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Technologies for CERCLA Assessments and Remediation Activities, and Alternative Paths for CERCLA Site Remediation

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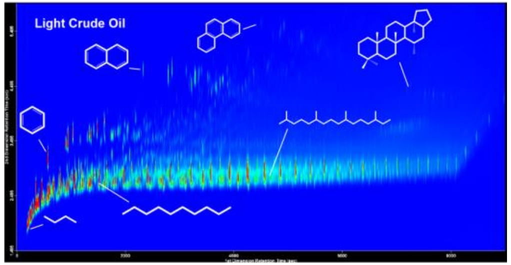
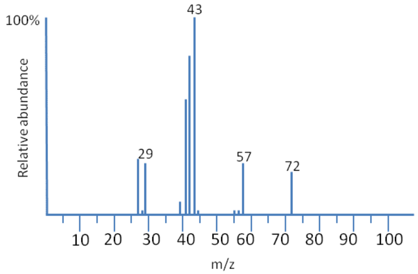
Innovations and Advances for CERCLA Sites

- **Innovations in analysis**
  - Next generation analytical techniques
  - Non-targeted analysis
- **Sediment CERCLA sites**
  - Passive samplers
  - *In situ* remediation using sediment amendments
- **Groundwater CERCLA sites**
  - Emerging contaminants
  - Collaborative and cooperative approaches to CERCLA site remediation and management
- **Environmental liability analysis**

Next Generation Analytical Techniques to Characterize Environmental Contaminants

- CERCLA sites require detailed and comprehensive characterization of contaminants
- Current challenges come from the complexity of environmental samples
  - Often dealing with multiple contaminants (e.g., petroleum hydrocarbons, chlorinated solvents, naturally occurring contaminants, emerging contaminants, and more)
  - Reducing interferences from complex samples is needed for environmental forensic investigations and chemical fingerprinting
- Enhanced analytical techniques provide higher resolution data through chemical isolation, sensitive detection, and accurate identification





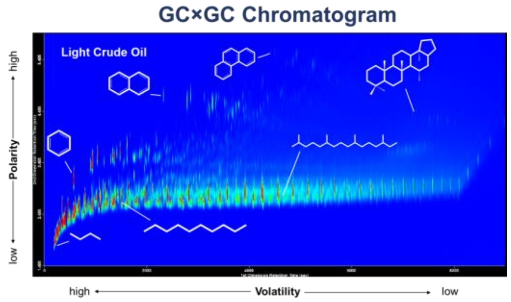
Analytical Solutions for Complex Samples

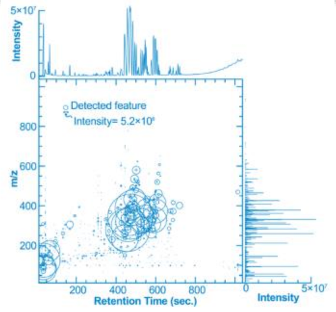
Comprehensive Two-Dimensional Gas Chromatography (GCxGC)

- Ideally suited for environmental samples with multiple classes of contaminants
- Isolates single compounds from mixtures of thousands
- Resulting data aid in contaminant source identification and chemical fingerprinting

High Resolution Mass Spectrometry (HRMS)

- Provides accurate chemical mass information to aid in identification
- Suited for analysis of emerging contaminants
- Detects contaminants that are not routinely screened in traditional environmental analyses



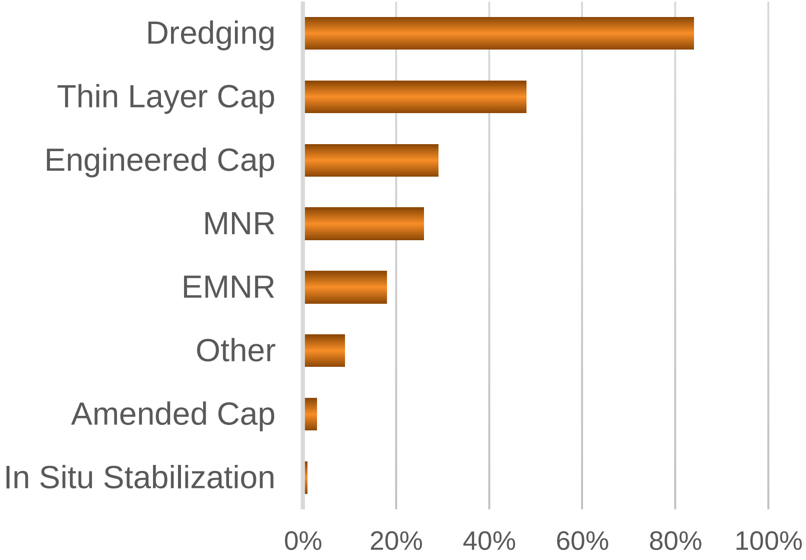


Targeted v Non-Targeted Chemical Analysis

- **Targeted analysis** measures a set list of compounds and is the traditional approach to site assessment
- **Non-targeted analysis**, in contrast, is used to identify all compounds within a sample
- Non-targeted analysis is expected to identify new compounds of concern and additional liability at CERCLA sites

