ECOSTABLE Technologies

Presented by: Chuck Hornaday and Amine Dahmani, Ph.D.

SEDFIRST™ Sediment Cap Stabilization

Who is ECOSTABLE Technologies ?

SESI Consulting Engineers & Samarcel Partnership

- EcoStable Technologies is the exclusive distributor SEDFIRST™ & SANDFIRST™ technologies in the US
- Samarcel created the product concept
- SESI provides technical, marketing and administrative support

Dr. Amine Dahmani, Ph.D., Inventor and Owner of Samarcel

- 27 years of experience
- Senior Project Manager at SESI
- Adjunct Professor at the Civil & Environmental Engineering department at UCONN

Chuck Hornaday, Sales Support for SEDFIRST™

- 25 years of experience in the environmental and sediment remediation markets
- Geologist and product development specialist

Introduction of SEDFIRST™ Sediment Stabilizer

Provides cohesion and enhances natural processes of

- Sand (SANDFIRST™ product)
- Sediment
- Soil

Cohesion will enhance cap performance and reduce material requirements

Technology Description

- Protein-Polysaccharide Biopolymer (PPB) technology
- Natural, non-toxic, food-grade, and biodegradable ingredients
- White odorless powder
- Added at a low dosage rate (typically < 1 % by weight)

SEDFIRST™

Benefits of SEDFIRST™

Improves water quality during cap placement

- Decreases costs associated with WQ management and compliance
- Reduces loss of high-value amendments
- Reduces costs associated with over-placement of capping materials

Provides a more homogeneous blend of capping material during and after placement

- No separation during the placement
- No stratification
- Better cap performance

Benefits of SEDFIRST™

Cohesion reduces erosion by providing shear strength

- Reducing loss of high-value amendments after placement
- Increased stability
- Reducing need for over-placement to account for erosion

Stimulates colonization of sediment cap biota

- Naturally increases cap stability

Bringing Life to Your Cap

- Natural biota secretions, increase cohesion
- Biofilms on the sand grains
- Organic secretions increase the erosion resistance
- SedFirst “Jump-starts” the process, attracting microphytobenthos and macrobenthos to the cap

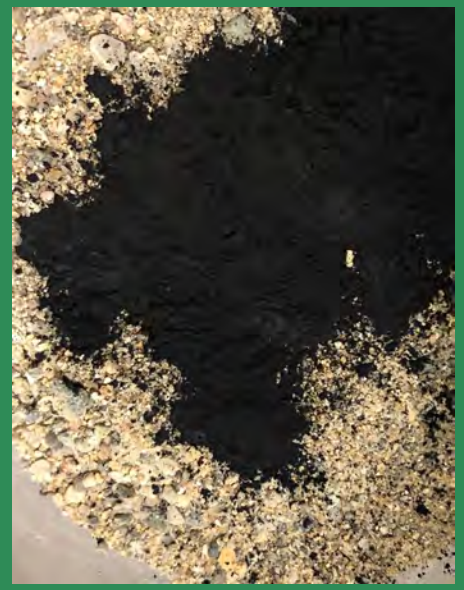
SEDFIRST™ Technology Overview

Site-specific formulations are tailored to meet your performance objectives.

- Minimized turbidity during placement
- Reduced loss of amendments
- Homogenized capping layer
- Reduced cap erosion

The formulation and dosage of SEDFIRST™ is optimized for each project based on objectives and site characteristics

Mixing Approach

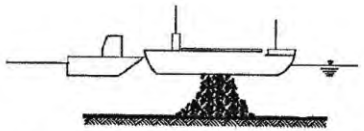


Sand/PAC

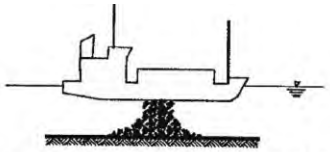
Sand/PAC/SED-3

Add 20% Moisture

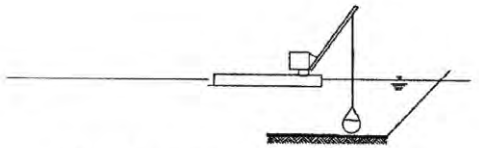
Potential Application Methods



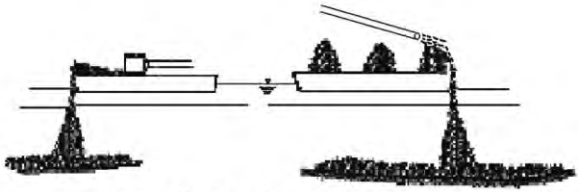
Surface Release from Barge



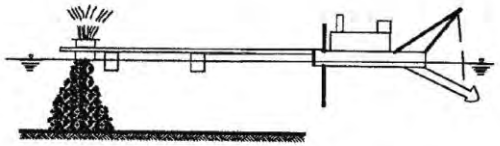
Surface Release from Hopper Dredge



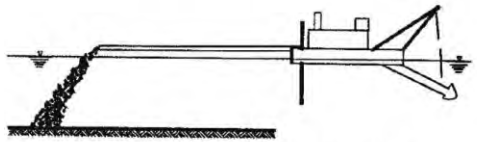
Direct Mechanical Placement



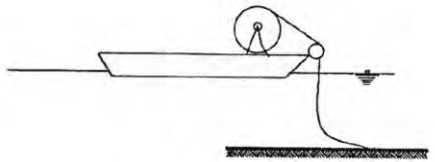
Spreading/Jetting from Barge



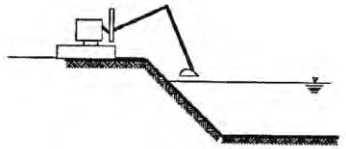
Spreading with Pipeline and Baffle Plate or Box



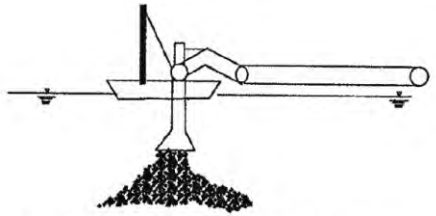
Surface Discharge with Pipeline



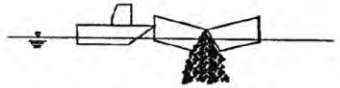
Barge Equipped for Geotextile Placement



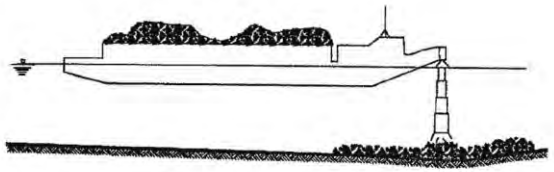
Land - based Direct Placement



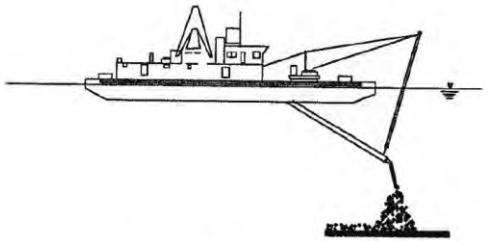
Submerged Diffuser with Pipeline



Spreading by Controlled Barge Release



Barge with Tremie



Sand Spreader Barge

Ref: ITRC

Testing

University of Connecticut (UCONN) - Civil & Environmental Engineering Laboratories:

