IDA

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Executive Summary

The Strategic Environmental Research and Development Program (SERDP) and the Environmental Security and Technology Certification Program (ESTCP) with the Environmental Protection Agency Office of Water, Engineering and Analysis Division developed a novel method for measuring trace contamination of per- and polyfluoroalkyl substances (PFAS), a broad category of man-made chemicals that are environmentally persistent and associated with health problems in humans. Aqueous film-forming foam (AFFF), which contain mixtures of PFAS, have been used widely by the Department of Defense (DoD) to extinguish high-hazard liquid hydrocarbon fires. The use of AFFF has resulted in the widespread occurrence of PFAS in groundwater, drinking water, soils, and sediments at many current and former military installations. The DoD has environmental management responsibilities for the release of PFAS into the environment associated with the use of AFFF. SERDP/ESTCP is sponsoring the validation of the novel PFAS measurement method for complex water matrices (e.g., wastewater, surface water, groundwater, landfill leachate), solids (e.g., soil, sediment, biosolids) and tissues. The first step in the validation process is a single laboratory validation (SLV) study.

SERDP/ESTCP asked IDA to calculate summary statistics from the data generated in the SLV study and systematically compile the statistics and data into specified tables to support subsequent analysis by Naval Sea Systems Command, the Air Force Civil Engineer Center, and SERDP/ESTCP itself. IDA automatically generated data tables in a systematic and reproducible fashion using a coded Python computer script to eliminate human error. The summary statistics (means and standard deviations) included native concentrations, spike concentrations, and percent recoveries of the PFAS analytes in aqueous and solid-type matrices and tissues. IDA performed a rigorous quality check on the summary statistics to be confident they were calculated correctly. A digital appendix with all data tables accompanies this document with the full set of tables. These data can now be used to support the government's SLV of the novel PFAS method.

Contents

1.   Introduction

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that are resistant to heat, oil and water. The properties of PFAS can be attributed to short, strong bonds between carbon and fluorine atoms, but a consequence for such durability is the chemical structure does not easily break down in the environment.[1] In recent years, scientists have nicknamed PFAS "forever chemicals" because of their rise as a persistent and mobile pollutant. Some familiar consumer product brands that contain PFAS include Teflon (i.e., non-stick cookware) and Scotchgard (i.e., stain/water repellants for fabrics).[2] PFAS have been used in numerous industrial applications but most notably is the aqueous film-forming foam (AFFF) that were adopted widely across the Department of Defense (DoD) on ships and military bases to extinguish high-hazard liquid hydrocarbon fires.[3] The use of AFFF has resulted in the prevalence of PFAS in groundwater, drinking water, soils, and sediments at many current and former military installations.[4]

PFAS are present in drinking water systems and groundwater supplies around DoD military installations at levels above the Environmental Protection Agency (EPA) Lifetime Health Advisories of 70 parts per trillion (individually or combined).[5] The EPA published the Lifetime Health Advisories and Health Effects Support Documents notice for Perfluorooctanoic Acid (PFOA) and perfluorooctane sulfonate (PFOS) in 2016.[6] Concern

[1]   Reddy, Prakash. (2015), *Organofluorine Compounds in Biology and Medicine*, Elsvier, accessed September 16, 2021, https://www.sciencedirect.com/book/9780444537485/organofluorine-compounds-in-biology-and-medicine.

[2]   United States Environmental Protection Agency, "Basic Information on PFAS," accessed August 3, 2021, https://www.epa.gov/pfas/basic-information-pfas.

[3]   Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP), accessed August 3, 2021, https://www.serdp-estcp.org/Featured-Initiatives/Per-and-Polyfluoroalkyl-Substances-PFASs.

[4]   Leeson, A. et al. (2020),"Identifying and Managing Aqueous Film-Forming Foam-Derived Per- and Polyfluoroalkyl Substances in the Environment," Environ. Toxicol. Chem. 40, 24-36.

[5]   M. Sullivan, "Addressing Perfluorooctane Sulfonate (PFOS)and Perfluorooctanoic Acid (PFOA)," DoD, 2018, accessed August 11, 2021, https://www.epa.gov/sites/default/files/2018-05/documents/dod_presentation_epa_summit_pfos_pfoa_may2018_final.pptxx_.pdf.

[6]   Environmental Protection Agency, Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. *Federal Register.* 18, 33250-33251, accessed August 26, 2021, https://www.federalregister.gov/documents/2016/05/25/2016-12361/lifetime-health-advisories-and-health-effects-support-documents-for-perfluorooctanoic-acid-and.

about the toxicity of PFAS and their impact on human health continues to grow. Researchers have observed noncancer effects following repeated oral exposures to PFAS, including abnormal thyroid and kidney development in animal studies. The number of human studies is too small to draw direct conclusions between PFAS exposure and health outcomes. In 2021, the EPA conducted a toxicity assessment for a specific PFAS—perfluorobutane sulfonic acid (PFBS) and its related ionic compound—to evaluate the human health hazard. After a rigorous peer review by external scientists, the EPA published human oral reference doses derived from animal models for various noncancer effects.[7] To understand the degree of a person's exposure to PFAS, scientists need to measure more of the possible thousands of PFAS in all facets of the environment (air, soil, water, tissue).

The DoD has environmental management responsibilities for the release of PFAS into the environment associated with the use of AFFF. The Strategic Environmental Research and Development Program (SERDP) and the Environmental Security and Technology Certification Program (ESTCP) with the EPA Office of Water, Engineering and Analysis Division developed a novel method for measuring trace contamination of PFAS using isotope-dilution liquid-chromatography mass spectroscopy/mass spectroscopy (LC-MS/MS).[8] SERDP/ESTCP is sponsoring the validation of the novel PFAS measurement method for complex water matrices (e.g., wastewater, surface water, groundwater, landfill leachate), solids (e.g., soil, sediment, biosolids) and tissues.

In pursuit of this effort, SERDP/ESTCP conducted a single-laboratory validation (SLV) study of the new method.[9] The SLV allows the opportunity to make any necessary adjustments to the method before a larger multi-laboratory validation effort. SERDP/ESTCP sponsored IDA to calculate summary statistics from the data collected in the SLV study and systematically compile the statistics and data into specified tables to support the SLV study. The compiled data tables will inform the government team, consisting of SERDP/ESTCP, Naval Sea Systems Command (NAVSEA), and Air Force Civil Engineer Center, as it completes the SLV, which will be documented in a later government report that will be submitted to the EPA.

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[7] EPA, *Human Health Toxicity Values for Perfluorobutane Sulfonic Acid* (CASRN 375-73-5) *and Related Compound Potassium Perfluorobutane Sulfonate* (CASRN 29420-49-3), EPA/600/R-20/345F, U.S. EPA Office of Research and Development Center for Public Health and Environmental Assessment, April 2021, accessed August 11, 2021, https://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=542393.

[8] EPA, *Draft Method 1633 Analysis of Per- and Polyfluoroalkyl (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS*, August 2021, accessed September 16, 2021, https://www.epa.gov/system/files/documents/2021-09/method_1633_draft_aug-2021.pdf

[9] SERDP/ESTCP PFAS Method Validation Team, "Study Plan for Single-Laboratory Validation of PFAS by Isotope Dilution LC-MS/MS," April 2020.

The purpose of this short turnaround IDA project was to compile the data reported by the laboratory in a systematic, reproducible mode that the government team could then analyze to perform the SLV. This report documents how we compiled the data tables (including calculating summary statistics like means and standard deviations), presents examples for each set of tables generated, and discusses some high-level observations about the dataset. A digital appendix accompanies this paper with the full set of tables.

2. Method

SERDP/ESTCP provided the data collected in the SLV study. The single laboratory[10] in the study produced electronic data delivery (EDDs) files that report the results for 64 PFAS analytes from 32 environmental matrix samples measured using the experimental method. NAVSEA then reviewed the EDDs for data validation. The EDDs report values for

1. the native analyte concentration (the value of PFAS analyte native to the environmental sample measured with the method);

2. the spike analyte concentration, which is a known physical amount (mass per unit volume = concentration), or "spike," of PFAS analyte the laboratory *added* to the environmental sample);

3. the measured spike analyte concentration (the value of the spike analyte concentration measured with the method); and

4. the percent recoveries of the spiked analyte (the measured value of the spike analyte concentration measured with the method relative to the known physical amount that the laboratory added to the environmental sample; see Equation 1)

for over 30,000 subsamples. The laboratory created subsamples from the environmental matrix samples to make duplicate native and spike concentration measurements as outlined in the SLV study procedure.[11]

SERDP/ESTCP also provided direction on what specific calculations and tables to generate from the EDDs, including the table templates with specific rows and columns to populate with values. We used Python to read in the sponsor-provided EDDs; process the data to calculate percent recoveries, means, mean of means, standard deviations (SD), and percent relative standard deviations (RSD); and output the sponsor-requested tables in CSV format, using a coded script. Upon a request from SERDP/ESTCP, we reported all means for PFAS concentrations with three significant figures and all percent recoveries, means, SD (i.e. 2x SD, etc.), and percent RSD to two places after the decimal. These metrics were defined in the SLV study plan.

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[10] SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada

[11] SERDP/ESTCP PFAS Method Validation Team, Attachment 1 in "Study Plan for Single-Laboratory Validation of PFAS by Isotope Dilution LC-MS/MS," April 2020.

We used the equations that follow in the sponsor-requested calculations.

Equation 1: Percent recovery

$$\left(\frac{\text{Measured spike [ ]} - \text{Meausured native [ ]}}{\text{Known spike [ ] added}}\right) \cdot \mathbf{100};$$

$$\text{where [ ]} = \text{concentration}$$

Equation 1 describes how percent recovery is calculated based on the measured native concentration, and the measured and known analyte spike concentrations of a particular PFAS analyte in an environmental matrix.

Equation 2: Mean

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i;$$

$$\text{where } n = \text{number of quantities}, x_i = i\text{th quantity value}$$

Equation 2 describes how the mean of a type of quantity was calculated. That quantity could be a native concentration, a known spike concentration, a measured spike concentration, or a percent recovery for a PFAS analyte.

Equation 3: Mean of means

$$\mu_G = \frac{1}{G}\sum_{g=1}^{G} \bar{x}_g;$$

$$\text{where } G = \text{number of groups}, \bar{x}_g = g\text{th mean}$$

Equation 3 describes how the mean was calculated from a group of means for a given quantity. For example, Equation 2 could be used to calculate the mean percent recovery of a PFAS analyte in a particular groundwater matrix, and then Equation 3 could be used to calculate the mean of the mean percent recoveries of *all* groundwater matrices. In another example, Equation 2 could be used to calculate the mean measured spike concentration of a PFAS analyte in a particular soil matrix, and then Equation 3 could be used to calculate the mean of the mean measured spike concentration of *all* soil matrices.

SERDP/ESTCP instructed us to use the mean of means as written in Equations 3 since that is how the EPA calculated the mean from a group of means in a previous method validation study. We recognize there is a risk of bias toward lower sample sizes in the calculation.

Equation 4: Standard deviation (SD)

$$\frac{\sqrt{\sum(x_i - \mu)^2}}{n-1};$$

where n = **number of quantities**, x_i = **ith quantity**, μ = **sample mean**

Equation 4 describes how we calculated the standard deviation for a given quantity. That quantity could be a native concentration, a known spike concentration, a measured spike concentration, or a percent recovery for a PFAS analyte.

Equation 5: % Relative standard deviation (RSD)

$$\left(\frac{SD}{Mean}\right) \cdot 100$$

Equation 5 describes how we calculated the relative standard deviation for a given quantity. For example, Equation 2 and Equation 4 could be used to calculate the mean and standard deviation of the percent recovery of a PFAS analyte in a particular groundwater matrix, and then Equation 5 could be used to calculate the relative standard deviation for the PFAS analyte in that particular groundwater matrix using the values from the mean in Equation 2 and the standard deviation in Equation 4.

We verified the calculation in every column in each of the tables generated by the coded script by comparing those values to values manually calculated using Excel. The data in the EDDs were used in the manual calculations based on the equations outlined in this section. At least one analyte (i.e., across a row in the table) was checked for each table.

3. Results

We generated more than 100 tables grouped into categories at the request of the sponsor. This section describes the calculations we performed and provides an example of the tables produced in each category. The eight table categories were as follows:

- Sample Native Concentration Tables

- Sample Matrix Recovery Tables

- Media Type Matrix Recovery Tables

- Extracted Internal Standard (EIS) Spike Recovery Tables

- Injected Internal Standard (IIS) Spike Recovery Tables

- Ongoing Precision and Recovery (OPR) Spike Recovery Tables

- Limit of Quantitation Verification (LOQVER) Spike Recovery Tables

- Method Blank (MB) Spike Recovery Tables

All tables produced are part of the digital appendix that accompanies this paper.

A. PFAS Analytes and Compounds

The SLV study comprises of 40 PFAS analytes and 24 isotopically labeled internal standard compounds. Table 1 is a list of the chemical names of the PFAS analyte acronyms that were listed in the EDDs and their chemical abstract service (CAS) registry numbers. This table is file A-1 SLV PFAS Analytes.csv from section A of the digital appendix.

Table 1. SLV PFAS Acronyms and Chemical Names

Group	Acronym	Chemical Name	CAS
	PFBA	Perfluorobutanoic acid	375-22-4
	PFPeA	Perfluoropentanoic acid	2706-90-3
	PFHxA	Perfluorohexanoic acid	307-24-4
	PFHpA	Perfluoroheptanoic acid	375-85-9
Analytes	PFOA	Perfluorooctanoic acid	335-67-1
	PFNA	Perfluorononanoic acid	375-95-1
	PFDA	Perfluorodecanoic acid	335-76-2
	PFUnA	Perfluoroundecanoic acid	2058-94-8
	PFDoA	Perfluorododecanoic acid	307-55-1

Group	Acronym	Chemical Name	CAS
Analytes	PFTrDA	Perfluorotridecanoic acid	72629-94-8
	PFTA	Perfluorotetradecanoic acid	376-06-7
	PFBS	Perfluorobutanesulfonic acid	375-73-5
	PFPeS	Perfluoropentanesulfonic acid	2706-91-4
	PFHxS	Perfluorohexanesulfonic acid	355-46-4
	PFHpS	Perfluoroheptanesulfonic acid	375-92-8
	PFOS	Perfluorooctanesulfonic acid	1763-23-1
	PFNS	Perfluorononanesulfonic acid	68259-12-1
	PFDS	Perfluorodecanesulfonic acid	335-77-3
	PFDoS	Perfluorododecanesulfonic acid	79780-39-5
	4:2FTS	4:2 fluorotelomersulfonic acid	757124-72-4
	6:2FTS	6:2 fluorotelomersulfonic acid	27619-97-2
	8:2FTS	8:2 fluorotelomersulfonic acid	39108-34-4
	PFOSA	Perfluorooctanesulfonamide	754-91-6
	NMeFOSA	N-methyl perfluorooctanesulfonamide	31506-32-8
	NEtFOSA	N-ethyl perfluorooctanesulfonamide	4151-50-2
	NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9
	NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6
	MeFOSE	N-methyl perfluorooctanesulfonamidoethanol	24448-09-7
	NEtFOSE	N-ethyl perfluorooctanesulfonamidoethanol	1691-99-2
	HFPO-DA	Hexafluoropropylene oxide dimer acid	13252-13-6
	ADONA	4,8-dioxa-3H-perfluorononanoic acid	919005-14-4
	PFMPA	Perfluoro-3-methoxypropanoic acid	377-73-1
	PFMBA	Perfluoro-4-methoxybutanoic acid	863090-89-5
	NFDHA	Perfluoro-3,6-dioxaheptanoic acid	151772-58-6
	9Cl-PF3ONS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1
	11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9
	PFEESA	Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7
	3:3 FTCA	2H, 2H, 3H, 3H-perfluorohexanoic acid	356-02-5
	5:3 FTCA	2H, 2H, 3H, 3H-perfluorooctanoic acid	914637-49-3
	7:3 FTCA	2H, 2H, 3H, 3H-perfluorodecanoic acid	812-70-4
Internal Standards		Perfluoro-n-[13C4]butanoic acid	
		Perfluoro-n-[13C5]pentanoic acid	
		Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	
		Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	
		Perfluoro-n-[13C8]octanoic acid	
		Perfluoro-n-[13C9]nonanoic acid	

Group	Acronym	Chemical Name	CAS
Internal Standards		Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	
		Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	
		Perfluoro-n-[1,2-13C2]dodecanoic acid	
		Perfluoro-n-[1,2-13C2]tetradecanoic acid	
		Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	
		Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	
		Perfluoro-1-[13C8]octanesulfonic acid	
		1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	
		1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	
		1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	
		Perfluoro-1-[13C8]octanesulfonamide	
		N-methyl-d3-perfluoro-1-octanesulfonamide	
		N-ethyl-d5-perfluoro-1-octanesulfonamide	
		N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	
		N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	
		N-methyl-d7-perfluorooctanesulfonamidoethanol	
		N-ethyl-d9-perfluorooctane sulfonamidoethanol	
		Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	

B. Environmental Sample Matrices

The SLV study includes 32 environmental samples from four aqueous matrices (groundwater, surface water, wastewater, and landfill leachate), three solid matrices (soil, sediment, and biosolid) and tissue.

Table 2 is a list of the environmental samples from the EDDs. We also include three-character codes for each environmental sample, which are used in later figures. This table is file B-1 SLV Environmental Samples.csv from section B of the digital appendix.

Table 2. SLV Environmental Sample Names

Environmental Matrix	Sample Name	Abbreviation
Groundwater	GW CO	GW 1
	GW WL378	GW 2
	GW Wurtsmith AFB	GW 3
Landfill Leachate	LCH MSW Landfill	LC 1
	LCH C & D landfill	LC 2
	LCH MSW incineration ash landfill	LC 3
Surface water	SW COP-SW01 to 11	SW 1
	SW RP-SW01 to 11	SW 2

Environmental Matrix	Sample Name	Abbreviation
Wastewater	SW Marine Surface water	SW 3
	WW #3	WW 1
	WW #5	WW 2
	WW #6	WW 3
	WW #7	WW 4
	WW #8	WW 5
	WW #9	WW 6
	WW #10	WW 7
Biosolid	Biosolid #1	BS 1
	Biosolid #2	BS 2
	Biosolid #3	BS 3
Sediment	Marine sediment	SD 1
	Sediment #3	SD 2
	Sediment #2	SD 3
Soil	Soil 2014-107	SS 1
	Soil 2016-106	SS 2
	Soil 2017-111	SS 3
	Soil 2018-105	SS 4
	Soil 2018-116	SS 5
	Soil 2019-107	SS 6
	Soil 2019-110	SS 7
Tissue	Fish Tissue #1	TS 1
	Fish Tissue # 2	TS 2
	Clam Tissue	TS 3

Note: Correct abbreviations are shown for SD 2 and SD 3.

