WRF SOLIDS MANAGEMENT PROJECTS: ONGOING AND UPCOMING RESEARCH

Maitreyi Nagarkar

June 9, 2026

advancing the science of water®

THE Water Research FOUNDATION®

OUR PURPOSE

To **advance the science of water** to improve the quality of life for all communities.

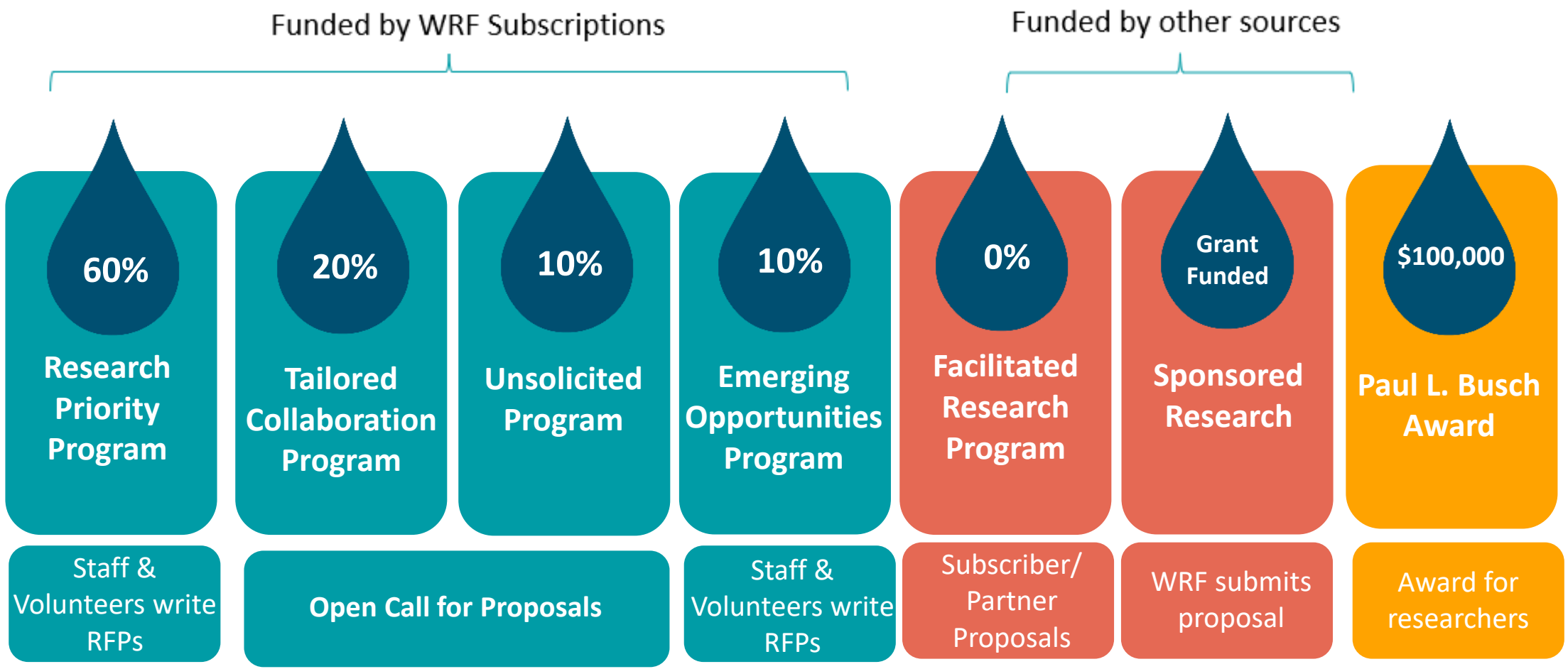
OUR VISION

The science and knowledge we generate allow the water sector to **provide high-quality, safe, accessible, and affordable water services** that contribute to healthy, resilient communities and a sustainable global environment.

