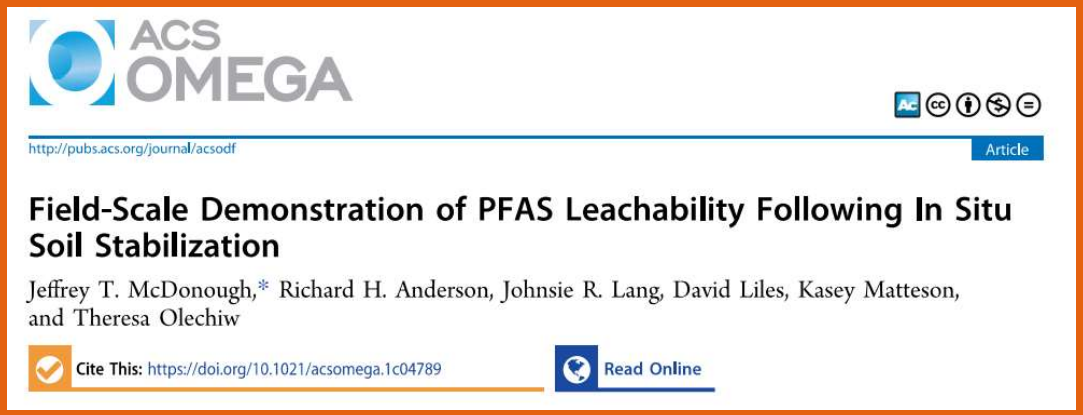
Soil stabilization

NEWMOA

September 22, 2022



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Field-Scale Demonstration of PFAS Leachability Following In Situ Soil Stabilization

Jeffrey T. McDonough,* Richard H. Anderson, Johnsie R. Lang, David Liles, Kasey Matteson, and Theresa Olechiw

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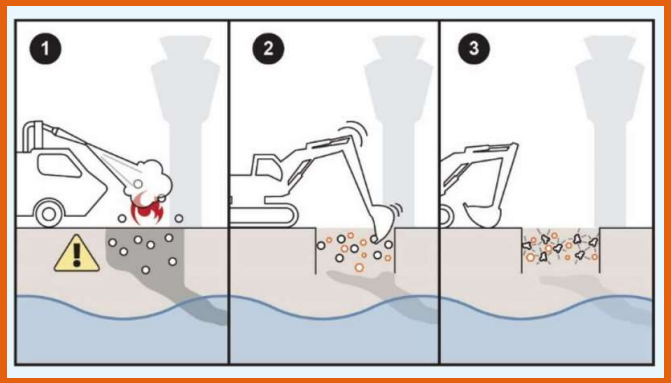

