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EPA Tools and Resources Webinar
PFAS Strategic Roadmap: Research Tools and Resources

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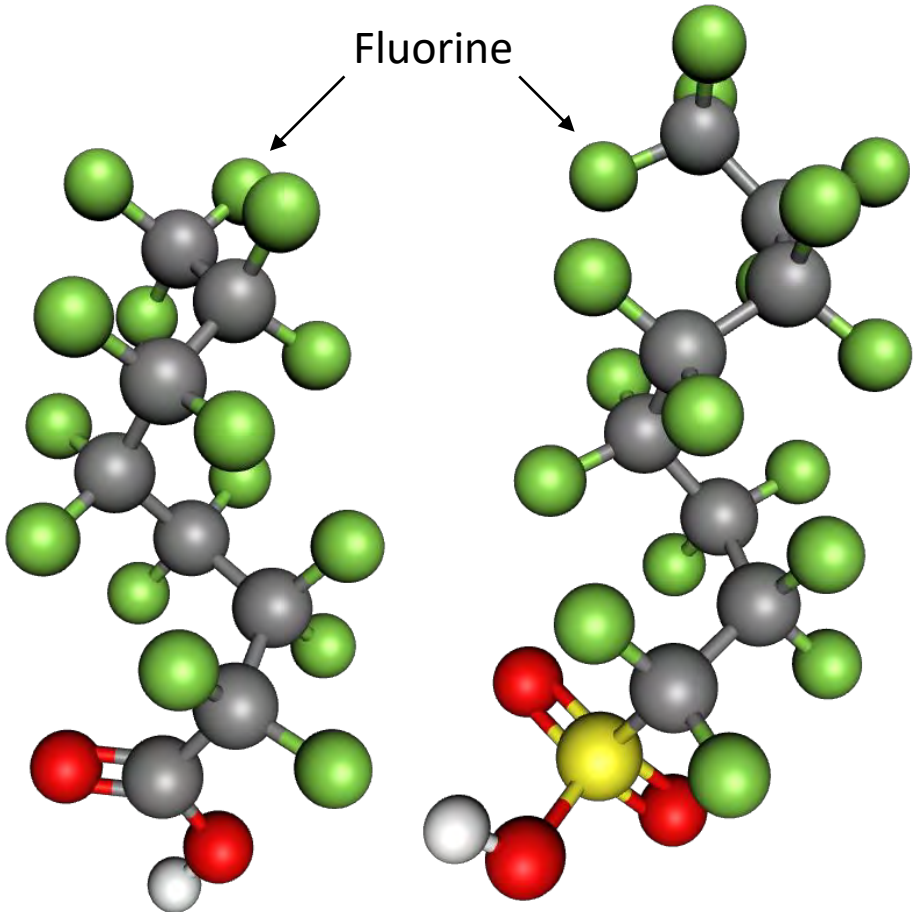
Per- and Polyfluoroalkyl Substances (PFAS)



Perfluorooctanoic acid (PFOA)

Perfluorooctanesulfonic acid (PFOS)

A large class of synthetic chemicals

- Features chains of carbon atoms surrounded by fluorine atoms
- Wide variety of chemical structures, from single molecules to polymers

Used in homes, businesses and industry for decades

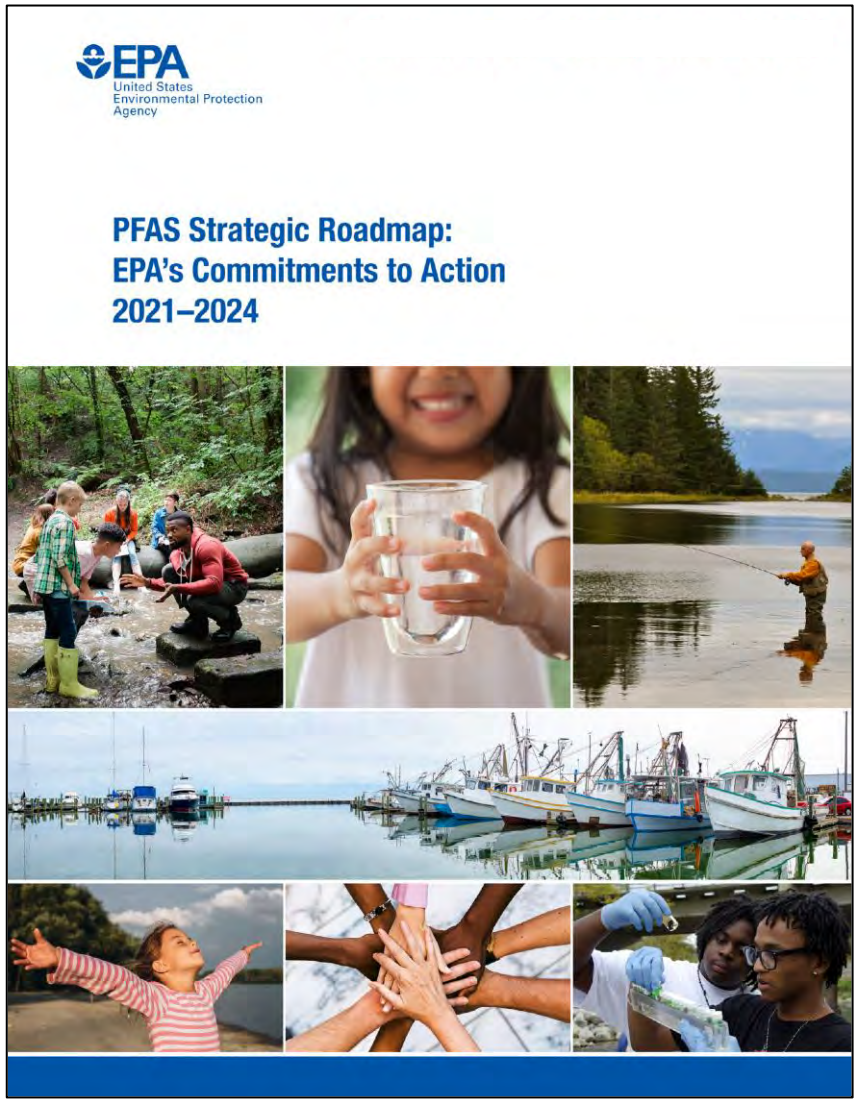
- Have been detected in soil, water and air samples
- Most people have been exposed to PFAS

