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Stakeholder Meeting Facilitation for Issues Related to PFAS and Biosolids

Prepared for the U.S. EPA

Contents

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The EPA typically uses the term “biosolids” to mean sewage sludge treated to meet the requirements in Title 40 of the *Code of Federal Regulations* (CFR) part 503 and intended to be applied to land as a soil amendment. This document summarizes views from participants outside the EPA where the terms are used interchangeably, so for the purposes of this report, “biosolids” means “sewage sludge.”

Purpose of Report

The rise in concern over PFAS in municipal biosolids has created challenges and uncertainties for publicly owned treatment works that rely on the three main biosolids management options: land application, disposal in landfills, and incineration. These concerns have also created challenges for land appliers and solid waste management facilities. Due to the significant challenges facing utilities around the United States associated with the management of municipal biosolids, the US EPA, with input from the National Association of Clean Water Agencies (NACWA) and other stakeholders convened a series of three workshops. These three workshops convened 21 participants representing both wastewater utilities and solid waste organizations ("regulated entities"), state regulators, and the EPA. The original stated purpose of these three workshops, held between October 2023 and May/June 2024 was to:

- Explore the three main management options for biosolids, their benefits and challenges, and their ability to meet capacity and public health needs
- Identify management practices and treatment technologies to address PFAS in biosolids
- Discuss practices for, and gaps in, communication related to PFAS and biosolids

The workshops served to collect information from individual participants on considerations and challenges with managing PFAS in biosolids. No collective advice or recommendations were pursued or received from the meeting process. This document reports the perspectives and contributions that participants shared across the three meetings and one-on-one discussions between the facilitators and meeting participants and does not seek to demonstrate consensus or offer recommendations for action.

Methodology

In August 2023, Ross Strategic was contracted by the US EPA as the third-party facilitator tasked with assisting in the selection of workshop participants, holding one-on-one discussions with individual participants, planning and executing the three workshops, and synthesizing notes across the three workshops to inform this report. Below is a brief description of each of the three methods.

- **Workshop Participation:** Workshop participants were selected by their individual organizations, including the Association of Clean Water Administrators (ACWA), Association of State and Territorial Solid Waste Management Officials (ASTSWMO), Environmental Council of the States (ECOS), National Association of Clean Water Agencies (NACWA), National Association of State Departments of Agriculture (NASDA),

Solid Waste Association of North America (SWANA), and Water Environment Federation (WEF).

- **One-on-One Discussions:** Prior to holding the three workshops, the Ross Strategic team held one-on-one discussions with each of the individual participants. These discussions were meant to gather early perspectives prior to prioritizing workshop agenda topics. For the series of questions utilized during these discussions, see Appendix B: One-on-One Interview Guide. Discussion questions were prioritized based on the individual participant's experience and role.
- **Workshops:** The first two workshops were held virtually and the third was held in person in Washington D.C. The workshop ordering was designed to first focus on challenges, then opportunities to solve the identified challenges, and lastly, opportunities for coordination. Agendas for each of the three workshops can be found in Appendix C: Workshop Agendas.

This report represents perspectives and insights provided from both the one-on-one discussions and across the three workshops.

Perspectives on the Management of Biosolids with Respect to PFAS

PFAS and Biosolids Regulatory Landscape

The EPA "Basics of Biosolids" webpage describes biosolids as the product of the wastewater treatment process. During wastewater treatment the liquids are separated from the solids. Those solids are then treated physically and chemically to produce a semisolid, nutrient-rich product known as biosolids. The EPA goes on to describe that examples of beneficial use include application to agricultural land and reclamation sites (e.g. mining sites). "When applied to land at the appropriate agronomic rate, biosolids provide a number of benefits including nutrient addition, improved soil structure, and water reuse. Land application of biosolids also can have economic and waste management benefits (e.g., conservation of landfill space; reduced demand on non-renewable resources like phosphorus; and a reduced demand for synthetic fertilizers). Biosolids also may be disposed of by incineration, landfilling, or other forms of surface disposal."[1]

Each of the three biosolids management methods (land application, incineration, and landfilling) poses challenges as PFAS are not destroyed during the standard wastewater treatment process. The ability of incineration to destroy PFAS is still under investigation. Landfills may have limited capacity for the acceptance of additional biosolids. The leachate landfills produce is a known source of PFAS released into the environment. In addition, there are concerns with greenhouse gas generation (methane) from the landfilling of biosolids. Land application of biosolids raises concerns about PFAS entering soils, surface water, and groundwater and movement from soil to plants and livestock through grazing. Additionally, in some communities there is interdependence among available management methods, and restricted access to any one management method exacerbates the potential issues with the other method(s).

The EPA regulates the disposal[2] and use of biosolids under 40 CFR Part 503. As of publication, there are no federal pollutant limits for PFAS in biosolids. The EPA is currently conducting a

[1] Basic Information about Biosolids | US EPA

[2] Disposal practices may also be regulated under solid waste or air regulations.

biosolids risk assessment for two PFAS in biosolids: perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS).[3] The biosolids risk assessment is part of the EPA's PFAS Strategic Roadmap which sets timelines by which the EPA plans to take specific actions to safeguard communities from PFAS contamination.[4] In regard to PFAS testing in biosolids, the EPA has published the final EPA Method 1633.[5] The EPA currently recommends Method 1633 for use in biosolids monitoring alongside other methods such as EPA Method 1621 for aqueous samples.