- Advanced Geotechnical/ Soils Laboratory
- Geo-environmental Laboratory

Enhancing PAC Placement Study

Comprehensive testing program

- 3 PACs - Calibration curves developed correlating turbidity to PAC mass in suspension
- Sand selected to be used in upcoming sediment capping project in New Jersey
- Control compared to .5% SedFirst treated samples for PAC concentrations from 5 to 50% PAC and MC ranging from 20 – 80%
- Turbidity measured at 5, 10, 30 minutes, and 24 hours
- Video and photo documentation
- Full report available
- Studies have also been conducted on GAC and Organoclay amended cap material

PAC Characteristics

1. The GC Powdered from **General Carbon** in New Jersey. GC Powdered Activated Carbon is a virgin carbon derived from sleeved grades of bituminous coal. It has a minimum surface area of 900 m2/g. It meets the requirements of AWWA B600-90. Its specifications are as follows:

Specifications

Mesh Size, (US Sieve):	
-100 mesh, %	99 (min)
-200 mesh, %	95 (min)
-325 mesh, %	90 (min)
Iodine Number, mg/g	800 (min)
Surface Area, m^2/g	900 (min)
Moisture, % (as packaged):	5 (min)
Typical Density, lbs/cu.ft.:	29-33
g/cc:	0.48-0.52

2. **NORIT**® SedimentPure™ powdered activated carbon from Cabot. It is a lignite coal-based activated carbon grade specifically designed for removing PCBs, PAHs, dioxin and furan in contaminated sediments. It has an approximate surface area of 550 m^2/g, according to the vendor.

Specifications

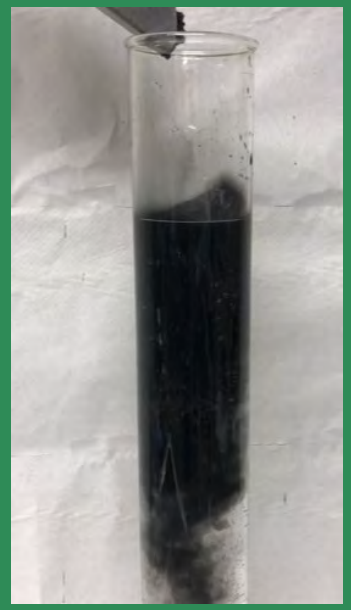
Mesh size (U.S. Sieve Series) less than 325 mesh	min. 90	mass -%
Moisture (as packed)	Max 12	mass -%

3. **Hydrosil** HS-AS-PAC is a highly active powdered activated carbon (PAC) produced from a blend of coal and wood. It has high a surface area ranging from 850-900 m^2/g. Hydrosoil's HS-AS-PAC is designed for liquid phase applications. The product is NSF/ANSI 61 certified. Its typical physical properties are as follows:

Typical Physical Properties

Type	Wood/Coal
Iodine Number, mg/gm (ASTMD-4607)	800
Apparent Density, g/L	420-480
U.S. Standard Sieve Size (Mesh Size)	100, 200, 325
Total Surface Area (BET), m^2/gm	850-900
Moisture, % (ASTM D-2867)	5%

Enhancing PAC Placement (GC PAC)



Untreated Sand 5% GC/PAC (Control)
Stratification and Dispersion

0.5% SedFirst-Treated Sand/5%PAC
Uniform Distribution, No Dispersion

Sand, 5% GC Powdered PAC; 20% moisture:	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
1) Control (sand, 5% PAC, 20% moisture)	> 3,000	2480/4	766/56	45.2/95
2) Treated with 0.5% SED 3	12.9/96.7	9.2/96.9	8.0/97	2.9/97.3
% NTU reduction / %Settled difference	>99%/>99%	99.63/92.9	98.96/41%	93.58/2.3

Note: PAC settled in a quiescent environment (column)

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Turbidity Results Comparison (3 PACs)

Sand, 5% GC Powdered PAC; 20% moisture:	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
1) Control (sand, 5% PAC, 20% moisture):	> 3,000	2480/4	766/56	45.2/95
2) Treated with 0.5% SED 3	12.9/96.7	9.2/96.9	8.0/97	2.9/97.3
% NTU reduction / %Settled difference	>99%/>99%	99.63/92.9	98.96/41	93.58/2.3

Sand, 5% Hydrosil PAC; 20% moisture	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
1) Control (sand, 5% PAC, 20% moisture):	2458/9.44	1057/61.48	387/86.37	18.2/100
2) Treated with 0.5% SED 3	5.9/100	4.9/100	3.7/100	2.32/100
% NTU reduction / %Settled difference	99.76/90.56	99.54/38.52	99.04/12.63	82.42/0

Sand, 5% Cabot PAC; 20% moisture	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
1) Control (sand, 5% PAC, 20% moisture):	122/96	84/96.8	70/97.1	12/97.8
2) Treated with 0.75% SF-2	6.9/98.5/84.76	5.5/98.6	3.5/98.6	2.0/98.8
% NTU reduction / %Settled difference	94.3/2.5	93..4/1.8	95/1.5	83/1.0

Enhancing PAC Placement (10% GC PAC)

Untreated sand/10% GC/PAC (Control) stratification and dispersion

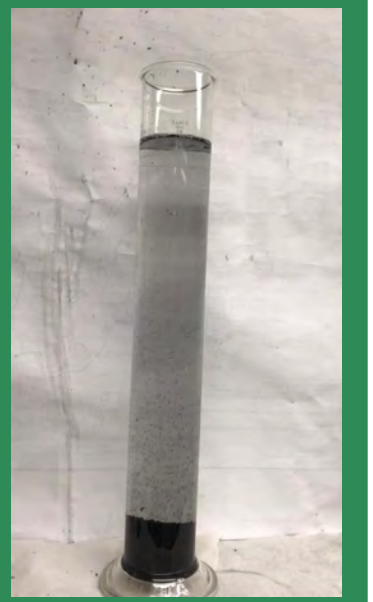
0.5% SEDFIRST™-treated sand/10%PAC uniform distribution

