

Biosolids Program Strategy: Fiscal Year 2020-2025

**U.S. Environmental Protection Agency
Office of Water
Office of Science and Technology
Washington, DC**



INTRODUCTION

This U.S. Environmental Protection Agency (EPA) Biosolids Program Strategy is a 5-year outlook that describes key activities in the following focus areas:

- Clean Water Act (CWA) Activities Based on the Latest Scientific Knowledge
- Resource Recovery and Reuse Alternatives
- Lifecycle Assessment
- Biosolids Partner Engagement
- Research

Specific activities for Fiscal Years 2020-2025 under the focus areas support meeting CWA requirements for biosolids and are consistent with scientific recommendations to EPA from the National Research Council (NRC).¹ The Biosolids Program is in the Health and Ecological Criteria Division (HECD) in the Office of Science and Technology within EPA's Office of Water (OW). This strategy aligns with HECD's role in protecting public health and the environment through the design of robust, efficient, and current methods for screening and assessing the potential risks of chemicals, pathogens, and other pollutants found in the environment.

What are Biosolids?

Biosolids result from the treatment of domestic sewage in a wastewater treatment facility. When applied to land at the appropriate agronomic rate, biosolids provide benefits including supplying nutrients for crop production, improved soil structure, and reuse of water.² Land application of biosolids also can have economic and waste management benefits (e.g., conservation of landfill space; recycling a waste product reducing the demand on non-renewable resources like phosphorus and the demand for synthetic fertilizers; reduced overall farm cost for fertilizers).

There are over 14,600 publicly owned treatment works, servicing over 238 million people across the U.S.³ Additionally, there are more than 60 million people in the U.S. that have private sewage systems (septic systems).⁴

There is no definitive source that reports the amount of biosolids produced annually in the United States. Data from the 2007 North East Biosolids and Residuals Association (NEBRA) survey showed that about seven million dry metric tons of biosolids are produced in the U.S. annually⁵. The NEBRA report also estimates that smaller facilities generate about eight percent of the total flow generated in the U.S. These smaller treatment facilities tend to store solids in lagoons, transport untreated solids to larger wastewater treatment plants, and generally use the lowest-cost and easiest methods of disposal such as landfilling.

¹ The National Research Council of the National Academies provided input on EPA's risk assessment approach that was used to develop 40 CFR Part 503: [Biosolids Applied to Land, 2002](#)

² Various studies cited at: [U.S. Department of Agriculture Agricultural Research Service](#).

³ [EPA Clean Watersheds Needs Survey 2012: Report to Congress](#).

⁴ [EPA Office of Wastewater Management](#).

⁵ NEBRA (July 20, 2007) 'A national biosolids regulation, quality, end use & disposal survey', North East Biosolids and Residuals Association, Tamworth, NH. Available at: <https://static1.squarespace.com/static/54806478e4b0dc44e1698e88/t/5488541fe4b03c0a9b8ee09b/1418220575693/NtlBiosolidsReport-20July07.pdf>

EPA collects annual biosolids reports from roughly 2,200 larger facilities in the U.S. Based on the EPA annual biosolids reports, approximately 4.75 million dry metric tons of biosolids were produced in the U.S. in 2019. Additional information from the EPA biosolids reports can be found in Figure 1.

Data from EPA Annual Biosolids Program Reports in 2019

Data gleaned from 2274 Publicly Owned Treatment Works (POTWs) representing:

- (1) Class 1 management facilities (POTWs with an approved pretreatment program)
- (2) major POTWs (a design flow rate greater than or equal to one million gallons per day)
- (3) POTWs that serve 10,000 people or more
- (4) or otherwise required to report by EPA or permitting authority.

EPA estimates:

- About 4.75 Million Dry Metric Tons (mdmt) of biosolids were generated.
- About 2.4 mdmt biosolids were applied to land.
 - 1.4 mdmt to agricultural land
 - 1 mdmt to non-agricultural land
- About 0.765 mdmt biosolids were incinerated.
- About 1.02 mdmt biosolids were landfilled.
- About 0.498 mdmt biosolids were disposed of via other management practices (deep well injection, storage, syngas and other).