While the biosolids risk assessment is ongoing, the EPA recommends that states monitor biosolids for PFAS contamination, identify likely industrial discharges of PFAS, and implement industrial pretreatment requirements where appropriate. Doing so will help prevent downstream PFAS contamination and lower the concentration of PFAS in biosolids as described in Section C of the EPA's December 2022 memo entitled "Addressing PFAS Discharges in NPDES Permits and Through the Pretreatment Program and Monitoring Programs."[6]

Actions regarding PFAS not directly related to biosolids but closely related that the EPA has taken recently include: published updated interim PFAS destruction and disposal guidance[7]; adopted National Primary Drinking Water Regulations for six PFAS[8]; proposed regulations that would add nine PFAS as hazardous constituents under the Resource Conservation and Recovery Act[9]; announced through the Effluent Guidelines Program Plan 15 that the EPA will 1) revise the existing Landfills Point Source Category Effluent Limitation Guidelines to address PFAS in landfill leachate and 2) conduct a POTW Influent study that will focus on collecting nationwide PFAS data on industrial discharges to POTWs as well as PFAS monitoring in biosolids.[10]

The EPA is the permitting authority for 41 states and implements a federal biosolids program under 40 CFR 503. In nine states, Arizona, Idaho, Michigan, Ohio, Oklahoma, South Dakota, Texas, Utah and Wisconsin, the state are the authorized NPDES permitting authority for

[3] Risk Assessment of Pollutants in Biosolids | US EPA

[4] PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024

[5] CWA Analytical Methods for Per- and Polyfluorinated Alkyl Substances (PFAS) | US EPA

[6] Memorandum Addressing PFAS Discharges in NPDES Permits and Through the Pretreatment Program and Monitoring Programs | US EPA

[7] Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024) | US EPA

[8] 89 Fed. Reg. 32532 (April 26, 2024).

[9] 89 Fed. Reg. 8606 (February 8, 2024).

[10] Current Effluent Guidelines Program Plan | US EPA

biosolids.[11] Regardless of whether a state is the authorized permitting authority, States are not precluded from imposing requirements for the use or disposal of sewage sludge more stringent than the Part 503 rules, or from imposing additional requirements for the use or disposal of sewage sludge.

States have taken a variety of actions to manage PFAS in biosolids either directly affecting biosolids or other types of regulatory actions such as sampling and monitoring requirements. Maine is the only state with a ban on land application of biosolids (Connecticut announced a ban on a land application of biosolids with detectable PFAS shortly after the meetings).[12] New Hampshire, Massachusetts, and Michigan have reporting requirements for monitoring PFAS in biosolids.[13] Michigan has tiered levels for PFOS in sewage sludge for land application that require different actions and has worked to identify industrial releases. While many States have not adopted specific requirements related to PFAS in biosolids, some state regulators have recommended voluntary testing and permittees may be engaged in voluntary monitoring programs to better understand PFAS coming into treatment plants and remaining in biosolids. There are also county, municipal, and other jurisdictions with regulatory authority that can affect biosolids management. This can create a complicated regulatory regime for municipal wastewater utilities to navigate.

The unique challenges and uncertainties presented by PFAS in biosolids were recognized in the Joint Principles for Managing PFAS in Biosolids ("Principles") developed jointly by the EPA, the Environmental Council of the States (ECOS), and the National Association of State Departments of Agriculture (NASDA).[14]

Key Challenges on the Management of Biosolids

The management of biosolids is highly dependent on the location, due to the different constraints, regulatory environments, and capacity of a given municipality, state, or region. The participants at this series of workshops brought their own individual perspectives on challenges they face regarding the management of biosolids. It should be noted that the relative use of the three management options (land application, incineration, and landfilling) varied greatly

[11] NPDES State Program Authority | US EPA

[12] Maine does allow land application of septage and provides exemptions for biosolids for some products like compost or other agricultural products. PFAS in Biosolids: A Review of State Efforts & Opportunities for Action, p. 4 (ECOS 2023)(Available at: PFAS in Biosolids: A Review of State Efforts & Opportunities for Action).

[13] PFAS in Biosolids: A Review of State Efforts & Opportunities for Action. p.8 (ECOS 2023)

[14] Joint Principles for Preventing and Managing PFAS in Biosolids (epa.gov)

amongst the group. Whereas some individuals lived in areas that relied on a mix of all three, others lived in regions where two or only one management option was utilized. Responding to a disruption in the management chain of biosolids due to PFAS is particularly challenging due to interconnectedness of the system, and regional/local constraints. Ultimately, participants stressed that maintaining viability of all three management options relieves stress on the system.

This section outlines cross-cutting challenges that the workgroup participants highlighted, regardless of the mix of management options utilized, as well as specific challenges associated with each of the management options.

Cross-Cutting Challenges

Uncertainty across management options has led to a regulatory patchwork which fills the space of no national standard.

Across all three management options, there is scientific uncertainty. The fate of PFAS in biosolids which are incinerated is still being studied, the risk of land application of biosolids containing PFAS is yet to be fully understood, and technologies to remove PFAS from leachate in landfills and wastewater operations are still being explored and tested for effectiveness. All these unknowns have led many regions and municipalities to respond in different ways to emerging events. Workshop participants often highlight Maine as an example of this, where testing and discovery of PFAS in farming and dairy operations led to the ban of land application of biosolids across the entire state. Participants noted that while individual states implement regulations, biosolids and products derived from biosolids move between and across state lines which can make it complicated for operators to know which rules and regulations to follow. Because states are, in many cases, responding to discrete events, the regulatory environment is varied, creating a patchwork of local ordinances and rules that make it challenging to understand how to manage biosolids with detectible levels of PFAS to minimize risk. Participants hoped that the exposure and risk from biosolids would be viewed in comparison with other PFAS exposure pathways.

Sampling, testing, and monitoring for PFAS in the waste system to date has been constrained by the absence of recommended methods and limited availability of testing facilities.

Determining PFAS concentrations in the wastewater stream is essential to understand the scope and scale of the issue in a municipality. However, participants noted that the challenges associated with identifying and distinguishing PFAS from domestic and industrial sources. Many workshop participants have been working to characterize PFAS in their waste streams through sampling and/or testing from industrial facilities, commercial activities, and in residential areas. This has required dedicated funding to carry out through states or through regular budgets. Costs per sample can be quite high, with one participant noting the cost to be $450 to $550 per sample. However, even if funding is available, it can be a challenge in some regions to find labs

that can conduct the analysis. Some stakeholders have sent samples to colleges, environmental organizations, or non-profits but participants were concerned that the analysis was not always reliable. When participants did have reliable labs to conduct the analysis, the turnaround time could range from 45 days to up to five months. Additionally, though EPA Method 1633 is recommended for use by the EPA for detecting PFAS in biosolids, participants were concerned with the number of labs currently available to run the method.

