Overview: PFAS Treatment and Destruction Research

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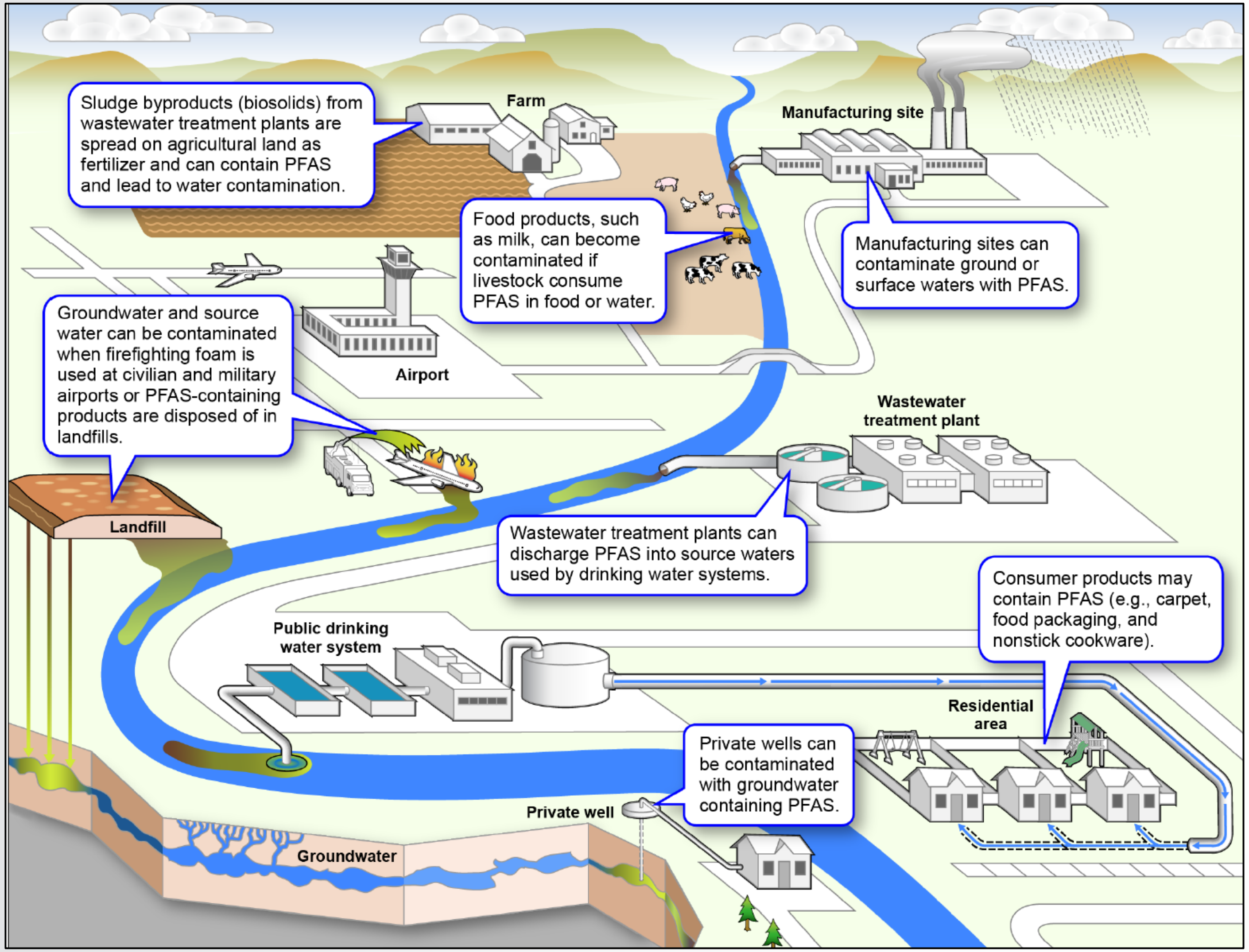
Risk Management Research