C. Sample Native Concentration Tables

We generated a total of 35 sample native concentration tables, which is section C of the digital appendix. Native concentration indicates the extent to which PFAS analytes occur in the environmental matrix before sampling. We calculated the mean native concentration and RSD for the 40 PFAS analytes, from three subsamples, for each environmental sample.

In the EDDs, the laboratory flagged results for various reasons indicated by specific letters based on the sponsor's instructions in the SLV study plan.[12] A list of all the flag letters that appear in the EDDs and their corresponding explanation is as follows:

- U indicates that the analyte was not detected and is reported as less than the limit of detection or as defined by the customer.

- J indicates that the reported result is an estimated value.

- B indicates a blank contamination. The recorded result is associated with a contaminated blank.

- Q indicates when one or more quality-control criteria failed.

- E indicates when the reported result exceeds the upper limit of the calibration range.

- D indicates when the reported result is from a dilution.

The laboratory also reported in the EDD the limit of quantification (LOQ), the smallest concentration of the analyte that is reliably detected and quantified, for the analytes. The LOQ for the PFAS analytes in the aqueous samples ranged from 1.43 to 296 ng/L, in the solid samples ranged from 0.16 to 44.3 µg/kg, and tissue samples ranged from 0.396 to 10.1 µg/kg.

At the sponsor's direction, we did not include in further analysis any data that were flagged by the lab as either B or U. Furthermore, at the sponsor's request, we did not calculate the mean native concentration if all three subsamples were qualified with a B or U. We could not calculate the RSD of the native concentration if there was only one subsample.

Table 3 is from a soil sample. This table is file C-19 Soil 2017-111 Native Concentration Table.csv in section C of the digital appendix. There are 32 tables like this, 1 for each of the 32 environmental samples.

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[12] SERDP/ESTCP PFAS Method Validation Team, "Study Plan for Single-Laboratory Validation of PFAS by Isotope Dilution LC-MS/MS," April 2020.

Table 3. Example Sample Native Concentration Table

Analyte	L33303-13 Qualifier	L33303-13 Concentration (µg/kg)	L33303-14 Qualifier	L33303-14 Concentration (µg/kg)	L33303-15 Qualifier	L33303-15 Concentration (µg/kg)	Number of Detections	Mean	RSD
PFBA	U	0.409	U	0.41	U	0.412	0	NA	NA
PFPeA	U	0.0214	J	0.027	U	0.0216	1	0.03	NA
PFHxA	J	0.026	U	0.0204	JQ	0.021	2	0.02	15.04
PFHpA	U	0.0296	U	0.0296	U	0.0298	0	NA	NA
PFOA	U	0.0377	J	0.057	J	0.056	2	0.06	1.25
PFNA	U	0.0877	U	0.0879	U	0.0884	0	NA	NA
PFDA	U	0.0316	U	0.0317	U	0.0319	0	NA	NA
PFUnA	U	0.0337	U	0.0337	U	0.0339	0	NA	NA
PFDoA	U	0.0602	U	0.0603	U	0.0607	0	NA	NA
PFTrDA	U	0.0388	U	0.0388	U	0.0391	0	NA	NA
PFTeDA	U	0.0326	U	0.0327	U	0.0329	0	NA	NA
PFBS	U	0.0143	U	0.0143	U	0.0144	0	NA	NA
PFPeS	U	0.0153	U	0.0153	U	0.0154	0	NA	NA
PFHxS	U	0.0184	U	0.0184	U	0.0185	0	NA	NA
PFHpS	U	0.0581	U	0.0582	U	0.0586	0	NA	NA
PFOS	U	0.0683	U	0.0685	U	0.0689	0	NA	NA
PFNS	U	0.0469	U	0.047	U	0.0473	0	NA	NA
PFDS	U	0.0408	U	0.0409	U	0.0411	0	NA	NA
PFDoS	U	0.0388	U	0.0388	U	0.0391	0	NA	NA
4:2 FTS	U	0.288	U	0.288	U	0.29	0	NA	NA
6:2 FTS	U	0.118	U	0.119		2.69	1	2.69	NA
8:2 FTS	U	0.229	U	0.23	U	0.231	0	NA	NA
PFOSA	U	0.0693	U	0.0695	U	0.0699	0	NA	NA
N-MeFOSA	U	0.05	U	0.0501	U	0.0504	0	NA	NA

Analyte	L33303-13 Qualifier	L33303-13 Concentration (µg/kg)	L33303-14 Qualifier	L33303-14 Concentration (µg/kg)	L33303-15 Qualifier	L33303-15 Concentration (µg/kg)	Number of Detections	Mean	RSD
N-EtFOSA	JQ	0.092	JQ	0.067	JQ	0.101	3	0.09	20.33
N-MeFOSAA	U	0.0306	U	0.0307	U	0.0308	0	NA	NA
N-EtFOSAA	U	0.0449	U	0.045	U	0.0452	0	NA	NA
N-MeFOSE	U	0.207	U	0.207	U	0.209	0	NA	NA
N-EtFOSE	U	0.252	U	0.252	U	0.254	0	NA	NA
HFPO-DA	U	0.139	U	0.139	U	0.14	0	NA	NA
ADONA	U	0.0581	U	0.0582	U	0.0586	0	NA	NA
PFMPA	U	0.0337	U	0.0337	U	0.0339	0	NA	NA
PFMBA	U	0.0296	U	0.0296	U	0.0298	0	NA	NA
NFDHA	U	0.0857	U	0.0858	U	0.0864	0	NA	NA
9Cl-PF3ONS	U	0.0388	U	0.0388	U	0.0391	0	NA	NA
11Cl-PF3OUdS	U	0.0724	U	0.0726	U	0.073	0	NA	NA
PFEESA	U	0.0184	U	0.0184	U	0.0185	0	NA	NA
3:3 FTCA	U	0.0612	U	0.0613	U	0.0617	0	NA	NA
5:3 FTCA	U	0.37	U	0.371	U	0.373	0	NA	NA
7:3 FTCA	U	0.314	U	0.315	U	0.317	0	NA	NA

A description of each column in Table 3:

- Analyte—Always 40 PFAS analytes.

- Qualifier—Lab flag for the native concentration of each of the three analyte subsamples from the EDD.

- Concentration—Native concentration for each of the three subsamples of the analyte from the EDD in µg/kg (or ng/L for aqueous matrices).

- Number of Detections—Number of subsamples for the analyte that do not have a U or B flag for native concentration. Could be 0, 1, 2 or 3.

- Mean—Mean native concentration of the subsamples that do not have a U or B flag. If all three subsamples have U or B, then the value is NA.

- RSD— Percent RSD of the mean native concentration. If the number of samples is less than two then NA was used.

The laboratory created additional subsamples from the groundwater samples to later spike at a higher concentration. We generated tables for the additional groundwater native concentration subsamples.

Table 4 is from a groundwater sample. This table is file C-1(b) GW CO Native HIGH 2 Concentration Table.csv from section C of the digital appendix. There are three "HIGH 2" tables like this, one for each of the three groundwater samples.

Table 4. Example Groundwater Sample Native Concentration Table

	L33877-1	
Analyte	**Qualifier**	**Concentration (ng/L)**
PFBA	J	4.86
PFPeA		5.81
PFHxA		4.96
PFHpA		1.98
PFOA		5.74
PFNA	J	0.446
PFDA	U	0.329
PFUnA	U	0.259
PFDoA	U	0.379
PFTrDA	U	0.24
PFTeDA	U	0.259
PFBS		5.05
PFPeS		1.99
PFHxS		11.1
PFHpS	J	0.261

Analyte	Qualifier	L33877-1 Concentration (ng/L)
PFOS		20.1
PFNS	U	0.299
PFDS	U	0.329
PFDoS	U	0.18
4:2 FTS	U	2.28
6:2 FTS	U	3.96
8:2 FTS	U	1.57
PFOSA	J	0.968
N-MeFOSA	U	0.2
N-EtFOSA	U	0.579
N-MeFOSAA	U	0.589
N-EtFOSAA	U	0.319
N-MeFOSE	U	1.19
N-EtFOSE	U	1.02
HFPO-DA	U	0.409
ADONA	U	0.778
PFMPA	U	0.18
PFMBA	U	0.12
NFDHA	U	1.38
9Cl-PF3ONS	U	0.868
11Cl-PF3OUdS	U	0.818
PFEESA	U	0.14
3:3 FTCA	U	0.719
5:3 FTCA	U	5.06
7:3 FTCA	U	5.93

A description of each column in Table 4:

- Analyte—Always 40 PFAS analytes.

- Qualifier—Lab flag for the native concentration of the analyte subsample from the EDD.

- Concentration—Native concentration for the subsample of the analyte from the EDD in ng/L.

D. Sample Matrix Recovery Tables

We generated a total of 32 sample matrix recovery tables, which is section D of the digital appendix. We calculated the mean spike concentration and mean percent recovery for the 40 PFAS analytes, from three subsamples, for each environmental sample. Spike

concentration indicates the known amount of analyte added to the native sample, while percent recovery indicates the percent of the analyte detected compared with the known amount. We subtracted the native concentration from the spike concentration before calculating the percent recovery, for each subsample. At the sponsor's request, we reported only positive percent recovery values. Upon the sponsor's direction, we also did not include spike concentrations that were flagged by the lab as either U (where it was not detected and less than the limit of detection) or B (where the results were associated with a contaminated blank in our calculations). We reported the mean spike concentration value with an asterisk when all three subsamples had B-flags. For all samples except groundwater, we also calculated the mean and percent RSD of the percent recoveries for an analyte across the three spike concentrations: low, medium, and high. At the sponsor's direction, we did not include instances where the mean native concentration (values also reported in digital appendix section C) were greater than the mean spike concentration for an analyte in the calculations of the mean and RSD of the mean percent recovery, for a sample.

Table 5 is from a soil sample (same sample in Table 3). This table is file D-19 Soil 2017-111 Matrix Recovery.csv in section D of the digital appendix. There are 29 tables like this, 1 for each solid and most aqueous matrices (except groundwater). The % Recovery column is the mean of the calculated percent recoveries for the three subsamples. At the sponsor's request, the % Mean Recovery column is the mean of the mean percent recoveries; we recognize that it is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data.

Table 5. Example Sample Matrix Recovery Table

Analyte	Number Detects	Low Spike Recovery Native Mean PFAS Concentration (μg/kg)	Mean PFAS Spike Concentration (μg/kg)	% Recovery	Native> Spike (Yes/No)	Number Detects	Medium Spike Recovery Native Mean PFAS Concentration (μg/kg)	Mean PFAS Spike Concentration (μg/kg)	% Recovery	Native> Spike (Yes/No)
PFBA	0	NA	2.62	104.07	No	0	NA	3.94	108.55	No
PFPeA	1	0.027	1.31	112.7	No	1	0.027	1.97	111	No
PFHxA	2	0.0235	0.656	95.71	No	2	0.0235	0.984	104.02	No
PFHpA	0	NA	0.656	105.34	No	0	NA	0.984	104.38	No
PFOA	2	0.0565	0.656	99.67	No	2	0.0565	0.984	101.68	No
PFNA	0	NA	0.656	105.85	No	0	NA	0.984	109.8	No
PFDA	0	NA	0.656	102.24	No	0	NA	0.984	112.17	No
PFUnA	0	NA	0.656	104.93	No	0	NA	0.984	108.79	No
PFDoA	0	NA	0.656	105.69	No	0	NA	0.984	105.37	No
PFTrDA	0	NA	0.656	115.04	No	0	NA	0.984	116.23	No
PFTeDA	0	NA	0.656	102.65	No	0	NA	0.984	108.79	No
PFBS	0	NA	0.656	107.02	No	0	NA	0.984	109.45	No
PFPeS	0	NA	0.658	101.83	No	0	NA	0.987	107.78	No
PFHxS	0	NA	0.656	104.88	No	0	NA	0.984	114.88	No
PFHpS	0	NA	0.657	98.17	No	0	NA	0.986	103.28	No
PFOS	0	NA	0.656	113.78	No	0	NA	0.984	118.6	No
PFNS	0	NA	0.657	88.89	No	0	NA	0.986	99.76	No
PFDS	0	NA	0.656	98.37	No	0	NA	0.984	101.32	No
PFDoS	0	NA	0.657	76.7	No	0	NA	0.985	86.12	No
4:2 FTS	0	NA	2.62	96.06	No	0	NA	3.94	106.01	No
6:2 FTS	1	2.69	2.36*	NA	NA	1	2.69	3.55	37.5	No
8:2 FTS	0	NA	2.62	121.35	No	0	NA	3.94	127.01	No
PFOSA	0	NA	0.656	105.13	No	0	NA	0.984	109.79	No
N-MeFOSA	0	NA	0.754	109.85	No	0	NA	1.13	108.85	No
N-EtFOSA	3	0.0867	1.64	108.74	No	3	0.0867	2.46	115.83	No
N-MeFOSAA	0	NA	0.656	101.53	No	0	NA	0.984	97.63	No
N-EtFOSAA	0	NA	0.656	110.17	No	0	NA	0.984	112.16	No
N-MeFOSE	0	NA	6.56	104.98	No	0	NA	9.84	112.51	No
N-EtFOSE	0	NA	4.91	109.43	No	0	NA	7.37	113.56	No
HFPO-DA	0	NA	2.49	109.9	No	0	NA	3.74	119.7	No
ADONA	0	NA	2.63	112.8	No	0	NA	3.95	119.98	No
PFMPA	0	NA	1.31	116.03	No	0	NA	1.97	116.95	No
PFMBA	0	NA	0.656	122.27	No	0	NA	0.984	116.56	No
NFDHA	0	NA	1.31	97.2	No	0	NA	1.97	88.15	No
9Cl-PF3ONS	0	NA	2.63	120.53	No	0	NA	3.94	128.09	No
11Cl-PF3OUdS	0	NA	2.63	114.2	No	0	NA	3.94	121.27	No
PFEESA	0	NA	0.656	99.95	No	0	NA	0.984	94.93	No
3:3 FTCA	0	NA	2.62	106.1	No	0	NA	3.94	112.86	No
5:3 FTCA	0	NA	16.4	97.56	No	0	NA	24.6	92.44	No
7:3 FTCA	0	NA	16.4	97.36	No	0	NA	24.6	99.87	No

Analyte	Number Detects	Native Mean PFAS Concentration (µg/kg)	High Spike Recovery Mean PFAS Spike Concentration (µg/kg)	% Recovery	Native> Spike (Yes/No)	ALL SPIKE RECOVERIES n =	% Mean Recovery	RSD
PFBA	0	NA	6.57	104.41	No	3	105.68	2.36
PFPeA	1	0.027	3.28	109.63	No	3	111.11	1.38
PFHxA	2	0.0235	1.64	102.23	No	3	100.65	4.35
PFHpA	0	NA	1.64	105.49	No	3	105.07	0.57
PFOA	2	0.0565	1.64	97.98	No	3	99.78	1.86
PFNA	0	NA	1.64	103.46	No	3	106.37	3.01
PFDA	0	NA	1.64	106.5	No	3	106.97	4.66
PFUnA	0	NA	1.64	104.27	No	3	106	2.3
PFDoA	0	NA	1.64	106.71	No	3	105.92	0.66
PFTrDA	0	NA	1.64	108.74	No	3	113.34	3.55
PFTeDA	0	NA	1.64	105.49	No	3	105.64	2.91
PFBS	0	NA	1.64	106.3	No	3	107.59	1.53
PFPeS	0	NA	1.65	100	No	3	103.2	3.94
PFHxS	0	NA	1.64	108.74	No	3	109.5	4.61
PFHpS	0	NA	1.65	98.99	No	3	100.15	2.74
PFOS	0	NA	1.64	111.99	No	3	114.79	2.98
PFNS	0	NA	1.64	110.34	No	3	99.66	10.76
PFDS	0	NA	1.64	100.2	No	3	99.97	1.49
PFDoS	0	NA	1.64	82.35	No	3	81.73	5.8
4:2 FTS	0	NA	6.57	107.91	No	3	103.33	6.16
6:2 FTS	1	2.69	5.92	61.96	No	2	49.73	34.78
8:2 FTS	0	NA	6.57	121.4	No	3	123.25	2.64
PFOSA	0	NA	1.64	105.08	No	3	106.67	2.54
N-MeFOSA	0	NA	1.89	111.29	No	3	110	1.11
N-EtFOSA	3	0.0867	4.1	114.06	No	3	112.88	3.27
N-MeFOSAA	0	NA	1.64	103.66	No	3	100.94	3.03
N-EtFOSAA	0	NA	1.64	111.79	No	3	111.37	0.95
N-MeFOSE	0	NA	16.4	108.74	No	3	108.74	3.46
N-EtFOSE	0	NA	12.3	111.38	No	3	111.46	1.85
HFPO-DA	0	NA	6.24	100.75	No	3	110.12	8.61
ADONA	0	NA	6.59	91.91	No	3	108.23	13.48
PFMPA	0	NA	3.28	102.74	No	3	111.91	7.1

Analyte	Number Detects	Native Mean PFAS Concentration (µg/kg)	High Spike Recovery Mean PFAS Spike Concentration (µg/kg)	% Recovery	Native> Spike (Yes/No)	ALL SPIKE RECOVERIES n =	% Mean Recovery	RSD
PFMBA	0	NA	1.64	105.69	No	3	114.84	7.33
NFDHA	0	NA	3.28	99.09	No	3	94.81	6.16
9Cl-PF3ONS	0	NA	6.58	96.26	No	3	114.96	14.47
11Cl-PF3OUdS	0	NA	6.58	93.93	No	3	109.8	12.93
PFEESA	0	NA	1.64	96.75	No	3	97.21	2.61
3:3 FTCA	0	NA	6.57	101.17	No	3	106.71	5.5
5:3 FTCA	0	NA	41	96.83	No	3	95.61	2.9
7:3 FTCA	0	NA	41	102.19	No	3	99.81	2.42

A description of each column in Table 5:

- Headings: Low Spike Recovery, Medium Spike Recovery, and High Spike Recovery

    – Analyte—Always 40 PFAS analytes.

    – Number Detects—Number of EDD entries for the analyte that do not have a U or B flag for native concentration. Could be 0, 1, 2 or 3.

    – Native Mean PFAS Concentration—Mean native concentration of the EDD entries that do not have a U or B flag. Or NA, if all EDD entries have a U or B flag. Identical to values reported in the corresponding sample native concentration table in section C of the digital appendix.

    – Mean PFAS Spike Concentration—Mean spike concentration of the EDD entries that do not have a U or B flag. If all three subsamples have B-flags, then the mean concentration value is reported with an asterisk.

    – % Recovery—Mean of the three subsamples' percent recoveries for spike concentrations that do not have a U or B flag. The native concentration is subtracted before calculating each of the three subsamples' percent recoveries. If the native concentration is NA, then a value of 0 was used instead. If mean native concentration is greater than the spike concentration, then NA was used. If three subsample values have a B-flag, then NA was used. If the mean percent recovery is less than 0, then NA was used.