There is an unaddressed issue related to rural communities that have significant use of private wells – no one has strong purview over monitoring risk associated with private wells. Though not directly related to the responsibilities of water and waste utilities, it is still an important consideration noted by the participants.

Opportunities to test and better understand the presence of PFAS in biosolids is limited by liability concerns across the board.

Sampling, testing, and monitoring for PFAS in biosolids across different media (e.g., landfill leachate, agricultural soils) would help gain a clearer picture of the issue in different regions. In the absence of required monitoring and clear regulatory standards on how to conduct testing and sampling, analyses may be unreliable. Additionally, participants expressed that liability concerns around receiving biosolids with PFAS can disrupt the management chain.

Some workshop participants felt that in the absence of required monitoring for PFAS, there is concern by wastewater operators and landfill operators to begin testing for PFAS in the wastewater, biosolids and landfill leachate. They noted that though it would be good to understand its presence or absence, there are significant liability risks if they do find PFAS in samples. Because there is no national regulatory standard by which to take action and no existing guidance to consistently communicate risk, workshop participants expressed that if they do monitor and find PFAS in samples, it could open the facilities up to public backlash or lawsuits from residents or NGOs in the short-term.

For landfills, participants noted that waste operators may be hesitant to accept potentially contaminated materials. If they do accept contaminated materials, they may have limited options for leachate acceptance by wastewater treatment plants due to due to concerns of liability by wastewater operators. Pre-treating leachate also comes at a significant cost, and landfill operators' decision to accept contaminated waste - and the potential liability that comes with it - may be a cost-benefit decision until clear regulatory standards are put in place. Without contribution of funds by industry (i.e., those who may be driving high PFAS levels) to support treatment, it may not be economically viable and the cost of implementing new treatment technologies would likely be borne by water utility and landfill rate payers.

In the event an agricultural producer has exposure to PFAS in biosolids via land application, the producer may take on liability issues and risk, with a potential need to extensively modify or end agricultural operations. This may lead to a hesitancy to utilize biosolids or hesitancy to

allow testing of their land over time. The participants expressed concern that in the absence of clear regulatory standards and risk of PFAS uptake in agricultural products, any PFAS presence can risk a farmer losing business because of perceived risk or damaged reputation of the operation.

Maintaining public trust of utility systems requires consistent communication on risk.

Poor risk communication can negatively influence public perception and drive fast reactions in relation to the management of biosolids. Many participants spoke about how public perception has harmed agricultural business and could create liability for users of biosolids. Participants often stressed that consumers may find it difficult to understand the PFAS in products they use at home can translate to broader risks from PFAS in other parts of the product life cycle (i.e., biosolids or landfill leachate). As we continue to better understand biosolids land application through ongoing studies, such as research by the EPA and others to better understand PFAS uptake by crops, participants noted that ongoing and consistent communication with the public is key to maintaining trust and understanding of how management professionals are working to reduce risk to users of biosolids.

Communication must be targeted at a variety of audiences, including utility customers, state and local governments, industry, non-residential contributors to wastewater treatment plants (e.g., schools), and farmers. This is going to require tailoring information that is accurate and relevant to each individual audience's interests. Currently, communication of risk associated with biosolids falls on wastewater operators and other users and disposal managers, who are already time constrained within their existing responsibilities and roles. Without clear, consistent messaging on risk of PFAS in biosolids, there may be domino effects that impact the whole system. At present many utilities undertake proactive communications designed to educate their customers and stakeholders on actions being taken on PFAS, where a given facility's PFAS concentrations may fall within the range of facilities and media across the region, as well as information on exposure pathways and how to reduce exposure, and the ability of utilities and customers to reduce their use of PFAS-containing materials. Utilities are aware of and working to educate their customers as the public perception of potential PFAS contamination may influence farmers to halt their use of biosolids, which would reduce demand for biosolids and lead to a need to find other disposal options. In the event that there is low risk associated with land application of biosolids, this needs to be communicated to prevent public pressure to remove it as an option. In the event there is a significant human health risk associated with land application of biosolids, this needs to be well understood and communicated with relevant stakeholders.

Without proper source control, PFAS will continue to enter the waste system for years to come.

A significant theme across all three workshops was the pressing and urgent need for source control of PFAS, which has commonly been in consumer products and industry for decades. Without limiting or removing PFAS from products that are destined for wastewater utilities or landfills (which ultimately enter wastewater utilities though leachate), it will continue to enter the wastewater treatment system. It is worth highlighting stakeholders acknowledged that even if PFAS were to stop being used in products, legacy PFAS would still need to work their way through the wastewater treatment system for a significant period of time. Utilizing treatment and removal technologies was often described as a costly "short-term" fix to the larger issues of PFAS in products and industrial discharges.

Source control begins with understanding source contributions from industrial, commercial, and residential sources. Identifying sources of PFAS in the waste systems offers opportunities to understand the scope and scale of the problem. Examples of methods to identify sources are provided below. However, source identification and control have their own associated challenges. Namely, the scale of testing and monitoring needed for PFAS requires financial and human resources. Participants felt that resources are already constrained and to undertake this type of endeavor across municipalities and states would require dedicated funding flows, either from PFAS manufacturers and users or from other means, such as state legislatures.

A second issue, particularly in the case of residential source contribution, is that even if sources, such as school cleaning programs or carpet cleaning are identified, the role wastewater and landfill operators can play is limited. The operators can participate in education and communication, which some noted they are already doing, but it is not a long-term fix. As long as PFAS continue to be in products, wastewater operators and landfill operators will continue to receive inputs of these "forever chemicals" with few options for reducing these inputs.

Land Application Challenges

Land application bans have the potential to disrupt waste management systems, as risks are still being better understood.