Some PFAS are known to be PBT

- P = Persistent in the environment
- B = Bioaccumulative in organisms
- T = Toxic at relatively low levels (ppt)

PFAS Strategic Roadmap

- Released October 2021
- Presents EPA's whole-of-agency approach to protect public health and the environment from the impacts of PFAS
- Focused on three goals:
  - Research
  - Restrict
  - Remediate
- Available here



PFAS Research and Development

EPA is rapidly expanding the scientific foundation for understanding and addressing risk from PFAS

- EPA's Office of Research and Development (ORD) provides the best available environmental science and technology to inform and support human health and environmental decision making
- ORD is conducting scientific research to:
  - Develop methods and approaches for measuring PFAS in the environment
  - Advance the science to assess human health and environmental risks from PFAS
  - Evaluate and develop technologies for reducing PFAS in the environment

ORD collaborates with other federal agencies, states, tribes, utilities and academic institutions on PFAS research and technical assistance activities

Human Health Toxicity Research

Most PFAS have limited or no toxicity data to inform hazard assessment

CURATE EXISTING DATA

- Hazard
- Dose-response
- Chemical and physical properties

- CompTox Chemistry Dashboard – >10,000 PFAS
- HERO Database – >200,000 PFAS references
- Systematic evidence maps for ~150 PFAS

GENERATE NEW DATA

- ✓ Created chemical library of 480 PFAS samples
- ✓ Selected 150 PFAS to represent structural diversity of PFAS
- Testing PFAS using a battery of toxicological and toxicokinetic New Approach Methods (NAMs)
- Testing using traditional *in vivo* approaches

- Group PFAS into a smaller number of categories based on structural, toxicological and toxicokinetic similarity
- Prioritize PFAS for further toxicity testing and assessment

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PFAS Systematic Evidence Maps

Systematic Evidence Maps (SEMs)

What are Systematic Evidence Maps?

- Pre-decisional analyses that use systematic review methods to compile and summarize the available evidence
- Front end compilation of evidence does not include hazard ID or toxicity values
- Publishable in journals

How are they used?

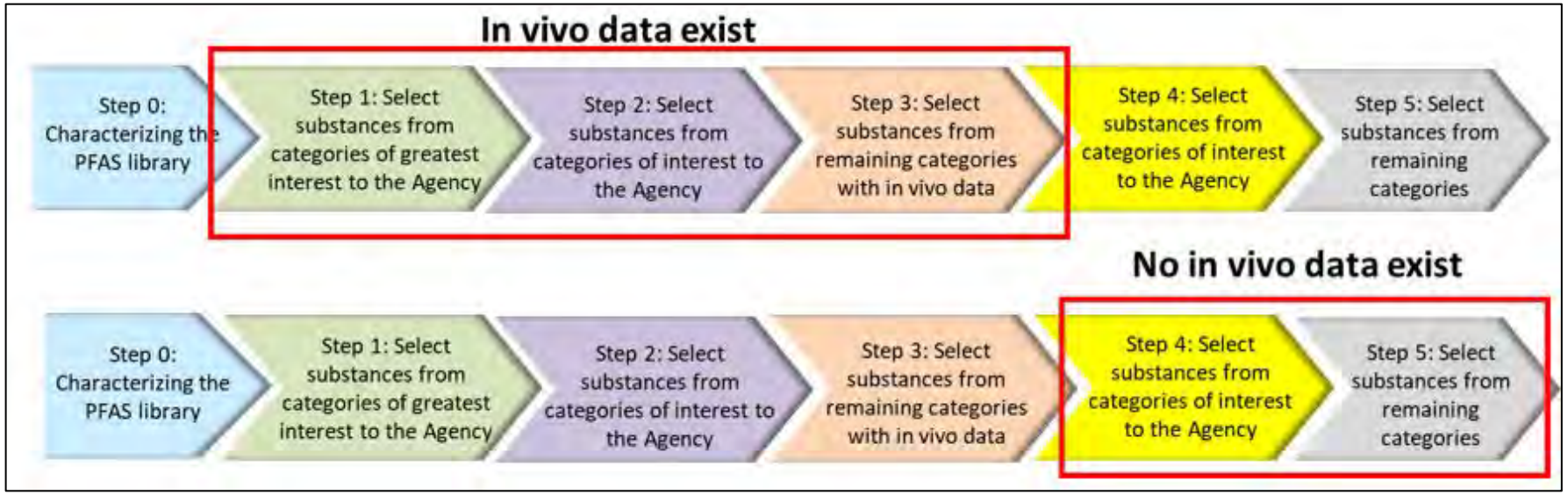
- *Prioritization and Scoping*: determine the extent to which the evidence supports an assessment, and of what type
- *Problem Formulation*: characterize the extent and nature of the evidence and reveal knowledge gaps/research needs
- *Updating*: rapidly characterize new evidence to update an assessment or decide whether an update is warranted

How are they developed?