OUR MISSION

To help our subscribers discover opportunities and solve problems by **delivering actionable water research** to meet the needs of the communities they serve.

WRF Research Programs



Bringing $8M of Research to Life in 2025

RESEARCH PRIORITY PROGRAM

60% of research budget

- Research Planning Summit: **250** experts, **42** concepts
- RAC approved **19** new projects totaling **$4.85M**
- RFPs posted in August and September
- Received **117** proposals

TAILORED COLLABORATION PROGRAM

20% of research budget

- Received **32** pre-proposals
- Received **24** full-proposals
- TCRC approved funding for **13** proposals totaling **$1.6M**

UNSOLICITED RESEARCH PROGRAM

10% of research budget

- Program launches every other year
- 10% of WRF's annual research budget
- Reviewing 2026 pre-proposals currently

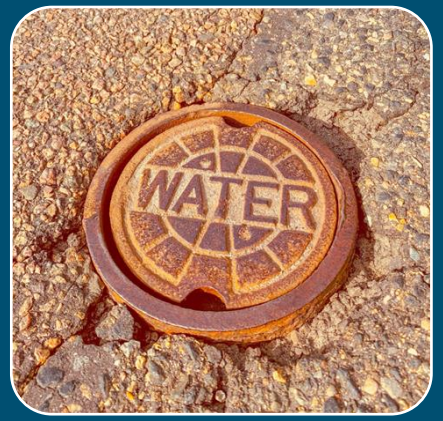
EMERGING OPPORTUNITIES PROGRAM

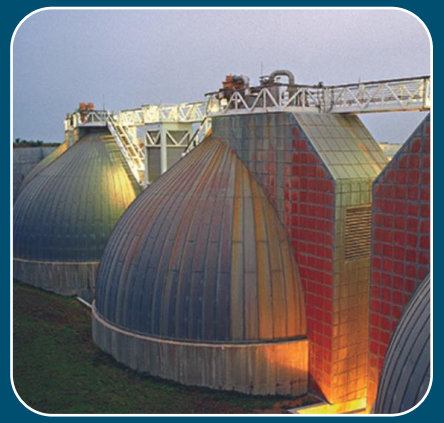
10% of research budget

- **8** projects funded totaling **$793K**

FACILITATED RESEARCH PROGRAM

- **6** projects funded totaling **$1.19M**





Healthy Communities & Environment

- Holistic Watershed Management & Integrated Planning
- Monitoring Tools at Watershed & Sewershed Scale
- Receiving Water Quality Management

Treatment Innovation & Optimization

- Treatment & Process Optimization
- Nature-based Solutions
- Diversifying Water Systems

Efficient Resource Use & Recovery

- Climate Change Mitigation: Addressing Greenhouse Gasses
- Nutrient Removal & Resource Recovery
- **Solids Management**

Resilient Infrastructure

- Asset Management
- Distribution System Integrity & Water Quality
- Collection Systems Integrity & Water Quality Impacts

Utility Operations & Management

- Water Resources Planning
- Workforce Management
- Financial Management

Climate Risk Assessment & Adaptation, Communication, Environmental Justice, Digital Transformation, Circular Water Economy

Solids Management Research Topics

Land Application

Innovative treatment technologies

PFAS

CECs

Digestion

Method development & optimization

Decision-making

Biosolids Land Application

Direct In Situ Measurement of PFAS Transformation & Leaching from Land Applied Biosolids (5214)

Final report coming soon

Unregulated Organic Chemicals in Biosolids: Prioritization, Fate and Risk Evaluation for Land Application (5215)

Final report coming soon

Comparison of PFAS Loading to Agricultural Systems (5413)

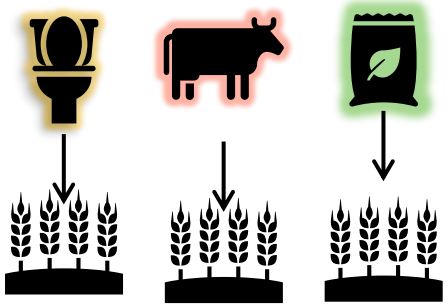
Funding approved for 2026 RPP cycle

Comparison of PFAS Loading to Agricultural Systems (5413)

This project will provide the first comprehensive comparison of PFAS loading from agricultural inputs other than land-applied biosolids, enabling utilities and to make informed, risk-based decisions on biosolids management and agricultural practices.