Dredging Continues to be the Remedy of Choice at Large Sediment Sites

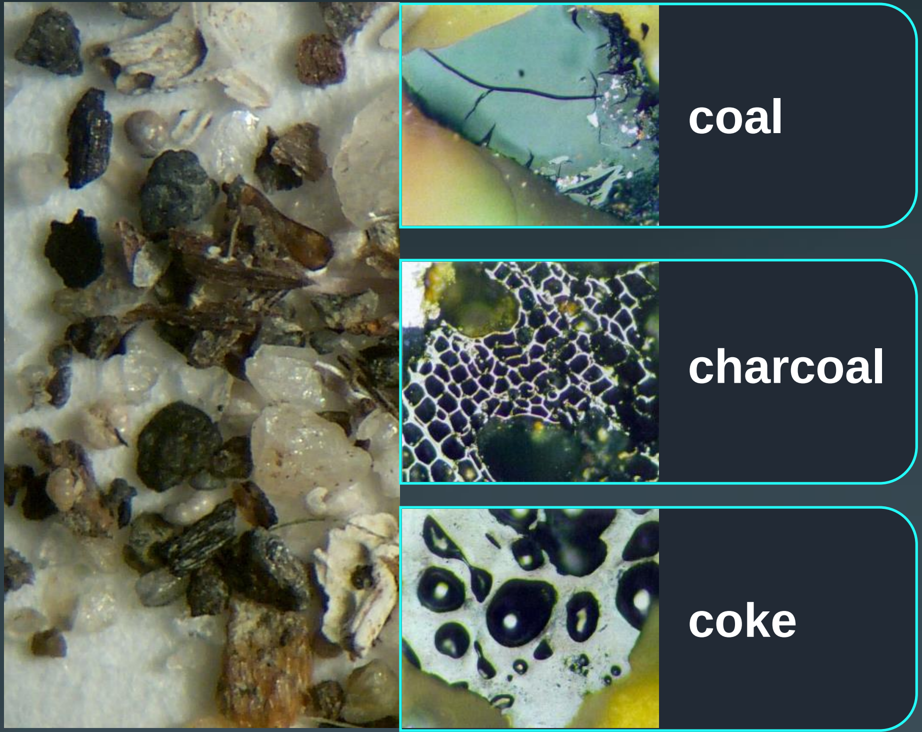
- Dredging and/or excavation performed at majority of sites
- Several sites have selected capping
  - Thin layer, engineered or amended caps, or combination
- Monitored Natural Recovery applied more frequently at larger sites than at smaller sites
  - Cost-effectiveness



Percent of 2012–14 RODs with Sediment Remedies (Tier 1 Sediment Sites)

USEPA. 2017. Superfund remedy trend report. 15th Edition. EPA-542-R-17-001. Office of Land and Emergency Management, U.S. Environmental Protection Agency. July.

Pollutant Bioavailability is More Important than Pollutant Concentration



Hunters Point Sediment (63–250 µm)

Source: Upal Ghosh.

- Carbon particles in sediments reduce bioavailability
- Passive samplers can provide an *in situ*, direct measure of bioavailability
- Sediment amendments can reduce pollutant bioavailability (e.g., lead, mercury, PAHs, PCBs, pesticides, dioxins)

Passive Samplers Measure Organic Compounds in Sediment Pore Water (using diffusion of the chemicals into the sampler)

