

FINAL
Prepared for the Massachusetts Department of Environmental Protection

Data Analysis Report

MassDEP PFAS Testing Study for NPDES POTWs (PRF77)

June 30, 2025

Tighe&Bond

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Prepared for: **Massachusetts Department of Environmental Protection (MassDEP)**

Project Title: **PFAS Testing Study for NPDES POTWs**

Data Analysis Report for MassDEP PFAS Testing Study for NPDES POTWs (PRF77)

Subject: Final Data Analysis Report

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Executive Summary

Project Background

Discharges from Massachusetts wastewater treatment plants to surface water bodies are subject to federal National Pollutant Discharge Elimination System (NPDES) permits and state Surface Water Discharge (SWD) Permits. Municipally-owned wastewater treatment plants are called publicly owned treatment works (POTWs). POTWs employ physical, biological, and chemical processes to remove pollutants from wastewater prior to discharging treated effluent to the environment. Primary treatment objectives of POTWs include removal of organic matter, nutrients, and other compounds from the influent waste stream in the form of solids, referred to as sludge. As emerging contaminants are identified, future management of waste streams from POTWs could become increasingly challenging in Massachusetts and other states, specifically as it relates to per- and polyfluoroalkyl substances (PFAS).

To better understand PFAS concentrations within the influent, effluent, and sludge at NPDES-permitted POTWs across Massachusetts, the Massachusetts Department of Environmental Protection (MassDEP) commissioned the MassDEP PFAS Testing Study at Massachusetts POTWs [PRF77] ("Study") designed to evaluate PFAS concentrations at all 114 Massachusetts POTWs with NPDES permits. Figure ES-1 provides a map with the locations of the 114 POTWs, depicted by size, that participated in the Study. POTW size is defined based on its NPDES-permitted flow and includes small [less than 1 million gallons per day (MGD)], medium (1-5 MGD), or large (greater than 5 MGD) facilities. Objectives of the Study included PFAS characterization and comparison within POTW waste streams using data obtained as part of this Study in addition to publicly available PFAS data from POTWs on the Massachusetts Energy and Environmental Affairs (EEA) Data Portal ("Portal") and identification of trends in PFAS loading based on several variables of interest.

This report presents the findings of the Study, which aims to provide MassDEP, as well as POTWs and other interested parties, with information and data on PFAS concentrations within waste streams at NPDES-permitted POTWs. A review of documented challenges with laboratory analysis of wastewater media encountered during the Study was also completed in consideration of potential future PFAS monitoring at Massachusetts POTWs.

Study Design

Samples were collected in accordance with a project-specific Sampling and Analysis Plan (SAP) and analyzed for PFAS via EPA Method 1633 with and without Total Oxidizable Precursor (TOP) Assay conducted, and for Adsorbable Organic Fluorine (AOF) via EPA Method 1621 over two sampling rounds. EPA Method 1633 includes analysis for 40 PFAS and these compounds are grouped into 9 PFAS classes.

There are numerous PFAS precursor compounds that are not detected by EPA Method 1633 alone. EPA Method 1633 tests for 40 specific PFAS compounds but cannot measure every one of the thousands of PFAS that exist. The TOP Assay process transforms (oxidizes) some PFAS precursors into PFAS that can be measured via EPA Method 1633. EPA Method 1621 for AOF approximates measuring all PFAS in aggregate by measuring organic fluorine, which is contained within PFAS as well as some other molecules such as pesticides and pharmaceuticals.

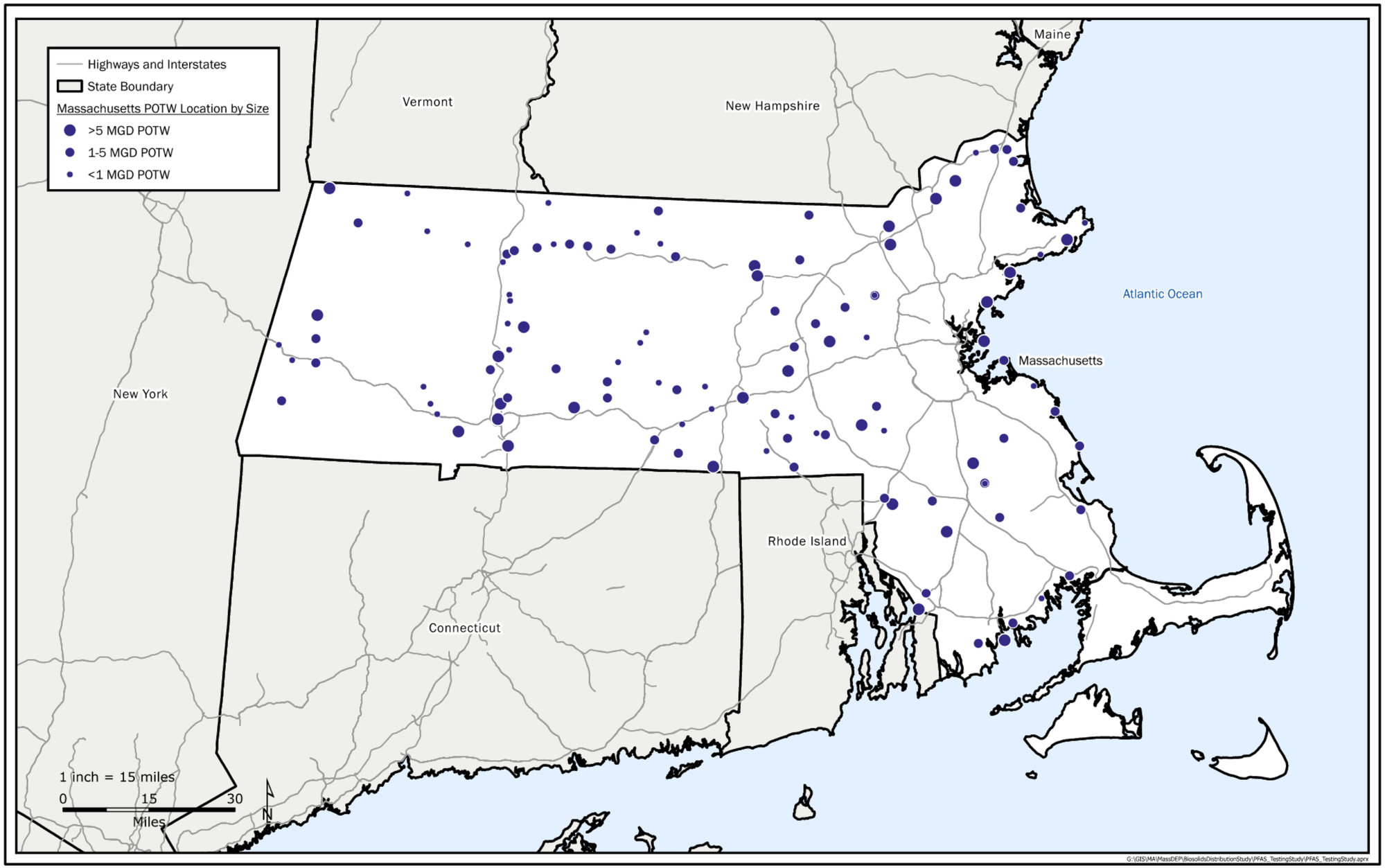


FIGURE ES-1
114 Massachusetts NPDES-Permitted POTWs

Influent, effluent, and sludge samples were collected from all 114 Massachusetts NPDES-permitted POTWs in Round 1 and from 86 POTWs (or 75%) in Round 2. Figure ES-2 provides a map depicting the POTWs that were sampled in Round 1 and Round 2 of the Study.

- EPA Method 1633: All influent, effluent, and sludge samples were analyzed by EPA Method 1633 which targets 40 PFAS. Total PFAS concentrations were calculated by summing the concentrations of all individual PFAS detected. Total PFAS concentrations using sums from EPA Method 1633 analysis alone are presented as "$\Sigma PFAS_{1633}$". Analytical results with no detections above the method detection limit were represented as 0 in this evaluation.

- TOP Assay: To provide a more comprehensive assessment of total measurable PFAS concentrations, influent, effluent, and sludge samples were also analyzed using the TOP Assay prior to analysis via EPA Method 1633. TOP assay is performed by the laboratory during sample preparation, where precursor compounds are oxidized into terminal PFAS. Subsequent analysis using EPA Method 1633 is expected to detect these newly formed terminal compounds. In this report, these two analytical procedures are referred to as "EPA Method 1633" when samples were analyzed directly and without prior oxidation, and as "TOP" when samples underwent the oxidation step. Total PFAS concentrations using sums from EPA Method 1633 analysis where TOP was conducted are presented as "$\Sigma PFAS_{TOP}$".

- AOF: Influent and effluent samples from 15% of POTWs sampled during each round were analyzed for AOF using EPA Method 1621. EPA Method 1621 measures the total concentration of organic fluorine in aqueous samples, including PFAS and other fluorinated organic substances, without identifying individual compounds. AOF analysis is typically used as a screening tool to assess if samples warrant a targeted analysis (such as EPA Method 1633). Elevated AOF concentrations may indicate the presence of PFAS compounds.

The results of this Study should not be used to draw broad conclusions for individual POTWs. The Study was limited to collecting one or two grab samples per waste stream (influent, effluent, and sludge) for each POTW and, where two rounds of samples were collected, they were collected only one month apart. As such, the data do not account for seasonal variability which significantly influence PFAS load calculations. In addition, notable variability was observed between primary and duplicate samples collected sequentially from the same location. Differences in both the types and concentrations of PFAS further underscore the inherent variability of PFAS in POTW waste streams and the limitations of drawing conclusions from limited sampling events.

Data Quality

During sample collection, various field quality control samples accompanied the analytical samples to the laboratory. These quality control samples included field duplicates and blanks (field blank, equipment blank, and temperature blank). Duplicates were collected immediately following collection of the primary sample from the same location and were labeled accordingly to differentiate between the two samples. Analytical results for blank samples indicate the quality control measures taken by the sampling team did not inadvertently introduce contaminants through the use of equipment or through sample handling.

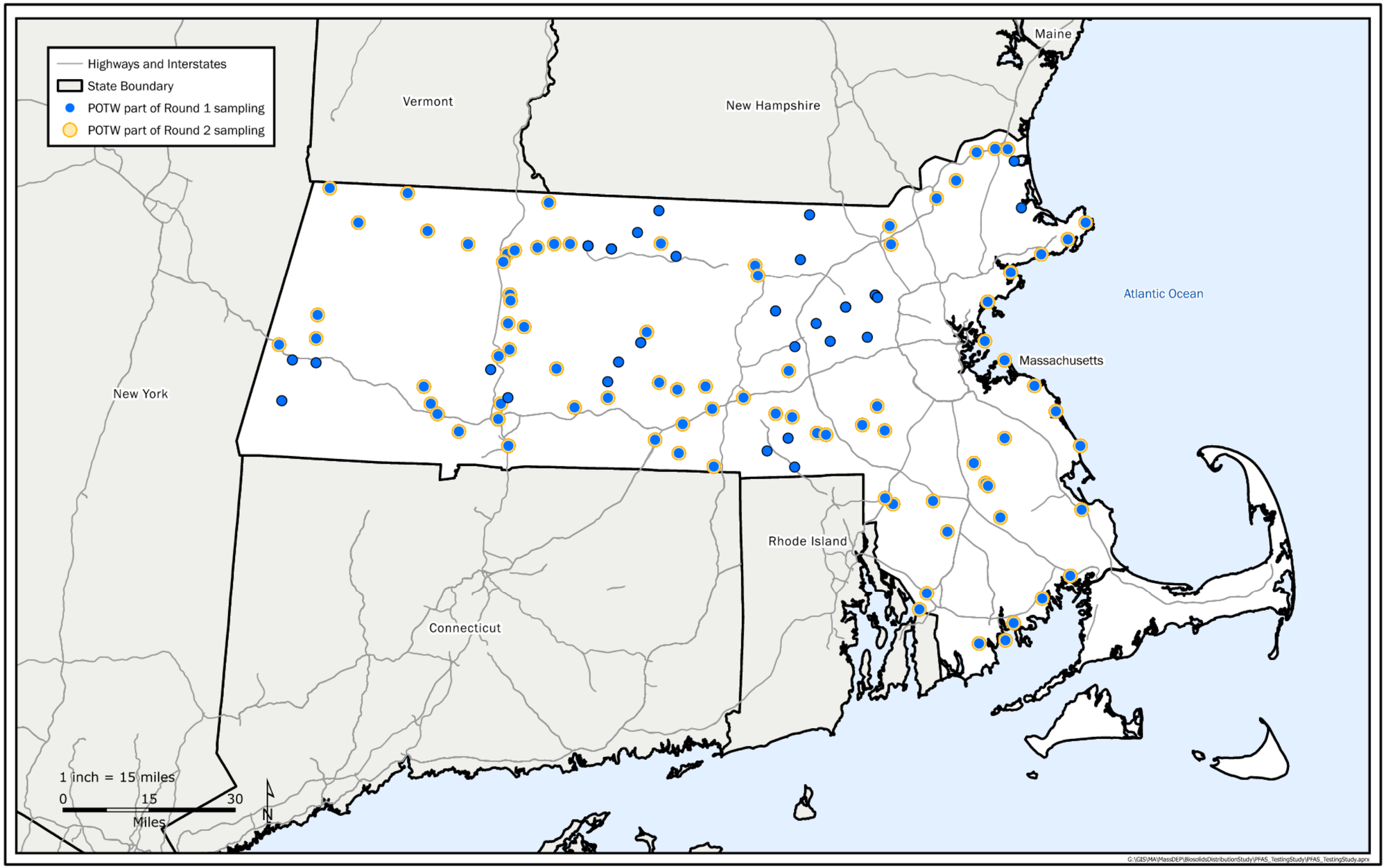


FIGURE ES-2
114 POTWs Sampled in Round 1 and 86 POTWs Sampled in Round 2

A total of 33 duplicate samples were collected over the course of the Study at facilities representing small, medium and large dischargers, from each location of the waste stream (influent, effluent, sludge), and from all four MassDEP regions. Again, the finding of considerable variability, both in terms of detected analytes and their concentrations suggests the highly variable nature of PFAS in the influent, effluent, and sludge when EPA Method 1633 and TOP analysis are applied for PFAS quantification. Consideration of data variability may inform future compliance monitoring at POTWs. Supplemental sampling requirements can build a more robust dataset to better understand ranges of PFAS concentrations in the waste stream on a facility-specific basis.

Detections of PFAS in Study Samples

During the Study, 29 PFAS were detected via EPA Method 1633 in influent, effluent, and/or sludge, out of the 40 PFAS analytes targeted through this method. The detected PFAS included compounds from 8 of the 9 PFAS classes [all but polyfluoroalkyl ether sulfonic acids (PFESAs)]. Similarly, 27 PFAS from the same 8 PFAS classes were detected via TOP analyses in influent, effluent, and/or sludge samples.

The expected increase in the prevalence of shorter chain PFAS relative to longer chain PFAS was not observed when comparing results of EPA Method 1633 to TOP analysis. This, along with the presence of precursor compounds in the TOP results, suggests overall poor oxidation of precursors across these samples using TOP.

PFAS Concentrations in Study Samples

The highest total PFAS ("ΣPFAS") concentrations from the Study were detected in sludge samples. Influent and effluent ΣPFAS concentrations were generally similar with no clear trend between the two, but were consistently less than sludge ΣPFAS concentrations. This finding is unsurprising since it is known that PFAS are present in influent and effluent wastewater streams and can accumulate in residual solids or sludge. The PFAS analyte detected among the highest concentrations for all liquid sample types (influent, effluent, and liquid sludge) for both EPA Method 1633 and TOP analyses was perfluoropentanoate or perfluoropentanoic acid (PFPeA). Perfluorohexanoate or perfluorohexanoic acid (PFHxA) was detected among the highest concentrations for influent and effluent samples for both EPA Method 1633 and TOP analyses. Influent samples with the highest median ΣPFAS concentration were observed to have the largest contributions from the compounds PFHxA, PFPeA, and perfluorooctanoic acid (PFOA). Effluent samples had the lowest median PFAS concentration with PFPeA, PFOA, and PFHxA as the largest contributors.

Median ΣPFAS concentrations in sludges analyzed as liquids were generally 3 to 8 times higher than influent and effluent concentrations. In addition, median ΣPFAS concentrations in sludges analyzed as solids were 50 to 100 times higher than ΣPFAS concentrations for sludges analyzed as liquids without wet weight and water density conversion factors applied. For EPA Method 1633, sludges analyzed as liquids had the largest contributions from compounds PFPeA, PFHxA, PFHpA, and PFOA. In contrast, sludges analyzed as solids with EPA Method 1633 had the largest contributions from two fluorotelomer carboxylic acids (5:3FTCA and 7:3FTCA) in addition to PFOS and PFPeA. The observation of different PFAS profiles in sludge samples depending on analysis as a solid or as a liquid highlights potential partitioning of individual PFAS to either the solid or liquid phase.

When TOP analysis was performed, sludges analyzed as liquids had the highest contributions from four short-chain PFCAs (PFBA, PFPeA, PFHxA, and PFHpA) whereas sludges analyzed as solids showed the highest contribution from PFPeS, the two

fluorotelemers (5:3FTCA and 7:3FTCA), and three short-chain PFCAs (PFBA, PFPeA, and PFHxA). These findings highlight the accumulation of PFAS into sludges and, in particular, the fractionation of short-chain PFCAs into the aqueous phase (influent, effluent, and liquid sludges) with the concentration of fluorotelomers and PFSAs (e.g., PFOS) into sludge solids.

When looking at the POTWs with the highest influent $\Sigma PFAS_{1633}$ concentrations, Study data indicated that these facilities' influent ΣPFAS concentrations tend to exceed their effluent ΣPFAS concentrations. Trends were less apparent for $\Sigma PFAS_{TOP}$ concentrations for influent and effluent, with comparable $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations in many cases and several unexpected instances of lower $\Sigma PFAS_{TOP}$ concentrations than the $\Sigma PFAS_{1633}$ concentrations. In contrast, the prevalence of oxidizable precursors still detected in sludge samples following TOP is apparent as shown in Figure 3-6, with $\Sigma PFAS_{TOP}$ concentrations far exceeding $\Sigma PFAS_{1633}$ concentrations for most POTWs. These trends highlight the potential prevalence of precursor mass stored in sludges that is not well quantified using a targeted analytical approach. Overall, ΣPFAS concentrations ($\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$) were not statistically significantly different from each other.

PFAS precursor conversion varied more substantially for some PFAS classes than others based on data from both Study sampling rounds. Median concentrations of certain PFAS classes were generally observed to be most variable in sludge for both Round 1 and Round 2 data, including results from both EPA Method 1633 and TOP analyses. The detection frequency evaluation demonstrates which compound classes were not measured using EPA Method 1633 alone and which classes were more efficiently converted from precursor compounds through the TOP Assay process.

A comparison of ΣPFAS concentrations of the Study data and available data from the Portal generally indicate higher mean, median, and maximum ΣPFAS concentrations observed in the Study data for influent, effluent, and sludge. Of the statistical comparisons, the greatest disparity was observed for the sludge data. It should be noted that all samples in this Study were analyzed using EPA Method 1633, whereas the samples included in the Portal were analyzed using several approved analytical methods of PFAS analysis, including EPA Method 1633 and other proprietary lab-modified methods. Distinctions among the PFAS analytical methods include intended sample matrix (e.g., drinking water, wastewater, or solids), variability in sample preparation and processing, and differences in reported PFAS by the laboratory. Factors which have the potential to influence results of the statistical analysis of ΣPFAS between the Study and Portal data may include seasonal variation, differences in sample processing between analytical methods, and variability of the incoming waste stream to facilities. These factors could not be assessed as part of the present Study because of the limited study duration.

Adsorbable Organic Fluorine

EPA Method 1621 measures the total amount of organic fluorine in aqueous samples, which includes PFAS compounds and other fluorinated organic substances, such as pesticides and pharmaceuticals, to assess the total organofluoride concentration in a sample. EPA Method 1621 is a non-targeted analytical method, and does not measure concentrations of individual PFAS compounds. For this reason, AOF results should always exceed $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations calculated based on targeted analytical methods, such as EPA Method 1633, unless total concentrations are below AOF detection limits, which are considerably higher than both EPA Method 1633 and TOP. AOF analysis is typically used as a screening method to determine if samples require a more targeted analysis (such as EPA Method 1633).

Typical AOF influent and effluent concentrations from this Study ranged from about 1,000 to 14,000 ng/L across the majority of facilities with a few exceptions. Facilities had significantly lower AOF concentrations in the effluent relative to the influent, indicating typical sequestration of organofluoride into the solids. Despite this general decreasing AOF trend from influent to effluent, some facilities were observed to have higher effluent AOF concentrations. Increased AOF in the effluent for specific facilities suggests release of stored organofluoride during the POTW's treatment process and/or variability in its influent concentrations that are not reflected in the effluent sampling event due to facility retention/detention time. Influent and effluent AOF concentrations were compared to the influent and effluent total $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations for the POTWs for which AOF was analyzed. As expected, AOF concentrations were significantly higher than total ΣPFAS concentrations from both EPA Method 1633 and TOP analyses.

PFAS Mass Loads

Based on the complete dataset (Study and Portal data), PFAS mass loading was estimated by facility and by population. The $\Sigma PFAS_{1633}$ concentrations were multiplied by the flow rate at the time of sample collection to generate estimates of ΣPFAS mass loads in pounds per year (lbs/yr) for influent, effluent, and sludge. In general, most small and medium POTWs are receiving and discharging less than 1 lb/yr (estimated) of PFAS. Facilities serving a population of 100,000 to 250,000 are typically receiving and discharging less than 5 lbs/yr (estimated). Two facilities were estimated to be receiving and discharging more than 75 lbs/yr, including Brockton AWRF and MWRA Deer Island, both large facilities serving greater than 100,000 people and with an industrial pretreatment program (IPP). These annual loadings were based on one or two sampling events and therefore are considered estimates of annual loads.

A comparison of mass loads calculated using both $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ for influent and effluent based on the four MassDEP regions (Northeast, Southeast, Central, and West) was completed. Findings revealed that the Western region of the state has a significantly lower median $\Sigma PFAS_{1633}$ influent mass load than any other region, while the Northeast and Central regions both have significantly higher $\Sigma PFAS_{1633}$ influent mass loads than the southeast or western regions. Median $\Sigma PFAS_{TOP}$ influent mass loads are comparable for the Northeast and Southeast regions, and both are significantly higher than the median $\Sigma PFAS_{TOP}$ influent mass loads in the Central and Western regions. These results suggest that POTWs in the Northeast and Southeast regions may receive and discharge higher mass loads than other regions and in particular, the Southeast region may receive higher mass loads of oxidizable PFAS precursors that are not adequately quantified by the targeted EPA Method 1633. Given the current and legacy industries in these regions and the overall degree of urbanization contributing to PFAS mass loads, this finding is not surprising; however, it lends itself to consideration of the potential for targeted source reduction efforts. A similar trend is apparent for EPA Method 1633 and TOP analyses effluent mass loads where POTWs in the Northeast and Southeast regions have significantly greater median effluent PFAS mass load than the Central region, which is itself significantly greater than the median effluent mass load for the Western region.

POTWs with more industrial users have significantly higher estimated ΣPFAS mass loading than POTWs with minimal industrial dischargers in their service areas. A comparison of POTWs with approved IPPs versus those that do not have an IPP indicates that POTWs with IPPs have significantly higher PFAS mass loading in both their influent and effluent, for both EPA Method 1633 and TOP analyses, than POTWs without IPPs.

Recommendations

A summary of recommendations for MassDEP for additional evaluations of PFAS at Massachusetts POTWs and for MassDEP's consideration for future compliance monitoring based on the findings from this Study is included below.

Future studies and analysis

- Conduct a longer-term study to include sample collection from Massachusetts NPDES-permitted POTWs to examine seasonal and regional variation of PFAS concentrations and mass loads.
- Conduct additional mass load evaluations based on Study and Portal data:
    - Based on PFAS6 concentrations and/or based on concentrations of the 18 PFAS compounds that are targeted by EPA Method 537.1.
    - Based on PFAS concentrations for POTWs with specific categorical users.
    - Based on AOF concentrations, and compare across sample locations both within and among POTWs.
- Evaluate the use of AOF as a potential PFAS screening tool for industrial users/categorical users of the wastewater system.
- Conduct additional analyses of duplicate and primary samples from this Study for shorter-chain PFAS compounds (8 or fewer carbons in the carbon chain) and for carboxylic acids to determine if consistent trends are observed regarding percent differences for influent, effluent, and sludge samples.

Laboratory Data Reporting

Encourage or require that laboratories include the following in their reports:

- All detected PFAS as estimated values (J-flag) down to analytical method detection limits for data evaluation purposes.
- Descriptions in the TOP case narrative when reporting limits differ for TOP post-treatment samples, potentially biasing comparisons.
- Percent solids content for all sludge samples including those analyzed on a liquid mass basis.

Develop guidance for laboratories regarding their front-end decision-making or modifications made within method standards during sample processing, and appropriate narration for final analytical report deliverables, including:

- Determination of percent solids content threshold for analysis of sludge as a solid or as the matrix identified by the client.
- Require the extraction and analysis of PFAS in both the solid and liquid fractions of sludge samples to quantify overall PFAS concentrations and facilitate comparison among facilities, waste streams, and sample media.
- Encourage/require the collection of larger sample volumes for watery sludges to ensure adequate solids content for analysis as a "solid".
- Sample processing protocols for low percent solids (i.e., watery) sludges.

- Encourage/require laboratories to analyze sludges as solids down to a specific total solids content threshold or as the matrix identified by the client.
- Encourage laboratories to analyze samples from the same POTWs using consistent dilutions and/or sample processing to improve the temporal consistency of results. When sample processing modifications are needed, discuss with facilities prior to making the change so that analytical implications are clear.

Sample Collection and Processing

Develop guidance for sample collection for POTWs including sample handling and processing procedures to mitigate issues associated with the difficult/variable matrix that wastewater and sludges represent, including:

- A standardized flow chart that provides key decision points and offers recommendations that POTWs could follow when laboratories report samples stored or analyzed out of hold times.
- Suggestions for POTWs to discuss with their laboratories potential sample processing modifications that may be needed based on their sample matrix.
- Requirements for resampling when PFAS samples collected for permit compliance are not analyzed within the method-specified hold times.
- Requirements for collecting and analyzing replicate (duplicate or split) samples and field and/or equipment blanks to improve data quality.
- Requirements for POTWs to report their influent and effluent flow rates at the time of sample collection to enable calculation of instantaneous mass loading rates.

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Section 1 Introduction

1.1 Background

Tighe & Bond has prepared this *Data Analysis Report* in accordance with requirements of the Massachusetts Department of Environmental Protection (MassDEP) Request for Quotes (RFQ) Contract PRF77 for the Per- and Polyfluoroalkyl Substances (PFAS) Testing Study for National Pollutant Discharge Elimination System (NPDES) permitted Publicly Owned Treatment Works (POTWs).

PFAS are a family of anthropogenic compounds that have been used since the 1950s to manufacture stain-resistant, water-resistant, and non-stick products. PFAS do not readily biodegrade or otherwise break down in the environment. They are known to be persistent in the environment and in the human body, and as a result, are widely detected in soil, water, air, and food, and may potentially lead to adverse health effects.

Waste streams discharged to POTWs, otherwise known as municipal wastewater treatment plants/facilities (WWTPs/WWTFs) and/or water pollution control facilities (WPCFs), can contain PFAS from residential, commercial, institutional, and industrial operations within their services areas. PFAS can be present in influent and effluent wastewater streams and can accumulate in residual solids or sludge.

Discharges from POTWs into surface water bodies are subject to federal NPDES permits and state Surface Water Discharge (SWD) Permits. Under authority provided by the Clean Water Act, U.S. Environmental Protection Agency (EPA) regulations prohibit the discharge of any water containing pollutants to Waters of the United States. Under the NPDES program, EPA or delegated states issue permits to entities that discharge treated wastewater directly to surface water, including POTWs, industries, institutions, and other privately owned sources. In Massachusetts, EPA retains the NPDES permit authority, while Massachusetts concurrently issues a state SWD permit under authority provided by the Massachusetts Clean Waters Act.

There are 114 POTWs in Massachusetts with NPDES permits, which collectively treat approximately 1 billion gallons of wastewater per day. POTWs employ physical, biological, and chemical processes to remove pollutants from the wastewater and discharge treated water to nearby groundwater, streams, rivers, or the ocean. POTWs clean the liquid stream by removing organic matter, nutrients, and other compounds in the form of solids, referred to as sludge, before releasing the liquid effluent back into the environment. Massachusetts sludge is typically managed through landfilling, incineration, or land application if processed into treated biosolids, as reviewed by Bone et al. (2024).[1] However, existing POTW treatment systems were not designed to effectively remove PFAS, and PFAS are released back into the environment through effluent discharges and sludge management.

As NPDES and SWD permits are renewed, PFAS sampling and analysis are being added to the permit monitoring requirements. PFAS testing requirements became effective for some Massachusetts NPDES POTWs as early as 2022, with most (103 of 114) required to monitor and report PFAS concentrations in influent, effluent, and sludge by the end of 2024. An additional 13 Massachusetts POTWs are regulated by groundwater discharge permits, which do not currently include PFAS monitoring requirements.

1.2 Objectives and Scope of Work

The objectives of this Study were to:

- Conduct PFAS sampling of influent, effluent, and sludge at up to 114 NPDES POTWs during Round 1 and at least 50% (or 57) of POTWs during Round 2 in accordance with the Study's Sampling and Analysis Plan (SAP).
- Analyze all influent, effluent, and sludge samples using EPA Method 1633 and Total Oxidizable Precursor (TOP) Assay.
- Analyze select samples for Adsorbable Organic Fluorine (AOF) to understand how results from targeted PFAS analytical methods (EPA Method 1633 and TOP) compared to other broader measures of PFAS.
- Collect and analyze additional samples for Quality Control (QC) including field duplicates for at least 5% of the samples, and field blanks as needed to verify sampling procedures.
- Compile and analyze data collected from this project alongside data previously collected by POTWs as part of their NPDES and SWD permit requirements.
- Document results in a comprehensive report including PFAS trends within and among POTWs in Massachusetts. PFAS data from this Study will be compared to data collected by POTWs for NPDES permit compliance and compared to studies conducted in other states. PFAS loading (pounds per day) into and out of POTWs will be evaluated. Statistical analyses will be conducted to evaluate PFAS fingerprints, loading, per capita contributions, regional trends, and industrial contributors. TOP and AOF data will be analyzed and compared with pre-TOP identification (ID) results.

The scope of work completed during the Study included:

- Influent, effluent, and sludge sampling was conducted over 2 rounds, with Round 2 conducted approximately 4 weeks after Round 1 sampling for selected POTWs.
- 100% of the NPDES POTWs were sampled during Round 1:
    - Influent and effluent samples from all 114 NPDES POTWs, and sludge samples from 113 of the 114 POTWs were collected. A sludge sample could not be collected from one POTW because its lagoon was frozen during the Round. Refer to Table B-1 in Appendix B for a list of POTWs included in Round 1.
- 75% of the NPDES POTWs were sampled during Round 2:
    - Influent and effluent samples were collected from a random selection of 86 NPDES POTWs, and sludge samples were collected from 85 of those 86 POTWs. (Consistent with Round 1, a sludge sample could not be collected from one POTW because the lagoon was frozen during Round 2 as well.) Refer to Table B-1 in Appendix B for a list of POTWs included in Round 2.
- All influent, effluent, and sludge samples collected as part of this study were analyzed for Total PFAS concentrations and TOP using EPA Method 1633 (Analysis of PFAS in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS).
- During Round 1, a random selection of 18 POTWs had their influent and effluent samples analyzed for AOF using EPA Method 1621. During Round 2, 13 of these

same 18 POTWs had their influent and effluent samples analyzed for AOF. (The other 5 POTWs sampled in Round 1 were not randomly selected for sampling during Round 2.) Refer to Table B-1 in Appendix B for a list of POTWs with AOF analyses conducted for Rounds 1 and 2.