Source: GAO | GAO-21-37

Research Needs

- Effective approaches for addressing PFAS in the natural and built environment
- Effective approaches for end-of-life materials management

Research Approach

- Laboratory studies
- Pilot-scale studies
- Full-scale field studies

Research to Inform Decision Making

RISK ASSESSMENT

Dose-response analysis

Hazard identification

Risk characterization

Exposure assessment

RISK MANAGEMENT

Contaminant Management

- Contaminated site cleanup
- Wastewater treatment
- Drinking water treatment
- Waste disposal and destruction

Sustainability

- Avoiding unintended consequences
- Operation suits operator capabilities
- Cost (capital and operating)
- Robustness and future flexibility

Technical Assistance

RISK COMMUNICATION

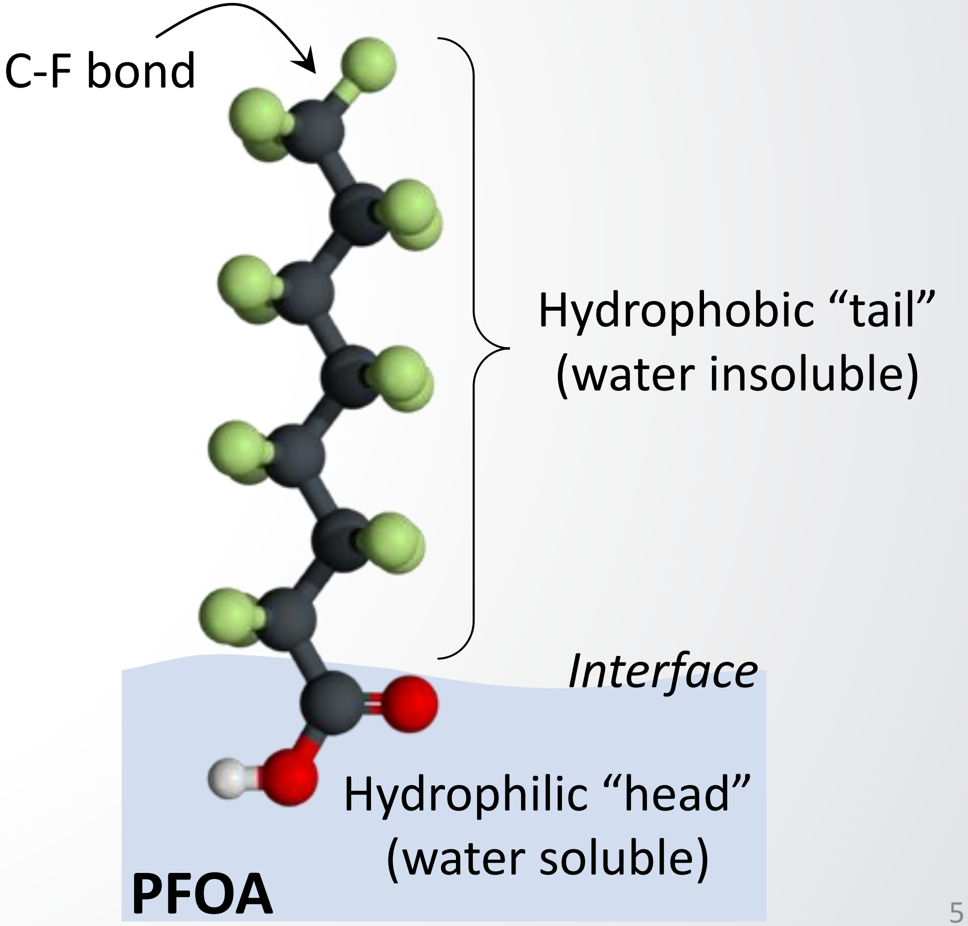
Addressing Two Scenarios

1. Existing waste streams and treatment processes where PFAS is present, for example:
   - Incineration of wastewater treatment plant biosolids
   - Regeneration or incineration drinking water treatment plant granular activated carbon (GAC)
2. Processes designed for PFAS treatment and control, for example:
   - Aqueous film forming foam (AFFF) (and other high strength wastes) destruction
   - Soils remediation
   - Off-gas treatment in stacks at manufacturing plants

