

REGENES

Colloidal Activated Carbon Barrier to Reduce PFAS Migration Into the Oakland Inner Harbor

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Site Overview

Site Background

- Installation Restoration (IR) Site 14 (Site) is located on former Naval Air Station (NAS) Alameda.
- NAS Alameda served as an active Navy Base from 1940 to 1997.
- Site was developed by dredge and fill operations.





Site Overview

Per- and Polyfluoroalkyl Substances (PFAS) Concentrations

PFAS Source: Firefighting foam used historically during firefighter training.

- Initial Data Set
 - Highest Levels
- PFBS: 16,000 ng/L
- PFOA: 1,100,000 ng/L
- PFOS: 230,000 ng/L







CERCLA Process



Source: https://exwc.navfac.navy.mil/Products-and-Services/Environmental-Security/NAVFAC-Environmental-Restorationand-BRAC/Program-Support/CERCLA-Phases-and-Milestones/



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Colloidal Activated Carbon (CAC) Overview

PlumeStop Attributes

- Carbon particle sizes 1–2 μm
- Suspends as a colloid in polymer solution
- Distributes easily under low pressure
- Creates an in-situ purifying filter within the saturated zone
- Reduces concentrations of target compounds in groundwater







Conceptual Design

Create a Barrier to Reduce the Migration of PFAS in the Groundwater

- Injectable
- Permeable formation
- In-situ
- 720-feet long
- 288 direct push injection points





DVT: Upfront Work Dictates Performance







Column Study

Three Columns

- C1 = 0.0% CAC
- C2 = 0.5% CAC
- C3 = 2.0% CAC

Setup

- 12 inches in length
- 3.6 milliliters/hour flow rate
- 1-ft flow every 28 hours

Operation

- Ran one month with site water, then added CAC
- Ran four months after CAC addition (9 liters water after CAC)
- Collected effluent into 1-L bottles
- Sampled soils and analyzed for PFAS and combustible carbon







Column Study

Results

- C1 = 0.0% CAC
 - Little adsorption from the native aquifer soils observed
- C2 = 0.5% CAC
 - Reduced from 438,000 ng/L to 1,300 ng/L by Day 47
- C3 = 2.0% CAC
 - Reduced from 438,000 ng/L to <200 ng/L on Day 47 (slightly faster adsorption)
- Site groundwater that was collected to run the test had PFAS concentrations over 400,000 ng/L
- CAC can reduce groundwater PFAS concentration as expected
- Different concentrations of CAC can be matched to different PFAS concentrations along the barrier







Passive Flux Meter (PFM) Study

PFM Phases

- Phase 1: Determine future well screen placement
- Phase 2: Collect pre-injection data
- Phase 3: Collect post-injection data (est. Q4-2024)







Passive Flux Meter (PFM) Study

(PFOS)

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10000

10

20000



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Final Design of CAC Permeable Barrier

Barrier Wall Overview

- 720-ft
- Two lines of injection borings parallel to the shoreline

Injection Overview

- Target Zone: 1–16 ft bgs
- Varying doses of CAC injected into each boring, depending on PFAS levels (2.5%, 5.0%, and 7.5%)





Implementation of Work

- Schedule: June 20th July 31st (28 Days on-site)
- 2 Injection & Drilling Crews
- 340,000 lbs. of PS Installed (170 IBC Totes)
- 10 Semitruck Deliveries
- 290 Injection Points (3-17 ft bgs)
- Barrier Length = 720'
- Daily Average: 14,000 lbs. Injected (26,399 lbs. Daily High)
- Injected on Average: 3,500–4,500 gallons each day









Site Challenges











Performance Monitoring

Quarterly Sampling

- Sampling 18 wells
- All transect wells
- Cross gradient wells

CAC Observed in Samples

- Primarily in-barrier wells
- CAC was not observed in downgradient wells
- Samples were centrifuged in analytical laboratory









