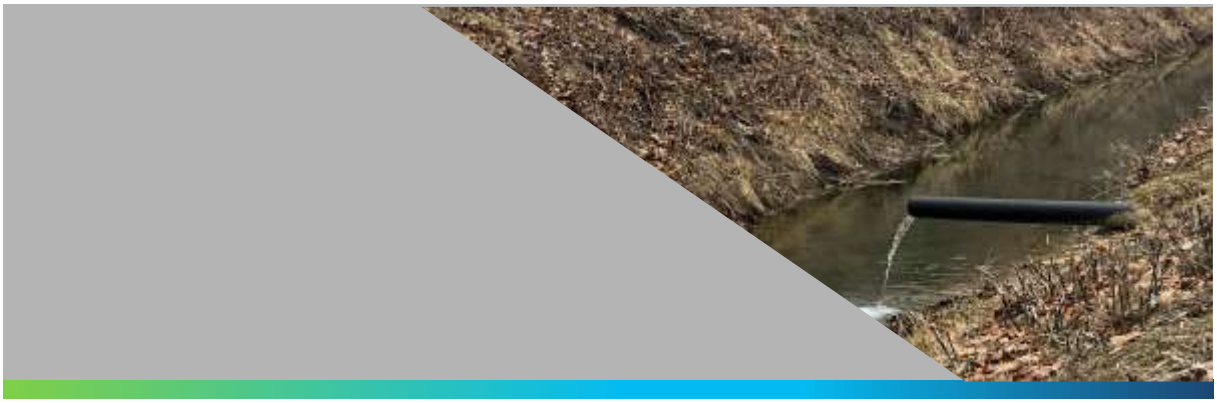


ENCAPSULATION OF PFAS FROM LANDFILL LEACHATE - Plus

Current Sate of Practice

PAUL RUEHL Environmental Remediation Specialist

HOLCIM

1

Encapsulation of PFAS in Landfill Leachate-Abstract

PFAS Encapsulation in Landfill Leachate Abstract

Encapsulation of PFAS from Landfill Leachate-This presentation describes the state-of-practice, and demonstrates typical results of the successful use of cement products for solidification/stabilization (S/S) of landfill leachate concentrate (concentrate). A typical landfill might generate 10,000-100,000 gpd that require management. As much as one third of the operating costs at a landfill is the management of leachate. The concentrated leachate will nearly always have PFAS in significant amounts. Holcim (US) has patented a method for encapsulating PFAS from the concentrate, dramatically reducing the availability of PFAS to the environment. Typical analytical results indicate two to five orders of magnitude reduction between the concentration of PFAS in the concentrate and the extraction fluid. The method describes how PFAS is encapsulated in an inorganic matrix formed by mixing the contaminated concentrate with a mineral binder. The slurried concentrate can be sprayed onto the landfill working face shortly after it has been treated. In this fashion, the landfill can increase its capacity and extend its useful life by using the treated leachate as an Alternate Daily Cover instead of the usual six inches of "free" dirt from onsite. This increased capacity can significantly offset the price of the binder and provide a permanent solution to recapturing PFAS contaminated leachate each day. This method eliminates off-site disposal costs for leachate and the need to recirculate leachate into the landfill. This process eliminates the endless cycle of PFAS from landfill to POTW and back again. This constitutes 100% resource recovery.

HOLCIM

2

How did we get here?

A casual lunch with a long-time friend

A brief question, “what do you know about PFAS”

Over lunch we proposed a sampling and testing methodology for PFAS in RO concentrate

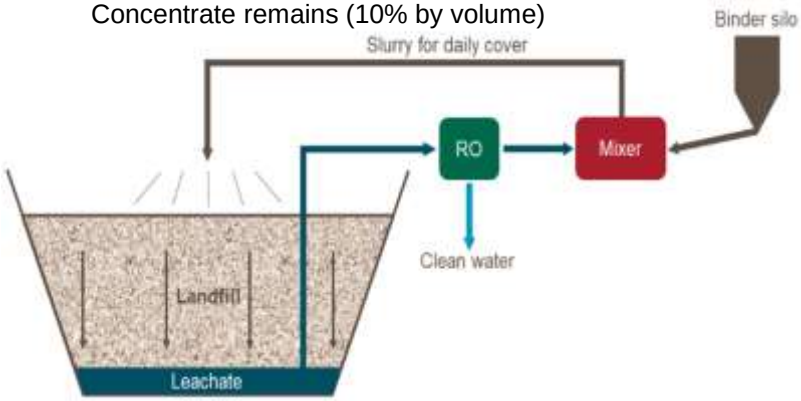
There was no “how to” or textbook; no “what does a successful test look like”

And so began 4 years of R&D on cementitious encapsulation of PFAS in Reverse Osmosis (RO), thermally treated and foam fractionated concentrates