- Use of standardized template format reduces time to prepare and review
- Tailorable (may include aspects of study evaluation or identify studies with characteristics for dose-response)
- Generally, ≤1 year to develop depending on the evidence base and available resources

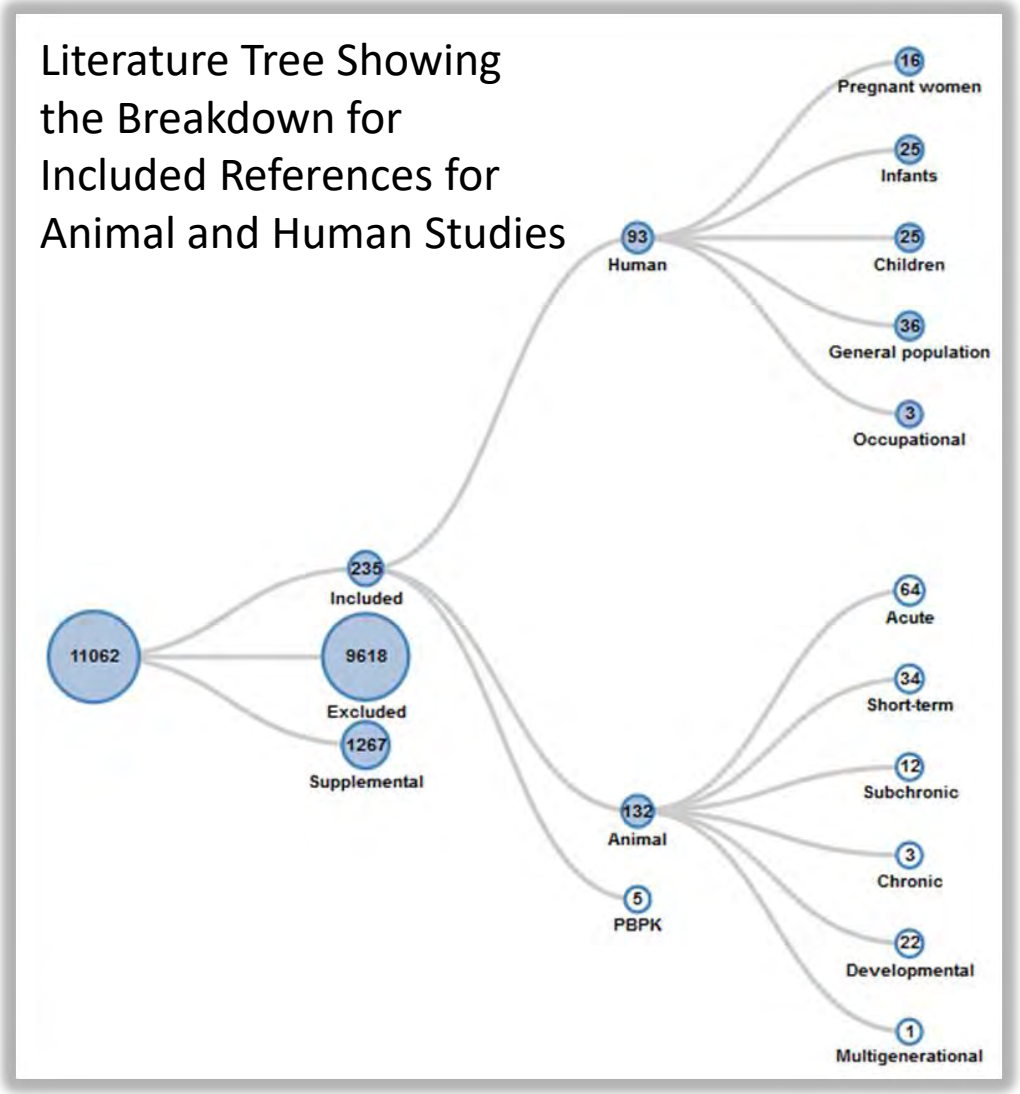
PFAS Evidence Maps

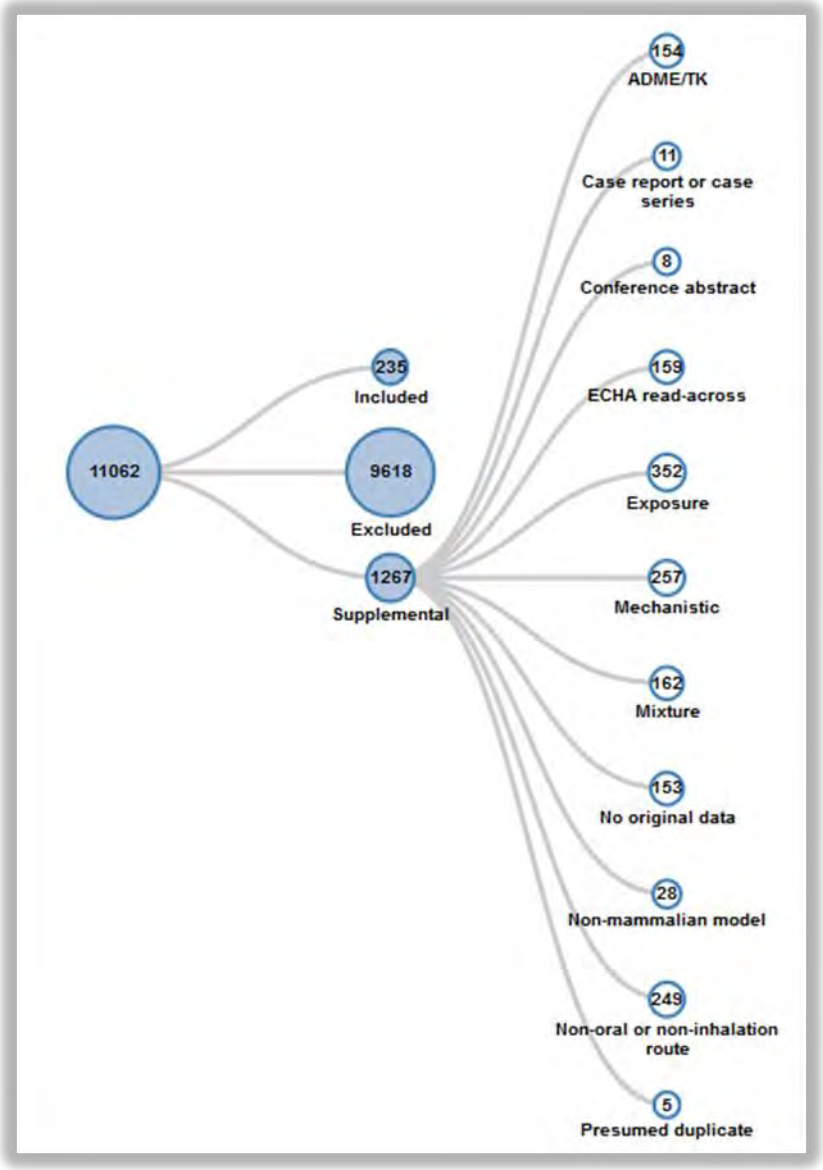
- EPA is conducting tiered toxicity testing of a structurally diverse landscape of PFAS
  - Initial effort from ORD (in 2019) identified 150 PFAS chemicals for in vitro toxicity and toxicokinetic assay evaluation, testing a range of PFAS structures, chemistries, and with environmental relevance (first 75 chemicals described in publication by Patlewicz et al. 2019)
- Existing *in vivo* toxicity data can be used to inform the toxicity of groups of PFAS using approaches like read-across
- PFAS "150" SEM conducted to help identify in vivo data and to identify data gaps



