Geosyntec consultants

CONSIDERATIONS FOR DISPOSAL OF PFAS-IMPACTED MATERIAL

Jeff Tracy, P.G. (WI)

April 10, 2024

- Introduction
- State of Regulations
- Type of PFAS Waste
- Management of PFAS Waste
- Other Considerations
- Questions

INTRODUCTION

Jeff Tracy, PG

- 32 Years of Experience
- Complex soil and groundwater remediation
- PFAS investigation
- PFAS groundwater remedy construction
- Experience implementing Voluntary, State and CERCLA/Superfund remedies

GEOSYNTEC'S PFAS PRACTICE

- 402 PFAS projects in the past 3 years
- PFAS points of contact in branch
- Federal, industrial and municipal clients

www.geosyntec.com/pfas

STATE OF REGULATIONS

DRINKING WATER

- Maximum Contaminant Limits (MCLs)
- MCL Goals (MCLGs)
- Hazard Index
- Final Rule announced on 4/10/2024.

RCRA

- PFOA and PFOS, plus precursors
- "Categories of PFAS"
- Proposed Rule in Federal Register Feb. 2024
- Nine PFAS as COCs
- Expand definition of "hazardous waste"

TSCA/TRI

TSCA Reporting

- Final Rule
- Manufactures and importers must report PFAS

TRI Reporting

- Requires reporting of 196 PFAS compounds
- Not subject to *de minimis* exemption

OTHER

Effluent Limitations Guidelines

- National, industry-specific wastewater regulations
- Expands study of PFAS influents to WWTPs

AFFF Alternatives

- Department of Defense approved alternative to AFFF

Not discussed later.

DRINKING WATER

Final Rule Announced by USEPA on April 10, 2024

Compound	Final MCLG	Final MCL (enforceable levels)
PFOA	Zero	4.0 parts per trillion (ppt) (also expressed as ng/L)
PFOS	Zero	4.0 ppt
PFHxS	10 ppt	10 ppt
PFNA	10 ppt	10 ppt
HFPO-DA (commonly known as GenX Chemicals)	10 ppt	10 ppt
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) Hazard Index	1 (unitless) Hazard Index

MCL = Maximum contaminant level MCLG = MCL Goal
ppt = parts per trillion or nanogram per liter (ng/L)

RCRA/CERCLA

RCRA

- Initiated rulemaking to designate PFOA, PFOS, PFBS, and GenX (HFPO-DA) as hazardous constituents (October 2021)
- Initiated rulemaking to "clarify that emerging contaminants such as PFAS can be cleaned up through the RCRA corrective action process" (October 2021)
- Published a proposed rule to designate PFBA, PFHxA, PFOA, PFNA, PFDA, PFBS, PFHxS, PFOS, and GenX as hazardous constituents (February 2024)
  - Makes hazardous constituents subject to corrective action at RCRA-permitted facilities
- Published a proposed rule to "…modify the definition of hazardous waste as it applies to cleanups at permitted hazardous waste facilities"

TSCA, TRI REPORTING, OTHERS

TSCA Reporting - Manufacturers and importers to report PFAS use

- Importers include manufacturers that imported materials
- Must report certain PFAS categories that were manufactured or imported between January 1, 2011 and December 31, 2022.
- Includes assessing:
  - Enterprise wide
  - Upstream supply chain
  - Downstream end-users
- Reporting to be completed 18 months after rule is final (final rule November 13, 2023)

TRI Reporting

- **TRI Reporting:** Requires TRI reporting of 196 PFAS compounds, which are not subject to de minimis exemption.

Effluent Limitations Guidelines (ELGs) – Plan 15

- Final Rule – ELGs: Requires EPA to develop national industry-specific wastewater regulations based on demonstrated wastewater treatment technologies.
- Revised ELGs for landfills and textile manufacturers
- Expands the study of PFAS influents to POTWs.