Participants in workshops noted that their primary role is to provide services (i.e., solid waste management and wastewater treatment) to communities and managing risk to the public is a core component of their work. Multiple participants spoke about existing biosolids programs which distribute biosolids to farmland. In some cases, farmers are paid to take the product, and in other cases farmers pay a comparatively low price for it (as opposed to traditional fertilizers). In either case, biosolids programs take these actions to reduce volumes going to landfill and save costs by avoiding tipping fees. Balancing risk with the benefits the waste system provides is a challenge, particularly in the face of biosolids land application bans which require significant adjustment of waste flows. State regulators described programs they have developed to

investigate biosolids and pursue source control approaches in order to maintain land application. Some participants discussed that because EPA has yet to set limits and provide enough information on risk from PFAS in biosolids, individual states have had to respond with a patchwork of regulatory frameworks. In the workshops it was suggested that given the public perception and perceived liability of PFAS in biosolids in particular in the land application context, it is essential that EPA provide information on limits based on science and with transparency about why certain decisions are made. One participant noted that Part 503 regulations have risk-based levels for several constituents in biosolids already that are related to management practices, and this type of framework can be helpful as it allows practitioners to think of the relative risk of land application and ultimately use it as a tool for communication. As mentioned above, participants want to maintain their management options for biosolids which includes the option to land apply. In order to do this, it is essential that risk of land application is well understood to best maintain it as a management option and protect public health to the fullest extent.

Landfill Challenges

Landfill capacity across different regions and opportunities to site new landfills are limited

Limited landfill capacity was often cited as a significant challenge during one-on-one discussions with participants and was noted as the most likely challenge to impact the long-term viability of landfill management in the workshops. The amount of space available in existing landfills is constrained and biosolids destined for landfills need to either be dried to reduce volume (which takes a lot of energy) or add bulky materials to stabilize it (which takes more space). Participants noted that though volume reduction can be a solution in the short-term, it will not solve the long-term issue of limited landfill capacity and does not reduce the amount of PFAS going into the landfill. Some facilities need to add bulky dry material for stability, which creates more volume and further constrains landfill capacity. In some cases, landfill operators can only accept a certain percentage of sewage sludge in their intake and certain areas of the country are struggling to obtain sufficient landfill space for other solid waste disposal. Adding to the limited space in existing landfills, the opportunity to site landfills, particularly in population dense regions like the Northeast, is constrained by public disinterest and lack of land availability.

Landfilling biosolids is already utilized as a backup option by some participants in the event of incinerator shutdowns or an inability to land apply (e.g., treatment train disruptions). As landfill capacity declines and other management options became less available to waste management professionals, it could create a serious disruption in the waste management system. From the perspective of landfill operators in the workshops, it is the responsibility of states and communities to resolve the larger issue of waste generation and disposal/recycling plans.

Handling of PFAS containing materials is unstandardized and removing PFAS from the system will require significant infrastructure investment

The procedures for accepting and handling PFAS-containing materials are not standardized, but rather reflect an individual landfill's operating plans. When incineration and land application are not available, states are faced with limited management options. In some cases, no more than 10% of the total waste stream of these landfills can be sewage sludge and the ratio of bulking material needed for sewage sludge can vary by landfill. Some stakeholders' landfills were seeking to impose a limit on biosolids being taken in to reduce PFAS intake, but this approach could prove tricky to implement and may not reduce the total amount of PFAS entering the system. For example, participants shared that household items (e.g., couches) sent to landfills can contain higher concentrations of PFAS – orders of magnitude higher than the limits that are being proposed by states, localities, or landfills for biosolids. Finally, several participants, as a method for managing PFAS, mentioned solidifying PFAS and placing them in the landfill and discharging leachate into deep injection wells. The absence of standardized methods for handling solid waste and PFAS contained in solid waste has led to a patchwork of methods across states and individual landfill operations that may or may not be effective at managing the issue.

Leachate management is a significant challenge and the movement of leachate between wastewater operations and landfills can be circular. Leachate is produced via the landfill, goes to wastewater treatment plants, and can return to the landfill in biosolids. Leachate generated by landfills can contain high amounts of PFAS that can be removed through treatment, though not through traditional wastewater treatment. Current landfill leachate treatments are still being researched for effectiveness of PFAS destruction. Though cycling of leachate between wastewater utilities and landfills can keep the circular waste system in place (if all biosolids are landfilled and not land applied), it does not address the need to reduce PFAS from upstream sources. Restrictions on discharging leachate to POTWs, because of concerns related to PFAS in biosolids, runs the risk of further complicating biosolids management.

Technology to remove or destroy PFAS in leachate is developing, and coordination between POTWs that need landfill capacity to dispose of their biosolids, and landfills that need leachate acceptance will facilitate development of leachate treatment. While there were a number of treatment technologies discussed, the top three technologies shared were foam fractionation, reverse osmosis, and granular activated carbon (GAC). Pilot programs on foam fractionation were discussed. Foam fractionation operates by PFAS attaching to the head of microbubbles formed in the foam. It works best for longer chains of PFAS but not necessary for short chains. Another pilot foam fractionation for leachate project involves the distribution of $10 million over the next five years within a state to test the treatment method's effectiveness and application to leachate and support regular maintenance activities. Despite its promise, the end life of the foam is often returned to the landfill, and one stakeholder expressed concern that this will result in just moving the problem further down the line. Other promising efforts are working with GAC with leachate. However, there are tradeoffs such that GAC works quite well, but it has limited storage capacity and must be replaced. Reverse osmosis has high removal efficiency; however, it generates a concentrated end product that then needs to be managed.

There are new planning tools becoming available that can model PFAS entering the wastewater plant and evaluate cost and environmental issues at each management decision point. One stakeholder demonstrated undertaking this planning process with a municipality which allowed them to evaluate combinations of landfilling and land applying and take into consideration leachate treatment and PFAS disposal costs. This approach allows the entity to truly consider the management of the PFAS throughout its lifecycle from the time it enters the wastewater treatment plant. Using innovative planning tools like this to coordinate PFAS management between POTWs and the other stakeholders will be a critical in the future but is not currently a widely available approach.