PFAS 150 SEM Screening Results

Literature Tree Showing the Breakdown for Included References for Animal and Human Studies

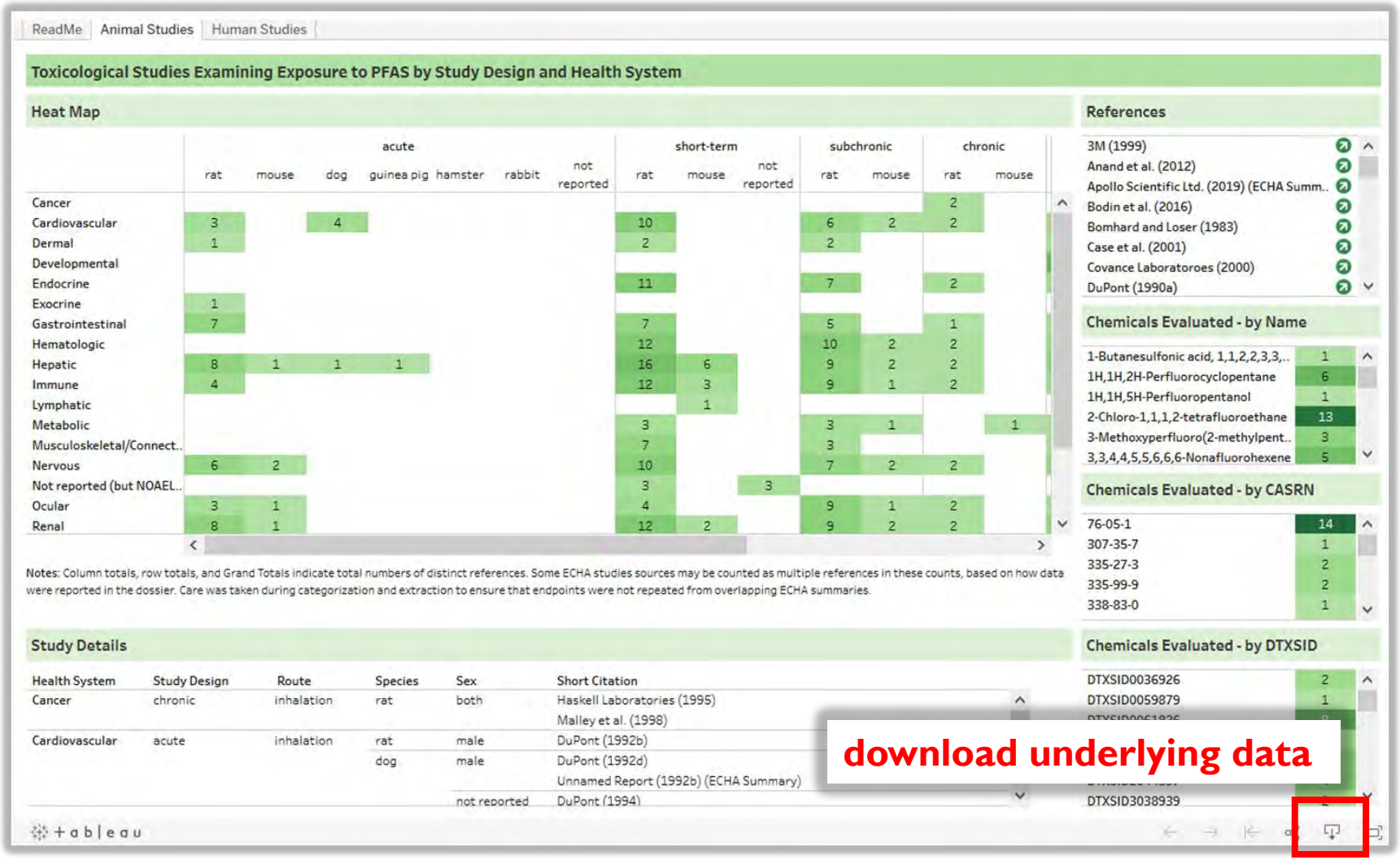




https://hawc.epa.gov/summary/assessment/100500085/visuals/

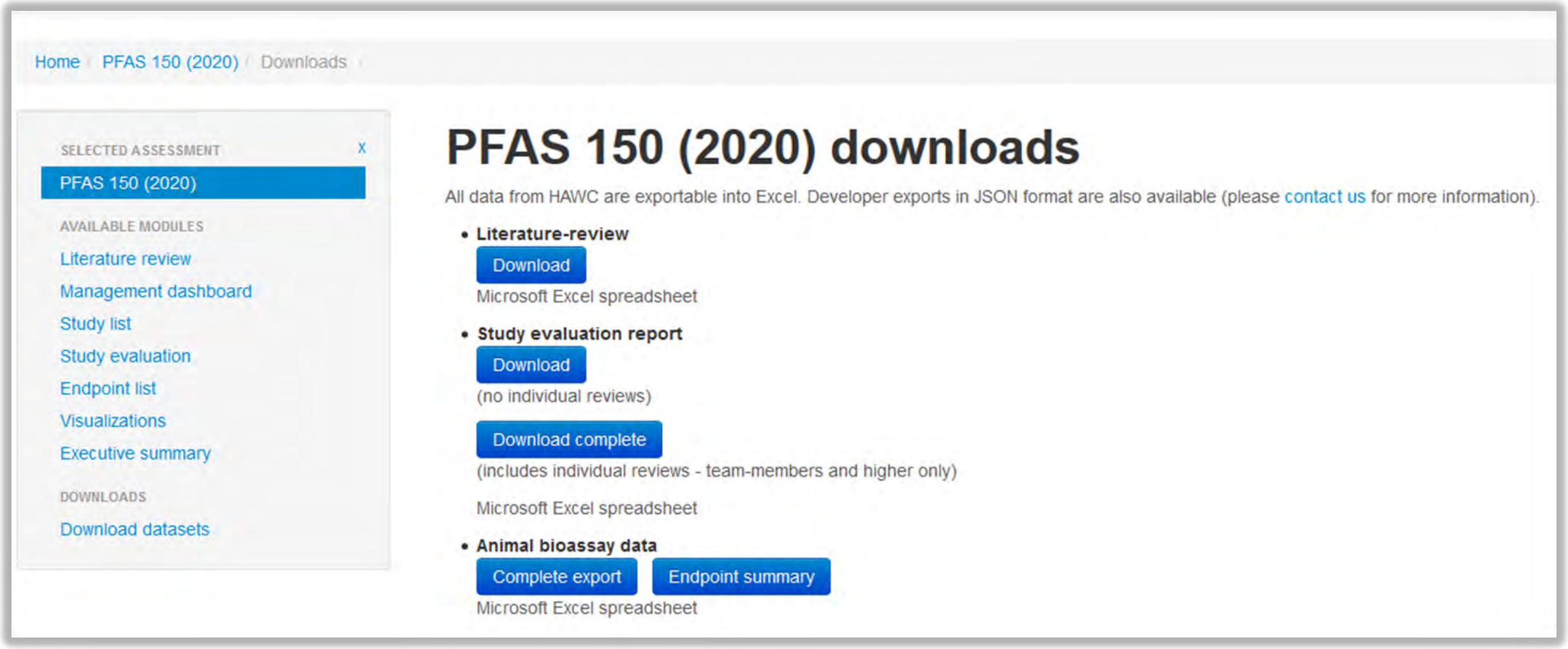
Example PFAS 150 SEM Literature Inventory: Animal Studies

- ~35 PFAS
- ~130 studies
- Sort by chemical (name, DTXID, CASRN), study design, health system



https://hawc.epa.gov/summary/visual/assessment/100500085/Figure-6-Survey-of-animal-studies/

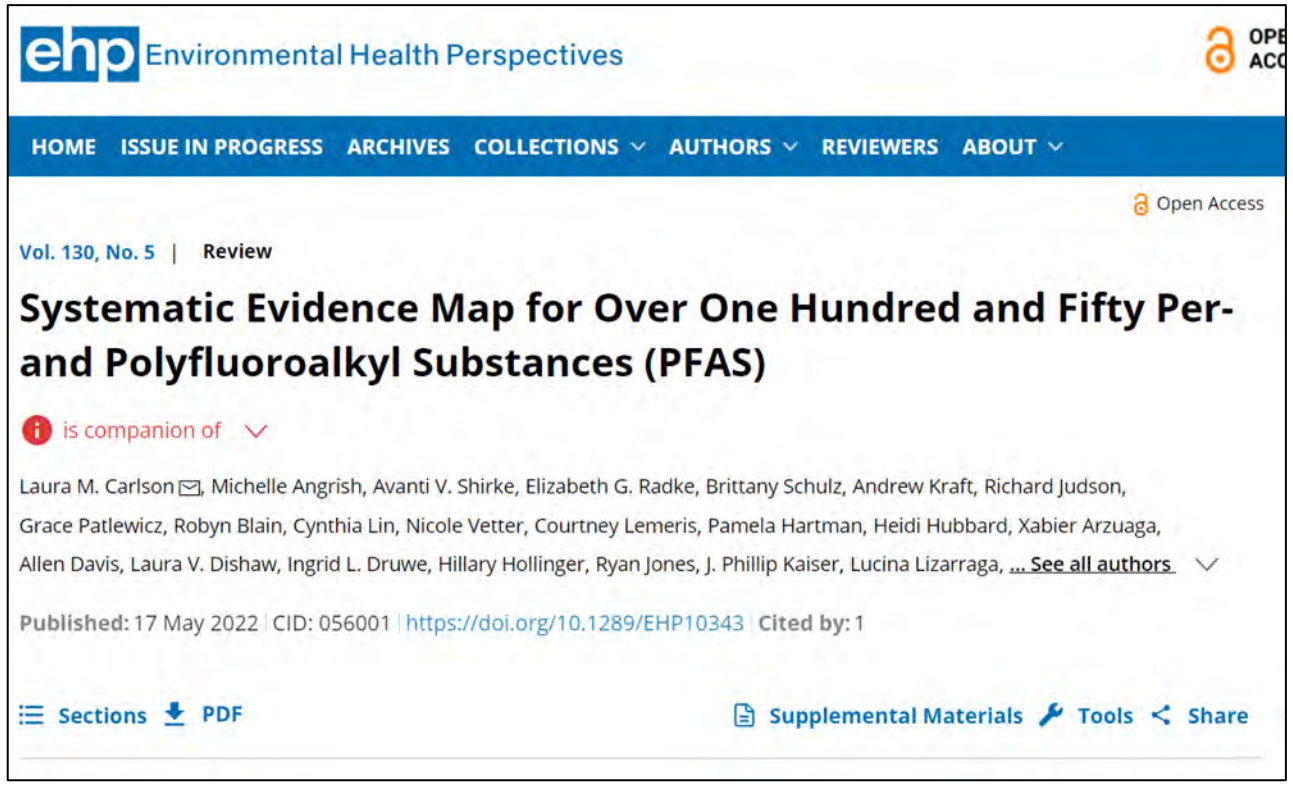
Download Data Sets



Findings to Date

- Many PFAS are data poor
  - **PFAS 150:** 136 animal studies for 35 PFAS, 166 human studies for 11 PFAS
  - **PFAS 430:** 341 unique chemicals searched that were not included in prior search; 142 had at least one human or animal study
  - **PFAS Universe:** 9,266 PFAS chemicals were searched; 416 have records
- Data extraction has been extended to shorter-term studies (<1 month)
- When a specific PFAS is identified as of interest, additional higher level of effort steps are taken to identify evidence (i.e., availability of CBI studies)
- Very few inhalation toxicity studies available
  - ORD is exploring approaches for extrapolating from oral administration studies