AFFF Alternative

- Department of Defense approved an alternative to AFFF for firefighting purposes

Geosyntec consultants

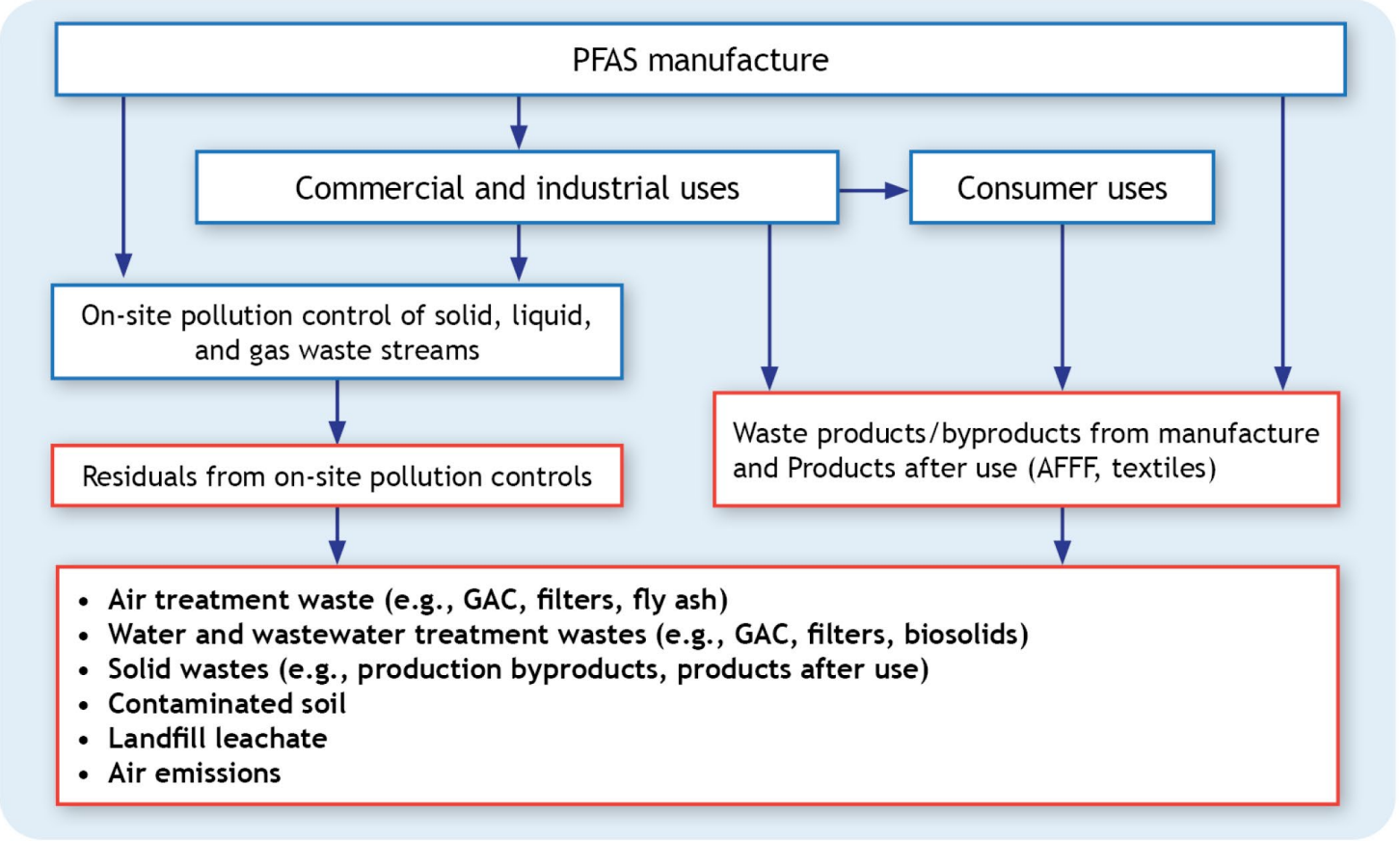
TYPES OF PFAS WASTE

TYPES OF PFAS WASTE

PFAS Waste Generation – Items highlighted in red boxes generally require management disposal or destruction and may be:

- Solids
- Liquids
- Gases

There are other types of PFAS waste; however, they also may be managed as discussed later.