Risk Management: PFAS Challenges

PFAS have unique chemical and physical properties compared to other environmental contaminants

- Strong C-F chemical bond
  - Presence of multiple fluorine atoms increases C-C and C-F bond strength
  - Fluorine (in organic molecules) is not very reactive
- Many PFAS are surfactants
  - Have water-soluble and water-insoluble parts
  - Accumulate at interfaces

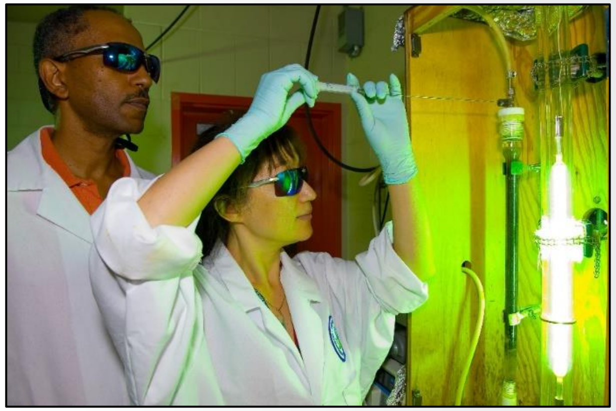


Laboratory and Pilot-Scale Studies

Laboratory and pilot-scale studies generate data under controlled conditions

- To measure the effectiveness of different technologies for removing or destroying PFAS
- To identify how treatment conditions can impact treatment performance

Can be conducted in partnership with educational institutions, utilities or facilities, and/or state and local government agencies



Field studies provide data from full-scale, real-world applications of different technologies and management approaches

- Decision makers have the most confidence in real-world data that comes from full-scale studies

Can be conducted in partnership with utilities or facilities and state and local government agencies

Risk Management Approaches

Water Treatment

Goal: Remove or reduce PFAS in drinking water and wastewater

Example Technologies

Drinking Water – Granular activated carbon (GAC), ion exchange resin, reverse osmosis (RO)

Wastewater – Sedimentation/partitioning, GAC

Site Remediation

Goal: Remove or reduce PFAS at contaminated sites (soil, sediment, groundwater, etc.)

Example Technologies

Soil excavation, stabilization, pump and treat

→ **Treated Water**

Waste →

→ **Remediated Site**

Destruction and Disposal

Goal: Prevent re-introduction of PFAS into the environment through destruction or containment