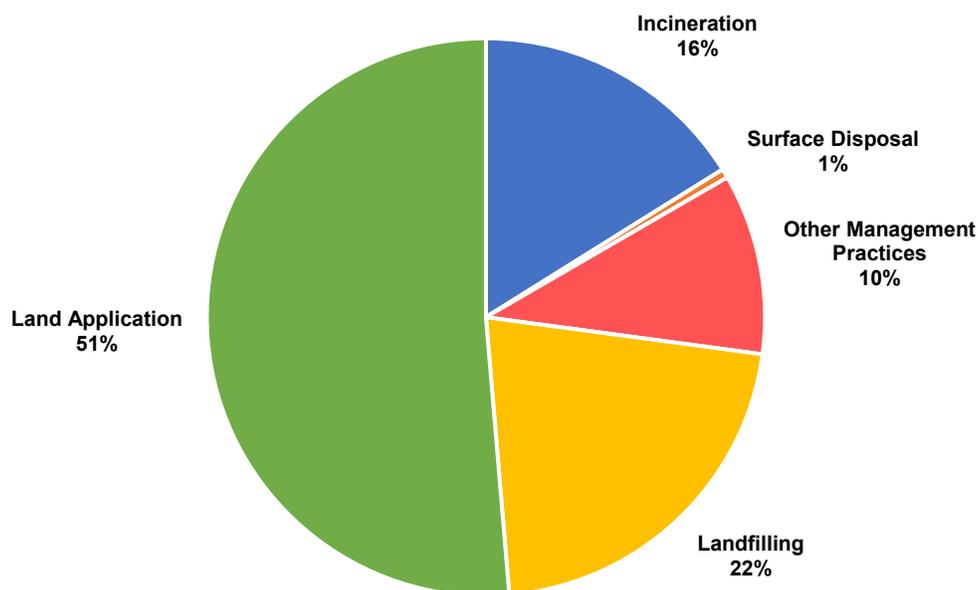


Figure 1. Distribution of biosolids use and disposal based on 2019 EPA annual program report data. [EPA Enforcement and Compliance History Online](#).

CWA ACTIVITIES

As required by Section 405(d) of the CWA, EPA developed a regulation to protect public health

Section 405(d) of the Clean Water Act (CWA) requires EPA to:

- *Establish numeric limits and management practices that protect public health and the environment from the reasonably anticipated adverse effects of chemical and microbial pollutants during the use or disposal of sewage sludge.*
- *Review biosolids (sewage sludge) regulations every two years to identify additional toxic pollutants that occur in biosolids (i.e., biennial reviews) and set regulations for those pollutants if sufficient scientific evidence shows they may harm human health or the environment.*

and the environment from any reasonably anticipated adverse effects of pollutants that might be present in sewage sludge. This regulation, *The Standards for the Use or Disposal of Sewage Sludge*, was published on February 19, 1993 (58 FR 9248).

The [*Standards for the Use or Disposal of Sewage Sludge*](#), found in [40 CFR Part 503](#) or “Part 503”, establishes requirements for the final use or disposal of sewage sludge when it is: 1) applied to land as a fertilizer or soil amendment; 2) placed in a surface disposal site, including sewage sludge-only landfills; or 3) incinerated. For example, land application of biosolids requirements in Part 503 include general requirements, pollutant limits, management practices, operational standards (i.e., technology requirements to reduce/limit pathogens and vectors) and requirements for the frequency of monitoring, record keeping and reporting. All Part 503 requirements apply to publicly- and privately-owned treatment works that generate or treat domestic sewage sludge and to anyone who uses or disposes of sewage sludge. The requirements of Part 503 are self-implementing and must be followed even without the issuance of a permit. In addition, persons using or disposing of biosolids are subject to state and possibly local biosolids management regulations.

Assessing potential risk from pollutants found in biosolids is the top priority for EPA's Biosolids Program. EPA conducts biennial reviews to identify pollutants found in biosolids and obtain data (e.g., fate and transport, toxicity, etc.) that may be used in assessing potential risk. The Agency also obtains data through its national sewage sludge surveys and collaboration with states and stakeholders. Pollutants identified in biosolids in biennial review reports and national sewage sludge surveys will be prioritized for risk screening. If the pollutant exceeds a level of concern during the initial risk screen, then a refined risk assessment will be conducted to determine the potential risk to public health and the environment. If risk is determined, then EPA may regulate the pollutant of concern per CWA Section 405(d) (Figure 2). Currently, efforts in the Biosolids Program are focused primarily on developing the necessary tools and obtaining data needed to assess risk.