Source: *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024).* USEPA. Interim Guidance for Public Comment. April 8, 2024

PHASES OF PFAS WASTE

Destruction and Disposal Technology, by Physical Phase of Materials	Examples of PFAS-Containing Materials (within the Scope of the FY 2020 NDAA) That Could Be Managed Using These Technologies

Solid phase:
Landfill disposal
Thermal treatment
	• Drinking water, groundwater, and wastewater treatment residuals
	  ○ Biosolids/sewage sludge
	  ○ Spent GAC
	  ○ Ion exchange resins
	• Air waste stream treatment residuals
	  ○ Spent GAC
	  ○ Fly ash
	• Contaminated soil
	• End-of-life products (e.g., textiles)
	• Solidified liquid wastes

Liquid phase: Underground injection Thermal treatment	• Sewage sludge (liquid) • Landfill leachate • AFFF (spent or concentrate) • End-of-life products (e.g., spent cleaning solvents) • Pollution control residuals (e.g., concentrates) from PFAS production and use
Gas phase: Thermal treatment	• Landfill gas (LFG) • Emissions from manufacture, use, or destruction of PFAS

Source: *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024).* USEPA. Interim Guidance for Public Comment. April 8, 2024

Geosyntec consultants

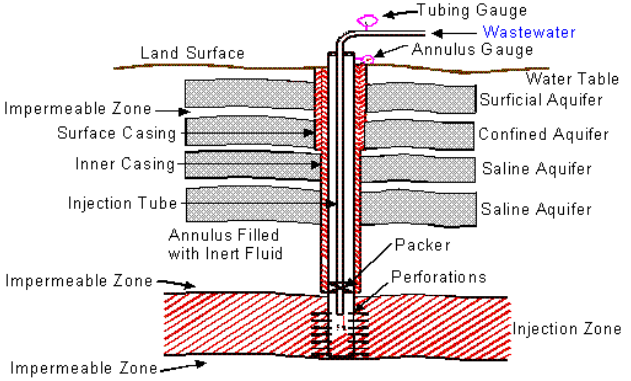
MANAGEMENT OF PFAS WASTE

DISPOSAL OR DESTRUCTION

USEPA Guidance Primarily Focuses on:

- Underground Injection
- Landfilling
- Thermal Treatment

New and innovative technologies are being developed.



UNDERGROUND INJECTION WELLS

Waste Injection Well Types

- Class I Wells
  - Inject waste below the lowest drinking water aquifer
  - Four subcategories:
    - Municipal wastewater
    - Radioactive waste
    - Non-hazardous industrial waste
    - Hazardous waste
- Class IV Wells
  - **BANNED** – were used to inject hazardous or radioactive waste in geologic formations above drinking water aquifers
- Class V Wells
  - Wells not included in other Classes
  - Subtypes:
    - Stormwater drainage wells
    - Septic wells
    - Agricultural drainage wells

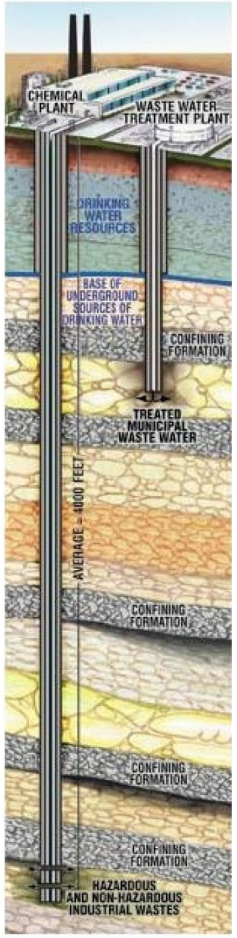


Figure 3-3. Class I wells.