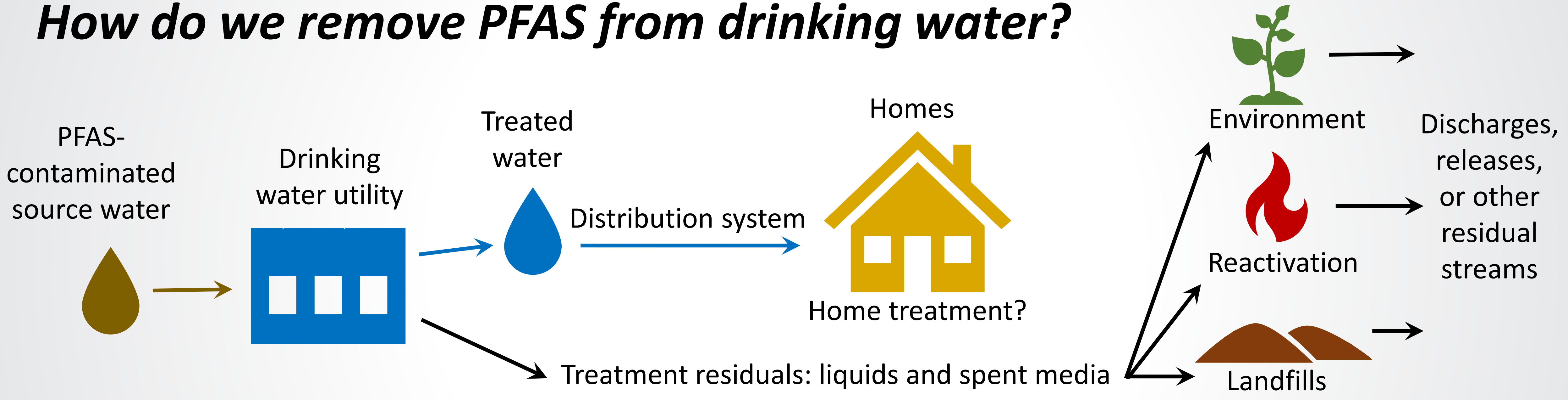
Example Technologies

"Conventional" – Incineration, landfilling, underground injection control, GAC reactivation

"Innovative" – Supercritical water oxidation, pyrolysis/gasification, electrochemical oxidation, mechanochemical destruction

Drinking Water Treatment

How do we remove PFAS from drinking water?



Effective Treatment Technologies for PFAS

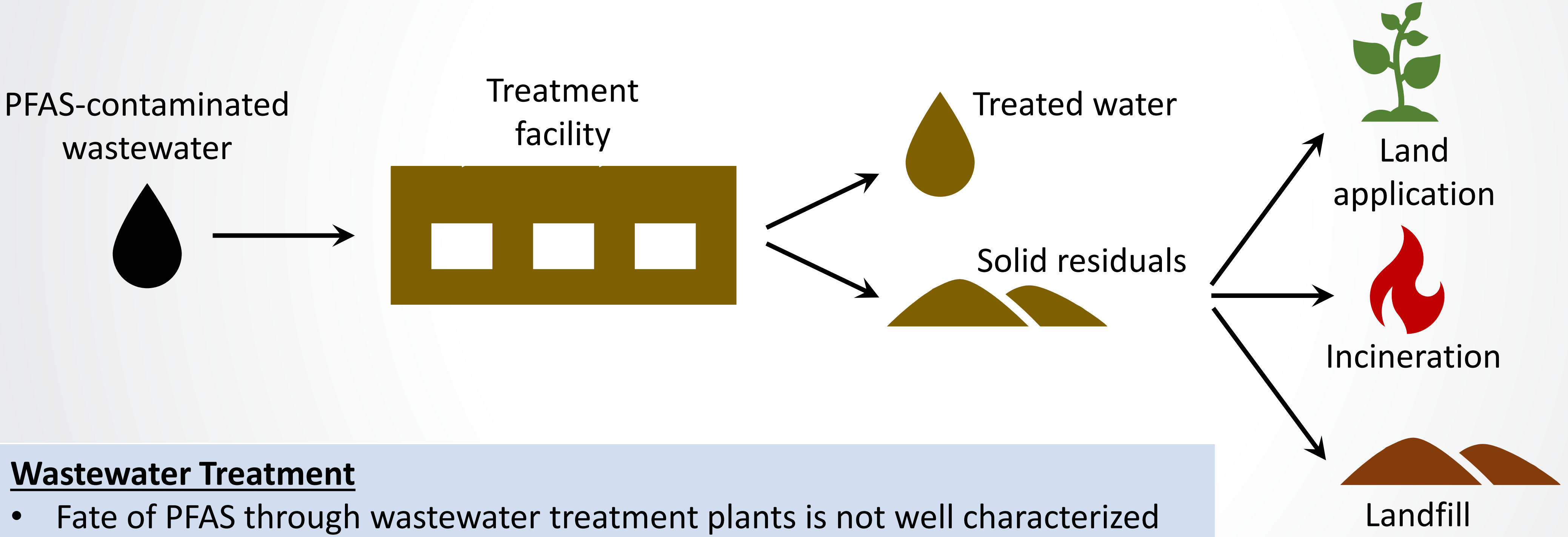
- Anion exchange resin, granular activated carbon (GAC), and membrane separation (RO) are generally effective at removing PFAS
- More effective for long-chain than short-chain PFAS
- Removal efficiencies and cost depend on source water characteristics and water system characteristics

