

CAPABILITY STATEMENT

GWC HRP JV LLC



WHO WE ARE

GWC HRP JV LLC specializes in environmental consulting for the Federal government, Department of Defense and the private sector. We bring multidisciplinary and institutional expertise specifically to our US government clients with the breadth and full span of our projects experience. Our services include Site Investigation and Remediation, PFAS Characterization and Forensics, Environmental Compliance, Drinking Water, Stormwater and Wastewater Programs Support, Environmental Construction Management, HAZMAT Surveys, and Abatement. Our team is well versed in traditional investigation methods covering a wide range of site constituents, geologic settings, and environmental media. With emerging contaminants like PFAS increasingly being detected in the environment, our team has stayed up to date on the research, regulations, and litigations surrounding PFAS.

CORE COMPETENCIES

- Compliance Audits
- EMSWeb and HWMS Subject Matter Experts
- Environmental Construction Management
- Environmental Engineering and Compliance
- Environmental Management Systems Audit and Implementation
- HAZCOM and HAZMAT Awareness Training
- Water Resources Engineering, Geotechnical Investigation and Design
- HAZMAT Surveys & Abatement
- Health and Safety Training and Consulting
- Management Plan Development, Permit Support, and Compliance Reporting for a wide diversity of programs (e.g., Air Quality, Drinking Water, EPCRA, Hazardous Waste, NEPA, SPCC, Storage Tanks, Stormwater, Wastewater)
- National Environmental Policy Act (NEPA) Evaluations
- Groundwater Monitoring of Explosive Residues
- Natural Resources Assessment, Threatened & Endangered Species Habitat Management, and Ecosystem Adaptive Planning
- NEPA Support and Ecological Studies
- PFAS and PCB Forensics
- PFAS and PCB Remediation Design and Oversight
- Proprietary PFAS Remediation Technology for Soil
- PFAS and PCB Source Delineation
- Radon Testing Services
- Site Investigation and Remediation
- Remediation System Optimization
- Stormwater Illicit Discharge Monitoring
- Stormwater Management
- Tank Management
- Water Sampling and Analysis, Quality Assurance Project Plans, Drinking Water Auditing, and Water Quality Monitoring Plans
- Water Systems Vulnerability Assessment, Emergency Response Planning, and Tabletop Exercises
- Civil Engineering, Site Design, and Permitting

PAST PERFORMANCE

Our subject matter experts have provided the environmental consulting services listed above for the following military installations in CONUS and OCONUS, US government agencies, and state agencies:

- Department of Veterans Affairs
- Marine Corps Base Quantico, VA
- NAVFAC Washington
- National Park Service NER - Boston
- Joint Base Anacostia Bolling, DC
- US EPA
- NSF Carderock, MD
- NAS Patuxent River Complex, MD
- NSA Bethesda, MD
- NSA Arlington, VA
- NSA Annapolis, MD
- NSA Mechanicsburg, PA
- NSA Philadelphia, PA
- NSF Dahlgren, VA
- NSF Indian Head, MD
- Washington Navy Yard, DC
- US Naval Observatory, DC
- Marine Corps Logistics Base Albany, GA
- Marine Corps Base Camp Lejeune, NC
- Military Ocean Terminal, Sunny Point, NC
- NSA Naples, and NAS Sigonella, Italy
- NAVSTA Rota, Spain
- New York State Department of Environmental Conservation

PERTINENT CODES

Designation

SBA certified 8(a)
Economically Disadvantaged
Woman-Owned Small
Business

JV Managing Partner

Greenwise Consulting LLC
PO Box 650143
Sterling VA, 20165
grnwise.com

JV Partner

HRP Associates, Inc.
701 Easley Bridge Road
Suite 4130
Greenville, SC 29611
hrpassociates.com

Unique Entity Identifier

PV5GSJMEBQD8

CAGE Code: 9SY92

NAICS Codes:

- 541620 - Environmental Consulting Services
- 541330 - Engineering Services
- 541690 - Other Scientific And Technical Consulting Services
- 541990 - All Other Professional, Scientific, And Technical Services
- 562910 - Remediation Services
- 611430 - Professional and Management Development Training



Zeina Hinedi | zeina@grnwise.com | (703) 717-8710

Bryan Massa | bryan.massa@hrpassociates.com | (781) 210-9840





Zeina Hinedi, PhD **PRESIDENT**

Over 30 years of Project Management as an Environmental Scientist. Dr. Hinedi is currently priming, as part of ACE JV, a \$30M NAVFAC Washington contract (N40080-21-D-0013) with focus on stormwater, drinking water, and wastewater (54 TOs, 3 years). Throughout her career as an environmental consultant, she has managed 600+ TOs across 25+ Navy and US Marine Corps facilities in CONUS and OCONUS. She has worked under various Navy contracts, also with JV partners and subcontractors. Dr. Hinedi oversaw the development and implementation of health and safety and QAQC procedures, managed several multifaceted environmental projects involving SDWA and CWA compliance, including SWPPPs, Contaminant Sampling Plans, sanitary surveys, wellhead protection plans, and pollution mitigations. Environmental compliance subject matter expert in Safe Dring Water Act and Clean Water Act.



Bryan Massa, LSP **PRINCIPAL, REGIONAL MANAGER**

Bryan is a Licensed Site Professional (LSP) in the State of Massachusetts and has over 23 years of experience in the environmental field. His experience includes the development and implementation of environmental site assessments, complex analytical data review, remediation design and oversight, risk assessments, emergency response to releases of oil and/or hazardous materials (OHM), soil gas and indoor air assessment, due diligence investigations, forensic evaluation, and cost allocation. His portfolio includes multiple interdisciplinary projects that combine remediation efforts with civil site design, stream restoration, and adaptive reuse. Bryan has significant experience in PCB and PFAS investigation, remediation, forensics, and cost allocation and has been involved in multiple complex PFAS projects.



Thomas Darby, PG **ENVIRONMENTAL PRACTICE LEADER**

Mr. Darby is a licensed Professional Geologist and currently serves as the Environmental Practice Leader with HRP in the Greenville, South Carolina office. He has more than 19 years of experience in site characterization, conceptual site model development, and developing and implementing remedial strategies. In his role as Environmental Practice Leader, he provides technical support to a wide variety of projects to encourage and broaden the development of HRP staff, improve, increase and contribute to the high level advancement of the individual practices. Mr. Darby has served on numerous high profile projects nationwide. Mr. Darby’s has worked on a wide range of projects throughout his career as a hydrogeologist.



Keith Bulla, PE, MCE **DIRECTOR OF ENGINEERING SERVICES**

Mr. Bulla has over 40 years of work experience, including over a decade at US Army Corps of Engineers, Wilmington District as a Project Engineer and five years as Staff Engineer with the City of Wilmington, NC. During his environmental consulting experience as Project Manager/SME Mr. Bulla worked on 500+ DoD projects in CONUS and OCONUS DoD installations. Mr. Bulla’s experience includes project management, planning, design, construction, operation, sanitary surveys, emergency response plans and vulnerability assessments for water, wastewater, and stormwater facilities (transmission, collection, and treatment). Mr. Bulla also has extensive experience in the hazardous waste field in the area of the investigation, assessment and remediation of contaminated soil and groundwater.



CAPABILITY STATEMENT

GWC HRP JV LLC



PFAS REMEDIATION FOR SOIL

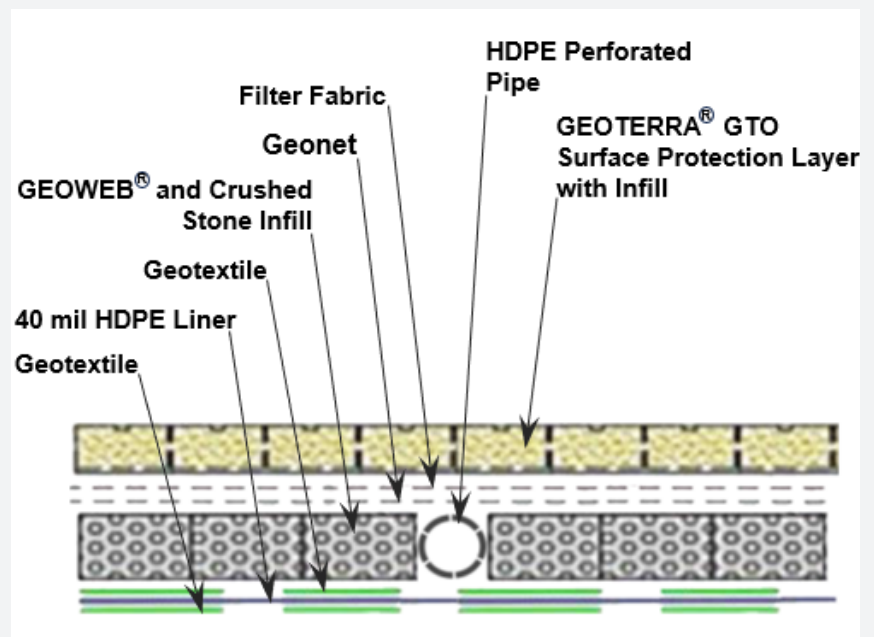
GWC HRP JV LLC is a newly formed 8(a) joint venture between Greenwise Consulting (GWC) LLC and HRP Associates (HRP) Inc. GWC, the 8(a) EDWOSB, are water resources compliance subject matter experts and HRP are site assessment, and remediation experts.