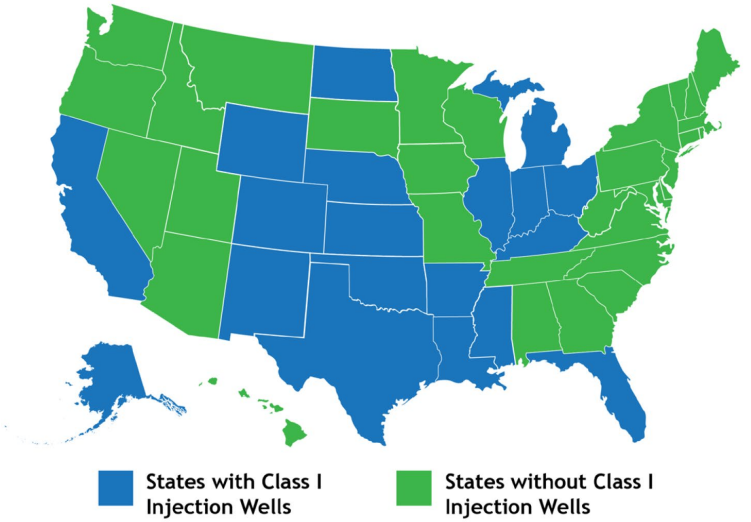


Figure 3-4. States with Class I non-hazardous or hazardous waste injection wells.

Source(s): *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024).* USEPA. Interim Guidance for Public Comment. April 8, 2024

PFAS MANAGEMENT AT LANDFILLS

- New Hampshire requires collection of groundwater samples for PFAS at all lined and unlined landfills that have a groundwater release detection or groundwater management permits
- 91% of the sampled landfills have PFAS detections
- 77.5% of the sampled landfills have PFAS detected over the NHDES Ambient Groundwater Quality Standard
- Other states may follow suit and begin requiring more PFAS sampling at landfills

PFAS MANAGEMENT AT LANDFILLS

- Waste containing PFAS is no longer accepted by many non-RCRA landfills
- Any amount of PFAS puts waste in a special handling category
  - Placement in a hazardous waste landfill or mixed RCRA landfill
  - Incineration
  - On-site reuse (may not be viable due to pending Federal regulations)
- Placement in a non-hazardous waste landfill may depend on client risk tolerance as well as landfill management

PFAS MANAGEMENT – SURVEY QUESTIONS

1. What type of analytical does your company require for waste profiling on PFAS-impacted waste (soil, groundwater)?
    a) We currently only incinerate material. Need SDS of what the material is impacted with. Any analytical helps but nothing specific.
    b) We currently will only evaluate PFAS contaminated waste that are analyzed with Test Method(s) ASTM 537, 537M or 533.
2. What are your threshold concentrations/parameters for accepting PFAS waste (soil, groundwater)?
    a) All PFAS is going for incineration. All concentrations are accepted.
    b) There is no set limit for acceptance of PFAS waste, although wastes contaminated with AFFF are not allowed for disposal. This is a case-by case circumstance based upon many factors including volume of waste, how waste is shipped for disposal as well as concentration of PFAS.
3. What are your biggest concerns for the future with regulation on PFAS and how it will impact your business?
    a) Once regulations in place we will look at additional disposal options based on EPA decision.
    b) The future regulations and how PFAS are classified according to RCRA is the biggest concern.
4. How frequently are you seeing PFAS showing up in waste profiles submitted to your facility(ies)?
    a) Daily.
    b) PFAS wastes account for less than 1% of the total number of industrial wastes submitted for evaluation.
5. Have you had to decline acceptance of waste materials due to presence of PFAS or concerns over potential PFAS?
    a) No.
    b) Yes