Sand, 10% GC Powdered PAC; 20% moisture	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
1) Control (sand, 10% PAC, 20% moisture)	>3000	>3000	2208/0	301/90.53
2) Treated with 0.5% SEDFIRST™	4.9/98.6	4.5/98.6	4.1/98.6	2.5/98.65
% NTU reduction / %Settled difference	>99%/>99%	>99%/>99%	99.81/98.6	99.17/8.12

Low turbidity (< 10NTU) may be achieved with SEDFIRST™ treatment up to 15% PAC dosages

Moisture Content Impact

0.5% SED-3 / Sand / 5% GC/PAC (20% moisture)



0.5% SED-3 / Sand / 5% GC/PAC (10% moisture)

Sand, 5% GC Powdered PAC; 20% moisture:	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
Treated with 0.5% SED 3	12.9/96.7	9.2/96.9	8.0/97	2.9/97.3

Sand, 5% GC Powdered PAC; 10% moisture:	5 min NTU/%Settled	10 min NTU/%Settled	30 min NTU/%Settled	24 hrs NTU/%Settled
Treated with 0.5% SED 3	18.2/96.44	16.4/96.54	15.2/96.6	4.63/97.18

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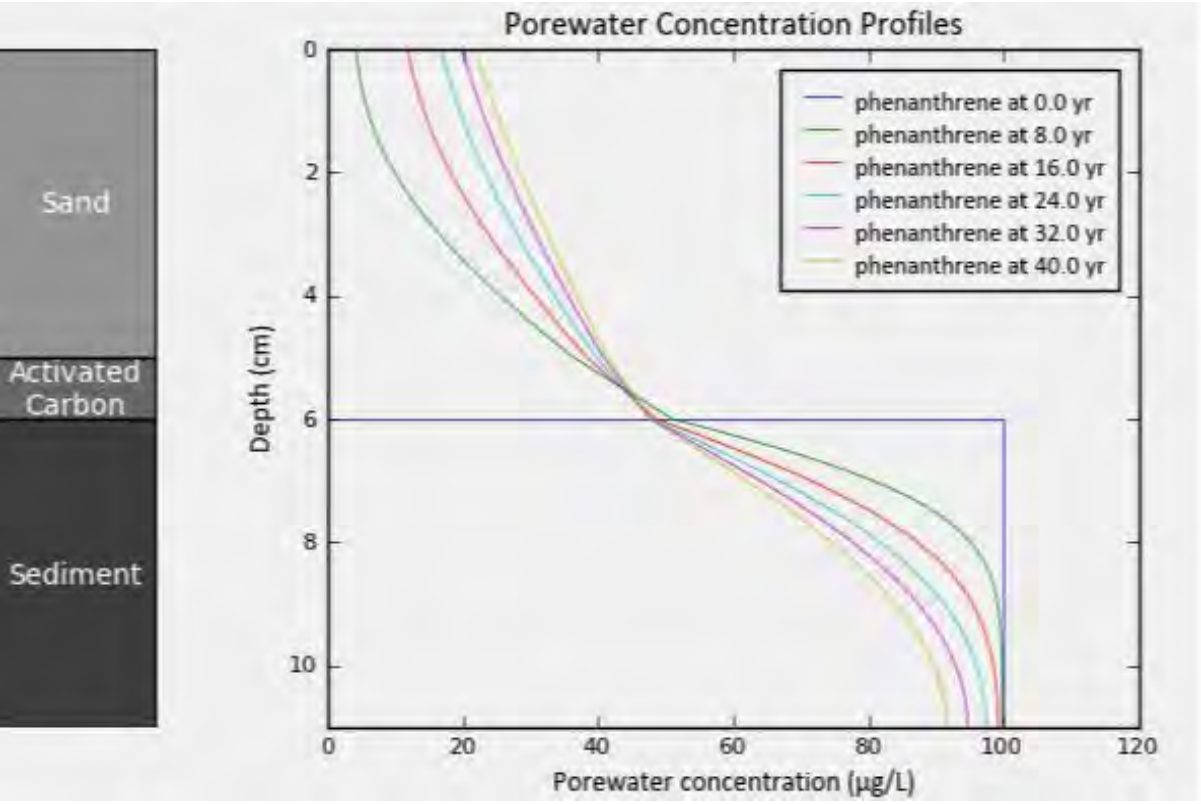
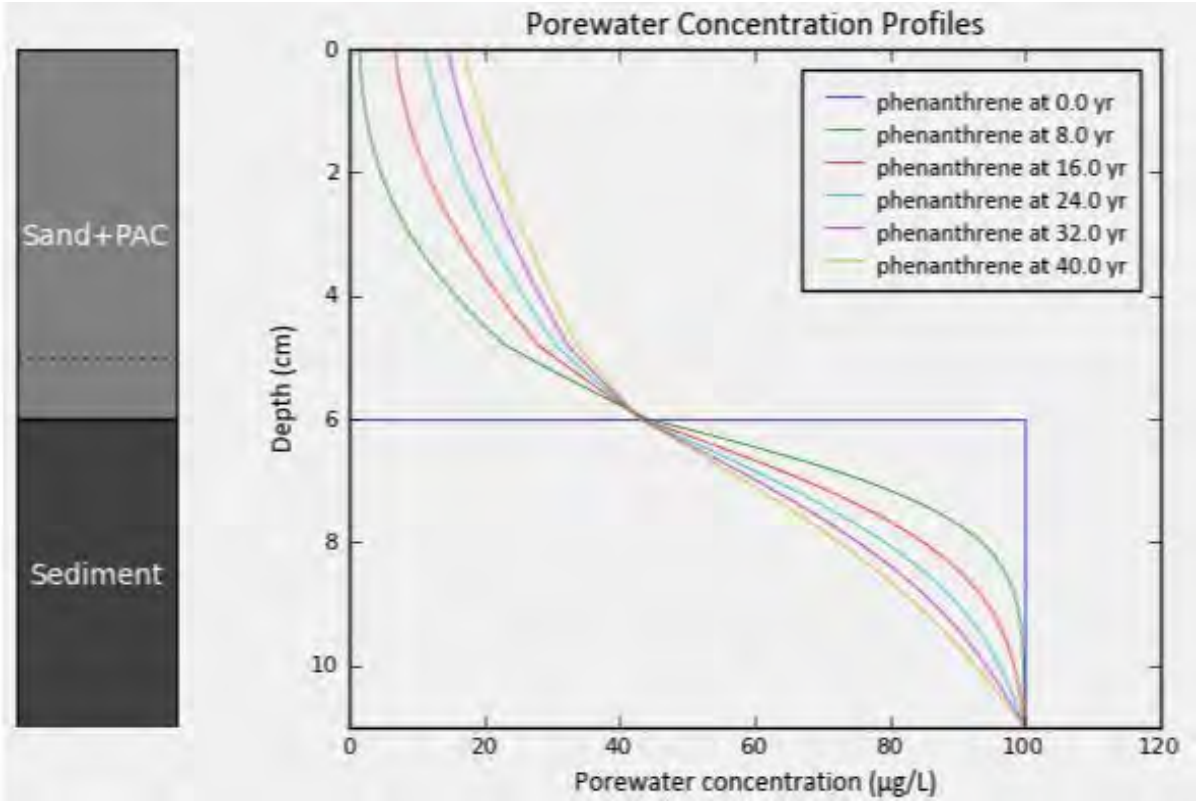
CAPSIM Modeling Results (Phenanthrene)