More Information Available



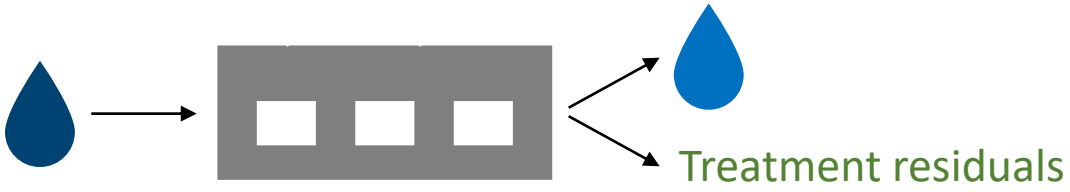
- For more information, see our first PFAS evidence map publication Carlson et al. (2022) *Environmental Health Perspectives* 130:5 https://doi.org/10.1289/EHP10343
- Download datasets in HAWC: https://hawcprd.epa.gov/assessment/100500085/downloads/
- Additional PFAS evidence maps for expanded groups of chemicals are under development

SEM Demonstration

Risk Management Research

Water Treatment

Goal: Remove or reduce PFAS in drinking water and wastewater

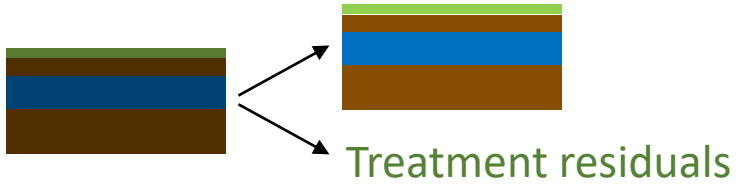


Recent Accomplishments

- Annual update to EPA's Drinking Water Treatability Database
- Modeling PFAS removal using GAC for full-scale system design (2022)

Site Remediation

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

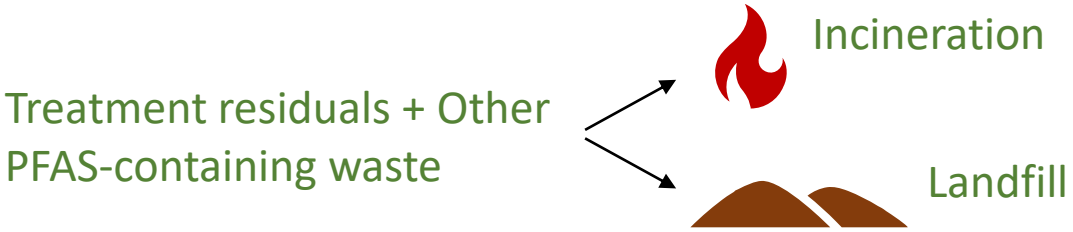


Recent Accomplishments

- Remediation and mineralization processes for PFAS in water: A review (2021)
- Investigation of an immobilization process for PFAS-contaminated soils (2021)

Destruction and Disposal

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



Recent Accomplishments

- PFAS Thermal Treatment Database (2022)
- Developing innovative treatment technologies for PFAS-containing wastes (2022)

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PFAS Thermal Treatment (PFASTT) Database

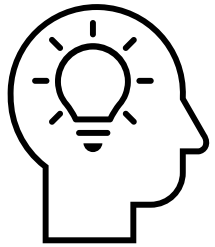
Introduction

- PFAS
  - No agency-wide definition
    - Can’t be too broad (will include fluorinated pharmaceuticals and agrichemicals)
    - Can’t be too restrictive (will exclude emerging classes of polyfluorinated species)
- Thermal treatment
  - Any transformative technique in which elevated temperature is the primary reaction driver
    - Examples include incineration, pyrolysis

Drinking Water Treatability Database

- https://tdb.epa.gov/tdb/home (or Google “epa tdb”)
- Data from thousands of references on 35 treatment processes and 123 contaminants (including 37 PFAS)
- Searchable by contaminant or treatment type

- Success! Let’s make one for thermal treatment of PFAS!