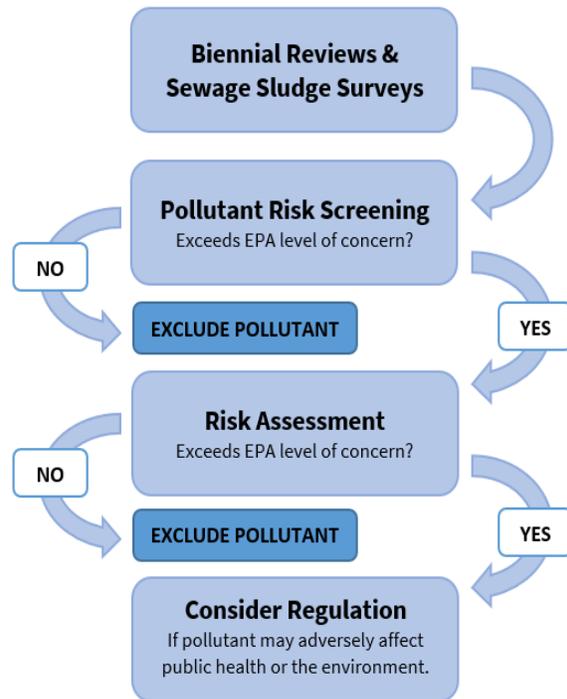


Figure 2. EPA's Multistep process to assess potential risk and regulate pollutants in biosolids.

BIENNIAL REVIEWS

Every two years EPA develops biennial reports by collecting and reviewing publicly available information on the occurrence, fate and transport in the environment, human health and ecological effects, and other relevant information for toxic pollutants that may occur in U.S. biosolids. EPA aims to publish biennial reviews within one year from the end of the literature search date. This aim is reflected in an annual performance measure with the following targets:

- *March: Primary literature search completed*
- *June: Secondary literature search completed*
- *September: Draft biennial review completed*
- *December: Biennial review completed and posted to the EPA website*

In response to the 2002 NRC report, EPA conducted an extensive literature review from 1993 to 2002 and data gleaned constitute EPA's first summary of contaminants detected in sewage sludge⁶.

⁶ *Standards for the Use or Disposal of Sewage Sludge; Final Agency Response to the National Research Council Report on Biosolids Applied to Land and the Results of EPA's Review of Existing Sewage Sludge Regulations.* 68 FR 75531 (December 31, 2003). Available at: <https://www.federalregister.gov/d/03-32217>

Subsequently, EPA published Biennial Reports No.1-8 which are posted to EPA's website: <https://www.epa.gov/biosolids/biennial-reviews-sewage-sludge-standards>. Development of Biennial Report No.9 in September 2021. **(Biennial Report No.9 Target Completion 2022)**

NATIONAL SEWAGE SLUDGE SURVEY (NSSS)

EPA has performed three national sewage sludge surveys to identify compounds found in biosolids, with the last samples being collected in 2006.

- [1988](#) (conducted in support of the Part 503 Rule),
- [2001](#) (conducted in support of the dioxins assessments and published in 2007)
- [2006](#) (published in 2009 and 2021)

EPA did not test for per- and polyfluoroalkyl substances (PFAS) in these surveys due to the lack of analytical methods. The Biosolids Team, collaborating with other EPA offices and EPA's Office of Research and Development (ORD) will begin planning the study design of a new NSSS to better understand the occurrence of pollutants in biosolids, particularly PFAS. **(Target Initiation 2022)**

EPA CompTox CHEMICALS DASHBOARD BIOSOLIDS LIST

The Biosolids Program and Office of Research and Development (ORD) are working to curate a list of all chemicals detected in biosolids from past biennial reviews and sewage sludge surveys representing the Agency's understanding of chemicals found in biosolids. Currently, a total of approximately 500 pollutants have been found to occur in biosolids (in at least one instance) since EPA began tracking their occurrence in 1993 when 40 CFR Part 503 was promulgated. The Biosolids Program plans to update the list of chemicals detected in biosolids when the curation is complete. To access the current list on the Dashboard:

https://comptox.epa.gov/dashboard/chemical_lists/BIOSOLIDS. **(Updated Periodically)**

RISK ASSESSMENT: SCREENING

Assessing the potential human health and ecological risks associated with pollutants found in biosolids is the top priority for EPA's Biosolids Program. Not all of the approximate 500 pollutants that have been found in biosolids will be present in every wastewater treatment facility. Pollutants found in biosolids will vary depending upon inputs to individual wastewater treatment facilities over time. Ten pollutants are currently regulated under Part 503: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, and molybdenum. While CWA 405(d) requires that EPA identify and regulate chemical and microbial pollutants found in biosolids if sufficient scientific evidence shows that the pollutants pose a risk to human health and the environment, the EPA must first assess the risk for the chemicals found in biosolids.