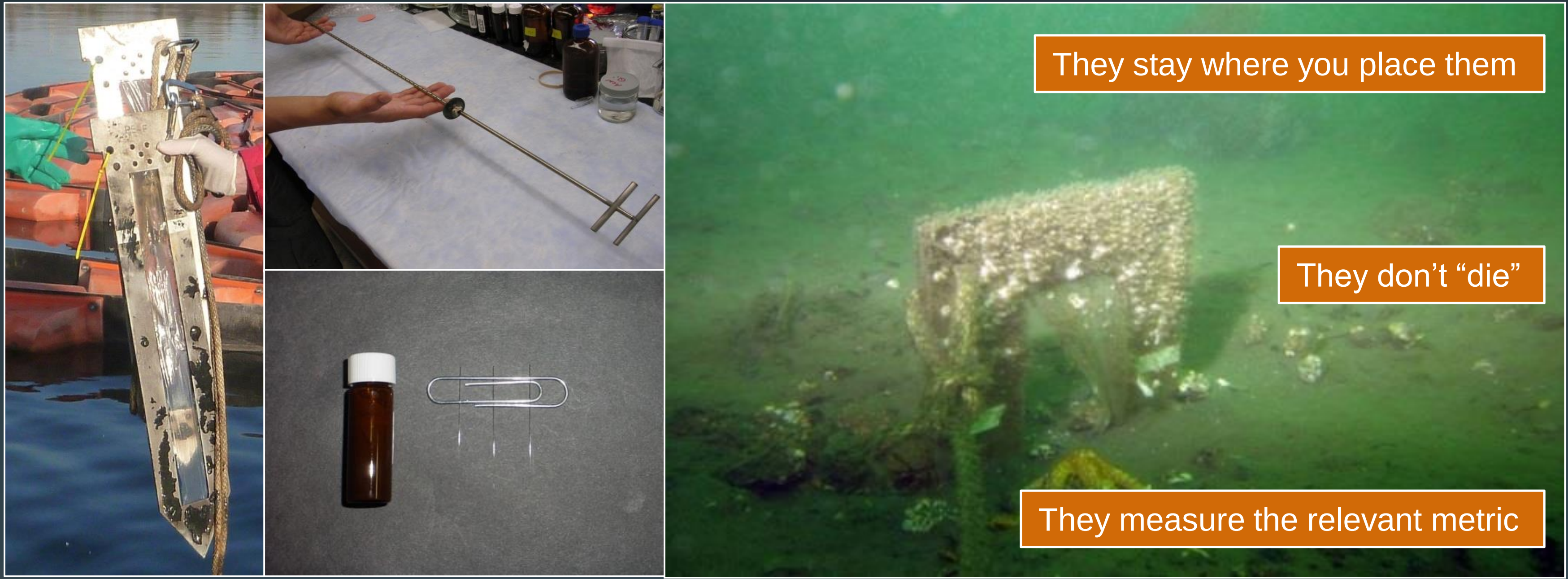


Photo credits: EPA Dive team, D. Reible, T. Thompson

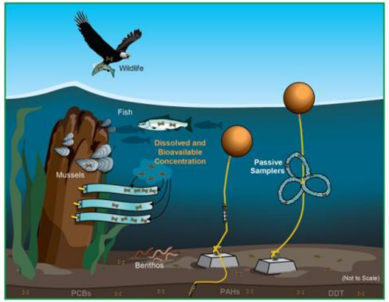
Use of Porewater and Passive Samplers as Metrics of Exposure is Strongly Supported by EPA

EPA United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation
and
Office of Research and Development

Sediment Assessment and Monitoring Sheet (SAMS) # 3

Guidelines for Using Passive Samplers to Monitor Organic Contaminants at Superfund Sediment Sites



