not limited to:

- Outstanding National Resource Waters or other specific category of high-quality waters;
- Waters with unique, valuable, or threatened species or their habitats;
- Waters and watersheds that constitute a public drinking water supply;
- Healthy segments in watersheds with impaired segments, including headwaters above downstream waters that are impaired;
- Healthy waters near areas with rapid land use changes;
- At risk waters that are not yet impaired but showing signs of degradation;
- Other waters facing elevated risks of degradation.

Intergovernmental and external partnerships, as well as leveraging additional watershed program authorities (e.g., CWA Section 319, CWA Section 401 certification, antidegradation policies, Clean Water State Revolving Fund, Natural Resources Conservation Service, Wild and Scenic Rivers System, etc.), can be valuable in protecting healthy waters and habitats. EPA's Healthy Watersheds Program can support the efforts of CWA 303(d) programs to identify, protect, and maintain healthy watersheds across the United States.

Data and Analysis Goal

The CWA 303(d) program coordinates with other government and non-governmental stakeholders to facilitate data production and sharing, and effectively analyzes data and information necessary to fulfill its multiple functions.

The Data and Analysis Goal highlights multiple ways that states, territories, and tribes can expand on and improve the data and information available for CWA 303(d) functions. In the context of this Goal, that includes:

- Determining the water quality condition for use in categorizing waters in the Integrated Report (Categories 1-5);
- Supporting the development of restoration plans and protection plans; and
- Evaluating the effectiveness of plan implementation in restoring and protecting water quality, thereby facilitating adaptive management so that plans remain productive.

State, territorial and tribal 303(d) programs are encouraged to collaborate and foster effective data sharing processes internally to develop and gather the data and information needed for CWA 303(d) functions. States, territories, and tribes also are encouraged to coordinate and foster effective data sharing processes externally to develop and gather data and information at different geographic scales from other agencies, universities, volunteer groups (e.g., local watershed groups), other interested organizations, and communities. States, territories, and tribes are encouraged to work with outside parties interested in submitting data or information to ensure they are aware of data quality and format expectations. The EPA understands that there may be challenges associated with compiling data in different formats coming from different sources and will continue to work to improve data tools that help with this task.

Data consideration and analysis can best support the multiple CWA 303(d) functions when performed in a manner that:

- Apply appropriate geographic and temporal scales for the implementing programs' functions;
- Work towards evaluating water quality standards attainment in previously unassessed waters and waters where there is insufficient information to make an attainment decision, such as those in Category 3;
- Address emerging program priorities (e.g., areas with environmental justice concerns and the effects of climate change); and
- Enable a reasonable demonstration of program successes (e.g., as appropriate, supporting the conclusion that a particular waterbody is no longer impaired).

Advances in science, technology and data transmission offer potential for improvements in the amount of data available and the efficiency of data integration and interpretation. Each biennial CWA 303(d) listing cycle provides an opportunity for states, territories, and tribes to develop or revise assessment methodologies as needed to reflect the latest standards and science. As a general matter, for CWA 303(d) functions, ambient monitoring (which may include targeted monitoring and statistical surveys with a reasonably high level of confidence) provides some of the most critical water quality data, in addition to information from models and other tools (which may include sources such as satellite imagery, geospatial analysis, climate forecasting, and water quality models). States, territories, tribes, and EPA will continue to apply existing tools and explore new ones as appropriate. As states, territories, and tribes continue to gain experience utilizing these tools, they will be in a better position to employ them in the assessment and listing process, the development of restoration and protection plans, and the evaluation of the overall effectiveness of those restoration and protection efforts.

Partnerships Goal

The CWA 303(d) program meaningfully communicates and collaborates with other government programs and non-governmental stakeholders to effectively and sustainably restore and protect water quality.

The intent of the Partnerships Goal is to encourage communication with governmental entities and stakeholders in ways that lead to productive, sustained collaboration, and ultimately better water quality. The Goal consists of two distinct but related approaches: programmatic coordination and stakeholder involvement and engagement. Both approaches rely on:

- Clear and effective communication that is appropriate for the target audience;
- Identification of and meaningful work towards shared goals;
- Development and maintenance of strong working connections and relationships; and

Creation of structures and processes to weave partnerships throughout CWA 303(d) program activities.

Programmatic Coordination

The CWA 303(d) program seeks to coordinate with and complement efforts across CWA programs, other statutory programs, and the water quality efforts of other governmental departments and agencies (local, state, territorial, tribal, regional, federal, etc.) to identify and achieve shared goals. This coordination can include, among other approaches, organizing and aligning processes with partner entities working on CWA implementation; generating plans that are user friendly and broadly implementable across programs; and identifying and drawing in additional programs and resources across government entities, including tribes, and the research community to achieve water quality goals.