In consideration of previous efforts to meet the agency's statutory responsibility in the CWA Section 405(d) and the 2002 scientific evaluation from the [National Resources Council \(NRC\)](#), Office of Water is consulting EPA's Science Advisory Board (SAB) to get feedback on a proposal to more efficiently assess risk for the chemical pollutants found in biosolids. EPA is recommending a three-step process to (1) prioritize the risk assessment of chemical pollutants found in biosolids using computational toxicology, (2) conduct screening-level risk assessments using a customized deterministic model, and (3) conduct refined, probabilistic risk assessments.

The use of a scientifically defensible prioritization method and screening-level model will aid the Agency in focusing limited resources on chemicals that have the greatest potential to result in risk to human health and the environment, while definitively making decisions on chemicals that present low-risk. The screening process may also identify areas of research needed to address data gaps and uncertainties for specific chemicals. EPA will conduct the more complex, resource-intensive probabilistic risk assessments only for chemicals that do not pass the screening-level assessment.

Prioritization and Screening

Where significant gaps in available data limit risk assessment EPA is exploring the use of computational toxicology approaches to prioritize pollutants identified in biosolids. New Approach Methodologies (NAMs) including computational/in silico models have the potential to play an important role in identifying and synthesizing existing data and in filling data gaps for pollutants reported in biosolids. The Biosolids Team is working with ORD and Office of Chemical Safety and Pollution Prevention to explore the use of these tools. In addition, the Biosolids Program is conducting an analysis of previous chemical risk evaluations in order to better inform the prioritization process. **(Ongoing)**

EPA has evaluated options for a screening-level deterministic model. Our goal is to identify chemicals, pathways, and receptors of greatest interest to facilitate decisions regarding whether to perform more refined modeling. The screening process may also highlight areas of research needed to address data gaps and uncertainties. The Biosolids Team is coordinating with the Office of Chemical Safety and Pollution Prevention to incorporate use of the screening-level deterministic model in its registration programs. **(Target Screening Initiation 2022)**

The proposed biosolids risk assessment approach will be presented to EPA's Science Advisory Board for review prior to implementation. SAB panel member solicitation via Federal Register Notice occurred on September 1, 2021. **(Review Scheduled for Early 2022)**

RISK ASSESSMENT: REFINED ASSESSMENTS

EPA's biosolids regulation, 40 CFR part 503, was based on refined risk assessments. EPA plans to assess chemicals identified in biosolids and those that do not pass screening will be prioritized for refined risk assessment.

Pollutant Risk Assessments

Ten pollutants were previously prioritized for risk assessment in 2003 as part of EPA's response to the 2002 NRC biosolids report: Barium, Beryllium, Manganese, Nitrite, Nitrate, Silver, Fluoranthene, Pyrene, 4-Chloroaniline and Molybdenum⁷. Although initial risk assessments were conducted and peer reviewed, substantial time has passed since the work was completed. To ensure consistency, EPA will also apply the risk screening process currently being developed to these 10 pollutants. Results of the risk screening process will determine whether refined risk assessments will be performed on these pollutants in the future. **(Target Screening Initiation 2022)**

⁷ Nitrate and nitrite were selected also in 2003, however risk assessments for PFOA and PFOS in biosolids are a higher priority at this time. The decision has been made to delay assessing nitrate and nitrite until additional resources are available.