Objectives:

- Report PFAS concentrations from a variety of agricultural inputs, including animal manures, fertilizers, pesticides, biosolids, and composts.
- Compare the impact of the various agricultural inputs on PFAS concentration in the soil profile over short and medium timeframes.
- Evaluate the fate and transport of different inputs to PFAS loadings in agricultural systems at field-scale.
- Determine the relative contributions from biosolids and other inputs to help develop & prioritize risk management strategies.



PFAS: Fate, Transport, Transformation, Removal

Understanding Gasification for PFAS Removal (5107)
Report & Webcast Available

Understanding the Value Proposition of Thermal Processes to Mitigate PFAS in Biosolids (5211)
Ongoing

Evaluation and Management of PFAS-Enriched Solids Dewatering Streams (5329)
Ongoing

Studying the Fate of PFAS through Sewage Sludge Incinerators (5111)
Report Available

Hydrothermal Alkaline Treatment of PFAS-contaminated Sludge (5328)
Ongoing

The Impact of Dryer Type on Biosolids PFAS Removal: A Suite of Full-Scale Analyses (5384)
Recently started

Hydrothermal Alkaline Treatment of PFAS-contaminated Sludge (5328)

- **Objective**: Develop and optimize an innovative Hydrothermal Alkaline Treatment (HALT) technology that can completely degrade PFAS in sewage sludge and test its ability to degrade PFAS under varying conditions, including using different solvents and metal catalysts.
- **Status**: Demonstrated near-complete PFOA defluorination at ~160°C, enabling implementation under less energy-intensive incineration or supercritical processes. Working on identifying parameters—temperature, solvent composition, and base dosage—to provide utilities with clear, adjustable operating levers that can be tailored to site-specific waste matrices.

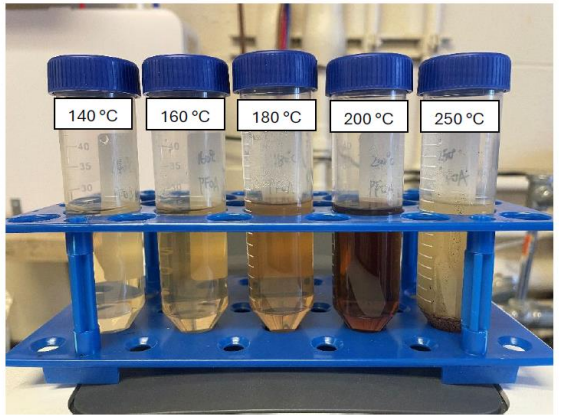


Figure 6. Hydrothermal liquids (100 dilutions) under different temperatures

Digestion

Acid+ (Full Acid + Process Lab Scale Testing) (5108)

Final report coming soon

Advancing integration of Hydrothermal Liquefaction Aqueous into WRRF Digestion Processes and Assessing PFAS fate (5341)

Ongoing

Intensifying Anaerobic Digestion: Downstream Impacts and Thermal Treatment Compatibility (5421)

Funding approved for 2026 RPP cycle

Intensifying Anaerobic Digestion: Downstream Impacts and Thermal Treatment Compatibility (5421)

Objectives:

- Identify effective methods for intensifying AD to maximize methane production, VS destruction, and biogas yield, while minimizing footprint and expansion needs.
- Characterize impacts of intensification on kinetics and stability, the physical/chemical properties of the digested biosolids, and their implications for downstream solids processing, including dewatering, thermal drying, and resource recovery pathways. Define parameters for acceptable biosolids feed for downstream processes.
- Assess regulatory considerations associated with intensified digestion processes, including potential effects on biosolids classification and compliance requirements.
- Provide guidance for utilities evaluating intensification projects, including operational and design considerations, economic impacts, risk factors, and implementation frameworks.