- QC samples were collected for 5% of all influent, effluent, and sludge samples. During Round 1, 6 influent, effluent, and sludge duplicate samples were collected, as well as 6 field blanks and 6 equipment blanks. During Round 2, 5 influent, effluent, and sludge duplicate samples were collected, as well as 5 field blanks and 5 equipment blanks. Duplicate and blank samples were collected from randomly selected POTWs for each round and were analyzed for Total PFAS concentrations using EPA Method 1633.

In summary, Tighe & Bond and its subcontractor, Stacey DePasquale Engineering, Inc. of Lawrence, Massachusetts (SDE) collected 655 samples between February 19 and April 2, 2025 from 114 POTWs for PFAS analyses including 202 influent [One POTW (MWRA Deer Island) had two influent locations that were sampled], 200 effluent, 198 sludge [One POTW (Salisbury WWTP) did not have sludge available to be sampled during either round], 11 influent duplicate, 11 effluent duplicate, 11 sludge duplicate, 11 equipment blank, and 11 field blank samples. Sampling was performed in accordance with the Sampling and Analysis Plan (SAP) developed in support of this Study. The SAP is included in Appendix A. Pace Analytical Services, Inc. of Mansfield, Massachusetts (Pace) analyzed all samples using EPA Method 1633 and/or EPA Method 1621.

This Data Analysis Report documents the analysis of the PFAS data collected during the Study alongside data previously collected by POTWs as part of permit-required sampling, as well as data from studies conducted in other states. Data from Massachusetts NPDES/SWD permit compliance sampling was downloaded from the Massachusetts Executive Office of Energy & Environmental Affairs (EEA) Data Portal[2] (Portal) for use in this Study. The goal of this comprehensive report is to provide insight into PFAS trends at Massachusetts NPDES POTWs. Health and environmental impacts associated with the management or disposal of wastewater or sludge containing PFAS were not evaluated in this Study. While these impacts may drive the relevance of this report, they are not analyzed in this report. MassDEP may use the data, trends, and other findings to help assess how to address PFAS in the wastewater stream.

1.3 Description of Calculated Metrics

This subsection provides a summary of the metrics calculated from the compiled dataset and used to develop report figures and tables. Section 2 includes a detailed discussion of the Study's methods including data collection, compilation of existing data, data processing, and statistical analyses, and Section 4 presents the findings from the analyses conducted. Data analyses were conducted using R and RStudio software.[3,4]

PFAS concentrations are presented in various units throughout the metrics discussed below, including nanograms per liter for PFAS mass in liquid samples and nanograms per gram for PFAS mass in solid samples. Nanograms per liter (ng/L) is equivalent to the units of parts per trillion (ppt) and nanograms per gram (ng/g) are equivalent to the units of parts per billion (ppb). AOF analytical results are also reported in ng/L (ppt).

In cases where a PFAS analyte was not detected above the laboratory method detection limit (MDL), results were reported by the laboratory as "ND". In detection frequency analyses and in all calculations of summary statistics, ND values were treated as missing

(commonly denoted as "NA"). In calculations of total PFAS concentrations, ND value were treated as a concentration of "0". When an analyte was detected above the laboratory MDL but below the method reporting limit (RL), the laboratory provided estimated results that were reported with a J-flag qualifier. In cases where a PFAS analyte was reported with a J-flag, a concentration equal to the reported estimated value was used in calculations and statistical evaluations.

The metrics in this subsection represent the study results in three analytical forms, EPA Method 1633, TOP, and AOF (EPA Method 1621) for the influent, effluent, and/or sludge samples from Round 1 and Round 2 of the Study.

1.3.1 PFAS Detection Frequency

The detection frequency for each PFAS analyte was calculated by determining whether the individual PFAS analyte was present above analytical detection limits (yes or no). Detections for concentrations between MDLs and RLs (J-flag values) were included as present ("yes"). The detection frequency was then calculated by summing the number of times each PFAS analyte was detected across all facilities, and dividing by the sum of the number of samples for which that PFAS analyte was measured. These frequencies are represented in tabular heatmaps for both Study data (Section 4.1.1) and Portal data (Section 4.2.1), with the calculated detection frequency shown on a percentage basis.

1.3.2 Total PFAS (ΣPFAS) Concentration

Total PFAS (ΣPFAS) concentration was calculated as the sum mass concentrations (ng/L or ng/g) for all compounds detected in each sample (up to the 40 analytes targeted by EPA Method 1633). In some cases involving comparisons between Study and Portal data, the ΣPFAS was calculated for six specific PFAS compounds: PFHpA, PFOA, PFNA, PFDA, PFHxS, and PFOS. All ΣPFAS concentrations included J-flag values as reported by the laboratory. For Study data, duplicate sample concentrations were averaged with the primary sample at that location prior to the calculation of ΣPFAS. ΣPFAS concentrations were compared by analytical methods within and among POTWs. For Study data, total PFAS concentrations were calculated for EPA Method 1633 ($\Sigma PFAS_{1633}$) and TOP analysis ($\Sigma PFAS_{TOP}$), and for Portal data, total PFAS concentrations were calculated for EPA Method 1633, EPA Method 537.1 and other targeted methods, and for a combination of all methods used for samples in the Portal.

1.3.3 Adsorbable Organic Fluorine

Influent and effluent samples from 15% of POTWs sampled during each round were analyzed for AOF using EPA Method 1621 (18 POTWs in Round 1 and 13 POTWs in Round 2). EPA Method 1621 measures the total amount of organic fluorine in a sample on a broad scale, which includes PFAS and other fluorinated organic substances, such as pesticides and pharmaceuticals, in order to assess the total organofluoride concentration in a sample. EPA Method 1621 is not a targeted analytical method, and it does not measure concentrations of individual PFAS compound concentrations. For this reason, AOF results should always exceed ΣPFAS concentrations calculated based on targeted analytical methods, such as EPA Method 1633, unless overall concentrations are below AOF analytical detection limits, typically 1,500 ppt. AOF analysis is typically used as a screening method to determine if samples require a targeted analysis (such as EPA Method 1633).

There are thousands of PFAS compounds used in commercial products; however, current standard analytical methods are only able to quantify/measure a limited number (<1%) of them. The unmeasured PFAS compounds include PFAS precursors, which are

compounds that, when chemically or biologically oxidized, may partially convert into measurable PFAS. The TOP analysis was conducted for all influent, effluent, and sludge samples collected as part of this Study to provide an estimate of potentially oxidizable PFAS precursor concentrations that can be compared to measurable PFAS concentrations. AOF and TOP concentrations serve as complementary indicators of total measurable PFAS concentrations in samples as opposed to those concentrations detected by EPA Method 1633 alone.

1.3.4 Oxidizable and Adsorbable PFAS

Mean concentrations of PFAS from the 9 classes were calculated for those measured by EPA Method 1633 and those measured by TOP analysis (Figures 4-14 and 4-15) based on concentrations of individual analytes. A percent change was calculated from the mean concentrations of each class.

Based on the ΣPFAS concentrations calculated for Study data, graphics were created to visualize the distribution of POTWs' ΣPFAS concentrations falling within distinct concentration ranges (e.g., 0-100 ng/L, 100-200 ng/L, 200-300 ng/L, etc.). The number of facilities with ΣPFAS concentrations falling within each concentration range was determined for each sample medium (influent, effluent, liquid/wet sludge, and dry/solid sludge), for both EPA Method 1633 and TOP analyses, and for each round of sampling. These metrics are presented in histograms for influent, effluent, and sludge samples, and for EPA Method 1633 and TOP analyses. ΣPFAS concentrations exceeding 1,000 ng/g or 1,000 ng/L were grouped as "≥1,000" to improve figure resolution.

1.3.5 Median ΣPFAS Mass Loads

Total median PFAS mass loads were calculated using all PFAS concentrations from Study and Portal data. The ΣPFAS concentration for each Study sampling event (Round 1 and Round 2) was multiplied by the flow rate at the time of sample collection to generate a ΣPFAS mass load per day (with appropriate conversions from gallons per day to liters per day). When using data from the Portal, the ΣPFAS concentration was multiplied by the annual average flow rate reported by the POTW because flow rate at the time of sample collection was not known.

Annual sludge generation rates reported on a dry basis in *Current and Near-Term Management of Massachusetts Wastewater Sludge* for 2023 were used to estimate the sludge mass load for each POTW.[1] For sludge samples with PFAS concentrations reported in ng/L, the original data collected via the *POTW Sludge Management Survey* conducted as part of the PFAS and Residuals Technology and Management Study, Part 1, were mined for annual sludge generation on a liquid basis and used to estimate the sludge mass load for those POTWs.[1]

From these individual ΣPFAS mass loads, a median load was calculated for each POTW across all sample events. Mass loads were sorted from largest to smallest based on influent load. Bar charts projecting influent mass load to the left and effluent load to the right for each facility were generated.

1.3.6 PFAS Fingerprinting

Using the compiled dataset of both Study and Portal data, median mass concentrations were calculated for each POTW's influent, effluent, and sludge (on a wet or dry basis). The resulting median mass concentrations (ng/g or ng/L) were converted to median molar concentrations (nmol/g or nmol/L) by dividing each PFAS' mass concentration by its molar mass (ng/nmol). $\Sigma PFAS_{molar}$ concentrations were calculated for each POTW by summing the median molar concentrations for all species. PFAS molar compositions were calculated for each POTW by dividing the median molar concentration for each species by that POTW's $\Sigma PFAS_{molar}$ concentration. These PFAS molar compositions are shown on a percentage basis for visual comparison of each PFAS "fingerprints" among POTWs. Molar concentrations were used to represent the quantity of each species independent of molecule size, in contrast to mass concentrations.

Section 2 Methods

2.1 Sampling and Analysis Plan

A Sampling and Analysis Plan (SAP) was developed in support of this Study to provide a comprehensive plan to govern all aspects of sample collection, quality control, analysis, data generation, and evaluation. The SAP defined the project purpose, and included a description of project roles and responsibilities, field study design and logistics, a Standard Operating Procedure (SOP) for collection of influent, effluent, and sludge samples for PFAS analyses at Massachusetts POTWs, and analytical procedures and data quality considerations. A copy of the SAP is included in Appendix A.

2.2 Compilation of Existing Data

In addition to samples collected and analyzed as part of this Study in accordance with the attached SAP (Appendix A), PFAS monitoring data were supplemented with data from samples previously collected at NPDES-permitted POTWs and publicly available in the EEA Wastewater NPDES & Residuals PFAS Data Portal[5] (Portal). The Portal is a growing database of PFAS monitoring data reported by NPDES permit-holders, including both POTWs and privately owned domestic WWTFs, in compliance with NPDES requirements and with Massachusetts' concurrent SWD permits.

The NPDES program and the Massachusetts SWD program began to require permit-holders to monitor and report PFAS concentrations in influent, effluent, and sludge as part of permit renewals beginning in 2022. Since 2022, PFAS monitoring requirements have continued to be added to permits being renewed. The lab method and number of compounds required have changed as EPA Method 1633 was developed and finalized. Not all POTWs had this requirement at the time of this Study. Recent NPDES permit renewals for POTWs have included requirements to annually monitor and report PFAS concentrations at regulated industries and Significant Industrial Users. These data are also included in the Portal, although Massachusetts POTWs operating under older NPDES permits do not yet have requirements to monitor industrial users' PFAS concentrations. The EPA provides the following list of industries to monitor:

- Commercial car washes
- Platers/metal finishers
- Paper and packaging manufacturers
- Tanneries and leather/fabric/carpet treaters
- Manufacturers of parts with polytetrafluoroethylene (PTFE) or Teflon-type coatings (i.e., bearings)
- Landfill leachate
- Centralized waste treaters
- Contaminated sites
- Firefighting training facilities
- Airports
- Any other known or suspected sources of PFAS

Data exported from the Portal (as of April 30, 2025) included 74 of the 114 Massachusetts POTWs with NPDES permits, 2 privately owned domestic WWTFs, and 17 industrial dischargers with NPDES permits. Note that an additional 13 Massachusetts POTWs are regulated by groundwater discharge permits, which do not yet include requirements for PFAS monitoring.

2.3 Data Processing

2.3.1 Data Quality

During the activities conducted by Tighe & Bond, Quality Assurance and Quality Control (QA/QC) procedures were followed to confirm that the data collected from the agreed upon locations met the needs of the project. The objectives for this project require data quality at a minimum to be representative, reproducible, and not contain any gross or compounding failures. These QA/QC objectives were quantified by assessing the data quality information provided by the laboratory as outlined in Section 5.4 of the SAP.

Data usability evaluations were on-going throughout the project as new data was obtained. Associated figures, tables, charts, and other graphical representations were prepared for use during data evaluations.

Existing data collected by POTWs as part of their NPDES and SWD permit monitoring requirements were evaluated by reviewing available data on the Portal. Due to the limitation of not having the case narratives, notes, or final reports from the laboratories for data obtained from the Portal, Tighe & Bond made assumptions for data handling based on data qualifiers, QA/QC qualifiers, and any additional information provided in the data set for Massachusetts POTWs.

EPA Method 1633 has specific criteria on the internal standards that are used, and the validity of internal standards is defined by the method and the laboratory. Tighe & Bond's data analysis team evaluated any deviations and/or failures of internal standards, and these issues were discussed with the Project Manager and our technical advisor Dr. Paula Mouser on a case-by-case basis. Samples and/or individual PFAS were noted for possible rejection based on the following qualifiers provided by the laboratory:

- Vague or missing documentation that only indicated that the case narrative should be considered
- Laboratory calibration failures that did not indicate re-extraction and/or re-analysis of the sample
- Qualifier ions reported <50% or >150% that did not indicate re-extraction and/or re-analysis of the sample
- Values flagged with an EMPC (Estimated Maximum Possible Concentration) qualifier

Based on these data quality considerations, 446 measurements (0.5% of all data) from 305 POTW samples and 19 industrial samples were omitted from the dataset, as summarized in Table 2-1. This includes 161 measurements (0.3%) from samples collected as part of the present Study.

TABLE 2-1
Summary of Rejected Study Data

Facility Type	Sample Location	# Facilities with Rejections	# Samples with Rejections	# Measurements Rejected
Industry[1]	Influent	1	2	3
	Effluent	4	10	13
	Sludge	1	7	9
	Total	4	19	25
POTW	Influent	64	103	157
	Effluent	44	61	68
	Sludge	77	129	175
	Industry[2]	7	12	21
	Total	103	305	421
	Total	**107**	**324**	**446**

1. Industrial dischargers with individual NPDES permits
2. Industrial users discharging to a POTW

Supplemental PFAS monitoring data provided by POTWs that are voluntarily monitoring PFAS independent of NPDES or SWD permit requirements were not evaluated as part of this project.

Data quality controls associated with specific statistical methods are discussed further in Section E.2.3 of the SAP.

2.3.2 Field and Sample Handling Quality Control

To ensure the integrity of environmental information obtained from a facility, Tighe & Bond included a field quality control program as part of the SAP. During sample collection activities, various field quality control samples accompanied the analytical samples to the laboratory. These quality control samples include field duplicates and blanks (field blank, equipment blank, and temperature blank).

Immediately prior to the Round 1 and Round 2 sampling events, separate bottle orders were completed, and laboratory-provided sample containers and dedicated coolers were delivered to Tighe & Bond and SDE offices to reduce the potential for contaminants migrating into sample containers over time. In accordance with the SAP, visual inspection of the delivered sample containers received from the laboratory were conducted to ensure the appropriate number of sample bottles were received and that no damage that would otherwise compromise the integrity of the container and/or sample are observed. Additional sample containers were requested from the laboratory for each sampling event to avoid repeat sampling events in the event a container was broken, lost, or deemed not usable for the sampling event.

Dedicated PFAS-free sampling equipment was also utilized as part of this project for sample collection purposes. Prior to sampling events, the equipment was visually inspected to ensure no residual contamination was present on the equipment and to assess the potential for damage. If damaged equipment used for sampling (i.e., extension rod, beaker collection cup) was noted, the damaged equipment was appropriately

documented to Operations Managers and the Project Manager, and was removed from service and replaced prior to the subsequent sampling events.

Quality Control (QC) samples (field blanks and equipment blanks) were collected at the time of sampling at a of 5% of facilities sampled (6 facilities for Round 1 and 5 facilities for Round 2) in accordance with the approved sampling program as summarized in the SAP in Appendix A. Field blank QC samples were collected at the time of sampling to replicate sampling/field conditions. To prevent inclusion of non-site related contaminants into the data assessment, concentrations reported in blanks were compared to field sample results. Equipment Blanks were collected to evaluate if proper decontamination was conducted prior to sampling. To prevent inclusion of non-site related contaminants into the data assessment, concentrations reported in blanks were evaluated on a case-by-case basis and compared to field sample results to evaluate sampling conditions and corrective actions.

Duplicate samples were collected immediately following collection of the initial sample from the same location at a frequency of 5% of facilities sampled (6 facilities for Round 1 and 5 facilities for Round 2) and processed identically to evaluate the precision of the analytical method. Additional information pertaining to the collection of Quality Control samples is included in the SAP as part of Appendix A. Analytical results of duplicate samples were compared with the initial sample to evaluate similarities between detected compounds and their specific concentrations in addition to concentration differences of $\Sigma PFAS_{1633}$.

Results for blank samples were evaluated by the laboratory and Tighe & Bond as the project proceeded to assess the likelihood of contamination and risk to data quality. Field data was evaluated routinely by the Tighe & Bond Project Manager and Operations Managers through the interpretation of field notes, photographs, and any additional field analytical data collected as part of the project. All observations, trends, assumptions, conclusions, and limitations discovered in reviewing the field data have been documented in the sections below.

A project-specific training program was developed for the Tighe & Bond and SDE sampling team in support of this project in order to establish consistency of sample collection and decontamination protocols and practices. The training program was conducted by Tighe & Bond staff who have extensive PFAS sampling experience and included a review of the project-specific Standard Operating Procedure (SOP) prepared by Tighe & Bond, which included laboratory-provided SOPs for EPA Method 1633 and AOF analysis by EPA Method 1621, sampling equipment usage and decontamination procedures, and proper sample handling, preservation, and chain-of-custody (COC) procedures.

A review of the Field Data Collection Form to be used during each sample round at each facility was also completed along with clarification of expectations for documentation filing following each sampling event. Oversight and review of field sampling activities and data quality were performed by Operations Managers. Specific sample containers were provided by the laboratory based on the analytical test being requested for each sample and the volume of sample required for each analysis.

2.3.3 Laboratory Quality Control

The laboratory data review was performed internally by the Tighe & Bond data management team. This comprehensive review consisted of an initial check to ensure that the laboratory reports were complete and a review of laboratory QA/QC procedures for the project, including laboratory control samples, field and laboratory duplicate analyses, laboratory surrogate samples and percent solids. The review included an evaluation of applicable certifications and accreditations included in the laboratory reports. In addition, the Project Manager and Operations Managers were responsible for reviewing the COC forms for completeness and confirming that the sample holding times and preservation methods used were appropriate for the analyses conducted. The Project Manager also reviewed the laboratory-provided Data Quality Review and documentation.

The laboratory case narrative documented any issues associated with each laboratory analysis. Data validation was performed by the laboratory analyst prior to reporting results to Tighe & Bond, and data validation procedures were performed by the laboratory in accordance with EPA Method 1633 and TOP, and EPA Method 1621 (AOF) requirements. Documentation from the laboratory indicated that the above methods were performed in accordance with EPA guidance, and any failures have been documented below.

The laboratory was responsible for instituting any required corrective action. Criteria used for accepting or rejecting any data are based on laboratory quality control metrics and specific MassDEP and/or EPA methodology standard operating procedures. Data quality was validated by reviewing all quality control analyses. Deviations that were not rectified by the laboratory were documented in the case narrative and summarized below.

A level four data delivery report was provided by the laboratory in addition to Electronic Data Deliverables (EDDs). Received EDDs were imported into a project-specific Environmental Database Management System (EDMS). When sampling was completed, all data was exported from the EDMS and evaluated by the Project Manager and data management team to determine if they support the data needs for the project. The QA/QC data was evaluated and assessed through the EDMS's data validation system which evaluates laboratory control samples, surrogates, recoveries, and relative percent differences (RPDs). Additionally, the case narratives provided by the laboratory were reviewed for issues including sample receiving outliers, expired hold times, and calibration standards outside method criteria.

If the review indicated that QC analyses were outside of reproducible range, or if any critical data gaps existed, sample data was evaluated on a case-by-case basis as to whether they should be noted for possible rejection. In accordance with laboratory procedures, during sampling activities, additional sample matrix volume beyond the minimum method requirement was provided to the laboratory to provide the opportunity for re-extraction and re-analysis if laboratory failures were encountered.

Table B-2 in Appendix B summarizes the numerical data validation from the EDMS that fell outside of method criteria. A summary of the non-numerical issues identified by the review of laboratory-provided case narratives is provided below. Based on a case-by-case review of the data quality issues, there were no samples that were fully rejected based on initial QA/QC criteria. However, select samples and/or analytes were flagged so that during statistical analysis they could be considered if they became outliers. The following is a summary of issues identified in the case narratives:

- Elevated RLs, most of which were due to a dilution required by the sample matrix. Detection limits were evaluated as part of the statistics and analysis section of this report; as such, data was not rejected due to elevated RLs.
- Re-extractions, where samples were re-extracted outside of method required hold times due to QC failures in the original samples. The re-extracted results were reported. Due to the nature of PFAS compounds and the limited number of samples affected; expired hold time was not considered to affect data usability.
- Surrogate recovery, where some samples had surrogate recoveries outside acceptable method criteria. Other QC data and/or other surrogates were within acceptable method criteria; as such, data usability is not likely to be affected.
- Extracted Internal Standard (EIS) recoveries, where EIS recoveries were sometimes outside the acceptance criteria. In most instances, re-extraction and/or re-analysis was able to be performed at the laboratory; however, in three samples re-extraction at a lower volume achieved a similar result. If the recovery of any EIS falls outside of criteria, method performance is unacceptable for that EIS in that sample. The results of the original extraction are reported for samples L2509327-04, L2509538-03, and L2518526-02. These three samples were flagged so that they could be evaluated as possible outliers during the statistics and analyses portion of this report.

The complete laboratory reports, including the case narratives or other QA/QC data provided by the laboratory are included electronically as Appendix D.

2.3.4 Blanks and Duplicates

2.3.4.1 Equipment and Field Blanks

Eleven (11) equipment blanks and eleven (11) field blanks were collected during the project between February 19 and April 2, 2025. Six each of equipment and field blanks were collected during Round 1 and five each of equipment and field blanks were collected during Round 2. Blanks were collected at facilities representing small, medium and large dischargers, and from all four MassDEP regions. In all cases, results for equipment and field blanks were below MDLs for all PFAS in all samples for all dates. These results indicate the quality control measures taken by the sampling team did not inadvertently introduce contaminants through the use of equipment or through sample handling.

2.3.4.2 Duplicate Samples

A total of 33 duplicates were collected over the course of the project. Duplicates were collected between the sampling dates of February 19 and April 2, 2025. Eighteen (18) duplicates were collected during Round 1 and fifteen (15) were collected during Round 2. Duplicates were collected at facilities representing small, medium and large dischargers, in all three media, and from all four MassDEP regions. At locations where duplicate samples were collected, a grab sample was collected immediately following collection of the initial sample from the same location and labeled accordingly. Refer to Table B-1 for a list of all POTWs and where duplicate samples were collected.

The similarity of duplicates was compared in two ways with results summarized in Tables 4-2 and 4-3. The first approach calculated the similarity of PFAS analyte detections between the two samples using the Jaccard Index, which is a ratio of the data intersect to the data union. In this study, the data intersect represents the number of PFAS analyte detections that were shared between the original and duplicate sample, while the data union represents the total number of PFAS analyte detections that occurred across both

samples (shared and unshared). This ratio (Intersect/Union) ranges from 0 to 1, with 1 representing detections of exactly the same compounds in both the original and duplicate samples. The Jaccard Index only considers whether the analyte was detected above MDLs (estimated or quantified) and is therefore independent of analyte concentration.

The second method of comparison was conducted on an analyte-by-analyte basis and considers differences in concentration. For analytes detected in both the original and duplicate sample (described as intersect, above), the percent difference (%) in concentration was calculated between the samples by taking the difference in analyte concentration as the numerator and dividing by the original sample concentration as the denominator. This ratio was then multiplied by 100 to obtain a percent between 0 and 100 [(Duplicate – Sample) / Sample * 100]. An average percent difference and the standard deviation was calculated from all individual analytes shared across both samples. The number of analytes for which concentrations were compared in each sample are reported as the intersect in Tables 2-2 and 2-3.

TABLE 2-2
Summary of Duplicate Similarity Using the Jaccard Index and Percent Differences for Study Round 1 Samples

Facility	**Sample Type**	**Intersect**	**Union**	**Jaccard Index** (Intersect/Union)	**Average % Difference** (Std Dev)
Ayers WWTP*	Sludge	4	6	0.67	47% (±7%)
Belchertown WWTP*	Effluent	5	8	0.63	14% (±8%)
Billerica WWTP*	Sludge	5	6	0.83	9% (±9%)
Concord WWTF*,**	Effluent	2	11	0.18	15% (±15%)
Fall River Regional WWF**	Sludge	1	8	0.13	78% (NA)
Marlborough East WWTP*	Effluent	9	9	1.0	97% (±95%)
Merrimac WWTP*	Influent	0	3	0	NA
Merrimac WWTP*	Effluent	6	7	0.86	7% (±3%)
Monroe WWTP**, ***	Sludge	2	9	0.22	57% (±16)
New Bedford WWTP*,**	Sludge	5	6	0.83	17% (±7%)
Scituate WWTP*	Influent	4	7	0.57	18% (±7%)
Spencer WWTP*	Influent	6	10	0.60	76% (±49%)
Springfield WWTP*	Influent	9	10	1.0	9% (± 5%)
Westborough WWTF	Influent	0	8	0	NA
Westborough WWTF	Effluent	6	9	0.67	21% (±22%)
West Stockbridge WWTF*	Influent	0	7	0	NA
Upton WWTP*	Sludge	1	8	0.13	48% (NA)
Uxbridge WWTF*	Effluent	8	8	1.0	7% (±5%)

TABLE 2-3
Summary of Duplicate Similarity Using the Jaccard Index and Percent Differences for Study Round 2 Samples

Facility	**Sample Type**	**Intersect**	**Union**	**Jaccard Index** (Intersect/Union)	**Average % Difference** (Std Dev)
Adams WWTP	Effluent	8	9	0.89	6% (±2%)
Amherst WWTP*,**	Sludge	1	2	0.50	1% (NA)
Brockton AWRF	Effluent	7	9	0.78	31% (±25%)
Dartmouth WPCF*	Influent	8	10	0.80	66% (±30)
Fairhaven WPCF*	Effluent	9	9	1.0	29% (±4%)
Greater Lawrence Sanitary District	Influent	6	6	1.0	14% (±17%)
Hatfield WWTP*	Influent	5	6	0.83	66% (+20%)
Lenox Center WWTP*,***	Sludge	0	4	0.0	NA
North Brookfield WWTP*	Effluent	0	8	0.0	NA
Pittsfield WWTP	Influent	4	4	1.0	5% (+3%)
Pittsfield WWTP*	Sludge	2	2	1.0	10% (+2%)
Rockport WWTP	Sludge	9	9	1.0	33% (±2%)
South Deerfield WWTP*	Sludge	0	0	0.0	NA
Webster WWTF*	Influent	7	9	0.78	50% (±34%)
Woronoco WWTF*	Effluent	9	9	1.0	8% (±5%)

*Samples had elevated RLs, differed in their RLs, and/or had flags reported by the laboratory that quality control sample exceeded associated acceptance criteria or were estimated values.
**Note that not all 40 analytes were compared for these duplicates as a result of removal of analytes due to poor QC.
***Duplicate was analyzed as a liquid while the original sample was analyzed as a solid.

Results of Duplicate Comparison. The degree of similarity (Jaccard Index) for analytes detected in original and duplicate samples ranged from 0 to 1. Lower Jaccard Indices were typically associated with Laboratory QA/QC issues in either the original or duplicate sample. This included elevated detection limits in one or more of the sample pairs, estimated values due to dilution, poor recovery of internal standards, or differences in sample processing (liquid versus solids). These QA/QC issues also occurred for other samples in the dataset and are discussed in more detail in the following paragraphs. Generally, a higher degree of Jaccard Index similarity was observed for effluent samples as compared with influent or sludges (Figure 2-1). Effluent samples had a higher median Jaccard Index and lower overall variability than other media. Similarly, effluent samples had lower variability in terms of percent differences than other samples (Figure 2-2). The average percent difference for effluent duplicate samples (24%) was slightly lower than other media as compared with influent (38%) and sludge (33%) samples. There was no observable trend with respect to percent differences by class (PFCAs versus PFSAs) or chain length. However, when high RLs occurred, there was generally little overlap in the number and type of PFAS detected, resulting in an overall low Jaccard Index for that comparison.