Stakeholder Involvement and Engagement

The CWA 303(d) program seeks to facilitate engagement early and often with non-governmental entities and other stakeholders across various sectors and disciplines. Meaningful engagement aims to understand non-governmental stakeholders' values and learn from their knowledge, and use this input to inform water quality activities. Through this engagement, the program also seeks to improve stakeholder understanding of matters such as the value of watershed management and the role of the CWA 303(d) program, encourage active involvement from those stakeholders in CWA 303(d) program activities, and empower the long-term contributions of stakeholders to water quality restoration and protection. This engagement should be fair and meaningful,[4] identifying and inviting input from all affected stakeholders, with particular attention to underrepresented communities and those with environmental justice concerns. The engagement will also strive to play a role in supporting community efforts to value, protect, and advance water quality over the long-term, including facilitating watershed stewardship, assisting stakeholders in building capacity for meaningful involvement, and helping local champions and messengers. Communication is best when it is multi-directional, structured in a way that creates a feedback loop for iterative progress, builds and maintains trust, respects community knowledge and cultural and ecological values, and produces sustainable solutions that are community driven.

Focus Areas

"Focus Areas" identify cross-cutting themes that EPA is emphasizing for growth at the national program level. Highlighting these areas is one way to jumpstart action and showcase progress towards EPA Agency Priorities. Recognizing state, territorial, and tribal efforts already underway, EPA further encourages the adoption and/or adaptation of these Focus Areas to tackle these important topics in the best manner according to individual state, territorial or tribal objectives. As with all other aspects of this Vision, these Focus Areas do not constitute regulation, policy, or new mandates.

Environmental Justice

It is imperative that EPA integrate environmental justice[5] considerations into EPA programs, plans, and actions and ensure equitable and fair access to the benefits of environmental programs for all individuals. EPA continues to make achieving environmental justice part of its mission by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on communities with Environmental Justice concerns.

The objective of the Environmental Justice Focus Area is to highlight the EPA CWA Section 303(d) program's commitment to environmental justice by seeking to actively consider environmental justice in assessment, listing, TMDLs, and other restoration and protection plans in order to address disproportionately high and adverse environmental, water quality, climate-related, and other relevant impacts on underserved communities.

[4] The EPA has defined "fair treatment" as meaning that "no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies," and "meaningful involvement" as "people have an opportunity to participate in decisions about activities that may affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; community concerns will be considered in the decision making process; and decision makers will seek out and facilitate the involvement of those potentially affected." See the EPA's website for more details.

[5] EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. See the EPA's Office of Environmental Justice Website for the full definition and more information.

In implementing CWA Section 303(d), thousands of communities and individuals can benefit through the work of State, Territorial, and Tribal programs. EPA recognizes that water quality and climate change impacts can disproportionately affect urban and rural communities that are predominately of color, indigenous, linguistically isolated, low-income, and/or impacted by other stressors. EPA commends immediate and affirmative steps to improve the program's assessment, listing, plan development, monitoring and engagement processes with a focus on pollution-burdened and underserved communities. The Partnerships Goal of this Vision speaks to some of the engagement approaches for integrating environmental justice into program work. EPA will collaborate with interested state, territorial, and tribal partners to further incorporate Environmental Justice opportunities into CWA 303(d) program operations. Opportunities to further integrate Environmental Justice into program implementation may include, but are not limited to, the following:

- Actively engage the public and other stakeholders to improve and protect water quality, as demonstrated by documented, inclusive, transparent, and consistent communication; requesting and sharing feedback on proposed approaches; providing equitable access to the public participation processes; and enhanced understanding of program objectives.
- Enhance understanding of the quality of more waterbodies near pollution-burdened, underserved, and tribal communities.
- Establish and communicate quality-controlled processes to more easily use data and information from community/watershed groups, universities, and other entities for assessment and listing.
- Consider prioritizing TMDLs, restoration and protection plans for development in areas most burdened by current and/or historical pollution.
- Consider impacts on overburdened communities when developing and implementing TMDLs, and other restoration and protection plans; and their ability to achieve and maintain water quality standards.

EPA will look to promote opportunities through case studies, tools and guidance as appropriate.