This document describes a cost-effective proprietary “**RAPID LEACHING TECHNOLOGY**” (RLT) developed by Next Earth Environmental (NEE) and used to remediate PFAS in soil. One of HRP’s principals is the founding member of NEE and co-inventor of the technology. RLT is not a soil washing technology. Soil washing is cumbersome and results in the production of soil fines that are unable to be cleaned and are considered a hazardous waste. RLT is much more efficient at producing clean soils without any residual fines and results in PFAS destruction. It uses a containment cell with a patented drainage system that has been in use within the frac sand industry since 2017. The patent holder of this drainage system is one of our collaborators.

Benchtop testing of RLT has shown removal rates of over 93% for total PFAS and over 99% for PFOA after four soil leaching cycles. This remediation technology mobilizes contaminants from soil to water and can be optimized for different contaminants. Once liquefied, contaminants are removed from water with traditional treatment methods.

The treated water is then cycled through the soil again, drained, and reused. The entire soil treatment process takes place within a 40-mil double-lined and bermed watertight containment cell. The process of soil leaching and water treatment is repeated multiple times until the contaminant reaches the desired removal level.

RLT is a cost-effective solution compared to traditional PFAS remediation methods. Once installed, the treatment cell is reusable for future projects. The technology is completely adaptable and scalable to different sized projects, different contaminants, and addition of other technologies under development. The cross-section to the left is a simplified diagram of the components of the drainage system. The soil within the containment is completely submerged with water. Air is then delivered through the same pipe system that drains the water and is used to agitate the soil. A leaching cycle consists of 10 to 60 minutes of agitation, depending on the soil type. During this cycle, large air bubbles move through the water and soil causing PFAS to leach out of the soil into the water. At the end of the leaching cycle, the water containing the PFAS is rapidly drained from the soil and treated. The soil is quickly dried and can be readily removed within 24 hours of the final leaching cycle. RLT can clean about 300 to 800 tons of soil a week depending on the size of the containment cell.



RLT is considered a **GREEN TECHNOLOGY**. It results in clean soil, clean wash water, no hazardous wastes, maintains landfill space, and reduces carbon emissions by limiting soil transportation to out-of-state facilities. PFAS remains trapped in activated carbon, which is then regenerated offsite via a process that destroys 99.9% of the contaminants and reactivates the carbon for future use.



Zeina Hinedi | zeina@grnwise.com | (703) 717-8710
Bryan Massa | bryan.massa@hrpassociates.com | (781) 210-9840



CAPABILITY STATEMENT

GWC HRP JV LLC



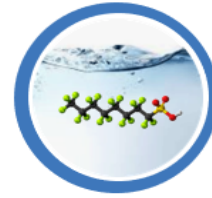
PFAS REMEDIATION FOR SOIL



STEP 1: PFAS impacted soil is excavated and then placed into the double lined soil containment cell with drainage system.



STEP 2: The soil containment cell is flooded with water and then the soil is agitated with large air bubbles.



STEP 3: PFAS leaches from the soil and mobilizes into the water.



STEP 4: PFAS impacted water is pumped through a treatment system. Resulting clean water is transferred back to the soil containment cell and Steps 2-4 are repeated.



STEP 5: Once desired contaminant removal level is reached, clean soil is removed from the containment cell and Steps 1-4 are repeated, as necessary.



STEP 6: Clean water is discharged or recycled after the project is completed and all soil has been cleaned.

Excavation of 35,000 yd ³ Between 2-5 ft below ground surface	Rapid Leaching Technology	Soil Excavation and Disposal (Subtitle C Landfill)
	100'X100' Cell	500 tons per week, 70 weeks
Leachability/Benchtop Testing	\$55,000 to \$65,000	N/A
Soil Disposal Characterization for Landfill (One sample per 500 cubic yards)	Not Applicable	\$100,000 to \$120,000
Civil Engineering Design Costs	\$70,000 to \$100,000	\$70,000 to \$100,000
Environmental Engineering Design Costs (Water Treatment Design)	\$25,000 to \$35,000	N/A
Reactor Cell Construction	\$1,560,000 to 1,700,000	N/A
Wastewater Treatment System Mobilization	\$40,000 to \$80,000	N/A
Construction Oversight /Equipment Costs	\$6,400,000 to \$6,600,000	\$2,800,000 to \$3,000,000
PFAS Post Treatment Sample Collection (one per 500 cubic yards)	\$35,000 to \$45,000	NA
Soil Import and Placement	N/A	\$3,150,000 to \$3,250,000
Soil Borrow Source Testing	N/A	\$50,000 to \$55,000
Soil Disposal	N/A	\$63,000,000 to \$63,200,000
TOTAL COST	\$8,185,000 to \$8,625,000	\$69,170,000 to \$69,725,000

This table demonstrates the cost savings of RLT compared with soil transport and disposal. Note that this project example uses a smaller 100 x 100 feet squared containment cell that can clean about 300 cubic yards of soil during a regular work week. For a large installation, we recommend a 100 x 150 feet squared cell to double the cleaning rate to 600 cubic yards of soil per week. A second project of the same size using the same cell would easily save \$1.5M to \$2M due to the reduced time working in the field. The increased capital costs of constructing the larger containment cell would be completely recouped via the savings on the reduced field labor by the end of the first project. Additionally, the entire treatment process can be built under a structure to protect the equipment from the elements and be reused for up to 10 years.



Zeina Hinedi | zeina@grnwise.com | (703) 717-8710
 Bryan Massa | bryan.massa@hrpassociates.com | (781) 210-9840



PFAS

Rapid Leaching Technology

Summary of Benchtop Studies

Bryan Massa (Licensed Site Professional and Principal with HRP Associates, Inc.) is one of the founding members of Next Earth Environmental, LLC and co-inventor of the rapid leaching and dewatering PFAS treatment technology. This document is a summary of laboratory studies that demonstrated the PFAS removal efficiency from contaminated soil after only four leaching cycles.

Two separate benchtop studies of the remediation technology have documented average total PFAS removal in soil ranging from 89 to 93 percent. Removal rates of the five PFAS analytes regulated by the EPA were between 94 and 100 percent. Additional rinse cycles can be introduced into the process to meet or approach 100 percent total PFAS removal. Once the PFAS is removed from the soil, the contaminants are destroyed using sorption with high temperature destruction and regeneration, sonication, or other innovative destructive methods. We anticipate achieving 89 to 99.99 percent destruction, consistent with the bench scale studies and the efficiencies of high temperature destruction and regeneration. The details provided below focus on the AFFF testing results as it is most relevant to the FAA grant application.

The AFFF benchtop study used a 50:50 mixture of Chemguard C301MS and Ansulite AFC-5-A AFFF concentrate spiked into four, approximate 250-gram aliquots of soil. The aliquots of soil were homogenized, and the tests completed. A photograph depicting the four test cells (A1, B1, C1, D1) used in the benchtop study is shown here.