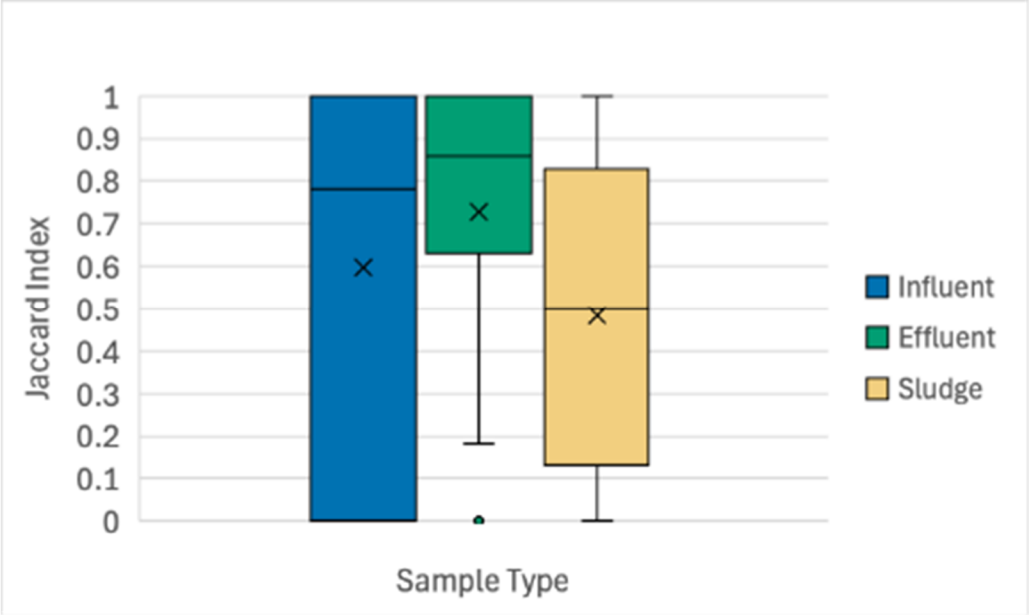


FIGURE 2-1
Comparison of Jaccard Indices of Duplicate Samples based on Media Type (Study Data Rounds 1 and 2)

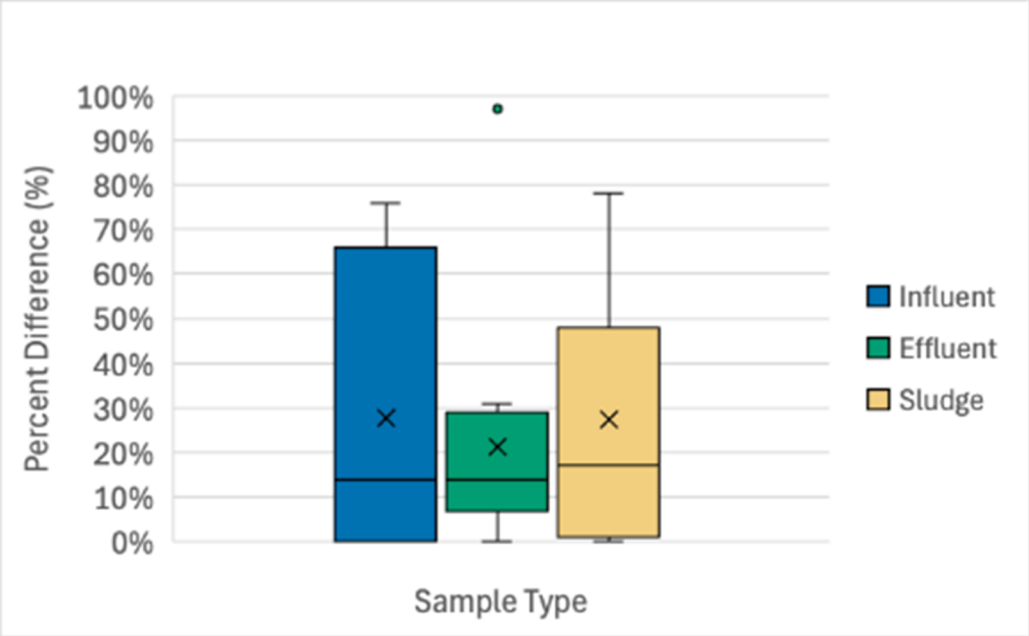


FIGURE 2-2
Comparison of Percent Difference (%) for Duplicate Samples based on Media Type (Study Data Rounds 1 and 2)

A comparison of the initial samples with the duplicate samples resulted in a large disparity both in terms of PFAS compounds detected and concentrations. This finding is likely due to the high variability of PFAS in the wastewater stream and variability within the sample matrix, especially with respect to influent and sludge samples.

During review of data from the laboratory by the Project Manager and data management team, several broader QA/QC issues were identified. The following sections describe deviations or challenges encountered during the project and their resolution.

2.3.5 Operational Method Adjustments for Sludge TOP Analysis

Wastewater and sludge are difficult matrices to analyze due to their variability and composition, which can directly influence pre-process handling and quantification. As a result, optimization of laboratory methods is sometimes necessary to improve the quality performance of the method, improve extraction success and efficiency, and promote consistency of analytical results. During laboratory analysis of wastewater (influent and effluent) and sludge samples generated in this project, several operational adjustments were implemented by the laboratory to improve TOP analysis. It is important to note that TOP analysis is not commonly applied to sludge due to the oxidation efficiency of this organic-rich matrix. This was discussed with the laboratory at the start of the project and acknowledged as an analytical challenge in this project. Modifications by the lab for this method were required for project samples and are summarized in the following paragraphs.

During the TOP precursor oxidation step, adjustments were made by the laboratory to improve the quality performance of the method. These included the use of a diluted acid (1:1 hydrochloric acid [HCl]) and base (10 Normal [N] sodium hydroxide [NaOH]) reagents to potentially improve TOP surrogate recoveries. The use of a diluted acid (1:1 HCl stock) for post-bath acidification was used to avoid over-acidification of the sample. In addition, the use of a specified volume of diluted base (10N NaOH stock) was used for Bath Blank samples to avoid inferences on TOP surrogate recoveries. These adjustments were monitored by implementation of periodic pH checks while samples were in TOP baths to ensure stable pH during the oxidation process and avoid the loss of light-end PFAS compounds.

To aid in improving TOP extraction efficiency, the laboratory elected to increase the volume of de-ionized (DI) water added to the Bath Blank to 2.5 milliliters (mL). The laboratory also adjusted the temperature of the nitrogen evaporator (N-EVAP) from 85 degrees Celsius to 60 degrees Celsius. To promote consistency and standardization of sludge extractions, the laboratory specified Ottawa sand as the Bath Blank matrix with a default weight of 0.1 grams (g).

In conjunction with the above-referenced sample pre-processing adjustments, the laboratory completed modifications to expand the method Quality Control (QC) acceptance criteria limits for surrogate recoveries. This change was based on control charting of the stability and performance the testing process, and completion of Initial Demonstration of Capability (IDC) in accordance with EPA Method 1633 performance standards. In other words, surrogate recovery acceptance windows were expanded as a result of the poor extraction and oxidization efficiency of sludge samples.

The laboratory also increased the size of their solid phase extraction (SPE) cartridges to run the largest sample volume/mass possible to achieve lower RLs and reduce extraction failures.

2.3.6 Modifications to Reporting Limits for EPA Method 1633 and TOP Analysis

During initial review of results from some facilities, it was noted that RLs were excessively high while results were below detection for most or all PFAS analyzed. Non detects for most/all PFAS is not consistent with known POTW waste streams, raising red flags for these results. After discussions with the laboratory, it was determined that adjustments to RLs for EPA Method 1633 was a direct result of modifications to sample loading issues during the extraction phase. Additionally, a reduction in sample volume loaded during EPA Method 1633 extraction of approximately five to ten times resulted in compounded RLs for TOP post-treatment handling, further skewing RLs and the number of detections.

In the case of the facility where this issue arose, it was unclear from the analytical report case summary why RLs changed and what modification(s) were made by the laboratory to cause increased RLs. It was also unclear from the analytical report whether additional information could be gleamed from the analytical data, for example if compounds were detected or could be estimated below the adjusted RLs.

The issue was resolved during the project in two ways. Firstly, it was requested that the laboratory provide more specific information in the case summary about modifications to sample processing that impact RLs. Secondly, analytical reports for all samples were re-issued and estimated values reported were reported with qualifiers (J-flag). A review of the re-issued laboratory reports showed more PFAS analytes were detected below RLs and provided further detail on sample modification approaches.

2.3.7 Analysis of Sludge Samples as Liquids vs. Solids

When the total solids content of a sludge sample is low, the laboratory may decide to analyze the sample as an aqueous media as opposed to a solid. This results in a slightly different upfront extraction approach and different reporting units for EPA Method 1633. In the case of solids handling, total solids content is measured, and a known mass is added to the extraction vial. The laboratory targets a mass of 5 grams dry weight for each sample, and the extraction weight is adjusted based on the total solids of the sample. PFAS are first extracted from sludge using a solvent before passing the solvent and extract across SPE media for concentration and purification. In the case of sludge processed as a liquid, a known volume would pass through SPE without a pre-solvent solids extraction step. In both cases, a pre-filter may be used to capture solids prior to SPE, with solids washed into the SPE using a known solvent volume. Solids extractions are therefore reported on a dry weight mass basis (ng/g) while liquids extraction is reported on a volumetric basis (ng/L).

During the project, the laboratory determined that several sludge samples contained total solids content that was too low to be handled as solids. The decision was made by the laboratory to process them as liquids. However, due to the presence of suspended solids and expected organic loading on the instrument, the volume loaded for SPE required adjustment. This resulted in elevated detection limits and poor detection of sludge solid PFAS (see 3.2.2 for further description).

2.4 Data Analyses

Statistical tools were used to further evaluate data quality during data analysis. As is common for chemical species in environmental matrices, PFAS data are log-normally

distributed, yet they are most commonly measured at extremely low concentrations or not detected above RLs. Because descriptive statistics, such as mean, and statistical tests based on the normal distribution can be sensitive to skew in the data, nonparametric methods were employed when possible. In addition, the sample median was used as the measure of central tendency to characterize the data because it is robust to extreme observations which may otherwise be considered "outliers," although an initial examination of potential outliers was conducted.

Potential outliers were identified using the common quantile-based method defined by Equation 1:

$$1.5 \times IQR \qquad (1)$$

Concentrations exceeding 1.5 times the interquartile range (IQR) were identified as potential outliers on a case-by-case basis to help ensure the validity of the analysis. Based on the results of the two-way analyses (the first including all data, and the second removing identified outliers as defined above), no significant differences between data distributions of the method were observed. This is further supported by the evaluation of the quality control blank samples in Section 2.3.4.

Laboratory MDLs and RLs for each quantified PFAS, developed according to Sections 9.2.2 and 9.2.3, respectively, of EPA Method 1633 (2024),[6] were reported for each sample. PFAS with measured concentrations below the MDL and reported by the laboratory as "not detected" in a given sample were reported as such in the final report as "ND". These values were treated as absent, or "NA", in all calculations unless otherwise specified in the text. Note that there is no difference between a value of NA and a value of zero when calculating sums; however, defining ND values as zero may introduce a low bias because the true value may be greater than zero, while omitting ND values may introduce a high bias because the true value is lower than the detection limit. Therefore, calculated descriptive statistics represent the distribution of PFAS detected. Similarly, measured PFAS concentrations between the MDL and the RL (commonly noted with the "J" data qualifier) were treated as equal to their laboratory-estimated value. Following initial processing, average PFAS concentrations were calculated for duplicate samples. Additional data processing specific to the statistical methods used in subsequent data analyses will be documented in the final report.

To facilitate visual comparison between aqueous and solid samples, dry sludge data reported in units of ng/g, equivalent to ppb, were multiplied by 1,000 to adjust the values to ppt. However, differences in sample processing procedures for aqueous and solid samples precludes their direct statistical comparison, as discussed in Section 2.3.7. For Portal data, sludge samples reported in units of ng/g were assumed to have been reported on a dry-weight basis in accordance with EPA Method 1633 section 15.4.1, which additionally requires sludge data to be reported with percent solids of each sample.[6] For Portal sludge data reported in units of ng/g that were missing percent solids data, percent solids values were assumed to be equal to the average of the percent solids reported for all other samples from the same facility (preferred) or equal to the average percent solids reported via the *POTW Sludge Management Survey*, part of the PFAS and Biosolids Technology and Management Study, Part 1,[1] depending on data availability.

General facility information and data were collected from each POTW prior to and during the Study's sampling program. At the conclusion of the sampling program, POTWs were contacted and requested to provide any information that was not provided or recorded during the two sampling rounds. If information was still missing following this outreach, the following assumptions were made to fill in data gaps:

- If the POTW did not provide an estimate for population served by the wastewater collection system but did provide an estimate for the number of service connections/accounts, an estimate of population served was made by using U.S. Census Data for "persons per household" as a multiplier for that municipality. If estimates for population served and number of connections/accounts were not provided, an estimate of population served was made by using the municipality's most recently reported population according to the U.S. Census.

- If flow could not be measured and/or recorded at the time of sample collection and the POTW did not provide an estimate for flow for one of either influent or effluent, they were assumed to be equal. If no measurement for influent or effluent was available from the date of sample collection, the POTW's average annual flow was used.

Section 3 Study and Portal Data Summaries

3.1 Study Round 1 and 2 Sample Data Summary

3.1.1 Summary of Facilities and Samples Included in Study

Table B-3 in Appendix B provides a summary of facility information for each of the 114 NPDES-permitted Massachusetts POTWs included in this Study. Facility information includes POTW size defined as small (<1 MGD), medium (1-5 MGD), or large (>5 MGD) based on NPDES design flow; whether the POTW has an industrial pretreatment program (IPP); the POTW's location within MassDEP's Administrative Regions; and the population served by the POTW's collection system. Where the population served was not provided by the POTW during field sampling efforts, the number of connections (multiplied by the U.S. census estimate for persons per household for the municipalities served by that POTW[7]) was used to estimate the population served by that POTW. Where neither the population served nor the number of connections was available, the municipality's population (as reported in the American Community Survey 5-Year Estimates Subject Tables published by the U.S Census Bureau[8]) was used to approximate the population served. Figure 3-1 provides the locations of the 114 NPDES-permitted POTWs within the four MassDEP Administrative Regions.

Table B-1 in Appendix B provides a list of the 114 NPDES-permitted Massachusetts POTWs included in this Study and summarizes the samples collected and analyses conducted for both Round 1 and Round 2 of the sampling program. It should be noted that all samples collected as part of this Study were grab samples and may not be representative of actual long-term average PFAS concentrations or mass loads. As discussed in Section 4, sludge concentrations reported in ng/L derive from facilities where little or no thickening or dewatering has occurred, and are therefore more reflective of liquid concentrations rather than solids. Concentrations in sludges analyzed as liquids may therefore be biased low relative to facilities with more complete sludge processing at the time of sample collection (i.e., a drier sludge sample analyzed). Refer to Section 2.3.7 for additional discussion on sludge analyses. In addition, PFAS detected in sludges analyzed as liquids may be partial towards more hydrophilic PFAS as compared to dryer sludges which are more likely to be associated with more hydrophobic PFAS. This general partition between hydrophilic and hydrophobic PFAS compounds in sludge is primarily driven by the total solids content of the sample as measured by percent solids by the laboratory. For instances where sludge is dewatered prior to sampling, hydrophilic PFAS present in the liquid-phase sludge may be recycled back to the headworks of the POTWs and may not be as prevalent in sludge with high total solids content.

3.1.2 Summary of Blank and Duplicate Data

No PFAS analytes were detected above the detection limits for all equipment blanks and field blanks collected as part of the Study, providing reasonable confidence that the sample collection team did not introduce PFAS during the sampling process or sample handling.

Duplicate samples showed considerable variability, both in terms of detected analytes and their concentrations. As discussed in Section 2.3.4, the Jaccard Index was used to gauge the similarity and diversity of the influent, effluent, and sludge data sets on a scale of 0 to 1. As the metric approaches 1, the similarity is higher. In the Study data, it was observed that effluent samples had higher similarity in terms of the number and type of PFAS analytes detected while influent and sludge samples were lower in similarity.

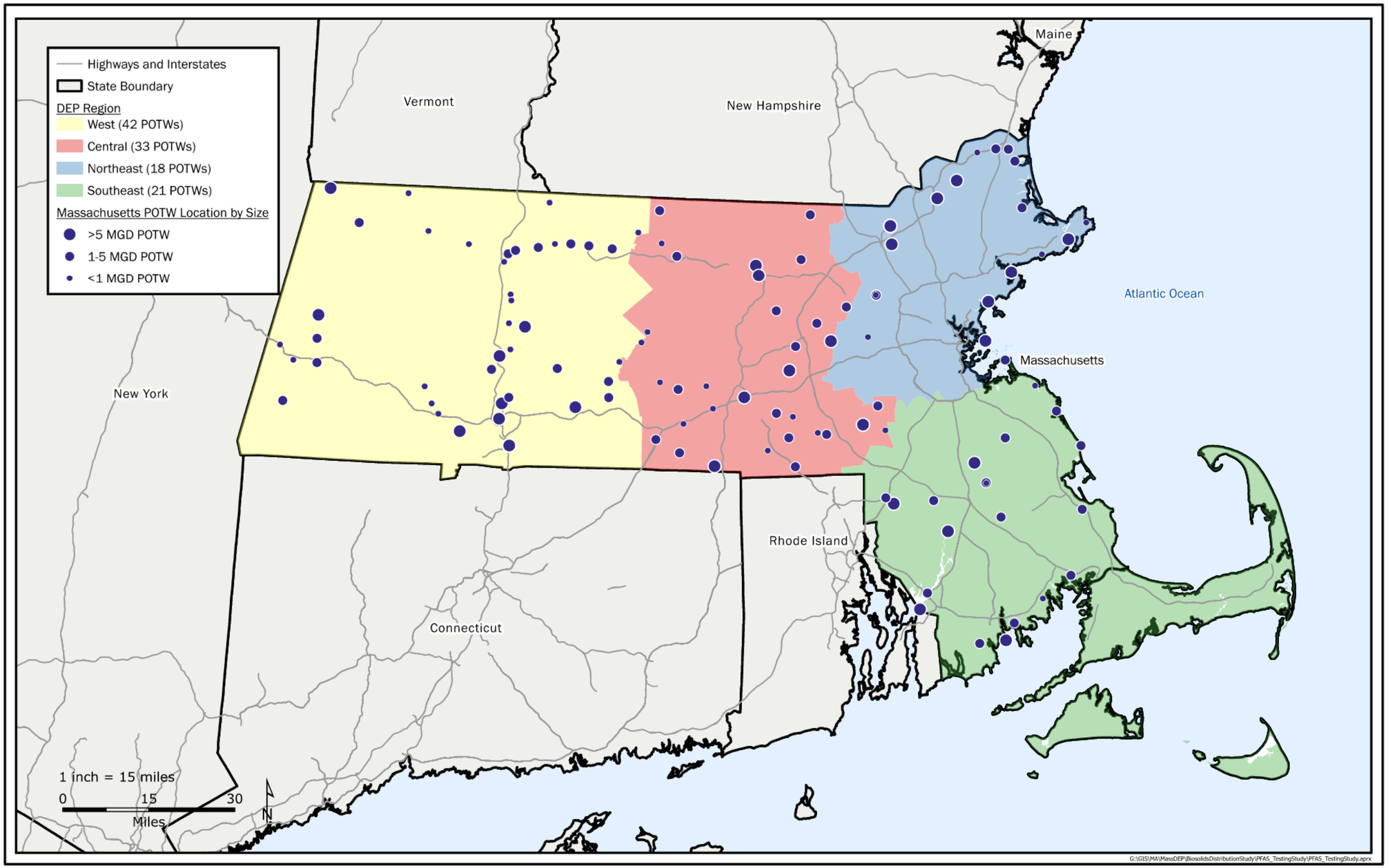


FIGURE 3-1
Locations of the 114 POTWs within the 4 MassDEP Administrative Regions

For analytes detected in the original and duplicate samples, the average percent difference in concentration was lower in effluent samples (24%) compared with influent (38%) and sludges (33%). Higher influent variability may be a result of inherently more variability in influent wastewater, where effluent may be more blended and uniform due to detention time and mixing in the wastewater treatment process; however, lower Jaccard Index values and higher percent differences in concentration were typically associated with laboratory QA/QC issues in either the original or duplicate sample. Please see Section 2.3.3 Laboratory Quality Control for a detailed description of these issues and the analyses conducted and Section 2.3.4 on a more detailed discussion on blank and duplicate data from Rounds 1 and 2 of this Study.

3.1.3 Statistical Characteristics

As a wide range of PFAS results were anticipated, statistical tools robust to extreme values (i.e., median, IQR, and nonparametric tests) were used to characterize the data. This section provides a brief summary of general statistical trends that are presented in greater detail in Section 4.

Table B-4 and Table B-5 in Appendix B show ΣPFAS concentrations based on both EPA Method 1633 ($\Sigma PFAS_{1633}$) and TOP analysis ($\Sigma PFAS_{TOP}$) analytes for influent, effluent, and sludge samples collected during Round 1 and Round 2 the sampling program, respectively. Additional information, including NPDES permitted flow, average annual flow, population served by the sewer collection system, and number and type of significant industrial users (SIUs) and categorical users, was collected from each POTW during sampling Rounds 1 and 2 and compiled for use in the calculated metrics described in Section 1.3.

The ΣPFAS concentrations detected in effluent samples changed the least when comparing results from EPA Method 1633 and TOP, showing the smallest percent change in both Study Round 1 and Round 2. Sludge by dry weight (ng/g) consistently showed elevated levels of 5:3 fluorotelomer carboxylic acid (FTCA) across Round 1 and Round 2. This trend was not observed in the influent and effluent samples. Detected samples were most concentrated in the analyte classes PFCAs, PFSAs, and FTCAs.

Accounting for all analytes, the overall median and mean PFAS concentrations increased most significantly from the $\Sigma PFAS_{1633}$ to $\Sigma PFAS_{TOP}$ analyses in sludge (ng/g) during Round 1 and in sludge (ng/L) during Round 2. The changes in overall median and mean PFAS concentration are outlined in Table 3-1.

TABLE 3-1
Summary of Median and Mean ΣPFAS Concentrations for Study Round 1 and Round 2

Sampling Location	Round 1			Round 2		
	$\Sigma PFAS_{1633}$	$\Sigma PFAS_{TOP}$	Change (%)	$\Sigma PFAS_{1633}$	$\Sigma PFAS_{TOP}$	Change (%)
Median						
Influent (ng/L)	69.6	51.5	-26.0	42.3	42.2	-0.2
Effluent (ng/L)	47.2	46.0	-2.5	48.6	48.4	-0.4
Sludge (ng/L)	369.6	157.7	-57.3	169.2	455.3	169.1
Sludge (ng/g)	17.2	166.4	867.4	21.7	28.8	32.7
Mean						
Influent (ng/L)	120.8	123.6	2.3	160.3	266.9	66.5
Effluent (ng/L)	65.0	68.0	0.05	65.4	65.2	-0.3
Sludge (ng/L)	3,988.9	2,914.7	-29.9	3,640.5	1,359.5	-62.7
Sludge (ng/g)	52.7	253.3	380.6	101.3	122.7	21.1

3.2 EEA PFAS Data Portal Data Summary

3.2.1 Summary of Data Obtained from EEA PFAS Data Portal

PFAS data from permit compliance sampling in Massachusetts are submitted by POTWs to MassDEP through its online filing system ("eDEP"), either by the POTW or its analytical laboratory. Data in eDEP are then reviewed by MassDEP staff and subsequently made publicly available through the Portal, specifically the EEA Wastewater NPDES & Residuals PFAS Data Portal[2] (Portal). As part of this Study, data were downloaded from the Portal at two points in time. Data were first downloaded prior to commencement of the Study's sampling program to identify missing data for facilities known to have PFAS monitoring requirements in their permits. These data gaps were communicated to MassDEP in an effort to resolve issues that may delay the final transfer of data to the Portal. The second and final download of data from the Portal was completed on April 30, 2025. Any permit compliance data with unresolved issues or that were not transferred to the Portal by this date were not included in the Study.

At the time this Data Analysis Report was developed, compliance PFAS data for inclusion and use in this Study were available for 66 facilities. For Portal data comparison, all results for samples were summed based on PFAS targeted by the analytical method. Duplicate measurements (results that were entered more than once) and measurements rejected based on the quality control considerations described in Section 2.3 were removed from the dataset, and measurements for duplicate samples were averaged. These procedures yielded over 32,400 measurements from nearly 900 samples that were collected between June 2022 and March 2025. Statistical median analysis on data obtained from the Portal was completed due to its resilience to outlier values. A discussion of the differences in target PFAS compounds by analytical method was included for evaluations where this conclusion was relevant to findings.

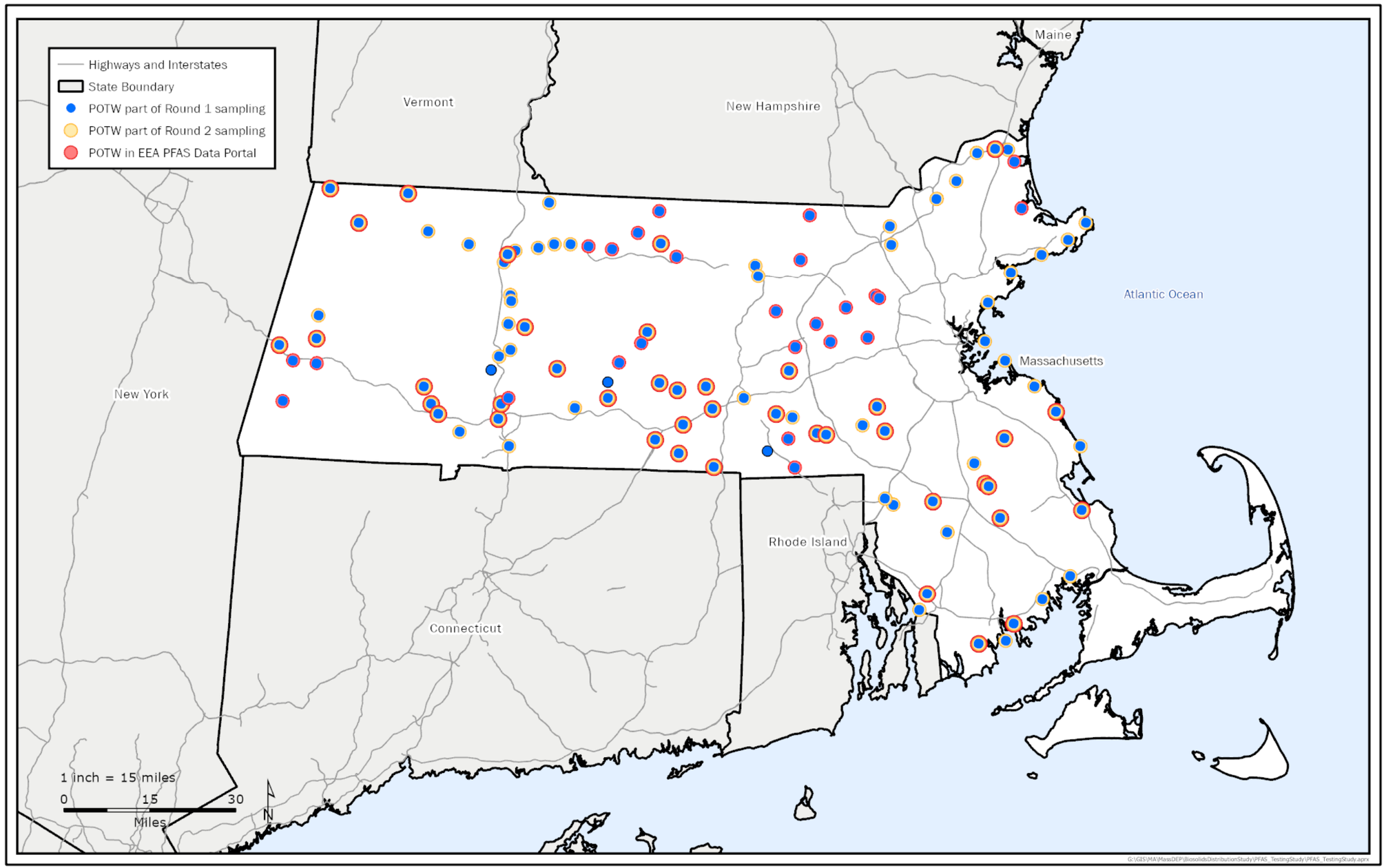


FIGURE 3-2
114 POTWs Sampled in Round 1, 86 POTWs Sampled in Round 2, and 66 POTWs with Portal Data

Table B-6 included in Appendix B provides a summary of facility information for each of the 66 NPDES-permitted Massachusetts POTWs with data available from the Portal were included in this Study's analyses. Facility information includes POTW size [small (<1 MGD), medium (1-5 MGD), or large (>5 MGD) based on NPDES design flow], whether the POTW has an industrial pretreatment program (IPP), the POTW's location within MassDEP's Administrative Regions, and the population served by the POTW's collection system. As described in Section 3.1.1, where the population served was not provided by the POTW during field sampling efforts, the number of connections (multiplied by the U.S. census estimate for persons per household for the municipalities served by that POTW[7]) was used to estimate the population served by that POTW. In a handful of cases, neither the population served nor the number of connections was available, so the municipality's population (as reported in the American Community Survey 5-Year Estimates Subject Tables published by the U.S Census Bureau[8]) was used to approximate the population served.

3.2.2 Summary of Blank and Duplicate Data

A detailed review of data in the Portal revealed that it contained samples from 13 POTWs with the same location and sample data, but a different (unique) lab identifier. This suggests they may potentially be split or duplicate samples. Unfortunately, it was unclear from the sample IDs whether these samples constituted true duplicates or were errors, laboratory re-runs, or re-extractions. In addition, there were two samples labeled as duplicates in the database, but this number was not sufficient for a rigorous statistical analysis. As a result, no further analysis of blank and duplicate samples was done for the data from the Portal from a QC standpoint.

3.2.3 Statistical Characteristics

Table B-7 in Appendix B shows median ΣPFAS concentrations calculated based on the 40 EPA Method 1633 ($\Sigma PFAS_{1633}$) analytes for influent, effluent, and sludge samples collected for permit compliance for each of the 66 NPDES-permitted Massachusetts POTWs with PFAS data available in the Portal. These calculations included monitoring samples for which fewer than 40 individual PFAS were reported. Additional information, including NPDES-permitted flow, average annual flow, population served by the sewer collection system, and number and type of significant industrial users (SIUs) and categorical users, was collected from each POTW during sampling Rounds 1 and 2 and compiled for use in the calculated metrics described in Section 1.3.

Section 4 PFAS Data Evaluations

4.1 Study Round 1 and 2 Sample Data Evaluations

Data processing procedures yielded nearly 50,500 unique measurements from samples collected as part of the present study. Rejected data include 160 measurements from 134 samples (39 influent, 29 effluent, and 66 sludge) collected from 88 POTWs. After removing rejected measurements and calculating average concentrations for duplicate samples, over 48,700 measurements were included in subsequent evaluations. Refer to Section 2.3 for a summary of all data processing procedures and decisions.

Most sludge samples were measured by the laboratory on a dry mass basis and reported in units of ng/g, but some sludges with low solids content were measured as aqueous samples and were reported in units of ng/L (refer to Section 2.3.7 for further discussion). Sludge ΣPFAS concentrations reported on a dry mass basis were converted to a wet mass basis according to Equation 1:

$$\sum \mathrm{PFAS}\left(\frac{ng}{g}, dry\right) \times \frac{100}{\%\ solids} = \sum \mathrm{PFAS}\left(\frac{\mathrm{ng}}{\mathrm{g}}, wet\right) \qquad \text{(Equation 1)}$$

The resulting ΣPFAS concentrations on a wet mass basis were then converted to a liquid basis, assuming a constant density of water of 1,000 g/L:

$$\Sigma \mathrm{PFAS}\left(\frac{\mathrm{ng}}{\mathrm{g}}, wet\right) \times 1{,}000\,\frac{g}{L} = \Sigma \mathrm{PFAS}\left(\frac{\mathrm{ng}}{\mathrm{L}}\right) \qquad \text{(Equation 2)}$$

The conversion of sludge data from dry mass basis to a wet liquid basis was greatly influenced by percent solids. For example, a sample with a dry mass ΣPFAS concentration of 12 ng/g and a 1% solids content would have a wet mass ΣPFAS concentration of 1,200 ng/g and an estimated wet liquid basis concentration of 1,200,000 ng/L. This same sample with a 10% solids content would result in an estimated wet liquid basis concentration of 120,000 ng/L. These aqueous concentrations are several orders of magnitude larger than the highest concentrations measured in sludges analyzed as liquids and assume a linear relationship between measured PFAS concentrations and solids content for conversion.

To explore this relationship, ΣPFAS concentrations on a wet liquid basis were then plotted against solids content (% solids), and a significant positive association between sludge solids content and ΣPFAS concentrations was observed (Spearman's $\rho=0.5$, $p=5\times10^{-14}$), as depicted in Figure 4-1. Since converted concentrations from a dry mass basis were considerably inflated by the % solids, it was unclear whether this relationship was truly linear. Therefore, the project team determined that the most straightforward approach for presenting data in this report was to avoid biasing the analysis through sludge unit conversions. Future studies should further investigate this relationship through a more extensive data analysis or through additional laboratory experiments.