    – Native> Spike (Yes/No)—Whether or not the mean native concentration is greater than the mean spike concentration. The mean spike concentration value is pulled directly from column Native Mean PFAS Concentration and compared with column % Recovery. If the mean native concentration was NA, then we used the value of 0 instead.

- Heading: ALL SPIKE RECOVERIES

    – n=—Number of spike categories for the analyte where the mean native concentration is NOT greater than the mean spike concentration (i.e., a No in columns Native> Spike (Yes/No)) and when there is not an NA in column % Recovery. Could be 0, 1, 2 or 3.

    – % Mean Recovery—Mean of the mean percent recoveries where the mean native concentration is not greater than the mean spike (i.e., a No in columns Native> Spike (Yes/No)) and when there is not an NA in column % Recovery.

–   RSD—Percent RSD of the mean percent recoveries, used to calculate column % Mean Recovery. If the number of samples is less than two then NA was used.

The laboratory spiked the subsamples in the groundwater matrix with an additional concentration (i.e., "high 2"). Table 6 is from a groundwater sample (same sample in Table 4). This table is file D-1 GW CO Matrix Recovery.csv in section D of the digital appendix. There are three tables like this, one for each of the three groundwater samples. The % Recovery column is the mean of the calculated percent recoveries for the three groundwater subsamples. The % Mean Recovery column is the mean of the mean percent recoveries from all groundwater spike concentrations and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data.

Table 6. Example Groundwater Sample Matrix Recovery Table

Analyte	Number Detects	Low Spike Recovery Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)	Number Detects	Medium Spike Recovery Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration	% Recovery	Native> Spike (Yes/No)
PFBA	3	18.2	15	NA	Yes	3	18.2	29.9	109.89	No
PFPeA	3	22.2	7.5	NA	Yes	3	22.2	14.9	NA	Yes
PFHxA	3	19.6	3.75	NA	Yes	3	19.6	7.47	NA	Yes
PFHpA	3	7.47	3.75	NA	Yes	3	7.47	7.47	102.93	No
PFOA	3	23	3.75	NA	Yes	3	23	7.47	NA	Yes
PFNA	3	2.08	3.75	90.56	No	3	2.08	7.47	102.16	No
PFDA	3	0.556	3.75	96.23	No	3	0.556	7.47	110.57	No
PFUnA	0	NA	3.75	91.09	No	0	NA	7.47	110.87	No
PFDoA	0	NA	3.75	82.26	No	0	NA	7.47	107.12	No
PFTrDA	0	NA	3.75	89.23	No	0	NA	7.47	112.42	No
PFTeDA	0	NA	3.75	91.86	No	0	NA	7.47	110.83	No
PFBS	3	20.6	3.75	NA	Yes	3	20.6	7.47	NA	Yes
PFPeS	3	8.06	3.76	NA	Yes	3	8.06	7.49	NA	Yes
PFHxS	3	48.1	3.75	NA	Yes	3	48.1	7.47	NA	Yes
PFHpS	3	1.3	3.76	91.96	No	3	1.3	7.49	108.63	No
PFOS	3	124	3.75	NA	Yes	3	124	7.47	NA	Yes
PFNS	0	NA	3.76	83.08	No	0	NA	7.48	97.51	No
PFDS	0	NA	3.75	78.04	No	0	NA	7.47	91.76	No
PFDoS	0	NA	3.75	74.59	No	0	NA	7.48	94.04	No
4:2 FTS	0	NA	15	87.74	No	0	NA	29.9	105.43	No
6:2 FTS	0	NA	13.5	108.06	No	0	NA	26.9	120.16	No
8:2 FTS	0	NA	15	108.2	No	0	NA	29.9	125.28	No
PFOSA	3	5.6	3.75	NA	Yes	3	5.6	7.47	130.25	No
N-MeFOSA	0	NA	4.31	73.25	No	0	NA	8.59	110.98	No
N-EtFOSA	0	NA	9.38	73.76	No	0	NA	18.7	105.67	No
N-MeFOSAA	0	NA	3.75	90.25	No	0	NA	7.47	118.67	No
N-EtFOSAA	0	NA	3.75	87.55	No	0	NA	7.47	114.16	No
N-MeFOSE	0	NA	37.5	85.57	No	0	NA	74.7	109.08	No
N-EtFOSE	0	NA	28.1	87.64	No	0	NA	56	115.45	No
HFPO-DA	0	NA	14.2	92.23	No	0	NA	28.4	105.74	No
ADONA	0	NA	15	84.22	No	0	NA	29.9	99.66	No
PFMPA	0	NA	7.5	95.42	No	0	NA	14.9	112.49	No
PFMBA	0	NA	3.75	84.43	No	0	NA	7.47	110.31	No
NFDHA	0	NA	7.5	83.42	No	0	NA	14.9	105.37	No
9Cl-PF3ONS	0	NA	15	82.45	No	0	NA	29.9	102.55	No
11Cl-PF3OUdS	0	NA	15	72.26	No	0	NA	29.9	94.43	No
PFEESA	0	NA	3.75	91.34	No	0	NA	7.47	106.35	No
3:3 FTCA	0	NA	15	91.75	No	0	NA	29.9	109.8	No
5:3 FTCA	0	NA	93.8	85.84	No	0	NA	187	97.1	No

Analyte	Number Detects	Low Spike Recovery Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)	Number Detects	Medium Spike Recovery Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration	% Recovery	Native> Spike (Yes/No)
7:3 FTCA	0	NA	93.8	83.5	No	0	NA	187	96.76	No

Individual Sample Matrix Recovery Table (Part 2)

Analyte	Number Detects	High Spike Recovery Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)	Number Detects	High 2 Spike Recovery (groundwater only) Native Mean PFAS Concentration (ng/L)	Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)
PFBA	3	18.2	44.7	103.36	No	1	4.86	199	99.74	No
PFPeA	3	22.2	22.4	117.45	No	1	5.81	99.7	106.14	No
PFHxA	3	19.6	11.2	NA	Yes	1	4.96	49.9	97.8	No
PFHpA	3	7.47	11.2	107.45	No	1	1.98	49.9	101.12	No
PFOA	3	23	11.2	NA	Yes	1	5.74	49.9	97.05	No
PFNA	3	2.08	11.2	106.72	No	1	0.446	49.9	98.78	No
PFDA	3	0.556	11.2	109.63	No	0	NA	49.9	104.62	No
PFUnA	0	NA	11.2	108.32	No	0	NA	49.9	99.95	No
PFDoA	0	NA	11.2	107.21	No	0	NA	49.9	101.31	No
PFTrDA	0	NA	11.2	108.95	No	0	NA	49.9	96.85	No
PFTeDA	0	NA	11.2	108.06	No	0	NA	49.9	99.35	No
PFBS	3	20.6	11.2	NA	Yes	1	5.05	49.9	103.84	No
PFPeS	3	8.06	11.2	111.29	No	1	1.99	50	94.23	No
PFHxS	3	48.1	11.2	NA	Yes	1	11.1	49.9	107.14	No
PFHpS	3	1.3	11.2	105.61	No	1	0.261	50	93.22	No
PFOS	3	124	11.2	NA	Yes	1	20.1	49.9	108.59	No
PFNS	0	NA	11.2	108.03	No	0	NA	50	97.6	No
PFDS	0	NA	11.2	93.74	No	0	NA	49.9	92.26	No
PFDoS	0	NA	11.2	91.69	No	0	NA	49.9	88.49	No
4:2 FTS	0	NA	44.7	109.69	No	0	NA	199	98.19	No
6:2 FTS	0	NA	40.3	115.16	No	0	NA	180	102.43	No
8:2 FTS	0	NA	44.7	124.31	No	0	NA	199	114.93	No
PFOSA	3	5.6	11.2	147.49	No	1	0.968	49.9	102.61	No
N-MeFOSA	0	NA	12.9	102.31	No	0	NA	57.4	98.03	No
N-EtFOSA	0	NA	28	100.34	No	0	NA	125	102.21	No
N-MeFOSAA	0	NA	11.2	144.62	No	0	NA	49.9	97.82	No
N-EtFOSAA	0	NA	11.2	127.37	No	0	NA	49.9	98.29	No
N-MeFOSE	0	NA	112	106.26	No	0	NA	499	105.44	No
N-EtFOSE	0	NA	83.9	109.89	No	0	NA	374	108.82	No
HFPO-DA	0	NA	42.5	106.87	No	0	NA	190	100.14	No
ADONA	0	NA	44.9	106.91	No	0	NA	200	84.12	No
PFMPA	0	NA	22.4	100.15	No	0	NA	99.7	100.02	No
PFMBA	0	NA	11.2	100.31	No	0	NA	49.9	99.83	No

Individual Sample Matrix Recovery Table (Part 2)

Analyte	Number Detects	High Spike Recovery Native Mean PFAS Concentration (ng/L)	High Spike Recovery Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)	Number Detects	High 2 Spike Recovery (groundwater only) Native Mean PFAS Concentration (ng/L)	High 2 Spike Recovery (groundwater only) Mean PFAS Spike Concentration (ng/L)	% Recovery	Native> Spike (Yes/No)
NFDHA	0	NA	22.4	92.83	No	0	NA	99.7	82.88	No
9Cl-PF3ONS	0	NA	44.8	104.81	No	0	NA	200	89.07	No
11Cl-PF3OUdS	0	NA	44.8	99.02	No	0	NA	200	88.26	No
PFEESA	0	NA	11.2	104.17	No	0	NA	49.9	97.44	No
3:3 FTCA	0	NA	44.7	102.01	No	0	NA	199	96.8	No
5:3 FTCA	0	NA	280	96.18	No	0	NA	1250	85.42	No
7:3 FTCA	0	NA	280	92.61	No	0	NA	1250	93.37	No

Individual Sample Matrix Recovery Table (Part 3)

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	RSD
PFBA	3	104.33	4.93
PFPeA	2	111.8	7.15
PFHxA	1	97.8	NA
PFHpA	3	103.84	3.14
PFOA	1	97.05	NA
PFNA	4	99.55	6.85
PFDA	4	105.26	6.24
PFUnA	4	102.56	8.74
PFDoA	4	99.47	11.87
PFTrDA	4	101.86	10.55
PFTeDA	4	102.53	8.42
PFBS	1	103.84	NA
PFPeS	2	102.76	11.74
PFHxS	1	107.14	NA
PFHpS	4	99.86	8.51
PFOS	1	108.59	NA
PFNS	4	96.55	10.62
PFDS	4	88.95	8.23
PFDoS	4	87.2	9.99
4:2 FTS	4	100.26	9.58
6:2 FTS	4	111.46	7
8:2 FTS	4	118.18	6.88
PFOSA	3	126.78	17.86
N-MeFOSA	4	96.14	16.83
N-EtFOSA	4	95.49	15.35
N-MeFOSAA	4	112.84	21.59
N-EtFOSAA	4	106.84	16.4
N-MeFOSE	4	101.59	10.62

Individual Sample Matrix Recovery Table (Part 3)

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	RSD
N-EtFOSE	4	105.45	11.59
HFPO-DA	4	101.25	6.61
ADONA	4	93.73	12.19
PFMPA	4	102.02	7.17
PFMBA	4	98.72	10.82
NFDHA	4	91.13	11.56
9Cl-PF3ONS	4	94.72	11.33
11Cl-PF3OUdS	4	88.49	13.2
PFEESA	4	99.82	6.82
3:3 FTCA	4	100.09	7.7
5:3 FTCA	4	91.14	6.99
7:3 FTCA	4	91.56	6.19

See Table 5 for a description of the columns for the spike concentrations Low Spike Recovery, Medium Spike Recovery, High Spike Recovery, and ALL SPIKE RECOVERIES. A description of the "High 2" columns in Table 6:

- Heading: High 2 Spike Recovery (groundwater only)

  - Number Detects—Number of EDD entries for the analyte that do not have a U or B flag for native concentration. Could be 0 or 1.

  - Native Mean PFAS Concentration—Mean native concentration of the EDD entry that does not have a U or B flag. Or NA, if the EDD entry has a U or B flag. Values are not labeled as means in the corresponding sample native concentration tables in section c of the digital appendix.

  - Mean PFAS Spike Concentration—Mean spike concentration of the EDD entry that does not have a U or B flag.

  - % Recovery—Mean of the three subsamples' percent recoveries for spike concentrations that do not have a U or B flag. The native concentration is subtracted before calculating each of the three subsamples' percent recoveries. If the native concentration is NA, then a value of 0 was used instead. If mean native concentration is greater than the spike concentration, then NA was used. If three subsample values have a B-flag, then NA was used. If the mean percent recovery is less than 0, then NA was used.

  - Native> Spike (Yes/No)—Whether or not the mean native concentration is greater than the mean spike concentration. The mean spike concentration is value is pulled directly from column Native Mean PFAS Concentration and compared with the column % Recovery. If the mean native concentration is NA, then we used the value of 0 instead.

E. Media Type Matrix Recovery Tables

We generated a total of 11 tables for section E of the digital appendix. We calculated the mean of the sample mean percent recovery, percent RSD, and SD for the 40 PFAS analytes, for the 8 environmental media (groundwater, surface water, wastewater, landfill leachate, soil, sediment, biosolid, and tissue). While the previous tables discussed in section D provide results for each of the 32 individual environmental samples, these tables in section E *summarize* those results for each of the 8 environmental media. At the sponsor's direction, we used the sample mean percent recovery values from tables in section D of the digital appendix for the three spike concentrations: low, medium, and high. we also identified the lowest and highest sample mean percent recovery for the matrix. We also calculated the mean of the matrix mean percent recovery, percent RSD, and SD for the 40 analytes, for aqueous and solid matrices for the three spike concentrations.

Also at request of the sponsor, we calculated the mean of the mean percent recoveries, percent RSD, and SD of the percent recoveries for an analyte across all spike concentrations, for the media type. We also identified the lowest and highest sample mean percent recovery for the media type.

Table 7 is constructed from all soil samples. This is file E-5 Soil Sample Matrix Recovery.csv in section E of the digital appendix. There are seven tables like this, one for all solid and most aqueous matrices (except groundwater). The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data. The Lowest % Recovery and Highest % Recovery columns are the mean of the three subsamples' percent recoveries for the given matrix.

Table 7. Example Matrix Recovery Table

Analyte	n =	Low Spike Recovery % Mean Recovery	RSD	SD	n =	Medium Spike Recovery % Mean Recovery	RSD	SD	n =	High Spike Recovery % Mean Recovery	RSD	SD
PFBA	7	106.26	1.6	1.7	7	106.6	2.27	2.42	7	105.63	0.86	0.91
PFPeA	7	107.08	5.33	5.71	7	104.95	5.75	6.04	7	109.7	1.09	1.2
PFHxA	7	99.83	3.12	3.12	7	101.28	3.91	3.96	7	101.13	1.84	1.86
PFHpA	7	100.9	3.38	3.42	7	101.06	3.09	3.12	7	102.3	3.55	3.63
PFOA	6	98.88	2.69	2.66	6	100.48	4.22	4.24	6	100.63	1.55	1.56
PFNA	7	102.9	3.65	3.76	7	103.94	4.96	5.15	7	103.64	1.76	1.83
PFDA	6	103.24	3.12	3.22	6	105.89	5.3	5.61	6	106.92	1.05	1.12
PFUnA	7	101.03	5.27	5.32	7	104.41	4.63	4.83	7	103.42	1.07	1.11
PFDoA	6	103.25	3.93	4.06	7	105.59	6.68	7.06	7	106.54	5.4	5.76
PFTrDA	7	111.91	3.45	3.87	7	114.71	1.51	1.73	7	111.14	4.2	4.67
PFTeDA	7	103.8	5.79	6.01	7	106.43	2.54	2.71	7	105.14	0.79	0.84
PFBS	7	104.18	3.02	3.14	7	106.39	3.16	3.36	7	106.44	1.96	2.09
PFPeS	7	103.61	1.79	1.85	7	103.39	3.33	3.44	7	104.1	3.67	3.82
PFHxS	7	107.3	1.93	2.07	7	110.53	2.82	3.12	7	110.14	2.47	2.72
PFHpS	7	97.71	1.4	1.37	7	99.74	3.95	3.94	7	99.82	1.98	1.98
PFOS	6	107.53	3.25	3.5	6	110.82	5.26	5.83	7	109.09	2.53	2.75
PFNS	7	101.5	9.23	9.37	7	99.83	4.78	4.77	7	101.09	7.2	7.28
PFDS	7	99.01	3.91	3.88	7	102.3	2.64	2.7	7	100.48	2.82	2.83
PFDoS	7	88.73	9.09	8.06	7	91.24	5.28	4.82	7	90.74	5.11	4.64
4:2 FTS	7	100.67	3.43	3.45	7	105.28	3.18	3.34	7	105.78	2.07	2.19
6:2 FTS	3	107.68	4.01	4.32	5	100.12	39.51	39.55	7	79.36	49.89	39.59
8:2 FTS	7	120.18	5.05	6.07	7	122.28	4.31	5.27	7	122.01	1.17	1.43
PFOSA	7	104.41	1.81	1.89	7	107.72	2.83	3.05	7	106.36	1.1	1.17
N-MeFOSA	7	108.96	3.41	3.72	7	109.36	1.75	1.91	7	108.35	1.63	1.77
N-EtFOSA	7	111.05	2.13	2.36	7	113.71	2.31	2.62	7	113.28	1.02	1.16
N-MeFOSAA	7	100.51	3.36	3.38	7	104.68	4.67	4.89	7	103.88	3.65	3.79
N-EtFOSAA	7	109.07	2.66	2.91	7	108.32	4.5	4.87	7	110.84	2.39	2.65
N-MeFOSE	7	105.4	1.56	1.65	7	109.35	2.29	2.51	7	108.52	0.78	0.84

Analyte	n =	Low Spike Recovery % Mean Recovery	RSD	SD	n =	Medium Spike Recovery % Mean Recovery	RSD	SD	n =	High Spike Recovery % Mean Recovery	RSD	SD
N-EtFOSE	7	108.55	1.39	1.51	7	110.45	2.84	3.14	7	112.16	1.04	1.17
HFPO-DA	7	104.56	6.11	6.39	7	104.67	11.17	11.69	7	105.92	5.19	5.5
ADONA	7	106.41	9.23	9.82	7	106.44	8.34	8.88	7	99.31	8.55	8.49
PFMPA	7	113.46	2.88	3.26	7	110.57	4.44	4.91	7	101.56	2.21	2.24
PFMBA	7	117.07	3.54	4.15	7	113.53	4.55	5.17	7	100.74	5.02	5.05
NFDHA	7	95.39	20.38	19.44	7	91.4	14.58	13.32	7	104.15	12.21	12.72
9Cl-PF3ONS	7	114.11	8.59	9.81	7	115.9	8.57	9.94	7	104.89	9.33	9.79
11Cl-PF3OUdS	7	111.36	7.63	8.5	7	112.96	7.5	8.48	7	106.55	11.59	12.34
PFEESA	7	103.38	2.78	2.87	7	99.01	3	2.97	7	99.39	2.08	2.06
3:3 FTCA	7	108.56	2.81	3.05	7	106.52	4.76	5.08	7	97.82	4.44	4.34
5:3 FTCA	7	100.01	5.4	5.4	7	94.09	3.11	2.93	7	95.14	6.74	6.41
7:3 FTCA	7	100.2	4.08	4.09	7	97.76	2.68	2.62	7	99.98	5.88	5.88