Homogeneous Sand/PAC yields about 20% lower pore water concentration at the top

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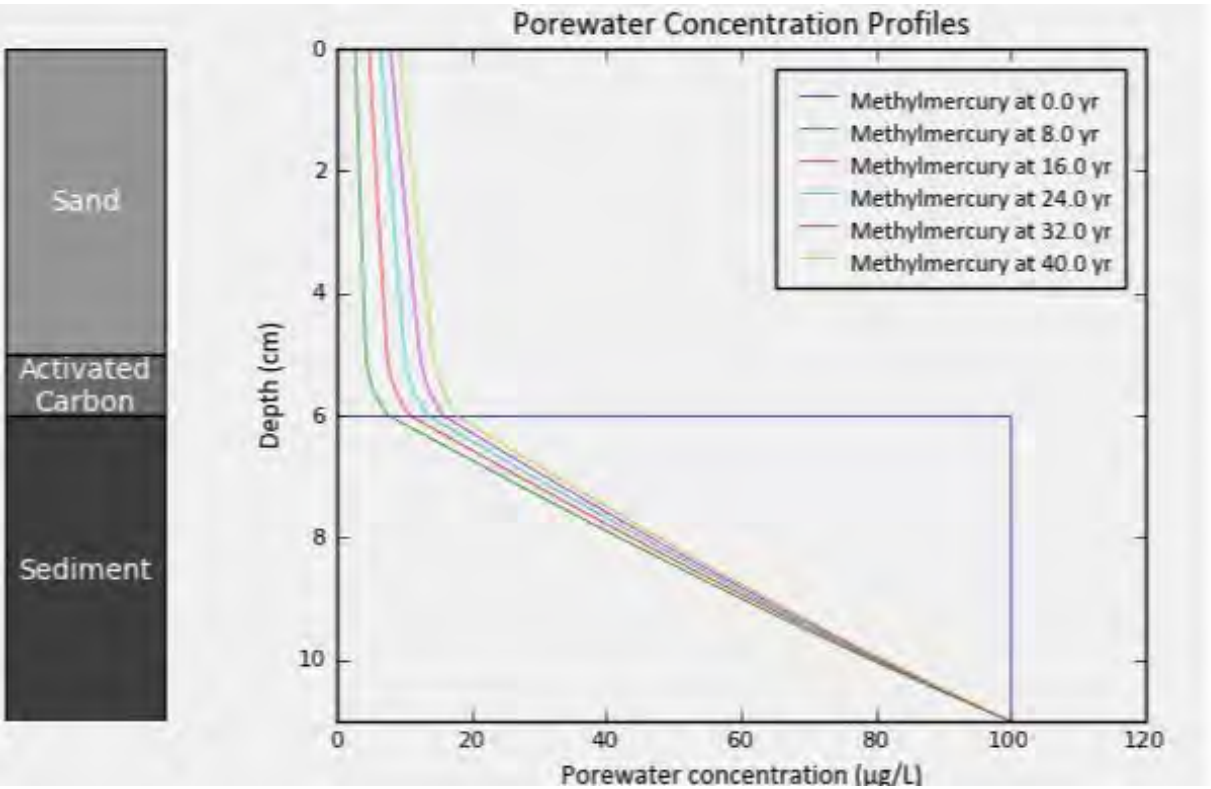
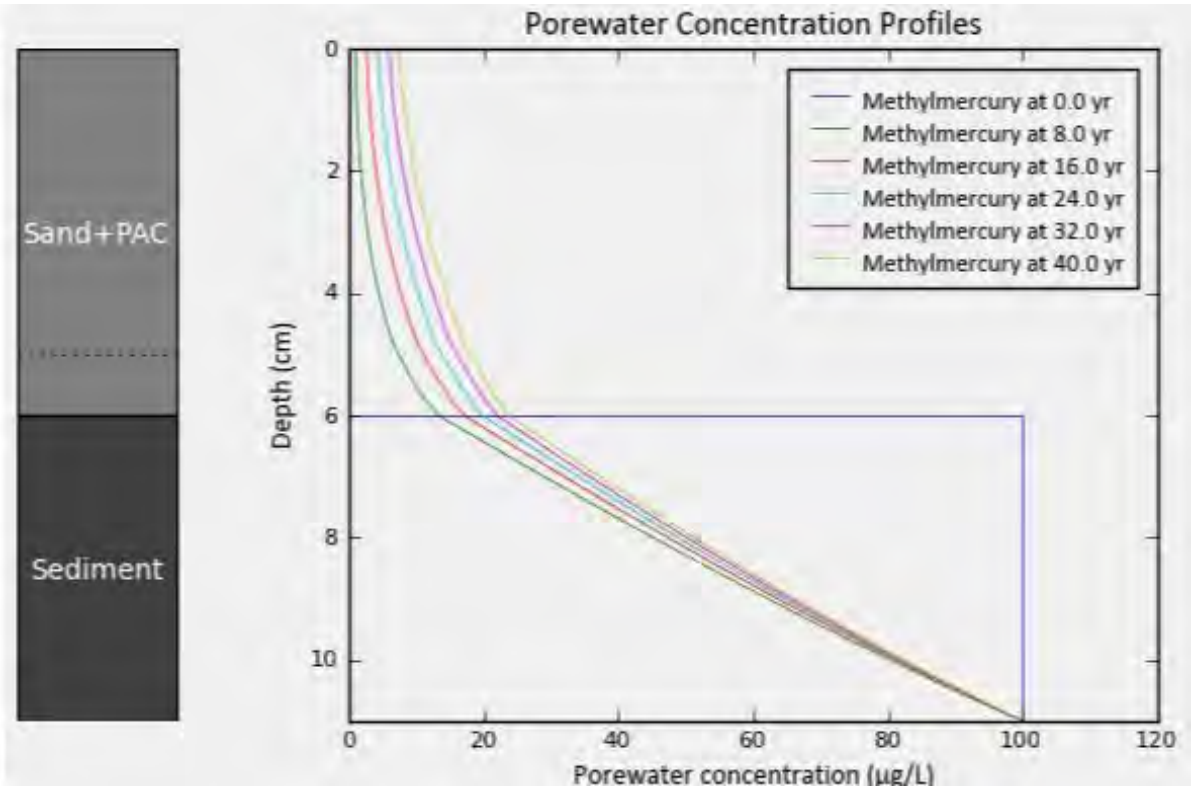
CAPSIM Modeling Results (Methylmercury)