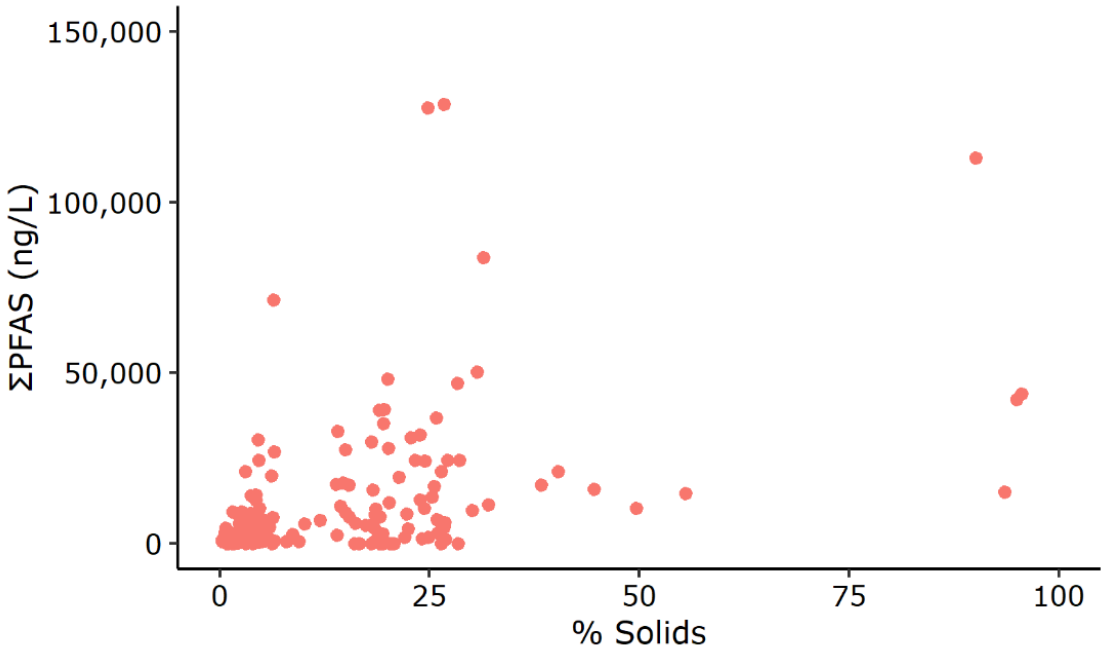


FIGURE 4-1
Sludge ΣPFAS Concentrations and Percent Solids (Study Data Rounds 1 and 2)

Note: Four data points with ΣPFAS concentrations exceeding 150,000 ng/L were truncated from the figure for clarity, although all data were included in the correlation test.

4.1.1 Study PFAS Detection Frequency

Twenty-nine (29) PFAS compounds were detected via EPA Method 1633 in influent, effluent, and/or sludge, out of the 40 PFAS measured using this method. The detected PFAS include compounds from 8 of the 9 PFAS classes (PFCAs, PFSAs, FTCAs, FTSAs, FASAAs, FASEs, FASAs, and PFECAs). Similarly, 27 PFAS from the same 8 PFAS classes (all but PFESAs) were detected via TOP analyses in influent, effluent, and/or sludge samples. Heatmaps representing frequency of detection for each PFAS during Round 1 and Round 2 are included in Figure 4-2 and Figure 4-3, respectively. Each figure presents detection frequencies (as a percent of all samples) from EPA Method 1633 analysis on the left and by TOP analysis on the right. Compounds in each PFAS class are listed in order of increasing chain length.

Differences in detection frequencies of PFAS and in the detection of shorter chain in comparison longer chain PFAS analyzed by EPA Method 1633 were evaluated based on a comparison of Round 1 to Round 2 data. While inconclusive due to the short duration between sampling rounds of this Study, the detection frequency for most PFAS in influent samples analyzed by EPA Method 1633 was lower in Round 2 compared with Round 1. In contrast, the detection frequency for shorter PFCAs and PFSAs (8 or fewer carbons in the carbon chain) in effluent and sludge samples (both analyzed as liquid and dry mass basis) analyzed by EPA Method 1633 were about the same in both Round 1 and Round 2 (Figure 4-2).

Detection frequency for shorter chain PFCAs and PFSAs did not materially increase from EPA Method 1633 to TOP analysis in either Round 1 or Round 2 for aqueous samples (influent, effluent, or sludge analyzed as liquid samples), which is inconsistent with other

studies and inconsistent with the TOP pretreatment process.[9,10] Minor and inconsistent increases were observed in the detection frequency of shorter chain PFCAs and PFSAs in sludge samples analyzed on a dry mass basis. If the TOP chemical oxidation process is efficient, precursors with known breakdown pathways are converted to shorter, measurable terminal products, namely, PFCAs generally with less than 8 carbons in their chain. However, detection of precursors still occurred in the TOP dataset, including FTCAs, FTSAs, FASAAs and FASAs. Examples of precursors which should be converted to terminal PFCAs through oxidation – but were detected in TOP analysis – include FASAAs (NMeFOSAA and NEtFOSAA), PFOSA, and FTCAs including 5:3FTCA. As an example, FASAAs were detected with a frequency of 3% to 9% using EPA Method 1633 in effluent samples, and that frequency remained about the same after TOP, ranging from 1% to 11%. In sludges analyzed as liquids, detection frequency of FASAAs decreased between EPA Method 1633 and TOP in Round 1 samples, but it increased after oxidation in Round 2. For sludges analyzed on a dry mass basis FASAAs, FASAs, and FTCAs are detected in 1% to 17% of samples after oxidation (Figure 4-3). These observations suggest overall poor oxidation of precursors across these samples using the TOP method. A recent study by one of the developers of the TOP Method excluded data when precursors remained after TOP analysis, indicating underestimation of PFAS mass and incomplete oxidation.[11] The completeness of oxidation is measured by the laboratory using a chemical surrogate and when conversion of this surrogate is below a specific range, this QC issue is described in the case narrative. However, oxidation efficiency of the surrogate is not necessarily representative of all PFAS precursors. Although all TOP results were included in the present report, further consideration of this issue is warranted.

Round 1, Percent Detection (%)

		PFAS 1633				TOP			
PFAS		Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)	Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)
PFCAs	PFBA	20	39	7	0	10	29	14	5
	PFPeA	77	93	60	12	61	88	50	58
	PFHxA	91	98	73	30	74	94	50	64
	PFHpA	77	81	67	11	59	78	43	54
	PFOA	91	97	80	38	73	90	50	59
	PFNA	61	44	53	23	45	36	43	39
	PFDA	42	18	53	32	27	16	36	24
	PFUnA	6	2	13	9	2	4	23	6
	PFDoA	11	2	20	9	7	2	36	2
	PFTrDA	0	0	0	1	1	0	7	1
	PFTeDA	0	0	7	0	1	0	8	0
PFSAs	PFBS	67	69	43	6	58	79	29	12
	PFPeS	8	11	0	0	2	4	0	19
	PFHxS	37	52	7	5	31	50	0	3
	PFHpS	0	0	0	0	1	0	0	0
	PFOS	85	82	86	80	69	81	54	60
	PFNS	0	0	0	3	0	0	0	0
	PFDS	0	1	0	9	0	0	0	2
	PFDoS	0	0	0	2	0	0	0	0
FTCAs	3:3 FTCA	0	0	0	1	0	0	0	0
	5:3 FTCA	3	1	0	15	2	0	0	6
	7:3 FTCA	0	0	0	2	0	0	0	1
FTSAs	4:2 FTSA	0	0	0	0	0	0	0	0
	6:2 FTSA	1	1	7	1	3	1	0	1
	8:2 FTSA	1	0	0	0	0	0	0	1
FASAAs	NMeFOSAA	1	6	13	40	1	11	0	10
	NEtFOSAA	1	3	21	40	0	2	0	8
FASEs	NMeFOSE	0	0	0	3	0	0	0	1
	NEtFOSE	1	0	0	0	0	0	0	0
FASAs	PFOSA	0	3	14	7	0	10	0	1
	NMeFOSA	0	0	0	0	0	0	0	0
	NEtFOSA	0	0	0	0	0	0	0	0
PFECAs	PFMPA	2	0	0	0	1	0	0	0
	PFMBA	0	0	0	0	0	0	0	0
	NFDHA	0	0	0	0	0	0	0	0
	HFPO-DA	0	0	0	0	0	0	0	0
	ADONA	0	0	0	0	0	0	0	0
PFESAs	PFEESA	0	0	0	0	0	0	0	0
	9Cl-PF3ONS	0	0	0	0	0	0	0	0
	11Cl-PF3OUdS	0	0	0	0	0	0	0	0

FIGURE 4-2
PFAS Detection Frequency (Study Data Round 1)

Round 2, Percent Detection (%)

		PFAS 1633				TOP			
PFAS		Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)	Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)
PFCAs	PFBA	13	38	0	0	21	44	0	3
	PFPeA	69	97	60	17	69	92	57	23
	PFHxA	88	99	80	40	84	97	57	35
	PFHpA	70	85	60	15	67	84	50	20
	PFOA	90	99	93	42	87	95	50	41
	PFNA	42	38	47	23	41	43	36	25
	PFDA	11	10	33	34	9	10	36	27
	PFUnA	2	5	13	16	1	0	21	8
	PFDoA	2	2	7	10	0	0	14	4
	PFTrDA	0	0	0	4	0	0	0	3
	PFTeDA	1	1	0	3	0	0	7	1
PFSAs	PFBS	61	86	60	14	49	80	29	15
	PFPeS	2	1	0	4	7	12	0	4
	PFHxS	30	64	0	7	27	56	7	4
	PFHpS	0	0	0	0	0	2	0	0
	PFOS	76	89	93	84	70	85	57	68
	PFNS	0	0	0	1	0	0	0	0
	PFDS	0	1	0	3	1	0	7	1
	PFDoS	1	0	0	0	0	0	0	0
FTCAs	3:3 FTCA	0	0	0	0	1	0	0	0
	5:3 FTCA	1	0	13	17	6	2	7	7
	7:3 FTCA	0	0	0	1	0	0	0	1
FTSAs	4:2 FTSA	0	0	0	0	0	0	0	0
	6:2 FTSA	0	1	0	0	2	0	0	3
	8:2 FTSA	0	0	0	3	0	0	0	0
FASAAs	NMeFOSAA	1	9	7	39	2	7	14	17
	NEtFOSAA	0	5	0	38	3	1	14	11
FASEs	NMeFOSE	0	0	0	4	0	0	0	0
	NEtFOSE	0	0	0	0	0	0	0	0
FASAs	PFOSA	1	9	0	5	0	1	21	1
	NMeFOSA	0	0	0	0	0	0	0	0
	NEtFOSA	0	0	0	0	0	0	0	0
PFECAs	PFMPA	0	0	0	0	0	0	0	1
	PFMBA	0	0	0	0	0	0	0	0
	NFDHA	0	0	0	0	0	0	0	0
	HFPO-DA	0	0	0	0	0	0	0	0
	ADONA	0	0	0	0	0	0	0	0
PFESAs	PFEESA	0	0	0	0	0	0	0	0
	9Cl-PF3ONS	0	0	0	0	0	0	0	0
	11Cl-PF3OUdS	0	0	0	0	0	0	0	0

FIGURE 4-3
PFAS Detection Frequency (Study Data Round 2)

4.1.2 Study PFAS Concentrations

4.1.2.1 Total PFAS by POTW & Sample Medium

ΣPFAS concentrations for influent and effluent samples are depicted in Figures 4-4 and 4-5 for all 114 facilities sampled during Round 1, with $\Sigma PFAS_{1633}$ concentrations shown on the left and $\Sigma PFAS_{TOP}$ concentrations shown on the right. Facilities were sorted from highest to lowest influent concentration (blue bars), with the effluent concentration projected in the opposite direction from the figure origin in each figure (green bars). The 57 facilities with the highest influent concentrations ("Upper 57") are shown in Figure 4-4, while the lowest 57 facilities ("Lower 57") are shown in Figure 4-5. A similar set of figures is included for Round 2 results in Appendix C, Figure C-1 and Figure C-2.

ΣPFAS concentrations for sludge samples are depicted in Figures 4-6 and 4-7 for 113 facilities sampled during Round 1, with the facilities presented in the same order as Figures 4-4 and 4-5. For each facility, $\Sigma PFAS_{1633}$ concentrations (orange bars) and $\Sigma PFAS_{TOP}$ concentrations (yellow bars) are projected in opposing directions from the figure origin. In Figure 4-6, the 50 facilities with the highest $\Sigma PFAS_{1633}$ concentrations on a dry mass basis are shown on the left, while the lowest 49 facilities are shown on the right. Figure 4-7 analogously shows ΣPFAS concentrations for the 15 POTWs with sludge data reported on a liquid basis during Round 1. A similar set of figures is included for Round 2 results in Appendix C, Figure C-3 and Figure C-4.

In general, Figures 4-4 and 4-5 indicate that influent ΣPFAS concentrations tend to exceed effluent ΣPFAS concentrations for the 50% of POTWs with the highest influent $\Sigma PFAS_{1633}$ concentrations ("Upper 57"). The 50% of POTWs with the lowest influent $\Sigma PFAS_{1633}$ concentrations ("Lower 57") appear to contain higher $\Sigma PFAS_{1633}$ concentrations in their effluent than in their influent at the time of sample collection. (A similar trend is observed in influent and effluent data from the Portal as discussed in Section 4.2.2.) This may be reflective of wastewater matrix issues, with better detection of low concentration PFAS in "cleaner" effluent samples than high organic influent samples. Trends are less apparent from the $\Sigma PFAS_{TOP}$ concentrations, with comparable $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations in many cases. There were several surprising instances of lower $\Sigma PFAS_{TOP}$ concentrations than the $\Sigma PFAS_{1633}$ concentrations which may be due to various contributing factors such as incomplete oxidation, differences in sample volume used for EPA Method 1633 versus TOP, quantification of short-chain compounds outside of the calibration range, and sample heterogeneity. There are only a few cases among the Upper 57 POTWs for which $\Sigma PFAS_{TOP}$ concentrations exceeded the $\Sigma PFAS_{1633}$ concentrations, with this expected trend more apparent for the Lower 57 POTWs.

In contrast, the prevalence of oxidizable precursors in sludge samples analyzed as solids (ng/g) is apparent in Figure 4-6, with $\Sigma PFAS_{TOP}$ concentrations far exceeding $\Sigma PFAS_{1633}$ concentrations for most POTWs. In fact, $\Sigma PFAS_{TOP}$ concentrations showed no related trend based on higher or lower $\Sigma PFAS_{1633}$ concentrations and varied by similar concentrations for all POTWs. These observations highlight the potential precursor mass stored in sludges which is not well quantified using a targeted analytical approach. Again, it should be noted that detection frequency trends indicated the TOP assay oxidization efficiency was low for sludges in general (see Figure 4-3); therefore, even the $\Sigma PFAS_{TOP}$ concentrations may underestimate oxidizable PFAS mass for some samples.

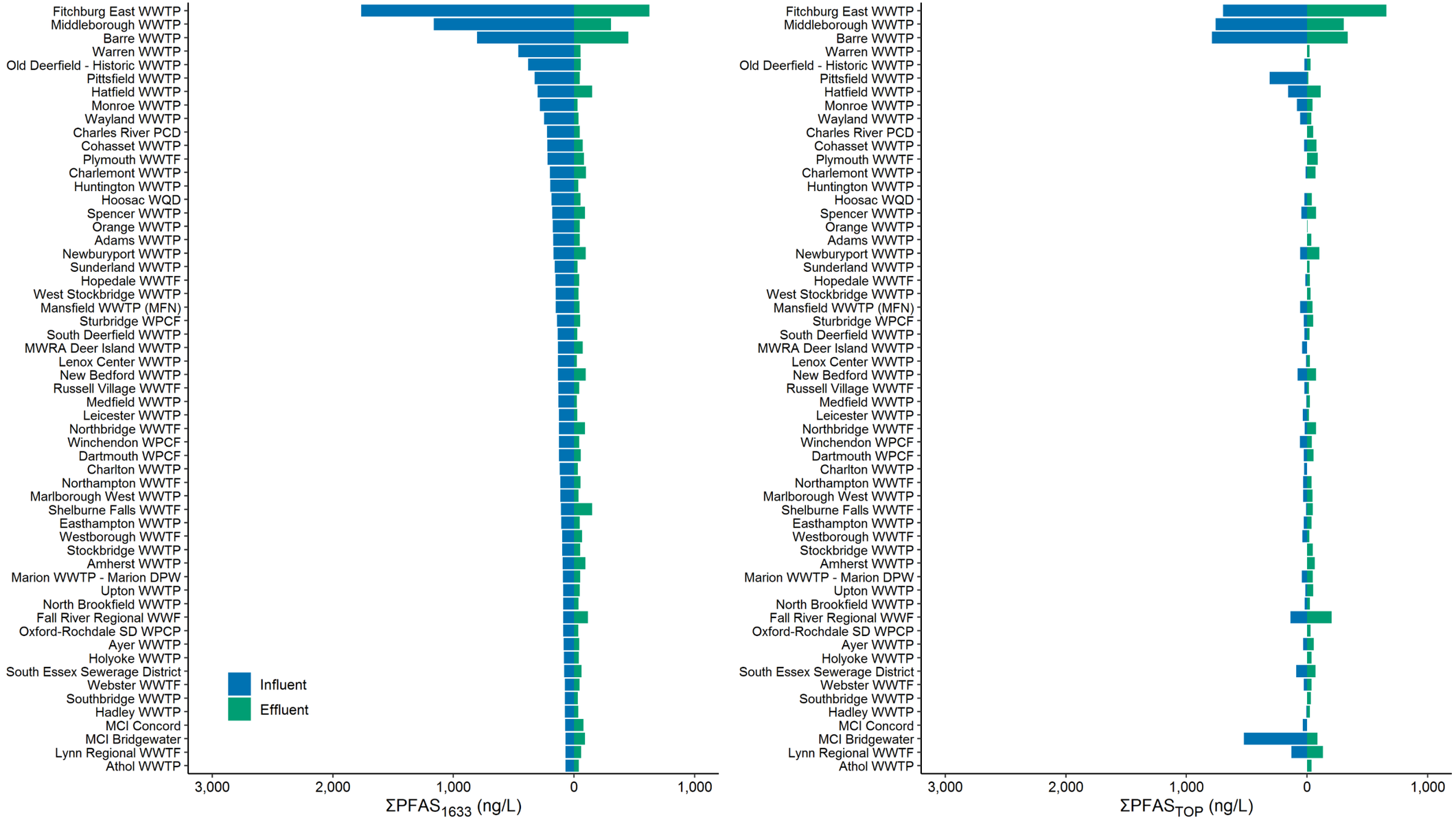


FIGURE 4-4
Total PFAS Concentrations for EPA Method 1633 and TOP analysis for the Upper 57 POTWs (Study Influent and Effluent Data Round 1)

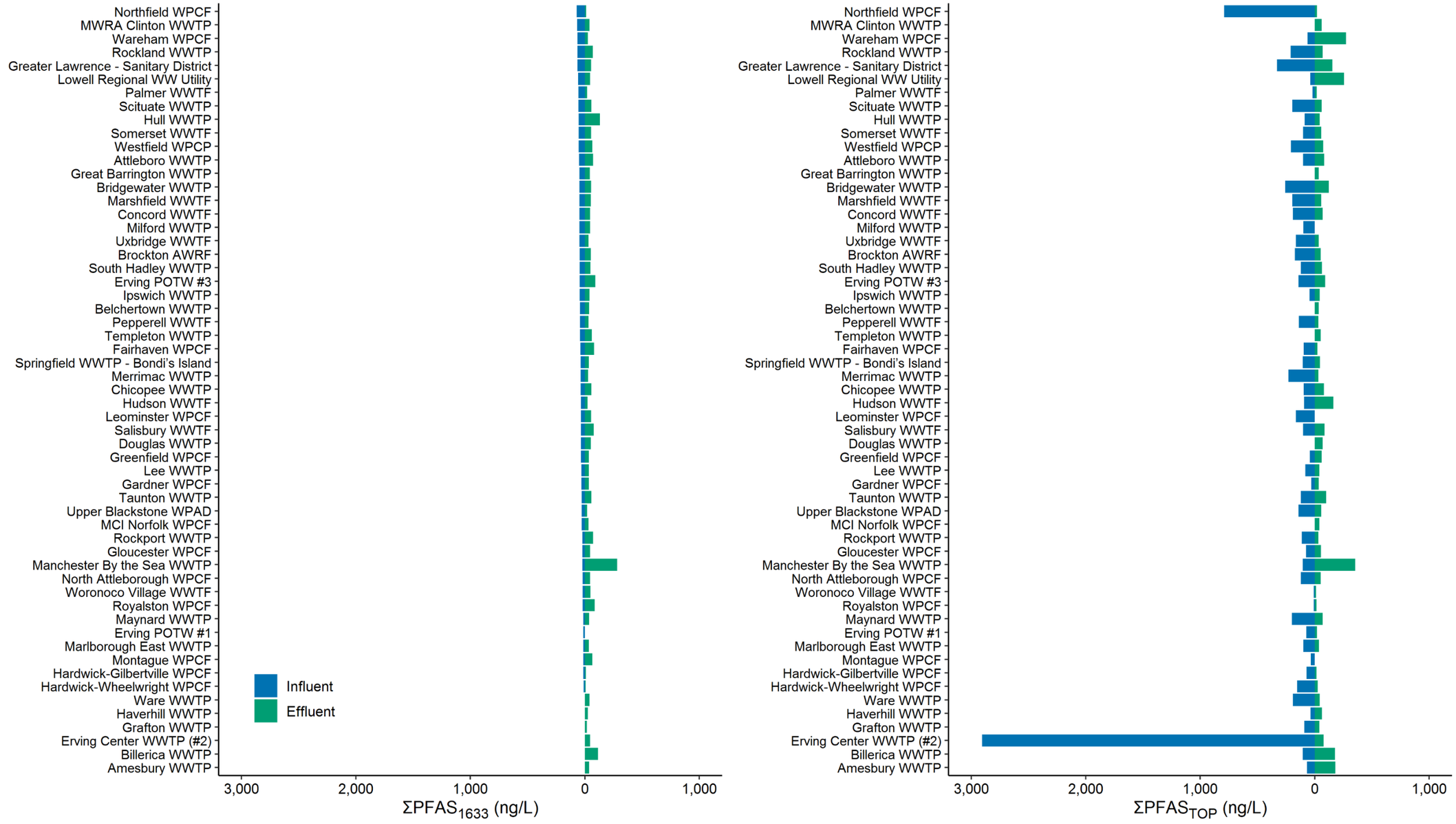


FIGURE 4-5
Total PFAS Concentrations for EPA Method 1633 and TOP analysis for the Lower 57 POTWs (Study Influent and Effluent Data Round 1)

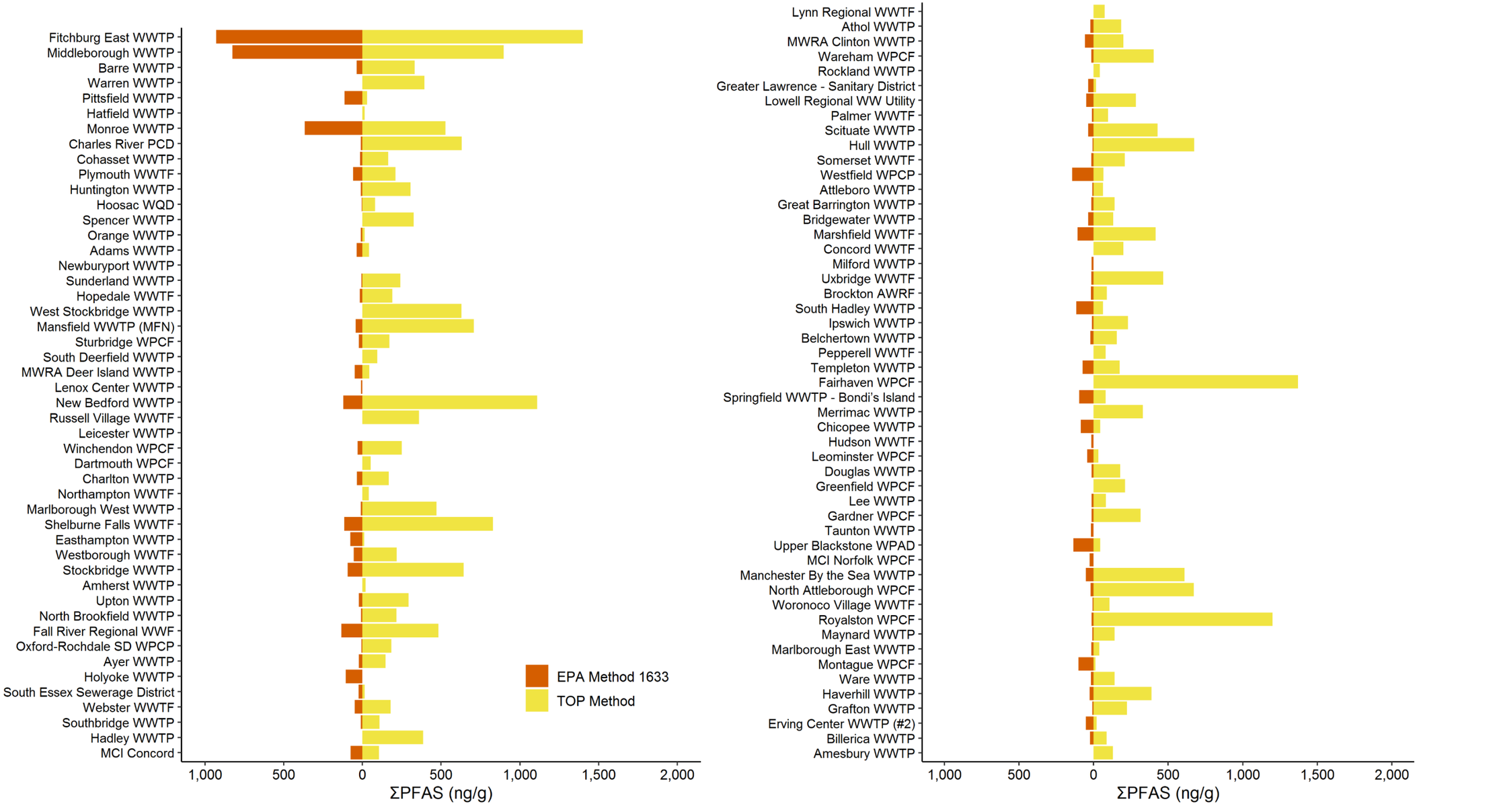


FIGURE 4-6
Total PFAS Concentrations for EPA Method 1633 and TOP (Study Dry Mass Sludge Data Round 1)
(POTWs are presented in the same order as they are presented in Figures 3-4 and 3-5)

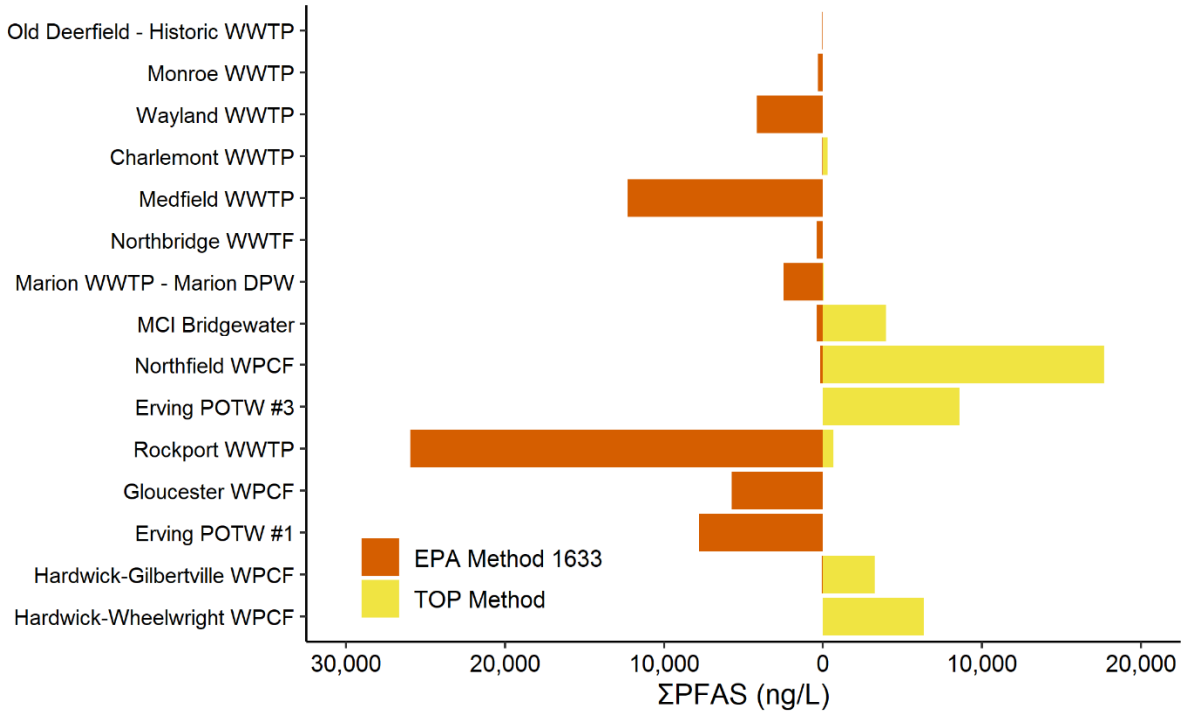


FIGURE 4-7
Total PFAS Concentrations for EPA Method 1633 and TOP (Study Liquid Mass Sludge Data Round 1)

There was no consistent trend in ΣPFAS concentrations between EPA Method 1633 and TOP analysis for sludge analyzed as liquids (ng/L) (Figure 4-7). In fact, for facilities that showed high $\Sigma PFAS_{1633}$ concentrations, $\Sigma PFAS_{TOP}$ was low or below detection, likely due to sample matrix/QC issues (see Section 2 for further discussion). Nevertheless, for most of the facilities where sludges were analyzed as liquids, the $\Sigma PFAS_{1633}$ or $\Sigma PFAS_{TOP}$ concentrations were consistent with those concentrations measured in sludges analyzed as solids. Further analysis of the relationship between ΣPFAS concentrations and solids content is needed to fully understand these caveats.

Median and mean ΣPFAS concentrations for influent, effluent, and sludges (for both EPA Method 1633 and TOP analysis) during Round 1 and Round 2 sampling events are provided again in Table 4-1 and illustrated in Figures 4-8 and 4-9. Note these data were presented previously in Table 3-1 with a focus on comparing percent change in concentrations between the EPA Method 1633 and TOP analyses. Table 4-1 focuses on comparing concentration differences between sampling rounds and analytical method. For influent, effluent, and sludge samples on a liquid basis, no significant differences were detected between Round 1 and Round 2 median ΣPFAS concentrations or between $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations based on sampling event (Wilcoxon signed-rank tests, all $p>0.1$).

Influent and effluent ΣPFAS concentrations were only significantly different from each other for Round 1 samples analyzed by EPA Method 1633 (Kruskal-Wallis test, $p=0.03$). $\Sigma PFAS_{TOP}$ was significantly greater than $\Sigma PFAS_{1633}$ for Round 1 sludge data on a dry mass basis, although this difference was not observed for the Round 2 sludge data on a dry mass basis.

Regardless of analytical method or Round, sludge ΣPFAS concentrations on a liquid basis were significantly greater than both influent and effluent ΣPFAS concentrations (Kruskal-Wallis tests, all $p<0.02$). In general, influent and effluent ΣPFAS concentrations were similar, with no clear trend between the two, but their concentrations were consistently less than sludge ΣPFAS concentrations.