LANDFILL TYPES

Landfill Types

- Hazardous Waste
  - Permitted to receive hazardous waste as defined by RCRA
  - PFAS disposed in these landfills
- Municipal Solid Waste (MSW)
  - Permitted to receive non-hazardous waste
  - PFAS may have been historically disposed in these landfills (some MSWs may still accept certain PFAS waste)
- Ash Landfill
  - Generally receives ash from MSW incinerators
  - Typically, low PFAS concentrations
- Industrial Landfill
  - Permitted to receive waste from industrial operations (non-MSW)
  - Likely have PFAS in waste streams
- Construction and Demolition Debris (C&D)
  - Building demolition and debris
  - Likely have PFAS impacts due to presence in building materials

Table 3-2. Required Environmental Controls by Landfill Type

Landfill Type	Federally Regulated Under	Bottom Liner and Leachate Collection System	Gas Collection and Control System	Final Cover
Hazardous waste	RCRA Subtitle C	Yes (double liner or better)	No	Flexible membrane liner (FML) cap
MSW	RCRA Subtitle D 40 CFR part 258 CAA 40 CFR parts 60 and 63	Yes (composite liner or better)	Yes (when regulatory size and emission thresholds are triggered)	FML cap
Ash monofills	RCRA Subtitle D 40 CFR part 257	Yes (composite liner or better)	No	Clay cap
Industrial	RCRA Subtitle D 40 CFR part 257	Varies by state, from no liner requirement to composite liner	No	Varies by state, from no requirements to FML cap
C&D debris	RCRA Subtitle D 40 CFR part 257	Varies by state, from no liner requirement to composite liner	No	Varies by state, from no requirements to FML cap

Source: *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024).* USEPA. Interim Guidance for Public Comment. April 8, 2024

PFAS WASTE IN LANDFILLS

PFAS Types

- PFAS Polymers
  - Stable polymeric PFAS (e.g., Teflon, PTFE)
  - Less likely to migrate in a landfill
  - Relatively stable, abrasion can form microplastics increasing dispersion and bioavailability.
- Soluble PFAS
  - Soluble PFAS and their precursors that degrade to soluble PFAS (PFAAs, such as PFOS, PFOA, GenX, etc.)
  - Migrates to leachate
  - Dispose in landfills with liners
- Volatile PFAS and forms that degrade to volatile PFAS
  - Alcohols such as FTOHs and FASEs
  - May migrate through uncollected or fugitive landfill gases
  - Breakdown of FTOHs may result in soluble PFAS
  - Dispose in landfills with gas extraction and management systems