Treatment Residuals

- PFAS found in spent GAC and spent resin
- Spent media can be regenerated, landfilled, or incinerated with unknown releases of PFAS or products of incomplete destruction (PICs)
- There are no known fully destructive treatments (mineralization) for RO concentrate streams

Wastewater Treatment

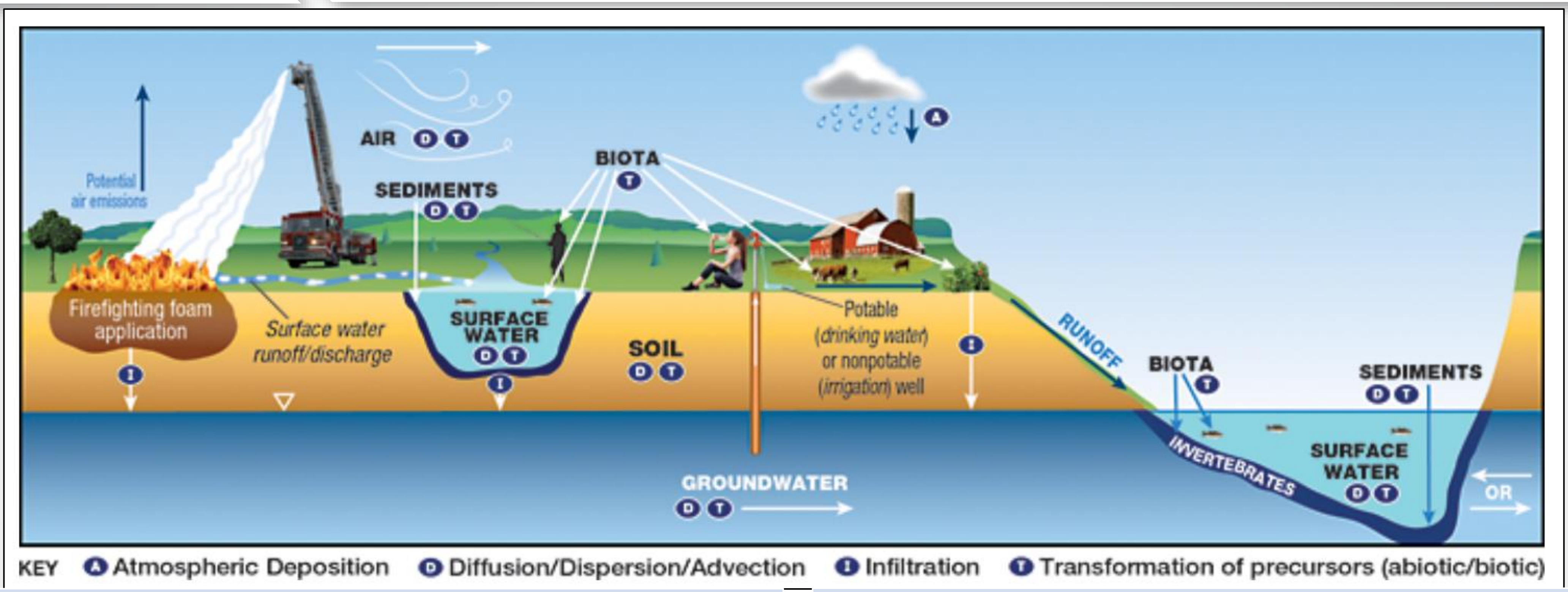
How do we remove PFAS from wastewater?