[PFOA and PFOS Biosolids Risk Assessment](#)

The Biosolids Program completed the problem formulation process for PFOA and PFOS biosolids risk assessments in December 2020. Problem formulation is the part of the risk assessment framework that articulates the purpose for the assessment, defines the problem, and determines a conceptual plan for analyzing and characterizing risk (EPA 2014, EPA 1998). Engagement with states and tribes (72 participants), risk managers, scientists, and members of the biosolids community (170 various stakeholders) regarding foreseeable science and implementation issues occurred in November 2020. The summary report for the meetings can be accessed [here](#). The PFOA and PFOS biosolids risk assessment is listed in the EPA PFAS Strategic Roadmap <https://www.epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024>. **(Target Completion 2024)**

[PFOA and PFOS Biosolids Risk Management and Potential Regulation](#)

If EPA determines from its risk assessment that PFOA or PFOS in biosolids may adversely affect public health or the environment, risk managers will consider options for numerical limitations and best management practices for these compounds. If regulatory limits are advised, EPA will utilize the standard rulemaking process including inter-agency review and public comment. **(Target Initiation 2025)**

[Re-evaluation of Dioxins, Dibenzofurans, and Coplanar Polychlorinated Biphenyls in Land Applied Sewage Sludge](#)

Based on the 2001⁸ and 2003⁹ EPA analyses of dioxins, dibenzofurans and coplanar polychlorinated biphenyls, the agency determined that it would not regulate dioxin in sewage sludge that is land applied, incinerated, or placed in a surface disposal site. In 2012, EPA completed an Integrated Risk Information System (IRIS) reassessment and established a non-cancer reference dose (RfD) for 2,3,7,8-TCDD, a chemical considered to be the most toxic and representative of the dioxins. As a result of this updated health effects information, a new biosolids dioxins risk assessment using the 2012 RfD needs to be completed and public comment on the draft assessment solicited. **(Target completion 2024)**

RESOURCE RECOVERY AND REUSE ALTERNATIVES

EPA is aware of new approaches to make and sell products recovered from sewage sludge waste streams regulated under Part 503. In some cases, Part 503 may create regulatory hurdles to the development of these products which EPA did not envision when it promulgated Part 503 in 1993. The Biosolids Team will continue to work with the Office of General Counsel and others as needed to address this issue and promote reuse alternatives that meet established health standards. **(Ongoing)**

⁸ 2001: [Final Action Not to Regulate Dioxins for Sludge that is Incinerated or Disposed of at a Surface Disposal Site](#)

⁹ 2003: [Final Action Not to Regulate Dioxins in Land-Applied Sewage Sludge](#)

LIFE CYCLE ASSESSMENT (LCA)

Determining environmental impacts of various biosolids management processes and practices serves to inform what approach may be the most appropriate to take. Per the International Standard (ISO) 14040, “the increased awareness of the importance of environmental protection, and the possible impacts associated with products and services, both manufactured and consumed, has increased interest in the development of methods to better understand and address these impacts. One of the techniques being developed for this purpose is life cycle assessment (LCA)... LCA addresses the environmental aspects and potential environmental impacts (e.g., use of resources and the environmental consequences of releases) throughout a product/service’s life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e., cradle-to-grave). There are four phases in an LCA study: 1) the goal and scope definition phase; 2) the inventory analysis phase; 3) the impact assessment phase; and 4) the interpretation phase.”

Researchers in Australia used LCA to explore the potential use of fired-clay bricks made of biosolids¹⁰. The Biosolids Team will explore how the use of LCA might inform the use of certain biosolids management and/or disposal practices. **(Target Initiation 2024)**

BIOSOLIDS PARTNER ENGAGEMENT

The Biosolids Program will continue to develop new and foster existing working relationships inside and outside the agency. Early engagement will help to ensure that final products are based on the best available science and help to avoid foreseeable implementation issues. Products will adhere to agency guidance and science policy directives (quality, objectivity, utility, transparency, and reproducibility) and will be brought to co-regulators and key stakeholders through timely and direct channels of communication.

EPA INFORMATION AND OUTREACH

[EPA Biosolids Website](#)

Extensive revisions to the biosolids website to better address stakeholder questions and to improve transparency and organization were completed in July 2020. The website is continually updated as needed. The biosolids website can be accessed using the following link:

<https://www.epa.gov/biosolids> **(Ongoing)**

[Response to Inquiries](#)

The Biosolids Team regularly responds to inquiries from Congress, federal and state agencies, internal and external stakeholders, and the public. As a multifaceted program, inquiries are specific to a variety of topics (e.g., Part 503 requirements, technical assistance, pollutant assessment, biosolids management, etc.) In some cases, significant coordination and effort are required for a response (e.g., [EPA’s response on land application requirements for Class A Exceptional Quality treated sewage sludge](#)).