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	Lowest % Recovery	Highest % Recovery	RSD	SD
PFBA	3	106.16	101.56	108.65	0.46	0.49
PFPeA	3	107.25	97.74	115.34	2.22	2.38
PFHxA	3	100.75	95.71	106.25	0.79	0.8
PFHpA	3	101.42	96.88	107.24	0.75	0.76
PFOA	3	100	94.2	106.42	0.97	0.97
PFNA	3	103.5	98.27	110.54	0.52	0.54
PFDA	3	105.35	99.3	112.17	1.8	1.9
PFUnA	3	102.95	91.73	108.82	1.69	1.74
PFDoA	3	105.13	90.57	116.27	1.61	1.69
PFTrDA	3	112.59	105.58	119.32	1.67	1.88
PFTeDA	3	105.12	93.43	112.88	1.25	1.31
PFBS	3	105.67	99.21	109.65	1.22	1.29
PFPeS	3	103.7	98.11	110.76	0.35	0.37
PFHxS	3	109.32	104.73	114.88	1.61	1.76

Analyte	n =	ALL SPIKE RECOVERIES			RSD	SD
		% Mean Recovery	Lowest % Recovery	Highest % Recovery		
PFHpS	3	99.09	94	103.28	1.21	1.2
PFOS	3	109.15	102.49	118.6	1.51	1.65
PFNS	3	100.81	88.02	111.46	0.87	0.87
PFDS	3	100.6	91.87	106.42	1.64	1.65
PFDoS	3	90.24	76.7	100.1	1.47	1.33
4:2 FTS	3	103.91	96.06	110.38	2.71	2.82
6:2 FTS	3	95.72	11.24	147.45	15.32	14.66
8:2 FTS	3	121.49	113.31	131.95	0.94	1.14
PFOSA	3	106.16	102.02	110.54	1.57	1.66
N-MeFOSA	3	108.89	102.26	113.86	0.47	0.51
N-EtFOSA	3	112.68	108.13	117.03	1.27	1.43
N-MeFOSAA	3	103.02	97.15	110.15	2.15	2.21
N-EtFOSAA	3	109.41	101.21	114.53	1.18	1.29
N-MeFOSE	3	107.76	104.07	112.51	1.94	2.09
N-EtFOSE	3	110.39	105.49	114.25	1.64	1.81
HFPO-DA	3	105.05	87.79	119.7	0.72	0.76
ADONA	3	104.05	91.91	123.47	3.95	4.11
PFMPA	3	108.53	98.34	116.95	5.72	6.21
PFMBA	3	110.44	90.68	122.27	7.78	8.59
NFDHA	3	96.98	70.63	125.78	6.73	6.52
9Cl-PF3ONS	3	111.64	96.26	130.43	5.29	5.91
11Cl-PF3OUdS	3	110.29	93.93	127.26	3.02	3.34
PFEESA	3	100.59	94.93	106.75	2.41	2.42
3:3 FTCA	3	104.3	92.31	112.86	5.47	5.7
5:3 FTCA	3	96.42	86.49	108.3	3.27	3.16
7:3 FTCA	3	99.32	90.65	108.69	1.36	1.35

A description of each column in Table 7:

- Headings: Low, Medium, and High Spike Recovery

  - Analyte—Always 40 PFAS analytes.

  - n=—Number of samples for a matrix, for a spike concentrations, that do not have U or B flagged values. Can range from 0 to 7.

  - % Mean Recovery—Mean of the sample mean percent recoveries, for a spike concentration, for the analyte, that does not have U or B flagged values (from the sample matrix recovery tables in section D of the digital appendix, column % Recovery). If all percent recoveries are NA, (i.e., if n = 0 in or mean percent recovery < 0), then NA was used.

  - RSD—Percent RSD of the mean of the sample mean percent recoveries, used to calculate column % Recovery. If the number of samples is less than two, then NA was used.

  - SD—SD of the mean of sample mean percent recoveries. If the number of samples is less than two, then NA was used.

- Heading: ALL SPIKE RECOVERIES

  - n=—Number of spike categories with percent recovery values, without NA in column % Recovery, for the analyte.

  - % Mean Recovery—Mean of the matrix mean percent recoveries, for the analyte. If the number of spike categories is less than two, then NA was used.

  - Lowest % Recovery—Lowest percent recovery of the mean of the three subsamples' percent recoveries for the matrix for values not flagged with U or B and non-negative values from the sample matrix recovery tables in section D of the digital appendix column % Recovery.

  - Highest % Recovery—Highest percent recovery of the mean of the three subsamples' percent recoveries for the matrix for values not flagged with U or B and non-negative values from the sample matrix recovery tables in section D of the digital appendix column % Recovery.

  - RSD—Percent RSD of the matrix mean percent recoveries from columns % Recovery. If the number of samples is less than two, then NA was used.

  - SD—SD of the matrix mean percent recoveries from columns % Recovery. If the number of samples is less than two, then NA was used.

For the groundwater matrix, we calculated the mean of the mean percent recoveries, percent RSD, and SD of the percent recoveries for an analyte across all four spike concentrations (low, medium, high, *and* high 2).

Table 8 is constructed from all groundwater samples. This file is E-1 Groundwater Sample Matrix Recovery.csv in section E of the digital appendix. There is only one table like this, containing "high 2" concentration subsamples, and only for the groundwater matrix. The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same size number of data. The Lowest % Recovery and Highest % Recovery columns are the mean of the three subsamples' percent recoveries for the matrix.

Table 8. Example Groundwater Matrix Recovery Table

Analyte	n =	Low Spike Recovery % Mean Recovery	RSD	SD	n =	Medium Spike Recovery % Mean Recovery	RSD	SD
PFBA	2	100.5	1.63	1.63	3	112.32	3.4	3.82
PFPeA	0	NA	NA	NA	2	115.54	3.25	3.75
PFHxA	0	NA	NA	NA	0	NA	NA	NA
PFHpA	0	NA	NA	NA	3	107.93	5.98	6.46
PFOA	0	NA	NA	NA	0	NA	NA	NA
PFNA	3	98.03	7.56	7.41	3	107.94	5	5.4
PFDA	3	103.39	8.25	8.53	3	117.09	6.09	7.13
PFUnA	3	99.85	8.42	8.4	3	112.78	4.95	5.58
PFDoA	3	95.24	12.82	12.21	3	113.65	4.98	5.66
PFTrDA	3	100.3	9.59	9.62	3	117.29	5.42	6.36
PFTeDA	3	99.89	7.2	7.19	3	115.48	4.59	5.31
PFBS	1	101.13	NA	NA	1	113.28	NA	NA
PFPeS	1	94.14	NA	NA	1	121.36	NA	NA
PFHxS	0	NA	NA	NA	0	NA	NA	NA
PFHpS	1	91.96	NA	NA	3	118.48	9.93	11.76
PFOS	0	NA	NA	NA	0	NA	NA	NA
PFNS	3	108.59	20.41	22.17	3	117.16	14.53	17.02
PFDS	3	93.64	15.28	14.3	3	106.21	11.88	12.62
PFDoS	3	88.74	14.23	12.62	3	99.14	5.56	5.51
4:2 FTS	3	98.79	10.05	9.93	3	112.46	6.05	6.8
6:2 FTS	1	108.06	NA	NA	2	125.32	5.81	7.29
8:2 FTS	2	108.9	0.91	0.99	3	128.21	3.91	5.02
PFOSA	0	NA	NA	NA	2	120.21	11.81	14.2
N-MeFOSA	3	88.07	14.57	12.83	3	108.6	6.13	6.66
N-EtFOSA	3	86.08	12.45	10.71	3	104.99	8.67	9.1
N-MeFOSAA	3	98.15	8.49	8.33	3	129.64	14.46	18.75
N-EtFOSAA	3	95.3	7.38	7.03	3	123.55	9.92	12.25
N-MeFOSE	3	96.41	9.85	9.49	3	113	3.84	4.34

Analyte	n =	Low Spike Recovery % Mean Recovery	RSD	SD	n =	Medium Spike Recovery % Mean Recovery	RSD	SD
N-EtFOSE	3	97.76	9.16	8.95	3	117.62	3.32	3.9
HFPO-DA	3	99.49	6.82	6.78	3	118.3	9.22	10.91
ADONA	3	93.84	10.9	10.23	3	110.96	8.87	9.84
PFMPA	3	102.51	6	6.15	3	115.14	4	4.6
PFMBA	3	99.75	13.71	13.68	3	112.01	3.47	3.89
NFDHA	3	98.28	14.25	14.01	3	106.93	2.01	2.15
9Cl-PF3ONS	3	96.42	15.11	14.57	3	113.13	8.39	9.5
11Cl-PF3OUdS	3	90.03	18.98	17.09	3	104.51	8.89	9.29
PFEESA	3	98.63	8.13	8.02	3	111.25	4.76	5.3
3:3 FTCA	3	99.19	6.69	6.63	3	115.21	4.41	5.09
5:3 FTCA	3	98.15	11.12	10.91	3	111.09	10.9	12.11
7:3 FTCA	3	99.22	13.75	13.64	3	113.36	12.7	14.4

Analyte	n =	High Spike Recovery % Mean Recovery	RSD	SD	n =	High 2 Spike Recovery (groundwater only) % Mean Recovery	RSD	SD
PFBA	3	108.21	4.96	5.37	3	99.67	0.43	0.43
PFPeA	3	114.82	2.19	2.51	3	104.95	1.03	1.09
PFHxA	0	NA	NA	NA	3	98.68	1.1	1.09
PFHpA	3	107.59	0.36	0.39	3	98.99	1.88	1.86
PFOA	0	NA	NA	NA	3	96.56	0.52	0.5
PFNA	3	108.46	3.56	3.87	3	98.96	0.35	0.35
PFDA	3	114.94	4.78	5.5	3	104.45	0.28	0.29
PFUnA	3	111.86	4.21	4.71	3	99.91	0.12	0.12
PFDoA	3	110.28	8.57	9.45	3	99.68	1.47	1.47
PFTrDA	3	114.66	8.85	10.14	3	93.57	3.08	2.88
PFTeDA	3	112.83	4.75	5.36	3	98.28	0.99	0.97
PFBS	1	111.97	NA	NA	3	104.02	0.43	0.45
PFPeS	2	113.27	2.48	2.81	3	93.01	1.54	1.43
PFHxS	0	NA	NA	NA	3	106.72	1.63	1.74
PFHpS	3	117.17	8.55	10.01	3	92.27	2.54	2.34
PFOS	0	NA	NA	NA	2	109.76	1.5	1.64
PFNS	3	120.44	9.47	11.41	3	99.5	4.12	4.1
PFDS	3	103.1	7.86	8.11	3	93.36	4.63	4.33
PFDoS	3	99.85	7.37	7.36	3	86.89	2.68	2.33
4:2 FTS	3	112.93	5.16	5.83	3	98.66	0.56	0.55
6:2 FTS	2	117.19	2.45	2.87	3	99.64	2.71	2.7
8:2 FTS	3	124.02	0.38	0.47	3	109.19	4.95	5.41
PFOSA	2	131.4	17.31	22.75	3	102.02	0.52	0.53
N-MeFOSA	3	110.62	6.51	7.2	3	98.07	0.03	0.03
N-EtFOSA	3	107.64	5.98	6.44	3	103.16	1.31	1.35
N-MeFOSAA	3	132.94	12.51	16.64	3	95.77	2.2	2.11

Analyte	n =	High Spike Recovery % Mean Recovery	RSD	SD	n =	High 2 Spike Recovery (groundwater only) % Mean Recovery	RSD	SD
N-EtFOSAA	3	122.3	6.86	8.39	3	96.6	1.52	1.47
N-MeFOSE	3	112.03	4.91	5.5	3	105.31	0.26	0.28
N-EtFOSE	3	115.69	5.2	6.02	3	107.79	0.9	0.97
HFPO-DA	3	114.45	7.92	9.07	3	102.94	2.41	2.48
ADONA	3	115.3	15.8	18.22	3	84.2	0.58	0.49
PFMPA	3	109.17	7.34	8.02	3	98.33	1.61	1.58
PFMBA	3	107.39	6.53	7.01	3	99.39	1.04	1.03
NFDHA	3	105.54	10.45	11.03	3	107.22	26.73	28.66
9Cl-PF3ONS	3	117.74	18.24	21.47	3	89.55	1.19	1.07
11Cl-PF3OUdS	3	107.1	15.27	16.36	3	88.09	2.79	2.46
PFEESA	3	111.46	6.25	6.96	3	100.17	2.37	2.38
3:3 FTCA	3	109.09	5.7	6.22	3	95.19	1.59	1.51
5:3 FTCA	3	108.62	9.91	10.77	3	88.59	3.28	2.91
7:3 FTCA	3	109.1	13.12	14.32	3	97.59	3.74	3.65

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	Lowest % Recovery	Highest % Recovery	RSD	SD
PFBA	4	105.17	99.21	116.73	5.82	6.12
PFPeA	3	111.77	104.01	118.19	5.29	5.92
PFHxA	1	98.68	97.8	99.9	NA	NA
PFHpA	3	104.84	97.66	115.22	4.83	5.06
PFOA	1	96.56	96.05	97.05	NA	NA
PFNA	4	103.34	90.56	112.89	5.44	5.62
PFDA	4	109.97	96.23	124.71	6.41	7.05
PFUnA	4	106.1	91.09	119.07	6.78	7.19
PFDoA	4	104.71	82.26	120.89	8.29	8.68
PFTrDA	4	106.45	89.23	126.37	10.69	11.38
PFTeDA	4	106.62	91.86	121.26	8.25	8.79
PFBS	4	107.6	101.13	113.28	5.53	5.95
PFPeS	4	105.45	91.43	121.36	13.38	14.11
PFHxS	1	106.72	104.81	108.21	NA	NA
PFHpS	4	104.97	89.6	131.5	14.15	14.85
PFOS	1	109.76	108.59	110.92	NA	NA
PFNS	4	111.42	83.08	130.47	8.43	9.39
PFDS	4	99.08	78.04	115.08	6.63	6.56
PFDoS	4	93.66	74.59	105.99	7.25	6.79
4:2 FTS	4	105.71	87.74	119.66	7.63	8.07
6:2 FTS	4	112.55	97.04	130.47	9.89	11.13
8:2 FTS	4	117.58	104.19	134	8.51	10
PFOSA	3	117.88	101.57	147.49	12.58	14.83
N-MeFOSA	4	101.34	73.25	115.11	10.28	10.42

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	Lowest % Recovery	Highest % Recovery	RSD	SD
N-EtFOSA	4	100.47	73.76	113.73	9.72	9.77
N-MeFOSAA	4	114.13	90.25	151.29	17.43	19.89
N-EtFOSAA	4	109.44	87.55	137.41	14.25	15.59
N-MeFOSE	4	106.68	85.57	117.66	7.18	7.66
N-EtFOSE	4	109.72	87.64	122.13	8.23	9.03
HFPO-DA	4	108.79	92.23	125.39	8.28	9
ADONA	4	101.07	83.75	136.2	14.42	14.58
PFMPA	4	106.29	95.42	120.45	6.96	7.4
PFMBA	4	104.63	84.43	116.45	5.87	6.15
NFDHA	4	104.49	82.88	138.81	4.02	4.2
9Cl-PF3ONS	4	104.21	82.45	142.53	12.86	13.4
11Cl-PF3OUdS	4	97.43	72.26	125.93	10.02	9.76
PFEESA	4	105.38	91.34	118.04	6.58	6.93
3:3 FTCA	4	104.67	91.75	119.89	8.73	9.14
5:3 FTCA	4	101.61	85.42	118.28	10.17	10.33
7:3 FTCA	4	104.82	83.5	122.44	7.28	7.64

See Table 7 for a description of the columns for the spike concentrations Low, Medium, High Spike Recoveries, and ALL SPIKE RECOVERIES. A description of the High 2 columns in Table 8:

- Heading: High 2 Spike Recovery (groundwater only)

    - n=—Number of samples for a matrix, for a spike concentrations, that do not have U or B flagged values. Can range from 0 to 3.

    - % Recovery—Mean of the sample mean percent recoveries, for a spike concentration, for the analyte, that does not have U or B flagged values (from the sample matrix recovery tables in section D of the digital appendix, column % Recovery). If all percent recoveries are NA, (i.e., if n = 0 in or mean percent recovery < 0), then NA was used.

    - RSD—%RSD of the mean of the sample mean percent recoveries, used to calculate column % Recovery. If the number of samples is less than two, then NA was used.

    - SD—SD of the mean of sample mean percent recoveries. If the number of samples is less than two, then NA was used.

The sponsor provided a separate template with additional columns for the high 2 spike concentration for the aqueous media that we used.

Table 9 is constructed from all aqueous matrices. This is table E-9 Aqueous Sample Matrix Recovery.csv in section E of the digital appendix. The other table does not have the

high 2 spike concentrations and summarizes results across all solid media (including biosolid, sediment, and soil, but excluding tissue). The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data. The Lowest % Recovery and Highest % Recovery columns are the mean of the three subsamples' percent recoveries for the matrix.