Homogeneous Sand/PAC yields about 20% lower pore water concentration at the top

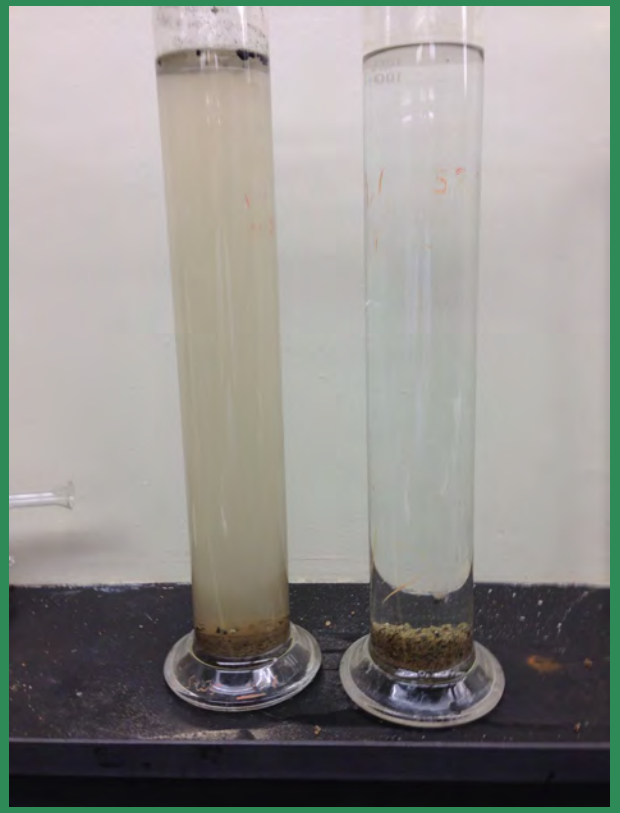
SEDFIRST™

Enhancing PAC Placement Study

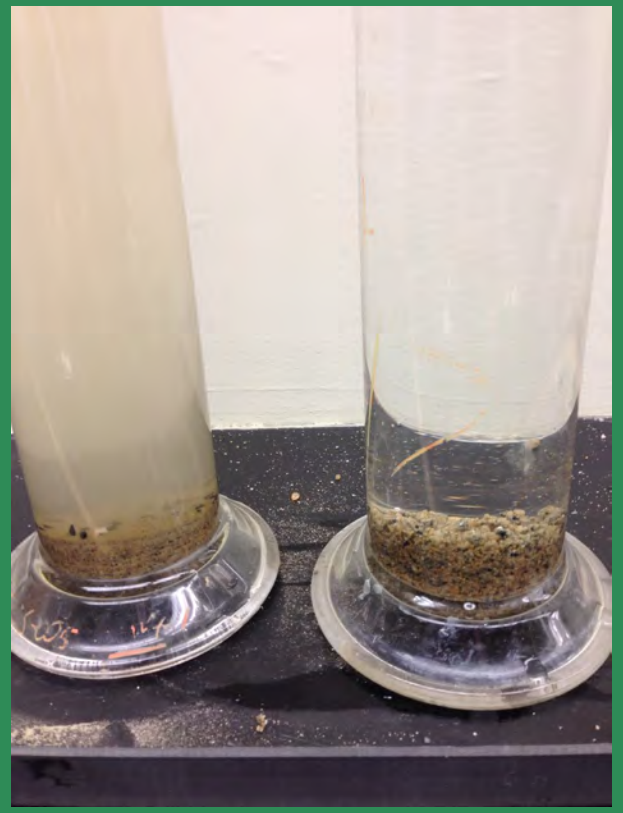
Conclusions:

- SEDFIRST™ performed best at reducing turbidity for placement of bituminous coal-based PAC.
- SEDFIRST™ performed well on PAC composed of blends of bituminous and wood/plant-based carbon
- SEDFIRST™ reduced stratification when used with lignite-based PAC, resulting in a more homogeneous cap structure.

Enhancing GAC Placement



Control vs Sand, 5% GAC, 1% SED-1



Close up of control vs SED-1 Treated
Note uniform GAC distribution

Enhancing Organic Material Placement

Samples prepared with 20% moisture content

- Control
- 0.2% Sed B
- 0.5% Sed B

Visual observations of the product effectiveness

Aquatic Toxicity - Lab Study Results

48-hr acute Ceriodaphnia Dubia test (EPA 821-R-02-012) in sand/freshwater reactors (endpoint % survival)

96-hr acute Pimephales Promelas test (EPA 821-R-02-012) in sand/freshwater reactors (endpoint % survival)