Climate Change

EPA is committed to integrating climate adaptation planning into the Agency's programs, policies, and rulemaking processes. The objective of the Climate Change Focus Area is to strategically consider how to account for the impacts of climate change, or address climate resiliency or vulnerability, in water quality assessment, impaired waters listing, and the development of TMDLs and other plans consistent with water quality standards. Examining the potential impact of changing climate conditions on CWA 303(d) program activities will often involve unique considerations depending on regional, local, or project-specific conditions. Measures taken to address climate change in CWA 303(d) program activities can be implemented with a focus on communities already experiencing disproportionately high adverse impacts, consistent with EPA's commitment to Environmental Justice, and considering efforts already underway by states, territories, and tribes.

EPA will collaborate with interested partners to further incorporate consideration of the impacts of changing climate conditions into program operations. Opportunities may include, but are not limited to, the following:

- Consider impacts of climate change on water quality in identifying impaired and threatened waters.
- Identify and utilize tools/resources that support prioritization of waters for protection and restoration that may be particularly susceptible to changing climate conditions.
- Consider the impact of changing environmental conditions on developing and implementing TMDLs, and other restoration and protection plans; and their ability to achieve and maintain water quality standards.
- Build program capacity to highlight or develop products and/or approaches (including TMDLs, modeling methods, reasonable assurance, implementation plans) that are robust and adaptive when facing uncertain conditions.
- Target program resources and staff capacity towards areas and communities most impacted by changing climate conditions.
- Engage the public and other stakeholders, and use available public processes to inform, solicit feedback, and enable constructive discourse to address impacts of climate change on CWA 303(d) program activities transparently and clearly.

EPA will look to promote opportunities through case studies, tools and guidance as appropriate.

Tribal Engagement

EPA works closely with tribal partners to support tribal nations as they protect and steward their waters. The objectives of the Tribal Engagement Focus Area are to help interested tribes administer the CWA 303(d) program, assess waters, and plan for restoration and protection of tribal waters, ensure meaningful consultation opportunities, and otherwise enable tribes to engage with EPA on CWA 303(d) program activities relevant to their interests.

Tribal, state and EPA representatives recognize the importance of tribal perspectives in implementing the CWA 303(d) program. Tribal-related topics include:

- EPA promoting and providing technical assistance to help tribes adopt and implement CWA 303(d) programs for reservation waters (Treatment in the Same Manner as State or TAS),
- Developing tribal capacity for water quality assessment and planning,
- Coordinating/integrating with other water programs to promote restoration and protection of Indian country waters and state waters where tribes have rights,
- Consulting/coordinating with tribes on EPA CWA 303(d) actions in state areas of interest or importance to tribes,
- Encouraging state and tribal coordination on CWA 303(d) actions early and throughout the process, and
- Considering the appropriate scope of direct implementation by EPA of CWA 303(d) listing and TMDL functions.

Program Capacity Building

The abilities of the staff (and resilience in the face of turnover) is vital to sustained, effective programs. These abilities and this resilience depend upon effectively training new staff, supporting existing staff in expanding their technical skills and subject matter knowledge, providing an information-exchanging community of practitioners across jurisdictions and levels of government, and fostering diverse perspectives and an inclusive work environment.

The objective of the Program Capacity Building Focus Area is to expand and build upon existing activities and materials developed to improve understanding of CWA 303(d) program foundations, familiarity with tools and various approaches to regular tasks and complex circumstances, and ability to accomplish statutory responsibilities and Vision Goals more efficiently and effectively. The CWA 303(d) webinar series and annual national CWA 303(d) training workshop will strive to reach more program staff and provide innovative content for all levels of practitioners. EPA training resources (e.g., forthcoming TMDL training resources) will be of particular value to newer practitioners, and a project focused on communicating success will yield examples, templates, and collaborative resources. The EPA also intends to develop new guidance and factsheets on topics highlighted by program staff, and work with partner organizations to collaboratively support program development. Activities might include expanding the collection of documents cataloging and summarizing program practices on specific matters, and supporting additional stakeholder trainings to improve program implementation. With input from new and well-established practitioners alike, these and other events and materials could fill notable knowledge gaps, advance critical thinking on issues of widespread interest, and improve collaboration inside the CWA 303(d) program as well as with other programs and stakeholders.