Table 9. Example Media Type Recovery Table

Analyte	n =	Low Spike Recovery % Mean Recovery	RSD	SD	n =	Medium Spike Recovery % Mean Recovery	RSD	SD
PFBA	4	98.92	3.31	3.27	4	106.59	6.71	7.15
PFPeA	4	103.53	1.67	1.73	4	113.43	6.41	7.27
PFHxA	4	94.11	1.1	1.04	4	100.74	3.57	3.6
PFHpA	4	97.03	8.67	8.41	4	107.63	6.37	6.85
PFOA	4	96.79	8.5	8.22	4	102.43	4.83	4.94
PFNA	4	98.24	1.12	1.1	4	105.14	5.91	6.22
PFDA	4	101.52	5.55	5.63	4	112.12	5.42	6.07
PFUnA	4	98.04	1.52	1.49	4	108.01	6.13	6.62
PFDoA	4	98.43	4.08	4.01	4	107.93	5.88	6.34
PFTrDA	4	102.85	4.08	4.2	4	112.19	4.98	5.59
PFTeDA	4	102.52	7.71	7.91	4	110.57	6.19	6.84
PFBS	4	99.36	4.41	4.38	4	108.89	4.26	4.63
PFPeS	4	97.06	4.35	4.22	4	111.22	8.66	9.63
PFHxS	4	107.76	9.14	9.85	4	109.85	2.36	2.59
PFHpS	4	99.32	6.4	6.36	4	111.28	4.95	5.51
PFOS	4	102.18	4.2	4.3	4	109.09	11.61	12.67
PFNS	4	98.3	7.39	7.26	4	104.99	8.36	8.78
PFDS	4	83.37	9.48	7.9	4	90.79	15.54	14.11
PFDoS	4	70.96	18.92	13.43	4	72.72	31.27	22.74
4:2 FTS	4	101.06	4.9	4.95	4	109.44	5.57	6.1
6:2 FTS	4	108.94	4.63	5.04	4	121.18	8.99	10.9
8:2 FTS	4	112.04	6.67	7.48	4	122.02	4.4	5.37
PFOSA	4	118.01	16.37	19.31	4	113.8	4.93	5.62
N-MeFOSA	4	92.71	8.72	8.08	4	107.16	6.05	6.48
N-EtFOSA	4	90.97	8.84	8.05	4	105.97	4.67	4.95
N-MeFOSAA	4	136.99	19.81	27.14	4	154.1	16.96	26.14
N-EtFOSAA	4	114.65	13.94	15.98	4	133.02	9	11.98
N-MeFOSE	4	96.51	6.38	6.16	4	106.76	8.05	8.6
N-EtFOSE	4	99.82	5.22	5.21	4	112.94	6.44	7.27
HFPO-DA	4	101.23	6.05	6.13	4	110.94	8.1	8.99
ADONA	4	107.15	21.23	22.75	4	115.6	16.75	19.36
PFMPA	4	105.08	6.51	6.84	4	120.06	14	16.8
PFMBA	4	104.47	15.48	16.17	4	113.62	13.13	14.91
NFDHA	4	80.8	27.01	21.82	4	86.71	30.94	26.83
9Cl-PF3ONS	4	104.16	21.6	22.5	4	112.66	20.76	23.39
11Cl-PF3OUdS	4	88.58	15.99	14.16	4	96.76	16.59	16.05
PFEESA	4	109.99	20.41	22.45	4	121.81	25.71	31.32
3:3 FTCA	4	99.76	4.19	4.18	4	111.54	18.47	20.6
5:3 FTCA	4	115.43	26.23	30.28	4	122.79	24.84	30.5
7:3 FTCA	4	97.26	10.22	9.94	4	111.83	16.34	18.27

Analyte	n =	High Spike Recovery % Mean Recovery	RSD	SD	n =	High 2 Spike Recovery (groundwater only) % Mean Recovery	RSD	SD
PFBA	4	104.88	3.77	3.95	1	99.67	NA	NA
PFPeA	4	111.54	4.11	4.58	1	104.95	NA	NA
PFHxA	4	102.98	2.69	2.77	1	98.68	NA	NA
PFHpA	4	104.1	4.91	5.11	1	98.99	NA	NA
PFOA	4	103.11	4.37	4.5	1	96.56	NA	NA
PFNA	4	106.98	3.89	4.17	1	98.96	NA	NA
PFDA	4	110.12	4.57	5.03	1	104.45	NA	NA
PFUnA	4	108.61	4.5	4.88	1	99.91	NA	NA
PFDoA	4	109.6	6.79	7.45	1	99.68	NA	NA
PFTrDA	4	111.12	2.25	2.5	1	93.57	NA	NA
PFTeDA	4	108.62	3.93	4.27	1	98.28	NA	NA
PFBS	4	111.57	4.33	4.83	1	104.02	NA	NA
PFPeS	4	109.87	6.73	7.4	1	93.01	NA	NA
PFHxS	4	111.98	3.79	4.24	1	106.72	NA	NA
PFHpS	4	111.58	5.75	6.42	1	92.27	NA	NA
PFOS	4	111.93	7.81	8.74	1	109.76	NA	NA
PFNS	4	107.83	9.05	9.75	1	99.5	NA	NA
PFDS	4	90.49	13.61	12.32	1	93.36	NA	NA
PFDoS	4	74.41	30.04	22.35	1	86.89	NA	NA
4:2 FTS	4	108.79	3.99	4.34	1	98.66	NA	NA
6:2 FTS	4	110.82	3.98	4.41	1	99.64	NA	NA
8:2 FTS	4	122.08	3.47	4.24	1	109.19	NA	NA
PFOSA	4	120.61	8.5	10.25	1	102.02	NA	NA
N-MeFOSA	4	108.89	3.72	4.05	1	98.07	NA	NA
N-EtFOSA	4	107.3	4.04	4.34	1	103.16	NA	NA
N-MeFOSAA	4	155.06	17.89	27.73	1	95.77	NA	NA
N-EtFOSAA	4	136.2	11.89	16.2	1	96.6	NA	NA
N-MeFOSE	4	107.09	7.02	7.52	1	105.31	NA	NA
N-EtFOSE	4	111.89	5.4	6.05	1	107.79	NA	NA
HFPO-DA	4	106.59	6.02	6.41	1	102.94	NA	NA
ADONA	4	116.8	16.01	18.7	1	84.2	NA	NA
PFMPA	4	117.77	17.5	20.61	1	98.33	NA	NA
PFMBA	4	112.04	12.85	14.4	1	99.39	NA	NA
NFDHA	4	89.22	28.11	25.08	1	107.22	NA	NA
9Cl-PF3ONS	4	114.44	17.67	20.23	1	89.55	NA	NA
11Cl-PF3OUdS	4	98.02	16.06	15.74	1	88.09	NA	NA
PFEESA	4	124.2	27.49	34.14	1	100.17	NA	NA
3:3 FTCA	4	111.72	18.26	20.4	1	95.19	NA	NA
5:3 FTCA	4	120.87	25.86	31.26	1	88.59	NA	NA
7:3 FTCA	4	112.19	15.48	17.37	1	97.59	NA	NA

Analyte	n =	ALL SPIKE RECOVERIES % Mean Recovery	Lowest % Recovery	Highest % Recovery	RSD	SD
PFBA	4	102.51	86.44	118.89	3.7	3.8
PFPeA	4	108.36	89.3	130.04	4.48	4.86
PFHxA	4	99.13	83.88	114.37	3.81	3.78
PFHpA	4	101.94	81.06	125.56	4.73	4.82
PFOA	4	99.72	83.56	119.23	3.54	3.53
PFNA	4	102.33	79.75	123.85	4.28	4.38
PFDA	4	107.05	78.41	124.71	4.59	4.92
PFUnA	4	103.64	86.75	119.96	5.26	5.45

Analyte	n =	% Mean Recovery	Lowest % Recovery	Highest % Recovery	RSD	SD
			ALL SPIKE RECOVERIES			
PFDoA	4	103.91	82.26	129.86	5.46	5.67
PFTrDA	4	104.93	87.19	136.24	8.24	8.65
PFTeDA	4	105	87.2	122.51	5.37	5.64
PFBS	4	105.96	93.97	123.82	5.09	5.4
PFPeS	4	102.79	88.86	125.46	8.88	9.12
PFHxS	4	109.08	95.26	125.4	2.14	2.33
PFHpS	4	103.61	84.43	132.05	9.14	9.47
PFOS	4	108.24	91.35	123.36	3.9	4.22
PFNS	4	102.66	76.66	130.47	4.4	4.52
PFDS	4	89.5	55.96	115.08	4.79	4.29
PFDoS	4	76.25	22.91	105.99	9.49	7.24
4:2 FTS	4	104.49	87.32	122.34	5.21	5.44
6:2 FTS	4	110.15	65.44	149.19	8.02	8.84
8:2 FTS	4	116.33	100.45	139.39	5.76	6.7
PFOSA	4	113.61	88.51	178.31	7.24	8.22
N-MeFOSA	4	101.71	73.25	132.85	7.52	7.65
N-EtFOSA	4	101.85	73.76	135.08	7.32	7.46
N-MeFOSAA	4	135.48	85.62	411.9	20.48	27.74
N-EtFOSAA	4	120.12	54.83	260.82	15.26	18.33
N-MeFOSE	4	103.92	76.32	123.75	4.81	5
N-EtFOSE	4	108.11	85.23	135.86	5.51	5.95
HFPO-DA	4	105.42	83.3	125.39	4.08	4.3
ADONA	4	105.94	82.04	196.71	14.27	15.11
PFMPA	4	110.31	64.16	197.46	9.38	10.35
PFMBA	4	107.38	84.43	166.11	6.2	6.66
NFDHA	4	90.99	17.3	139.28	12.51	11.38
9Cl-PF3ONS	4	105.2	49.8	200.22	10.8	11.36
11Cl-PF3OUdS	4	92.86	30.92	141.74	5.66	5.26
PFEESA	4	114.04	85.34	274.32	9.77	11.14
3:3 FTCA	4	104.55	23.76	210.24	8.02	8.38
5:3 FTCA	4	111.92	68.65	219.25	14.17	15.86
7:3 FTCA	4	104.72	60.18	167.59	8.05	8.42

A description of each column in Table 9:

- Headings: Low, Medium, High, and High 2 Spike Recovery

  - Analyte—Always 40 PFAS analytes.

  - n=—Number of matrices for a media type, for spike concentrations, that do not have U or B flagged values. Can be 4 or 1.

  - % Mean Recovery—Mean of the matrix mean percent recoveries, for a spike concentration, for the analyte (from the media type matrix recovery tables in section E of the digital appendix, column % Recovery). If all percent recoveries are NA, (i.e., if n = 0 or mean percent recovery < 0), NA was used.

  - RSD—Percent RSD of the mean of the matrix mean percent recoveries, used to calculate column % Recovery. If the number of samples is less than two, NA was used.

  - SD—SD of the mean of sample mean percent recoveries. If the number of samples is less than two, NA was used.

- Heading: ALL SPIKE RECOVRIES

  - n=—Number of spike categories with percent recovery values, without NA in column % Recovery, for the analyte.

  - % Mean Recovery—Mean of the mean percent recoveries for the media type, for the analyte. If the number of spike categories is less than two, NA was used.

  - Lowest % Recovery—Lowest percent recovery of the mean of the three subsamples' percent recoveries for the matrix for values without U or B flags and non-negative values from the sample matrix recovery tables in section D of the digital appendix, column % Recovery.

  - Highest % Recovery—Highest percent recovery of the mean of the three subsamples' percent recoveries for the matrix for values without U or B flags and non-negative values from the sample matrix recovery tables in section D of the digital appendix, column % Recovery.

  - RSD—Percent RSD of the mean percent recoveries for the media from columns % Recovery. If the number of samples is less than two, NA was used.

  - SD—SD of the mean percent recoveries for the media from columns % Recovery. If the number of samples is less than two, NA was used.

F. Extracted Internal Standard (EIS) Spike Recovery Tables

We generated a total of 11 EIS spike recovery tables, which are section F of the digital appendix. EIS spike recovery values indicate the extraction efficiency of the sample preparation and detection method for PFAS compounds. We calculated the mean sample concentration, mean of the sample percent recoveries, and percent RSD for 24 isotopically labeled analog PFAS analytes as the EIS compounds, for the 32 environmental samples. At the sponsor's direction, we used the sample percent recoveries values that were already calculated in the EDD. We then calculated the mean of the sample mean percent recoveries, percent RSD, and SD of the sample mean percent recoveries for an analyte, for the matrix. We also identified the lowest and highest sample mean percent recovery for the matrix.

We then calculated the mean of the matrix mean concentrations; mean of the matrix mean percent recoveries; and percent RSD, SD, and 2×SD of the matrix mean percent recoveries for the 24 EIS compounds, for all aqueous matrices, all solid matrices (including biosolid, sediment, and soil), and all solid matrices and tissue. We identified the lowest and highest sample mean percent recovery for the media type.

Table 10 is constructed from all tissue samples. This table is file F-8 Tissue Sample EIS Spike Recovery Table.csv in section F of the digital appendix. There are eight tables like this, one for each of the eight sample matrices. The Mean Percent Recovery columns for each sample is the mean of the percent recovery entries in the EDD. The Mean Percent Recovery column for all concentrations is the mean of the sample percent recoveries.

Table 10. Example Matrix EIS Spike Recovery Table

Compound	Clam Tissue				Fish Tissue # 2			
	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD
Perfluoro-n-[13C4]butanoic acid	20.1	12	98.52	2.44	20.1	12	93.36	14.03
Perfluoro-n-[13C5]pentanoic acid	10	12	93.84	6.09	10	12	107.34	19.46
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	5.01	12	94.88	3.65	5.02	12	92.31	15.7
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	5.01	12	93.01	2.09	5.02	12	82.66	19.48
Perfluoro-n-[13C8]octanoic acid	5.06	12	94.72	3.45	5.07	12	90.46	14.9
Perfluoro-n-[13C9]nonanoic acid	2.51	12	92.12	4.07	2.51	12	90.3	15.68
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	2.51	12	83.28	6.06	2.51	12	90.68	15.39
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	2.51	12	71.19	10	2.51	12	88.58	13.08
Perfluoro-n-[1,2-13C2]dodecanoic acid	2.51	12	53.52	14.64	2.51	12	70.06	18.56
Perfluoro-n-[1,2-13C2]tetradecanoic acid	2.51	12	31.36	21.81	2.51	12	38.36	75.43
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	5.01	12	97.87	3.29	5.02	12	88.83	19.85
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	5.06	12	98.39	2.18	5.07	12	98.64	20.1
Perfluoro-1-[13C8]octanesulfonic acid	5.06	12	96.11	3.99	5.07	12	91.9	15.79
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	10.1	12	192.33	8.87	10.1	12	214.83	17.31
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	10	12	145.25	13.18	10	12	149.49	20.1
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	10	12	164.92	27	10	12	136.17	25.55
Perfluoro-1-[13C8]octanesulfonamide	5.01	12	95.52	6.15	5.02	12	87.44	15.31
N-methyl-d3-perfluoro-1-octanesulfonamide	5.01	12	37.65	18.52	5.02	12	26.8	33.2
N-ethyl-d5-perfluoro-1-octanesulfonamide	5.01	12	30.11	27.83	5.02	12	21.64	36.58
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	10	12	125.83	10.5	10	12	138.53	15.91
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	10	12	141.25	11.5	10	12	151.09	14.23
N-methyl-d7-perfluorooctanesulfonamidoethanol	50.1	12	30.27	44.94	50.2	12	12.32	68.11
N-ethyl-d9-perfluorooctane sulfonamidoethanol	50.1	12	29.23	31.33	50.2	12	12.55	58.71
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	20.1	12	92.52	11.8	20.1	12	101.9	17.44

Compound	Fish Tissue #1				ALL EIS SPIKE RECOVERIES			
	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD
Perfluoro-n-[13C4]butanoic acid	20.1	12	84.01	23.09	20.1	3	91.96	8
Perfluoro-n-[13C5]pentanoic acid	10.1	12	86.44	14.08	10	3	95.88	11.05
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	5.02	12	94.94	6.77	5.02	3	94.04	1.6
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	5.02	12	79.69	6.35	5.02	3	85.12	8.21

Compound	Fish Tissue #1				ALL EIS SPIKE RECOVERIES			
	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	RSD
Perfluoro-n-[13C8]octanoic acid	5.07	12	95.25	4.72	5.07	3	93.48	2.81
Perfluoro-n-[13C9]nonanoic acid	2.51	12	98.02	3.67	2.51	3	93.48	4.32
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	2.51	12	97.19	4.18	2.51	3	90.39	7.7
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	2.51	12	90.94	4.83	2.51	3	83.57	12.9
Perfluoro-n-[1,2-13C2]dodecanoic acid	2.51	12	95.83	8.81	2.51	3	73.14	29.15
Perfluoro-n-[1,2-13C2]tetradecanoic acid	2.51	12	101.68	13.3	2.51	3	57.13	67.81
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	5.02	12	90.92	5.84	5.02	3	92.54	5.12
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	5.07	12	98.46	4.93	5.07	3	98.5	0.13
Perfluoro-1-[13C8]octanesulfonic acid	5.07	12	103.37	2.63	5.07	3	97.12	5.97
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	10.1	12	194.37	17.99	10.1	3	200.51	6.21
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	10.1	12	229.75	5.98	10	3	174.83	27.23
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	10.1	12	220.25	9.59	10	3	173.78	24.59
Perfluoro-1-[13C8]octanesulfonamide	5.02	12	92.63	6.9	5.02	3	91.87	4.46
N-methyl-d3-perfluoro-1-octanesulfonamide	5.02	12	8.08	16.75	5.02	3	24.18	61.86
N-ethyl-d5-perfluoro-1-octanesulfonamide	5.02	12	7.51	18.7	5.02	3	19.75	57.81
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	10.1	12	106.41	7.62	10	3	123.59	13.09
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	10.1	12	78.52	8.08	10	3	123.62	31.84
N-methyl-d7-perfluorooctanesulfonamidoethanol	50.2	12	5.2	23.74	50.2	3	15.93	81.09
N-ethyl-d9-perfluorooctane sulfonamidoethanol	50.2	12	0.37	63.6	50.2	3	14.05	103.11
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	20.1	12	94.49	7.44	20.1	3	96.31	5.13

A description of each column in Table 10:

- Heading: Sample ID

  – Compound—Always 24 EIS compounds.

  – Mean Concentration—Mean spike concentration of the EDD entries for a compound from a sample of a matrix in µg/kg (solid matrices) or ng/L (aqueous matrices).

  – Number EIS Spikes (n=)—Number of EDD entries for the compound from a sample of a matrix. Can be 12 or 16.

  – Mean Percent Recovery—Mean of the percent recovery entries in the EDD for a compound from a sample of a matrix.

  – RSD—Percent RSD of the mean percent recoveries reported in the EDD. If the number of samples is less than two, then NA was used.

- Heading: ALL EIS SPIKE RECOVERIES

  – Mean Concentration—Mean of the sample mean spike concentrations from columns Mean Concentration.

  – Number EIS Spikes (n=)—Number of samples for a matrix, for the compound. Always three.

  – Mean Percent Recovery—Mean of the sample mean percent recoveries from columns Mean Percent Recovery.

  – RSD—Percent RSD of the sample mean percent recoveries reported in the EDD. If the number of samples is less than two, then NA was used.

Table 11 summarizes EIS results across all soil, sediment and biosolids matrices (excluding tissue). This table is file F-10 Soil, Sediment and Biosolids EIS Spike Recovery Table.csv in section F of the digital appendix. There are three tables like this, summarizing results across all aqueous samples, most solid samples (including biosolid, sediment, and soil, but excluding tissue), and all solid samples (including biosolid, sediment, soil, and tissue). The Mean Percent Recovery column is the mean of the mean percent recoveries. Highest % Recovery and Lowest % Recovery columns are the highest and lowest mean of the sample percent recoveries.