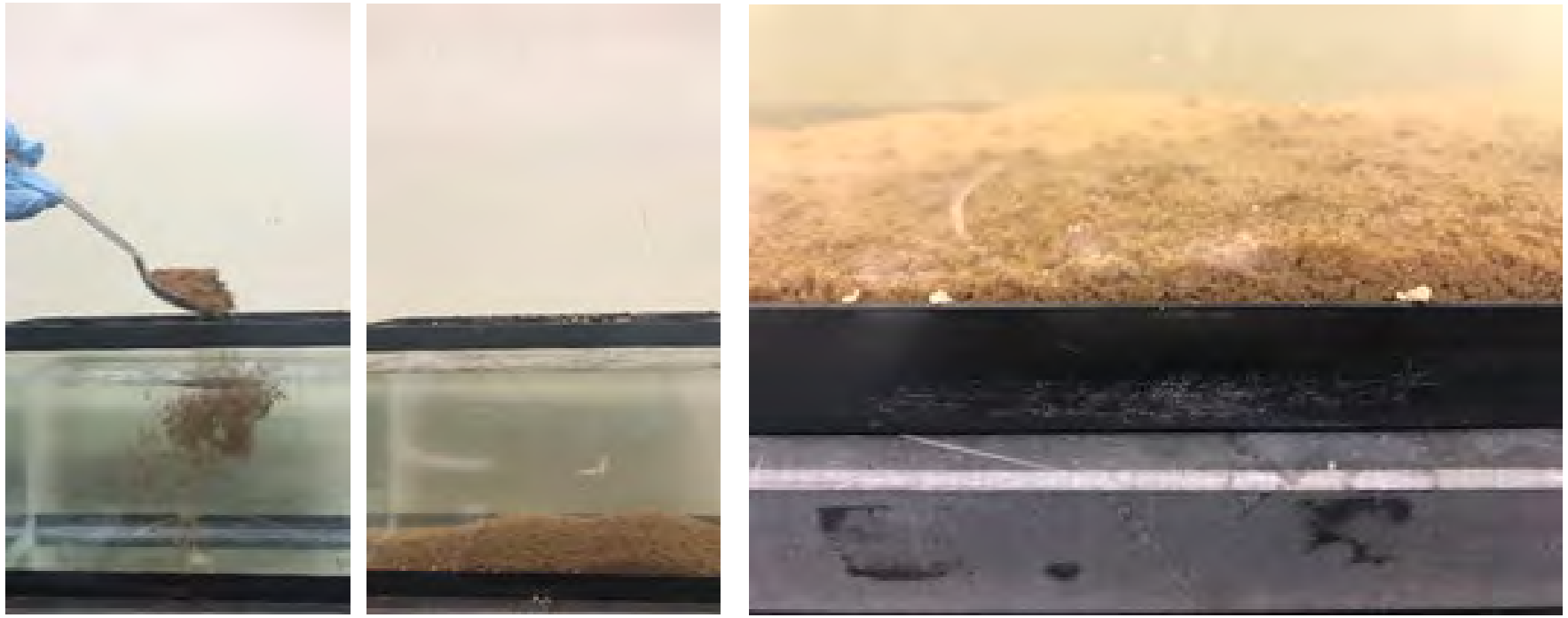
Percentage of Survival

	Ceriodaphina Dubia	Pimephales Promelas
SEDFIRST™ Treated	94%	100%
Untreated	82%	100%

Product Specifications:

- Vegetable Protein Extracts: < 20%
- Polysaccharides: < 95%
- Off-White Powder; Odorless

BOD5 Testing



From left to right (SED-3 treated sand placement; final placement; closeup)

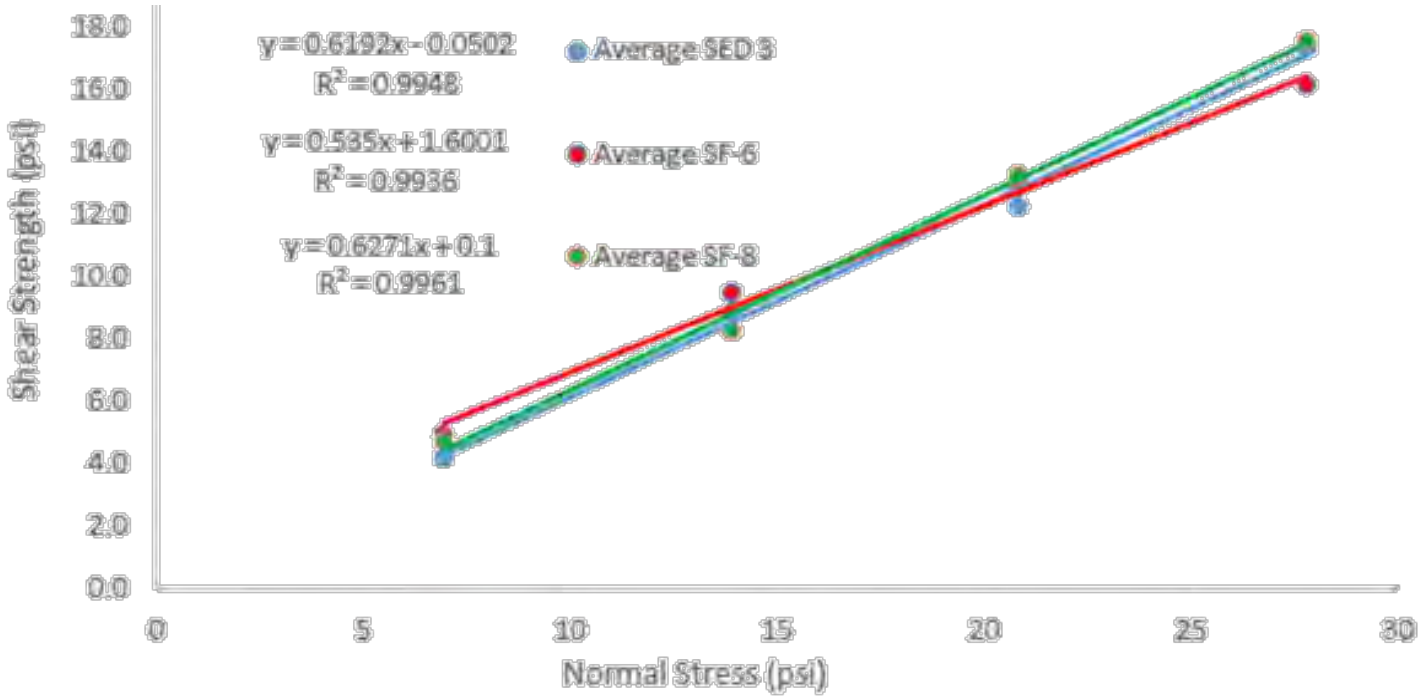
BOD5 Testing

- Flux rate of water above the sand: 74.4 L/ft^2/hr (semi-quiescent conditions).
- Flux rate of water above the sand at a site: 9746 L/ft^2/hr, 131 times higher.
- BOD5 testing presents a conservative approach. BOD5 samples taken just above the sand surface.
- BOD5 was not detected (< 4.1 mg/L) at Days 0,1,6,7,13 and 22.