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Agenda

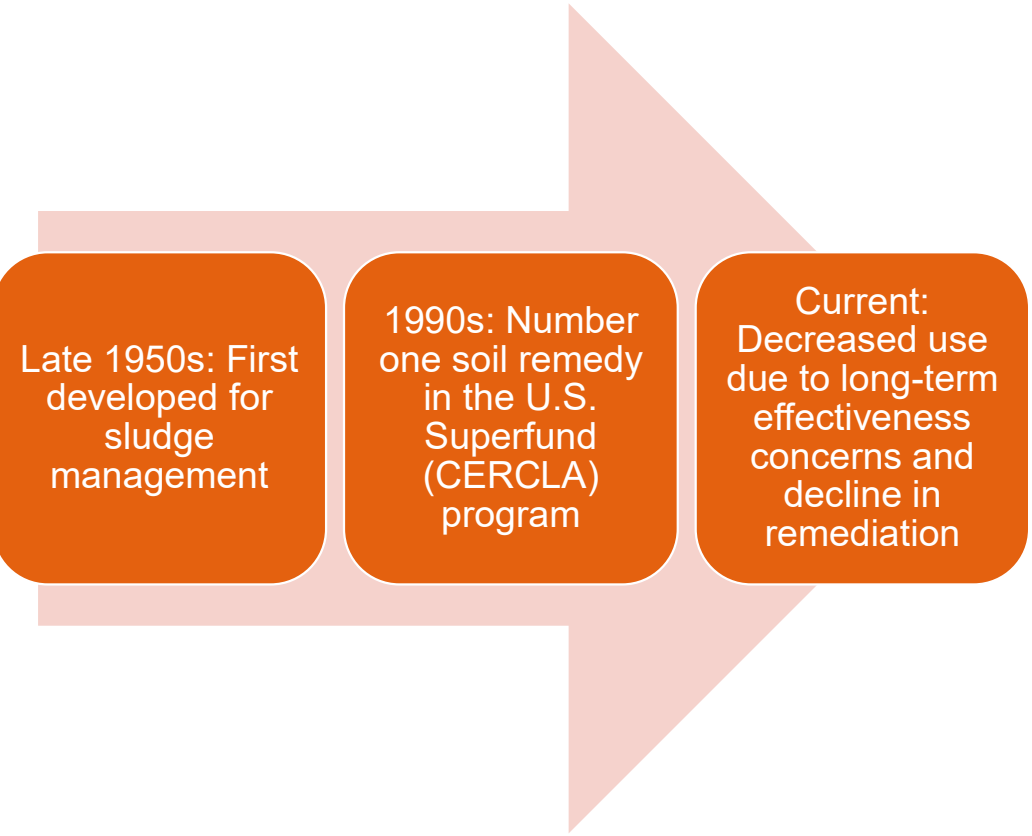
1 Introduction to Soil Stabilization

2 Site Selection and Characterization

3 Bench Scale Treatability Testing

4 Field Scale Demonstration

History of Soil Stabilization and Solidification



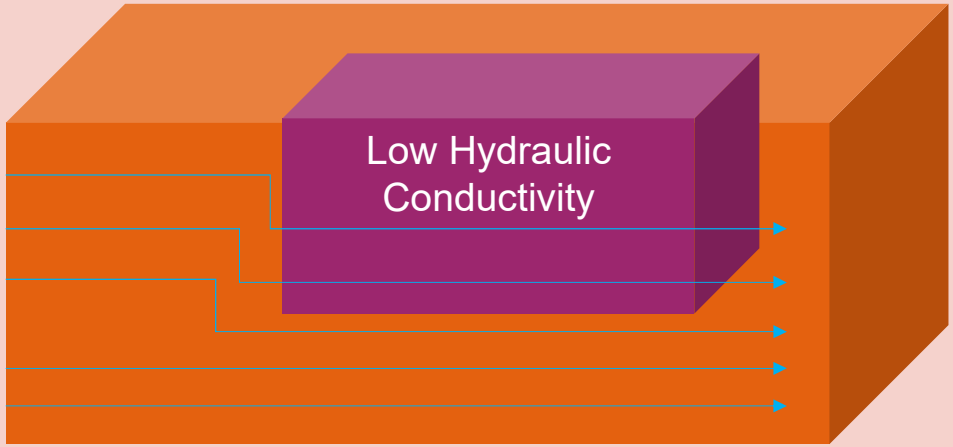
https://pubs.acs.org/doi/10.1021/acs.est.9b04990

	Organic Contaminants	Inorganic Contaminants	Reactive Compounds
Demonstrated	• Halogenated semi-volatiles • Non-halogenated semi- and non-volatiles	• Volatile metals • Non-volatile metals • Radioactive materials • Inorganic corrosives and cyanides	• Oxidizers • Reducers
Potential	• PCBs • Pesticides • Dioxins/Furans • Organic cyanides • Organic corrosives		
Ineffective	• Halogenated volatiles • Non-Halogenated volatiles		

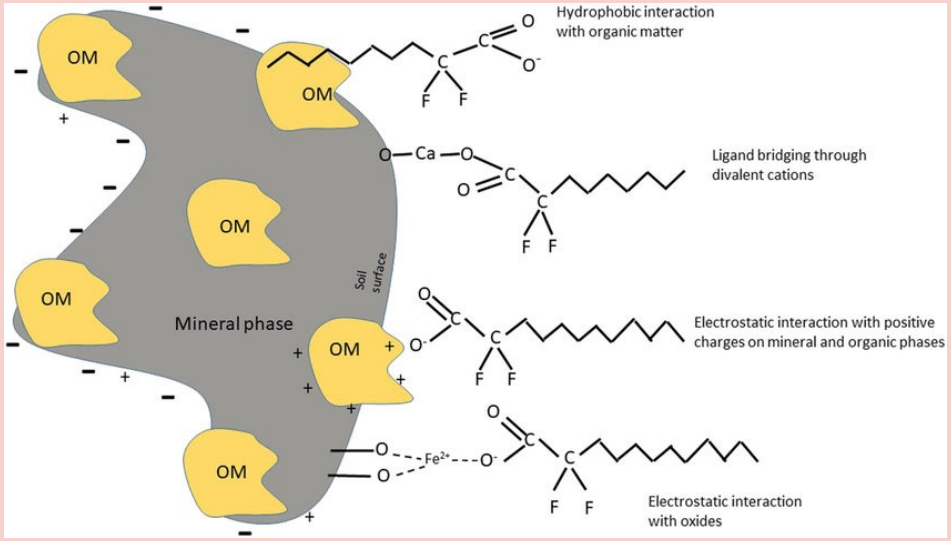
https://www.geoengineer.org/education/web-class-projects/cee-549-geoenvironmental-engineering-winter-2013/assignments/stabilization-solidification

Stabilization vs Solidification

Solidification: Create a solid



Stabilization: Stabilize the chemical



https://www.sciencedirect.com/science/article/abs/pii/S0304389420318811

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Project Objectives

Overall Objective: Establish an alternative to the typical PFAS source zone management practice of soil excavation/groundwater extraction followed by *ex situ* treatment

Three Specific Objectives:

1. Evaluate soil stabilization via chemical fixation as a remedy to reduce or eliminate leaching of PFAS to groundwater from source areas
2. Evaluate commercially available reagents (i.e., “fixants”) for stabilization of PFAS in field scale test pits
3. Use of a sequential leaching procedure (Method 1315) to understand how soil stabilized test pit leachate will vary with time in PFAS concentrations