Table 11. Example Media Type EIS Spike Recovery Table

Compound	Mean Concentration Spike (µg/kg)	Number EIS Spikes (n =)	Mean Percent Recovery	Highest % Recovery	Lowest % Recovery	RSD	SD	2× SD
Perfluoro-n-[13C4]butanoic acid	142	4	81.9	97.21	8.99	15.9	13.02	26.05
Perfluoro-n-[13C5]pentanoic acid	70.8	4	87.89	103.4	38.88	13.34	11.73	23.45
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	35.4	4	91.19	96.9	72.87	2.7	2.46	4.92
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	35.4	4	89.89	94.73	76.61	2.39	2.15	4.3
Perfluoro-n-[13C8]octanoic acid	35.8	4	92.35	95.05	87.27	0.81	0.75	1.49
Perfluoro-n-[13C9]nonanoic acid	17.7	4	91.22	95.19	82.37	1.59	1.45	2.89
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	17.7	4	87.48	92.71	70.56	3.31	2.9	5.79
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	17.7	4	85.66	94.49	56.25	6.46	5.53	11.06
Perfluoro-n-[1,2-13C2]dodecanoic acid	17.7	4	72.27	86.74	33.68	13.68	9.88	19.77
Perfluoro-n-[1,2-13C2]tetradecanoic acid	17.7	4	64.04	153.44	16.96	26.17	16.76	33.51
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	35.4	4	93.55	99.66	72.28	4.7	4.39	8.79
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	35.8	4	92.05	94.78	79.44	1.57	1.45	2.89
Perfluoro-1-[13C8]octanesulfonic acid	35.8	4	91.33	96.04	66.75	3.58	3.27	6.55
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	71.2	4	124.2	199	80.57	14.82	18.41	36.82
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	70.8	4	105.29	182.5	64.02	16.36	17.22	34.45
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	70.8	4	93.4	139.33	65.08	8.38	7.83	15.66
Perfluoro-1-[13C8]octanesulfonamide	35.4	4	77.6	92.62	26.68	15.42	11.97	23.94
N-methyl-d3-perfluoro-1-octanesulfonamide	35.4	4	59.82	74.05	13.51	16.42	9.82	19.64
N-ethyl-d5-perfluoro-1-octanesulfonamide	35.4	4	58.44	70.18	11.93	16.53	9.66	19.31
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	70.8	4	87.42	113.46	21.46	7.32	6.4	12.8
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	70.8	4	85.78	105.67	11.68	8.21	7.04	14.09
N-methyl-d7-perfluorooctanesulfonamidoethanol	354	4	61.92	77.01	10.99	18.55	11.48	22.97
N-ethyl-d9-perfluorooctane sulfonamidoethanol	354	4	57.63	72.61	7.99	19.62	11.31	22.61
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	142	4	101.07	112.5	91.83	2.02	2.04	4.08

A description of each column in Table 11:

- Compound—Always 24 EIS compounds.

- Mean Concentration—Mean of the matrix mean spike concentration (from Appendix F Matrix Tables, under ALL EIS SPIKE RECOVERIES, Column Mean Concentration) for solid matrices.

- Number EIS Spikes (n=)—Number of matrices for all media types. Always four.

- Mean Percent Recovery—Mean of the matrix mean percent recovery (from Appendix F Matrix Tables, under ALL EIS SPIKE RECOVERIES, Column Mean Percent Recovery) for solid media.

- Highest % Recovery—Highest percent recovery of the mean of the sample percent recoveries (from EIS spike recovery tables in section F of the digital appendix, under Sample IDs, column Mean Percent Recovery) for solid media.

- Lowest % Recovery—Lowest percent recovery of the mean of the sample percent recoveries (from EIS spike recovery tables in section F of the digital appendix, under Sample IDs, column Mean Percent Recovery) for solid media.

- RSD—Percent RSD of the matrix mean percent recoveries. If the number of samples is less than two, then NA was used.

- SD—SD of the matrix mean percent recoveries. If the number of samples is less than two, then NA was used.

- 2× SD—SD of the matrix mean percent recoveries times two. If the number of samples is less than two, then NA was used.

G. Injected Internal Standard (IIS) Spike Recovery Tables

We generated a total of 11 IIS spike recovery tables, which are section G of the digital appendix. IIS spike recovery tables indicate the extraction efficiency of the SLV method for isotopically labeled compounds. We calculated the mean of the sample percent recoveries, percent RSD, SD, and 2× SD for 7 isotopically labeled analog PFAS analytes, for the 32 environmental samples. Upon the sponsor's direction, we used the sample percent recoveries values in the EDD.

We then calculated the mean of the matrix mean percent recoveries; percent RSD, SD, and 2× SD of the matrix mean percent recoveries for the seven IIS compounds, for aqueous, solid, and all media.

Table 12 is constructed from all wastewater samples. This table is file G-3 Wastewater Sample IIS Spike Recovery Table.csv in section G of the digital appendix. There are eight tables like this, one for each environmental matrix.

Table 12. Example Matrix IIS Spike Recovery Table

Media	PFAS	n	Mean % Recovery	RSD	SD	2× SD
Wastewater	13C3-PFBA	105	81.56	14.46	11.8	23.59
Wastewater	13C2-PFHXA	105	73.13	14.98	10.96	21.91
Wastewater	13C4-PFOA	105	77.06	13.52	10.42	20.84
Wastewater	13C5-PFNA	105	78.95	13.83	10.92	21.84
Wastewater	13C2-PFDA	105	64.52	34.85	22.48	44.97
Wastewater	18O2-PFHXS	105	76.85	14.39	11.06	22.12
Wastewater	13C4-PFOS	105	68.87	16.55	11.4	22.79

Note: Percent recovery values used in the Mean % Recovery column were reported in the EDD and not calculated by IDA using Equation 1.

A description of each column in Table 12:

- Media—Media type. Eight possible matrices

- PFAS—IIS Compound. Always seven.

- n=—Number of subsamples in the EDD for a matrix type with numeric values. Entries represented as N/A are not counted.

- Mean % Recovery—Mean of the subsample percent recovery, for a compound, for a matrix.

- RDS—Percent RSD of the mean of the sample percent recoveries.

- SD—SD of the sample percent recoveries.

- 2× SD—SD of the sample percent recoveries times two.

Table 13 summarizes these results across all aqueous matrices. This table is file G-9 Aqueous Sample IIS Spike Recovery Table.csv in section G of the digital appendix. There are two tables like this, one for all solid media and one for all aqueous media. The Mean Percent Recovery column is the mean of the mean percent recoveries.

Table 13. Example Media Type IIS Spike Recovery Table

Media	PFAS	n =	Mean % Recovery	RSD	SD	2× SD
Aqueous	13C3-PFBA	4	75.77	10.25	7.77	15.53
Aqueous	13C2-PFHXA	4	68.3	18.6	12.7	25.41
Aqueous	13C4-PFOA	4	72.95	9.68	7.07	14.13
Aqueous	13C5-PFNA	4	75.36	7.47	5.63	11.25
Aqueous	13C2-PFDA	4	71.75	9.96	7.15	14.3
Aqueous	18O2-PFHXS	4	73.24	9.58	7.02	14.03
Aqueous	13C4-PFOS	4	71.02	7.52	5.34	10.67

A description of each column in Table 13:

- Media—Media type. Two possible media types.

- PFAS—IIS Compound. Always seven.

- n=—Number of matrices for a media type. Always four.

- Mean % Recovery—Mean of the matrix mean percent recoveries, for a compound, for a media type.

- RDS—Percent RSD of the mean of the matrix mean percent recoveries.

- SD—SD of the matrix mean percent recoveries.

- 2× SD—SD of the matrix mean percent recoveries times two.

Table 14 summarizes results across all matrices. This table is file G-11 All Media Sample IIS Spike Recovery Table.csv in section G of the digital appendix. This is the only table of this type, summarizing results across *all* environmental media. The Mean % Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same size.

Table 14. Example All Media IIS Spike Recovery Table

Media	PFAS	n =	Mean % Recovery	RSD	SD	2× SD
All	13C3-PFBA	8	71.73	9.62	6.9	13.8
All	13C2-PFHXA	8	65.99	13.81	9.11	18.22
All	13C4-PFOA	8	70.34	8.11	5.7	11.41
All	13C5-PFNA	8	72.62	7.12	5.17	10.34
All	13C2-PFDA	8	70.06	7.96	5.58	11.15
All	18O2-PFHXS	8	70.35	8.47	5.96	11.91
All	13C4-PFOS	8	69.29	6.31	4.37	8.74

A description of each column in Table 14:

- Media—Media type. All.

- PFAS—IIS Compound. Always seven.

- n=—Number of matrices for a media type. Always eight.

- Mean % Recovery—Mean of the matrix mean percent recoveries, for a compound, for all media.

- RSD—Percent RSD of the mean of the matrix mean percent recoveries.

- SD—SD of the matrix mean percent recoveries.

- 2× SD—SD of the matrix mean percent recoveries times two.

H. Ongoing Precision and Recovery (OPR) Spike Recovery Tables

We generated a total of four OPR spike recovery tables, which is section H of the digital appendix. OPR indicates the performance of the sample preparation and detection method at a mid-range spike concentration in the study as a quality control check. We calculated the mean of the OPR subsample percent recoveries and percent RSD, SD, 2× SD, and 3× SD for 64 PFAS analytes, from the 32 samples, for aqueous media and solid media (including biosolid, sediment, and soil, but excluding tissue). Separately, at the sponsor's direction, we also calculated the mean of the OPR subsample percent recoveries, percent RSD, SD, 2× SD, and 3× SD for 64 PFAS analytes from the tissue matrix. We used the sample percent recoveries values in the EDD and did not include data that had B flagged values (where the results was associated with a contaminated blank in our calculations).

We then calculated the mean of the OPR matrix mean percent recoveries and percent RSD, SD, 2× SD, and 3× SD of the matrix mean percent recoveries for the 64 analytes, from all media (i.e., aqueous, solid, and tissue).

Table 15 is constructed from tissue samples. This table is file H-3 Tissue Sample OPR Spike Recovery Table.csv in section H of the digital appendix. There are three tables like this, one for aqueous, one for solid (excluding tissue), and one for tissue media. The % Mean Recovery column is the mean of the mean percent recoveries.

Table 15. Example Media Type OPR Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluorobutanoic acid	4	99.88	5.12	5.11	10.23	15.34
Perfluoropentanoic acid	4	104.78	4.33	4.53	9.06	13.59
Perfluorohexanoic acid	4	100.62	5.19	5.22	10.44	15.65
Perfluoroheptanoic acid	4	102.53	7.78	7.97	15.95	23.92
Perfluorooctanoic acid	4	97.7	8.19	8	15.99	23.99
Perfluorononanoic acid	4	102.7	7.74	7.95	15.9	23.85
Perfluorodecanoic acid	4	98.35	7.14	7.02	14.04	21.05
Perfluoroundecanoic acid	4	103.53	6.29	6.51	13.03	19.54
Perfluorododecanoic acid	4	108.97	14.72	16.04	32.08	48.12
Perfluorotridecanoic acid	4	119.75	5.72	6.85	13.7	20.55
Perfluorotetradecanoic acid	4	100.9	5.14	5.19	10.38	15.57
Perfluorobutanesulfonic acid	4	102.88	6.63	6.82	13.64	20.45
Perfluoropentanesulfonic acid	4	100.8	5.8	5.85	11.69	17.54
Perfluorohexanesulfonic acid	4	106.92	7.64	8.17	16.33	24.5
Perfluoroheptanesulfonic acid	4	97.05	5.88	5.7	11.41	17.11
Perfluorooctanesulfonic acid	4	110.75	6.18	6.85	13.7	20.55
Perfluorononanesulfonic acid	4	99.5	7.08	7.05	14.09	21.14
Perfluorodecanesulfonic acid	4	93.9	8.67	8.14	16.28	24.41
Perfluorododecanesulfonic acid	4	68.43	28.97	19.82	39.64	59.46

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
4:2 fluorotelomersulfonic acid	4	96.4	3.36	3.24	6.48	9.72
6:2 fluorotelomersulfonic acid	4	105.35	6.46	6.81	13.62	20.43
8:2 fluorotelomersulfonic acid	4	118.75	7.09	8.42	16.84	25.26
Perfluorooctanesulfonamide	4	108.95	5.75	6.26	12.52	18.79
N-methyl perfluorooctanesulfonamide	4	101.55	7.52	7.63	15.27	22.9
N-ethyl perfluorooctanesulfonamide	4	108.75	8.51	9.25	18.5	27.75
N-methyl perfluorooctanesulfonamidoacetic acid	4	104.72	5.67	5.94	11.87	17.81
N-ethyl perfluorooctanesulfonamidoacetic acid	4	103.58	6.69	6.93	13.85	20.78
N-methyl perfluorooctanesulfonamidoethanol	4	231.25	24.47	56.58	113.15	169.73
N-ethyl perfluorooctanesulfonamidoethanol	4	109.9	22.29	24.5	48.99	73.49
Hexafluoropropylene oxide dimer acid	4	100.03	6.92	6.92	13.83	20.75
4,8-dioxa-3H-perfluorononanoic acid	4	109.03	10.69	11.65	23.31	34.96
Perfluoro-3-methoxypropanoic acid	4	97.6	5.97	5.83	11.65	17.48
Perfluoro-4-methoxybutanoic acid	4	100.45	8.12	8.15	16.31	24.46
Perfluoro-3,6-dioxaheptanoic acid	4	85.7	17.17	14.72	29.43	44.15
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	4	110.25	7.08	7.8	15.61	23.41
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	4	116.25	9.54	11.09	22.17	33.26
Perfluoro(2-ethoxyethane)sulfonic acid	4	97.38	4.91	4.78	9.56	14.35
2H, 2H, 3H, 3H-perfluorohexanoic acid	4	83.28	25.45	21.2	42.39	63.59
2H, 2H, 3H, 3H-perfluorooctanoic acid	4	138.53	21.91	30.35	60.69	91.04
2H, 2H, 3H, 3H-perfluorodecanoic acid	4	119	8.26	9.83	19.66	29.5
Perfluoro-n-[13C4]butanoic acid	4	100	2.38	2.38	4.76	7.14
Perfluoro-n-[13C5]pentanoic acid	4	95.97	3.82	3.66	7.33	10.99
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	4	93.12	2.68	2.49	4.99	7.48
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	4	90.95	6.21	5.65	11.3	16.96
Perfluoro-n-[13C8]octanoic acid	4	93.78	4.37	4.1	8.19	12.29
Perfluoro-n-[13C9]nonanoic acid	4	95.22	3.03	2.88	5.77	8.65
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	4	96.88	3.64	3.52	7.05	10.57
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	4	98.75	5.29	5.23	10.46	15.69
Perfluoro-n-[1,2-13C2]dodecanoic acid	4	88.95	10.61	9.43	18.87	28.3
Perfluoro-n-[1,2-13C2]tetradecanoic acid	4	59.85	41.55	24.87	49.73	74.6
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	4	100.15	2.74	2.75	5.5	8.25
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	4	96.7	3.15	3.05	6.09	9.14
Perfluoro-1-[13C8]octanesulfonic acid	4	98.95	1.86	1.84	3.68	5.51
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	4	223.25	15.28	34.12	68.24	102.36
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	4	132.75	6.04	8.02	16.03	24.05
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	4	191.75	29.3	56.18	112.36	168.54
Perfluoro-1-[13C8]octanesulfonamide	4	103.8	7.76	8.06	16.12	24.18
N-methyl-d3-perfluoro-1-octanesulfonamide	4	18.32	42.76	7.84	15.67	23.51

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
N-ethyl-d5-perfluoro-1-octanesulfonamide	4	26.4	55.67	14.7	29.39	44.09
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	4	169.75	7.7	13.07	26.15	39.22
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	4	199	5.99	11.92	23.83	35.75
N-methyl-d7-perfluorooctanesulfonamidoethanol	4	2.56	103.07	2.64	5.27	7.91
N-ethyl-d9-perfluorooctane sulfonamidoethanol	4	14.07	65.76	9.26	18.51	27.77
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	4	93.22	6.68	6.23	12.46	18.69

Note: Percent recovery values used in the %Mean Recovery column were reported in the EDD and not calculated by IDA using Equation 1.

A description of each column in Table 15:

- Analyte—Always 64 PFAS analytes.

- n=—Number of OPR subsamples that do not have B flagged values for the analyte in the EDD, for the media type (e.g., aqueous, solid (biosolid, soil, sediment), tissue).

- % Mean Recovery—Mean of the OPR subsample percent recoveries of the EDD entries.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the sample mean percent recoveries.

- 2× SD—SD of the sample mean percent recoveries times two.

- 3× SD—SD of the sample mean percent recoveries times three.

Table 16 is constructed from all matrices. This table is file H-4 All Sample OPR Spike Recovery Table.csv in section H of the digital appendix. There is only one table of this type, summarizing results across *all* media. The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data.