ATTACHMENT F

Nutrients

- **USEPA Memorandum: Accelerating Nutrient Pollution Reductions in the Nation’s Waters (4-2022)**
  (F-1 to F-9)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

April 5, 2022

MEMORANDUM

SUBJECT: Accelerating Nutrient Pollution Reductions in the Nation's Waters

FROM: Radhika Fox
Assistant Administrator

TO: State Environmental Secretaries, Commissioners, and Directors
State Agriculture Secretaries, Commissioners, and Directors
Tribal Environmental and Natural Resource Directors

CONTEXT

Nutrient pollution is a continuing and growing challenge with profound implications for public health, water quality, and the economy.[1] In a changing climate, the complexity and severity of the problem is increasing. Nutrients are the most widespread stressor impacting rivers and streams.[2] Fifty-eight percent of the nation's rivers and streams and 45 percent of our lakes have excess levels of phosphorus.[3] About two-thirds of the nation's coastal areas and more than one-third of the nation's estuaries are impaired by nutrients.[4] Excess nutrients contribute to harmful algal blooms, areas of low oxygen known as "dead zones," and high levels of nitrates that contaminate waters used for recreation, drinking water, wildlife, pets and livestock, and aquatic life—while also damaging the economy in many communities.

At the same time, promising innovations, creative partnerships, holistic One Water[5] solutions, and unprecedented opportunities to invest in clean and safe water through the Bipartisan Infrastructure Law (the Law) have the potential to rapidly accelerate progress on nutrient pollution. More effective strategies are particularly important as we see acute impacts of nutrient pollution fall on communities lacking the capacity to address them.

[1] See: A Compilation of Cost Data Associated with the Impacts and Control of Nutrient Pollution at https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf.
[2] See: EPA Rivers & Streams Assessment 2013-4 at https://riverstreamassessment.epa.gov/dashboard/?&view=indicator&studypop=rs&subpop=national&label=none&condition=poor.
[3] See: EPA National Aquatic Resource Surveys at https://www.epa.gov/national-aquatic-resource-surveys.
[4] See: EPA Nutrient Pollution – Where This Occurs: Coasts and Bays at https://www.epa.gov/nutrientpollution/where-occurs-coasts-and-bays.
[5] One Water approaches integrate holistic planning and management of water resources across the landscape and built environment to protect public health, water-based economies, ecological health, and habitat. For examples of One Water approaches to address nutrients, see: Yahara WINS: A Groundbreaking Initiative to Achieve Clean Water Goals at https://yaharawins.org/ and Middle Cedar Partnership Project at http://www.cedar-rapids.org/residents/utilities/middle_cedar_partnership_project.php.

As the U.S. Environmental Protection Agency's (EPA) Office of Water looks forward to celebrating the 50th Anniversary of the Clean Water Act (CWA) this year, we are mindful of both our progress and how much further we need to go as a nation to ensure that every community in the United States has access to clean, safe water. It will take all of us to meet this goal. State co-regulators, territories, and tribes play a primary role in managing nutrients, with strong support from federal partners and the involvement of all stakeholders. Office of Water is committed to reenergizing our partnerships with all levels of government, tribes, agriculture, community organizations, research institutions, and the public to make sustained progress. There has never been a more important time for partnership, innovation, and a determination to do more.

EPA affirms the foundational principles and approaches that are described in previous Office of Water nutrient policy memos. In the coming years, a key area of focus for the Office of Water is to accelerate progress in controlling excess nutrients entering our nation's waters by scaling up existing approaches and more broadly deploying new data assessments, tools, financing approaches, and implementation strategies. The cost and magnitude of the challenges require us to work across our programs to integrate the objectives of both the Safe Drinking Water Act and Clean Water Act in a One Water approach to find durable solutions. The realities of climate change, a growing population, aging infrastructure, increasing nonpoint source pollution, and issues of affordability, equity, and environmental justice add complexity and urgency to our work.

EPA's Office of Water will invest in, and pursue, science-based and data-driven strategies to reduce flows of excess nutrients into our nation's waters. We will deepen and expand our partnerships with the U.S. Department of Agriculture (USDA), states, tribes, territories, agriculture, industry, and the broader water sector to identify, highlight, and scale effective nutrient reduction approaches. We will use the Clean Water Act framework to make progress and to provide an incentive and backstop for collaborative approaches. We are committed to taking bold action to tackle the nutrient pollution challenge.

GOVERNING PRINCIPLES

Five governing principles will guide the Office of Water's strategies to work with states, tribes, and local partners to drive reductions in nutrient pollution.

- **Advance equity and environmental justice.** Nutrient runoff too often contaminates drinking water sources and compromises the health of waterways in rural, tribal, and low-income communities. EPA's Office of Water will prioritize nutrient pollution reduction, treatment, recovery, and mitigation activities that help protect public health and reduce pollution in communities that lack the resources to address these issues on their own.