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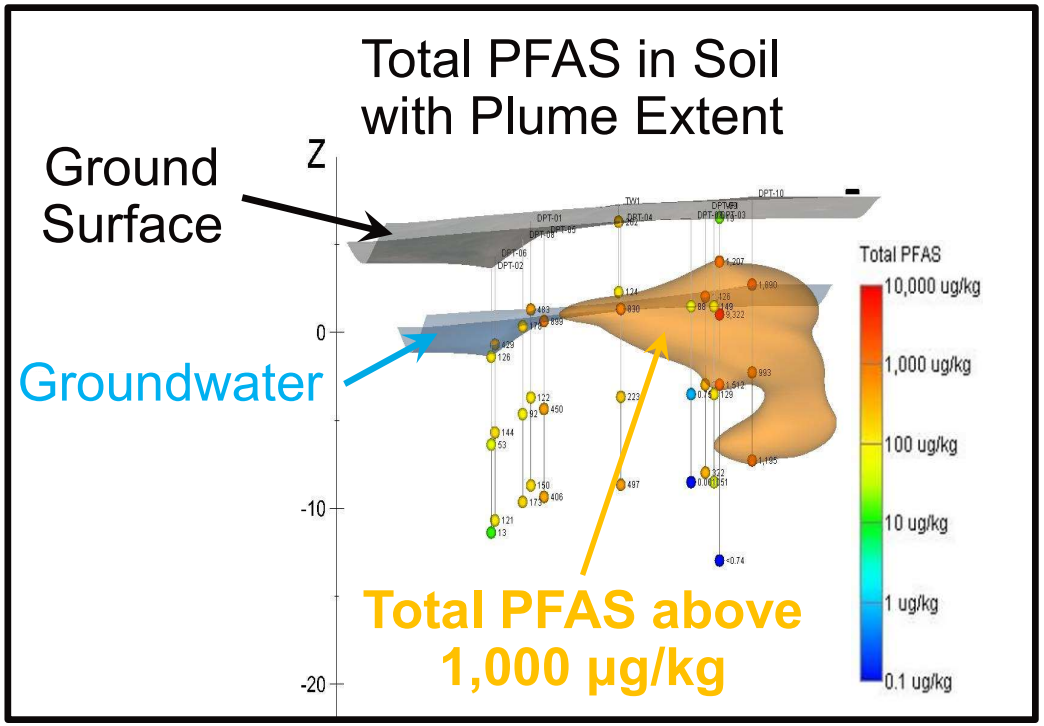
Site Selection and Characterization