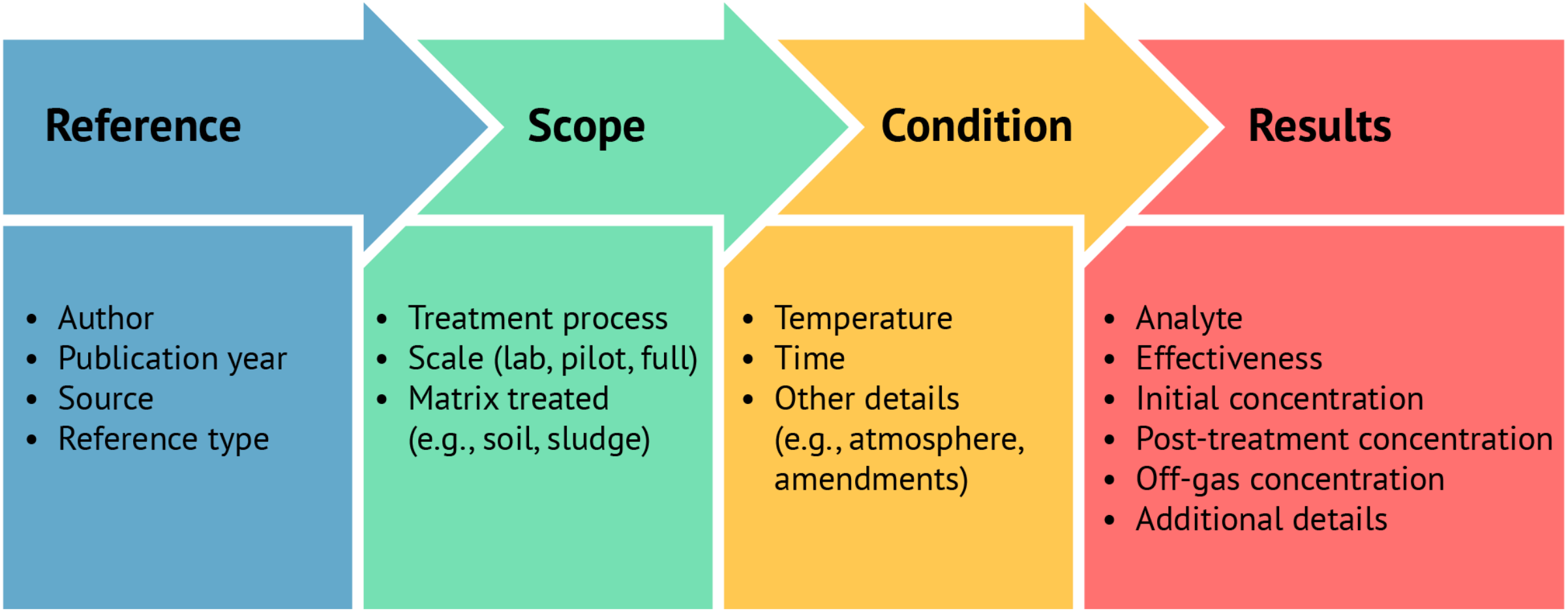
Thermal Treatment Literature Review

- Conducted Winter 2020 – Spring 2021
- Identified 49 data sources:
  - 17 review papers
  - 32 primary data sources
  - Majority are peer-reviewed journal articles
- Other EPA literature surveys added up to 52 additional sources
- Currently >2,000 ‘datapoints’

Scope of Review

- Thermal processes including, but not limited to:
  - Incineration, calcining, gasification, hydrothermal, indirect thermal desorption, pyrolysis, smoldering, GAC reactivation
- Excludes non-thermal/low temperature processes:
  - Persulfate, plasma, electrochemical, photolysis

Data Structure



Potential Uses

- Partners inside and outside the agency will find use for PFASTT
  - Searchable resource to view state of the science
  - Reveals data gaps
  - Inform best practices for full-scale thermal treatment
  - State decision-making on regulation

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PFASTT Demonstration

https://pfastt.epa.gov/

Other PFAS Tools and Resources

- Drinking Water Treatability Database – 183 references covering 54 PFAS and 20 treatment processes
- ECOTOX Knowledgebase – 1,303 references covering 173 PFAS and 704 aquatic and terrestrial species
- CompTox Chemicals Dashboard – chemical and physical properties, toxicity and exposure information for PFAS
- PFAS Analytical Method Development – EPA methods for measuring PFAS in the environment
- EPA's PFAS Website – Information about PFAS and EPA's actions to address PFAS (includes links to other resources)

Contacts

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Q&A from August EPA Tools and Resources Webinar

EPA PFAS Strategic Roadmap: Research Tools and Resources

General Q's and A's

1. **Are there any evaluations of open burning or detonation of waste explosives containing PFAS?**
   A: In FY22, the Department of Defense's Strategic Environmental Research and Development Program (SERDP) issued a "statement of need" to characterize and quantify products from thermal degradation of polymeric PFAS in munitions. Additional information about the statement of need and the selected project is available at Characterizing Products from Thermal Degradation of Polymeric PFAS in Munitions.

2. **Is electro-chemical oxidation (i.e., de-fluoro) accepted by EPA to destruct PFAS?**
   A: Electrochemical oxidation is one of four destruction technologies identified by EPA's PFAS Innovative Treatment Team as a promising technology for destroying PFAS. Further research, however, is needed to fully evaluate the effectiveness of this technology for PFAS destruction.

3. **How can we track EPA progress on assessing the toxicology? What do you suggest?**
   A: Results from EPA research on PFAS toxicity are published in the scientific literature as soon as possible. To search for the latest results, please visit the Agency's Science Inventory—a public, searchable database of published research: EPA Science Inventory.

4. **Can you recommend where to look for information on water treatment technologies?**
   A: EPA's Drinking Water Treatability Database provides referenced information on the control of contaminants in drinking water. The database currently includes information for 37 PFAS.

5. **How effective do you think Combustion Ion Chromatography (CIC) analysis would be for initial investigation for PFAS?**
   A: EPA has developed a draft method for screening organofluorine compounds in wastewater using CIC. The draft method is available at Draft Method 1621 for Adsorbable Organic Fluorine.

6. **Will EPA be funding water treatment research in the future?**
   A: EPA funds water research grants to develop and support the science and tools necessary to develop sustainable solutions to 21st Century water resource problems, ensuring water quality and availability to protect human and ecosystem health. Current research funding opportunities can be found at Research Funding Opportunities.

7. **Is there a minimum temperature to effectively destroy PFAS? On average approximately how much PFAS are released by incinerators? Are they in the smoke or the fly ash?**
   A: As described in EPA's 2020 Interim Guidance on Destroying and Disposing of Certain PFAS and PFAS-Containing Materials That Are Not Consumer Products, these are important scientific questions associated with thermal treatment of PFAS. EPA and others are conducting research to help answer these questions.

8. **Is US EPA looking into expanding testing beyond 537.1M for consumer products, such as total organic fluorine (TOF) and total oxidizable precursors (TOP)? Multiple PFAS are being found in plastics, such as synthetic turf, even within a single product.**
   A: EPA Method 537.1 is for the determination of certain PFAS in drinking water. The Agency is not currently developing methods for identifying and quantifying PFAS in consumer products.