Table 16. Example All Media OPR Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluorobutanoic acid	3	100.35	0.52	0.52	1.05	1.57
Perfluoropentanoic acid	3	104.94	0.39	0.41	0.82	1.23
Perfluorohexanoic acid	3	99.36	1.53	1.52	3.04	4.57
Perfluoroheptanoic acid	3	100.1	2.33	2.34	4.67	7.01
Perfluorooctanoic acid	3	98.36	0.99	0.97	1.95	2.92
Perfluorononanoic acid	3	100.95	1.54	1.56	3.12	4.68

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluorodecanoic acid	3	101.77	2.91	2.96	5.92	8.88
Perfluoroundecanoic acid	3	101.8	1.5	1.53	3.06	4.6
Perfluorododecanoic acid	3	105.19	3.12	3.28	6.56	9.85
Perfluorotridecanoic acid	3	110.7	7.1	7.86	15.73	23.59
Perfluorotetradecanoic acid	3	101.43	1.01	1.03	2.06	3.08
Perfluorobutanesulfonic acid	3	101.81	0.94	0.95	1.91	2.86
Perfluoropentanesulfonic acid	3	100.61	0.22	0.22	0.44	0.66
Perfluorohexanesulfonic acid	3	106.72	1.68	1.79	3.58	5.37
Perfluoroheptanesulfonic acid	3	97.73	2.08	2.03	4.06	6.09
Perfluorooctanesulfonic acid	3	106.84	3.21	3.43	6.86	10.29
Perfluorononanesulfonic acid	3	100.2	3.85	3.86	7.71	11.57
Perfluorodecanesulfonic acid	3	94.88	0.91	0.86	1.72	2.58
Perfluorododecanesulfonic acid	3	82.25	14.61	12.02	24.03	36.05
4:2 fluorotelomersulfonic acid	3	100.54	4.42	4.44	8.89	13.33
6:2 fluorotelomersulfonic acid	3	107.82	4.27	4.6	9.2	13.8
8:2 fluorotelomersulfonic acid	3	115.27	3.2	3.69	7.37	11.06
Perfluorooctanesulfonamide	3	106.43	2.4	2.55	5.1	7.65
N-methyl perfluorooctanesulfonamide	3	101.04	3.11	3.15	6.29	9.44
N-ethyl perfluorooctanesulfonamide	3	103.42	6.47	6.69	13.39	20.08
N-methyl perfluorooctanesulfonamidoacetic acid	3	102.24	2.16	2.21	4.41	6.62
N-ethyl perfluorooctanesulfonamidoacetic acid	3	103.31	1.11	1.15	2.3	3.44
N-methyl perfluorooctanesulfonamidoethanol	3	145.87	50.69	73.94	147.89	221.83
N-ethyl perfluorooctanesulfonamidoethanol	3	106.76	2.57	2.75	5.5	8.25
Hexafluoropropylene oxide dimer acid	3	100.25	0.52	0.52	1.03	1.55
4,8-dioxa-3H-perfluorononanoic acid	3	101.96	6.15	6.27	12.54	18.81
Perfluoro-3-methoxypropanoic acid	3	99.88	1.99	1.99	3.98	5.98
Perfluoro-4-methoxybutanoic acid	3	100.36	2.51	2.52	5.03	7.55
Perfluoro-3,6-dioxaheptanoic acid	3	93.48	7.21	6.74	13.47	20.21
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	3	105.16	4.83	5.08	10.16	15.24
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	3	104.66	9.99	10.45	20.91	31.36
Perfluoro(2-ethoxyethane)sulfonic acid	3	98.73	1.43	1.42	2.83	4.25
2H, 2H, 3H, 3H-perfluorohexanoic acid	3	92.04	8.25	7.6	15.19	22.79
2H, 2H, 3H, 3H-perfluorooctanoic acid	3	109.04	23.68	25.82	51.65	77.47
2H, 2H, 3H, 3H-perfluorodecanoic acid	3	102.43	14.72	15.08	30.15	45.23
Perfluoro-n-[13C4]butanoic acid	3	100.04	2.16	2.16	4.32	6.48
Perfluoro-n-[13C5]pentanoic acid	3	96.3	1.31	1.26	2.52	3.79
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	3	95.81	2.95	2.83	5.66	8.49
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	3	93.44	2.32	2.17	4.34	6.51
Perfluoro-n-[13C8]octanoic acid	3	95.86	2.27	2.18	4.36	6.54
Perfluoro-n-[13C9]nonanoic acid	3	96.34	1.75	1.69	3.38	5.06
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	3	96.45	1.44	1.39	2.78	4.17

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	3	99.56	3.48	3.47	6.94	10.4
Perfluoro-n-[1,2-13C2]dodecanoic acid	3	88.47	1.62	1.44	2.87	4.31
Perfluoro-n-[1,2-13C2]tetradecanoic acid	3	78.5	20.88	16.39	32.78	49.18
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	3	100.64	1.84	1.85	3.71	5.56
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	3	96.66	2.63	2.54	5.09	7.63
Perfluoro-1-[13C8]octanesulfonic acid	3	99.51	1.96	1.95	3.9	5.85
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	3	156.51	37.62	58.87	117.74	176.61
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	3	120.49	10.4	12.53	25.06	37.59
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	3	134.62	36.79	49.53	99.06	148.58
Perfluoro-1-[13C8]octanesulfonamide	3	89.69	13.62	12.22	24.44	36.66
N-methyl-d3-perfluoro-1-octanesulfonamide	3	41.4	52.63	21.79	43.58	65.37
N-ethyl-d5-perfluoro-1-octanesulfonamide	3	42.63	44.2	18.84	37.68	56.52
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	3	119.71	36.29	43.45	86.89	130.34
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	3	128.34	47.77	61.31	122.62	183.93
N-methyl-d7-perfluorooctanesulfonamidoethanol	3	42.84	83.27	35.67	71.35	107.02
N-ethyl-d9-perfluorooctane sulfonamidoethanol	3	44.33	61.49	27.26	54.51	81.77
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	3	100.5	6.27	6.3	12.61	18.91

A description of each column in Table 16:

- Analyte—Always 64 PFAS analytes.

- n=—Number of matrices for the analyte in the EDD, for aqueous, solid (biosolid, sediment, and soil), and tissue media.

- % Mean Recovery—Mean of the OPR matrix mean percent recoveries, for aqueous, solid (biosolid, sediment, and soil), and tissue media.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the matrix mean percent recoveries.

- 2× SD—SD of the matrix mean percent recoveries times two.

- 3× SD—SD of the matrix mean percent recoveries times three.

I. Limit of Quantitation Verification (LOQVER) Spike Recovery Tables

We generated a total of four LOQVER spike recovery tables, which are section I of the digital appendix. LOQVER indicates the performance of the sample preparation and

detection method at a lowest spike concentration in the study as a quality control check. We calculated the mean of the LOQVER subsample percent recoveries and percent RSD, SD, 2× SD, and 3× SD for 64 analytes, from the 32 samples, for aqueous media and solid media (including biosolid, sediment, and soil, but excluding tissue). At the sponsor's direction, we also calculated the mean of the LOQVER subsample percent recoveries and percent RSD, SD, 2× SD, and 3× SD for 64 PFAS analytes, for the tissue matrix. At the sponsor's direction, we used the sample percent recoveries values in the EDD.

We then calculated the mean of the LOQVER matrix mean percent recoveries and percent RSD, SD, 2× SD and 3× SD of the matrix mean percent recoveries for the 64 analytes, for all media (i.e., aqueous, solid, and tissue).

Table 17 is constructed from solid samples. This table is file I-2 Solid Sample LOQVER Spike Recovery Table.csv in section I of the digital appendix. There are three tables like this, summarizing results for aqueous, solid (excluding tissue), and tissue media.

Table 17. Example Media Type LOQVER Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluorobutanoic acid	17	100.96	7.2	7.27	14.53	21.8
Perfluoropentanoic acid	17	100.44	9.77	9.81	19.63	29.44
Perfluorohexanoic acid	17	97.24	6.62	6.43	12.87	19.3
Perfluoroheptanoic acid	17	97.36	6.79	6.61	13.22	19.83
Perfluorooctanoic acid	17	98.34	8.04	7.9	15.8	23.71
Perfluorononanoic acid	17	98.82	5.64	5.58	11.16	16.73
Perfluorodecanoic acid	17	100.06	7.04	7.04	14.09	21.13
Perfluoroundecanoic acid	17	97.56	7.13	6.95	13.91	20.86
Perfluorododecanoic acid	17	98.55	7.82	7.71	15.42	23.13
Perfluorotridecanoic acid	17	102.25	7.34	7.51	15.02	22.53
Perfluorotetradecanoic acid	17	100.28	6.75	6.77	13.55	20.32
Perfluorobutanesulfonic acid	17	100.66	7.12	7.17	14.34	21.52
Perfluoropentanesulfonic acid	17	97.71	8.34	8.15	16.3	24.45
Perfluorohexanesulfonic acid	17	103.94	7.67	7.97	15.94	23.91
Perfluoroheptanesulfonic acid	17	93.24	6.52	6.08	12.16	18.24
Perfluorooctanesulfonic acid	17	100.27	8.92	8.95	17.89	26.84
Perfluorononanesulfonic acid	17	88.45	13.28	11.75	23.5	35.25
Perfluorodecanesulfonic acid	17	91.68	8.68	7.96	15.91	23.87
Perfluorododecanesulfonic acid	17	85	8.77	7.45	14.9	22.35
4:2 fluorotelomersulfonic acid	17	96.69	6.93	6.7	13.39	20.09
6:2 fluorotelomersulfonic acid	16	128.41	53.88	69.18	138.37	207.55
8:2 fluorotelomersulfonic acid	17	113.05	7.85	8.87	17.75	26.62
Perfluorooctanesulfonamide	17	104.66	7.01	7.33	14.67	22
N-methyl perfluorooctanesulfonamide	17	95.91	9.24	8.87	17.73	26.6
N-ethyl perfluorooctanesulfonamide	17	99.75	9.38	9.36	18.71	28.07

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
N-methyl perfluorooctanesulfonamidoacetic acid	17	92.45	14.12	13.05	26.1	39.15
N-ethyl perfluorooctanesulfonamidoacetic acid	17	99.38	11.43	11.36	22.71	34.07
N-methyl perfluorooctanesulfonamidoethanol	17	97.56	5.63	5.49	10.99	16.48
N-ethyl perfluorooctanesulfonamidoethanol	17	100.8	6.16	6.21	12.43	18.64
Hexafluoropropylene oxide dimer acid	17	95.55	11.92	11.39	22.77	34.16
4,8-dioxa-3H-perfluorononanoic acid	17	92.54	12.4	11.47	22.94	34.42
Perfluoro-3-methoxypropanoic acid	17	96.12	7.19	6.91	13.82	20.73
Perfluoro-4-methoxybutanoic acid	17	95.32	10.87	10.36	20.72	31.08
Perfluoro-3,6-dioxaheptanoic acid	17	90.95	24.78	22.54	45.07	67.61
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	17	97.06	11.7	11.35	22.7	34.05
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	17	94.19	14.03	13.22	26.43	39.65
Perfluoro(2-ethoxyethane)sulfonic acid	17	93.18	9.56	8.91	17.81	26.72
2H, 2H, 3H, 3H-perfluorohexanoic acid	17	88.01	10.5	9.24	18.47	27.71
2H, 2H, 3H, 3H-perfluorooctanoic acid	17	86.91	6.91	6.01	12.02	18.03
2H, 2H, 3H, 3H-perfluorodecanoic acid	17	86.06	8.62	7.42	14.83	22.25
Perfluoro-n-[13C4]butanoic acid	17	102.26	3.44	3.52	7.03	10.55
Perfluoro-n-[13C5]pentanoic acid	17	95.68	8.03	7.68	15.36	23.04
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	17	99.08	4.1	4.06	8.13	12.19
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	17	95.31	4.56	4.34	8.68	13.03
Perfluoro-n-[13C8]octanoic acid	17	98.42	3.94	3.88	7.75	11.63
Perfluoro-n-[13C9]nonanoic acid	17	98.99	4.97	4.92	9.84	14.75
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	17	97.68	3.98	3.89	7.78	11.66
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	17	101.82	6.13	6.24	12.48	18.72
Perfluoro-n-[1,2-13C2]dodecanoic acid	17	91.36	7.24	6.61	13.22	19.84
Perfluoro-n-[1,2-13C2]tetradecanoic acid	17	88.42	9.34	8.26	16.51	24.77
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	17	103.06	3.84	3.96	7.92	11.88
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	17	98.15	3.17	3.11	6.23	9.34
Perfluoro-1-[13C8]octanesulfonic acid	17	101.51	4.27	4.33	8.67	13
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	17	143.29	4.7	6.73	13.47	20.2
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	17	122.47	6.08	7.45	14.9	22.35
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	17	109.51	6.12	6.7	13.4	20.1
Perfluoro-1-[13C8]octanesulfonamide	17	84.56	11.83	10	20.01	30.01
N-methyl-d3-perfluoro-1-octanesulfonamide	17	42.41	26.9	11.41	22.81	34.22
N-ethyl-d5-perfluoro-1-octanesulfonamide	17	35.94	33.93	12.19	24.39	36.58
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	17	98.52	9.02	8.88	17.77	26.65
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	17	97.76	10.18	9.95	19.91	29.86
N-methyl-d7-perfluorooctanesulfonamidoethanol	17	54.89	20.11	11.04	22.08	33.11

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
N-ethyl-d9-perfluorooctane sulfonamidoethanol	17	51.39	20.79	10.68	21.36	32.05
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	17	106.15	10.09	10.71	21.43	32.14

Note: Percent recovery values used in the % Mean Recovery column were reported in the EDD and not calculated by IDA using Equation 1.

A description of each column in Table 17:

- Analyte—Always 64 PFAS analytes.

- n=—Number of LOQVER subsamples that do not have B flag values, for the analyte in the EDD, for the media type.

- % Mean Recovery—Mean of the LOQVER subsample percent recoveries of the EDD entries.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the sample mean percent recoveries.

- 2× SD—SD of the sample mean percent recoveries times two.

- 3× SD—SD of the sample mean percent recoveries times three.

Table 18 is constructed from all matrices. This is file I-4 All Sample LOQVER Spike Recovery Table.csv in section I of the digital appendix. There is only one table like this, summarizing results across all media. The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data.

Table 18. Example All Media LOQVER Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluorobutanoic acid	3	103.5	2.14	2.22	4.44	6.66
Perfluoropentanoic acid	3	106.09	4.62	4.9	9.79	14.69
Perfluorohexanoic acid	3	102.33	4.31	4.41	8.82	13.23
Perfluoroheptanoic acid	3	101.13	3.35	3.38	6.77	10.15
Perfluorooctanoic acid	3	102.74	4.15	4.26	8.52	12.78
Perfluorononanoic acid	3	103.14	3.74	3.86	7.72	11.58
Perfluorodecanoic acid	3	103.22	2.73	2.82	5.64	8.46
Perfluoroundecanoic acid	3	106.31	10.07	10.71	21.42	32.13
Perfluorododecanoic acid	3	100.83	1.95	1.97	3.94	5.91
Perfluorotridecanoic acid	3	112.01	11.1	12.43	24.86	37.29
Perfluorotetradecanoic acid	3	103.29	2.66	2.75	5.51	8.26
Perfluorobutanesulfonic acid	3	102.65	1.72	1.76	3.53	5.29
Perfluoropentanesulfonic acid	3	100.44	2.4	2.41	4.81	7.22
Perfluorohexanesulfonic acid	3	109.15	4.19	4.58	9.15	13.73

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluoroheptanesulfonic acid	3	97.21	3.62	3.52	7.04	10.56
Perfluorooctanesulfonic acid	3	111.8	12.13	13.57	27.13	40.7
Perfluorononanesulfonic acid	3	97.85	8.33	8.15	16.29	24.44
Perfluorodecanesulfonic acid	3	94.96	2.99	2.84	5.68	8.51
Perfluorododecanesulfonic acid	3	78.22	18.79	14.7	29.4	44.09
4:2 fluorotelomersulfonic acid	3	100.73	4.83	4.87	9.74	14.6
6:2 fluorotelomersulfonic acid	3	121.36	5.11	6.2	12.39	18.59
8:2 fluorotelomersulfonic acid	3	118.99	6.67	7.93	15.86	23.8
Perfluorooctanesulfonamide	3	109.57	5.8	6.35	12.71	19.06
N-methyl perfluorooctanesulfonamide	3	91.37	11.9	10.87	21.74	32.61
N-ethyl perfluorooctanesulfonamide	3	96.2	16.33	15.71	31.41	47.12
N-methyl perfluorooctanesulfonamidoacetic acid	3	93.89	7.63	7.16	14.33	21.49
N-ethyl perfluorooctanesulfonamidoacetic acid	3	103.28	3.86	3.99	7.98	11.97
N-methyl perfluorooctanesulfonamidoethanol	3	144.75	55.35	80.11	160.23	240.34
N-ethyl perfluorooctanesulfonamidoethanol	3	108.51	13.58	14.74	29.47	44.21
Hexafluoropropylene oxide dimer acid	3	97.64	4.21	4.11	8.23	12.34
4,8-dioxa-3H-perfluorononanoic acid	3	100.05	8.59	8.59	17.19	25.78
Perfluoro-3-methoxypropanoic acid	3	97.92	4.57	4.48	8.96	13.44
Perfluoro-4-methoxybutanoic acid	3	99.91	3.99	3.98	7.97	11.95
Perfluoro-3,6-dioxaheptanoic acid	3	94.73	5.31	5.03	10.06	15.09
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	3	104.06	8.15	8.49	16.97	25.46
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	3	102.37	12.4	12.7	25.39	38.09
Perfluoro(2-ethoxyethane)sulfonic acid	3	98.2	6.01	5.9	11.8	17.71
2H, 2H, 3H, 3H-perfluorohexanoic acid	3	87.96	7.3	6.42	12.84	19.26
2H, 2H, 3H, 3H-perfluorooctanoic acid	3	107.6	23.69	25.49	50.98	76.47
2H, 2H, 3H, 3H-perfluorodecanoic acid	3	101.5	15.24	15.47	30.94	46.41
Perfluoro-n-[13C4]butanoic acid	3	99.27	2.65	2.63	5.26	7.89
Perfluoro-n-[13C5]pentanoic acid	3	97.57	2.92	2.85	5.71	8.56
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	3	96.37	2.86	2.75	5.51	8.26
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	3	92.83	2.53	2.35	4.7	7.06
Perfluoro-n-[13C8]octanoic acid	3	96.96	1.55	1.5	3	4.5
Perfluoro-n-[13C9]nonanoic acid	3	96.84	2.35	2.28	4.56	6.84
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	3	97.29	2.63	2.56	5.11	7.67
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	3	99.49	2.58	2.57	5.14	7.71
Perfluoro-n-[1,2-13C2]dodecanoic acid	3	91.25	4.56	4.16	8.33	12.49
Perfluoro-n-[1,2-13C2]tetradecanoic acid	3	73.84	30.5	22.52	45.04	67.56
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	3	99.07	3.63	3.59	7.19	10.78
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	3	96.21	2.01	1.93	3.87	5.8
Perfluoro-1-[13C8]octanesulfonic acid	3	99.54	2.05	2.04	4.09	6.13
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	3	160.17	34.26	54.87	109.74	164.61

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	3	119.86	7.3	8.75	17.5	26.25
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	3	131.97	32.04	42.28	84.57	126.85
Perfluoro-1-[13C8]octanesulfonamide	3	89.86	13.61	12.23	24.46	36.69
N-methyl-d3-perfluoro-1-octanesulfonamide	3	39.32	50.06	19.68	39.36	59.04
N-ethyl-d5-perfluoro-1-octanesulfonamide	3	37.97	51.14	19.42	38.84	58.26
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	3	120.29	36.82	44.29	88.58	132.87
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	3	130.18	48.89	63.64	127.28	190.92
N-methyl-d7-perfluorooctanesulfonamidoethanol	3	41.21	84.74	34.92	69.84	104.76
N-ethyl-d9-perfluorooctane sulfonamidoethanol	3	41.78	67.48	28.19	56.39	84.58
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	3	102.22	5.33	5.45	10.9	16.35

A description of each column in Table 18:

- Analyte—Always 64 PFAS analytes.

- n=—Number of matrices for the analyte in the EDD, for all media type.

- % Mean Recovery—Mean of the LOQVER matrix mean percent recoveries for all media.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the matrix mean percent recoveries.

- 2× SD—SD of the matrix mean percent recoveries times two.

- 3× SD—SD of the matrix mean percent recoveries times three.