Baseline Data

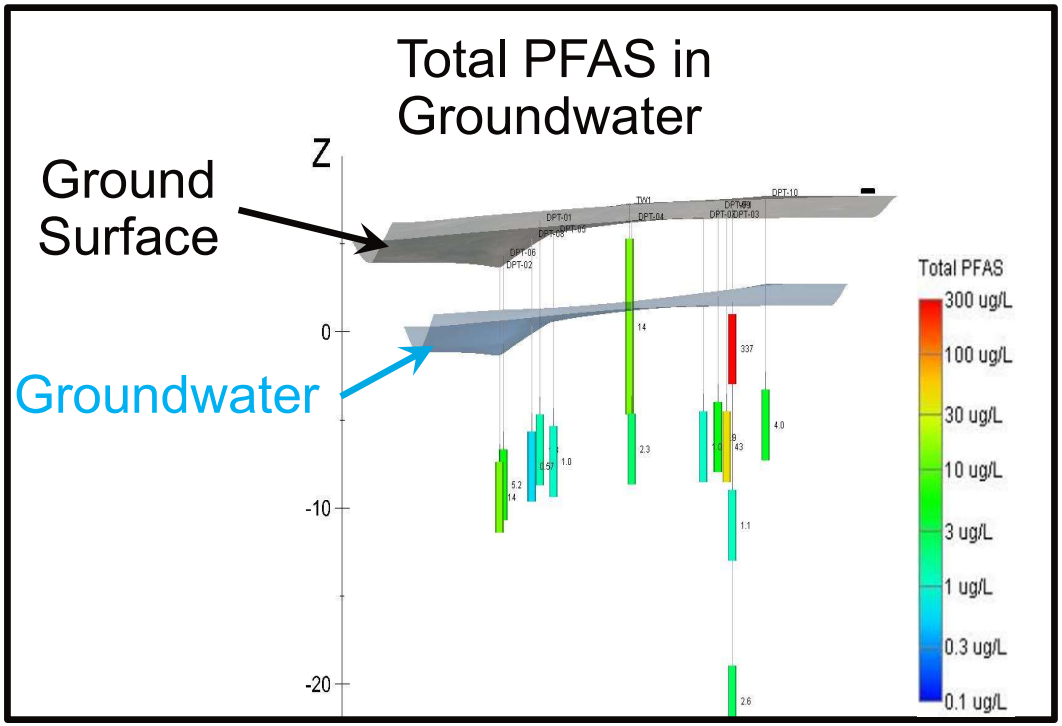
Collected in February 2018

- Soil and groundwater samples collected from 10 locations

Soil

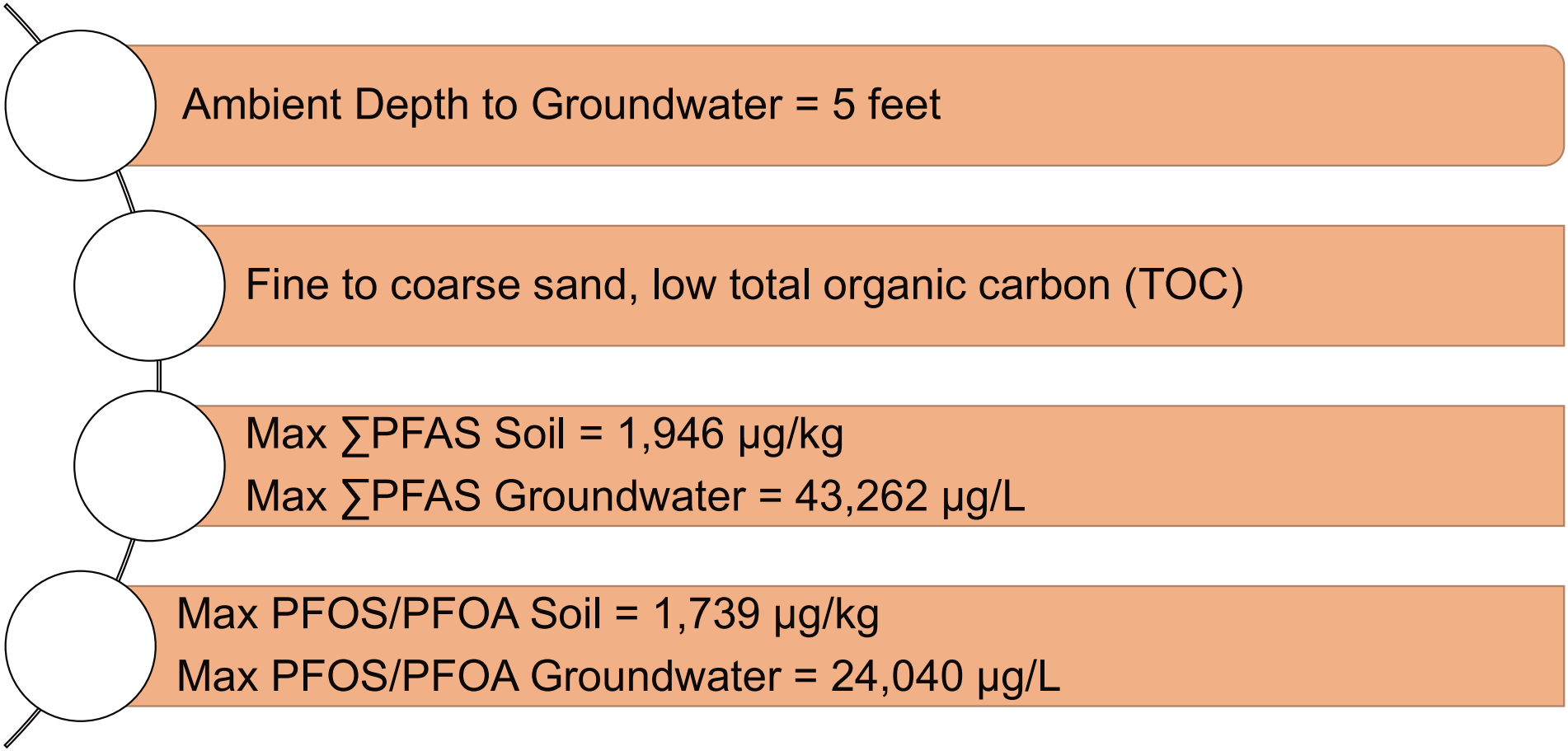


Groundwater



Soil stabilization mixing target depth interval: 5 – 15 ft bgs

Site Selection and Characterization



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Bench Scale Treatability Testing

Bench-Scale Treatability Test

Objective: To optimize fixant mixing rates and geotechnical performance

- RemBind®* (aluminum hydroxide and carbon blend)
- Fluorosorb®* (modified organoclay)
- Layered double hydroxide (NoName #1)
- Proprietary concrete sealant (NoName #2)

*Mention of RemBind® and FluoroSorb® is not an endorsement

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Bench-Scale Treatability Test

Step 1: Baseline Analytical

Step 2: Fixant Optimization Dosing

Step 3: Strength Determination

Step 4: Monolith Leach Evaluation

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Bench-Scale Treatability Test
Step 1: Baseline Analytical
Theorical PFAS Maximums

48-hour bottle tests:
Soil Mass = 88.4 grams
Groundwater Volume = 200 mL

Final PFAS Mass (Control)

PFAA	GW (ng)	Soil (ng)
PFBA	15.7	
PFPeA	9.2	47.2
PFHxA	63.5	92.4
PFHpS	2.9	
PFOA	8.8	114.5
PFPeS	1.4	
PFHxS	46.8	789.4
PFHpS		
PFOS	90.9	2965.8
Total PFAA	**239.2**	**4,009.3**
	4,248.5	