Cohesion Testing

- Sand is generally cohesionless
- Small addition of SedFirst creates cohesion capable of resisting bed shear forces
- Sand and Granular Organoclay (2 & 4% by wt) were mixed with 0.5 and 1% SEDFIRST™ – sample sheared as mixed (no heating or curing)

Increased Shear Strength & Cohesion - Lab Results



For Comparison

Silty Clay	1.89 psi
Silty or Clayey Fine Sands	1.02 psi
Silty Sand	3.19 psi

- Cohesion values of 1.6 psi and 2.55 psi achieved, 0.5% and 1% SedFirst respectively. Internal friction angles of up to 29° (2% OC, .5% SED8)

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Effect of SED-3/PAC on Saturated Sand Cohesion

Sand + 5% GC PAC				
	Shear Stress (psi)			
Normal Stress (psi)	Trial 1	Trial 2	Trial 3	Trial Average
6.95	2.9	2.9	3.3	**3.0**
13.89	8	6.9	7.3	**7.4**
20.83	10.9	11.3	10.9	**11.0**
27.78	15.7	16.4	14.6	**15.6**
			Soil Cohesion	1.05
			Frictional Angle	**28.18**

Sand + 0.5% SED 3 + 5% GC PAC				
	Shear Stress (psi)			
Normal Stress (psi)	Trial 1	Trial 2	Trial 3	Trial Average
2.9	1.5	2.9	2.6	**2.3**
8	8	8	6.6	**7.5**
11.7	11.3	11.7	10.9	**11.3**
15	16.1	15	15.7	**15.6**
			Soil Cohesion	1.92
			Frictional Angle	**29.83**

For Comparison: Silty Clay 1.89 psi

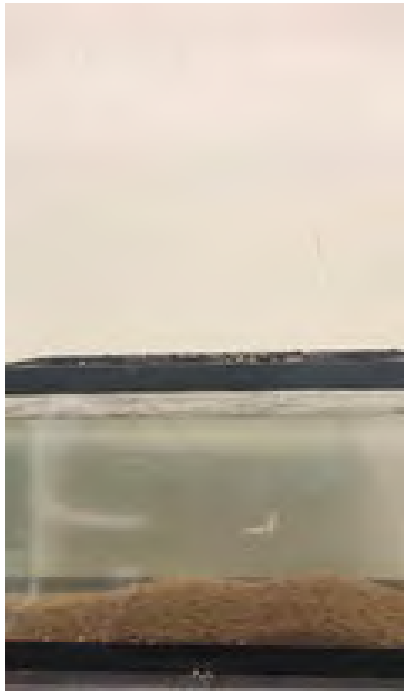
Silty or Clayey Fine Sands 1.02 psi

Silty Sand 3.19 psi

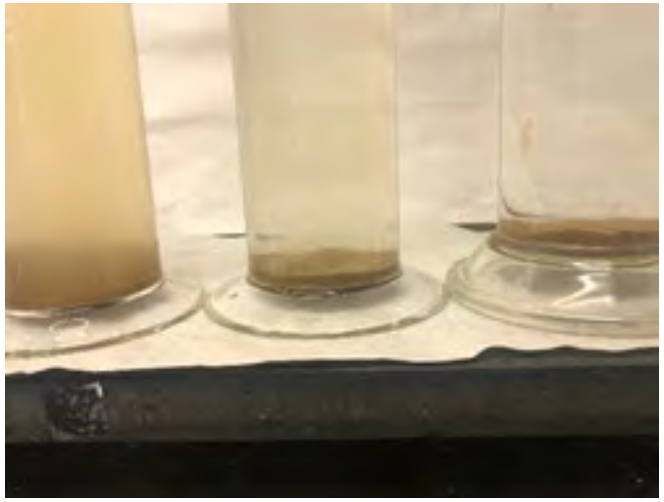
Control, Sand Only — Cohesionless

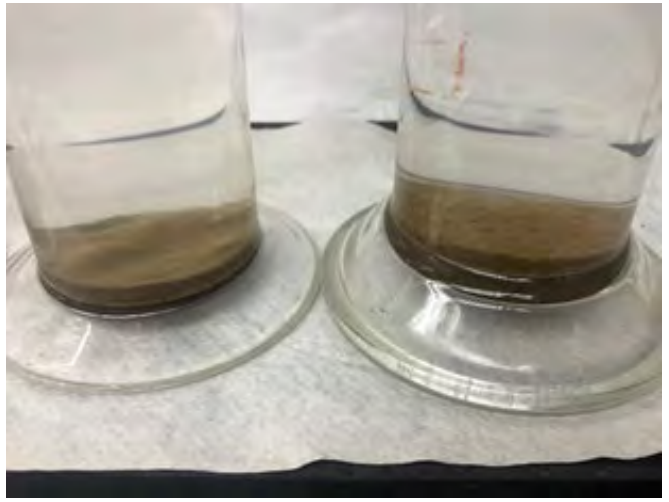
Longevity Testing

- SedFirst longevity depends on formulation, surface water velocity, pore water velocity and biodegradation.
- SedFirst-SED-3 designed for limited longevity.
- Flux rate of water above the sand in tank test: 74.4 L/ft^2/hr (semi-quiescent conditions).
- Flux rate of water above the sand at a site: 9746 L/ft^2/hr, 131 times higher.



Longevity Testing





Tank **Control** **Day 6** **Day 0** **Day 0** **Day 6**

- Turbidity generated by sand subsamples from tank used as surrogate for SED-3 removal.
- 22 days were needed to lose all the SED-3 product under low experimental flux rate.
- When adjusted to actual water flux rate at a site, it would take 4 hours to lose the SED-3 product.

Longevity Testing

- Likely only short-term effect on K and adsorption.
- “temporary cohesion” can be achieved.
- Longer-term cohesion can be achieved using different formulations and higher dosages.