Incineration Challenges

The fate of PFAS in incinerated biosolids is uncertain

Multiple participants noted that there is a significant amount of uncertainty around air emissions, deposition, and whether PFAS are fully destroyed in sewage sludge incineration. Ultimately, it is unknown whether many incinerators operate at a high enough temperature or residence times to achieve full PFAS destruction. PFAS could also be ending up in ash or the air. Participants felt that improved testing methodologies for incinerators, further research on PFAS and air emissions, and better understanding of fate and transport of PFAS via incineration would be beneficial to alleviate this challenge.

Incinerators may be unreliable, costly to maintain, and opportunity to build new incinerators is limited

Multiple participants noted that incinerators are often old, and subject to frequent shutdowns for maintenance. The unreliability of incinerators as a consistent management practice is challenging as biosolids will often need to be managed with a different option during these times. On top of that, incinerators operate at high temperatures (800 – 1700 degrees F), which results in high energy use and costs. While some regions favorably utilize incinerators, it is not often viable for regions that do not readily have the available infrastructure. Incinerators are not only expensive to run, but associated permitting and building of new incineration facilities is costly. In addition, getting permits approved for new facilities is challenging given air emissions standards for pollutants other than PFAS. If a state does have incinerators already, retrofitting with new technologies can be very costly. Participants were not aware of federal infrastructure funding for incineration waste management.

Opportunities in PFAS Biosolids Management

Though there are significant hurdles regarding the management of biosolids with or without the added complication of PFAS, the workshops also clarified a few significant opportunities to better manage the situation. In general, there was a large interest in continued coordination

and learning among the group to continue understanding how individuals are responding to PFAS in the waste stream across the United States. The opportunities described were both collaborative in nature and technical and are outlined below. This section highlights opportunities elucidated by the workshop participants that are cross-cutting and applicable to all three management options and one that is specifically a technical solution that could be pursued.

Clear analytical methods and procedures for sampling, testing, and monitoring can enable better management and source control of PFAS

Many participants identified information gathering about PFAS levels and sources in their wastewater streams as an important tactic in positioning themselves to make decisions about current PFAS management strategies, reducing sources of PFAS, preparing for an unknown regulatory landscape, and improving their communication with stakeholders. Approaches to testing and monitoring differ among POTWs, but all are focused on gathering as much information possible given resource constraints, to either reduce PFAS levels in biosolids, prepare for future reductions, or be responsive to regulator and public requests for information.

Multiple stakeholders used a process of identifying industrial sources of PFAS in their waste streams through sampling and/or testing. Two stakeholders took a ranking approach to their sampling and testing processes. One stakeholder from a POTW described their ranking approach which started with testing over 150 industrial facilities and their effluent. Concentrations of PFAS in effluent and the volume of total mass released from facilities were then utilized to rank facilities in terms of priority. A similar approach expressed by another participant involved testing municipalities' influent, and then prioritizing facilities into rankings of low, medium, and high. PFAS-specific plans can be developed for medium and high priority facilities. This stakeholder and the municipalities are looking to understand what potential industrial users are within the collection system.

Another participant provided information about a PFAS source identification approach that utilized standard industrial classification (SIC) codes for industrial discharges. Annual sampling and testing at industrial facilities can be identified by SIC codes. Another participant conveyed an early risk program that involved monitoring industries that discharge into indirect potable reuse facilities and targets facilities that are discharging a range of chemicals/pollutants, including PFAS.

A key point raised by multiple stakeholders is the importance of maintaining good relationships with industries contributing to the waste stream as they go through efforts to identify and reduce sources of PFAS into the collection system, particularly in the context of not having defined regulatory limits for industries' discharges. One stakeholder stated that leaning into areas of mutual benefit and collaboration can support this effort, and another participant referenced utilizing agreements of understanding to reduce PFAS in the absence of requirements/regulations.

Testing and identifying residential sources of PFAS in the waste stream is an important source of information for a POTW; however, sampling and identifying residential contributions of PFAS can be challenging given the number of homes, potential other sources (e.g., commercial entities not classified as industrial), and facilities in a given area. One participant found that testing for PFAS in various residential community sewer systems found differences by up to three orders of magnitude, even when there was not an identified industrial contribution. Two stakeholders mentioned that levels can be influenced by the presence of schools or hotels, particularly when janitorial waste is not containerized. One stakeholder is working with schools and hotels to better contain their waste, in particular when those facilities use septic systems, in order to reduce any potential contamination of nearby wells.

The suggestion was made by one stakeholder that a national database on residential sources, providing information such as the PFAS levels found with numbers and sizes of homes, would be helpful to municipalities so they could extrapolate testing results from other locations to reduce the amount of time and money on residential source testing.

Monitoring Costs

Monitoring for PFAS--sampling, testing, generating data, and reporting data--and identifying their sources from waste streams takes time and financial resources. Alternative approaches to financing PFAS sampling, testing and monitoring that were used by participants included:

- Engaging in a cost share with the state and region.
- Testing is done at the cost of the POTW for existing dischargers, while new contributors are responsible for paying for their own PFAS testing.
- Obtaining funding through state legislation for monitoring with biosolid permit holders.
- Working with research institutions that want to develop PFAS data.
- Adding PFAS monitoring and pre-treatment language to NPDES or state permits.

Stakeholders noted that communicating with POTW customers and PFAS contributors now will be an advantage towards compliance with any potential future regulations. Challenges around testing, sampling and monitoring in addition to cost include reliable trained sample takers and turnaround times for labs that can use the appropriate methods. In some cases, utilities are hesitant to conduct monitoring voluntarily due to potential liability ramifications. Though participants noted they are striving for transparency when they do conduct sampling and analytical detection and data generation it can be challenging, particularly when sampling land application sites, to avoid negative impacts to agricultural producers. Other stakeholders have been utilizing monitoring data to educate and inform legislators and the public about the current state of the prevalence of PFAS.