J. Method Blank (MB) Spike Recovery Tables

We generated a total of four MB spike recovery tables which are section J of the digital appendix. MBs are quality assurance samples. Spike recoveries of MBs indicate the meticulousness of the laboratory's preparation of samples. We calculated the mean of the MB subsample percent recoveries and percent RSD, SD, 2× SD, and 3× SD for 24 analytes, from the 32 samples, for aqueous and solid media (including biosolid, sediment, and soil, but excluding tissue). At the sponsor's direction, we also performed similar calculations for the tissue matrix only. We used the sample percent recovery values in the EDD and did not include data that had B flags (where the results was associated with a contaminated blank in our calculations).

We then calculated the mean of the MB matrix mean percent recoveries and percent RSD, SD, 2× SD, and 3× SD of the matrix mean percent recoveries for the 24 analytes, for all media (i.e., aqueous, solid, and tissue).

Table 19 is constructed from aqueous samples. This table is file J-1 Aqueous Sample MB Spike Recovery Table.csv in section J of the digital appendix. There are three tables like this, for aqueous, solid (excluding tissue), and tissue matrixes.

Table 19. Example Media Type MB Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluoro-n-[13C4]butanoic acid	22	95.95	5.39	5.17	10.35	15.52
Perfluoro-n-[13C5]pentanoic acid	22	96.7	7.69	7.44	14.88	22.31
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	22	93.34	6.57	6.13	12.26	18.39
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	22	92.47	5.66	5.23	10.46	15.69
Perfluoro-n-[13C8]octanoic acid	22	94.09	5.86	5.52	11.04	16.55
Perfluoro-n-[13C9]nonanoic acid	22	93.77	5.29	4.96	9.91	14.87
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	22	92.05	7.25	6.68	13.35	20.03
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	22	94.32	6.72	6.34	12.67	19.01
Perfluoro-n-[1,2-13C2]dodecanoic acid	22	84.48	9.84	8.31	16.62	24.93
Perfluoro-n-[1,2-13C2]tetradecanoic acid	22	82.75	10.51	8.7	17.39	26.09
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	22	97.9	4.54	4.45	8.89	13.34
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	22	94.1	5.18	4.88	9.75	14.63
Perfluoro-1-[13C8]octanesulfonic acid	22	96	7.1	6.81	13.62	20.43
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	22	119.35	10.36	12.36	24.72	37.08
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	22	113.13	17.57	19.88	39.75	59.63
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	22	108.87	15.27	16.62	33.24	49.87
Perfluoro-1-[13C8]octanesulfonamide	22	80.41	16.13	12.97	25.94	38.91
N-methyl-d3-perfluoro-1-octanesulfonamide	22	59.4	19.28	11.45	22.9	34.36
N-ethyl-d5-perfluoro-1-octanesulfonamide	22	60.33	17.9	10.8	21.6	32.39
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	22	90.97	13.18	11.99	23.97	35.96
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	22	88.4	13.45	11.89	23.79	35.68
N-methyl-d7-perfluorooctanesulfonamidoethanol	22	69.03	21.74	15.01	30.02	45.03
N-ethyl-d9-perfluorooctane sulfonamidoethanol	22	64.19	19.49	12.51	25.02	37.54
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	22	101.23	9.72	9.84	19.69	29.53

Note: Percent recovery values used in the % Mean Recovery column were reported in the EDD and not calculated by IDA using Equation 1.

A description of each column in Table 19:

- Analyte—Always 24 PFAS analytes.

- n=—Number of MB subsamples that do not have B flag values for the analyte in the EDD, for the media type (e.g., aqueous, solid (i.e., biosolid, sediment, and soil), tissue).

- % Mean Recovery—Mean of the MB subsample percent recoveries of the EDD entries.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the sample mean percent recoveries.

- 2× SD—SD of the sample mean percent recoveries times two.

- 3× SD—SD of the sample mean percent recoveries times three.

Table 20 is constructed from all matrices. This is file J-4 All Sample MB Spike Recovery Table.csv from section J of the digital appendix. This is the only table of this type, summarizing results across *all* matrices. The % Mean Recovery column is the mean of the mean percent recoveries and is potentially biased toward means with lower sample sizes since the sample means are not composed from the same number of data.

Table 20. Example All Media MB Spike Recovery Table

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
Perfluoro-n-[13C4]butanoic acid	3	99.05	2.78	2.76	5.52	8.28
Perfluoro-n-[13C5]pentanoic acid	3	96.16	1.09	1.05	2.1	3.14
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	3	95.79	2.27	2.17	4.34	6.51
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	3	92.74	1.35	1.25	2.51	3.76
Perfluoro-n-[13C8]octanoic acid	3	95.78	1.93	1.84	3.69	5.53
Perfluoro-n-[13C9]nonanoic acid	3	95.57	1.64	1.56	3.13	4.69
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	3	95.07	2.81	2.67	5.33	8
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	3	99.2	4.31	4.27	8.54	12.82
Perfluoro-n-[1,2-13C2]dodecanoic acid	3	88.98	5.5	4.9	9.8	14.69
Perfluoro-n-[1,2-13C2]tetradecanoic acid	3	79	14.97	11.83	23.66	35.48
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	3	98.45	2.83	2.78	5.57	8.35
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	3	95.93	1.77	1.7	3.4	5.1
Perfluoro-1-[13C8]octanesulfonic acid	3	98.68	2.39	2.35	4.71	7.06
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	3	153.93	26.65	41.02	82.04	123.05
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	3	119.92	5.58	6.69	13.37	20.06
1H, 1H, 2H, 2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	3	128.1	26.81	34.34	68.69	103.03
Perfluoro-1-[13C8]octanesulfonamide	3	91.83	17.32	15.91	31.82	47.73

Analyte	n =	% Mean Recovery	RSD	1× SD	2× SD	3× SD
N-methyl-d3-perfluoro-1-octanesulfonamide	3	46.76	24.47	11.44	22.88	34.32
N-ethyl-d5-perfluoro-1-octanesulfonamide	3	45.02	29.45	13.26	26.52	39.78
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	3	114.52	31.46	36.03	72.06	108.09
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	3	125.58	45.25	56.83	113.66	170.48
N-methyl-d7-perfluorooctanesulfonamidoethanol	3	43.52	77.43	33.69	67.39	101.08
N-ethyl-d9-perfluorooctane sulfonamidoethanol	3	47.6	40.75	19.4	38.8	58.19
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	3	98.94	4.15	4.1	8.21	12.31

A description of each column in Table 20:

- Analyte—Always 24 PFAS analytes.

- n=—Number of matrices for the analyte in the EDD, for all media type.

- % Mean Recovery—Mean of the MB matrix mean percent recoveries, for all media.

- RSD—Percent RSD of the mean of the sample percent recoveries.

- 1× SD—SD of the matrix mean percent recoveries.

- 2× SD—SD of the matrix mean percent recoveries times two.

- 3× SD—SD of the matrix mean percent recoveries times three.

4.   Discussion

We plotted the mean native concentration of the 40 PFAS analytes measured from each of the 32 environmental samples in the SLV study, using tables described in Section 3.C and in section C of the digital appendix (Figure 1). Figure 1 illustrates the prevalence of PFAS contamination across environmental media. The native PFAS analyte concentration was reported by the laboratory in units of ng/L for aqueous matrices and µg/kg for solid matrices. Concentrations of chemical compounds in aqueous solution are typically measured in units of mass of chemical (e.g., grams) per volume of water (e.g., liters) but can also be written as a mass fraction in units of mass of chemical per mass of water since the density of water is 1 g/mL. We converted the PFAS analyte concentrations for the aqueous samples to mass fraction in units of µg/kg or parts per billion (ppb) to plot the native PFAS analyte concentration for both the aqueous and solid matrices with the same scale on the plot. Each square was based on 0, 1, 2, or 3 subsample points, after throwing out all subsamples with U or B flags (refer back to Section 3.C). The gray NA color means all three subsamples had U or B flags (e.g., NA is used when the analyte was not detected or associated with contamination).

Figure 1 shows that several of the samples (columns), including one of the leachate samples (column LC1), contain many of the PFAS analytes. Across the analytes (rows), several (e.g., PFOA and PFOS) were detected in almost every sample. A thick grey line separates the aqueous sample columns from the solid sample columns.
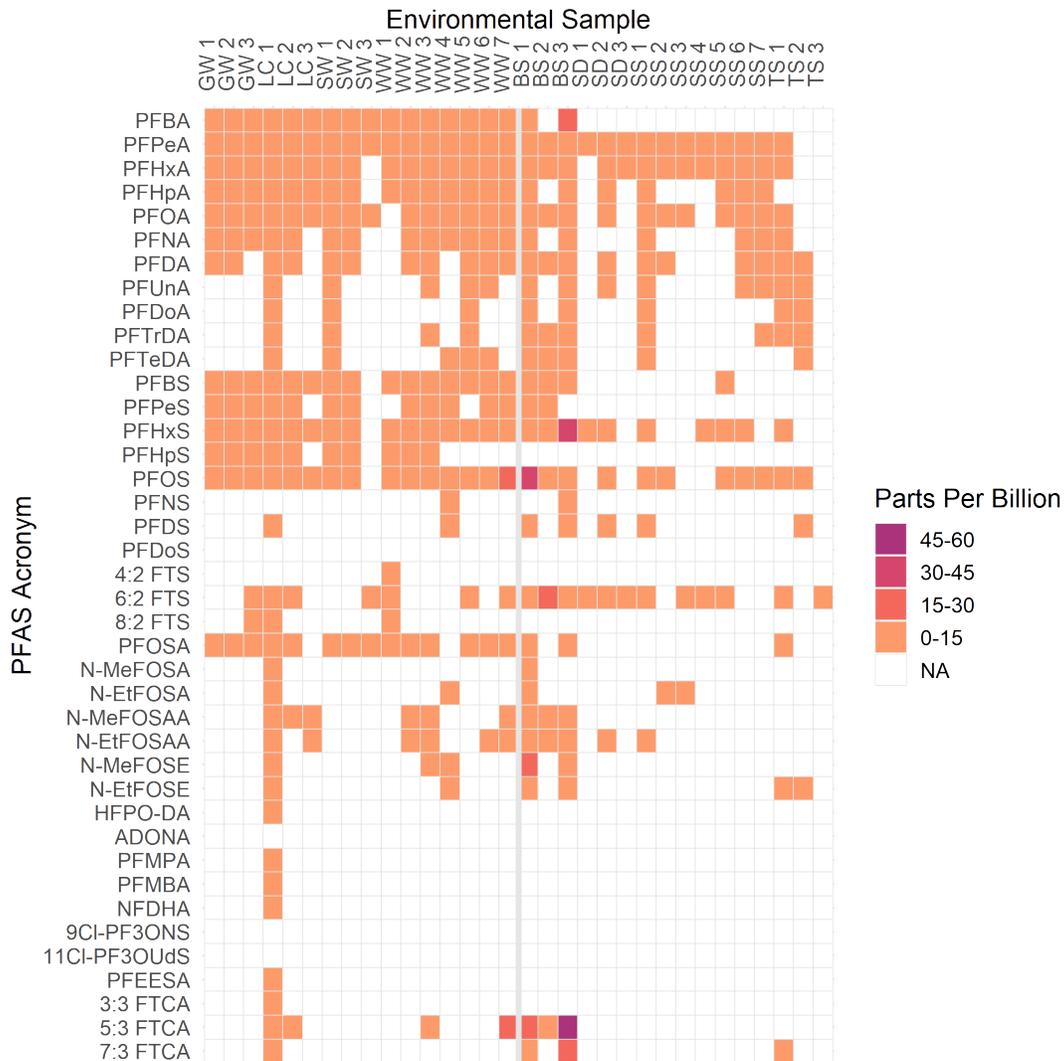
Figure 1. Mean Native Concentrations of 40 PFAS Analytes from 32 Environmental Samples in the SLV Study from the Tables in Section C of the Digital Appendix for Groundwater (GW), Landfill Leachate (LC), Surface Water (SW), Wastewater (WW), Biosolid (BS), Sediment (SD), Soil (SS), and Tissue (TS) Matrices. Numbers reported are mean values over all subsamples for that analyte/matrix combination that are greater than the detection limit.

We then plotted the mean percent recovery values for the 40 PFAS analytes measured from each of the environmental samples in the SLV, using tables described in the Section 3.D and in section D of the digital appendix (Figure 2). Each square was based on zero to four subsample points after throwing out U and B flags (refer to Section 3.C). The average percent recovery was greater than 75% for 92% of the analyte/matrix combinations. The analytes were spiked at different concentrations so the individual percent recoveries for a specific concentration cannot be determined from the figure. Figure 2 does show in white where we could not calculate the percent recovery when the mean native concentration for the analyte was greater than the subsample spike concentration or three subsample values

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had B flags. The native concentration was greater than the spike concentration (see Figure 1) for several analytes in the leachate samples (columns LC1, LC2, and LC3), so the mean percent recovery could not be calculated in Figure 2 (shown in white). Comparing Figure 1 and Figure 2, we could not calculate the mean percent recovery for some analytes (e.g., PFOA and PFOS); these two analytes were prevalent in many of the native samples. Analytes PFDoS and 6:2 FTS had the lowest mean percent recoveries in some of the environmental samples.
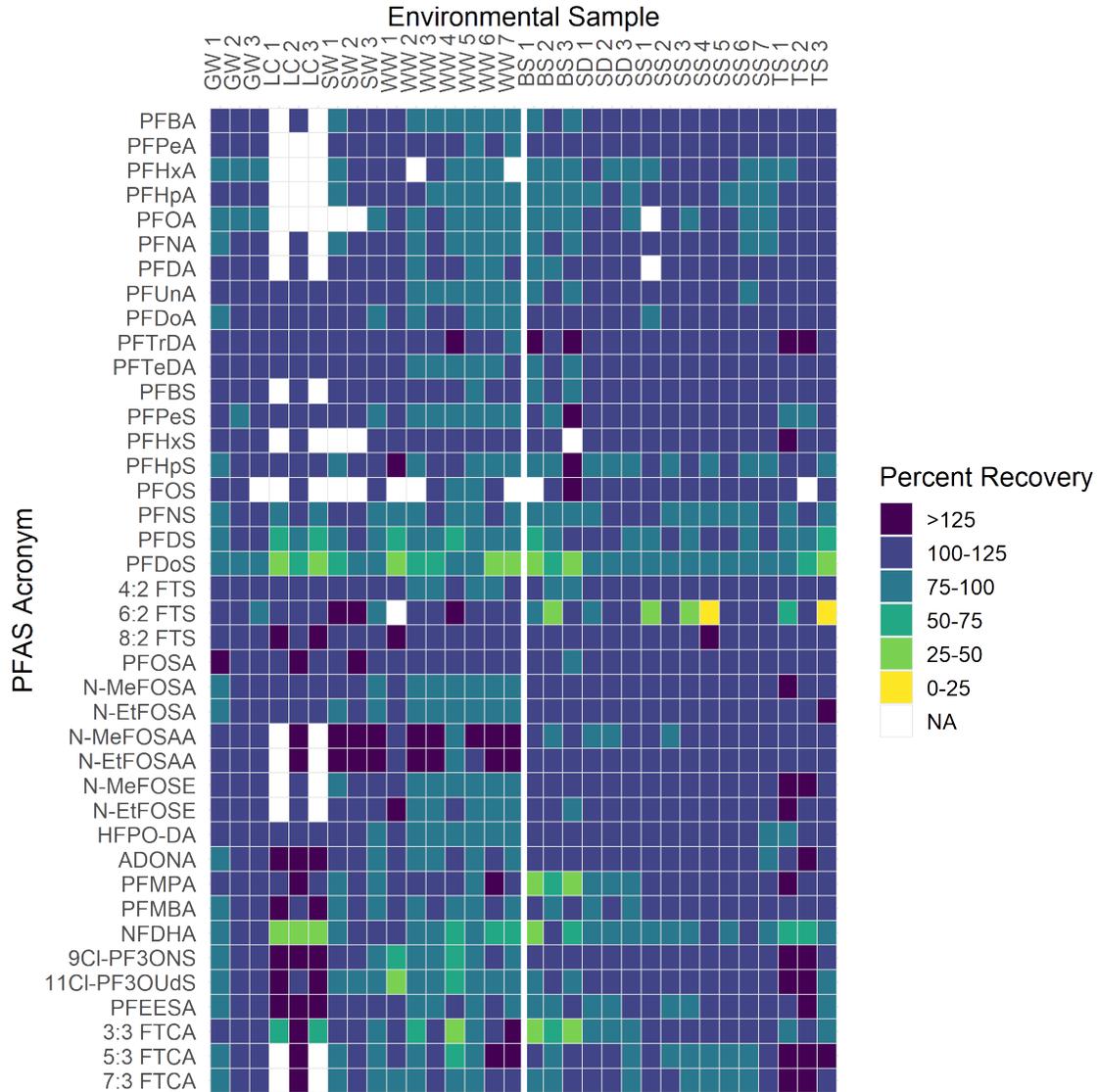
Figure 2. Matrix Spike Percent Recovery Values for the 40 PFAS Analytes from the 32 Environmental Samples in the SLV Study Corresponding to the Tables in Section D of the Digital Appendix for Groundwater (GW), Landfill Leachate (LC), Surface Water (SW), Wastewater (WW), Biosolid (BS), Sediment (SD), Soil (SS), and Tissue (TS) Matrices. Numbers reported are mean values over all subsamples for that analyte/matrix combination that are greater than the detection limit.

5. Conclusion

We compiled the laboratory reported results and calculated the summary statistics in support of the government's SLV study of PFAS analytes in environmental media. We automatically generated data tables in a systematic and reproducible fashion using a coded Python computer script to eliminate human error. We performed a rigorous quality check on our summary statistics to be confident they were calculated correctly. These data can now be used to support the government's SLV of the novel PFAS method.

The calculations included the mean native concentration, the mean spike concentration, and the percent recoveries of the 40 PFAS analytes in 32 environmental samples from aqueous and solid matrices. In addition, we calculated the mean spike concentration and percent recovery of the PFAS isotopically labeled EIS and IIS in the same environmental media. We also calculated the ongoing precision spike recovery and limit of quantitation verification spike recovery for the PFAS analytes across all the samples. Several of the samples had very high native concentrations of many of the PFAS analytes, which exemplifies the prevalence of PFAS throughout the environment. The average percent recovery was greater than 75% for 92% of the analyte/matrix combinations.

Appendix A.
Figures and Tables

Figures

Tables

Appendix B.
Abbreviations

AFFF	aqueous film-forming foam
CAS	chemical abstract service
EDD	electronic data delivery
EIS	extracted internal standard
EPA	Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
IIS	injected internal standard
LC	liquid chromatography
LOQVER	limit of quantitation verification
MS	mass spectroscopy
NAVSEA	Naval Sea Systems Command
OLEM	Office of Land and Emergency Management
OPR	ongoing precision and recovery
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
RSD	relative standard deviation
SD	standard deviation
SERDP	Strategic Environmental Research and Development Program
SLV	single laboratory validation

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