Transect Sampling Locations 1-3







PFOS Reductions

-		Upgradient - Shallow						PRB A	djacent - Sha	allow		DG of PRB						
Transect 1 (West)		M14-MW36S						P	M14-MW375		_	M14-MW27						
	Units	Baseline	Qtr.1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr.1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr.1	Qtr. 2	Qrt. 3	Reduction		
Analyte		6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%		
Perfluorobutanesulfonic Acid (PFBS)	ng/L	1,680	738	495	1,100	35	2,410	100	20	50	98	5,930	245	438	704	88		
Perfluorooctanesulfonic Acid (PFOS)	ng/L	215,000	97,300	57,900	115,000	47	167,000	140	9	188	100	36,700	15	186	842	98		
Perfluorooctanoic Acid (PFOA)	ng/L	73,500	26,200	17,300	37,000	50	99,700	87	10	62	100	247,000	45	491	1,740	99		
Transect 1 (West)			Upg	gradient - De	ер			PRB	Adjacent - D	eep								
			N	14-MW36D		ar ar		N	114-MW37D	н. 1								
	Units	Baseline	Qtr. 1	Qtr.2	Qrt.3	Reduction	Baseline	Qtr.1	Qtr. 2	Qrt. 3	Reduction			Travesci 2 - Carriel				
Analyte		6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%							
Perfluorobutanesulfonic Acid (PFBS)	ng/L	1,490	1,090	1,020	1,440	3.4	2,670	100	8	9	98.1	-						
Perfluorooctanesulfonic Acid (PFOS)	ng/L	218,000	74,100	75,800	102,000	53.2	171,000	417	26	19	100	T and the	America America	and control				
Perfluorooctanoic Acid (PFOA)	ng/L	77,400	59,100	70,800	85,200	-10.1	123,000	118	10	13	100	Constraining the Product States Laws Chain Lowing States That States Chain Consig States Performance Mediated Propuest States Performance Mediated Propuest States Performance Mediated Propuest States Performance Propuest Performance	And States of the Design	отранатолькой Лики (1915) Вали понитолькой Лики (1914) Така понитолькой Лики (1916) (1916) Така (1916)	Puncting MI will stay 23 fort true Sterm int enneatie Reactive Barrier	ALARCA CALPORAL ALARCA CALPORAL ALARCA CALPORAL ALARCA CALPORAL 6		





PFOS Reductions

Transact 2 (Contral)		Upgradient - Shallow						PRB A	Adjacent - Sh	allow		DG of PRB						
Transect 2 (Central)			Ν	/14-MW38S				1	M14-MW395			M14-MW22						
Analyte	Units	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction		
		6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%		
Perfluorobutanesulfonic Acid (PFBS)	ng/L	1,810	1,730	1,100	935	48.3	3,120	100	21	15	99.5	3,600	2,530	1,240	1,630	54.7		
Perfluorooctanesulfonic Acid (PFOS)	ng/L	141,000	149,000	107,000	154,000	-9.2	312,000	54	26	25	100	153,000	195,000	108,000	82,800	45.9		
Perfluorooctanoic Acid (PFOA)	ng/L	126,000	128,000	95,500	102,000	19	282,000	31	15	9	100	152,000	139,000	38,700	34,900	77		
Transact 2 (Control)			Upg	gradient - De	ep			PRB	Adjacent - D	eep								
Transect 2 (Central)			N	114-MW38D)		M14-MW39D											
Analyte	Units	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction			Trenant 2 - Gamma				
		6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%				Litren 1 - Ent			
Perfluorobutanesulfonic Acid (PFBS)	ng/L	1,710	33	240	376	78	2,970	100	11	37	98.8		in the second se					
Perfluorooctanesulfonic Acid (PFOS)	ng/L	90,900	18	761	8,640	90.5	392,000	232	49	36	100		C	Part and for an fa				
Perfluorooctanoic Acid (PFOA)	ng/L	143,000	31	2,710	15,300	89.3	260,000	129	18	72	100	Konzymonia per film orani orani Konzymonia per film orani Konzymonia kalko film Massa i sprawi kalko fil	Marine a Danne for the Dank Danne for grant and the Dank The Dank backgrant backgrant the Dank backgrant backgrant backgrant the Dank backgrant backgrant backgrant backgrant backgrant the Dank backgrant backgran		Nurveiling 195 all das 13 bet hen biere ne en onder kostter kanter	ACAREDA CALPONEA		