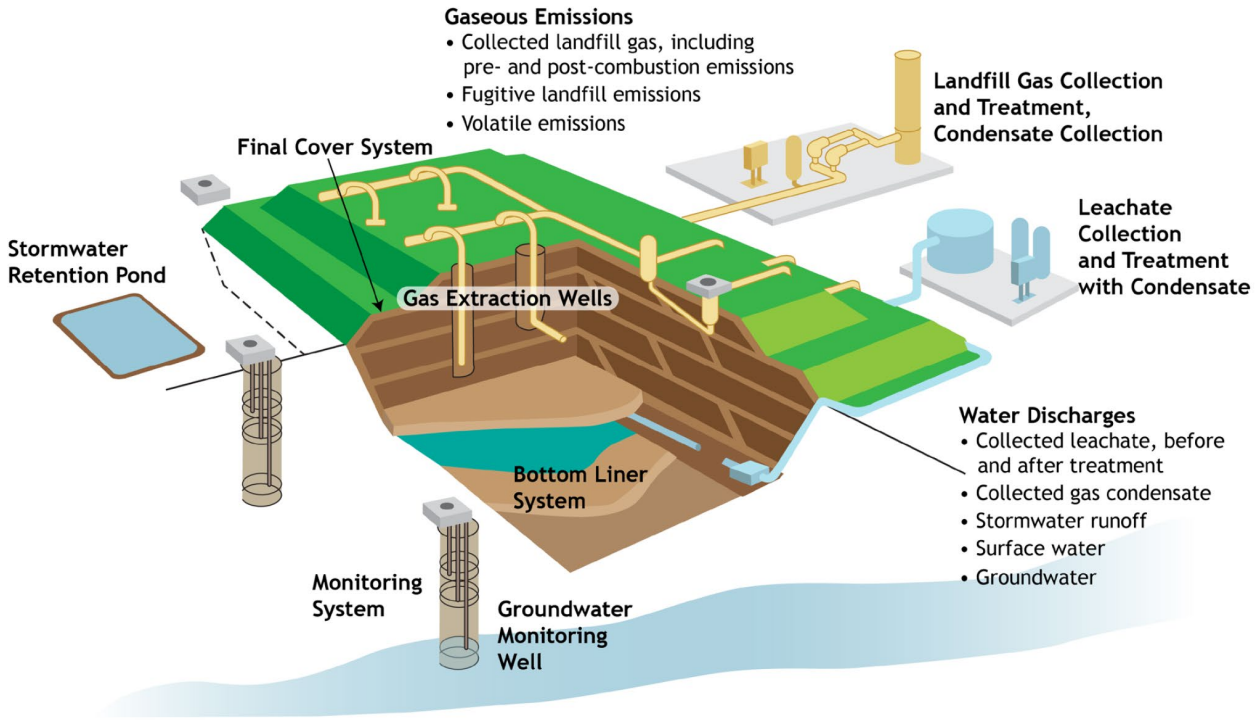


Figure 3-1. Engineered landfill components and potential PFAS release pathways.

Source: *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances – Version 2 (2024).* USEPA. Interim Guidance for Public Comment. April 8, 2024

THERMAL TREATMENT

Thermal Treatment

- PFAS Destruction
  - Requires temperatures greater than 1,400°C to break the C-F bond
  - Thermal treatment may cause Products of Incomplete Combustion (PICs)
    - Complete destruction is not likely achievable due to temperature and mixing limitations
    - Thermal treatment units may be able to reach temperature and mixing requirements to break the C-F bond; however, they may not always operate at levels required to achieve complete destruction.
    - Not possible to test for complete PFAS destruction using current testing methodologies (complete destruction leads HF gas and CO_2 as only compounds left after thermal treatment.
- Types of Thermal Treatment Devices
  - Hazardous waste combustors
    - Subject to RCRA and CAA permitting
    - Regulatory oversight and emissions limitations, but not for PFAS
    - May have site-specific permits for PFAS destruction
    - Five PFAS studied showed adequate destruction; however, PICs not evaluated
  - Hazardous waste incinerators (HWIs)
    - Limited studies of PFAS in HWIs
    - Five PFAS studied showed adequate destruction; however, PICs not evaluated
  - Carbon Regeneration and Reactivation Units
    - May destroy PFAS; however, additional studies needed.

PFAS SMOLDERING

SERDP
DOD • EPA • DOE

ESTCP

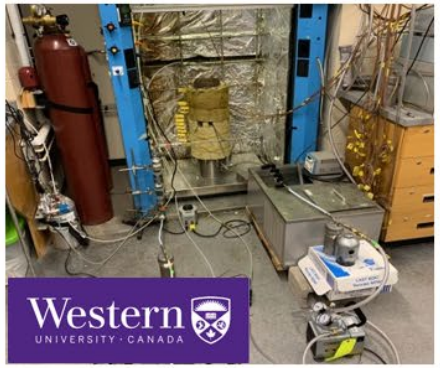
DEFENSE INNOVATION UNIT

PFAS SMOLDERING

2017

Can we use smoldering to treat PFAS?

PFAS SMOLDERING



Phase 1:

Lab Column Tests

Mass Balance / Optimization

Phase 2:

Intermediate Scale Reactor

Heterogeneity

Phase 3:

Pilot Scale Tests

Field Implementation

SERDP
DOD · EPA · DOE

PROJECT OF THE YEAR 2021
SERDP
ENVIRONMENTAL RESTORATION

savron

PFAS DESTRUCTION BY SMOLDERING

Smoldering Combustion Treatment of PFAS-Impacted Investigation-Derived Waste
SERDP ESTCP Project Numbers: ER18-1593 and ER22-7470