- **Build and foster partnerships.** Many of the most successful and lasting efforts to significantly reduce nutrient pollution have resulted from partnerships between farmers, ranchers, local water utilities, municipalities, industry, and conservation organizations. These partnerships succeed because they benefit from the diverse knowledge and perspectives of their participants. We will seek opportunities to highlight successful partnerships, and to create the enabling conditions for their continued success.

- **Follow the science and invest in data-driven solutions.** Our focus areas and priorities will be based on the best available science and data. We will continue to build new tools and platforms that allow us to manage and analyze information to more efficiently target funding to identify and address sources of pollution and enhance tracking of progress in watersheds.

- **Support innovation.** New ideas and forward-thinking strategies are critical to meet the urgency of the nutrient pollution challenge. While we will continue to pursue the agency's tried and true work with states, tribes, and territories, we also plan to invest in and elevate new models, technologies, tools, and policies. The Office of Water is particularly interested in identifying and helping to scale programs that employ "outcomes-based" approaches that can maximize the delivery of water quality improvements and other benefits. EPA's Office of Water will identify and recommend financial innovations that can underwrite incentives for market-based investment.

- **Scale successful initiatives.** We will provide technical assistance and other support to help ensure that states, tribes, and territories have the knowledge, skills, and resources to scale effective nutrient reduction strategies.

STRATEGIES
To drive continued reductions in nutrient pollution, we will pursue three primary strategies:

- **Deepen collaborative partnerships with agriculture.**

- **Redouble our efforts to support states, tribes, and territories to achieve nutrient pollution reductions from all sources.**

- **Utilize EPA's Clean Water Act authorities to drive progress, innovation, and collaboration.**

Deepen collaborative partnerships with agriculture.
Deeper and more extensive partnerships with agriculture will be critical to reduce the nutrient loads that impair our nation's waters. Given the opportunity for nutrient reduction through conservation efforts on agricultural lands, working collaboratively with USDA and the agricultural community will be a central focus of EPA's nutrient agenda.

1. **EPA will actively collaborate with USDA leadership to build and maintain connections and momentum.** A primary goal of this partnership is to continue to target funds whenever feasible to the locations and practices that will generate the most significant reductions in nutrient loads. Areas for collaboration include:
    - Fulfilling Farm Bill requirements to devote significant resources to source water protection**.** We will support USDA efforts to reduce agricultural impacts on waterways and drinking water sources to protect public health and to document investments in source water areas.
    - Assisting USDA, utilities, and local partners in targeting conservation investments to improve water quality in waters suffering from nutrient pollution and measure their impact. Our goal is to expand our joint capacity to evaluate the water quality impacts of USDA investments.
    - Promoting and facilitating broader use of watershed assessments in USDA programs. In collaboration with EPA and states, USDA is expanding reliance on watershed planning to maximize the effectiveness of conservation investments. We will continue to work with states to support USDA in documenting water quality outcomes from its investments. Our

goal is to increase the proportion of USDA resources that are tied to watershed plans or other prioritization mechanisms, such as the National Water Quality Initiative (NWQI).[6]
- Expanding the strong collaboration between USDA and EPA's programs for drinking water and wastewater infrastructure in rural and tribal communities**.** Our goal is to help underserved communities and households improve their capacity to secure funds, comply with requirements, and sustainably operate and maintain their infrastructure.

2. **EPA will expand engagements with agricultural stakeholders and highlight their successes**. We will pursue additional opportunities to learn from and support agricultural leaders and innovators working to address nutrient loads. Our priorities include:
   - Initiating new partnerships and deepening our existing collaborations.
   - Identifying and elevating examples of producer innovation. To keep abreast of innovation, Office of Water will pursue opportunities to participate in agriculture convenings.
   - Maximizing engagement with agricultural stakeholder groups, including new quarterly roundtables and continuation of existing fora, including the Office of Wastewater Management's Animal Agriculture Discussion Group.[7]