PFOS Reductions

Transact 2 (Fast)		Upgradient - Shallow						PRB /	Adjacent - S	hallow		DG of PRB						
Transect 5 (East)		M14-MW40S							M14-MW41	S		M14-MW28						
Analyta	Units	Pacalina	0+- 1	0+- 2	0-+ 2	Paduation	Pacalina	0+- 1	0+- 2	0+2	Paduation	Pacalina	0+- 1	0+- 2	0+2	Paduation		
Analyte		6/5/2022	10/22/2022	Qtr. 2	Qrt. 5	Reduction	6/5/2022	10/22/2022	Qtr. 2	Qrt. 5	Reduction	6/5/2022	10/22/2022	Qtr. 2	4/24/2024	Reduction		
		6/5/2025	10/25/2025	1/23/2024	4/24/2024	70	6/5/2025	10/25/2025	1/25/2024	4/24/2024	70	6/5/2025	10/25/2025	1/25/2024	4/24/2024	70		
Perfluorobutanesulfonic Acid (PFBS)	ng/L	2,840	2,960	1,170	1,430	49.6	4,740	100	21	1,820	61.6	5,980	5,850	3,410	865	85.5		
Perfluorooctanesulfonic Acid (PFOS)	ng/L	101,000	81,300	42,100	72,600	28.1	97,500	100	21	10,900	88.8	37,700	37,100	34,300	11,900	68.4		
Perfluorooctanoic Acid (PFOA)	ng/L	230,000	169,000	67,600	117,000	49.1	301,000	162	32	72,200	76	252,000	254,000	168,000	28,600	88.7		
T			Upg	radient - D	eep			PRB	Adjacent -	Deep		Market Market Andrew States and St						
Transect 3 (East)		M14-MW40D							M14-MW41	D		-	the second se					
	Units											-		Transet 2 - Canna		A DESCRIPTION OF		
Analyte		Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction	Baseline	Qtr. 1	Qtr. 2	Qrt. 3	Reduction			Stores .				
-		6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	6/5/2023	10/23/2023	1/23/2024	4/24/2024	%	大 王 二		- Palet	Conset 1 - East	Shengless.		
															House and the second second	Contra Co		
Perfluorobutanesulfonic Acid (PFBS)	ng/L	4,400	3,680	1,630	1,450	67	6,210	4,200	2,060	15	99.8	= huis	antes .	1				
													A Print		and fine			
Perfluorooctanesulfonic Acid (PFOS)	ng/L	91,700	73,300	39,500	31,000	66.2	47,200	12,800	9,260	25	99.9		1 1 1/	and the second s		PROPOSED PLINICIPAL ALMAN		
												Control Memory Net Dig Federation Academy Memory Net Dig Federation Economy Med Party Network Memory Property And Party Network Memory Property Academy Technology Memory Property Statemy Technology Memory	Sanahigi - San'i Sanci Jak - Agamanana Sasamatin Nas Sanahi - Farna Fatiphing Turang Asabam - Sanahi Sanching - San - Sanahi Sanching - San - Sanching - S		n Phone/Seg PHD will stay 12 heet heen (some n (seg Annexader Associate Associate	AND POWYORKANCH WOMFOORNANCH STEL 14 ALAMBOA FORMY		
Perfluorooctanoic Acid (PFOA)	ng/L	230,000	227,000	90,400	81,500	64.6	301,000	115,000	69,300	27	100	Propulation gradest file large gradest Propulation (1993) Propulation (1993) Propulation (1994) Propulation (1994)	Life		-	ENAVEAC		



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Questions?





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