Coordinating on clear, consistent communication can assure the public of safety and build trust

Every individual participant highlighted that they are involved in communicating about PFAS and biosolids to their communities. Stakeholders noted that there is not enough public awareness of the necessity for waste management infrastructure and the potential consequences of PFAS regulations on existing systems. However, there is an opportunity to educate communities on the role of clean water systems and the importance of environmental protection as a catalyst for raising public awareness. Improved communications on PFAS in biosolids is seen as a critical component of all future scenarios for managing PFAS in biosolids.

Critical audiences for communications include the entire range of stakeholders: the general public, utility customers, utility employees, septage haulers, community groups, policy makers, state regulators, farmers, well owners, and the media. Information sought- by the general public and ratepayers and important for building trust and transparency include: information on risk, and providing information that is most critical for residents, such as actions being taken on PFAS by different utilities, where a given WWTP may fall within the range of WWTPs across a broader region with regard to PFAS levels, and the benefits/services provided by utilities to the public. Additionally, information on public exposure pathways and how to reduce exposure, and the ability of utility and customers to reduce their use of PFAS-containing materials are communications that can inform the public and reduce the overall need for management of PFAS in biosolids. Communications for POTWs should focus on technical information, available resources and tools (e.g., map of state resources available to address PFAS, training materials and protocols on sampling, information on classes to perform sampling compliant with permit conditions) and providing a space to contribute data from monitoring and testing efforts at different facilities. Communications for policy makers (legislators) should focus on presenting the challenges of limited management options, resources and methods available to regulators, and the results of investigations and assessments. Communications for farmers should focus on describing what PFAS is and how much is generally contained in the biosolids they are accepting in order to maintain flexibility in managing crops and maintaining viability of farms. Communications for well owners should focus on how to test their well or apply for a state funded well sample, and information about how to understand what the sample means. A communication tool offered to customers, community groups, and the public as well as policymakers and media is tours at facilities and demonstration gardens.

The media plays an important role in conveying information about local governmental actions to communities, and the POTW and media relationship is very important. If a relationship can be developed where the media trusts the POTW or state regulators as source of information, when there is an event relating to PFAS and biosolids, the POTW as an expert on the topic can get its information out to the public quickly and the media would trust that the information is accurate.

Messaging consistency and coordination between the EPA, states, and POTWs offers opportunities to provide clear, consistent information that can inform decision-making by policy makers and the public, while creating an understanding of the dynamic challenges that currently exist for managing PFAS in biosolids.

Continued coordination between the EPA, states, and POTWs can help everyone better manage and respond to the issue of PFAS in biosolids.

All stakeholders in the workshops expressed a desire for continued coordination— between the EPA and states; the EPA, states and POTWs; and POTW-POTW. Collaboration regarding new and emerging technologies for PFAS management, biosolids processing, testing, sampling and monitoring, source reduction, and communications are all topics where there is interest for POTWs to continue learning from each other. Coordination with the EPA could be centered on maintaining consistent messaging to the public, both before and after the EPA's PFOA/PFOS biosolids risk assessment is finalized. There is some concern amongst stakeholders on how to provide consistent and transparent communication around what a risk assessment does and does not do, and how it relates or not to regulatory limits. Continued coordination with the EPA, states, and POTW could be used to provide information sheets and messaging that POTWs could utilize in communicating with customers, farmers, and the public.

Given the public perception and perceived liability of PFAS in biosolids, it is essential that coordinated messaging from the EPA and utilities provides information based on sound science, while being transparent about why certain decisions are being made.

Conclusion

The dialogue in this workshop series provided an important opportunity for participants across the regulated and regulator communities to better understand from each other how to navigate current uncertainties, to share knowledge and expertise, and to identify efforts needed to maintain the range of options to manage municipal biosolids that contain PFAS safely and effectively. The experiential and anecdotal information from participants on challenges in managing PFAS in biosolids provided critical insight into the day-to-day practicalities involved with managing this material in the current regulatory and social context, as well as the challenges of longer-term decision-making and planning that must be undertaken with limited information on the future regulatory environment. The discussions illustrated the balance among the three management options and the series of consequences that affect that balance when one option becomes restricted.

The experiences offered by participants demonstrated that continued communication, collaboration, and coordination will be crucial as sustainable pathways for managing biosolids, including safely addressing PFAS, continue to be developed. Monitoring, source control, and continued innovation are essential activities to maintaining all three management options and are all strategies that will be facilitated by coordination and communication. Participants

identified coordination on collecting and managing information related to PFAS in biosolids as an opportunity for data collection to benefit the larger regulator and regulated community. Building trust and relationships between the key parties will be critical during the next phase of biosolids management as the risk profile and potential regulatory framework is developed. Good relationships and communication will facilitate effective implementation of any future regulatory structures with sensitivity to impacts to current approaches. As PFAS concerns have grown across communities and in the public consciousness, communication with stakeholders such as those represented in this convening is critical. However, additional communication with other federal and state agencies, industry sectors, communities and local governments, and advocates will be essential to ensure the public has accurate and comprehensive information. This broader coordination and communication will help the regulated, regulator, and potentially impacted communities navigate biosolids management in the future.

Appendix A: Workshop Participants

The following list includes participants that joined the workshops, either virtually or in-person, and their professional affiliation. This list does not include individuals who joined the workshop in an observer capacity.

Participant	**Affiliation**
Anthony Drouin	New Hampshire Department of Environmental Services
Arie Kremen	Tetra Tech
Brent Herring	KC Water
Chris Peot	DC Water
David Tobias	U.S. EPA
Emy Liu	Iowa Department of Natural Resources (Formerly); U.S. EPA (Currently)
Haley Falconer	City of Boise
Ivan Cooper	Civil & Environmental Consultants, Inc.
Martin Robinson	U.S. EPA
Jamie Heisig-Mitchell	Hampton Roads Sanitation District
Sec. Jeff Witte	New Mexico Department of Agriculture
Jen Lichtensteiger	New England Interstate Pollution Control Agency
Kasey Kathan	Vermont DEC
Kerry Callahan	ASTSWMO
Maggie Macomber	Charlotte Water
Matt Klasen	U.S. EPA
Mickey Conway	Metro Water Recovery (CO)
Millie Garcia-Serrano	Massachusetts Department of Environmental Protection
Rick Burns	NTH Consultants
Rob Devlin	South Carolina DHEC
Sally Rowland	NY State Department of Environmental Conservation
Scott Firmin	Portland Water District (ME)
Sherry Bock	Minnesota Pollution Control Agency
Stephanie Kammer	Michigan EGLE
Susanne Miller	Maine DEP
Tom Sigmund	NEW Water (Green Bay, WI)

Appendix B: One-on-One Interview Guide

Note: The following questions explored the three main biosolids management options: land application, incineration, and disposal in landfills. Interviews focused on the questions related to management options or issues with which participants were most familiar. At the start of the interview, questions were prioritized to best utilize the time.