Laboratory Results From the Benchtop Study

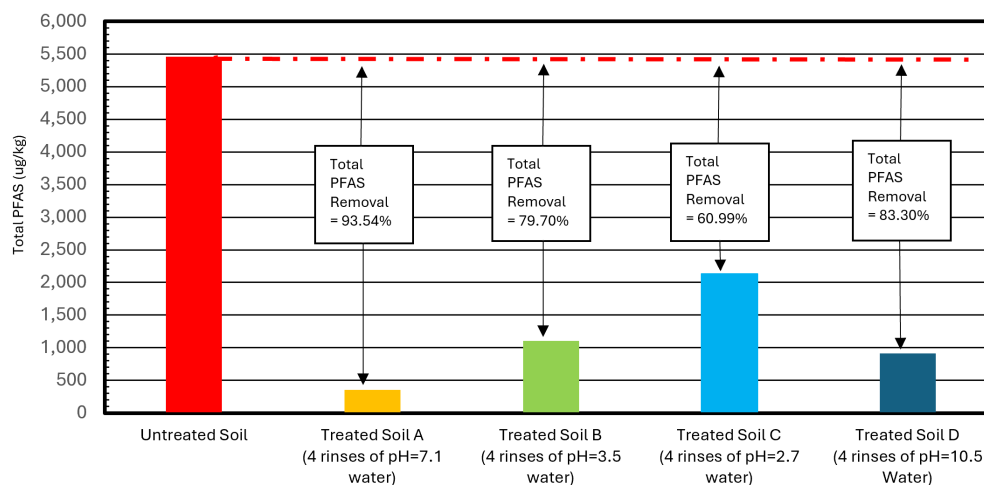
The benchtop study included the collection of 26 samples for laboratory analysis of PFAS via EPA Method 1633 at Alpha Analytical, a Pace laboratory located in Massachusetts. A description of the samples submitted are indicated below:

QA/QC Samples	Soil Samples	Water Samples
PFAS Free Water, pH = 7.1 (reagent grade water)	"A" Soil spiked with 10 milliliters of the 50:50 AFFF concentrate the rinsed with "A" water	A1: First rise of 1.5 liters of PFAS Free Water, pH=7.1 A2: Second rise of 1.5 liters of PFAS Free Water, pH=7.1 A3: Third rinse of 1.5 liters of PFAS Free Water, pH=7.1 A4: Fourth rinse of 1.5 liters of PFAS Free Water, pH=7.1
PFAS Free Water, pH = 3.5 (reagent grade water and hydrochloric acid)	"B" Soil spiked with 10 milliliters of the 50:50 AFFF concentrate the rinsed with "B" water	B1: First rise of 1.5 liters of PFAS Free Water, pH=3.5 B2: Second rise of 1.5 liters of PFAS Free Water, pH=3.5 B3: Third rinse of 1.5 liters of PFAS Free Water, pH=3.5 B4: Fourth rinse of 1.5 liters of PFAS Free Water, pH=3.5
PFAS Free Water, pH = 2.7 (reagent grade water and hydrochloric acid)	"C" Soil spiked with 10 milliliters of the 50:50 AFFF concentrate the rinsed with "C" water	C1: First rise of 1.5 liters of PFAS Free Water, pH=2.7 C2: Second rise of 1.5 liters of PFAS Free Water, pH=2.7 C3: Third rinse of 1.5 liters of PFAS Free Water, pH=2.7 C4: Fourth rinse of 1.5 liters of PFAS Free Water, pH=2.7
PFAS Free Water, pH = 10.5 (reagent grade water and sodium hydroxide)	"D" Soil spiked with 10 milliliters of the 50:50 AFFF concentrate the rinsed with "D" water	D1: First rise of 1.5 liters of PFAS Free Water, pH=10.5 D2: Second rise of 1.5 liters of PFAS Free Water, pH=10.5 D3: Third rinse of 1.5 liters of PFAS Free Water, pH=10.5 D4: Fourth rinse of 1.5 liters of PFAS Free Water, pH=10.5
Blank Soil (un-spiked soil, sandy loam)	Spike Soil spiked with 10 milliliters of the 50:50	Not Applicable

Notes:

1. pH adjustment completed using reagent grade hydrochloric acid or sodium hydroxide as indicated above.
2. Reagent grade PFAS-free water provided by Alpha Analytical.
3. All QA/QC samples did not have detectable levels of PFAS, verifying proper sample handling and testing procedures.
4. Spike soil was used to represent the concentration of PFAS within the soil prior to treatment (A Soil through D Soil).

The pH neutral water (pH = 7.1) yielded the highest removal efficiency, achieving 93% removal of total PFAS and 99% of PFOA. Refer to the attached tables for tabulated laboratory results. The pH adjustment is necessary in determining the most efficient way to partition PFAS from soil based on the unique chemical properties of Site-specific soil (i.e., total organic carbon). The graph below shows how pH adjustment of the rinse water affected total PFAS removal during each of the four test runs. The untreated soil ("Spiked Soil") is the initial PFAS concentration before treatment. Please refer to attached Tables 1 and 2 for the raw data for soil and water samples, respectively. Please refer to notes beneath the tables for more information.



Tabulated Soil Results - Table 1

SAMPLE ID:	BLANK SOIL	SPIKE SOIL	A SOIL			B SOIL			C SOIL			D SOIL		
LAB ID:	L2404927-01	L2404927-02	L2404927-03			L2404927-04			L2404927-05			L2404927-06		
COLLECTION DATE:	1/28/2024	1/28/2024	1/28/2024			1/28/2024			1/28/2024			1/28/2024		
SAMPLE MATRIX:	SOIL	SOIL	SOIL			SOIL			SOIL			SOIL		
Extraction Water pH	NA	NA	pH=7			pH=3.5			pH=2.7			pH=10.5		
PERFLUORINATED ALKYL ACIDS BY EPA 1633 (ng/g)	Result	Result	Result	Percent Difference (Spike Soil and A Soil, ND=0)	Percent Difference (Spike Soil and A Soil 1/2 RL)	Result	Percent Difference (Spike Soil and A Soil, ND=0)	Percent Difference (Spike Soil and A Soil 1/2 RL)	Result	Percent Difference (Spike Soil and A Soil)	Percent Difference (Spike Soil and A Soil 1/2 RL)	Result	Percent Difference (Spike Soil and A Soil)	Percent Difference (Spike Soil and A Soil 1/2 RL)
Perfluorobutanoic Acid (PFBA)	<0.791	16.8	<0.872	100.00%	97.40%	<0.872	100.00%	97.64%	<0.793	100.00%	97.64%	<0.8	100.00%	97.62%
Perfluoropentanoic Acid (PFPeA)	<0.396	23.2	<0.436	100.00%	99.06%	0.756	96.74%	96.74%	1.15	95.04%	95.04%	1.2	94.83%	94.83%
Perfluorobutanesulfonic Acid (PFBS)	<0.198	2.36	<0.218	100.00%	95.38%	<0.218	100.00%	95.81%	<0.198	100.00%	95.81%	<0.2	100.00%	95.76%
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	<0.791	<8.22	<0.872	NA	89.39%	<0.872	NA	90.34%	<0.793	NA	90.35%	<0.8	NA	90.27%
Perfluorohexanoic Acid (PFHxA)	<0.198	44.3	0.264	99.40%	99.40%	1.21	97.27%	97.27%	2.09	95.28%	95.28%	1.74	96.07%	96.07%
Perfluoropentanesulfonic Acid (PFPeS)	<0.198	2.14	<0.218	100.00%	94.91%	<0.218	100.00%	95.37%	<0.198	100.00%	95.37%	<0.2	100.00%	95.33%
Perfluoroheptanoic Acid (PFHpA)	<0.198	78.1	0.299	99.62%	99.62%	1.92	97.54%	97.54%	6.95	91.10%	91.10%	3.19	95.92%	95.92%
Perfluorohexanesulfonic Acid (PFHxS)	<0.198	10.8	<0.218	100.00%	98.99%	0.465	95.69%	95.69%	2	81.48%	81.48%	0.554	94.87%	94.87%
Perfluorooctanoic Acid (PFOA)	<0.198	159	0.568	99.64%	99.64%	7.22	95.46%	95.46%	35.3	77.80%	77.80%	8.04	94.94%	94.94%
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	<0.791	297	14.3	95.19%	95.19%	19.7	93.37%	93.37%	57.3	80.71%	80.71%	21.7	92.69%	92.69%
Perfluoroheptanesulfonic Acid (PFHpS)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
Perfluorononanoic Acid (PFNA)	<0.198	3,200	89.3	97.21%	97.21%	625	80.47%	80.47%	1,530	52.19%	52.19%	430	86.56%	86.56%
Perfluorooctanesulfonic Acid (PFOS)	<0.198	78.9	7.74	90.19%	90.19%	20.6	73.89%	73.89%	27.8	64.77%	64.77%	18.1	77.06%	77.06%
Perfluorodecanoic Acid (PFDA)	<0.198	34.1	4.08	88.04%	88.04%	10.3	69.79%	69.79%	12.6	63.05%	63.05%	9.41	72.40%	72.40%
1H,1H,2H,2H-Perfluorodecane sulfonic Acid (8:2FTS)	<0.791	66.5	7.35	88.95%	88.95%	16.2	75.64%	75.64%	24.9	62.56%	62.56%	16.1	75.79%	75.79%
Perfluorononanesulfonic Acid (PFNS)	<0.198	4.66 F	<0.218	100.00%	97.66%	0.326 F	93.00%	93.00%	0.861 F	81.52%	81.52%	0.345 F	92.60%	92.60%
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
Perfluoroundecanoic Acid (PFUnA)	<0.198	1,120	172	84.64%	84.64%	305	72.77%	72.77%	315	71.88%	71.88%	322	71.25%	71.25%
Perfluorodecanesulfonic Acid (PFDS)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
Perfluorooctanesulfonamide (PFOSA)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
Perfluorododecanoic Acid (PFDoA)	<0.198	10.3	1.82	82.33%	82.33%	3.14	69.51%	69.51%	3.62	64.85%	64.85%	3.34	67.57%	67.57%
Perfluorotridecanoic Acid (PFTrDA)	<0.198	305	54	82.30%	82.30%	89.7	70.59%	70.59%	102	66.56%	66.56%	69.1	77.34%	77.34%
Perfluorotetradecanoic Acid (PFTeDA)	<0.198	5.36	0.807	84.94%	84.94%	1.47	72.57%	72.57%	1.85	65.49%	65.49%	1.53	71.46%	71.46%
Hexafluoropropylene Oxide Dimer Acid (HFPO-DA)	<0.791	<8.22	<0.872	NA	89.39%	<0.872	NA	90.34%	<0.793	NA	90.35%	<0.8	NA	90.27%
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	<0.791	<8.22	<0.872	NA	89.39%	<0.872	NA	90.34%	<0.793	NA	90.35%	<0.8	NA	90.27%
Perfluorododecanesulfonic Acid (PFDoS)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	<0.791	<8.22	<0.872	NA	89.39%	<0.872	NA	90.34%	<0.793	NA	90.35%	<0.8	NA	90.27%
11-Chloroheptafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	<0.791	<8.22	<0.872	NA	89.39%	<0.872	NA	90.34%	<0.793	NA	90.35%	<0.8	NA	90.27%
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	<0.198	<2.06	<0.218	NA	89.42%	<0.218	NA	90.39%	<0.198	NA	90.39%	<0.2	NA	90.29%
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	<1.98	<20.6	<2.18	NA	89.42%	<2.18	NA	90.39%	<1.98	NA	90.39%	<2	NA	90.29%
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	<1.98	<20.6	<2.18	NA	89.42%	<2.18	NA	90.39%	<1.98	NA	90.39%	<2	NA	90.29%
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	<0.396	<4.11	<0.436	NA	89.39%	<0.436	NA	90.34%	<0.397	NA	90.34%	<0.4	NA	90.27%
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	<0.396	<4.11	<0.436	NA	89.39%	<0.436	NA	90.34%	<0.397	NA	90.34%	<0.4	NA	90.27%
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEEESA)	<0.396	<4.11	<0.436	NA	89.39%	<0.436	NA	90.34%	<0.397	NA	90.34%	<0.4	NA	90.27%
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	<0.396	<4.11	<0.436	NA	89.39%	<0.436	NA	90.34%	<0.397	NA	90.34%	<0.4	NA	90.27%
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	<0.989	<10.3	<1.09	NA	89.42%	<1.09	NA	90.36%	<0.992	NA	90.37%	<1	NA	90.29%
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	<4.95	<51.4	<5.45	NA	89.40%	<5.45	NA	90.35%	<4.96	NA	90.35%	<5	NA	90.27%
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	<4.95	<51.4	<5.45	NA	89.40%	5.26 F	NA	79.53%	5.97 F	NA	76.77%	5.13 F	NA	80.04%
STATISTICS														
Total PFAS (ug/kg)	ND	5,453.86	352.53			1,102.681			2,122.560			906.004		
Total PFAS Removal	NA	NA	93.54%			79.78%			61.08%			83.39%		