TABLE 4-1
Summary of Median and Mean ΣPFAS Concentrations for Study EPA Method 1633 and TOP analyses

Sampling Location	Round 1		Round 2	
	Median	Mean	Median	Mean
		$\Sigma PFAS_{1633}$		
Influent (ng/L)	69.6	120.8	42.3	160.3
Effluent (ng/L)	47.2	65.0	48.6	65.4
Sludge, wet (ng/L)	369.6	3,988.9	169.2	3,640.5
Sludge, dry (ng/g)	17.2*	52.7	21.7	101.3
		$\Sigma PFAS_{TOP}$		
Influent (ng/L)	51.5	123.6	42.2	266.9
Effluent (ng/L)	46.0	68.0	48.4	65.2
Sludge, wet (ng/L)	157.7	2,914.7	455.3	1,359.5
Sludge, dry (ng/g)	166.4*	253.3	28.8	122.7

*Significant difference between sludge (ng/g) for $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations (Wilcoxon signed-rank tests, $p=4\times10^{-12}$)

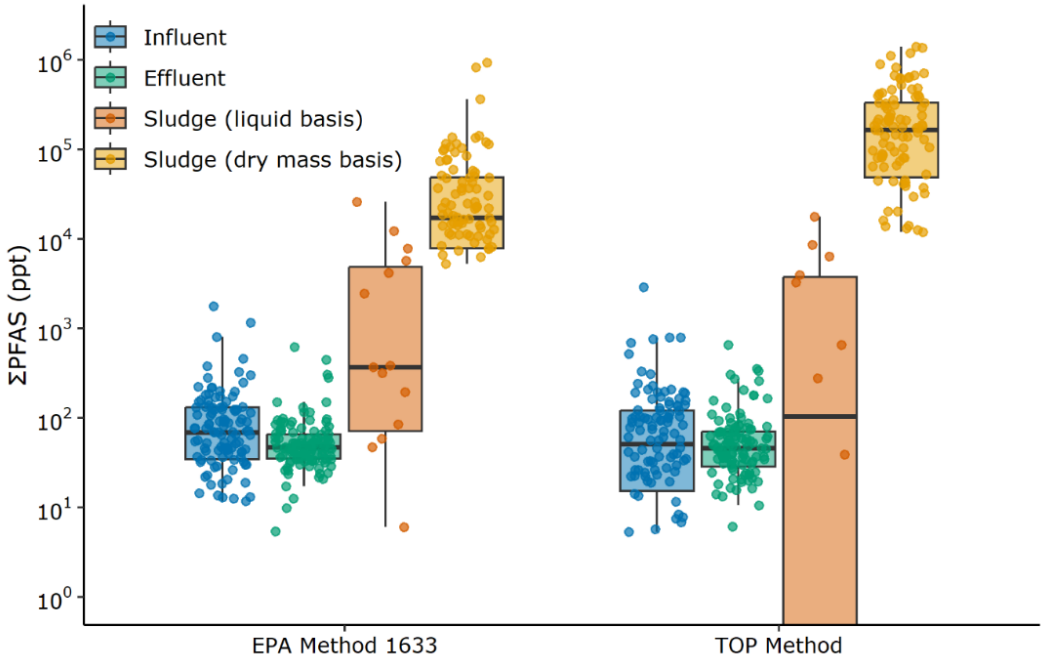


FIGURE 4-8
ΣPFAS Distribution for Influent, Effluent, & Sludge (Study Data Round 1)

Note: Sludge concentrations originally reported in ng/g (ppb) were multiplied by 1,000 to convert to ppt for visual comparison with ΣPFAS for liquid samples. To visualize concentrations of 0 ppt on the logarithmic scale, a value of 1×10^{-10} ppt was added to each data point.

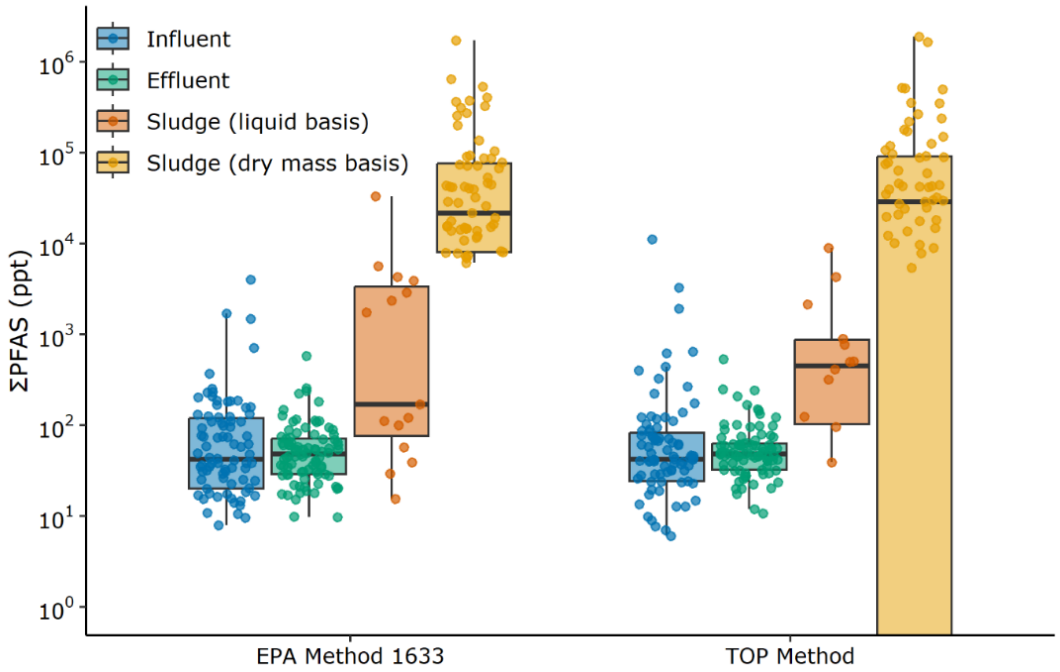


FIGURE 4-9
ΣPFAS Distribution for Influent, Effluent, & Sludge (Study Data Round 2)

Note: Sludge concentrations originally reported in ng/g (ppb) were multiplied by 1,000 to convert to ppt for visual comparison with ΣPFAS for liquid samples. To visualize concentrations of 0 ppt on the logarithmic scale, a value of 1×10^{-10} ppt was added to each data point.

Notably, the facilities with the highest ΣPFAS concentrations measured by EPA Method 1633 also had higher ΣPFAS concentrations measured by TOP analysis with a few exceptions. Fitchburg East WWTP, Middleborough WWTP, and Barre WWTP had influent ΣPFAS concentrations >500 ng/L and effluent ΣPFAS concentrations >300 ng/L regardless of analytical method, indicating that targeted analytical methods accounted well for measurable precursors. MCI Bridgewater, Northfield WPCF, and Erving Center WWTP #2, on the other hand, had influent ΣPFAS concentrations <100 ng/L using EPA Method 1633, but ΣPFAS concentrations >500 ng/L using TOP analysis, suggesting significant precursor mass in their influent not accounted for with the targeted analytical approach. A discrepancy between EPA Method 1633 and TOP analysis concentrations was also noted for New Bedford WWTP and Sturbridge WPCF during the Round 2 sample collection. Sludge sample results indicate considerable variability in ΣPFAS concentrations with analytical method. In most cases, $\Sigma PFAS_{1633}$ concentrations were <50,000 ng/L, but $\Sigma PFAS_{TOP}$ concentrations range from 10,000 to 60,000 ng/L. The $\Sigma PFAS_{TOP}$ concentrations are consistent with those measured in other studies, but they suggest that a targeted analytical approach (EPA Method 1633) may poorly quantify PFAS concentrations in POTW sludges.[9] Please see Section 2.3 for a detailed description of analytical challenges encountered in sludge samples as a result of organic inhibitors and total solids content. Further analysis of the relationship between total organic carbon concentration, total solids, and $\Sigma PFAS_{TOP}$ concentrations may better elucidate these trends.

Again, as depicted in Figure 4-9, there is no significant difference between $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ for Round 2 influent, effluent, or sludge samples (Wilcoxon signed-rank tests, $p>0.4$), which may be due to several contributing factors, including incomplete oxidation and elevated RLs/MDLs for TOP.

4.1.2.2 Total PFAS by Compound

Tables 4-2 through 4-5 provide summary statistics for PFAS concentrations in influent, effluent, and sludge by species, sorted by increasing chain length for Round 1 and Round 2 Study data, respectively. The PFAS analyte detected among the highest concentrations for all sample types (influent, effluent, and sludge) for both $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ analyses was perfluoropentanoate, or perfluoropentanoic acid (PFPeA). Within influent and effluent samples, perfluorohexanoate or perfluorohexanoic acid (PFHxA) was detected among the highest concentrations for both EPA Method 1633 and TOP analyses. Other analytes contributing to PFAS mass in influent and effluent samples were PFPeA and perfluorooctanoic acid (PFOA). PFAS analytes detected among the highest concentrations in sludge included5:3 fluorotelomer carboxylic acid (FTCA), perfluorooctane sulfonate (PFOS), and PFPeA.

The Interstate Technology and Regulatory Council (ITRC) notes that 5:3 FTCA may be found in landfill leachate. In general, FTCAs are associated with the potential production of linear perfluoroalkyl carboxylic acids (PFCAs), with 5:3 FTCA believed to be a breakdown product of 6:2 FTCA and, possibly, other fluorotelomers.[12]

Mean concentrations of PFCAs with fewer than 8 carbons in their carbon chains were generally higher post-oxidation for influent, effluent, and sludge samples, as shown in Tables 4-3 through 4-6. However, detection of convertible precursor mass within FTCA, FTSA, FASAA, and FASA classes post-oxidation for all sample types highlight the poor oxidation efficiency of the TOP treatment methods. As discussed in the detection frequency section (Section 4.1.1), when the TOP chemical oxidation process is inefficient, precursors with known breakdown pathways are not completely converted to shorter, terminal products that can be measured via EPA Method 1633, such as PFCAs generally with fewer than 8 carbons in their chain. Further consideration of this issue is warranted.

In order to evaluate the efficiency of the TOP oxidation process, two surrogate indicators (1H,1H,2H,2H-Perfluoro[1,2-13C2D4]Hexanesulfonic Acid (13C2D4-4:2FTS) and Perfluoro-[1,2-13C2]octanoic Acid (13C2-PFOA)) are added by the laboratory prior to the oxidation and extraction step. If the reported percent recovery of 13C2D4-4:2FTS is between 0 and 25%, this suggests complete oxidation occurred. Similarly, if the percent recovery of 13C2-PFOA is within the acceptable range (typically between 50 and 150%), this also suggests that the oxidation step was successful and that PFAS precursors were transformed into target PFAAs during the oxidation process.

TABLE 4-2
Summary of Pre-Oxidation Statistics for Study Round 1

		Influent (ng/L)							Effluent (ng/L)							Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	3.20	0.92	4.275	0	0	114	91	3.21	0.59	4.38	0	3.845	114	70	111.33	7.56	1670	0	0	15	14	0	0	-	0	0	99	99
	PFPeA	24.50	1.85	25.4	2.625	36.6	114	26	15.08	1.06	12.2	7.4825	16.275	114	8	1112.79	39.49	896	0	1278	15	6	3.88	0.58	43.4	0	0	99	87
	PFHxA	20.29	1.53	16.5	4.6375	27.25	112	10	17.58	1.31	12.7	9.395	17.2	114	2	827.06	28.68	868.5	1.2	1270	15	4	2.74	0.33	5.34	0	0.952	96	67
	PFHpA	12.72	0.97	14.6	1.4525	19.475	114	26	3.69	0.29	2.975	1.62	3.87	113	22	644.54	22.76	567	0	761.5	15	5	1.19	0.18	12.7	0	0	97	86
	PFOA	14.99	1.25	12.65	5.9025	17.225	114	10	10.16	0.72	7.87	5.765	10.475	114	3	629.55	23.66	331	4.77	881	15	3	2.79	0.29	3.91	0	1.6125	99	61
	PFNA	3.78	0.29	6.45	0	6.215	114	45	0.94	0.10	2.01	0	1.08	113	63	233.47	8.99	180	0	180	15	7	0.64	0.08	3.425	0	0	98	75
	PFDA	1.87	0.16	3.935	0	3.33	113	66	0.35	0.05	2.575	0	0	114	94	159.06	6.50	235	0	155.9	15	7	1.18	0.14	2.765	0	1.09	99	67
	PFUnA	0.16	0.03	2.72	0	0	114	107	0.02	0.01	1.03	0	0	114	112	23.55	1.44	316	0	0	15	13	0.58	0.21	1.34	0	0	98	89
	PFDoA	0.26	0.04	2.86	0	0	114	102	0.01	0.01	1.02	0	0	114	112	26.75	1.42	199.5	0	0	15	12	0.10	0.02	1.08	0	0	99	90
	PFTrDA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0.13	0.06	12.7	0	0	99	98
	PFTeDA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	3.09	0.21	46.4	0	0	15	14	0	0	-	0	0	99	99
PFSAs	PFBS	9.64	2.16	4.45	0	5.2425	112	37	7.15	1.39	3.82	0	5.045	114	35	102.08	4.08	79.75	0	31.2725	14	8	0.36	0.08	5.28	0	0	98	92
	PFPeS	0.09	0.02	2.18	0	0	113	104	0.07	0.01	0.87	0	0	113	101	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	PFHxS	1.49	0.18	2.615	0	2.12	114	72	1.57	0.15	2.25	0	2.345	114	55	0.17	0.01	2.62	0	0	15	14	0.17	0.04	2.85	0	0	99	94
	PFHpS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	98	98
	PFOS	8.50	0.58	7.9125	2.6375	13.05	110	17	4.60	0.31	4.16	2.015	6.2075	114	20	113.26	3.33	83.2	8.855	108.25	14	2	13.49	1.69	10.4	4.73	12.9	91	18
	PFNS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0.39	0.10	13.75	0	0	99	96
	PFDS	0	0	-	0	0	114	114	0.02	0.01	1.87	0	0	114	113	0	0	-	0	0	15	15	0.19	0.04	2.3	0	0	98	89
	PFDoS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0.05	0.02	2.25	0	0	98	96
FTCAs	3:3 FTCA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0.04	0.02	3.77	0	0	99	98
	5:3 FTCA	15.66	5.76	688	0	0	114	111	0.14	0.07	15.4	0	0	114	113	0	0	-	0	0	15	15	20.21	4.87	31.7	0	0	99	84
	7:3 FTCA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	1.40	0.46	69.5	0	0	99	97
FTSAs	4:2 FTSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	6:2 FTSA	2.57	1.33	293	0	0	114	113	0.04	0.02	4.7	0	0	114	113	10.53	0.72	158	0	0	15	14	0.03	0.01	3.18	0	0	99	98
	8:2 FTSA	0.09	0.04	9.75	0	0	114	113	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
FASAAs	NMeFOSAA	0.05	0.03	6.18	0	0	114	113	0.13	0.05	1.0015	0	0	113	106	0.65	0.03	4.9	0	0	15	13	1.96	0.19	3.12	0	2.335	99	59
	NEtFOSAA	0.01	0.01	1.22	0	0	114	113	0.06	0.02	5.04	0	0	113	110	3.35	0.18	3.44	0	0	14	11	1.39	0.14	2.37	0	1.74	97	58
FASEs	NMeFOSE	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0.24	0.06	7.28	0	0	99	96
	NEtFOSE	0.11	0.06	13	0	0	114	113	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
FASAs	PFOSA	0	0	-	0	0	114	114	0.02	0.01	0.875	0	0	112	109	2.45	0.13	17.12	0	0	14	12	0.08	0.02	1.74	0	0	92	86
	NMeFOSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	NEtFOSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
PFECAs	PFMPA	0.03	0.01	2.49	0	0	114	112	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	PFMBA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	NFDHA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	HFPO-DA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	ADONA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
PFESAs	PFEESA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	9Cl-PF3ONS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99
	11Cl-PF3OUdS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	15	15	0	0	-	0	0	99	99

TABLE 4-3
Summary of Post-Oxidation Statistics for Study Round 1

		Influent (ng/L)							Effluent (ng/L)							Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	11.26	3.98	5.2	0	0	114	103	1.63	0.31	3.26	0	2.2575	114	81	182.00	8.35	1274	0	0	14	12	10.97	2.754472	189	0	0	99	94
	PFPeA	35.11	7.09	30.85	0	34.1	114	45	18.35	1.51	11.6	5.14	19.7	114	14	812.11	25.74	1310	0	1282.5	14	7	53.60	4.08	83.7	0	85.05	99	42
	PFHxA	21.55	2.09	19.8	0	24.45	112	29	17.86	1.33	13.7	8.04	19	113	7	539.71	17.94	1100	0	965.25	14	7	24.35	1.74	31.75	0	37	99	36
	PFHpA	11.99	1.40	15.45	0	16.275	113	46	5.10	0.48	3.17	1.08	4.8	113	25	509.28	18.40	941	0	527.5	14	8	16.36	1.23	22.6	0	23.725	98	45
	PFOA	14.15	1.44	11.8	0	17.1	113	30	10.28	0.90	7.87	3.6925	12	114	11	419.62	15.34	373	0	330.25	14	7	20.39	1.71	22.2	0	28.85	99	41
	PFNA	3.88	0.50	6.91	0	5.54	114	63	1.32	0.16	2.755	0	0.955	113	72	174.46	6.33	489.5	0	157.85	14	8	4.96	0.47	11.7	0	7.165	99	60
	PFDA	1.48	0.24	3.71	0	2.3	114	83	0.54	0.08	3.775	0	0	114	96	98.16	3.77	205	0	78.3	14	9	2.19	0.27	7.145	0	0	99	75
	PFUnA	0.19	0.08	17.7	0	0	114	112	0.08	0.02	3.14	0	0	114	110	34.51	1.27	185.5	0	0	13	10	0.82	0.22	4.925	0	0	99	93
	PFDoA	0.34	0.10	2.62	0	0	114	106	0.05	0.02	2.85	0	0	114	112	41.91	1.48	127.6	0	44	14	9	0.02	0.01	1.7	0	0	99	97
	PFTrDA	0.035	0.018252	4.03	0	0	114	113	0	0	-	0	0	114	114	3.2	0.202898	44.8	0	0	14	13	0.14	0.06	14.1	0	0	99	98
	PFTeDA	0.082	0.042482	-	0	0	114	113	0	0	-	0	0	114	114	10.31	0.61	134	0	0	13	12	0	0	-	0	0	99	99
PFSAs	PFBS	9.42	1.86	5.36	0	5.8	106	44	7.18	1.40	3.68	1.735	4.6325	110	23	38.96	1.69	64.8	0	44.85	14	10	1.15	0.17	8.48	0	0	99	87
	PFPeS	0.05	0.02	2.675	0	0	113	111	0.03	0.01	1.23	0	0	114	110	0	0	-	0	0	14	14	85	11.11153	387	0	0	99	80
	PFHxS	1.40	0.19	3.14	0	2.18	114	79	1.41	0.13	2.535	0	2.305	114	57	0.00	0.00	-	0	0	14	14	0.38	0.12	19.3	0	0	98	95
	PFHpS	0.005	0.002477	-	0	0	114	113	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	PFOS	7.08	0.53	8.19	0	11.3	112	35	4.48	0.30	4.13	1.42	6.32	109	21	57.77	1.69	134.6	0	78.4	13	6	9.88	0.74	12.3	0	14.1	95	38
	PFNS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.00	0.00	-	0	0	99	99
	PFDS	0	0	-	0	0	114	114	0.00	0.00	-	0	0	114	114	0	0	-	0	0	14	14	0.02	0.01	1.235	0	0	99	97
	PFDoS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.00	0.00	-	0	0	98	98
FTCAs	3:3 FTCA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.00	0.00	-	0	0	99	99
	5:3 FTCA	1.78	0.85	187	0	0	114	112	0.00	0.00	-	0	0	114	114	0	0	-	0	0	14	14	20.51	6.40	21.65	0	0	99	93
	7:3 FTCA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.83	0.37	82.1	0	0	99	98
FTSAs	4:2 FTSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	6:2 FTSA	5.16	1.86	289.5	0	0	114	111	0.05	0.02	5.15	0	0	114	113	0.00	0.00	-	0	0	14	14	1.05	0.47	104	0	0	99	98
	8:2 FTSA	0.00	0.00	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.26	0.116394	25.7	0	0	99	98
FASAAs	NMeFOSAA	0.01	0.00	-	0	0	114	113	0.10	0.02	1.01	0	0	114	102	0.00	0.00	-	0	0	14	14	0.59	0.10	5.875	0	0	99	89
	NEtFOSAA	0.00	0.00	-	0	0	114	114	0.03	0.01	1.905	0	0	114	112	0.00	0.00	-	0	0	14	14	0.23	0.04	2.125	0	0	98	90
FASEs	NMeFOSE	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0.15	0.07	14.5	0	0	99	98
	NEtFOSE	0.00	0.00	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
FASAs	PFOSA	0	0	-	0	0	113	113	0.18	0.03	2.865	0	0	110	99	0.00	0.00	-	0	0	14	14	0.01	0.00	-	0	0	96	95
	NMeFOSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	NEtFOSA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
PFECAs	PFMPA	0.06	0.03	6.38	0	0	114	113	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	PFMBA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	NFDHA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	HFPO-DA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	ADONA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
PFESAs	PFEESA	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	9Cl-PF3ONS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99
	11Cl-PF3OUdS	0	0	-	0	0	114	114	0	0	-	0	0	114	114	0	0	-	0	0	14	14	0	0	-	0	0	99	99

TABLE 4-4
Summary of Pre-Oxidation Statistics for Study Round 2

		Influent (ng/L)							Effluent (ng/L)							Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	5.26	1.83	3.62	0	0	86	75	3.35	0.60	3.82	0	3.2675	86	53	0.00	0.00	-	0	0	15	15	0	0	-	0	0	71	71
	PFPeA	51.28	8.51	22	0	36.4	86	27	14.31	0.78	11.3	5.635	20	86	3	1251.26	48.53	1340	0	1460	15	6	8.42	1.07	43.4	0	0	71	59
	PFHxA	28.07	3.11	9.325	3.205	25.1	84	10	16.81	0.99	11.8	6.865	18.85	86	1	728.38	33.95	329	3.36	532.5	15	3	4.55	0.48	5.23	0	3.8925	70	42
	PFHpA	15.30	1.81	9.675	0	14.7	86	26	3.52	0.21	3.17	1.27	4.22	86	13	667.01	29.36	542	0	572	15	6	3.05	0.41	5.8	0	0	71	60
	PFOA	27.97	6.22	9.6	4.1975	14.1	86	9	10.23	0.62	7.04	4.7275	10.9	86	1	422.48	19.16	203	5.42	286	15	1	5.37	0.51	6.26	0	3.86	71	41
	PFNA	5.85	0.97	4.93	0	3.65	85	49	0.93	0.09	2.015	0	0.811875	86	53	232.40	10.52	215	0	195.5	15	8	2.44	0.31	6.5	0	0	71	55
	PFDA	0.61	0.12	2.92	0	0	85	76	0.35	0.06	3.78	0	0	86	77	93.63	4.78	203	0	46.9	15	10	2.96	0.31	5.255	0	3.0825	70	46
	PFUnA	0.12	0.04	5.33	0	0	86	84	0.04	0.01	1.63	0	0	86	82	28.47	1.77	213.5	0	0	15	13	1.26	0.19	3.605	0	0	69	58
	PFDoA	0.13	0.04	5.485	0	0	86	84	0.02	0.01	1.22	0	0	86	84	25.87	1.76	388	0	0	15	14	0.48	0.08	4.78	0	0	70	63
	PFTrDA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.22	0.04	5.28	0	0	71	68
	PFTeDA	0.04	0.01567	3.46	0	0	86	85	0.006	0.002464	-	0	0	86	85	0.00	0.00	-	0	0	15	15	0.092	0.025447	3.2625	0	0	71	69
PFSAs	PFBS	15.65	3.35	4.525	0	5.23	84	33	7.75	1.08	4.41	2.29875	5.41	86	12	75.19	3.57	23.045	0	48.55	15	6	0.79	0.10	3.835	0	0	71	61
	PFPeS	0.11	0.04	8.51	0	0	84	82	0.01	0.00	-	0	0	84	83	0	0	-	0	0	15	15	13.72	3.077131	353	0	0	71	68
	PFHxS	1.31	0.14	2.96	0	0.721	86	60	1.84	0.13	2.46	0	2.5575	86	31	0.00	0.00	-	0	0	15	15	0.24	0.06	13.2	0	0	69	64
	PFHpS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	PFOS	8.27	0.45	10.15	4.1	11	85	20	5.60	0.35	4.54	2.21	6.91	85	9	101.23	3.21	70.8	12.25	117.5	15	1	14.09	0.92	12.6	7.11	15.3	69	11
	PFNS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.37	0.12	26	0	0	71	70
	PFDS	0	0	-	0	0	86	86	0.01	0.01	1.24	0	0	86	85	0	0	-	0	0	15	15	0.13	0.04	-	0	0	71	69
	PFDoS	0.024	0.009375	-	0	0	86	85	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.00	0.00	-	0	0	70	70
FTCAs	3:3 FTCA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.00	0.00	-	0	0	71	71
	5:3 FTCA	1.28	0.50	110	0	0	86	85	0.00	0.00	-	0	0	86	86	14.34	0.703691	107.55	0	0	15	13	36.75	7.25	58.4	0	0	71	59
	7:3 FTCA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	1.55	0.50	110	0	0	71	70
FTSAs	4:2 FTSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	6:2 FTSA	0.00	0.00	-	0	0	86	86	0.06	0.02	4.79	0	0	86	85	0.00	0.00	-	0	0	15	15	0.00	0.00	-	0	0	71	71
	8:2 FTSA	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.118	0.027074	4.185	0	0	71	69
FASAAs	NMeFOSAA	0.08	0.03	6.88	0	0	85	84	0.18	0.04	1.78	0	0	86	78	0.26	0.02	3.92	0	0	15	14	2.84	0.22	5.96	0	3.685	71	43
	NEtFOSAA	0.00	0.00	-	0	0	86	86	0.11	0.02	2.38	0	0	86	82	0.00	0.00	-	0	0	15	15	1.95	0.18	3.93	0	1.805	68	42
FASEs	NMeFOSE	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0.53	0.11	10.3	0	0	71	68
	NEtFOSE	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
FASAs	PFOSA	0.018	0.007156	1.58	0	0	86	85	0.11	0.02	1.55	0	0	85	77	0.00	0.00	-	0	0	15	15	0.07	0.01	1.94	0	0	65	62
	NMeFOSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	NEtFOSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
PFECAs	PFMPA	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	PFMBA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	NFDHA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	HFPO-DA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	ADONA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
PFESAs	PFEESA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	9Cl-PF3ONS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71
	11Cl-PF3OUdS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	15	15	0	0	-	0	0	71	71

TABLE 4-5
Summary of Post-Oxidation Statistics for Study Round 2

		Influent (ng/L)							Effluent (ng/L)							Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	28.41	10.11	4.495	0	0	86	68	3.52	0.42	4.485	0	4.22	85	48	0.00	0.00	-	0	0	14	14	7.521	1.823873	267	0	0	71	69
	PFPeA	91.23	23.41	12.7	0	25.875	86	27	13.81	0.78	10.6	7.185	15.375	86	7	416.24	14.61	370	0	405	14	6	18.23	1.87	66.75	0	0	71	55
	PFHxA	58.75	15.13	7.825	3.58	18.4	85	14	17.09	1.04	13.15	7.9175	17.275	86	3	223.54	8.45	133	0	131.75	14	6	8.58	0.88	18.6	0	5.51	71	46
	PFHpA	24.13	4.32	9.44	0	12.8	85	28	3.27	0.18	3.49	1.3	3.9775	86	14	211.35	7.56	283	0	147.25	14	7	6.22	0.73	21.6	0	0	70	56
	PFOA	16.32	1.76	9.2625	4.8475	13	86	11	10.74	0.71	8.34	5.535	10.4	86	4	158.67	6.13	81	0	75.35	14	7	10.85	1.14	13	0	7.6	71	42
	PFNA	4.64	1.01	4.665	0	2.14	86	51	0.93	0.09	2.14	0	1.11	86	49	75.74	2.89	151	0	39.275	14	9	4.32	0.64	12.1	0	0.3385	71	53
	PFDA	1.21	0.28	4.93	0	0	86	78	0.34	0.06	3.58	0	0	86	77	47.76	2.07	61.6	0	18.65	14	9	3.40	0.48	6.875	0	1.91	71	52
	PFUnA	0.13	0.05	11.4	0	0	86	85	0.00	0.00	-	0	0	86	86	10.84	0.50	58.25	0	0	14	11	1.57	0.37	6.87	0	0	71	65
	PFDoA	0.00	0.00	-	0	0	86	86	0.00	0.00	-	0	0	86	86	14.11	0.75	98.8	0	0	14	12	0.55	0.15	5.01	0	0	71	68
	PFTrDA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.30	0.08	17.2	0	0	71	69
	PFTeDA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	1.11	0.07	15.5	0	0	14	13	0.146	0.047101	10.4	0	0	71	70
PFSAs	PFBS	14.13	2.85	5.6	0	5.26	85	43	7.71	1.14	4.785	2.145	5.6325	86	17	26.57	1.06	101	0	13.8	14	10	1.17	0.12	8.09	0	0	68	58
	PFPeS	0.05	0.01	0.527	0	0	84	78	0.09	0.01	1.24	0	0	86	76	0	0	-	0	0	14	14	8.444	1.88049	254	0	0	71	68
	PFHxS	1.11	0.12	2.86	0	1.1775	86	63	1.64	0.12	2.48	0	2.46	85	37	0.88	0.06	12.3	0	0	14	13	0.49	0.10	20.8	0	0	69	66
	PFHpS	0	0	-	0	0	86	86	0.013	0.003582	0.52	0	0	86	84	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	PFOS	8.40	0.61	8.915	0	11.0375	84	25	5.64	0.35	4.99	2.27	6.73	85	13	88.63	2.85	92.4	0	93.4	14	6	15.45	1.12	14.9	0	18.75	68	22
	PFNS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.00	0.00	-	0	0	71	71
	PFDS	0.01	0.003909	-	0	0	86	85	0.00	0.00	-	0	0	86	86	4.8571	0.30797	68	0	0	14	13	0.12	0.04	8.58	0	0	71	70
	PFDoS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.00	0.00	-	0	0	71	71
FTCAs	3:3 FTCA	0.062	0.024321	5.37	0	0	86	85	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.00	0.00	-	0	0	71	71
	5:3 FTCA	17.88	5.37	100	0	0	86	81	0.44	0.12	19	0	0	86	84	21.643	1.372278	303	0	0	14	13	32.10	7.96	75.7	0	0	71	66
	7:3 FTCA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	1.63	0.53	116	0	0	71	70
FTSAs	4:2 FTSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	6:2 FTSA	1.53	0.57	65.58	0	0	86	84	0.00	0.00	-	0	0	86	86	0.00	0.00	-	0	0	14	14	0.18	0.04	6.545	0	0	71	69
	8:2 FTSA	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
FASAAs	NMeFOSAA	0.10	0.03	4.17	0	0	86	84	0.06	0.01	1.08	0	0	86	80	7.31	0.42	51.2	0	0	14	12	1.01	0.11	5.375	0	0	71	59
	NEtFOSAA	0.17	0.04	5.52	0	0	86	83	0.01	0.00	-	0	0	85	84	25.50	1.55	178.5	0	0	14	12	1.07	0.18	4.685	0	0	71	63
FASEs	NMeFOSE	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.00	0.00	-	0	0	71	71
	NEtFOSE	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
FASAs	PFOSA	0	0	-	0	0	86	86	0.03	0.01	2.41	0	0	85	84	24.74	1.24	68.5	0	0	14	11	0.01	0.00	-	0	0	71	70
	NMeFOSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	NEtFOSA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
PFECAs	PFMPA	0.00	0.00	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0.137	0.044112	9.74	0	0	71	70
	PFMBA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	NFDHA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	HFPO-DA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	ADONA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
PFESAs	PFEESA	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	9Cl-PF3ONS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71
	11Cl-PF3OUdS	0	0	-	0	0	86	86	0	0	-	0	0	86	86	0	0	-	0	0	14	14	0	0	-	0	0	71	71

4.1.3 Adsorbable Organic Fluorine

Eighteen (18) facilities were randomly selected for sampling during Round 1 for AOF analysis. During Round 2, 13 of these 18 facilities were again sampled for AOF analysis, resulting in a total of 31 paired influent and effluent samples analyzed for AOF using EPA Method 1621. (EPA Method 1621 is only conducted on aqueous samples and is not designed for sludges.) The following figures show AOF results for Round 1 samples (Figure 4-10) and Round 2 samples (Figure 4-11), with the x-axis representing concentration in units of ng/L (or ppt). Facilities are ranked from highest to lowest influent concentration (blue) by sampling round, with effluent concentration projected in the opposite direction from the figure origin (green).