(Response to Inquiries Ongoing)

¹⁰ Abbas Mohajerani et al, A Proposal for Recycling the World’s Unused Stockpiles of Treated Wastewater Sludge (Biosolids) in Fired-Clay Bricks, Buildings (2019). DOI: 10.3390/buildings9010014

[Biosolids Management and Technical Materials](#)

Based on input from states and biosolids stakeholders, inquiry topics and biosolids website monthly reports the Biosolids Team develops new or updates existing biosolids information. In many cases the team collaborates with other internal and/or external stakeholders. Examples include the update to the ORD technical document titled, *Control of Pathogens and Vector Attraction in Sewage Sludge*, and a technical support document for Part 503 requirements for lagoon. **(Ongoing)**

[EPA Biosolids Webinar Series](#)

The Biosolids Program initiated its [webinar series](#) in October 2019 to provide information to biosolids co-regulators, stakeholders, and the public. Speakers internal and external to EPA address programmatic and regulatory issues, provide technical assistance, and share best practices. Topics have ranged from an EPA Biosolids Program and Part 503 overview to technical treatments processes. Approximately 150 participants attend each webinar. Future webinars planned will cover a range of topics that have been solicited from co-regulators and stakeholders. They also may be recorded and made available on EPA's YouTube Channel. **(Ongoing)**

[Meetings, Conferences and Teleconferences](#)

Engaging biosolids partners includes participation on EPA-wide monthly calls (e.g., PFAS working group), and on existing stakeholder calls (e.g., [Water Environment Federation](#) and [National Association of Clean Water Agencies](#)). As resources permit, EPA will continue to attend key conferences and meetings to maintain current knowledge and to foster relationships. Participation also provides a forum to communicate accomplishments and initiatives in the Biosolids Program to stakeholders. **(Ongoing)**

[Canada Biosolids Coordination](#)

The Biosolids Team holds bi-monthly calls with Canadian provincial biosolids contacts to exchange information and examine opportunities for potential collaboration. **(Ongoing)**

[Regional Biosolids Association Calls](#)

The Biosolids Team holds bi-monthly calls with the regional biosolids associations: [Northeast Biosolids and Residuals Association](#), [Mid-Atlantic Biosolids Association](#), [Northwest Biosolids](#), [Virginia Biosolids Council](#), [California Association of Sanitation Agencies](#), and [Southeast Biosolids Association](#) that is still being formed to share information and look for opportunities for leveraging limited resources. **(Ongoing)**

[EPA National Biosolids Meetings](#)

The virtual EPA National Biosolids Meeting 2020 (held December 8-10, 2020) brought together EPA, state and tribal co-regulators, utilities, academia and biosolids stakeholders for the first time in almost 10 years to discuss technical and programmatic challenges and needs with the goal of hearing how EPA can best support biosolids management efforts. The 2020 meeting summary report can be accessed [here](#). The virtual 2021 EPA National Biosolids Meeting is scheduled for November 2-4, 2021. EPA is planning to host annual National Biosolids Meetings to collaborate across the sectors on the management and implementation of the biosolids program. **(Ongoing)**

[Biosolids Co-Regulator Collaboration](#)

Follow-up to the 2020 national meeting included the formation of a biosolids co-regulator workgroup. The purpose of the workgroup is to help ensure continued, regular collaboration and

communication to meet collective goals. Multiple meetings with contractor support are planned through mid-2022. The Biosolids Program is also in the process of creating a co-regulator SharePoint site that contains training materials and other information. Continuity and institutional knowledge transfer within and across biosolids programs were identified as priorities during the 2020 national meeting. **(Ongoing)**

ROLE OF EPA REGIONS

The EPA regional biosolids role is essential to biosolids management and implementation of 40 CFR Part 503. Regional biosolids representatives respond to inquiries, issue permits, and maintain and foster relationships with state biosolids coordinators, tribes and biosolids stakeholders. The Biosolids Center of Excellence (located in Region 7) is responsible for biosolids compliance and enforcement across the country. The center issues informal and formal enforcement actions for biosolids violations discovered through tips and complaints, and reviews annual biosolids reports and inspections. Informal actions include letters of warning while formal actions include compliance orders and administrative penalties.