December 2012

OSWER Directive 9200.1-110 FS

ESTCP

INTEGRATING PASSIVE SAMPLING METHODS INTO MANAGEMENT OF CONTAMINATED SEDIMENT SITES

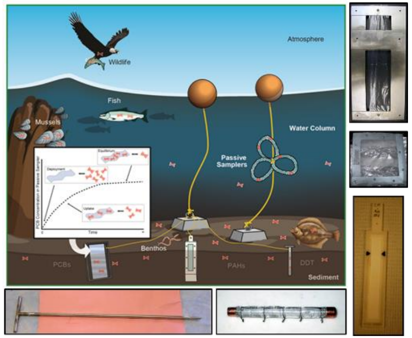
Environmental Restoration Projects

January 2016

EPA United States Environmental Protection Agency

SERDP DOD • EPA • DOE | ESTCP

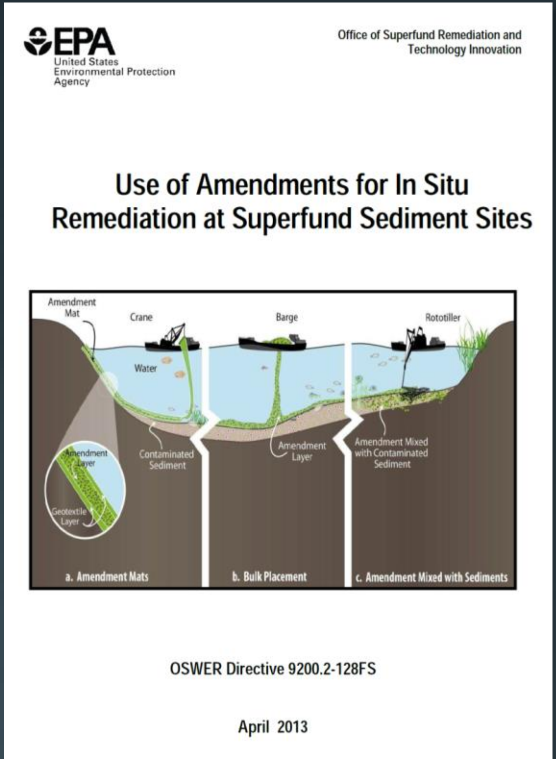
Laboratory, Field, and Analytical Procedures for Using Passive Sampling in the Evaluation of Contaminated Sediments: User's Manual



2017

***In situ* remediation can be an effective, less damaging alternative to invasive remediation methods (e.g., dredging, capping)**

Guidance from EPA and the States (ITRC) Supports the Use of *In Situ* Amendments

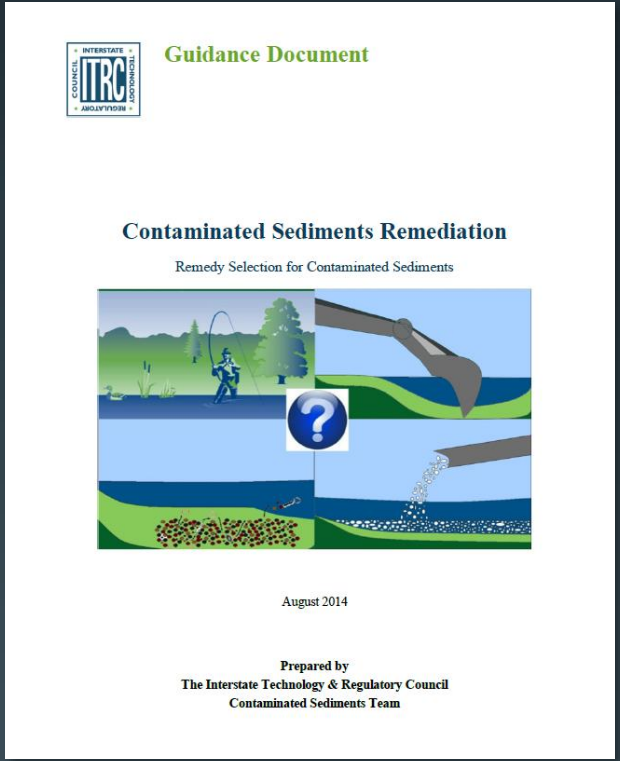

EPA United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation

Use of Amendments for In Situ Remediation at Superfund Sediment Sites

OSWER Directive 9200.2-128FS

April 2013


INTERSTATE TECHNOLOGY REGULATORY COUNCIL ITRC

Guidance Document

Contaminated Sediments Remediation

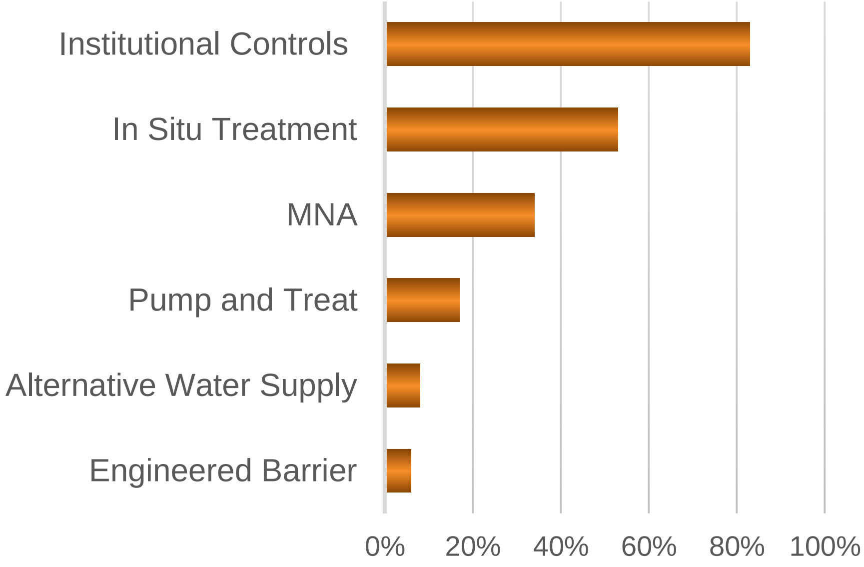
Remedy Selection for Contaminated Sediments