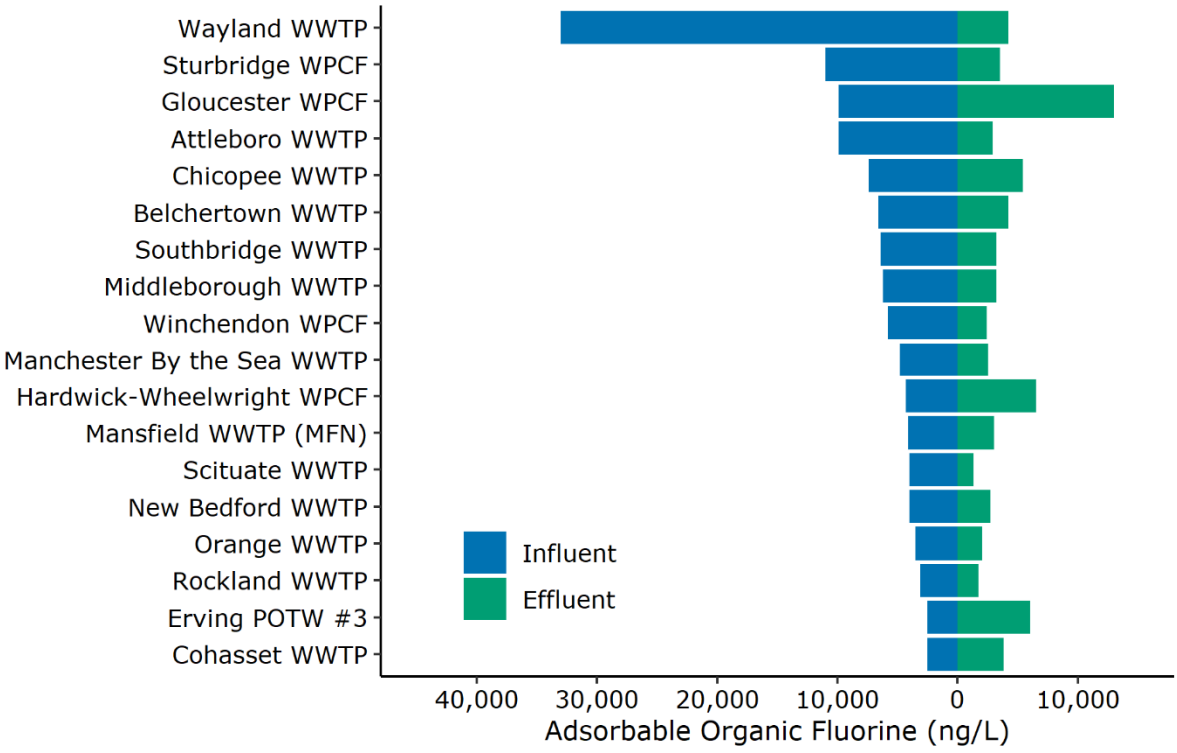


FIGURE 4-10
Influent and Effluent AOF Concentrations - 18 POTWs (Study Data Round 1)

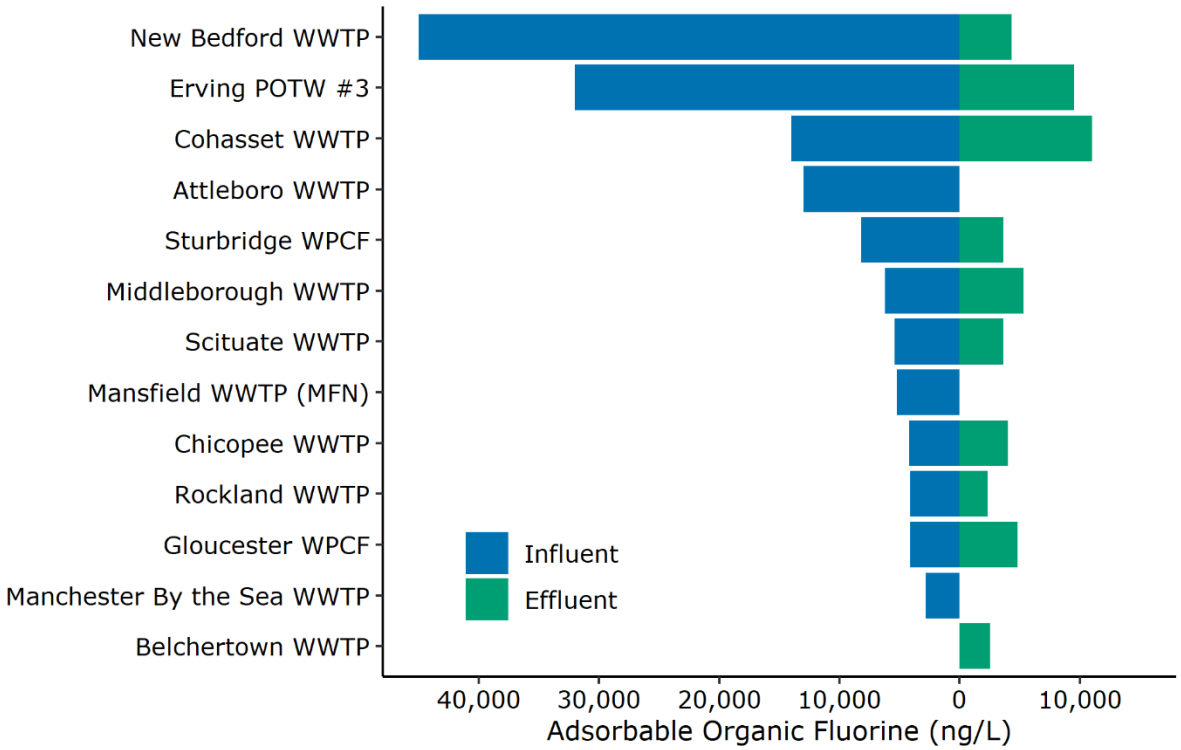


FIGURE 4-11
Influent and Effluent AOF Concentrations - 13 POTWs (Study Data Round 2)

Typical AOF influent and effluent concentrations ranged from about 1,000 to 14,000 ng/L across the majority of facilities, with a few exceptions. For example, the influent sample from the Wayland WWTP had a concentration greater than 30,000 ng/L during Round 1, while New Bedford WWTP and Erving POTW #3 had concentrations greater than 30,000 ng/L during Round 2. New Bedford WWTP and Erving POTW #3 represented the two largest influent concentrations during Round 2, with AOF concentrations greater than 15,000 ng/L. However, both facilities had influent concentrations less than 5,000 ng/L during Round 1 sampling, indicating considerable variability depending upon sampling event.

Facilities had significantly lower AOF concentrations in the effluent relative to the influent (Mann Whitney U-test, $p<0.002$), indicating typical sequestration of organofluoride into the solids. Median AOF concentrations in facility influent were 5,400 ng/L (when NDs were included as a value of "0") and 5,600 ng/L (when NDs were omitted). Median AOF concentrations in facility effluent were 3,500 ng/L (when NDs were included as "0") and 3,600 ng/L (when NDs were omitted). Figure 4-12 shows the distribution of AOF data for influent and effluent samples from both Round 1 and Round 2 (NDs omitted). Despite this general decreasing AOF trend from the influent to the effluent, some facilities had higher effluent AOF concentrations: Hardwick-Wheelwright WPCF, Erving POTW #3, Gloucester WPCF, and Cohasset WWTP (Round 1) as well as Erving POTW #3 and Gloucester WPCF (Round 2). Increased AOF in the effluent for these specific facilities suggests release of stored organofluoride during the treatment process and/or variability in influent concentrations that are not reflected in the effluent sampling event due to facility retention/detention time.

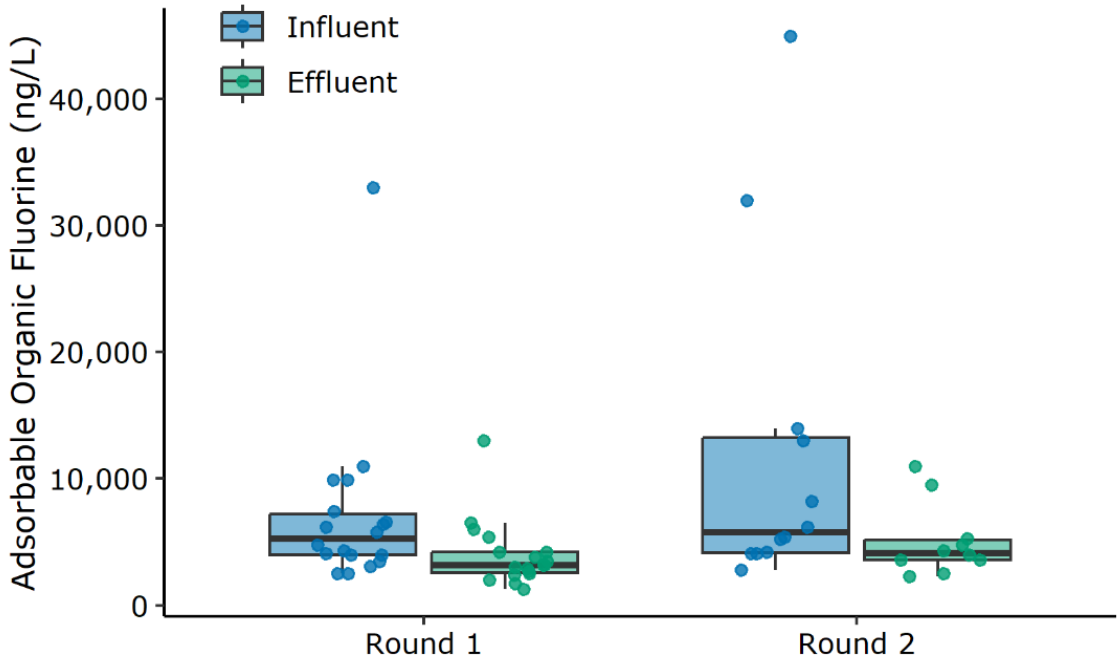


FIGURE 4-12
AOF Concentration Distributions (Study Data Rounds 1 and 2)

The Study dataset was filtered to include those influent and effluent samples that were analyzed for AOF via EPA Method 1621 in addition to PFAS via EPA Method 1633 and TOP. Individual samples were collected at each location and analyzed by each method from 18 POTWs during Round 1 and 13 of those 18 POTWs again for Round 2. As depicted in Figure 4-13, for both Round 1 and Round 2 data, AOF concentrations in both influent and effluent samples were significantly greater than the total PFAS concentrations from EPA Method 1633 and TOP, which, as discussed earlier in this section, were not significantly different from each other (Kruskal-Wallis tests, all $p<1\times10^{-7}$). As discussed in Section 1.3.4, EPA Method 1621 measures the total amount of organic fluorine in aqueous samples, which includes PFAS compounds and other fluorinated organic substances. For this reason, AOF results should always exceed $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations calculated based on a targeted analytical method such as EPA Method 1633.

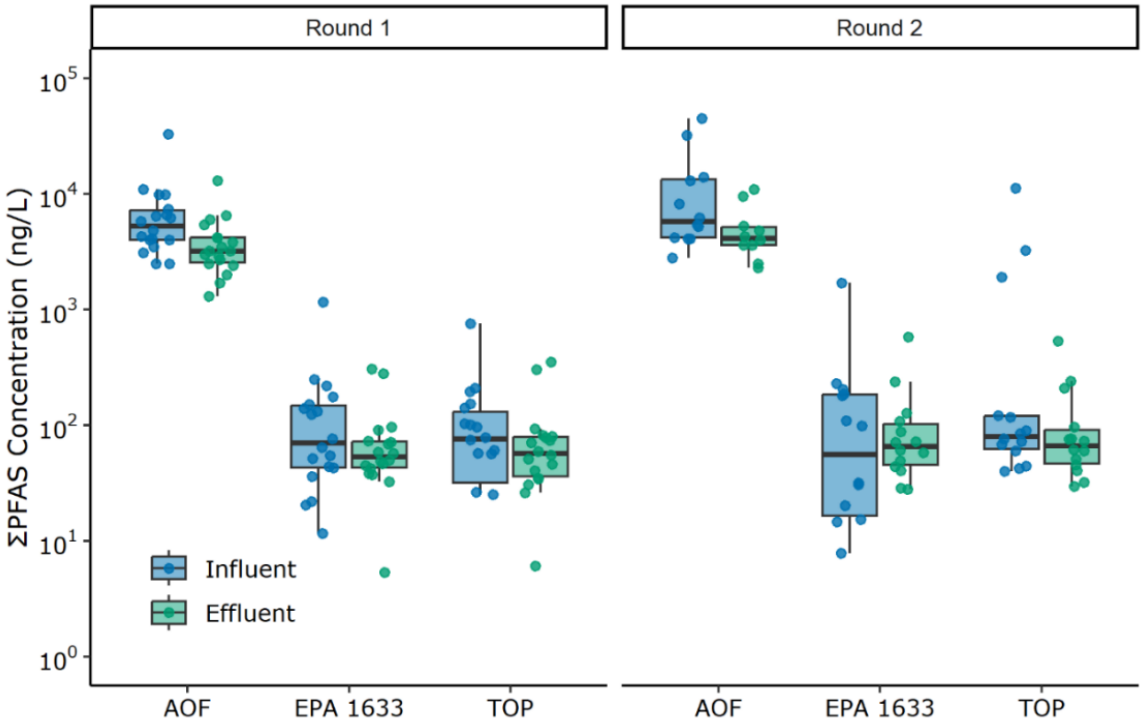


FIGURE 4-13
Comparison of AOF Concentrations to $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations (Study Data Rounds 1 and 2)

4.1.4 Study Oxidizable and Adsorbable PFAS

Mean concentrations of 9 PFAS classes were calculated for those measured by EPA Method 1633 and those measured by TOP analysis (Figures 4-14 and 4-15) based on concentrations of individual analytes (Tables 4-3 through 4-6). A percent change was calculated from the mean concentrations of each class. It would be expected that PFCA and PFSA classes would show a positive change (orange or red) between EPA Method 1633 and TOP whereas FASAA, FASE, and FASA classes should show negative change (green or yellow) if detected precursors are completely converted to precursors. If samples contain undetected precursors, the terminal product classes would be unknown but could include PFCAs, PFSAs, FTCAs and FTSAs, among others.

When concentrations were compared by percent change, there were differential changes based on class, sample medium, and sample round. Mean concentrations of FASAA, FASE, and FASEs decreased for sludges analyzed as dry mass in both rounds, and for sludges analyzed as liquids in Round 1. However, in Round 2, FASEs increased considerably for sludge analyzed as a liquid. In the influent and effluent samples, FASAs and FASAAs sometimes decreased and sometimes increased. Sludges analyzed as liquids showed a decrease in PFCAs between EPA Method 1633 and TOP for both Rounds, which is inconsistent with all other sample media and the expected oxidation result. Despite this variability in class percent change, these figures more clearly show which classes were more efficiently converted from precursors to quantifiable PFAS through oxidation. For example, during Round 1, PFCAs increased 22% in influent and 911% in the dry sludge after oxidation. Similarly, FTSAs increased 94% in influent and 3,979% in dry sludge after oxidation.

Round 1

PFAS	ΣPFAS1633 Influent (ng/L)	ΣPFAS1633 Effluent (ng/L)	ΣPFAS1633 Sludge (Wet, ng/L)	ΣPFAS1633 Sludge (Dry, ng/g)	ΣPFASTOP Influent (ng/L)	ΣPFASTOP Effluent (ng/L)	ΣPFASTOP Sludge (Wet, ng/L)	ΣPFASTOP Sludge (Dry, ng/g)	Change (%) Influent (ng/L)	Change (%) Effluent (ng/L)	Change (%) Sludge (Wet, ng/L)	Change (%) Sludge (Dry, ng/g)
PFCAs	81.78	51.04	3,771.19	13.23	100.08	55.22	2,825.27	133.80	22	8	-25	911
PFSAs	19.72	13.41	215.51	14.64	17.96	13.10	96.73	96.43	-9	-2	-55	559
FTCAs	15.66	0.14	0.00	21.65	1.78	0.00	0.00	21.34	-89	-100	-	-1
FTSAs	2.66	0.04	10.53	0.03	5.16	0.05	0.00	1.31	94	10	-100	3,979
FASAAs	0.06	0.19	4.00	3.35	0.01	0.13	0.00	0.81	-91	-31	-100	-76
FASEs	0.11	0.00	0.00	0.24	0.00	0.00	0.00	0.15	-100	-	-	-38
FASAs	0.00	0.02	2.45	0.08	0.00	0.18	0.00	0.01	-	778	-100	-89
PFECAs	0.03	0.00	0.00	0.00	0.06	0.00	0.00	0.00	92	-	-	-
PFESAs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-

FIGURE 4-14
Relative Abundance of Mean PFAS Concentrations (Study Data Round 1)

Round 2

PFAS	ΣPFAS1633 Influent (ng/L)	ΣPFAS1633 Effluent (ng/L)	ΣPFAS1633 Sludge (Wet, ng/L)	ΣPFAS1633 Sludge (Dry, ng/g)	ΣPFASTOP Influent (ng/L)	ΣPFASTOP Effluent (ng/L)	ΣPFASTOP Sludge (Wet, ng/L)	ΣPFASTOP Sludge (Dry, ng/g)	Change (%) Influent (ng/L)	Change (%) Effluent (ng/L)	Change (%) Sludge (Wet, ng/L)	Change (%) Sludge (Dry, ng/g)
PFCAs	134.62	49.58	3,449.49	28.82	224.82	49.70	1,159.36	61.69	67	0	-66	114
PFSAs	25.37	15.21	176.43	29.33	23.70	15.09	120.94	25.67	-7	-1	-31	-12
FTCAs	1.28	0.00	14.34	38.30	17.95	0.44	21.64	33.74	1303	-	51	-12
FTSAs	0.00	0.06	0.00	0.12	1.53	0.00	0.00	0.18	-	-100	-	56
FASAAs	0.08	0.29	0.26	4.79	0.27	0.07	32.81	2.08	235	-75	12,456	-56
FASEs	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	-	-	-	-100
FASAs	0.02	0.11	0.00	0.07	0.00	0.03	24.74	0.01	-100	-74	-	-84
PFECAs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	-	-	-	-
PFESAs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-

FIGURE 4-15
Relative Abundance of Mean PFAS Concentrations (Study Data Round 2)

Additional knowledge of specific PFAS classes represented in undetected precursors would improve our understanding of how precursors could be converted through wastewater treatment and which terminal products would be expected from this oxidation.

Figures 4-16 through 4-19 illustrate the distribution of median ΣPFAS concentrations at Massachusetts POTWs by medium (influent, effluent, wet/liquid sludge, and dry/solid sludge) and by analytical method (EPA Method 1633 and TOP analysis) for Study Round 1 data. (Similar figures for Study Round 2 data are included in Appendix C as Figure C-5 through C-8.) Frequency is represented as the number of POTWs with a ΣPFAS concentration falling within the specified concentration range: 100 ng/L increments for influent, effluent, and liquid sludge, and 100 ng/g increments for dry sludge. ΣPFAS concentrations greater than 1,000 ng/L (for influent, effluent, and liquid sludge) or 1,000 ng/g (for solid sludge) were grouped for ease of visualization. A rightward shift in SPFAS distributions between EPA Method 1633 and TOP analysis was expected, analogous to the expected increase in a POTW's ΣPFAS concentration after TOP analysis relative to its $\Sigma PFAS_{1633}$ concentration.

In general, most facilities had median influent and effluent ΣPFAS concentrations below 200 ng/L regardless of analytical method. However, sludge ΣPFAS concentrations on both liquid and dry mass basis exhibited a wider range of concentrations, particularly for TOP analysis. For Study Round 2 data presented in Appendix C, most facilities had median influent and effluent ΣPFAS concentrations below 200 ng/L and dry sludge ΣPFAS concentrations below 200 ng/g regardless of analytical method, with liquid sludge ΣPFAS concentrations showing much more variability for both analytical methods. Therefore, the expected rightward shift in ΣPFAS distributions was not observed between $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations, consistent with the elevated RLs for TOP results and possible inefficient oxidation of PFAS precursors discussed in previous sections.

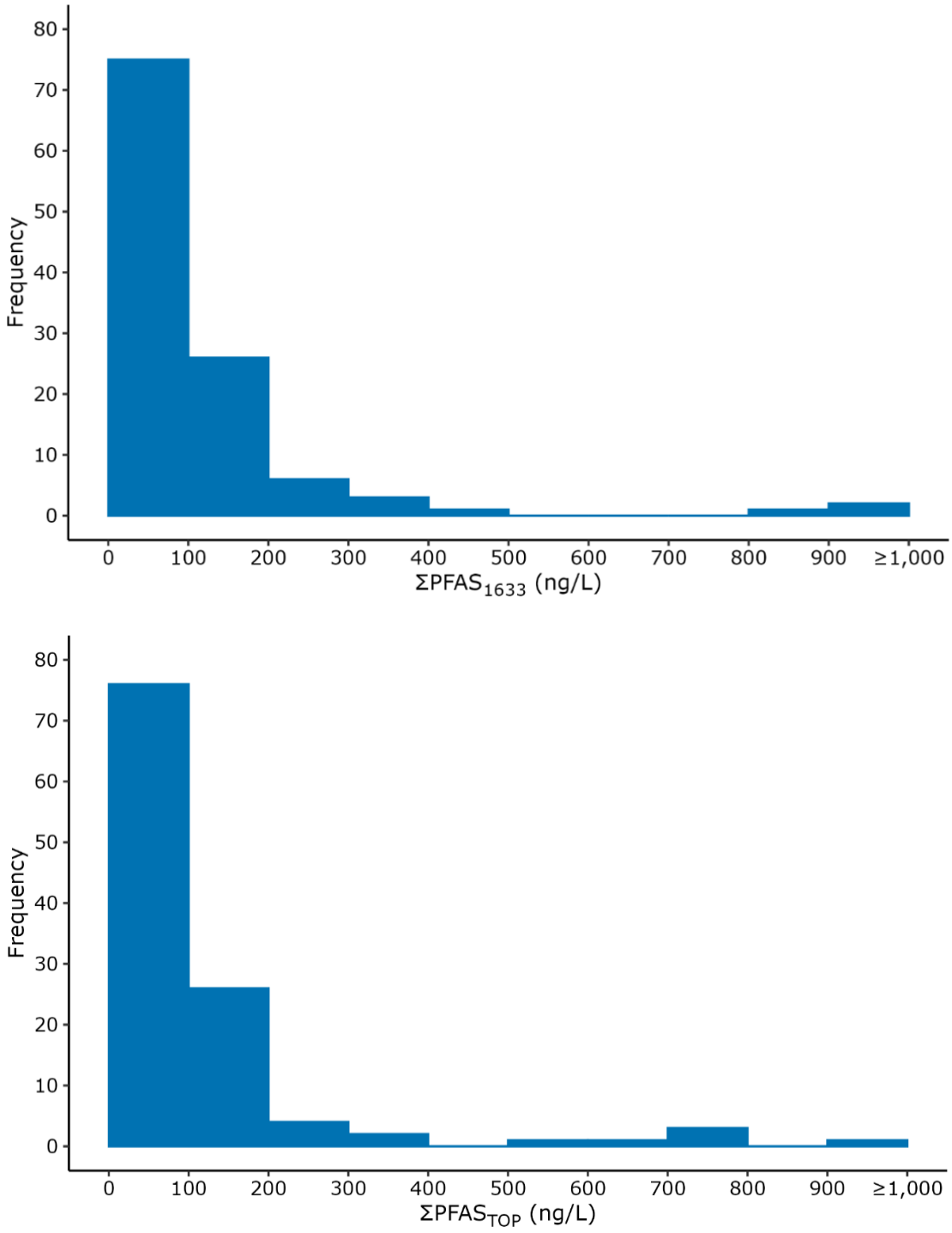


FIGURE 4-16
Relative Abundance of ΣPFAS Concentration Ranges EPA Method 1633 and TOP (Study Data Round 1 Influent)

As shown in Figure 4-16, for Round 1 influent samples, 75 out of 114 POTWs (66%) had PFAS concentrations <100 ng/L via EPA Method 1633, and 76 POTWs (67%) had PFAS concentrations <100 ng/L via TOP analysis.

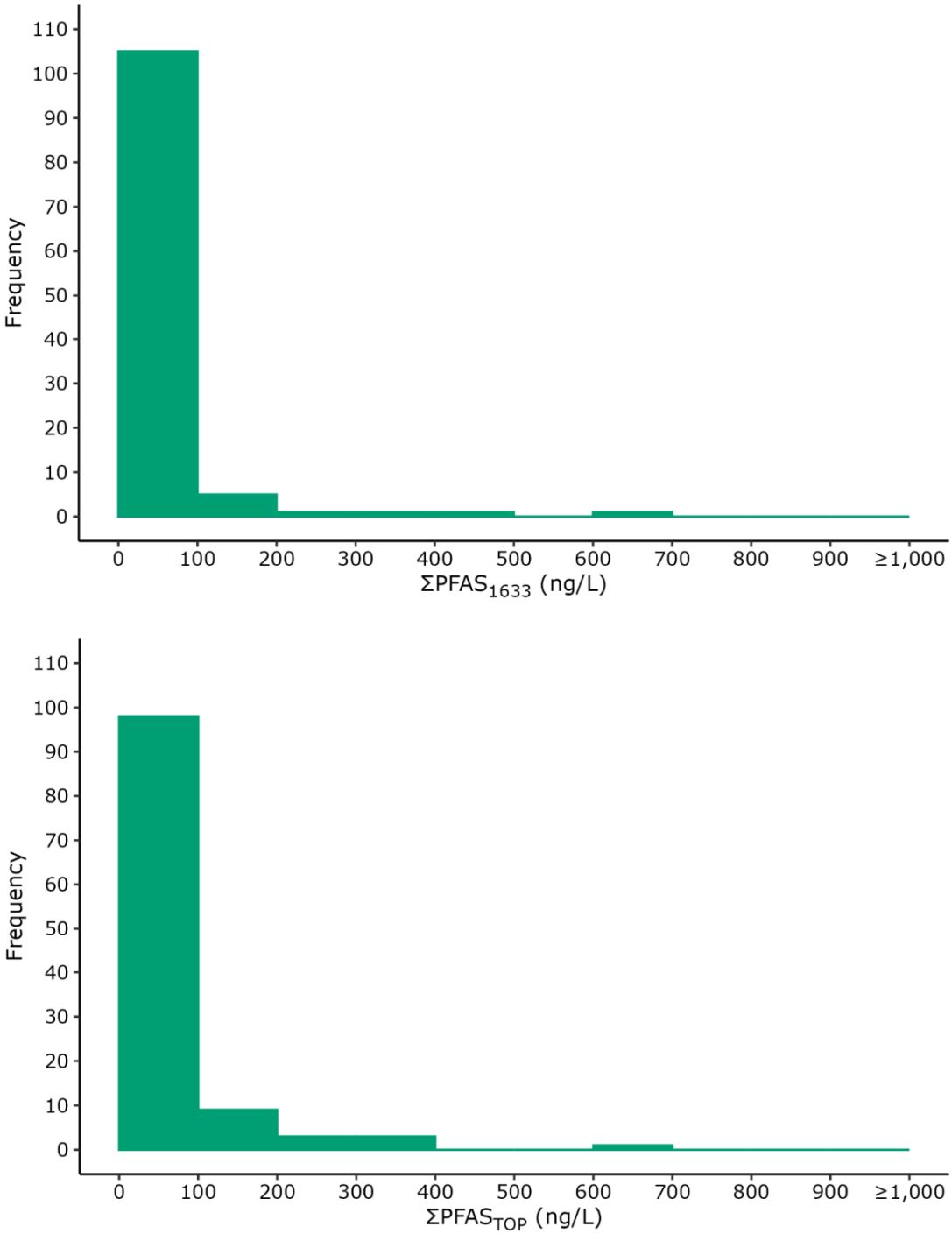


FIGURE 4-17
Relative Abundance of ΣPFAS Concentration Ranges EPA Method 1633 and TOP (Study Data Round 1 Effluent)

As shown in Figure 4-17, for Round 1 effluent samples, 105 out of 114 POTWs (92%) had PFAS concentrations <100 ng/L via EPA Method 1633, and 98 POTWs (86%) had PFAS concentrations <100 ng/L via TOP analysis.