Technology description

- Mix fuels into PFAS-containing soils and sustain soil smoldering at temperatures >900°C
- In situ and ex situ applications

Objectives

- Demonstrate PFAS destruction using surrogate fuels such as spent activated carbon and soil types
- Assess emissions, scale-up

- ❑ Thirteen PFAS were reduced to below detection limits in soils, sand, and ash
- ❑ Emissions contained <1% of PFAS
  - Majority of PFAS was destroyed (converted to HF)
  - No PFAS breakthrough in emissions collection system
  - Calcium oxide promoted PFAS destruction, removed HF from emissions
- ❑ PFAS are altered during smoldering
  - Formation of carboxylate PFAS
  - Conversion from C4-C9 to C2-C3
- ❑ HF data suggests ~70-80% mass balance

Geosyntec consultants

OTHER CONSIDERATIONS

VULNERABLE POPULATIONS

Properties of Vulnerability

- Differences in Susceptibility: Increased likelihood of an adverse effect from exposure to a chemical or release of a chemical
- Differences in Exposure: magnitude, duration, frequency, and pathways of exposure
- Differences in Ability to Recover: Resources or abilities to recover from an exposure
  - Income level
  - Access to health care
  - Ability to relocate away from an exposure area
- Differences in Preparedness: Regulations and protections an individual, group or community can use to withstand an exposure or chemical release.

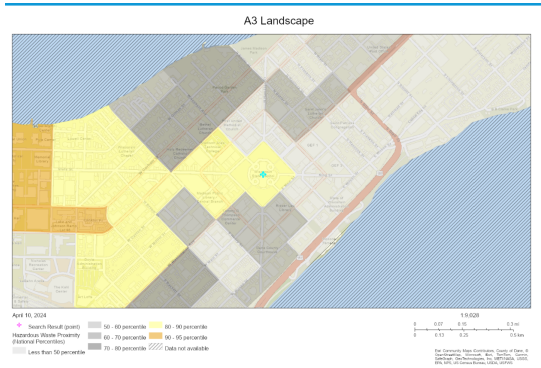
VULNERABLE POPULATIONS

Properties of Vulnerability

- Differences in Susceptibility: Increased likelihood of an adverse effect from exposure to a chemical or release of a chemical
- Differences in Exposure: magnitude, duration, frequency, and pathways of exposure
- Differences in Ability to Recover: Resources or abilities to recover from an exposure
  - Income level
  - Access to health care
  - Ability to relocate away from an exposure area
- Differences in Preparedness: Regulations and protections an individual, group or community can use to withstand an exposure or chemical release.
- Environmental Justice Screening Tool: https://www.epa.gov/ejscreen

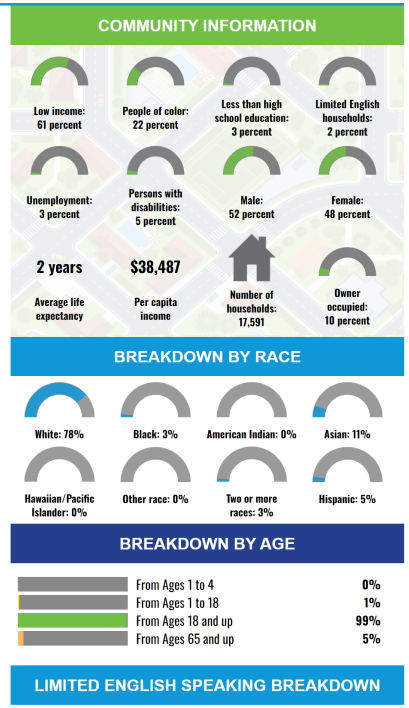
EJ SCREEN

Wisconsin State Capitol
2 E Main Street
Madison, WI 53703



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	88%
Spanish	3%
French, Haitian, or Cajun	1%
German or other West Germanic	1%
Russian, Polish, or Other Slavic	1%
Other Indo-European	2%
Chinese (including Mandarin, Cantonese)	3%
Other Asian and Pacific Island	1%
Total Non-English	12%