Evaluating Treatment Options

Evaluating Innovative and Sustainable Treatment Options for Biosolids (5169)

Final report & webtool coming soon

Identification and Valuation of Innovative Wastewater Residual Products Beyond Conventional Biosolids (5286)

Ongoing

Comprehensive Evaluation of Biosolids Drying Technologies (5370)

In contracting

Evaluating Innovative and Sustainable Treatment Options for Biosolids (5169)

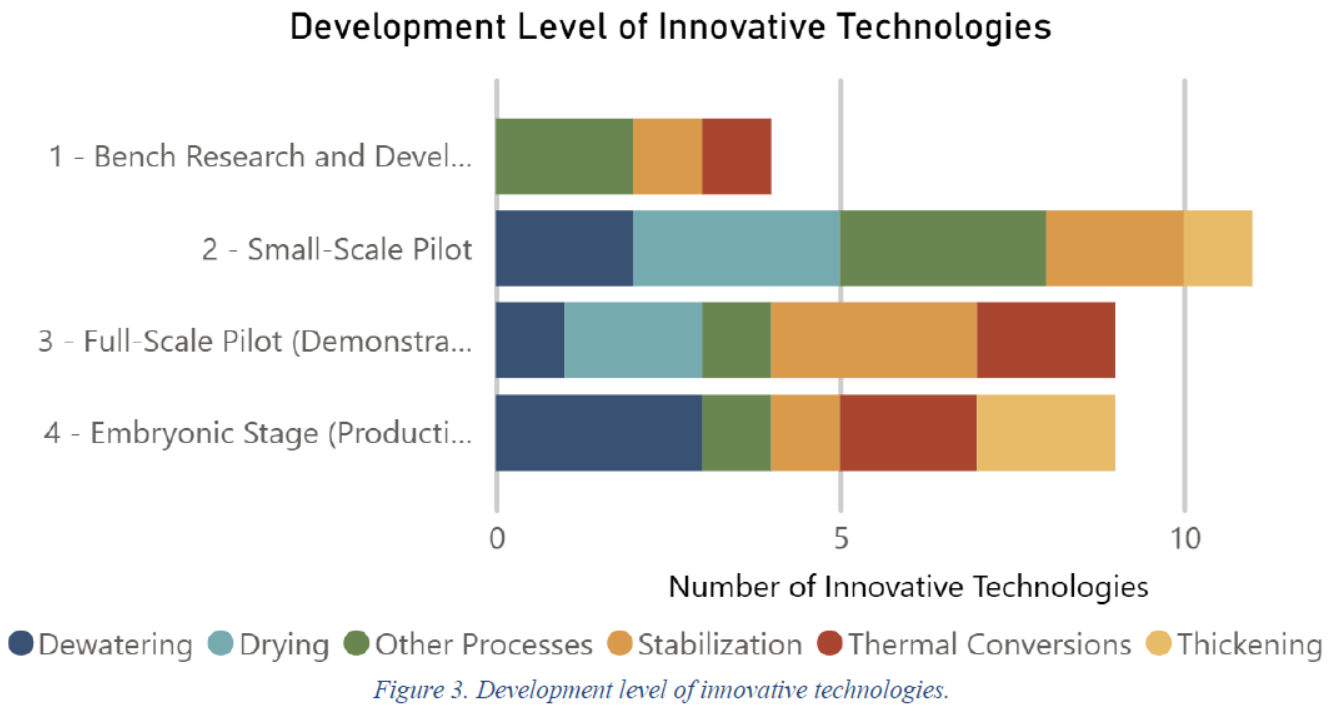


Figure 3. Development level of innovative technologies.