3. **EPA will deepen on-the-ground collaboration with USDA, states, territories, tribes, and stakeholders in key geographic areas**. Although we recognize that water quality improvements will take years to achieve, we are committed to sustaining partnerships over time to make progress. To leverage our current activities and identify other opportunities, our efforts will include:
   - Intensifying our engagement in geographies such as the Chesapeake Bay, Mississippi River Basin, Puget Sound, and National Estuary Program watersheds across the country, where structures for collaboration have been established and new resources in the Bipartisan Infrastructure Law can accelerate progress. The Law will deliver $132 million to support the National Estuary Program and more than $1.7 billion for Geographic Programs.
   - Building on regional collaborations such as the Hypoxia Task Force to leverage federal, state, local, and tribal resources and engage university, industry, and nonprofit partnerships to help advance state- and regionally-driven actions. The Law will be a key lever for scaling progress, with $60 million in new resources to implement the Gulf Hypoxia Action Plan.[8]
   - Supporting partnerships in areas where agriculture is the predominant land use and nutrient loss contributes significantly to water quality concerns. We will look for opportunities where EPA membership, research, technical assistance, or grant and loan programs can help amplify existing efforts.
   - Further broaden collaborations among USDA, EPA, and the agricultural community to enhance, encourage, and promote conservation cropping systems that minimize soil disturbance and maximize plant cover that preserves soil organic matter content, enhance farm profitability, promote sustainability, and improve water quality.

Redouble our efforts to support states, tribes, and territories to achieve nutrient pollution reductions from all sources.

[6] For information on how the NWQI has led to significant improvements, see USDA National Water Quality Initiative at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/?cid=stelprdb1047761.
[7] For information about the Animal Agriculture Discussion Group, see: Factsheet on the Animal Agriculture Discussion Group at https://www.epa.gov/npdes/factsheet-animal-agriculture-discussion-group.
[8] See: Mississippi River/Gulf of Mexico Hypoxia Task Force at https://www.epa.gov/ms-htf.

EPA aims to address the diversity of point and nonpoint sources of nutrient pollution, including municipal and industrial wastewaters, stormwater, and decentralized systems. We will work to ensure that rural, environmental justice, low income, and tribal communities benefit from these efforts. EPA will use the urgently needed funding through the Bipartisan Infrastructure Law to expand our support for the work of our partners. Our priorities include:

1. **Strongly encouraging states and tribes to use a One Water approach to deliver a range of water quality benefits including protection of sources of drinking water.** The Office of Water will seek to support holistic water resource management efforts that protect public health, water-based economies, ecological health, and habitat. Expected activities include:
   - Encouraging states to incorporate a One Water approach in their overarching nutrient strategies. State nutrient strategies provide an opportunity to bridge existing planning to reduce nutrient loads from point and nonpoint sources with source water protection. We will continue to encourage states to establish and broaden these strategies to protect drinking water sources, as well as ecosystem health and other water quality benefits.
   - Working with EPA's Regional Offices to memorialize, in Performance Partnership Agreements or appropriate grants, state commitments to evaluate, update, and submit for EPA review State Nutrient Loss Reduction Strategies. These strategies should align with existing statutory and regulatory frameworks and target resources to the most important opportunities for progress. States with existing strategies will be able to use them as a basis for revisions. For states without Nutrient Reduction Strategies, Regional Offices will document state commitments to nutrient reduction actions. After consulting with state partners, the Office of Water will provide a memo to Regional Administrators outlining suggested review criteria later in 2022.
   - Deploying advanced watershed planning tools to identify critical source areas, track practice adoption, and quantify progress over a broad landscape, large watershed, or state or tribal areas. EPA has developed and will promote powerful tools such as Watershed Index Online,[9] DWMAPS[10] and Recovery Potential Screening[11] that can help evaluate key watershed attributes. These tools allow states to display Clean Water Act and Safe Drinking Water Act data alongside land use and other relevant spatial information to identify potential sources of contamination to drinking water sources.
   - Publishing a web-based tool to help states and tribes identify federal funding sources to protect drinking water sources and encourage cross-program coordination for shared water quality benefits.
   - Identifying and highlighting effective nutrient reduction approaches and projects that deliver a range of water quality benefits that could be useful in a variety of settings.[12]
   - Supporting state collaboration with USDA to improve the health of waters including source water protection through the NWQI and other targeted investments through USDA conservation programs Through the NWQI, USDA, state water quality agencies and source water protection programs can jointly identify priority areas for conservation, use traditional

[9] See: EPA Watershed Index Online at https://www.epa.gov/waterdata/watershed-index-online.
[10] See: EPA Drinking Water Mapping Application to Protect Source Waters at https://www.epa.gov/sourcewaterprotection/drinking-water-mapping-application-protect-source-waters-dwmaps.
[11] See: EPA Recovery Potential Screening at https://www.epa.gov/rps.
[12] For example, the use of Clean Water State Revolving Loan Funds to finance forest management to reduce the risk of devastating wildfires and post-fire flooding. That risk reduction helps prevent contamination of drinking water sources, damage to infrastructure, and increases in sediment runoff and associated nutrient pollution. EPA, USDA, and the Water Infrastructure Finance Authority of Arizona created a Measurable Benefits Tool that quantifies the environmental, financial, and social benefits associated with undertaking forest thinning projects.