Notes:

- < = Analyte not detected above the laboratory reporting limit. Laboratory reporting limit shown.
- A Soil was collected from the test cell after four leaching cycles of 1.5 liters each with PFAS free water. Corresponding rinse cycle leachate data is included as samples A1 through A4.
- B Soil was collected from the test cell after four leaching cycles of 1.5 liters each with PFAS free water adjusted to pH =3.5. Corresponding rinse cycle leachate data is included as samples B1 through B4.
- C Soil was collected from the reactor cell after four leaching cycles of 1.5 liters each with PFAS free water adjusted to pH =2.7. Corresponding rinse cycle leachate data is included as samples C1 through C4.
- A Soil was collected from the test cell after four leaching cycles of 1.5 liters each with PFAS free water. Corresponding rinse cycle leachate data is included as samples A1 through A4.
- Spike Soil contains 10 ml of 3% 50:50 Ansilite AFC-5-A and Chemgard C301MS aqueous film forming foam.
- Blank Soil is unspiked study soil which is consistent with sandy loam.
- A Soil through B Soil were all spiked with 10 ml of 50:50 Ansilite AFC-5-A and Chemgard C301MS aqueous film forming foam concentrate and then rinsed in cycles as indicated above.
- ND = Not Detected above the laboratory reporting limit.
- RL = Laboratory Reporting Limit
- Total PFAS is the sum of all detected PFAS analytes with ND set to zero.
- Total PFAS Removal was calculated by subtracting the Total PFAS Spike Soil concentration for the corresponding Total PFAS value from A Soil through B Soil and then dividing it by the Total PFAS Spike Soil concentration.
- NA = Not Applicable.
- F = the ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