- Suspended Air Flotation Thickening
- Pyrolysis and Thermal Oxidation
- Gasification and Thermal Oxidation
- Electro-dewatering
- Low Temperature Thermal Drying
- Supercritical Water Oxidation

Evaluating Innovative and Sustainable Treatment Options for Biosolids (5169)

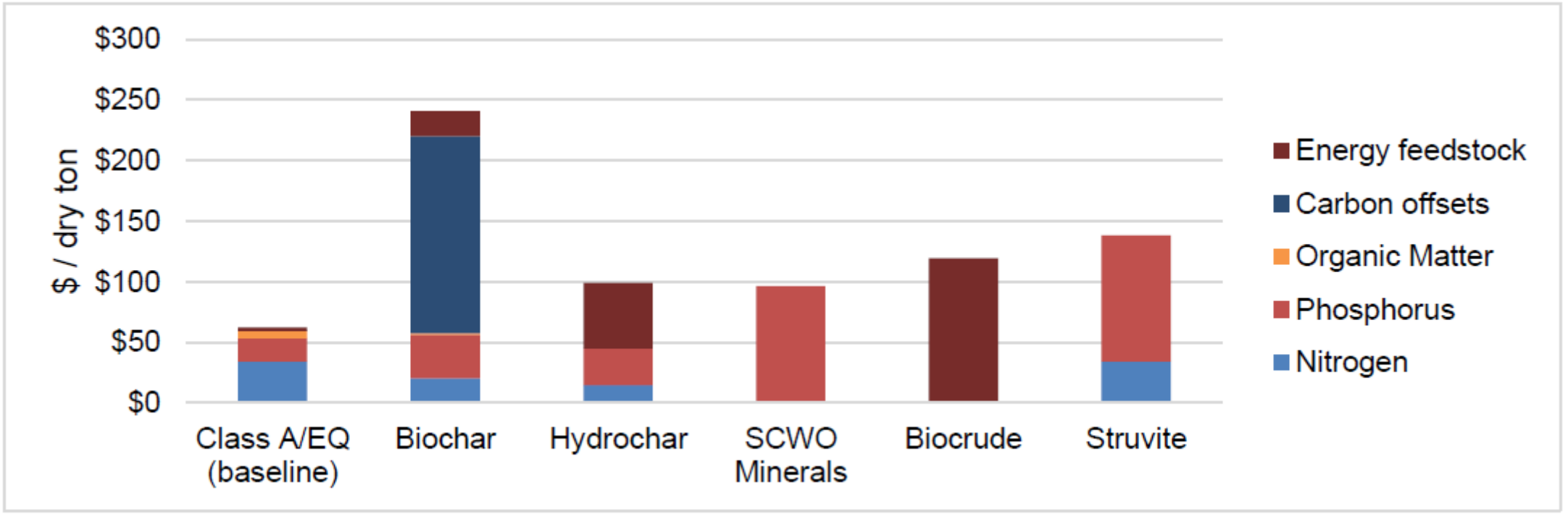


Figure 4. Aggregated estimated dollar value of nutrients and carbon of residual products of innovative technologies.

Evaluating Innovative and Sustainable Treatment Options for Biosolids (5169)