CWA Section 319 project funding, and technical assistance to support planning and fund plan implementation.[13]

- Helping states, territories, and authorized tribes use the CWA Section 319 grant program for projects that help to protect and restore drinking water sources. Currently there are more than 300 active projects across the country that address source water concerns.[14] We will also promote innovative approaches including new outreach strategies to reach non-operator landowners and new funding mechanisms to address barriers to conservation practices such as procurement of shared agricultural equipment.
- Exploring opportunities to help states track and account for the adoption of agricultural conservation practices, conservation planning, and technical assistance, including through USDA conservation programs, as they implement nutrient strategies, total maximum daily loads, and watershed-based plans.

2. **Championing innovative financing and using the flexibility of the Clean Water Act regulatory framework** to spur development of more effective technologies, drive market-based approaches, including water quality trading, third-party credit aggregation and banking, and stronger agriculture-water sector partnerships. Our activities will include:
   - Promoting state use of the Clean Water State Revolving Loan Fund for nonpoint sources, including expanded use of innovative approaches like pay-for-success models.[15]
   - Strengthening relationships between states, tribes, and territories with our federal partners, like USDA and its U.S. Forest Service, as well as non-profits, community organizations, foundations, and private sector stakeholders. These partnerships can leverage existing resources to effectively facilitate and fund nutrient management projects on a broad scale.
   - Finalizing a policy statement on flexibilities for implementing market-based approaches within the National Pollutant Discharge Elimination System (NPDES) permit program.
   - Initiating a rulemaking to explicitly state that NPDES permits may include conditions allowing market-based approaches, including trading, to meet applicable effluent limits.
   - Hosting web-based training for permit writers to increase the number of permits with nutrient limits that improve water quality and incentivize purchase of nutrient credits and agriculture-water sector collaboration.
   - Building connections between the state programs and market-based environmental services providers that can combine water quality outcomes with other commodities such as carbon sequestration credits. EPA will provide technical assistance as needed to support states' use of CWA Section 319 funds to purchase water quality credits generated by such projects.
   - Supporting development and evaluation of more effective technologies and approaches using funding from geographically targeted and nonpoint source management programs.

3. **Prioritizing strategies to support small, rural, and disadvantaged communities**. Our activities will include:
   - Providing clear guidance for the State Revolving Funds to outline Office of Water's expectations for using new authority in the Bipartisan Infrastructure Law to make grants and

[13] For example, Iowa Department of Natural Resources has used small investments from EPA technical assistance to develop source water protection plans which garnered substantial on-the-ground investment from the NWQI.
[14] For example, Virginia DEQ worked with local partners to implement best management and conservation practices in the Muddy Creek watershed that brought nitrogen levels into compliance with state water quality standards for surface waters that are used as sources of drinking water.
[15] For examples of successful approaches see: Clean Water State Revolving Funds Best Practices Guide for Financing Nonpoint Source Solutions at https://www.epa.gov/system/files/documents/2021-12/cwsrf-nps-best-practices-guide.pdf.

provide additional subsidization to address and mitigate the impacts of nutrient pollution in these communities.

- Engaging with states on an EPA memorandum that outlines near term actions to support environmental justice and other disadvantaged communities through their nonpoint source pollution programs.[16]
- Releasing a Lagoon Action Plan to help small, rural, and tribal communities protect public health and meet Clean Water Act requirements for ammonia and nutrients.
- Taking action to address decentralized systems, including promoting financing via the State Revolving Funds, conducting an Advanced Septic System Nitrogen Sensor Challenge, and supporting research pilots and demonstration projects for innovative/alternative septic systems.
- Working with entities that can help support state adoption and implementation of strategies to better support disadvantaged communities, including the Environmental Council of the States, the Association of Clean Water Administrators, and the Association of State Drinking Water Administrators.