Tabulated Water Results - Table 2

SAMPLE ID:	PFAS FREE WATER	PFAS FREE WATER PH=3.5	PFAS FREE WATER PH=2.7	PFAS FREE WATER PH=10.5	A1	A2	A3	A4
LAB ID:	L2404943-01	L2404943-02	L2404943-03	L2404943-04	L2404943-05	L2404943-06	L2404943-07	L2404943-08
COLLECTION DATE:	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024
SAMPLE MATRIX:	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
PERFLUORINATED ALKYL ACIDS BY EPA 1633 (ug/l)								
Perfluorobutanoic Acid (PFBA)	0.00107 U	0.00107 U	0.00104 U	0.00106 U	2.37	0.15	0.0328	0.00927
Perfluoropentanoic Acid (PFPeA)	0.000897 U	0.000896 U	0.000866 U	0.000882 U	3.53	0.2	0.0508	0.0174
Perfluorobutanesulfonic Acid (PFBS)	0.000562 U	0.000561 U	0.000542 U	0.000552 U	0.278	0.0158 J	0.00315	0.000817 J
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	0.00175 U	0.00175 U	0.00169 U	0.00172 U	0.289 J	0.0334 U	0.00368 J	0.00172 U
Perfluorohexanoic Acid (PFHxA)	0.000495 U	0.000494 U	0.000478 U	0.000486 U	7.2	0.4	0.0877	0.0321
Perfluoropentanesulfonic Acid (PFPeS)	0.000293 U	0.000293 U	0.000283 U	0.000289 U	0.25	0.0149 J	0.00367	0.000883 J
Perfluoroheptanoic Acid (PFHpA)	0.000335 U	0.000335 U	0.000324 U	0.00033 U	12.2	0.741	0.171	0.0442
Perfluorohexanesulfonic Acid (PFHxS)	0.000402 U	0.000402 U	0.000389 U	0.000396 U	1.42	0.103	0.0331	0.0102
Perfluorooctanoic Acid (PFOA)	0.000729 U	0.000728 U	0.000704 U	0.000717 U	14.3	1.05	0.369	0.114
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	0.00226 U	0.00226 U	0.00219 U	0.00223 U	51	3.83	1.2	0.453
Perfluoroheptanesulfonic Acid (PFHpS)	0.000453 U	0.000452 U	0.000445 U	0.000445 U	0.0432 U	0.00976 J	0.00138 J	0.000916 J
Perfluorononanoic Acid (PFNA)	0.000528 U	0.000527 U	0.00051 U	0.00052 U	356	38.4	19.1	12.8
Perfluorooctanesulfonic Acid (PFOS)	0.000763 U	0.000762 U	0.000737 U	0.00075 U	12.4	1.11	0.45	0.396
Perfluorodecanoic Acid (PFDA)	0.000679 U	0.000678 U	0.000656 U	0.000668 U	5.93	0.541	0.264	0.234
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	0.00261 U	0.00261 U	0.00252 U	0.00256 U	13.1	0.937	0.533	0.452
Perfluoronanesulfonic Acid (PFNS)	0.00052 U	0.000519 U	0.000502 U	0.000511 U	0.0496 U	0.00992 U	0.000512 U	0.000512 U
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	0.000914 U	0.000912 U	0.000883 U	0.000899 U	0.0872 U	0.0174 U	0.000901 U	0.000899 U
Perfluoroundecanoic Acid (PFUnA)	0.000729 U	0.000728 U	0.000704 U	0.000717 U	203	10.2	3.8	3.5
Perfluorodecanesulfonic Acid (PFDS)	0.000386 U	0.000385 U	0.000372 U	0.000379 U	0.0368 U	0.00736 U	0.00038 U	0.00038 U
Perfluorooctanesulfonamide (PFOSA)	0.000453 U	0.000452 U	0.000437 U	0.000445 U	0.0432 U	0.00864 U	0.000446 U	0.000446 U
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	0.000906 U	0.000904 U	0.000874 U	0.000891 U	0.0864 U	0.0173 U	0.000892 U	0.000891 U
Perfluorododecanoic Acid (PFDoA)	0.000771 U	0.00077 U	0.000745 U	0.000759 U	1.82	0.0742	0.0312	0.0212
Perfluorotridecanoic Acid (PFTrDA)	0.000629 U	0.000628 U	0.000607 U	0.000618 U	52.1	2.76	0.287	0.503
Perfluorotetradecanoic Acid (PFTeDA)	0.000444 U	0.000444 U	0.000429 U	0.000437 U	0.745	0.0274 J	0.00523	0.00342
Hexafluoropropylene Oxide Dimer Acid (HFPO-DA)	0.000939 U	0.000937 U	0.000907 U	0.000924 U	0.0896 U	0.0179 U	0.000926 U	0.000924 U
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	0.00106 U	0.00105 U	0.00102 U	0.00104 U	0.101 U	0.0202 U	0.00104 U	0.00104 U
Perfluorododecanesulfonic Acid (PFDoS)	0.000637 U	0.000636 U	0.000615 U	0.000627 U	0.0608 U	0.0122 U	0.000628 U	0.000627 U
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	0.00138 U	0.00138 U	0.00134 U	0.00136 U	0.132 U	0.0264 U	0.00136 U	0.00136 U
11-Chloroeicosafuoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	0.00138 U	0.00138 U	0.00134 U	0.00136 U	0.132 U	0.0264 U	0.00136 U	0.00136 U
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	0.000729 U	0.000728 U	0.000704 U	0.000717 U	0.0696 U	0.0139 U	0.000719 U	0.000718 U
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	0.000771 U	0.00077 U	0.000745 U	0.000759 U	0.0736 U	0.0147 U	0.00076 U	0.000759 U
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	0.00394 U	0.00394 U	0.00388 U	0.00388 U	0.376 U	0.0752 U	0.00388 U	0.00388 U
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	0.00205 U	0.00205 U	0.00198 U	0.00202 U	0.196 U	0.0392 U	0.00202 U	0.00202 U
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	0.000478 U	0.000477 U	0.000462 U	0.00047 U	0.0456 U	0.00912 U	0.000471 U	0.00047 U
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	0.000444 U	0.000444 U	0.000429 U	0.000437 U	0.0424 U	0.00848 U	0.000438 U	0.000437 U
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEEESA)	0.000369 U	0.000368 U	0.000356 U	0.000363 U	0.0352 U	0.00704 U	0.000364 U	0.000363 U
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	0.00198 U	0.00198 U	0.00191 U	0.00195 U	0.189 U	0.0378 U	0.00195 U	0.00195 U
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	0.00277 U	0.00276 U	0.00267 U	0.00272 U	0.264 U	0.0528 U	0.00273 U	0.00272 U
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	0.00981 U	0.00979 U	0.00947 U	0.00965 U	0.936 U	0.187 U	0.00967 U	0.00965 U
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	0.00662 U	0.0066 U	0.00639 U	0.00651 U	2 JF	0.126 U	0.0486	0.0204
Total PFAS	ND	ND	ND	ND	739.932	60.56406	26.47531	18.612806
STATISTICS								
Flush Cycle Total PFAS Removal (ug)	NA	NA	NA	NA	4,439.592	363.38436	158.85186	111.676836
Percent PFAS Removal	NA	NA	NA	NA	81.33%	6.66%	2.91%	2.05%

Notes:

1. U = Analyte not detected above the laboratory method detection limit. Laboratory method detection limit shown.
2. The four PFAS FREE WATER samples are all field/equipment checks to document that PFAS was not accidentally introduced during the study.
3. The A1 through A4 samples were collected as the first through fourth leaching sample collected from the Soil A sample. Each leaching sample was collected independently from 1.5 liters of pH=7.1 water run through the cell.
4. The B1 through B4 samples were collected as the first through fourth leaching sample collected from the Soil B sample. Each leaching sample was collected independently from 1.5 liters of pH = 3.5 water run through the cell.
5. The C1 through C4 samples were collected as the first through fourth leaching sample collected from the Soil C sample. Each leaching sample was collected independently from 1.5 liters of pH = 2.7 water run through the cell.
6. The D1 through D4 samples were collected as the first through fourth leaching sample collected from the Soil D sample. Each leaching sample was collected independently from 1.5 liters of pH = 10.5 water run through the cell.
7. ND = Not Detected above the laboratory method detection limit.
8. Flush Cycle Total PFAS Removal = the Total PFAS concentration multiplied by six to adjust for the amount of mass removed in 6 liters of water. Total PFAS is the sum of laboratory PFAS analytes with non-detects counted as zero.
9. Percent PFAS Removal is the amount of Total PFAS removed during each leaching cycle. It is calculated by subtracting the Total PFAS from the Soil Spike concentration from the Flush Cycle Total PFAS Removal and then dividing by Spike Soil Total PFAS concentration.
10. NA = Not Applicable.
11. J = Analyte detected between the laboratory method detection limit and reporting limit. The value is an estimated value.
12. F = the ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.
13. ug = micrograms

Tabulated Water Results - Table 2 (Continued)