Regional Biosolids Coordinators Calls

The Biosolids Team, Regional Biosolids Coordinators, and colleagues working on biosolids issues in ORD and Office of Wastewater Management have monthly calls to discuss biosolids issues. **(Ongoing)**

Regional Biosolids Coordinators Meeting

The Biosolids Team and the Regional Biosolids Coordinators participated in a facilitated planning meeting focused on collaboration to meet biosolids community goals. **(September 2021)**

COORDINATION WITH EPA OFFICES

The Biosolids Program will continue coordination with EPA offices and labs. This includes the Office of Science and Technology's Engineering and Analysis Division (e.g., biosolids methods); Office of Wastewater Management (e.g., pre-treatment, permitting, biosolids management technologies, NPDES state biosolids programs); Office of Land and Emergency Management (e.g., risk assessment, modeling, landfills); Office of Research and Development (e.g., research coordination involving methods development, incineration and other thermal technologies, fate and transport of chemicals, microbial pollutants, Pathogen Equivalency Committee, CompTox Chemicals Dashboard); Office of Chemical Safety and Pollution Prevention (e.g., technical review of pollutants); and the Office of Enforcement and Compliance Assurance (e.g., electronic reporting, Biosolids Center of Excellence).

RESEARCH

Biosolids research is needed in a number of areas to support the implementation of Part 503 and to ensure that the latest scientific knowledge is being employed to protect public health and the environment. The Biosolids Program will continue to work across EPA and with external partners such as the Water Research Foundation; the U.S. Department of Agriculture-sponsored biosolids research workgroup (W4170) and others to leverage resources and knowledge to meet extensive research needs. ORD research and research grants specific to

PFAS/biosolids projects are listed using this link: <https://www.epa.gov/biosolids/biosolids-research-epa>. In September 2021, EPA awarded nearly \$6 Million (four grants) for research on potential risks from pollutants found in biosolids from wastewater treatment: <https://www.epa.gov/newsreleases/epa-awards-nearly-6-million-research-potential-risks-pollutants-found-biosolids>. **(Ongoing)**

A gap analysis was performed by the Biosolids Program, in consultation with ORD, and the following research needs were identified:

Exposure Characterization and Source Apportionment:

- Characterization of influent, effluent and biosolids is needed to have a better understanding of pollutant source apportionment. This should include ways to compare and contrast the results in order to identify distinguishing features between municipal-only and mixed (municipal/industrial) sources. Information is needed on both POTWs and smaller wastewater treatment facilities.
- Information is needed on the fate and treatability of contaminants of emerging concern, including PFAS, in various typical and innovative municipal wastewater and solids treatment trains/processes to determine expected removal rates and the impact of operational factors on performance.
- Models are needed to predict source apportionment for specific compounds using surrogate compounds that may be unique to industrial operations or diffuse sources of PFAS contamination.

Pollutant Assessment:

- A better understanding is needed of distribution and variability in the uptake and movement of pollutants in plants and/or chemical classes in plants.
- Large-scale field studies are needed to characterize the fate and transport of contaminants in land-applied biosolids and treated effluent.
- Models are needed to predict chemical contaminant concentrations in relevant media for considerations in assessing exposure (e.g., groundwater and/or soil porewater based on soil/subsurface attributes).
- Exposure and toxicity data development is needed for risk assessment. For the majority of pollutants identified in biosolids, there are limited data available to support a screening level or refined risk assessment, resulting in greater uncertainty.

Technologies and Management Practices:

- A better understanding of minimum conditions for incineration (time, temperature, method, etc.) for complete degradation of PFAS, as well as other pollutants of concern is needed.
- Alternative thermal technologies for biosolids need to be analyzed to ensure that they are protective of human health and the environment.
- Determine what technologies and operational process modifications and practices can be used to effectively treat or reduce PFAS in biosolids, particularly in a cost-effective manner.
- Biosolids management strategies are needed based on characterization and modeling studies.
- Reliable measures of biosolids stability are needed (this is directly related to vector attraction and odor).

Microbial Research:

- Research is needed to find indicator organisms which perform in the same way as helminth ova and poliovirus/enteric viruses but are commonly observed in wastewater residuals. Ideally, these indicators could be used to determine process effectiveness and would be ubiquitous and numerous in wastewaters, safe to handle, and easily isolated and enumerated.
- Currently, indicators for wastewater residuals are not consistent with those for wastewater effluents. Improved indicator methods for biosolids are needed.
- The reexamination of holding time for bacterial indicators is needed.
- Prevalence of antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARG) in biosolids. More research is needed to determine if different biosolids treatment regimens have a positive or negative impact on the contribution of antimicrobial resistance (AMR) as a potential environmental source of these organisms.