Holcim has a patent on this process

Leachate Treatment Overview

Typical quantities	50k – 100k gallons managed daily - 1/3 of Landfill O&M
Effectiveness	90% meets water quality standards
Issues	Concentrate remains (10% by volume)



RO concentrate tank
(this is where the problem lives)

HOLCIM

5

Proprietary Holcim Cement Binder

HOLCIM

6

Mixing binder and concentrate in a ready mix truck for field trial

The spraying process

LOADING SPRAYER TRUCK

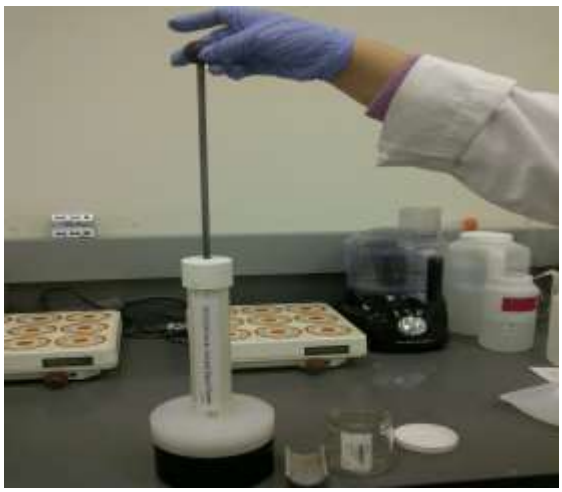
SPRAYING ALTERNATE DAILY COVER

Encapsulated PFAS in Alternate Daily Cover

Spraying Slurried RO Concentrate as Alternate Daily Cover

Alternate Daily Cover @ 15 minutes

EPA Method 1310B Structural Integrity Test



EPA Method 1310B Structural Integrity Test

Sample Analytical Results

Site 1- Enviroset	As Received	SPLP
	Results	Results
Sand	ppt (ng/L)	ppt (ng/L)
PFNA	150	ND
PFOS	630	1
PFOA	2,400	5
Site 2- Enviroset		
No sand		
PFNA	222	ND
PFOS	383	ND
PFOA	7,460	31

Sample Analytical Results

MAR- Enviroset	As Received	SPLP
	Results	Results
Sand	ppt (ng/L)	ppt (ng/L)
PFNA	800	11
PFOS	4,900	63
PFOA	1,500,000	390
NY State- Enviroset		
Sand		
PFNA	500	ND
PFOS	5,900	ND
PFOA	2,400	ND

HOLCIM

15

Sample Analytical Results

Comparison of sand vs no sand - same mix

South ADC Lite	As Received	SPLP
Sand	Results	Results
	ppt (ng/L)	ppt (ng/L)
PFBA	33,000	52
PFHxA	58,000	100
PFPeA	31,000	54
South- ADC Lite		
No Sand		
PFBA	33,000	120
PFHxA	58,000	290
PFPeA	31,000	120

HOLCIM

16

Sample Analytical Results

Parameter	As Received	Treated	Units
Arsenic	432	1.3	mg/L
Beryllium	<5	ND	mg/L
Cadmium	<1	ND	µg/L
COD	5,460	38	µg/L
Chloride	6,940	53	mg/L
Chromium	446	5	µg/L
Copper	22.7	2.3	µg/L
Iron	19,100	890	µg/L
Magnesium	425,000	410	µg/L
Manganese	2,980	22	µg/L
Mercury	<0.2	ND	µg/L

Parameter	As Received	Treated	Units
Nickel	418	11	µg/L
N, Ammonia	1,850	15	mg/L
Potassium	1,930,000	65,000	µg/L
TDS	22,000	1,760	mg/L
Selenium	43.5	ND	µg/L
Silver	<1	ND	µg/L
Sodium	4,930,000	80,000	µg/L
Sulfate	8,530	3.1	mg/L
Zinc	541	ND	ug/L

HOLCIM

17

Plus- DOT In-Situ Soil Sample Analytical Results Phase 2

DOT	As is Soil	As is Soil	Treated
Top Eight	MeOH	SPLP	SPLP
Congeners	ng/Kg- dry	ng/L	(9-S) ng/L
8:2 FTS	180,000	5,400	ND
PFDS	300,000	88	ND
PFDA	31,000	430	8
PFHxS	7,900	370	ND
PFNS	120,000	210	ND
PFOS	1,800,000	55,000	69
PFOA	33,000	1,300	24
FOSA	580,000	1,600	9
Total	3,051,900	64,398	110

HOLCIM

18

Presenter Biography

Paul Ruehl, US Environmental Remediation Coordinator

- Paul has over 45 years as an environmental professional, 41 years in the cement industry with 40 years focused on cement solidification/stabilization (S/S) at contaminated sites across North America
- Over last 4 years, actively conducting research to determine the best cementitious mix design for the encapsulation of PFAS in landfill leachate and soils
- Specializes in resource recovery type projects and alternative end uses
- Paul.ruehl@holcim.com
- 313-506-8495