SAMPLE ID:	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
LAB ID:	L2404943-09	L2404943-10	L2404943-11	L2404943-12	L2404943-13	L2404943-14	L2404943-15	L2404943-16	L2404943-17	L2404943-18	L2404943-19	L2404943-20
COLLECTION DATE:	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024	1/28/2024
SAMPLE MATRIX:	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
PERFLUORINATED ALKYL ACIDS BY EPA 1633 (ug/l)												
Perfluorobutanoic Acid (PFBA)	2.48	0.17	0.0652	0.028	2.08	0.218	0.075	0.0325	2.64	0.194	0.0532	0.0275
Perfluoropentanoic Acid (PFPeA)	3.52	0.253	0.106	0.0414	3.16	0.294	0.114	0.052	4.01	0.313	0.0949	0.0495
Perfluorobutanesulfonic Acid (PFBS)	0.291 J	0.0189 J	0.00853	0.00289	0.25	0.0263	0.00981	0.00355	0.262	0.0241	0.00622	0.00295
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	0.334 U	0.0334 U	0.0082	0.00346 J	0.226 J	0.0316 J	0.0551	0.0262	0.606 J	0.107	0.0319	0.0218
Perfluorohexanoic Acid (PFHxA)	10.2	0.485	0.192	0.0948	6.42	0.707	0.427	0.369	9.46	0.794	0.216	0.105
Perfluoropentanesulfonic Acid (PFPeS)	0.23 J	0.0195 J	0.00678	0.00359	0.206	0.0254	0.00841	0.00459	0.263	0.0224	0.00548	0.00284
Perfluoroheptanoic Acid (PFHpA)	12.8	0.898	0.374	0.163	10.5	1.22	0.463	0.218	10.9	1.1	0.31	0.164
Perfluorohexanesulfonic Acid (PFHxS)	1.38	0.133	0.0593	0.0314	1.06	0.121	0.0584	0.0319	0.556	0.166	0.0495	0.0282
Perfluorooctanoic Acid (PFOA)	15.4	1.34	0.724	0.345	10.9	1.03	0.539	0.271	1.7	1.65	0.622	0.306
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	50.8	4.96	1.85	1.09	38	4.76	9.36	5.84	12.7	35.3	11.7	9.54
Perfluoroheptanesulfonic Acid (PFHpS)	0.102 J	0.00864 U	0.0017	0.000758 J	0.0544 J	0.00432 U	0.000834 J	0.000439 U	<0.2	0.00288 J	0.0015 J	0.00116 J
Perfluorononanoic Acid (PFNA)	394	33.6	19.2	13.8	280	16.9	9.19	4.6	2.45	58.2	20	16.9
Perfluorooctanesulfonic Acid (PFOS)	10.9	0.424	0.444	0.264	9.04	0.354	0.226	0.106	0.152 J	1.1	0.527	0.467
Perfluorodecanoic Acid (PFDA)	4.5	0.17	0.159	0.0898	4.08	0.152	0.0863	0.0334	0.081 U	0.452	0.319	0.203
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	10	0.455	0.312	0.184	7.41	0.334	0.278	0.12	0.662 J	2.45	1.36	0.856
Perfluorononanesulfonic Acid (PFNS)	0.0992 U	0.00992 U	0.000513 U	0.000511 U	0.0496 U	0.00496 U	0.000544 U	0.000504 U	0.062 U	0.00248 U	0.000536 U	0.000518 U
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	0.174 U	0.0174 U	0.000902 U	0.000898 U	0.0872 U	0.00872 U	0.000957 U	0.000886 U	0.109 U	0.00436 U	0.000943 U	0.000911 U
Perfluoroundecanoic Acid (PFUnA)	161	3.91	1.8	0.78	104	3.54	0.848	0.463	7.74	10.8	4.51	4.04
Perfluorodecanesulfonic Acid (PFDS)	0.0736 U	0.00736 U	0.000381 U	0.000379 U	0.0368 U	0.00368 U	0.000404 U	0.000374 U	0.046 U	0.00184 U	0.000398 U	ND
Perfluorooctanesulfonamide (PFOSA)	0.0864 U	0.00864 U	0.000447 U	0.000445 U	0.0432 U	0.00432 U	0.000474 U	0.000439 U	0.054 U	0.00216 U	0.00155 JF	0.00154 J
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	0.173 U	0.0173 U	0.000894 U	0.00089 U	0.0864 U	0.00864 U	0.000948 U	0.000878 U	0.108 U	0.00432 U	0.000934 U	0.000902 U
Perfluorododecanoic Acid (PFDoA)	1.34	0.0334	0.0156	0.00669	1.13	0.0296	0.00896	0.00252	0.137 J	0.0721	0.0266	0.0197
Perfluorotridecanoic Acid (PFTDA)	54.6	1.2	0.329	0.212	43.4	1.12	0.296	0.0887	9.68	1.93	0.495	0.341
Perfluorotetradecanoic Acid (PFTeDA)	0.515	0.0136 J	0.00489	0.00185	0.429	0.0126 J	0.00277	0.000935 J	0.098 J	0.029	0.00864	0.00452
Hexafluoropropylene Oxide Dimer Acid (HFPO-DA)	0.179 U	0.0179 U	0.000927 U	0.000923 U	0.0896 U	0.00896 U	0.000984 U	0.00091 U	0.112 U	0.00448 U	0.000969 U	0.000936 U
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	0.202 U	0.0202 U	0.00104 U	0.00104 U	0.101 U	0.0101 U	0.00111 U	0.00102 U	0.126 U	0.00504 U	0.00109 U	0.00105 U
Perfluorododecanesulfonic Acid (PFDoS)	0.122 U	0.0122 U	0.000629 U	0.000626 U	0.0608 U	0.00608 U	0.000667 U	0.000618 U	0.076 U	0.00304 U	0.000657 U	0.000635 U
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3ONS)	0.264 U	0.0264 U	0.00137 U	0.00136 U	0.132 U	0.0132 U	0.00145 U	0.00134 U	0.165 U	0.0066 U	0.00143 U	0.00138 U
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-PF3OUdS)	0.264 U	0.0264 U	0.00137 U	0.00136 U	0.132 U	0.0132 U	0.00145 U	0.00134 U	0.165 U	0.0066 U	0.00143 U	0.00138 U
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	0.139 U	0.0139 U	0.00072 U	0.000717 U	0.0696 U	0.00696 U	0.000764 U	0.000707 U	0.087 U	0.00348 U	0.000752 U	0.000727 U
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	0.147 U	0.0147 U	0.000762 U	0.000758 U	0.0736 U	0.00736 U	0.000808 U	0.000748 U	0.092 U	0.00368 U	0.000796 U	0.000769 U
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	0.752 U	0.0752 U	0.00389 U	0.00387 U	0.376 U	0.0376 U	0.00413 U	0.00382 U	0.47 U	0.0188 U	0.00406 U	0.00393 U
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	0.392 U	0.0392 U	0.00203 U	0.00202 U	0.196 U	0.0196 U	0.00215 U	0.00199 U	0.245 U	0.0098 U	0.00212 U	0.00205 U
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	0.0912 U	0.00912 U	0.000472 U	0.00047 U	0.0456 U	0.00456 U	0.0005 U	0.000463 U	0.057 U	0.00228 U	0.000493 U	0.000476 U
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	0.0848 U	0.00848 U	0.000439 U	0.000437 U	0.0424 U	0.00424 U	0.000465 U	0.000431 U	0.053 U	0.00212 U	0.000458 U	0.000443 U
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEEESA)	0.0704 U	0.00704 U	0.000364 U	0.000363 U	0.0352 U	0.00352 U	0.000386 U	0.000358 U	0.044 U	0.00176 U	0.000381 U	0.000368 U
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	0.378 U	0.0378 U	0.00195 U	0.00194 U	0.189 U	0.0189 U	0.00207 U	0.00192 U	0.236 U	0.00944 U	0.00204 U	0.00197 U
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	0.528 U	0.0528 U	0.00273 U	0.00272 U	0.264 U	0.0264 U	0.0029 U	0.00268 U	0.33 U	0.0132 U	0.00285 U	0.00276 U
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	1.87 U	0.187 U	0.00969 U	0.00964 U	0.936 U	0.0936 U	0.0103 U	0.00951 U	1.17 U	0.0468 U	0.0101 U	0.00978 U
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	1.26 U	0.126 U	0.0618 F	0.0343 JF	0.865 JF	0.0753 JF	0.0442 F	0.02 JF	0.789 U	0.156 JF	0.0627 F	0.04 JF
Total PFAS	734.058	48.0834	25.722	17.176938	523.2104	30.9508	22.090784	12.283295	64.016	114.86248	40.40119	33.12171
STATISTICS												
Flush Cycle Total PFAS Removal	4,404.348	288.5004	154.332	103.061628	3,139.2624	185.7048	132.544704	73.69977	384.096	689.17488	242.40714	198.73026
Percent PFAS Removal	80.69%	5.29%	2.83%	1.89%	57.51%	3.40%	2.43%	1.35%	7.04%	12.63%	4.44%	3.64%

Notes:

1. U = Analyte not detected above the laboratory method detection limit. Laboratory method detection limit shown.
2. The four PFAS FREE WATER samples are all field/equipment checks to document that PFAS was not accidentally introduced during the study.
3. The A1 though A4 samples were collected as the first through fourth leaching sample collected from the Soil A sample. Each leaching sample was collected independently from 1.5 liters of pH=7.1 water run through the cell.
4. The B1 though B4 samples were collected as the first through fourth leaching sample collected from the Soil B sample. Each leaching sample was collected independently from 1.5 liters of pH = 3.5 water run through the cell.
5. The C1 though C4 samples were collected as the first through fourth leaching sample collected from the Soil C sample. Each leaching sample was collected independently from 1.5 liters of pH = 2.7 water run through the cell.
6. The D1 though D4 samples were collected as the first through fourth leaching sample collected from the Soil D sample. Each leaching sample was collected independently from 1.5 liters of pH = 10.5 water run through the cell.
7. ND = Not Detected above the laboratory method detection limit.
8. Flush Cycle Total PFAS Removal = the Total PFAS concentration multiplied by six to adjust for the amount of mass removed in 6 liters of water. Total PFAS is the sum of laboratory PFAS analytes with non-detects counted as zero.
9. Percent PFAS Removal is the amount of Total PFAS removed during each leaching cycle. It is calculated by subtracting the Total PFAS from the Soil Spike concentration from the Flush Cycle Total PFAS Removal and then dividing by Spike Soil Total PFAS concentration.
10. NA = Not Applicable.
11. J = Analyte detected between the laboratory method detection limit and reporting limit. The value is an estimated value.
12. F = the ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.
13. ug = micrograms

Enviro-BAC

Green Remediation Technology

About Enviro-BAC

In conjunction with a leading microbial manufacturing expert, we have developed an innovative and unique blend of non-pathogenic, non-genetically modified microbial organisms (Enviro-BAC) to facilitate the bioremediation of petroleum spills in both soil and groundwater. Enviro-BAC has undergone extensive testing and product application under various conditions and environments including laboratory bench top trials as well as actual field applications. Enviro-BAC is manufactured as a spray dried powder and is easily dispersed in soil and water for a variety of applications. Enviro-BAC has been listed with the North Carolina Department of Environmental Quality (NCDEQ) Division of Water Resources (DWR) as an approved injectant without use restrictions. Additional states within the southeastern United States have also provided acceptance of Enviro-BAC for use as an injection/remedial product. Our team of experts are ready to engage with the appropriate regulatory agencies to facilitate approval of Enviro-BAC as a remedial agent, if required.