MILESTONE TRACKING

Milestone	Target Initiation Date	Completion Date	Comments
Biennial Reviews <ul style="list-style-type: none"> • Report No.8 • Report No.9 	9/2021	2/2021 12/2022	Contract task order awarded for Report No.9. Report development and OST management review deadlines were met for Reports No.7 and 8.
National Sewage Sludge Survey (NSSS)	5/2022		Early tasks include: scope determination including chemical selection; coordination with ORD; contract task order. Work is funding dependent.
EPA CompTox Chemicals Dashboard Biosolids List Updates		Ongoing	Coordination with ORD on updates and journal article ongoing.
EPA Science Advisory Board (SAB) review of Biosolids Risk Assessment Approach	1/2022	Fall 2022	Review panel solicitation via Federal Register Notice completed 9/1/2021.
EPA Response to SAB Recommendations	12/2022		Completion of EPA response to SAB recommendations dependent on extent of comments. EPA response may include a report, modifications to models, etc.
Potential Modifications to Risk Models			Tracking can begin once extent of SAB recommendations is known.
Chemical Risk Screening			Potential modifications to Biosolids Risk Assessment Approach influence screening initiation. Minor modifications may result in initiation of risk screening at end of 2022.
PFOA/PFOS Problem Formulation Process <ul style="list-style-type: none"> • States/Tribes Input Session • Stakeholder Session 	12/2019	12/2020 11/2020 11/2020	
PFOA/PFOS Biosolids Risk Assessment <ul style="list-style-type: none"> • Draft Risk Assessment • Risk Assessment Internal Peer Review • Public Comment 	2021	2024	Initiation of risk assessment dependent on potential modifications needed to probabilistic risk assessment framework based on SAB recommendations.

PFOA/PFOS Biosolids Risk Management			Risk managers will consider options for numerical limitations and best management practices for these compounds.
PFOA/PFOS <i>Potential</i> Regulatory Limits			If regulatory limits are advised, they will go through a standard regulatory process including peer review, inter-agency, and OMB review as well as public comment.
Re-evaluation of Dioxins, Dibenzofurans, and Coplanar Polychlorinated Biphenyls	2024		
Resource Recovery	2019		Work was put on hold at the end of 2020 and will resume as resources allow.
Life Cycle Assessment	2024		Work is resources dependent.
Website Overhaul	2019	7/2020	Additional updates occur as needed.
EPA Class A EQ Memo	9/25/2019	11/5/2020	Memo from OW Assistant Administrator to EPA Regions
Biosolids Management and Technical Materials <ul style="list-style-type: none"> Control of Pathogens and Vector Attraction in Sewage Sludge document revisions Part 503 Requirements for Lagoons 	2019 9/2021		Pathogen/vector document peer review ongoing. Development of lagoon document initiated (task order awarded 9/2021).
Meetings/Conferences/Teleconferences		Ongoing	
EPA Biosolids National Meeting <ul style="list-style-type: none"> 2020 2021 		12/2020 11/2021	future national meeting scheduled annually.
Co-Regulator Workgroup <ul style="list-style-type: none"> Inaugural meeting Training webinars/SharePoint site Meeting Meeting 	1/2021 7/2021 1/2022 5/2022	6/2021	Work is ongoing to provide recorded webinars and develop materials to assist in knowledge transfer. Peer mentoring options are being explored.
Regional Biosolids Coordinators Meeting	4/2021	9/2021	Follow-up ongoing.
Research <ul style="list-style-type: none"> National Priorities Grants: Evaluation of Pollutants in Biosolids 	10/13/2020		Four cooperative agreements were awarded 9/28/2021.

CONCLUSION

EPA takes seriously its statutory obligations to evaluate and regulate, where appropriate, contaminants in biosolids that may pose a risk to human health and the environment. The Biosolids Program continues to make significant progress in building capacity to assess pollutants found in biosolids by developing the necessary tools and data needed to evaluate risk. The program is committed to working with federal, state and tribal partners, biosolids stakeholders and academia to provide technical assistance, share information and help ensure sound biosolids management.