Interview Questions

1. How do you and your sector most acutely experience the PFAS in municipal biosolids issue?
2. What are the two or three most important conversations you think we should have?

Management Option: Land Application

3. From your perspective, how would you characterize the current state of land application of biosolids?
4. How would you characterize the long-term viability of land application of biosolids? What could weaken the long-term viability of land application of biosolids? What could strengthen it?
5. What thoughts do you have (or have you heard) regarding the public health impacts of land application of PFAS-containing biosolids? What practices are you aware of that can help mitigate these concerns?
6. What are important conversations regulators and regulated entities need to have regarding land application of biosolids?
7. What opportunities exist for land application of biosolids? What would have to happen to maximize this opportunity?

Management Option: Disposal in Landfills

8. From your perspective, how would you characterize the current state of biosolids (sewage sludge) management in landfills?
9. How would you characterize the long-term viability of landfilling biosolids? What could weaken the long-term viability of landfilling biosolids? What could strengthen it?
10. What thoughts do you have regarding the public health impacts of landfilling biosolids? What practices are you aware of that can help mitigate these concerns?

11. What are important conversations regulators and regulated entities need to have regarding landfilling biosolids?
12. What opportunities exist for landfilling biosolids? What would have to happen to maximize this opportunity?

Management Option: Incineration

13. From your perspective, how would you characterize the current state of the incineration of biosolids (through sewage sludge incineration)?
14. How would you characterize the long-term viability of this management by the incineration of biosolids? What could weaken the long-term viability of incineration of biosolids? What could strengthen it?
15. What thoughts do you have regarding the public health impacts of incineration? What practices are you aware of that can help mitigate those concerns?
16. What are important conversations regulators and regulated entities need to have regarding the incineration of biosolids?
17. What opportunities exist for the incineration of biosolids? What would have to happen to maximize this opportunity?

Overarching Questions

18. From your perspective, what are the 1-2 most important factors or considerations for addressing PFAS in municipal biosolids by the EPA?
19. From your perspective, what are the 1-2 most important factors or considerations for addressing PFAS in municipal biosolids for State Regulators?
20. From your perspective, what are the 1-2 most important factors or considerations for addressing PFAS in municipal biosolids by wastewater system operators?
21. From your perspective, what are the 1-2 most important factors or considerations for addressing PFAS in municipal biosolids by the waste management professionals?
22. From your perspective, what critical gaps exist in current communication practices related to PFAS and biosolids? Do you have any suggestions of how to best fill these gaps?
23. What questions and/or additional information do you have for EPA and/or other actors engaged in this process?

Appendix C: Workshop Agendas

PFAS in Municipal Biosolids Workshop #1 Agenda

On October 25, 2023, from 11:30am – 4:30pm EST, EPA convened a virtual workshop to discuss challenges and opportunities related to the management of PFAS in biosolids. The workshop participants represent state regulators and wastewater and waste management regulated entities and three EPA participants. The workshop also included observers.

October 30th 11:00am - 4:30 pm

11:00 am Welcome, Get Settled, Ground Rules, and Agenda Review

11:10 am Icebreaker Exercise (25 mins)

11:35 am Current EPA Activities and Timeline (30 presentation + 15 Q/A)

- EPA share with workshop participants the current timing and status of key PFAS and Biosolids related work.
    - Risk Assessment Work
    - Source Reduction and Pre-Treatment
    - The national picture of management options/current practices.
    - PFAS work in other parts of EPA that are connected to our workshop.

12:20 pm Landfill Challenges: Root Causes, Impacts, and Strategies for Managing Uncertainty

- In plenary, participants will answer a series of poll questions about challenges, root causes, impacts, and strategies for managing uncertainty with the landfill management option. Workshop participants will dissect and discuss poll results.

1:35 pm Break

1:55 pm Land Application Challenges: Root Causes, Impacts, and Strategies for Managing Uncertainty

- In breakout groups, participants will discuss challenges, root causes, impacts, and strategies for managing uncertainty of the land application management option.

3:30 pm Incineration Challenges: Root Causes, Impacts, and Strategies for Managing Uncertainty

- In plenary, participants will answer a series of poll questions about challenges, root causes, impacts, and strategies for managing uncertainty. Workshop participants will dissect and discuss poll results.

4:15 pm Next Steps

PFAS in Municipal Biosolids Workshop #2 Agenda

On March 19 and 20, 2024, from 11:30am – 4:30pm EDT, U.S. EPA's Office of Water convened a second virtual workshop to discuss participants' individual feedback on the challenges and opportunities related to the management of PFAS in biosolids. The workshop participants represent state regulators, wastewater and waste management regulated entities, and three EPA participants. The workshop also included a number of observers.