Enviro-BAC is designed for various applications related to soil and groundwater remediation, achieving both environmental and cost benefits through the use of a naturally occurring product. This product effectively remediates soil and groundwater from petroleum releases. Its uses include:

- Open hole excavations
- Surficial spills
- Soil borings
- Passive and active groundwater injections

The product is available to a range of stakeholders, such as:

- Environmental consultants

- Contractors
- Responsible parties
- State agencies
- Other environmental stakeholders

The key benefits of using Enviro-BAC as an in situ bioremedial product are:

- Minimizes disturbance to facilities and their operations
- Decreases the duration of remediation
- Provides an efficient alternative to traditional remediation methods
- Is landfill conscious
- Is effective on both soil and groundwater
- Is environmentally responsible

Current status of Enviro-BAC underground injection approval by Underground Injection Control (UIC) Programs:

- Approved for injection:
 - North Carolina
 - Florida
 - District of Columbia

Technical information presented (no formal review process):

- South Carolina
- Georgia

Requires a case-by-case review and UIC permit (no formal review process):

- Virginia
- Approval pending:
 - Tennessee



Case Study #1

Laboratory Treatment and Analysis of Petroleum Contaminated Groundwater

An initial laboratory study evaluated the potential impact of Enviro-BAC on petroleum-contaminated groundwater. The groundwater samples were collected in the field from a petroleum-impacted site and immediately delivered to an independent laboratory for analysis and treatment.

The laboratory decanted the groundwater sample into 1,000 mL beakers and divided the sample into untreated (control sample) and treated samples. Laboratory tests indicated that Enviro-BAC significantly degraded (i.e., > 92% decrease in contaminant levels) petroleum constituents in the groundwater sample under laboratory conditions. Laboratory data summarizing contaminant reduction of the groundwater sample is provided in Table 1 below.



Table 1 . Laboratory Data Summarizing Contaminant Reduction of the Groundwater Sample

Sample ID	Groundwater Day 1	Untreated Groundwater Day 30	Treated Groundwater Day 30	% Improvement Treated (Untreated v. Treated)
Volatile Organic Compounds (ug/l):				
Benzene	6,090	1,600	17.7	99.7%
Ethylbenzene	1,900	BQL	BQL	100%
Toluene	2,960	31.0	BQL	100%
Total Xylenes	5,500	1,300	151	96.66%
Total BTEX	16,450	2,931	168.7	98.99%
Naphthalene	61.0	35.0	BQL	100%
1,2,4,-Trimethylbenzene	1,610	58.5	82.1	92.03%

BQL = Below Quantity Limits
Results in ug/L



Case Study #2

On-Site Treatment of Soil Contaminated with Fuel Oil

In an effort to evaluate the effectiveness on petroleum contaminated soil, Enviro-BAC was applied to a surface spill of fuel oil that occurred within a residence basement. Using hand tools, two areas approximately 24" x 24" x 20" deep of contaminated soil were agitated within the basement around the perimeter of the slab foundation. The areas were sampled and analyzed for Total Petroleum Hydrocarbons as Diesel (TPH-D) and Gasoline (TPH-G). Following sampling, approximately 140g of Enviro-BAC was mixed with approximately 2.5 gallons of water and applied to one of the contaminated areas.



Note that an untreated control area was also disturbed and sampled per above. Confirmatory sampling and analyses conducted approximately six weeks later indicated that the TPH-G in the treated and control areas had decreased at similar rates. The TPH-D concentrations remained essentially unchanged for the treated and control areas. However, a perceptible odor change was noted in the treated area and the laboratory indicated that there had been a significant change in the associated chromatogram which included peak reduction and retention time changes. An additional soil sample from the treated area, was collected approximately 12 weeks following application of the product and indicated a 72% decrease from the initial concentration. As a result, soil was collected from the contaminated area for additional ex-situ treatment and analysis.

An additional 30 grams of Enviro-BAC, 5 grams of sucrose, and one liter of water were added to the contaminated soil as a second dosage. A soil sample was collected and tested for TPH-D approximately nine weeks later. The sample exhibited an approximately 81.9% decrease in TPH-D since the August 14, 2015, sampling event, with an approximately 35.1% decrease since the October 9, 2015, sampling event. Summary of soil analytical results are in Table 2 below.

Table 2. Summary of Soil Analytical Results

Sample ID	Sample Collection Date	TPH (mg/Kg)	% Reduction
Contaminated Source Area	7/2/2015	4,140	N/A
Contaminated Source Area	8/14/2015	4,150	-1.0
Contaminated Source Area	10/9/2015	1,160	72.0
Contaminated Source Area	12/18/2015	753	81.9



Case Study #3

On-Site Treatment of Petroleum Contaminated Groundwater Monitoring Well

In 2017, State of North Carolina regulatory personnel approved pilot testing of Enviro-BAC at a petroleum contaminated groundwater site. The site is a gasoline station located within a coastal plain area with sandy soils and relatively shallow groundwater (i.e., approximately 5-6 feet below ground surface). An on-site monitoring well located within the source area had exhibited persistent dissolved-phase petroleum groundwater contamination. One kilogram of Enviro-BAC was introduced into the monitoring well via suspension within a five-foot, one-inch Schedule 40 PVC pipe with 0.10 slotted screen. A small amount of sucrose (approximately 1-2% by weight) was added in order to stimulate microbial activity.

The goal was to introduce microbes into the contaminant plume to facilitate petroleum degradation. Groundwater samples were collected from the monitoring well prior to and, at approximate 30-day intervals, following injection activities in order to evaluate the effectiveness of Enviro-BAC on dissolved-phase petroleum constituents and influence on bacteriological populations under field conditions. The groundwater samples have been analyzed for volatile organic compounds (VOCs) by Standard Method 6200B including ethanol, methyl tert butyl ether (MTBE), and isopropyl ether (IPE). In addition, groundwater samples were collected for analysis via heterotrophic plate count (HPC). This procedure is used for estimating the number of live culturable heterotrophic bacteria in water. Colonies may arise from pairs, chains, clusters, or single cells, all of which are included in the term “colony-forming units” (CFU).

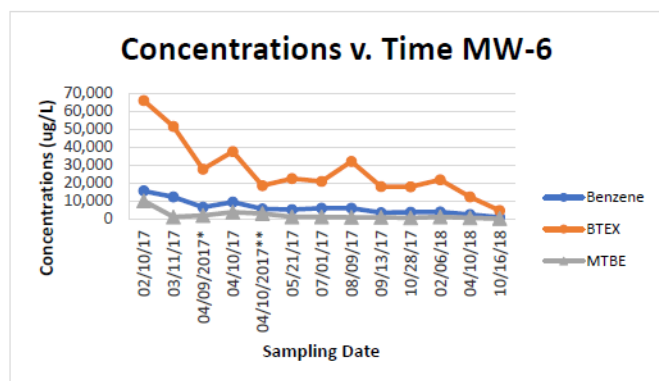
Subsequent sampling and analysis of the Enviro-BAC treated monitoring well indicated that, after 60 days following the initial Enviro-BAC injection:

- Benzene decreased 64%;
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) decreased 72%; and,
- Methyl tert butyl ether (MTBE) decreased 70%.

In addition, CFUs have increased from 130, prior to treatment with Enviro-BAC, to as high as 186,700,000. For the purposes of the pilot study only two, one-kilogram passive injection devices were introduced into the contaminated monitoring well at an approximately five-month interval. One year following the second injection event, groundwater samples collected from the monitoring well have not indicated evidence of rebound. The most recent data collected from the monitoring well indicates:

- Benzene decreased 94%;
- BTEX decreased 93%; and,
- MTBE decreased 98%.