Utilize EPA's Clean Water Act authorities to drive progress, innovation, and collaboration.
EPA will continue to evolve and implement the Clean Water Act regulatory framework. Technology-based controls for point sources, development and implementation of strong water quality standards, and strategies for addressing nutrients at a watershed scale remain critical. The Clean Water Act regulatory authorities are the foundation for much of the nation's progress to date on nutrient pollution and can provide both an incentive and backstop for collaborative approaches. We will prioritize:

1. **Urging more robust adoption of numeric nutrient criteria into Water Quality Standards.** EPA has strongly advocated for states, territories, and authorized tribes to adopt numeric nutrient criteria into their water quality standards since the publication of the *National Strategy for the Development of Regional Nutrient Criteria* in 1998, but many states have not yet done so. To accelerate progress, our priorities include:
   - Promoting EPA's newly published stressor-response based numeric criteria recommendations to address nutrient pollution in lakes and reservoirs.[17] Office of Water recommends states apply the criteria to protect drinking water, recreational and aquatic life uses and expects states to consider the new criteria during their next triennial water quality standards review. EPA regions are encouraged to negotiate commitments to establish numeric nutrient criteria in performance partnership agreements.
   - Supporting and strongly encouraging states to rely on numeric targets for water quality assessment, CWA Section 303(d) assessment and lists, TMDL targets, and NPDES permitting. Office of Water expects that states will either adopt numeric nutrient criteria into their water quality standards or commit to use numeric targets to implement applicable narrative criteria statements. For lakes and reservoirs that have previously been assessed using a state's nutrient-related narrative criterion, we expect states to consider the new criteria recommendations to determine whether more can be done to ensure the protection and restoration of those waters.

[16] See: EPA Near-term Actions to Support Environmental Justice in the Nonpoint Source Program at https://www.epa.gov/system/files/documents/2021-10/equity-in-the-nps-program-section-319-policy-memo-signed.pdf.
[17] See: EPA Ambient Water Quality Criteria to Address Nutrient Pollution in Lakes and Reservoirs at https://www.epa.gov/nutrient-policy-data/ambient-water-quality-criteria-address-nutrient-pollution-lakes-and-reservoirs.

2. **More Fully Using the Clean Water Act Assessment and Listing Process and Supporting Development of TMDLs for Nutrient Pollution.** There are more than 26,000 water bodies with nutrient-related impairments still on state lists of impaired waters that do not yet have a TMDL. Many completed TMDLs have not been fully implemented. To continue progress, our activities will include:
    - Expecting and assisting states to develop robust, ready-for-implementation TMDLs, and other restoration plans.
    - Supporting targeted water quality monitoring and developing scientifically robust assessment methods for identifying nutrient-related impairments.
    - Exploring ways to account for climate change in watershed protection and restoration plans, TMDLs, and best management practices so they will continue to be effective in the future.

3. **Further Reducing Nutrient Loads from Point Sources.** EPA strongly supports innovative permitting approaches that can drive deeper, sustained nutrient reductions. Our activities will include:
    - Supporting states by providing information on innovative treatment technologies analysis of performance, and management approaches such as water reuse.
    - Continuing training and technical assistance to wastewater treatment plants operators with secondary treatment to help optimize nutrient reductions. Optimization techniques are particularly valuable for small and medium-sized systems where system upgrades may not be affordable.
    - Supporting states to employ a variety of permitting approaches, including watershed-based permitting, integrated planning, adaptive management, and various market-based approaches including trading and offsets. We will encourage states to consider permitting approaches that strengthen upstream/downstream partnerships.
    - Issuing a compendium of state approaches for nutrient permitting to highlight the varied approaches states are using to make progress.
    - Promulgating revised effluent limitation guidelines for industries with significant nutrient loads that cause or contribute to water quality problems.
    - Working with states and EPA regional permitting authorities as they write water quality-based permit limits to meet water quality standards, including those that implement TMDLs. We will ensure that both EPA and state-issued permits: analyze whether nutrients have a reasonable potential to cause or contribute to a WQS exceedance in all permits; incorporate technically sound nutrient limits when necessary; and include permit limits that reflect the loads contained in the approved TMDLs.
    - Assisting states in using water quality standard variances, targeted designated use changes, compliance schedules in NPDES permits, and other flexibilities to make progress. The Office of Water will encourage mechanisms to facilitate a balance of appropriate point source and nonpoint source actions that makes best attainable progress toward water quality goals.

CONCLUSION

Nutrient pollution continues to present a daunting and costly set of challenges, despite considerable prioritization and investment. Our best hope for more effectively addressing our nutrient management challenges is to continue building partnerships. EPA is committed to working across federal agencies, with states, territories, tribes, and with farmers, ranchers, local water utilities, municipalities, and industry to make progress. Acting together, using foundational approaches, innovative new tools and programs, and an unprecedented level of investment in the work of our partners, we can do more to address nutrient pollution and protect water quality and public health.

cc: Regional Administrators
Regional Water Division Directors
Office of Water Office Directors
ECOS Executive Director
ACWA Executive Director
Chair, National Tribal Water Council
Chair, National Tribal Caucus