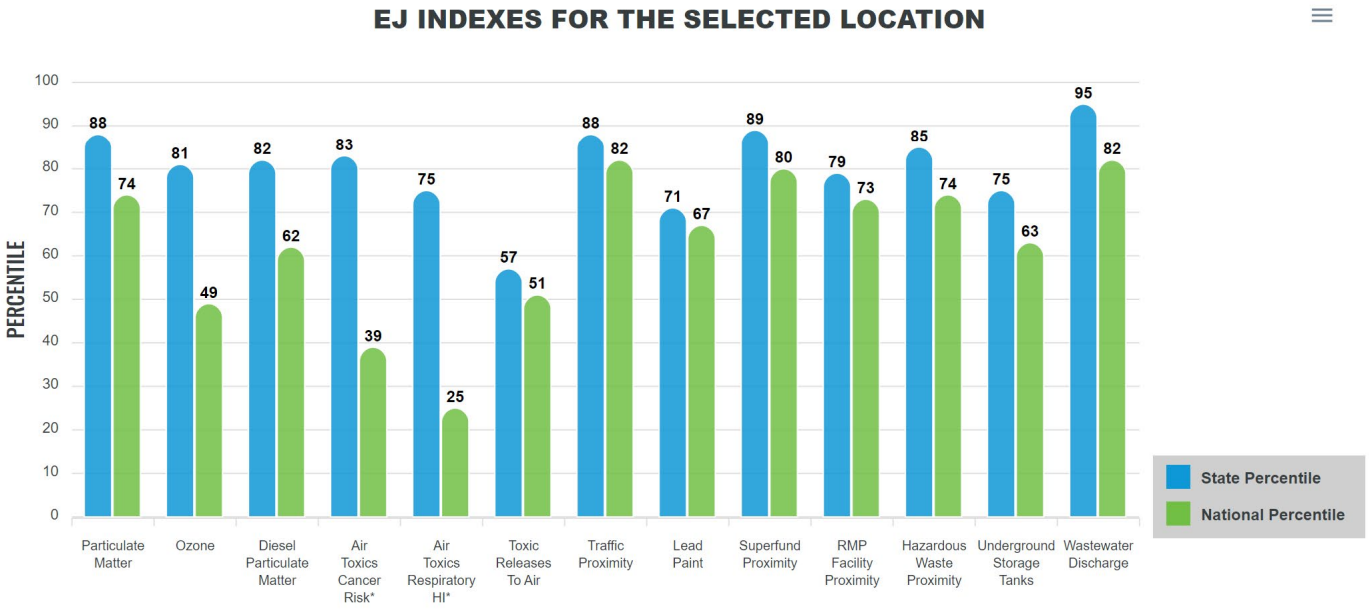


Environmental Justice & Supplemental Indexes

The environmental justice and supplemental indexes are a combination of environmental and socioeconomic information. There are thirteen EJ indexes and supplemental indexes in EJScreen reflecting the 13 environmental indicators. The indexes for a selected area are compared to those for all other locations in the state or nation. For more information and calculation details on the EJ and supplemental indexes, please visit the EJScreen website.

EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.



COST CONSIDERATIONS

Cost is Always a Factor

- Client risk tolerance
  - Higher protections generally cost more
  - Stronger liability protections generally cost more
  - Shareholder stewardship objectives can influence cost
- Supply and demand
  - Availability of air space or thermal capacity can influence cost
  - Proximity of disposal/destruction facilities relative to each other can influence cost
- Regulatory environment
  - Waste classification will have an impact on costs
- Technology preference
  - Different technologies have different costs
  - Usually decided by Client risk tolerance
- Waste Stream Characteristics
  - PFAS concentrations may dictate disposal or destruction technology
  - Waste volume may impact cost
    - Volume discounts
    - Economies of scale

Thank You!

Special thanks to Hannah McIntyre, Senior Staff Professional in Geosyntec's Overland Park, KS office, for preparing many of the slides for today's presentation.

Questions?