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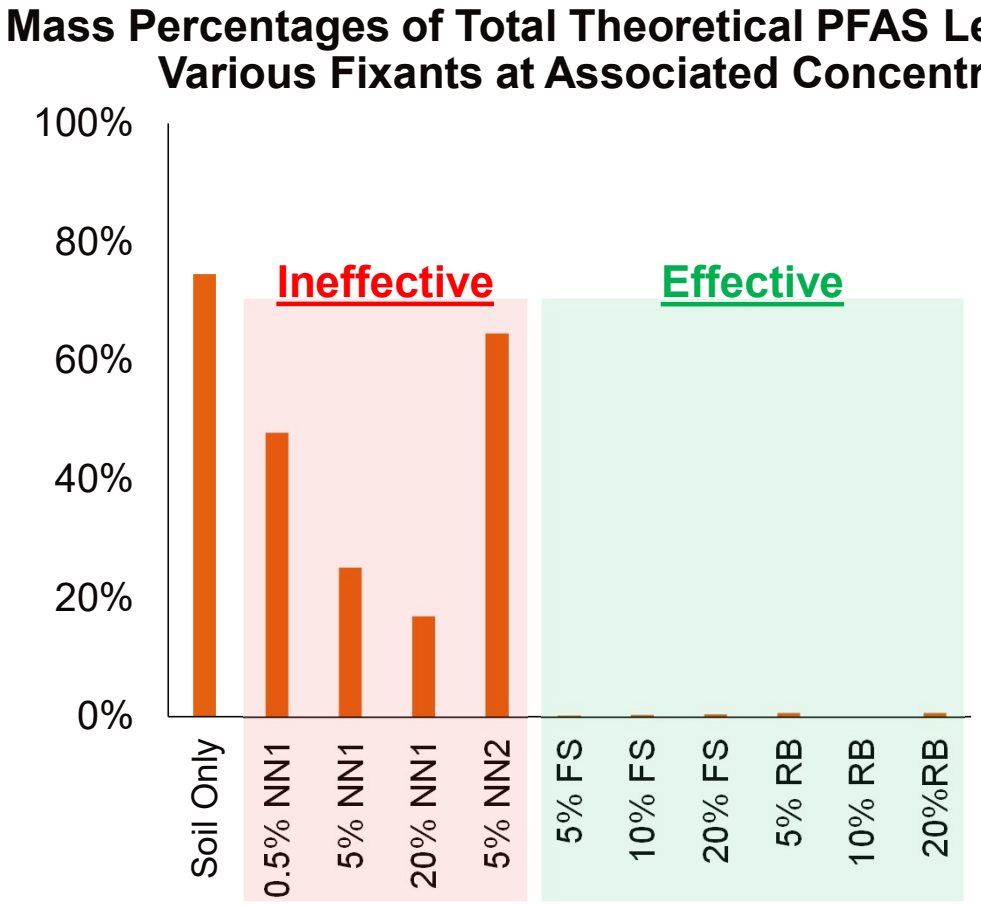
Bench-Scale Treatability Test – Step 2: Fixant Optimization Dosing



- Layered double hydroxide (NN1 - NoName #1)
- Proprietary concrete sealant (NN2 -NoName #2)
- Fluorosorb®* (FS - modified organoclay)
- RemBind®* (RB - aluminum hydroxide and carbon blend)

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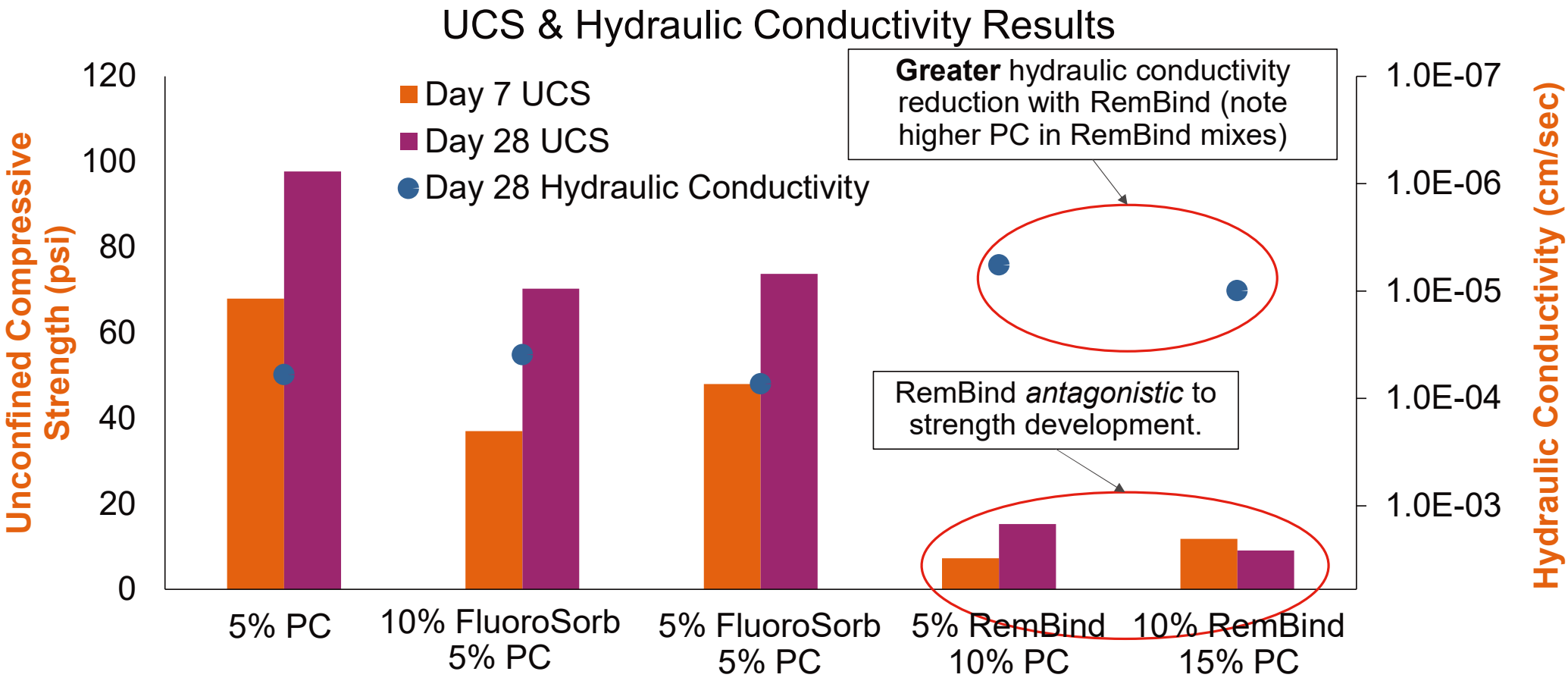
Bench-Scale Treatability Test
Step 3: Strength Determination