August 2014

Prepared by
The Interstate Technology & Regulatory Council
Contaminated Sediments Team

Groundwater Remedies Trend toward *In Situ* and Monitored Natural Attenuation

- Institutional controls, *in situ* treatment and natural attenuation increasing
  - Bioremediation and chemical treatment most prevalent
- Traditional pump and treat decreasing
  - 90% of RODs selected P&T in 1990
  - 17% of RODs selected P&T in 2014



Percent of 2014 RODs with Groundwater Remedies

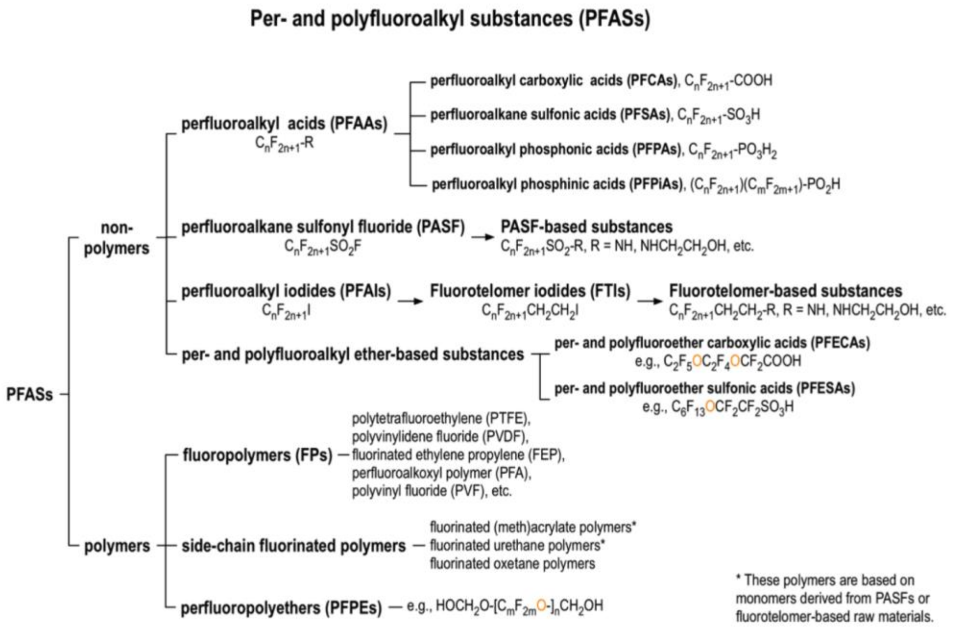
USEPA. 2017. Superfund remedy trend report. 15th Edition. EPA-542-R-17-001. Office of Land and Emergency Management, U.S. Environmental Protection Agency. July.

Chemicals of Emerging Concern (CECs)

- Presence of CECs can:
  - Cause reopening of previously closed sites
  - Complicate CERCLA site assessments
  - Require a site-specific approach to management and remediation (one-size-fits-all approaches are likely unreliable and inefficient)
- 1,4-dioxane
  - ***Ex situ* treatment:** Modified Fenton's reagent, AOPs, adsorption/desorption media, *bioreactors*
  - ***In situ* treatment:** In-well air stripping, sparging, soil vapor extraction; chemical oxidation; monitored natural attenuation (but hindered by lack of long-term monitoring data)

Per- and Polyfluorinated Alkyl Substances (PFAS)

- Chemically similar but different sub-groups (e.g., carboxylates, sulfonates, and many more)
- Potential remediation strategies:
  - Stabilization/immobilization
  - *In situ* oxidation/reduction
  - Pump and treat in tandem with GAC or other sorbent materials
  - Foam fractionation and/or separation
  - Sonochemistry



Source: OECD 2015. Working Towards A Global Emission Inventory Of PFASs: Focus On PFASs - Status Quo And The Way Forward.