A summary of the monitoring data and groundwater analytical results is provided in Table 3 on the following page.



Case Study #3 - continued

Table 3. Passive Injection at Gasoline Contamination Site – Coastal Plain

Contaminant of Concern			Benzene	Ethylbenzene	I-Propylbenzene	MTBE	Naphthalene	n-Propylbenzene	Toluene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Total Xylenes	Total BTEX
Well ID	Date Collected (mm/dd/yy)	Depth to Water (Ft. Below TOC)											
MW-6	02/10/17*	5.54	15,640	5,560	1,340	10,080	6,240	3,920	26,390	15,600	9,060	18,340	65,930
	2/10/17	--	1 Kilogram of <i>Enviro-BAC</i> passively injected										
	03/11/17	6.44	12,300	1,900	148	1,198	614	210	26,760	1,900	556	10,550	51,510
	04/09/17	5.69	6,480	1,310	168	1,890	896	332	12,900	1,800	505	7,070	27,760
	04/10/17	5.60	9,430	1,800	164	3,770	840	272	16,900	2,130	628	9,440	37,570
	04/10/17	5.60	5,580	932	188	2,980	904	436	7,560	1,160	352	4,450	18,522
	05/21/17	5.61	5,220	1,180	BQL	1,170	605	BQL	9,500	1,520	440	6,530	22,430
	07/01/17	5.72	6,040	1,050	112	1,200	618	218	9,230	1,190	330	4,560	20,880
	07/01/17**	--	1 Kilogram of <i>Enviro-BAC</i> passively injected										
	08/09/17	NM	5,970	1,290	BQL	910	400	BQL	17,840	1,340	290	6,930	32,030
	09/13/17	4.62	3,440	1,100	108	869	528	BQL	7,150	1,430	BQL	6,370	18,060
	10/28/17	5.40	3,760	1,060	BQL	625	530	BQL	7,850	1,360	370	5,220	17,890
	02/06/18	5.51	3,930	1,090	BQL	1,090	595	208	10,100	1,540	420	6,680	21,800
	04/10/18	4.82	2,410	739	115	660	533	252	6,600	904	222	2,480	12,229
	10/16/18	4.32	1,000	439	58.6	215	313	BQL	1,660	730	BQL	1,594	4,693
	% Reduction	-		94%	92%	96%	98%	95%	100%	94%	95%	100%	91%

*Pre-Treatment Sample Followed by *Enviro-BAC* Treatment

** Second *Enviro-BAC* Treatment Conducted

BQL = Below Quantitation Limits

Exceeds North Carolina 2L Groundwater Quality Standards (NC2LGWQS)
 Exceeds North Carolina Gross Contamination Levels

Based on the results of the October 2018 sampling event, the site was granted a No Further Action Letter by the North Carolina Department of Environmental Quality (NCDEQ). The use of *Enviro-BAC* significantly shortened the duration of the natural attenuation processes at the site. Receiving regulatory closure optimizes the use of the property, maximizes the property value, and allows for an unencumbered property transaction.



Case Study #4

On-Site Treatment of Petroleum Contaminated Groundwater Plume

Enviro-BAC has been effectively used at multiple sites with leaking underground storage tanks (USTs), leading to immediate positive results. Here's a specific example of its application:

- Site Description: Dormant gasoline release site with ongoing natural attenuation monitoring for several years.
- Remediation Method: Active injection of Enviro-BAC into the groundwater plume.
- Implementation Details: Injection conducted via 17 injection points.
- Results Documentation: Table 4 documents the pre-existing concentrations and the results from two post-application sampling events.

Analytical Method		Standard Method 6200B											
Contaminant of Concern		Benzene	Ethylbenzene	1-Propylbenzene	1,2-Dichlorobenzene	1,4-Dichlorobenzene	1,2,4-Trichlorobenzene	1,2,3-Trichlorobenzene	Toluene	o-Xylene	m-Xylene	p-Xylene	Total Xylenes
MW-1 (Source Area)	11/19/2016	31.60	30.10	1,630	<0.5	15,700	<0.5	4,980	<0.5	111.00	35,700	3,750	140.00
	02/27/2018	7,320	13.40	1,630	2,000	4,160	<0.5	<0.5	<0.5	47,200	7,760	2,000	44,700
	10/16/2018	Enviro-BAC Injection (Pilot Test)											
	11/12/2018	542	2,330	52.5	<25	577	<25	286	<25	2,830	368	464	3,880
	12/18/2018	519	1,930	51.0	<25	456	<25	267	<25	304	465	212	1,670
	02/23/2019	Enviro-BAC Injection											
	02/28/2019	500	2,250	145	<40	515	152	410	<40	173	722	212	1,900
	03/23/2019	656	1,890	98.8	<1.0	354	31.0	226	16.2	256	731	249	2,470
	% Improvement from		91.0%	85.9%	93.9%	NA	85.7%	NA	NA	99.5%	90.6%	87.6%	94.5%
	MW-3	11/19/2016	16.50	1,770	56.0	<0.5	265	<0.5	157	<0.5	561	279	201
02/27/2018		13.90	8,980	<0.5	<0.5	3,730	<0.5	770	<0.5	36,100	5,370	1,340	36,400
10/16/2018		Enviro-BAC Injection (Pilot Test)											
11/12/2018		6340	1,110	<50	<50	155	<50	93	<50	305	283	301	1,270
12/18/2018		7390	1,070	<50	<50	154	<50	<0.5	<50	410	224	226	1,280
02/23/2019		Enviro-BAC Injection											
02/28/2019		1,710	750	16.6	<10	45.4	10.6	25.6	10.2	122	55.0	21.2	363
03/23/2019		727	135	18.0	<1.0	20.7	6.9	25.6	8.4	25.8	24.8	15.2	102
% Improvement from		94.8%	98.5%	NA	NA	99.4%	NA	96.7%	NA	99.5%	99.9%	99.7%	
NCZLGWS (µg/L)		1	900	70	20	6	70	70	600	400	400	500	
GCL (µg/L)		5,000	94,500	25,000	20,000	6,000	16,900	30,000	8,500	280,000	20,500	25,000	

Table 4. Active Injection at Gasoline Contamination Site – Piedmont (SM 6200B)

Case Study #5

On-Site Treatment of Surface Spill of Mineral Oil

Following a lightning strike that resulted in the release of approximately 300 gallons of mineral oil at an electrical substation, approximately 750 gallons of an Enviro-BAC slurry were applied to the affected area. Note that site conditions, including energized electrical equipment and the need for uninterrupted facility operations, precluded the use of more traditional remedial methods such as over-excavation of contaminated soils. The site measured approximately 750 square feet and was characterized by an approximately four-inch gravel layer underlain by clayey silts and silty sands soils. The application procedure included the on-site mixing of 16 kg of Enviro-BAC (and sucrose) in three approximate 250-gallon batches. The Enviro-BAC was mixed with water using a high shear mixer and added to an on-site 275-gallon tote. The slurry was applied directly to the contaminated area (three applications) via a gravity fed two-inch hose. Subsequent sampling of the soil in the source area indicated a decrease in Total Petroleum Hydrocarbons as Diesel (TPH-D) of nearly 50% within four weeks of application. At twelve weeks following the application of Enviro-BAC, the soil samples generally exhibited an average decrease of approximately 76% in TPH-D concentrations, with the soil sample collected in the immediate source area of the release exhibiting an 87% reduction in TPH-D concentrations.



Pollution Mitigation Plans

Case Study #6

Copper (Cu) Best Management Plan (BMP)

The Copper (Cu) Best Management Plan (BMP) Plan has been prepared to address Cu benchmark exceedances above 19 micrograms per liter (ug/L) at stormwater drainage areas flowing through Outfall 002 and Outfall 006. Designed a study consisting of two sampling events, a dry weather soil/sediment sampling followed by a wet-weather stormwater sampling. The Cu concentration in stormwater runoff from both Outfall 002 and Outfall 006 drainage areas correlates well with the soil/sediment analytical results, which indicated that the main Cu contributors are the gun mount and boat yard areas, respectively.

Copper fragments and dust from exploding rounds in the gun mount area are likely source of Cu impacting Drainage Area 002. Runoffs from the propellant residues deposited on the asphalt would likely collect in stormwater drains running through base property grass land and ultimately flow to receiving water. Drainage Area 006 is likely impacted by the Yard Craft and Marina where many products including paint (e.g., boat hull coatings, building paint), glue, building materials, and construction materials contain Cu used as a biocide or antifoulant agent.