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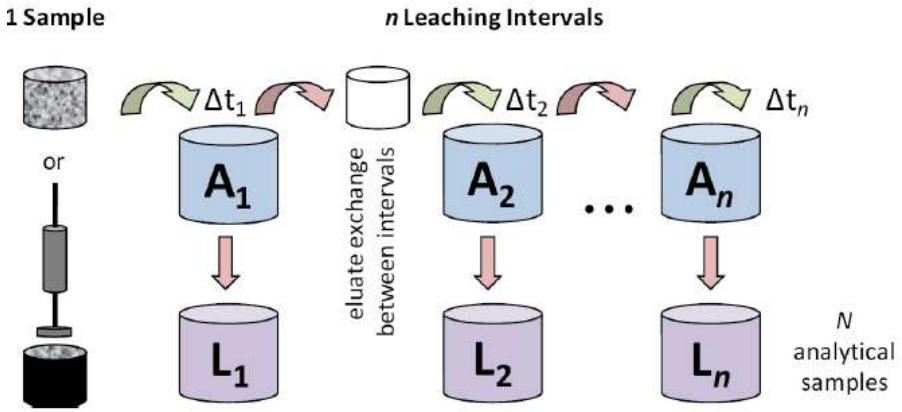
Bench-Scale Treatability Test
Step 4: Monolith Leach Evaluation

- Leaching Environmental Assessment Framework (LEAF) Method 1315 at Test America Pittsburgh
- Monoliths immersed in fresh deionized water as leaching solution for each time intervals
- Leachate generated from intervals T03 and T09 submitted to SGS Axys for PFAS analysis by total oxidizable precursor (TOP) Assay.
- Both pre-TOP (MLA-110) and post-TOP (MLA-111) samples were analyzed.



SCHEDULE OF ELUATE RENEWALS

Interval Label	Interval Duration (h)	Interval Duration (d)	Cumulative Leaching Time (d)
T01	2.0 ± 0.25	–	0.08
T02	23.0 ± 0.5	–	1.0
T03	23.0 ± 0.5	–	2.0
T04	–	5.0 ± 0.1	7.0
T05	–	7.0 ± 0.1	14.0
T06	–	14.0 ± 0.1	28.0
T07	–	14.0 ± 0.1	42.0
T08	–	7.0 ± 0.1	49.0
T09	–	14.0 ± 0.1	63.0

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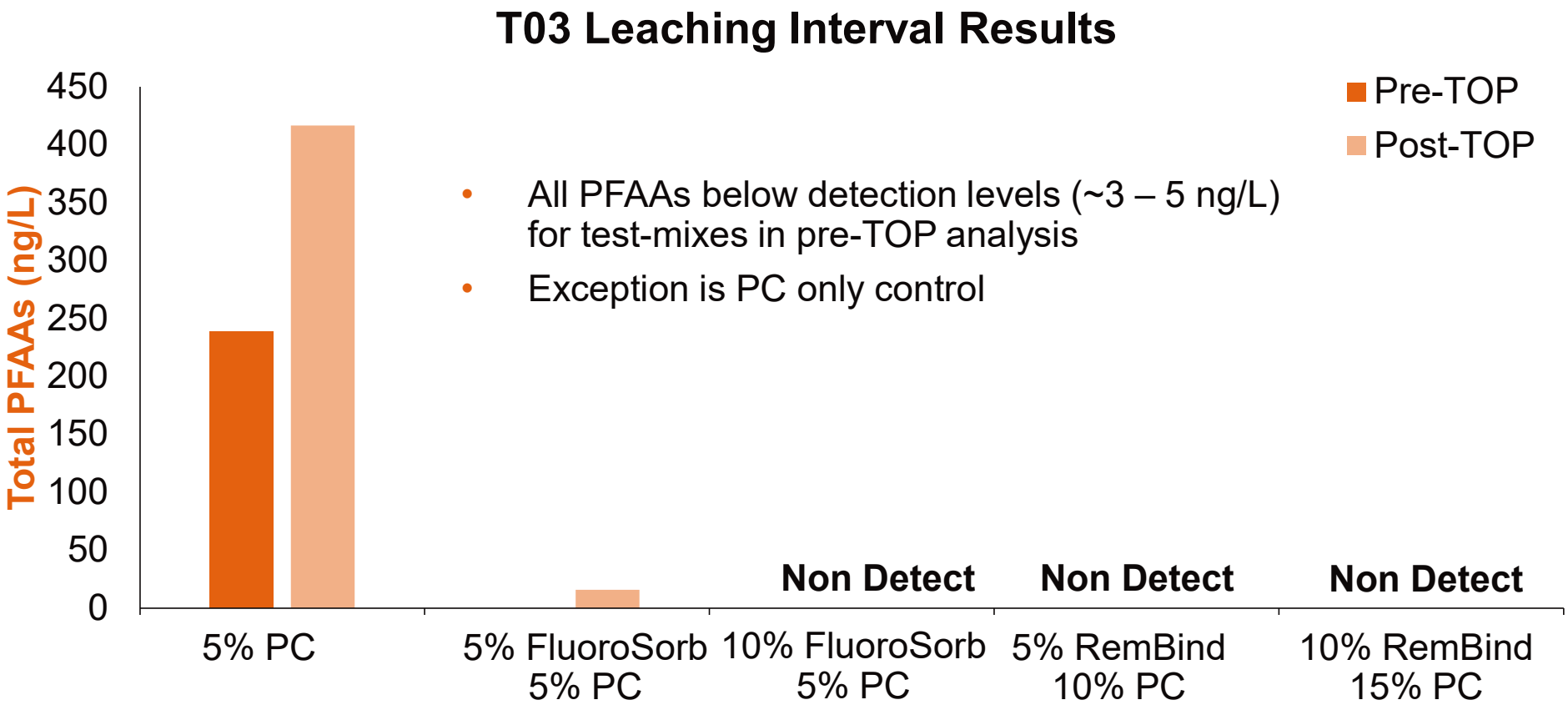
Bench-Scale Treatability Test
Step 4: Monolith Leach Evaluation



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Bench Scale Conclusions

Fluorosorb

RemBind

Field Work (In-Situ Soil Stabilization)

?