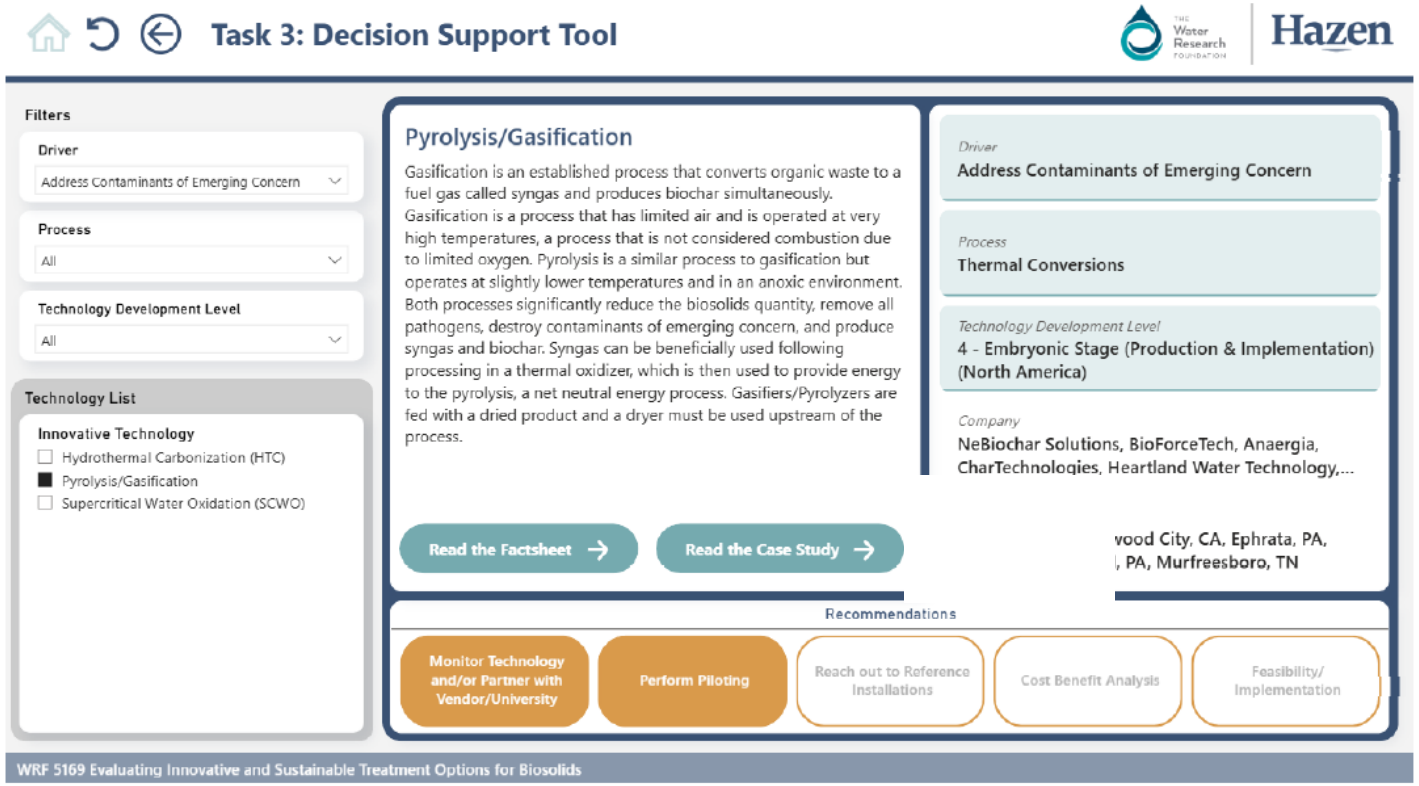