Collaborative Approaches to CERCLA Sites Must Recognize and Address Challenges of Each Site

- Pollutants may be present from many sources (traditional, orphan, agriculture, natural)
- New chemicals may be discovered over time
- Cleanup goals (or end use) may change over time
- Regulations can challenge putting treated groundwater to highest beneficial use
- Lack of certainty is challenging for PRPs
- Competing regulatory requirements and agencies
- Pumping may pull contaminants beyond OUs
- Water agencies may have limited authority to participate in solutions

Collaborative, Creative Approaches May Accomplish More in Shorter Timeframes

- Alternative approaches require collaboration between PRPs, water agencies, regulatory agencies, watermaster
  - Put treated groundwater to highest beneficial use
  - Recognize value in returning basins to service
  - Provide certainty over defined timeframe
  - Recognize complicated nature of groundwater flow
  - Require creative regulatory approach
  - Allow water agencies to participate as partners in remedies (e.g., can operate treatment facilities, may have access to funding)

Benefits of Collaborative Solutions

Can the parties find a creative, collaborative solution that benefits all?

PRPs and water agencies develop coordinated cleanup and management strategy, and regulatory agencies (and NGOs) approve strategy, for fixed timeframe

- PRPs obtain certainty (limits on legal and remedy costs, liability) over specified time frame, in partnership with water and regulatory agencies
- Water agencies get water and full use of basin over time, more comprehensive solutions, regulatory and other agencies avoid litigation

No solution found—"business as usual" continues

- Cleanup projects are delayed and piecemeal, loss of water and storage continues

Environmental Liabilities Assessment

- Elements of work related to environmental liabilities
  - Identification/recognition
  - Quantification
  - Reporting/disclosure
  - Management and settlement
  - Based on:
    - ASTM Standards E3123, E2137, E2173
    - Generally accepted accounting practices (GAAP) best practices
  - Standard methods provide
    - Daylighting of uncertainties and assumptions and their significance

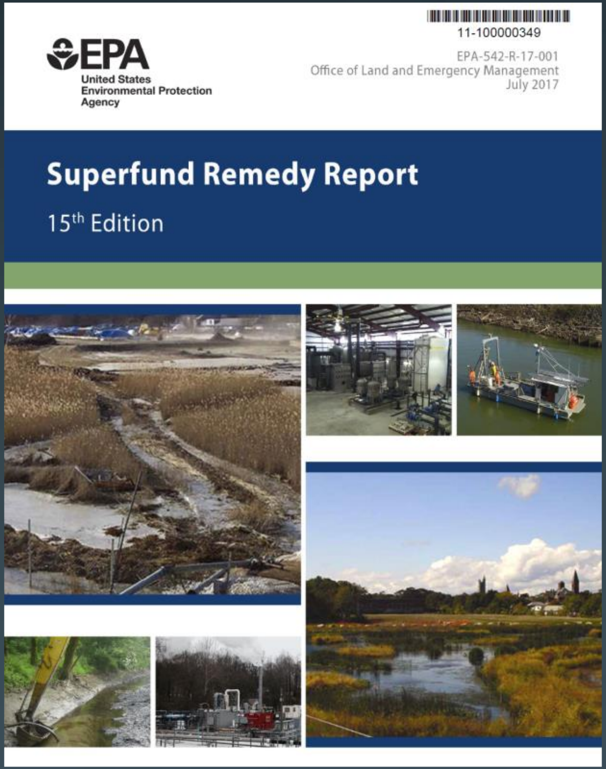
E3123-17 *Standard Guide for Recognition and Derecognition of Environmental* Liabilities, www.astm.org/Standards/E3123.htm
E2137-17 *Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters*, www.astm.org/Standards/E2137.htm
E2173-16 *Standard Guide for Disclosure of Environmental Liabilities*, available at https://www.astm.org/Standards/E2173.htm.

Environmental Liabilities Assessment Addresses Important Questions and Leads to Better Outcomes

- Is spending on remediation achieving corresponding liability reductions?
- Do we need to optimize remediation strategies and spending?
- Are cost recoveries capturing the expected full life-cycle costs?
- Are some remediation liabilities better characterized as asset retirement obligations?
- Are my organization's tools, policies and processes capable of preventing surprises or strategy failures? e.g., counterparty failures or remediation failures?
- Are we prepared for strategic opportunities (e.g., M&A)?

Exponent serves as a “strategic advisor” to help clients with complex CERCLA sites

- Effectively interpret and use information from innovative analytical techniques
- Evaluate bioavailability and implement new remediation techniques for sediments
- Identify and develop remedies for CECs
- Develop creative and collaborative approaches to problem-solving
- Analyze and manage environmental liabilities



Thanks!

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