9. **What is the status of developing an analytical test method for total organic fluorine?**
   A: In April, EPA released draft Method 1621, "Screening Method for the Determination of Adsorbable Organic Fluorine in Aqueous Matrices by Combustion Ion Chromatography," which is a single-laboratory validated method to screen for organofluorine compounds in wastewater. The draft method is undergoing multi-laboratory validation.

10. **Where are PFAS found in the environment?**
    A: PFAS can be present in water, soil, air, and food, as well as in materials found in homes and workplaces. More information is available at Our Current Understanding of the Human Health and Environmental Risks of PFAS.

11. **Have you characterized the breakdown/deterioration rates for PFAS?**
    A: EPA is conducting research to help understand the environmental fate and transport of PFAS, including their transformation products. Results from these research efforts are published in the scientific literature as soon as possible. To search for the latest results, please visit the Agency's Science Inventory—a public, searchable database of published research: EPA Science Inventory.

Systematic Evidence Map (SEM) Q's and A's

12. **What type of animals were assessed in the animal studies?**
    A: Information on the inclusion criteria for animal studies can be found in *Systematic Evidence Map for Over One Hundred and Fifty Per- and Polyfluoroalkyl Substances (PFAS) | Science Inventory | US EPA*). The species assessed can be found in the Tableau visual, available at PFAS-150 Evidence Map Visualizations by literature inventory.

13. **Will fish be included? Does there need to be a request for that to occur? Who is the EPA Office of Research and Development group?**
    A: Fish were not included as a focus of this SEM, as we were focused on the human health effects of PFAS. However, some fish studies may be tagged as "Supplemental Material- non-mammalian model systems," though that tag should not be considered a comprehensive inventory of all fish studies on PFAS. EPA's ECOTOX Knowledgebase group is working on a systematic evidence map for terrestrial and aquatic species.

14. **Maine is doing research on crop uptake. Will a SEM be added for that?**
    A: Our SEM utilized systematic review approaches to compile and summarize the human and experimental animal evidence for a subset of approximately 150 PFAS that were selected by EPA for high throughput toxicity and toxicokinetic testing. Our effort focused on collecting information directly related to the question, "What are the human health effects of PFAS exposure?" As such, we focused on studies that reported health outcomes. Because research on crop uptake does not provide data on health outcomes, it was not used to inform our evidence maps and research question.

15. **Does the thermal treatment database include conclusions regarding the effectiveness or data gaps?**
    A: The PFASTT includes destruction efficiencies as they are reported in the references but does not include EPA conclusions regarding the effectiveness of any technologies included in the database. While the database does not include a discussion of data gaps, the database could be used to identify data gaps.

16. **Will EPA release information on the effectiveness of thermal treatment techniques that seem particularly promising? If so, what's the timeline?**
    A: Results from Agency research on PFAS destruction technologies will be published in the scientific literature as soon as possible. To search for the latest results, please visit the Agency's Science Inventory—a public, searchable database of published research: EPA Science Inventory.

17. **Does landfill have the similar database? Are there similar databases for other PFAS destruction methods besides thermal methods? Will the database be expanded for non-thermal destructive technologies?**
    A: No, EPA has not currently developed similar databases for other destruction or disposal methods. EPA is considering expanding the scope of the PFASTT with future updates.

18. **Will the treatment database be linked with CLU-IN resource managed by EPA's Office of Land and Emergency Management?**
    A: There are no immediate plans to connect the PFASTT with the CLU-IN resource. We appreciate the suggestion and will consider it in the future.

19. **Do any of the thermal treatment studies include stack testing as well as information on temperature and residence times, etc.?**
    A: Temperatures and residence times are shown in the database for all references that include them. There is also a column that shows whether gas emissions were sampled.

20. **On PFASTT, is supercritical water oxidation (SCWO) considered hydrothermal treatment?**
    A: Yes, available references on SCWO are currently included in the database.

21. **The thermal treatment information is useful, but since carbon and resin are the most common treatment technologies, was there consideration to a similar database?**
    A: EPA's Drinking Water Treatability Database provides referenced information on the control of contaminants in drinking water. This database includes information on the use of granular activated carbon and ion exchange resins for treatment of certain PFAS in drinking water.

22. **Is there a way to filter for PFAS treatment methods that can remove PFAS to the interim health advisory level EPA established? Additionally, is there a way to filter for PFAS analytical methods that can detect PFAS at the interim health advisory level EPA established?**
    A: The health advisories released by EPA in June 2022 provide technical information on specific PFAS that can cause human health effects and are known or anticipated to occur in drinking water. The health advisories describe information about health effects, analytical methodologies, and treatment technologies for those PFAS in drinking water. The PFASTT provides data on the treatability of PFAS via various thermal processes and does not provide data on PFAS in drinking water.

23. **How do destruction efficiencies (associated with thermal treatment) for specific PFAS compounds reflect the potential creation of "new" PFAS compounds without analytical standards (not quantified or identified)?**
    A: By itself, destruction efficiency of a single compound does not reflect the possibility of formation of products of incomplete combustion (PICs). The PFASTT database currently records whether non-targeted analysis of PICs was attempted by included references, but most references do not currently include this analysis.

24. **Is there a plan to add other treatment methods in the database?**
    A: Yes, EPA is currently considering expanding the scope of included technologies.

25. **What are the typical products from the thermal destruction of PFAS?**
    A: Hydrofluoric acid is the most common product of complete PFAS destruction, but short-chain PFAS can also be formed during thermal treatment of PFAS.

26. **Does the PFASTT include the 'grey literature'?**
    A: Yes, in addition to commercial and academic publications, the PFASTT database also includes government reports.

27. **Does the thermal database note the effectiveness of each treatment technology/process for PFAS? For example, does it note to what level each treatment removes PFAS from water, air, etc.?**
    A: Yes, the database contains all information provided by each reference, including compounds treated, concentrations before/after treatment, and sample type (e.g., water, sludge, GAC).