Wastewater Treatment

- Fate of PFAS through wastewater treatment plants is not well characterized
- PFAS are found in solid residuals and, subsequently, biosolids
- Some management approaches for solid residuals can release PFAS into the environment
- Pretreatment practices are likely more effective that central treatment

Site Characterization and Remediation



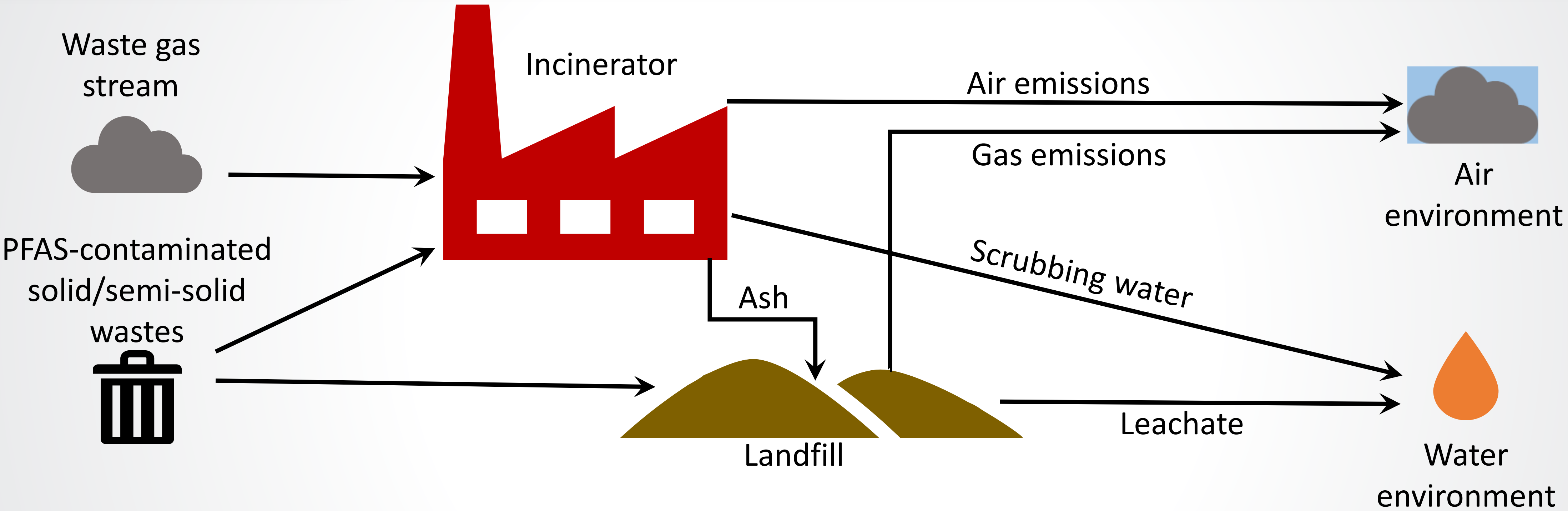
Site Characterization

- Fate of PFAS through natural systems is not well characterized
- PFAS are found in air, soils, plants, biota, water, and sediments

Remediation

- All management approaches have residual streams that potentially re-release PFAS into the environment
- Managing at the source is optimal economically and environmentally

Destruction and Disposal



PFAS Waste Destruction and Disposal

- Data gap in the understanding of PFAS behavior during end-of-life management and ultimate disposal
- Some management approaches may release PFAS into the environment
- Evaluate efficacy of disposal/destruction technologies for solid and semi-solid wastes (e.g., landfilling, incineration, in situ stabilization) to manage end-of-life disposal
- Evaluate the treatment of waste gas streams and the emissions from those thermal oxidizers
- Evaluate possibility of products of incomplete combustion/destruction

Summary

- ORD will continue to develop data on the treatment of PFAS for various medias
  - Drinking water
  - Remediation medias (water, soils, etc.)
  - Waste streams (wastewater, solid wastes, etc.)
  - Residual streams from above treatments (spent media, regeneration solutions, concentrates, ash, biosludge/biosolids, etc.)
- Results will be used to determine the most cost effective and sustainable method of PFAS mitigation while avoiding unintended consequences