Original Cap Design

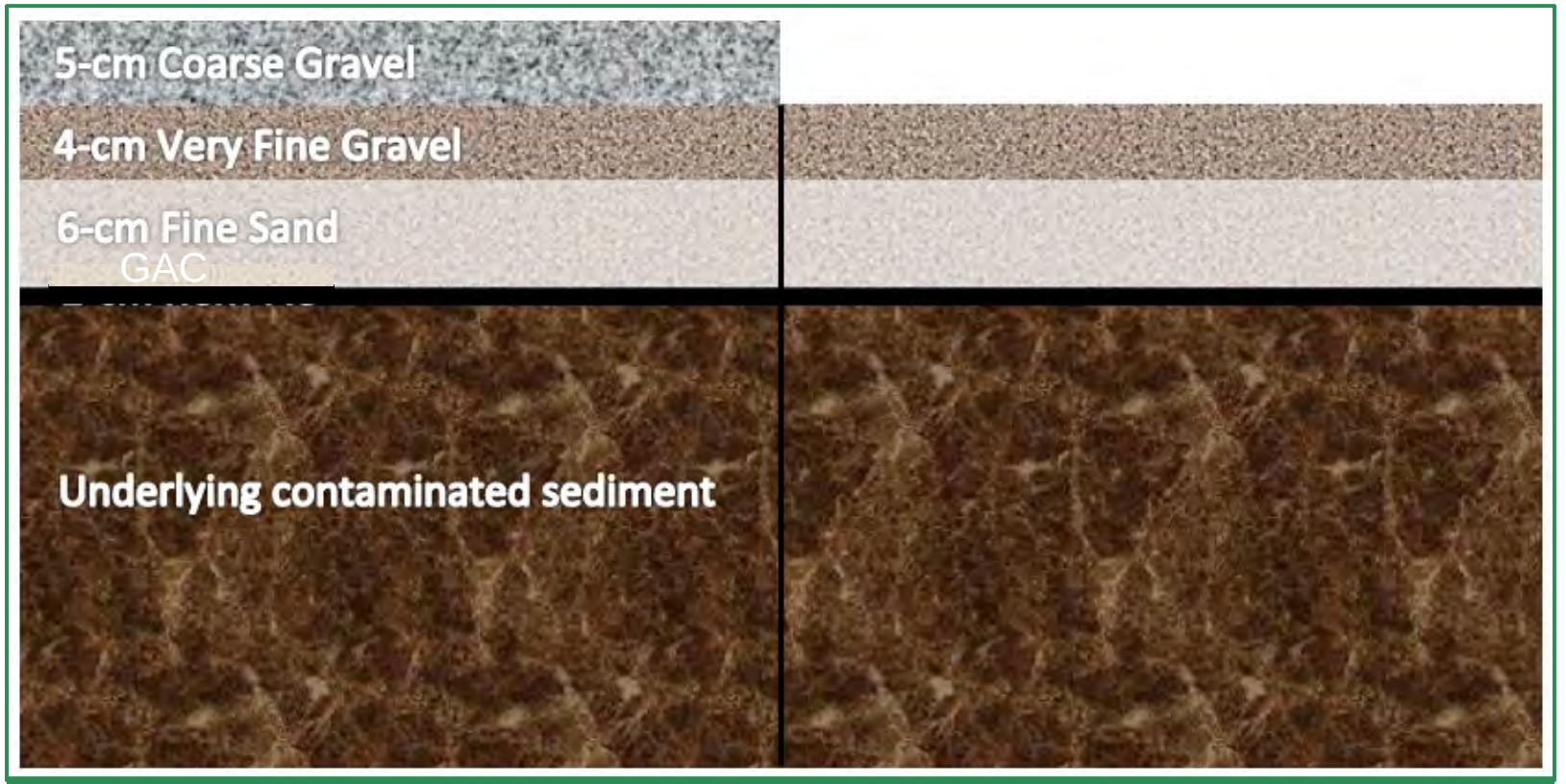


Diagram of proposed cap layering

Alternative Cap Design

SedFirst Cap

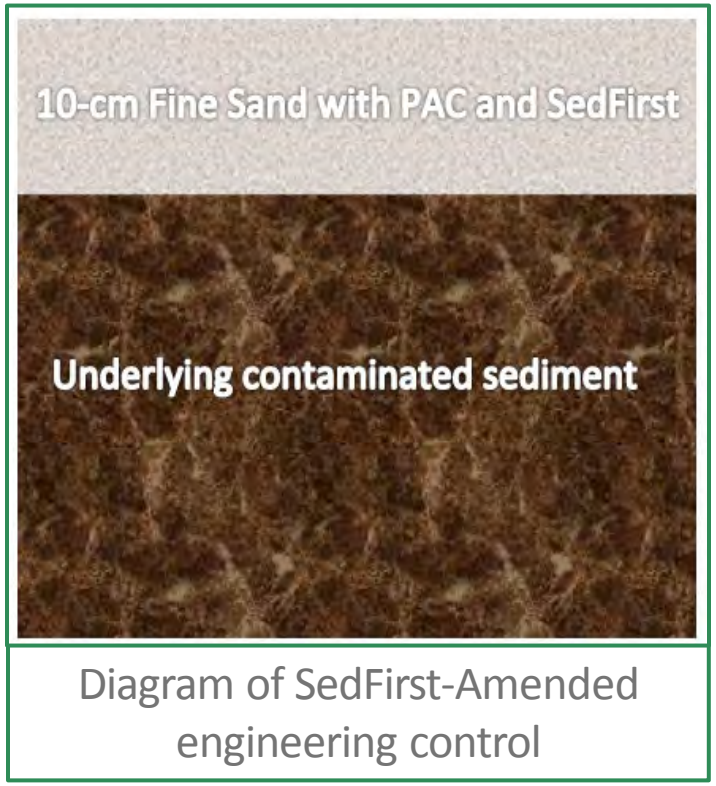


Diagram of SedFirst-Amended engineering control

Cap Design

- The entirety of the pond would be covered in a single-layer cap of 10-cm consisting of a mixture of fine sand mixed with 5% PAC and 0.5% SEDFIRST™
- A sand/0.5%PAC/0.5% SEDFIRST™ mixtures have shown a cohesion value of 1.92 psi (~13,000 Pa), which is much higher than the 8 Pa armored cap design criterion.
- Adjustable ratio of PAC to sand from 5% PAC:95% sand up to 20% PAC:80% sand

Other Applications

- ✓ Reduce turbidity and associated contaminant transport related to intertidal mudflats
- ✓ Barrier Island restoration
- ✓ Dredged material marsh creation
- ✓ Sediment and nutrient trapping
- ✓ Stabilize upland soils (erosion control)
- ✓ Shoreline protection – beach erosion SANDFIRST™

SEDFIRST™ Summary

- Non-toxic, natural biopolymer that enhances natural processes & provides cohesion
- Stabilizes sand-based isolation caps
- Enhances placement of Activated Carbon (PAC & GAC) and Organoclay with sand
- Enhanced cohesion provided reduces costs and improves performance of the cap.

Pilot tests are sought to test the technology's various applications.

SEDFIRST™ FAQs

What is the specific SEDFIRST™ formulation?

The technology is protected by trade secrets, as such specific detail is not available regarding the formulation.

How much does it cost?

The material is sold on a per pound basis.

$3.00 to $6.00 per pound

SEDFIRST™ FAQs

What is the difference between SEDFIRST™ and a Type B Soil Stabilizer?

Type B stabilizers are often made from synthetic non-biodegradable chemicals The most common commercial polymer used on agricultural soils is polyacrylamide (PAM). SEDFIRST™ is a natural biopolymer that biodegrades.

Will it impact the dewatering process of PPB treated sediments?

PPB treated sediments will have an increase water holding capacity, however this is not anticipated to impact the typical dewatering processes

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