Other Potential Applications:

- Ex-Situ Soil Stabilization
- Biosolids Stabilization

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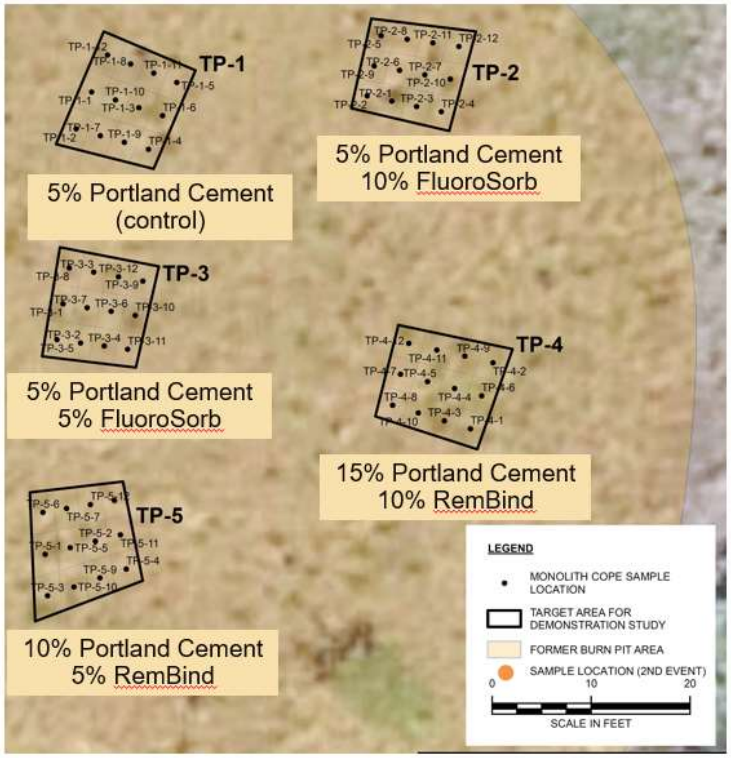
Field Scale Demonstration

Field Implementation of Soil Mixing

- 5 test pits installed in July 2018
- 5 feet of overburden removed from each test pit. Mixing target depth interval was 5 – 15 ft bgs.
- Excavator was used to loosen the material to a depth of 15 ft bgs
- Fixants were measured and mixed with a bucket and rotary mixers while the necessary amount of water was added
- Plastic sheets were placed over the test pits while the fixant mixture dried out and hardened
- Site was graded with excess overburden soil
- 4 days total to stabilize the 5 test pits



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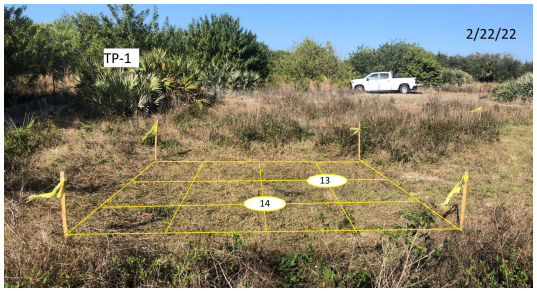
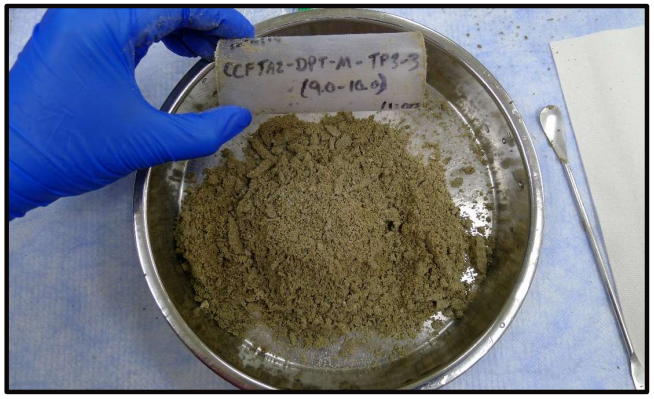
Field Implementation of Soil Mixing

1st Sampling Event (5-months post stabilization)
2nd Sampling Event (12-months)
3rd Sampling Event (16-months)
4th Sampling Event (22-months)
5th Sampling Event (28-months)