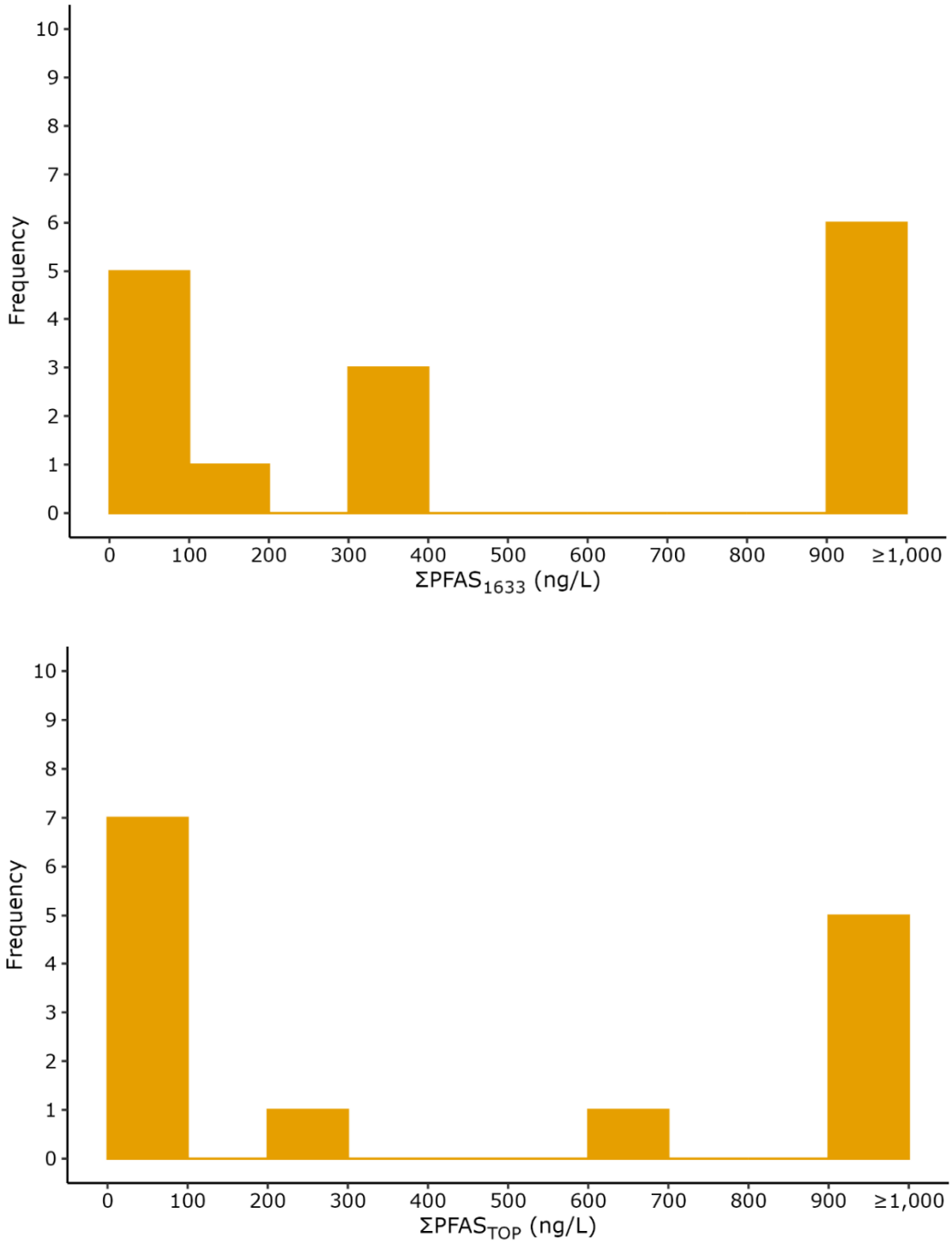


FIGURE 4-18
Relative Abundance of ΣPFAS Concentration Ranges EPA Method 1633 and TOP (Study Data Round 1 Liquid Mass Sludge)

As shown in Figure 4-18, for Round 1 liquid mass sludge samples, 5 out of 15 POTWs with sludge analyzed as a liquid (33%) had PFAS concentrations <100 ng/L via EPA Method 1633, and 7 out of 15 POTWs (47%) had PFAS concentrations <100 ng/L via TOP analysis.

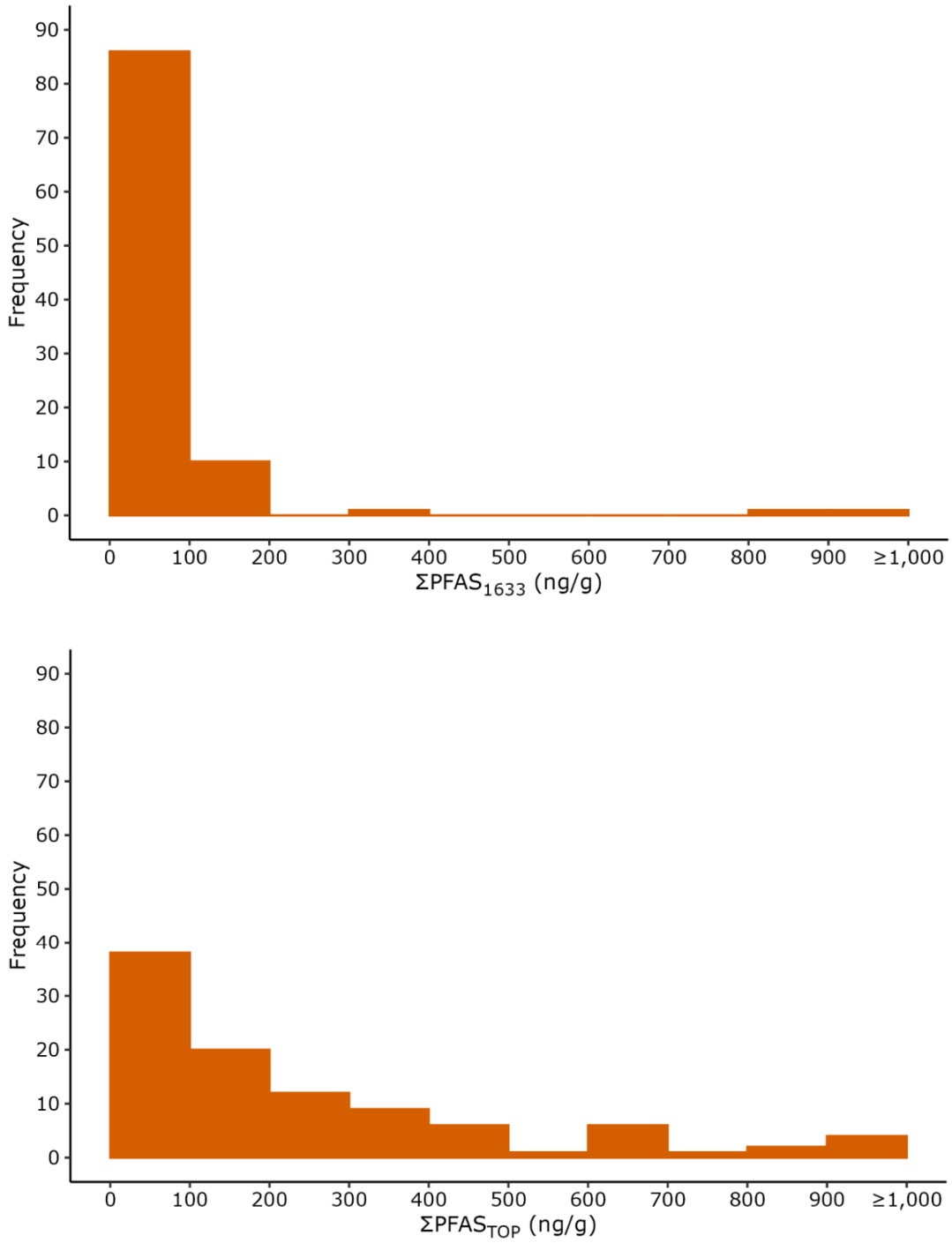


FIGURE 4-19
Relative Abundance of ΣPFAS Concentration Ranges for EPA Method 1633 and TOP
(Study Data Round 1 Dry Mass Sludge)

As shown in Figure 4-19, for Round 1 dry mass sludge samples, 86 out of 99 POTWs with sludge analyzed as a solid (87%) had PFAS concentrations <100 ng/g via EPA Method 1633, and 38 out of 99 POTWs (38%) had PFAS concentrations <100 ng/g via TOP analysis.

4.2 EEA PFAS Data Portal Data Evaluations

4.2.1 Portal PFAS Detection Frequency

Figure 4-20 displays the frequency of PFAS compound detections in influent, effluent, and sludge samples from the Portal data. The frequencies in Figure 4-20 are presented as a heat map depicting compounds detected in lower to higher percentages of samples in scale of lighter to darker red color, respectively. For Portal samples analyzed by EPA Method 1633, 25 of the 40 PFAS compounds were detected in influent samples, 22 in effluent samples, 23 in sludge samples that were analyzed as liquids, and 38 in sludge samples that were analyzed as solids. For Portal samples analyzed by EPA Method 537.1 and other targeted methods, 16 PFAS compounds were detected in both influent samples and effluent samples (although not the same 16 compounds), and 15 compounds were detected in sludge samples that were analyzed as solids. (No sludge samples were analyzed as a liquid by these non-1633 methods.) Compounds from the PFAS classes PFCAs, PFSAs, and FASAAs occur with the greatest detection frequency for samples analyzed by EPA Method 1633. PFCAs, FTCAs, FASSAs, and one FASA occurred with the greatest detection frequency for samples analyzed by 537.1 and other targeted methods, with several individual compounds detected in 100% of samples.

		EPA 1633				EPA 537.1 and Other Targeted			
PFAS		Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)	Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)*	Sludge (Dry, ng/g)
PFCAs	PFBA	40	64	20	12	80	83	-	0
	PFPeA	66	87	60	26	80	100	-	0
	PFHxA	81	95	65	56	100	100	-	67
	PFHpA	56	77	33	16	90	100	-	0
	PFOA	78	94	67	49	95	100	-	75
	PFNA	28	45	29	29	57	76	-	55
	PFDA	9	25	43	59	38	67	-	85
	PFUnA	2	2	15	30	0	0	-	17
	PFDoA	3	0	11	39	0	0	-	17
	PFTrDA	0	0	5	16	0	0	-	0
	PFTeDA	0	0	0	13	0	0	-	0
PFSAs	PFBS	67	82	33	20	83	83	-	0
	PFPeS	14	24	5	3	0	17	-	0
	PFHxS	52	70	19	21	57	85	-	5
	PFHpS	2	2	5	5	0	0	-	0
	PFOS	78	88	55	90	94	95		94
	PFNS	0	0	0	2	0	0	-	0
	PFDS	2	2	0	24	20	0	-	60
	PFDoS	4	1	0	5	20	0	-	33
FTCAs	3:3 FTCA	2	1	5	2	0	0	-	0
	5:3 FTCA	4	1	20	31	100	100	-	100
	7:3 FTCA	0	0	0	11	0	0	-	100
FTSAs	4:2 FTSA	0	0	0	1	0	0	-	0
	6:2 FTSA	4	2	5	3	0	17	-	0
	8:2 FTSA	0	0	5	3	0	0	-	0
FASAAs	NMeFOSAA	3	13	20	67	0	17	-	100
	NEtFOSAA	5	6	10	61	0	0	-	100
FASEs	NMeFOSE	2	0	5	20	20	0	-	0
	NEtFOSE	1	1	0	7	0	0	-	0
FASAs	PFOSA	2	12	30	36	83	100	-	83
	NMeFOSA	0	0	0	1	0	0	-	0
	NEtFOSA	0	0	0	1	0	0	-	0
PFECAs	PFMPA	1	0	0	2	0	0	-	0
	PFMBA	0	0	0	1	0	0	-	0
	NFDHA	0	0	0	1	0	0	-	0
	HFPO-DA	0	0	0	2	50	50	-	0
	ADONA	0	0	0	0	0	0	-	0
PFESAs	PFEESA	0	0	0	1	0	0	-	0
	9Cl-PF3ONS	0	0	0	0	0	0	-	0
	11Cl-PF3OUdS	0	0	0	1	0	0	-	0

*No sludge samples recorded in ng/L for methods EPA 537.1 and Other Targeted.

FIGURE 4-20
PFAS Detection Frequency by Percent of Samples (Portal Data)

4.2.2 Portal PFAS Concentrations

4.2.2.1 Total PFAS by POTW & Sample Medium

Figure 4-21 displays a heat map for PFAS compound concentrations (median and mean) in influent, effluent, and sludge samples from all Portal data including EPA Method 1633, Method 537.1 and other targeted methods, as well as unspecified methods (which include both EPA Method 1633 and non-1633 methods). Because all non-1633 methods do not target the same 40 PFAS, the same evaluation was completed using Portal data known to come from EPA Method 1633 analyses. Figure 4-22 displays a heat map for PFAS compound concentrations (median and mean) in influent, effluent, and sludge samples from all Portal data analyzed by EPA Method 1633 only. In both figures, PFAS compounds detected at higher concentrations are presented in a darker red color.

Figures 4-23 through 4-25 depict ΣPFAS concentrations from the Portal data (all analytical methods) for influent, effluent, and sludges. Figure 4-23 provides influent and effluent ΣPFAS concentrations presented in order of highest to lowest influent concentration (blue bars), with the with the effluent concentration projected in the opposite direction from the figure origin (green bars). The 33 facilities with the highest influent concentrations in the Portal ("Upper 33") are shown on the left, while the lowest 33 facilities ("Lower 33") are shown on the right.

Figure 4-24 provides dry sludge concentrations and Figure 4-25 provides wet sludge concentrations (both with POTWs presented generally in the same order as Figure 4-23). In general, Portal effluent concentrations are higher than influent concentrations for all POTWs. These higher effluent ΣPFAS concentrations may be attributed to the transformations occurring within the POTWs treatment processes converting precursor compounds into terminal compounds, especially those found in the PFCAs class. As shown in Figure 4-24, facilities with the highest ΣPFAS concentrations in dry sludge from the Portal data include Middleborough WWTP and Pepperell WWTF, both with results of over 300 ng/g. Both facilities are classified as medium POTWs; however, Pepperell WWTF does not have IPP. Both Middleborough WWTP and Pepperell WWTF were shown to have larger ΣPFAS concentrations in effluent than in influent, suggesting transformation of PFAS precursors within the POTW. As shown on Figure 4-25, facilities with the highest ΣPFAS concentrations in wet sludge from the Portal data include Barre WWTP and Hopedale WWTF. Both facilities are classified as small POTWs with no IPP. Available Portal data indicates that the Barre WWTP was also observed to have elevated ΣPFAS concentrations in both influent and effluent, whereas Hopedale WWTF showed a significant disparity between ΣPFAS concentrations when comparing sludge to influent and effluent sample results.

		Median				Mean			
PFAS		Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)	Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)
PFCAs	PFBA	4.60	6.07	19.30	1.77	6.89	7.45	197.43	0.36
	PFPeA	6.40	14.00	51.50	3.06	9.70	20.18	396.80	1.49
	PFHxA	5.23	12.65	49.00	2.42	6.39	21.48	414.65	3.57
	PFHpA	2.34	2.56	4.30	0.56	1.78	2.80	49.51	0.23
	PFOA	6.07	7.90	30.00	3.05	6.04	11.40	691.52	2.31
	PFNA	1.00	1.10	24.00	1.28	0.48	1.13	191.86	0.72
	PFDA	0.50	0.98	60.00	3.16	0.10	0.44	351.91	2.58
	PFUnA	0.34	0.57	166.00	1.04	0.03	0.02	278.85	0.47
	PFDoA	1.50	2.82	522.20	1.27	0.05	0.01	54.97	0.59
	PFTrDA	-	-	990.00	0.57	-	-	49.50	0.11
	PFTeDA	-	-	-	0.50	-	-	-	0.11
PFSAs	PFBS	4.02	4.40	5.47	0.99	4.76	12.12	73.60	0.47
	PFPeS	0.85	0.50	0.58	0.69	0.37	0.19	0.03	0.07
	PFHxS	2.50	2.14	9.05	0.83	4.32	2.83	40.10	0.45
	PFHpS	0.52	0.47	0.55	0.43	0.01	0.01	0.03	0.03
	PFOS	8.37	5.41	72.00	11.00	9.47	6.57	213.16	13.49
	PFNS	-	-	-	0.94	-	-	-	0.02
	PFDS	2.67	2.40	-	1.13	0.06	0.05	-	0.37
	PFDoS	5.09	8.02	-	1.93	0.22	0.06	-	0.21
FTCAs	3:3 FTCA	197.50	67.00	8.10	3.96	3.44	1.22	0.41	0.10
	5:3 FTCA	17.00	1.56	296.50	16.25	4.18	0.18	57.35	22.93
	7:3 FTCA	-	-	-	6.41	-	-	-	2.51
FTSAs	4:2 FTSA	-	-	-	0.72	-	-	-	0.01
	6:2 FTSA	7.40	1.70	39.50	2.92	0.30	0.06	1.98	0.15
	8:2 FTSA	1.20	-	51.00	0.60	0.00	-	2.55	0.12
FASAAs	NMeFOSAA	1.43	1.38	8.17	4.50	0.07	0.19	42.35	4.08
	NEtFOSAA	1.10	1.15	476.61	3.25	0.16	0.10	47.66	2.63
FASEs	NMeFOSE	3.05	30.90	113.00	6.88	0.09	0.12	5.65	1.75
	NEtFOSE	3.33	15.02	-	5.50	0.03	0.11	-	0.89
FASAs	PFOSA	0.56	0.65	43.70	1.19	0.03	0.96	304.51	0.71
	NMeFOSA	-	2.17	-	2.06	-	0.01	-	0.02
	NEtFOSA	-	-	-	4.68	-	-	-	0.07
PFECAs	PFMPA	23.00	0.73	-	0.52	0.17	-	-	0.01
	PFMBA	-	-	-	0.67	-	-	-	0.01
	NFDHA	-	-	-	10.31	-	-	-	0.09
	HFPO-DA	2.82	1.46	-	3.41	0.02	0.01	-	0.08
	ADONA	-	-	-	0.26	-	-	-	0.00
PFESAs	PFEESA	3.90	-	-	-	0.01	-	-	0.00
	9Cl-PF3ONS	-	-	-	1.38	-	-	-	0.01
	11Cl-PF3OUdS	-	-	-	2.72	-	-	-	0.01

FIGURE 4-21
PFAS Detection Frequency (Portal Data – All Analytical Methods)

		Mean				Median			
PFAS		Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)	Influent (ng/L)	Effluent (ng/L)	Sludge (Wet, ng/L)	Sludge (Dry, ng/g)
PFCAs	PFBA	7.04	7.54	197.43	0.37	4.61	6.10	19.30	1.77
	PFPeA	9.88	20.46	396.80	1.53	6.54	14.1	51.50	3.06
	PFHxA	6.45	21.74	414.65	3.64	5.25	12.95	49	2.52
	PFHpA	1.75	2.78	49.51	0.25	2.20	2.50	4.30	0.57
	PFOA	6.00	11.66	691.52	2.42	5.86	7.80	30	3.41
	PFNA	0.46	1.15	191.86	0.77	1	1.10	24	1.45
	PFDA	0.08	0.43	351.91	2.69	0.44	1.10	60	3.31
	PFUnA	0.03	0.02	278.85	0.48	0.34	0.57	166	1.06
	PFDoA	0.05	0.01	54.97	0.60	1.50	2.82	522.20	1.27
	PFTrDA	-	-	49.50	0.11	-	-	990	0.57
	PFTeDA	-	-	-	0.11	-	-	-	0.50
PFSAs	PFBS	4.83	12.33	73.60	0.48	4.12	4.41	5.47	0.99
	PFPeS	0.38	0.19	0.03	0.08	0.85	0.50	0.58	0.69
	PFHxS	4.69	2.96	40.10	0.50	2.54	2.20	9.05	0.82
	PFHpS	0.01	0.01	0.03	0.03	0.52	0.47	0.55	0.43
	PFOS	9.21	6.30	213.16	13.48	7.90	5.13	72	10.8
	PFNS	-	-	-	0.02	-	-	-	0.94
	PFDS	0.06	0.05	-	0.36	2.95	2.40	-	1.10
	PFDoS	0.22	0.06	-	0.19	5.35	8.02	-	1.93
FTCAs	3:3 FTCA	3.52	1.23	0.41	0.10	197.50	67.00	8.10	3.96
	5:3 FTCA	4.24	0.16	57.35	23.25	62.70	11.50	296.50	16.60
	7:3 FTCA	-	-	-	2.51	-	-	-	7.50
FTSAs	4:2 FTSA	-	-	-	0.01	-	-	-	0.72
	6:2 FTSA	0.31	0.06	1.98	0.15	7.40	2.12	39.50	2.92
	8:2 FTSA	0.00	-	2.55	0.12	1.20	-	51.00	0.60
FASAAs	NMeFOSAA	0.07	0.20	42.35	4.12	1.43	1.41	8.17	4.58
	NEtFOSAA	0.16	0.10	47.66	2.64	1.20	1.15	476.61	3.32
FASEs	NMeFOSE	0.09	0.12	5.65	1.79	3.40	30.90	113.00	6.88
	NEtFOSE	0.03	0.11	-	0.92	3.33	15.02	-	5.50
FASAs	PFOSA	0.01	0.96	304.51	0.70	0.86	0.69	43.70	1.21
	NMeFOSA	-	0.01	-	0.02	-	2.17	-	2.06
	NEtFOSA	-	-	-	0.07	-	-	-	4.68
PFECAs	PFMPA	0.18	0.00	-	0.01	23	0.73	-	0.52
	PFMBA	-	-	-	0.01	-	-	-	0.67
	NFDHA	-	-	-	0.09	-	-	-	10.31
	HFPO-DA	0.00	0.00	-	0.08	-	-	-	3.41
	ADONA	-	-	-	0.00	-	-	-	0.26
PFESAs	PFEESA	0.02	-	-	0	3.90	-	-	-
	9Cl-PF3ONS	-	-	-	0.01	-	-	-	1.38
	11Cl-PF3OUdS	-	-	-	0.01	-	-	-	2.72

FIGURE 4-22
PFAS Detection Frequency (Portal Data – EPA Method 1633)

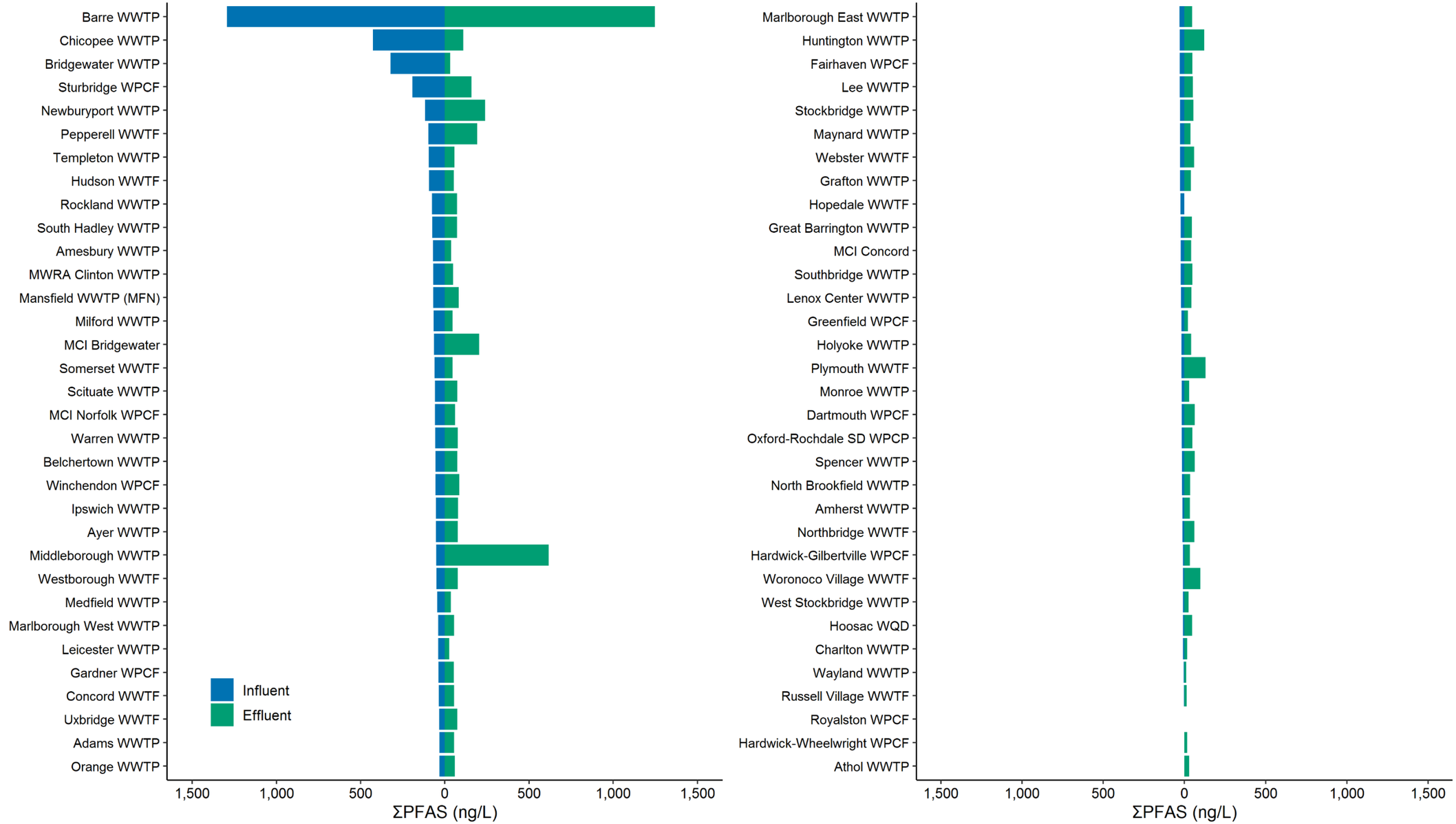


FIGURE 4-23
Total PFAS Concentrations for the Upper 33 POTWs (left) and Lower 33 POTWs (right) (Portal Data Influent and Effluent – all analytical methods)

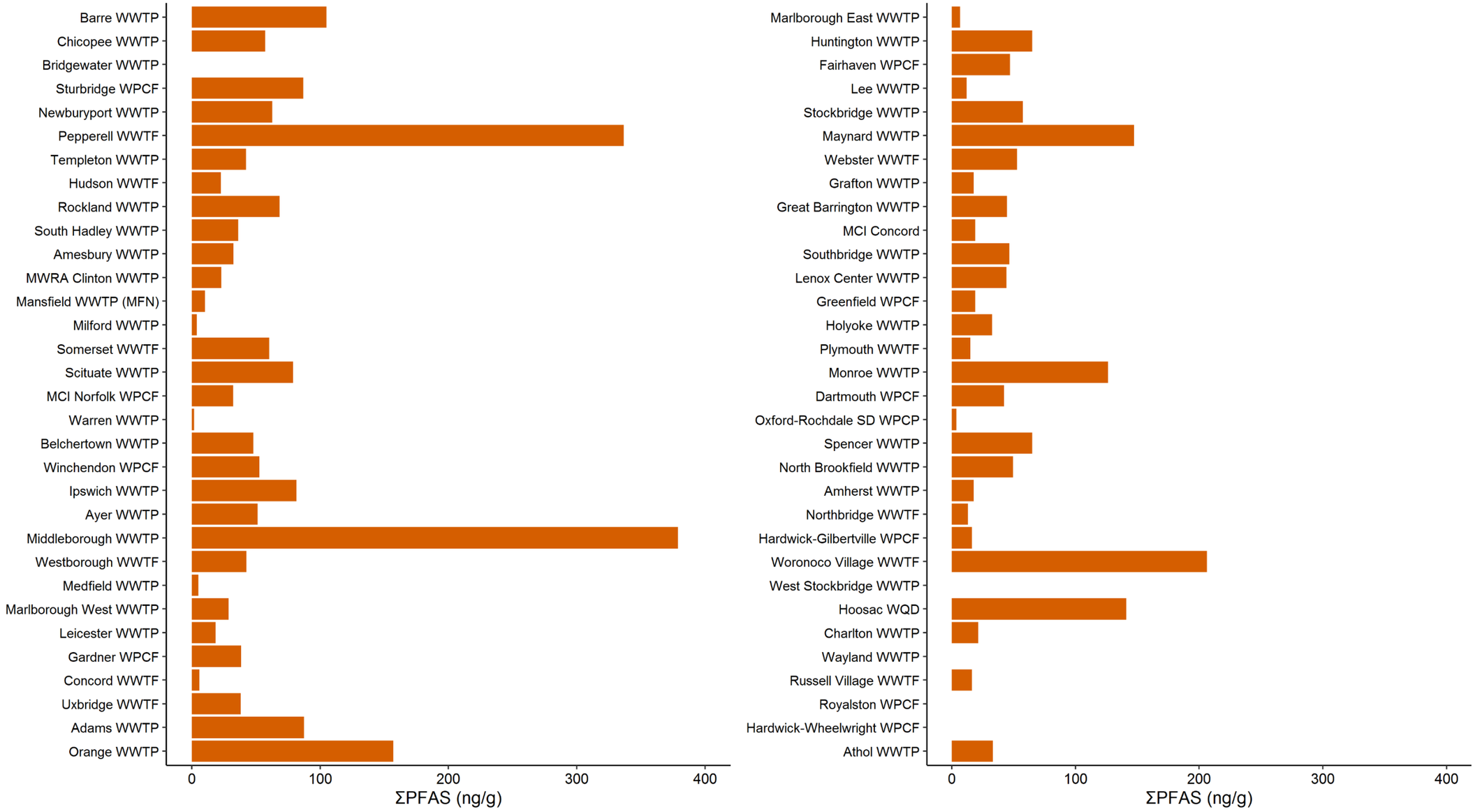


FIGURE 4-24
Total PFAS Concentrations (Portal Data Dry Mass Sludge – all analytical methods)

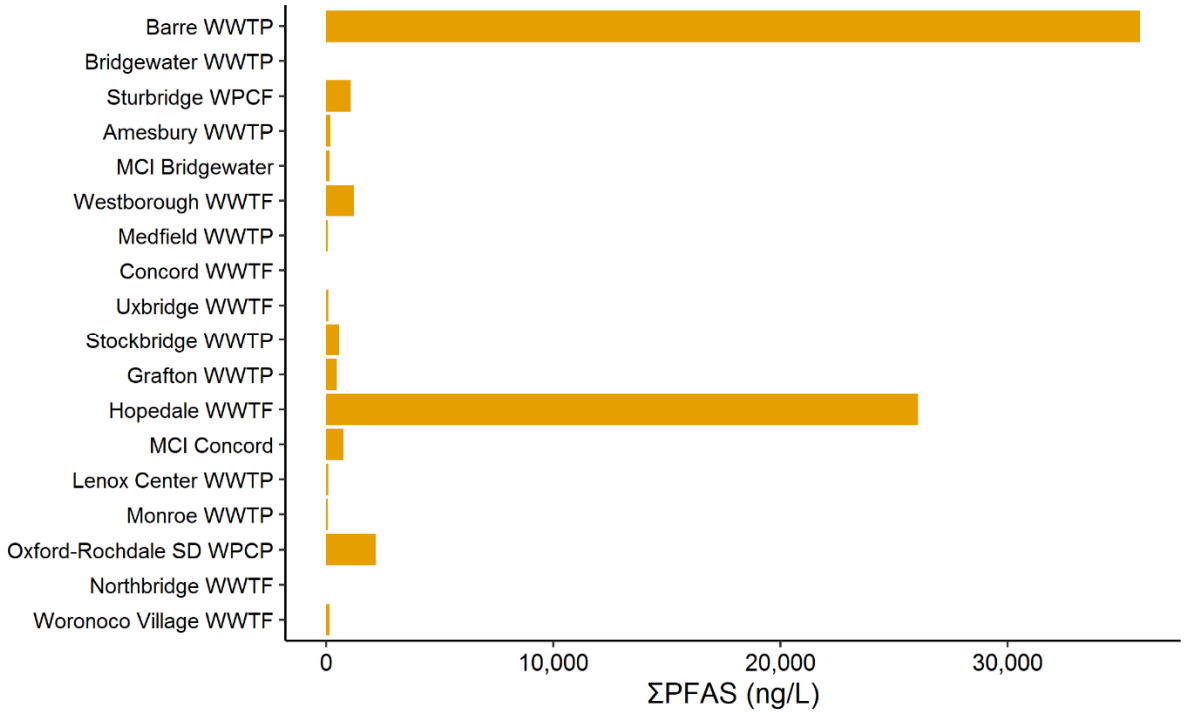


FIGURE 4-25
Total PFAS Concentrations (Portal Data Liquid Mass Sludge – all analytical methods)

As indicated in Table 4-6 and Figure 4-26, the median effluent ΣPFAS concentration was significantly greater than the median influent ΣPFAS concentration for paired influent and effluent samples (Wilcoxon signed-rank test, $p=9\times10^{-12}$). Sludge samples measured on a liquid basis had a significantly higher median ΣPFAS concentration than both influent and effluent ΣPFAS concentrations (Kruskal-Wallis test, both $p<0.007$).