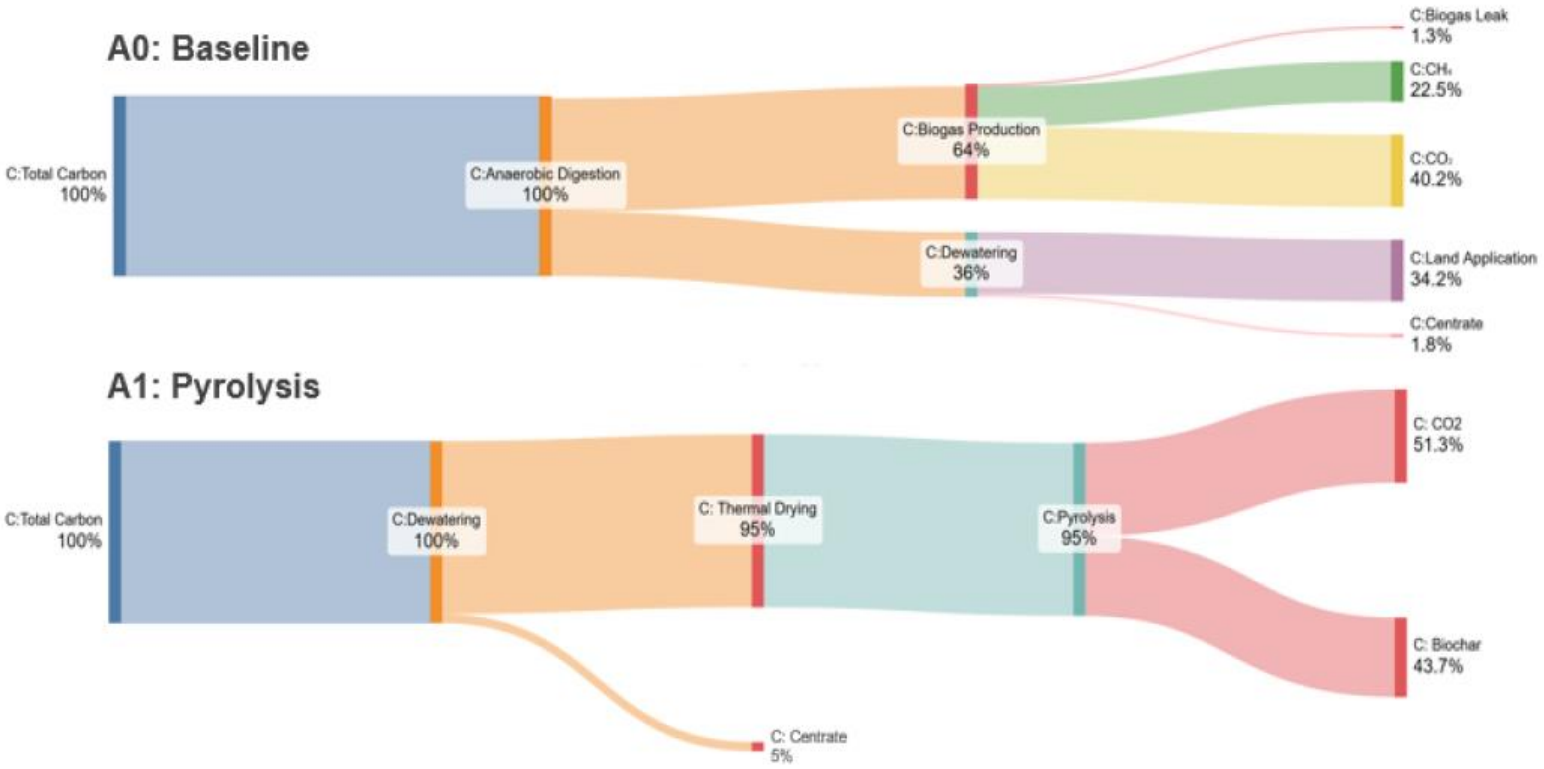