FluoroSorb® Core



FluoroSorb® Core

RemBind® Core

RemBind® Core

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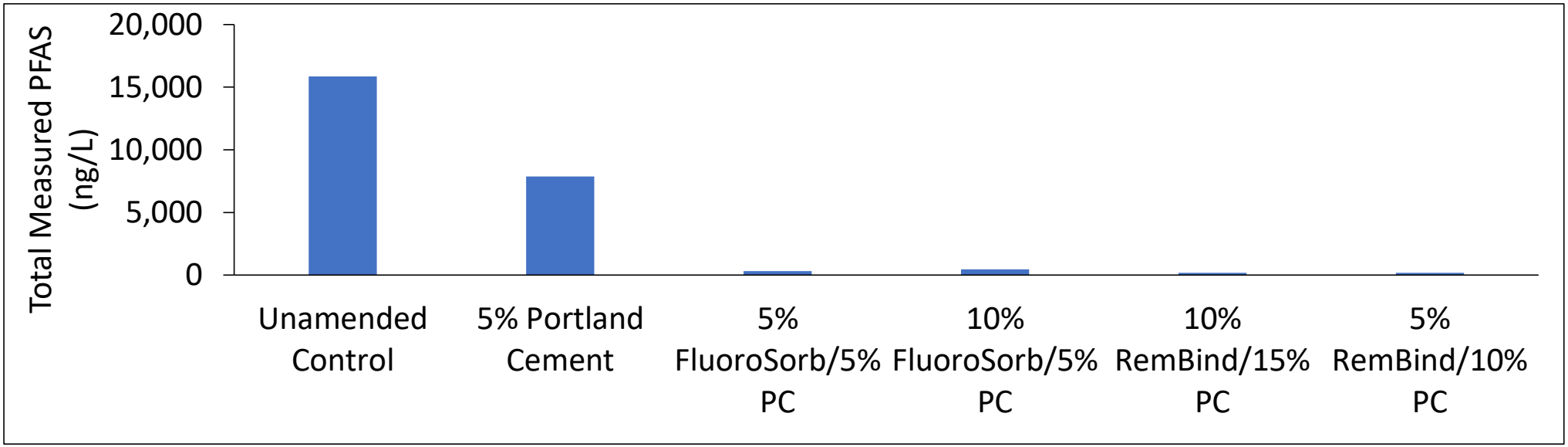
Field Performance Monitoring (Method 1315 – T03 Leaching Interval) 28 months Post Stabilization



Long-term field-scale test pits - multiple orders of magnitude reduced leachability versus portland cement or unamended control

Negligible differences between FluoroSorb® and RemBind® at the 5% and 10% concentrations

USEPA Method 1315 successfully used to evaluate time series leachability from test pits

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BAA 120

July 2018 - Soil Stabilization Implemented

December 2018 – 1st Sampling Event (5-months post stabilization)

July 2019 – 2nd Sampling Event (12-months)

October 2019 – 3rd Sampling Event (16-months)

April 2020 – 4th Sampling Event (22-months)

October 2020 – 5th Sampling Event (28-months)

August 2021 – BAA 120 Final Report

BAA 2105

February 2022 – Conducted Sampling Event (42-months)

January 2023 – Planned Sampling Event (54-months)

January 2024 – Planned Sampling Event (66 months)

Novel imaging methods - Establish location of PFAS in soil column relative to the fixants

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In-Situ Stabilization Costing Tool

Important Input Parameters:

- Total volume/weight of soil to be stabilized
- Production rates (i.e. how much soil can be stabilized per day)
- Costs for stabilization agents

User Name | Date

Input for general information
Input for formulas
Calculation
Drop Down — Drop down that does not match based on inputs (should be updated)

*If In Situ Soil Treatment & Stabilization (ISS)/restored area is able to be capped with no offsite soil disposal set Bulking volume to 0%
Cost for post excavation/ISS sampling are not included in this model

Project Information

Project Number							
Project Name							
Project Location			Operator	Type	Max Concentration		
PFAS Soil Waste Disposal Location*	New Liverpool, Ohio	(Drop down)	Heritage Envi	Incineration	None	Distance	100 miles

Site Specifics

Perimeter	200	linear feet				
Area	1000	sq feet				
Depth	40	feet	Soil Type	Sand	(Drop down)	
Volume (CY)	1481.48	CY	Soil Density	1.3	Handling Volume	2962.96
Soil Weight (ton)	1925.93	ton	(adjust to achieve average soil density)		(Handled for removal and replacement)	
Scenario (Order of Magnitude Volume)	1,000 to 10,000 cubic yards	(Drop down)	Shoring	eel Sheet Pile -70'	(Drop down)	

*Use picklist to modify if scenario is known and adjust site specifics to be within parameters.

Schedule	Production Rate	Days	Weeks	Weather Days (1 day per 3 weeks)	Total Duration Days	Weeks	Months
Mobilization / Site Preparation		1	1				
Excavation + Backfill	400 cy/day	7	2	2	14	3	0.80
ISS (Amendment+PC)	250 cy/day	10	3	2	17	4	0.90
ISS (Amendment)	250 cy/day	10	3	2	17	4	0.90
ISS (Portland Cement)	250 cy/day	10	3	2	17	4	0.90
Loadout/ Demobilization		2	1		Days	Weeks	Months
Site Restoration		2	1				

ISS

Bulking Volume	15%	Volume assumed to require offsite disposal	Sampling			
RemBind	5%	by weight		Waste Characterization	600	CY
FluoroSorb	5%	by weight		Performance Monitoring	600	CY
Portland Cement (with oth	5%	by weight	Other			
Portland Cement (only)	8%	by weight		Utility Survey and Markout	3.00	days
				Site Survey and Asbuilts	15.00	days

Note: Dewatering is not included in the model. Standard dewatering unit costs are included on the cost variable tab. User should determine applicability and
* Additional facilities may accept PFAS containing waste. Facilities locations are provided as an aid to determine distance to disposal facilities.

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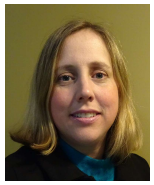
Contact Information



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