March 19th 1130a-430p ET

11:30a	**Networking, Welcome, and Agenda Review**
11:50a	**Source Control and Source Reduction Strategies** Strategies for managing industrial sources ○ What strategies has your city/municipality used to identify industrial users discharging PFAS? ○ If/how do wastewater treatment facilities use industrial user inventories to address the PFAS challenge? ○ How have you attempted to reduce the amount of PFAS received from those industrial sources? If so, how? ○ What barriers exist for Control Authorities (POTW, state, or EPA), to more aggressively pursue reductions from industrial users? Strategies for managing domestic sources ○ What monitoring strategies have you used to identify/mitigate PFAS in the waste stream? ○ What strategies have wastewater treatment plants used to manage domestic sources?
1:10p	**Progress on other EPA PFAS efforts since 1st Workshop** *A.* EPA Presentation on Relevant PFAS Roadmap actions + Q&A ○ Recent EPA PFAS Roadmap Actions ○ EPA Methods 1621 and 1633 ▪ ELG program updates
2:00p	**Break**

2:30p	**Strategies for Managing PFAS Leachate** A. For landfills collecting leachate ○ What technologies are you using, considering, or heard of others using for leachate containing PFAS? Please consider both monitoring and treatment technologies. B. Source management ○ To what extent are landfills considering strategic handling of PFAS-containing materials? Wastewater Treatment and Leachate ○ What strategies are wastewater treatment operators using to manage leachate that may contain PFAS? ○ How are wastewater treatment and landfill operators coordinating/cooperating to more effectively manage leachate containing PFAS?
3:30p	**Strategies for Managing Landfill Capacity** A. Strategies for managing volume of PFAS-containing biosolids ○ How does the presence of PFAS in biosolids change your volume reduction approach? B. Other ○ In states where capacity is an acute issue (i.e., Northeastern US), what conversations are wastewater operators and landfill operators having with regard to accepting biosolids? Does this conversation play out differently in other parts of the country?
4:30p	**Adjourn**

March 20th 1130a-430p E

11:30a	**Communications: Messaging, Tools, and Strategies (Breakouts)** Prior to breakouts polling: Audiences and Communications needs 2 breakout groups. Each breakout will meet for 30 mins on each topic. Breakout Round #1: Key Messaging ○ What are key messages for the audiences and communication needs to improve understanding of risk due to PFAS in municipal biosolids? ○ What are the key messages for the audiences and communication needs to improve public understanding of biosolids?

	Breakout Round #2: Tools/Strategies ○ What tools or strategies does the biosolids community as a whole need to most effectively reach their desired audiences? ○ What specific tools or strategies do specific segments of the community need (e.g., regulators, wastewater treatment operators, landfill operators, etc.)?
12:45p	**Breakout Report Out**
1:15p	**Sampling and Monitoring Strategies** A. Approaches and Best Practices ○ What challenges and successes have states/municipalities had in establishing a sampling and monitoring approach? ▪ Experience with EPA Methods 1633 and 1621 and other methods ▪ Finding labs ▪ Cost ▪ Other B. Incentivizing Sampling and Monitoring ○ How do you align the incentives so that wastewater treatment operators, landfill operators, and operators of incinerators voluntarily implement sampling and monitoring strategies? How can communications support this?
2:15p	**Break**
2:45p	**Cost and Financing** A. Treatment ○ What financing approaches or cost considerations could wastewater treatment operators consider in pursuing solutions to better understand concentrations and reduce PFAS in biosolids? ○ What financing approaches could municipalities, states, and/or EPA take to facilitate wastewater treatment operators to pursue solutions to better understand concentrations and reduce PFAS in biosolids (e.g., financing programs, partnerships, other?)? B. Disposal or Beneficial Use ○ What financing approaches or cost considerations could landfill operators, incinerators, or land applicators consider, respectively, to manage the challenge of PFAS in biosolids (e.g., understand concentrations, reduce PFAS in biosolids, other?)?
3:45p	**Engaging Other Stakeholders** • What can workshop participants do to support engaging other stakeholders?
4:15p	**Wrap Up and Next Steps**

4:30p	**Adjourn**

PFAS in Municipal Biosolids Workshop #3 Agenda

On May 29 -30, 2024, U.S. EPA's Office of Water convened a third in-person workshop to discuss participants' individual feedback on the challenges and opportunities related to the management of PFAS in biosolids. The workshop was held at the Environmental Council of the States headquarters in Washington DC, and workshop participants represent state regulators, wastewater and waste management regulated entities, and three EPA participants.

May 29th 9:00am – 4:30 pm

9:00 am **Welcome, Get Settled, and Agenda Review (10 min)**

9:10 am **Scenario Breakouts: Round 1 (90 minutes)**

Table top exercise in which participants will work through a scenario and actions that would be taken in the event of a pre-determined PFAS level at a POTW. The participants will break into two groups and work through the same scenario. The Facilitation Team will provide an overview of the exercise prior to breaking into groups. Participants will have a short period of time to read and think through the scenario prior to discussing as a group.

10:40 am **Break (15 minutes)**

10:55 am **Breakout Report out and Discussion (60 minutes)**

11:55 am **Lightning Talks (20 minutes)**

Two individuals will give a lightning talk for 10-14 minutes, and we will have 5-10 minutes for questions.

12:15 pm **Lunch (75 minutes)**

1:30 pm **Lightning Talks (25 minutes)**

Three individuals will give a lightning talk for 15-20 minutes, and we will have 10-20 minutes for questions.

1:55 pm **Scenario Breakouts: Round 2 (65 minutes)**

This second scenario breakout session will follow the same format as the morning session, in which groups will be presented with a scenario. Participants will break into group sand work through the table top exercise.

3:00 pm **Break (10 minutes)**

3:10 pm **Breakout Report Out and Discussion (35 minutes)**

3:45 pm **Lightning Talks (25 minutes)**

Three individuals will give a lightning talk for 15-20 minutes, and we will have 10-20 minutes for questions.

4:10 pm **Agenda Day 2 Preview and Close Out**

May 30th 8:30am – 12:30 pm

9:00 am **Welcome, Get Settled, and Agenda Review (10 minutes)**

9:10 am **Communications Show and Tell (70 minutes)**

Participants will present on a communications product their organization uses that they particularly like and talk through what seems to work about it. Everyone will be encouraged to share a product.

10:20 am **Break (10 minutes)**

10:30 am **Workshopping a Communications Product (90 minutes)**

After the Facilitation Team provides directions, the group will self-select into 2-4 different groups to talk through key messages, audiences, and dissemination tactics.

12:00 pm **EPA Closing Remarks, Next Steps, and Meeting Close Out**