Figure 7. Decision Support Tool.

Evaluating Innovative and Sustainable Treatment Options for Biosolids (5169)



Miscellaneous

Impact of Solid Stream Treatment on Microplastics in Biosolids (5221)

Ongoing

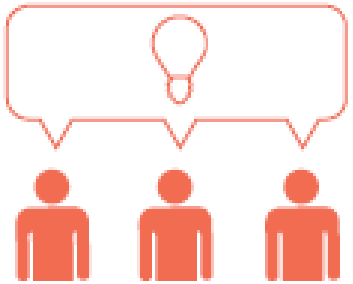
Practical Considerations for the Application of Phosphorus Recovery in Biosolids Utilizing Struvite-Based Mineral Production (5347)

Ongoing

Enhancing the Viability of Hydrothermal Liquefaction for Biosolids Treatment through Ammonia Recovery (5267)

Ongoing

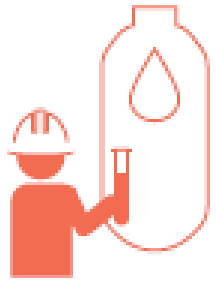
Get Involved in WRF Research



Project Advisory Committees

Provide technical oversight and peer review on research to ensure projects stay on track and results are beneficial to the water community

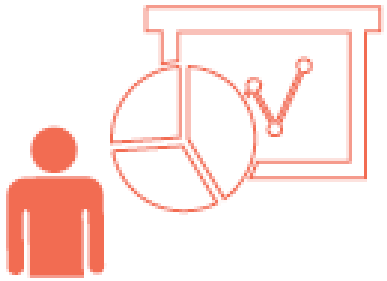
May – Oct, depending on program



Utility Research Participation

Get early insight into research findings by playing a hands-on role—serving as a test site, providing water samples, sharing expertise, and more

Apr – Oct for RPP



Workshops and Industry Events

Engage with leading experts in the water research industry to learn about the latest science, tools, technologies, and processes

Throughout year as scheduled

www.waterrf.org/get-involved

Thank you!

www.waterrf.org

mnagarkar@waterrf.org

Project Advisory Committee (PAC) Involvement

- A PAC is assigned to every WRF research project
- Work with WRF Research Program Managers and research team
- Primary functions and responsibilities:
  - Review periodic reports quarterly for the project duration
  - Review one detailed draft final report towards the end of the project
  - Participate in calls 30-60 minutes long (frequency is semi-annually or as needed)
  - Participate in 1 in-person meeting (optional - if the PAC decides its important - WRF covers your travel expenses

Utility Participation in Research (UPIR)

- Helps ensure that WRF-sponsored research is directly responsive to current industry needs
- Provides the opportunity for utilities to participate as an integral part of a research team.
- Participating utilities gain firsthand information on the study and benefit from working with researchers and others in the water community.
- Participation examples:
  - Serve as test facility
  - Provide water samples
  - Respond to surveys
  - Loan equipment
  - Share staff expertise

WRF Solids Management Projects

	Title	Status	Topics
5107	Understanding Gasification for PFAS Removal	Published; Webcast 2025	
5108	Acid+ (Full Acid + Process Lab Scale Testing)	Almost published	
5111	Studying the Fate of PFAS through Sewage Sludge Incinerators	Published	
5221	Impact of Solid Stream Treatment on Microplastics in Biosolids	To be completed 2026	
5169	Evaluating Innovative and Sustainable Treatment Options for Biosolids	Almost published	
5214	Direct In Situ Measurement of PFAS Transformation & Leaching from Land Applied Biosolids	To be completed 2026	
5125	Unregulated Organic Chemicals in Biosolids: Prioritization, Fate and Risk Evaluation for Land Application (EPA Grant)	Almost completed	
5211	Understanding the Value Proposition of Thermal Processes to Mitigate PFAS in Biosolids	To be completed 2027	
5267	Enhancing the Viability of Hydrothermal Liquefaction for Biosolids Treatment through Ammonia Recovery	To be completed 2027	
5328	Hydrothermal Alkaline Treatment of PFAS-contaminated Sludge	To be completed 2027	

Land app. PFAS CECs Innovative tech

	Title	Start	Topics
5347	Practical Considerations for the Application of Phosphorus Recovery in Biosolids Utilizing Struvite-Based Mineral Production	Mar 2025	
5329	Evaluation and Management of PFAS-Enriched Solids Dewatering Streams	May 2025	●
5341	Advancing integration of Hydrothermal Liquefaction Aqueous into WRRF Digestion Processes and Assessing PFAS fate	July 2025	● ●
5286	Identification and Valuation of Innovative Wastewater Residual Products Beyond Conventional Biosolids	Sept 2025	●
5370	Comprehensive Evaluation of Biosolids Drying Technologies	Soon!	● ●
5384	The Impact of Dryer Type on Biosolids PFAS Removal: A Suite of Full-Scale Analyses		

● PFAS ● Innovative tech