TABLE 4-6
Summary Statistics for Portal ΣPFAS Concentrations

Medium	Median ΣPFAS	Mean ΣPFAS	Minimum ΣPFAS	Maximum ΣPFAS
Influent (ng/L)	30.69	55.36	0	2,393.90
Effluent (ng/L)	50.54	85.24	0	1,679.80
Sludge, wet (ng/L)	137.40	3,354.77	0	35,840.00
Sludge, dry (ng/g)	28.50	59.19	0	1,625.44

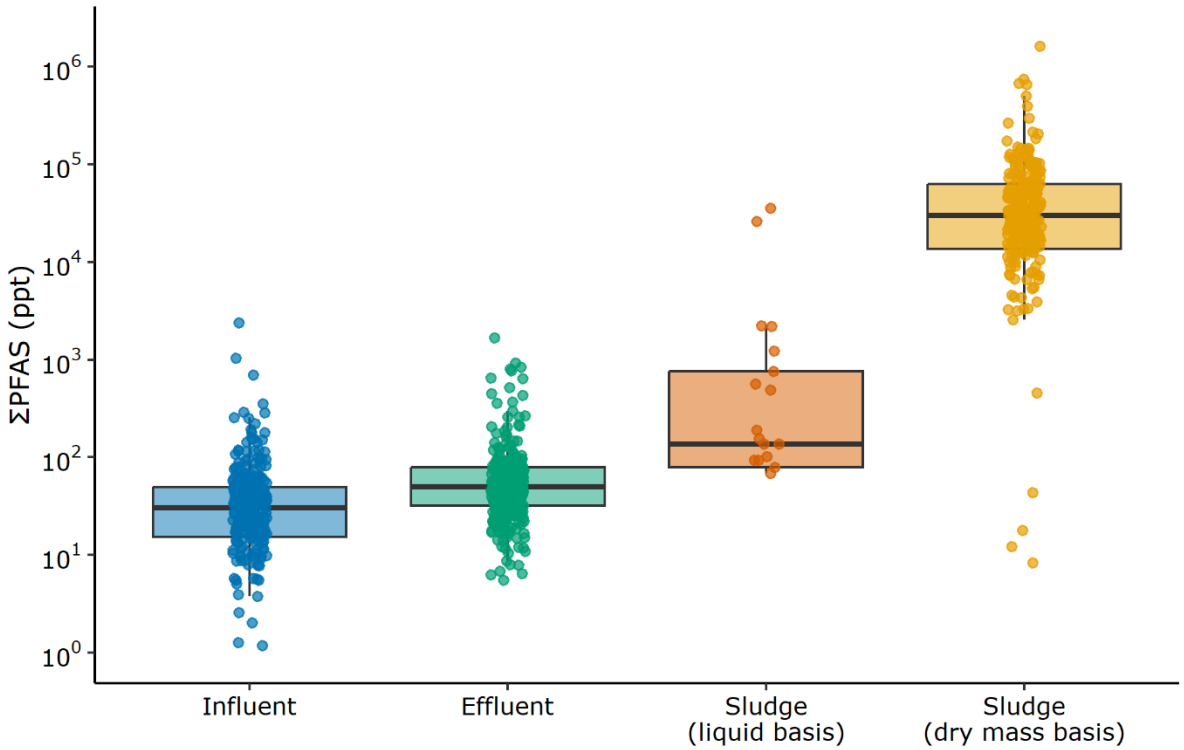


FIGURE 4-26
ΣPFAS Distribution for Influent, Effluent, & Sludge (Portal Data)
Note: Sludge concentrations originally reported in ng/g (ppb) were multiplied by 1,000 to convert to ppt for visual comparison with ΣPFAS for liquid samples.

4.2.2.2 Total PFAS by Compound

Table 4-7 provides summary statistics for the 66 POTWs with PFAS concentration data in the Portal from all analytical methods including EPA Method 1633, Method 537.1 and other targeted methods, as well as unspecified methods (which include both 1633 and non-1633 methods). Table 4-8 provides summary statistics for PFAS concentration data in the Portal analyzed by EPA Method 1633 only. In both tables, PFAS compounds detected at higher concentrations are presented in a darker red color. The ΣPFAS concentrations by compound from the Portal data is consistent with the results of the Study, indicating PFCAs and PFSAs have the highest average concentrations across influent, effluent, and sludge. Notably in the Portal data, the sludge by wet weight has an increased concentration of FASAs and the sludge by dry weight has an increased concentration of FTCAs. A comparison of the statistics of PFAS concentration data from all analytical methods (Table 4-7) to statistics of PFAS concentration data from EPA Method 1633 only (Table 4-8) are generally consistent with respect to PFAS classes detected based on media type, suggesting statistical similarity between results of EPA Method 1633 and all available PFAS data from the Portal. Potential variability between the statistical summary of PFAS concentrations between EPA Method 1633 and all other analytical methods may be a result of the differences between target individual PFAS analytes based on method.

TABLE 4-7
Summary of EEA PFAS Portal Data Statistics (All Analytical Methods)

		Influent (ng/L)							Effluent (ng/L)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	6.89	61.34	4.60	-	3.61	269	159	7.45	20.44	6.07	-	7.40	273	98
	PFPeA	9.70	24.53	6.40	-	7.62	264	89	20.18	30.54	14.00	5.81	22.75	272	35
	PFHxA	6.39	15.75	5.23	2.35	6.94	267	51	21.48	44.48	12.65	7.90	18.83	272	12
	PFHpA	1.78	4.91	2.34	-	2.51	297	124	2.80	5.25	2.56	1.03	3.17	300	63
	PFOA	6.04	12.53	6.07	2.27	7.22	297	61	11.40	38.67	7.90	5.12	10.15	300	16
	PFNA	0.48	1.29	1.00	-	0.65	298	208	1.13	5.30	1.10	-	1.07	300	157
	PFDA	0.10	0.46	0.50	-	-	298	265	0.44	1.65	0.98	-	0.54	299	213
	PFUnA	0.03	0.48	0.34	-	-	269	264	0.02	0.18	0.57	-	-	272	267
	PFDoA	0.05	0.30	1.50	-	-	269	261	0.01	0.17	2.82	-	-	273	272
	PFTrDA	-	-	-	-	-	269	269	-	-	-	-	-	273	273
	PFTeDA	-	-	-	-	-	261	261	-	-	-	-	-	265	265
PFSAs	PFBS	4.76	16.14	4.02	-	4.90	261	85	12.12	47.00	4.40	2.12	5.66	268	47
	PFPeS	0.37	1.44	0.85	-	-	249	214	0.19	0.51	0.50	-	-	273	208
	PFHxS	4.32	40.81	2.50	-	2.59	296	144	2.83	9.96	2.14	-	2.57	298	88
	PFHpS	0.01	0.07	0.52	-	-	266	261	0.01	0.12	0.47	-	-	271	265
	PFOS	9.47	19.36	8.37	2.39	11.20	269	58	6.57	7.75	5.41	2.56	7.23	282	34
	PFNS	-	-	-	-	-	269	269	-	-	-	-	-	273	273
	PFDS	0.06	0.41	2.67	-	-	269	262	0.05	0.38	2.40	-	-	273	267
	PFDoS	0.22	1.58	5.09	-	-	263	253	0.06	0.81	8.02	-	-	268	266
FTCAs	3:3 FTCA	3.44	32.30	197.50	-	-	259	255	1.22	15.94	67.00	-	-	265	262
	5:3 FTCA	4.18	36.41	17.00	-	-	264	249	0.18	1.59	1.56	-	-	267	259
	7:3 FTCA	-	-	-	-	-	263	263	-	-	-	-	-	267	267
FTSAs	4:2 FTSA	-	-	-	-	-	268	268	-	-	-	-	-	272	272
	6:2 FTSA	0.30	1.84	7.40	-	-	268	258	0.06	0.50	1.70	-	-	272	265
	8:2 FTSA	0.00	0.07	1.20	-	-	268	267	-	-	-	-	-	272	272
FASAAs	NMeFOSAA	0.07	0.63	1.43	-	-	263	255	0.19	0.60	1.38	-	-	268	234
	NEtFOSAA	0.16	1.23	1.10	-	-	268	255	0.10	0.49	1.15	-	-	270	253
FASEs	NMeFOSE	0.09	0.67	3.05	-	-	264	258	0.12	1.89	30.90	-	-	268	267
	NEtFOSE	0.03	0.30	3.33	-	-	264	262	0.11	1.71	15.02	-	-	268	266
FASAs	PFOSA	0.03	0.16	0.56	-	-	268	259	0.96	11.48	0.65	-	-	271	233
	NMeFOSA	-	-	-	-	-	264	264	0.01	0.13	2.17	-	-	268	267
	NEtFOSA	-	-	-	-	-	264	264	-	-	-	-	-	268	268
PFECAs	PFMPA	0.17	2.15	23.00	-	-	263	261	0.00	0.04	0.73	-	-	267	266
	PFMBA	-	-	-	-	-	263	263	-	-	-	-	-	267	267
	NFDHA	-	-	-	-	-	263	263	-	-	-	-	-	267	267
	HFPO-DA	0.02	0.29	2.82	-	-	263	261	0.01	0.15	1.46	-	-	266	264
	ADONA	-	-	-	-	-	263	263	-	-	-	-	-	267	267
PFESAs	PFEESA	0.01	0.24	3.90	-	-	263	262	-	-	-	-	-	267	267
	9Cl-PF3ONS	-	-	-	-	-	263	263	-	-	-	-	-	267	267
	11Cl-PF3OUdS	-	-	-	-	-	263	263	-	-	-	-	-	267	267

		Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	197.43	871.52	19.30	-	-	20	16	0.36	1.47	1.77	-	-	244	215
	PFPeA	396.80	1,410.51	51.50	-	63.50	20	8	1.49	4.61	3.06	-	0.00	240	180
	PFHxA	414.65	1,357.60	49.00	-	64.50	20	7	3.57	7.44	2.42	-	3.00	242	107
	PFHpA	49.51	217.83	4.30	-	2.26	21	14	0.23	1.58	0.56	-	-	270	231
	PFOA	691.52	2,098.68	30.00	-	65.00	21	7	2.31	4.81	3.05	-	3.10	269	131
	PFNA	191.86	764.83	24.00	-	3.76	21	15	0.72	2.27	1.28	-	0.47	270	185
	PFDA	351.91	1,434.34	60.00	-	46.00	21	12	2.58	4.53	3.16	-	3.59	270	105
	PFUnA	278.85	1,205.96	166.00	-	-	20	17	0.47	1.16	1.04	-	0.57	241	169
	PFDoA	54.97	222.24	522.20	-	-	19	17	0.59	1.15	1.27	-	0.96	243	149
	PFTrDA	49.50	221.37	990.00	-	-	20	19	0.11	0.32	0.57	-	-	244	206
	PFTeDA	-	-	-	-	-	20	20	0.11	0.39	0.50	-	-	234	204
PFSAs	PFBS	73.60	306.08	5.47	-	3.72	18	12	0.47	1.58	0.99	-	-	236	190
	PFPeS	0.03	0.13	0.58	-	-	20	19	0.07	0.80	0.69	-	-	238	230
	PFHxS	40.10	178.72	9.05	-	-	21	17	0.45	2.20	0.83	-	-	269	217
	PFHpS	0.03	0.12	0.55	-	-	20	19	0.03	0.16	0.43	-	-	241	229
	PFOS	213.16	497.61	72.00	-	98.25	20	9	13.49	14.41	11.00	4.64	17.30	257	28
	PFNS	-	-	-	-	-	20	20	0.02	0.21	0.94	-	-	235	231
	PFDS	-	-	-	-	-	20	20	0.37	1.09	1.13	-	-	239	181
	PFDoS	-	-	-	-	-	20	20	0.21	1.19	1.93	-	-	236	222
FTCAs	3:3 FTCA	0.41	1.81	8.10	-	-	20	19	0.10	0.77	3.96	-	-	237	232
	5:3 FTCA	57.35	154.73	296.50	-	-	20	16	22.93	119.60	16.25	-	7.65	238	160
	7:3 FTCA	-	-	-	-	-	20	20	2.51	11.78	6.41	-	-	237	207
FTSAs	4:2 FTSA	-	-	-	-	-	20	20	0.01	0.07	0.72	-	-	243	241
	6:2 FTSA	1.98	8.83	39.50	-	-	20	19	0.15	1.24	2.92	-	-	243	235
	8:2 FTSA	2.55	11.40	51.00	-	-	20	19	0.12	1.25	0.60	-	-	241	233
FASAAs	NMeFOSAA	42.35	185.41	8.17	-	-	20	16	4.08	5.54	4.50	-	5.25	237	76
	NEtFOSAA	47.66	212.39	476.61	-	-	20	18	2.63	3.35	3.25	-	3.86	240	91
FASEs	NMeFOSE	5.65	25.27	113.00	-	-	20	19	1.75	7.16	6.88	-	-	239	193
	NEtFOSE	-	-	-	-	-	20	20	0.89	6.20	5.50	-	-	239	222
FASAs	PFOSA	304.51	957.80	43.70	-	0.98	20	14	0.71	1.42	1.19	-	0.92	233	146
	NMeFOSA	-	-	-	-	-	20	20	0.02	0.18	2.06	-	-	239	236
	NEtFOSA	-	-	-	-	-	20	20	0.07	0.74	4.68	-	-	238	235
PFECAs	PFMPA	-	-	-	-	-	20	20	0.01	0.10	0.52	-	-	238	234
	PFMBA	-	-	-	-	-	20	20	0.01	0.06	0.67	-	-	238	236
	NFDHA	-	-	-	-	-	20	20	0.09	1.04	10.31	-	-	238	236
	HFPO-DA	-	-	-	-	-	20	20	0.08	0.63	3.41	-	-	238	233
	ADONA	-	-	-	-	-	20	20	0.00	0.02	0.26	-	-	238	236
PFESAs	PFEESA	-	-	-	-	-	20	20	-	-	-	-	-	238	238
	9Cl-PF3ONS	-	-	-	-	-	20	20	0.01	0.16	1.38	-	-	238	236
	11Cl-PF3OUdS	-	-	-	-	-	20	20	0.01	0.18	2.72	-	-	238	237

TABLE 4-8
Summary of EEA PFAS Portal Data Statistics (EPA Method 1633 only)

		Influent (ng/L)							Effluent (ng/L)							Sludge (Wet, ng/L)							Sludge (Dry, ng/g)						
PFAS		Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs	Mean	St. Dev.	Median	1st Quartile	3rd Quartile	N	# NDs
PFCAs	PFBA	7.04	62.15	4.61	-	3.93	262	156	7.54	20.66	6.10	-	7.50	267	97	197.43	871.52	19.30	-	-	20	16	0.37	1.49	1.77	-	-	238	209
	PFPeA	9.88	24.84	6.54	-	7.68	257	87	20.46	30.82	14.10	6.00	22.98	266	35	396.80	1,410.51	51.50	-	63.50	20	8	1.53	4.66	3.06	-	0.02	234	174
	PFHxA	6.45	15.95	5.25	2.33	7.07	260	50	21.74	44.94	12.95	7.90	18.88	266	12	414.65	1,357.60	49.00	-	64.50	20	7	3.64	7.52	2.52	-	3.16	236	105
	PFHpA	1.75	5.14	2.20	-	2.40	269	118	2.78	5.49	2.50	0.86	3.15	274	63	49.51	217.83	4.30	-	2.26	21	14	0.25	1.67	0.57	-	-	243	205
	PFOA	6.00	13.14	5.86	2.08	7.03	269	59	11.66	40.46	7.80	5.02	10.55	274	16	691.52	2,098.68	30.00	-	65.00	21	7	2.42	4.98	3.41	-	3.26	243	124
	PFNA	0.46	1.34	1.00	-	0.55	269	194	1.15	5.54	1.10	-	1.00	274	150	191.86	764.83	24.00	-	3.76	21	15	0.77	2.38	1.45	-	0.52	244	173
	PFDA	0.08	0.44	0.44	-	-	269	245	0.43	1.72	1.10	-	0.31	273	204	351.91	1,434.34	60.00	-	46.00	21	12	2.69	4.73	3.31	-	3.99	243	99
	PFUnA	0.03	0.49	0.34	-	-	262	257	0.02	0.18	0.57	-	-	266	261	278.85	1,205.96	166.00	-	-	20	17	0.48	1.18	1.06	-	0.59	235	164
	PFDoA	0.05	0.31	1.50	-	-	262	254	0.01	0.17	2.82	-	-	267	266	54.97	222.24	522.20	-	-	19	17	0.60	1.16	1.27	-	0.98	237	144
	PFTrDA	-	-	--	-	-	262	262	-	-	--	-	-	267	267	49.50	221.37	990.00	-	-	20	19	0.11	0.32	0.57	-	-	238	200
	PFTeDA	-	-	--	-	-	256	256	-	-	--	-	-	259	259	-	-	--	-	-	20	20	0.11	0.40	0.50	-	-	228	198
PFSAs	PFBS	4.83	16.39	4.12	-	5.15	253	83	12.33	47.52	4.41	2.11	5.70	262	46	73.60	306.08	5.47	-	3.72	18	12	0.48	1.60	0.99	-	-	230	184
	PFPeS	0.38	1.46	0.85	-	-	242	207	0.19	0.51	0.50	-	-	267	203	0.03	0.13	0.58	-	-	20	19	0.08	0.81	0.69	-	-	232	224
	PFHxS	4.69	42.96	2.54	-	2.60	267	127	2.96	10.39	2.20	-	2.62	273	83	40.10	178.72	9.05	-	-	21	17	0.50	2.32	0.82	-	-	242	191
	PFHpS	0.01	0.07	0.52	-	-	259	254	0.01	0.12	0.47	-	-	265	259	0.03	0.12	0.55	-	-	20	19	0.03	0.16	0.43	-	-	235	223
	PFOS	9.21	19.77	7.90	2.33	11.20	245	54	6.30	7.50	5.13	2.36	7.20	256	31	213.16	497.61	72.00	-	98.25	20	9	13.48	14.60	10.80	4.55	17.08	232	24
	PFNS	-	-	--	-	-	262	262	-	-	--	-	-	267	267	-	-	--	-	-	20	20	0.02	0.22	0.94	-	-	229	225
	PFDS	0.06	0.42	2.95	-	-	262	256	0.05	0.38	2.40	-	-	267	261	-	-	--	-	-	20	20	0.36	1.10	1.10	-	-	234	179
	PFDoS	0.22	1.60	5.35	-	-	256	247	0.06	0.82	8.02	-	-	262	260	-	-	--	-	-	20	20	0.19	1.15	1.93	-	-	230	218
FTCAs	3:3 FTCA	3.52	32.68	197.50	-	-	253	249	1.23	16.07	67.00	-	-	261	258	0.41	1.81	8.10	-	-	20	19	0.10	0.78	3.96	-	-	233	228
	5:3 FTCA	4.24	36.91	62.70	-	-	257	247	0.16	1.60	11.50	-	-	262	259	57.35	154.73	296.50	-	-	20	16	23.25	120.86	16.60	-	7.64	233	160
	7:3 FTCA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	2.51	11.91	7.50	-	-	232	207
FTSAs	4:2 FTSA	-	-	--	-	-	261	261	-	-	--	-	-	266	266	-	-	--	-	-	20	20	0.01	0.07	0.72	-	-	237	235
	6:2 FTSA	0.31	1.87	7.40	-	-	261	251	0.06	0.51	2.12	-	-	266	260	1.98	8.83	39.50	-	-	20	19	0.15	1.25	2.92	-	-	237	229
	8:2 FTSA	0.00	0.07	1.20	-	-	261	260	-	-	--	-	-	266	266	2.55	11.40	51.00	-	-	20	19	0.12	1.27	0.60	-	-	236	228
FASAAs	NMeFOSAA	0.07	0.64	1.43	-	-	256	248	0.20	0.61	1.41	-	-	262	229	42.35	185.41	8.17	-	-	20	16	4.12	5.61	4.58	-	5.32	231	76
	NEtFOSAA	0.16	1.25	1.20	-	-	261	249	0.10	0.50	1.15	-	-	264	247	47.66	212.39	476.61	-	-	20	18	2.64	3.39	3.32	-	4.06	234	91
FASEs	NMeFOSE	0.09	0.68	3.40	-	-	257	252	0.12	1.91	30.90	-	-	262	261	5.65	25.27	113.00	-	-	20	19	1.79	7.25	6.88	-	-	233	187
	NEtFOSE	0.03	0.31	3.33	-	-	257	255	0.11	1.73	15.02	-	-	262	260	-	-	--	-	-	20	20	0.92	6.27	5.50	-	-	233	216
FASAs	PFOSA	0.01	0.14	0.86	-	-	260	256	0.96	11.61	0.69	-	-	265	233	304.51	957.80	43.70	-	0.98	20	14	0.70	1.43	1.21	-	0.84	227	145
	NMeFOSA	-	-	--	-	-	257	257	0.01	0.13	2.17	-	-	262	261	-	-	--	-	-	20	20	0.02	0.18	2.06	-	-	233	230
	NEtFOSA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.07	0.75	4.68	-	-	232	229
PFECAs	PFMPA	0.18	2.18	23.00	-	-	257	255	0.00	0.05	0.73	-	-	262	261	-	-	--	-	-	20	20	0.01	0.10	0.52	-	-	233	229
	PFMBA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.01	0.06	0.67	-	-	233	231
	NFDHA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.09	1.05	10.31	-	-	233	231
	HFPO-DA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.08	0.63	3.41	-	-	233	228
	ADONA	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.00	0.02	0.26	-	-	233	231
PFESAs	PFEESA	0.02	0.24	3.90	-	-	257	256	-	-	--	-	-	262	262	-	-	--	-	-	20	20	-	-	--	-	-	233	233
	9Cl-PF3ONS	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.01	0.16	1.38	-	-	233	231
	11Cl-PF3OUdS	-	-	--	-	-	257	257	-	-	--	-	-	262	262	-	-	--	-	-	20	20	0.01	0.18	2.72	-	-	233	232

4.2.2.3 Total PFAS by Analytical Method

A comparison of PFAS concentrations by analytical method was conducted for the Portal data. At least five different targeted analytical methods were used to quantify PFAS for influent, effluent, and sludge data within the Portal. All analytical methods listed in the Portal containing "1633" were grouped together, all methods containing "537" and other targeted analytical methods, for example, proprietary methods, were grouped as "other", and all samples without an analytical method specified were grouped as "unspecified" for comparison. Samples with "unspecified" methods represent data that was uploaded in eDEP before tracking of the method was added; these samples represent a mix of methods and some may include EPA Method 1633. Distinctions among the PFAS analytical methods include intended sample matrix (drinking water, wastewater, solids), variability in sample preparation and processing, and differences in reported PFAS compounds by the laboratory. For example, EPA Method 1633 targets up to 40 PFAS compounds, while Method 537.1 targets up to 18 PFAS compounds. Table 4-9 summarizes the median and mean ΣPFAS concentrations for each of the analytical methods used for data in the Portal.

TABLE 4-9
Summary of Median and Mean ΣPFAS Concentrations from Portal by Analytical Method

Media Type	$\Sigma PFAS_{1633}$			$\Sigma PFAS_{537.1\ and\ Other}$			$\Sigma PFAS_{Unspecified}$		
	Median	Mean	N	Median	Mean	N	Median	Mean	N
Influent (ng/L)[1]	32.9	59.1	259	39.5	33.9	50	8.8	14.3	8
Effluent (ng/L)[2]	56.1	92.3	265	44.9	44.4	50	18.0	25.9	5
Sludge, wet (ng/L)	137.4	3474.3	21	-	-	44	-	-	0
Sludge, dry (ng/g)[3]	32.1	64.1	234	31.8	31.7	50	13.0	17.2	7

1. $\Sigma PFAS_{1633}$ is significantly larger than $\Sigma PFAS_{Unspecified}$ (Kruskal-Wallis test, p=0.03).
2. $\Sigma PFAS_{1633}$ is significantly larger than $\Sigma PFAS_{Other}$ and $\Sigma PFAS_{Unspecified}$ (Kruskal-Wallis test, $p=1\times10^{-5}$).
3. $\Sigma PFAS_{1633}$ is significantly larger than $\Sigma PFAS_{Other}$ (Kruskal-Wallis test, p=0.005).

The comparison of median ΣPFAS concentrations by analytical method shows effluent and dry sludge samples analyzed by EPA Method 1633 are significantly larger than other methods in the Portal. EPA Method 1633 has undergone considerable interlaboratory methodological testing and is designed for difficult sample media, such as wastewater and sludge. It also measures additional compounds relative to earlier analytical methods, namely precursor classes that could represent considerable PFAS concentrations in wastewater/sludge. Figure 4-27 depicts the notably different sample sizes among these data categories.

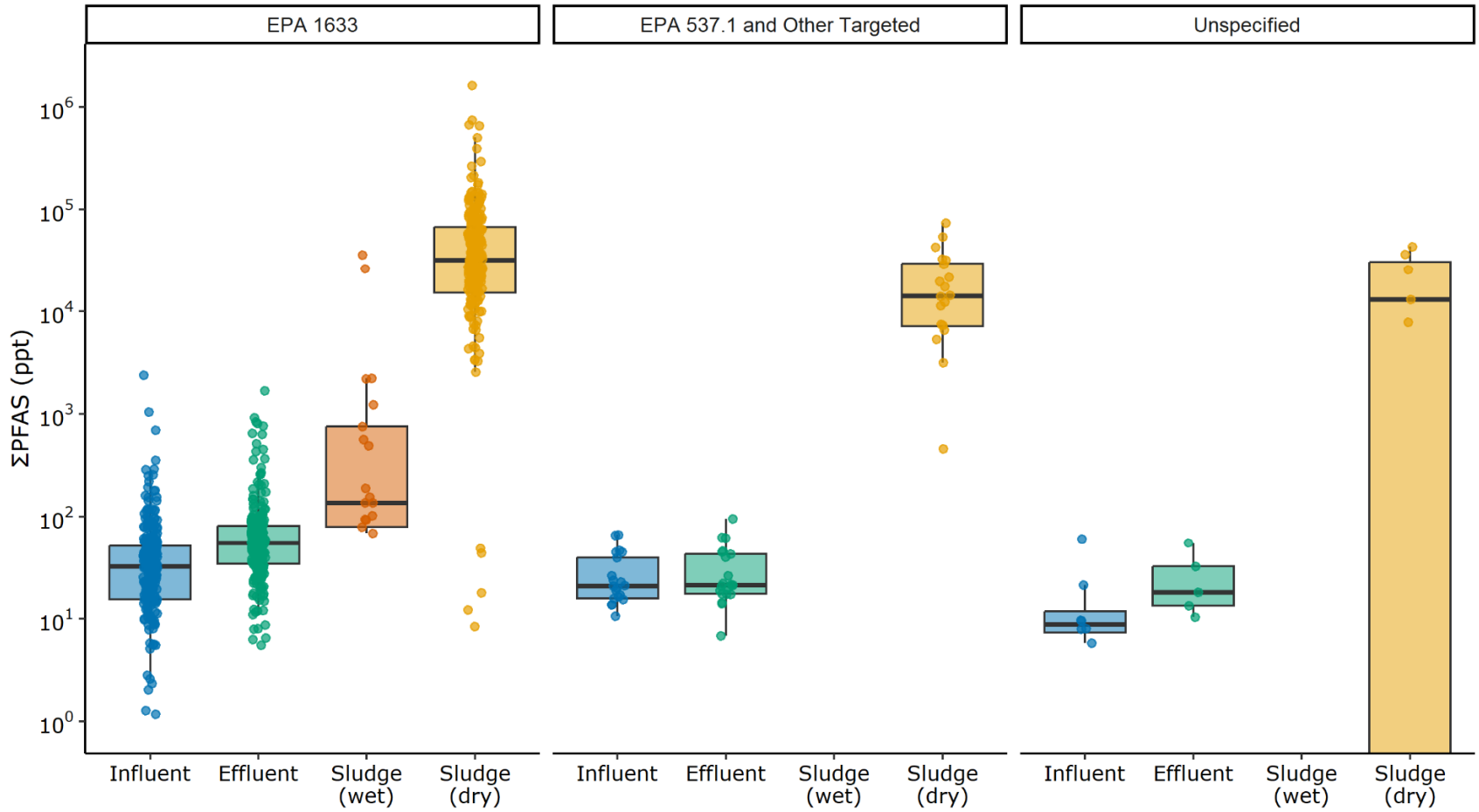


FIGURE 4-27
ΣPFAS Concentrations by Analytical Method (Portal Data Influent, Effluent, and Sludge)

4.3 Comparison of Study versus Portal Data

All samples in this Study were analyzed using EPA Method 1633 while the samples included in the Portal were analyzed using numerous methods including EPA Method 1633, Method 537.1, and other targeted methods (e.g., Method 454 and LC-MS/MS-ID). Therefore, several comparisons of PFAS concentrations and detections were made between data from this Study and data available and compiled from the Portal including:

- PFAS concentrations from all methods in the Portal vs EPA Method 1633 in the Study,
- Concentrations of six PFAS compounds only ("PFAS6") including PFHpA, PFOA, PFNA, PFDA, PFHxS, and PFOS from all methods in the Portal vs PFAS6 concentrations from the Study, and
- PFAS concentrations from only EPA Method 1633 only in the Portal vs EPA Method 1633 in the Study.

4.3.1 PFAS Concentrations & Detection Frequency

Table 4-10 provides summary statistics for influent, effluent, and sludge ΣPFAS concentrations for Portal data and Study data. This table includes Portal data from all methods represented in the Portal for the 66 POTWs with data in the Portal, Study data for just the 66 POTWS with data in the Portal, and Study data for all 114 POTWs. In general, POTW influent and dry sludge ΣPFAS concentrations were higher in those samples collected during this Study than in influent and effluent compliance samples collected from the 66 POTWs with data available in the Portal. However, effluent ΣPFAS concentrations from this Study were generally lower than effluent concentrations from the Portal Data.

TABLE 4-10
Summary Statistics for Study vs. Portal ΣPFAS concentrations

	ΣPFAS concentration			
	Influent[1] (ng/L)	Effluent[2] (ng/L)	Sludge, wet[3] (ng/L)	Sludge, dry[4] (ng/g)
Portal ΣPFAS Data (66 POTWs with Portal Data)				
Mean	55.8	85.7	3,354.8	59.8
Median	30.7	50.5	137.4	30.0
Maximum	2,393.9	1,679.8	35,840.0	1,625.4
Minimum	0.0	0.0	0.0	0.0
Study ΣPFAS Data (66 POTWs with Portal and Study data)				
Mean	125.9	57.3	3,134.3	134.0
Median	46.8	41.0	396.6	38.8
Maximum	3,262.4	582.5	33,146.0	1,892.1
Minimum	0.0	0.0	0.0	0.0
Study ΣPFAS Data (all 114 POTWs with Study data)				
Mean	137.4	65.0	3,814.8	72.9
Median	59.0	47.2	342.9	18.0
Maximum	4,003.0	624.6	33,146.0	1,715.2
Minimum	0.0	0.0	0.0	0.0

Comparing just the 66 POTWs with Portal and Study data, the data show:

1. Median influent ΣPFAS concentrations were significantly higher for Study data than for Portal data (Wilcoxon signed-rank test, $p=5\times10^{-6}$).
2. Median effluent ΣPFAS concentrations were significantly higher for Portal data than for Study data (Wilcoxon signed-rank test, p=0.001).
3. There was no significant difference between Study and Portal liquid sludge ΣPFAS concentrations (Wilcoxon signed-rank test, p=0.33).
4. Median dry sludge ΣPFAS concentrations were significantly higher for Study data than for Portal data (Wilcoxon signed-rank test, p=0.007).

Of the statistical comparisons, the greatest disparity was observed from the sludge data, followed by influent data. Effluent data was shown to have the smallest difference in concentration, similar to conclusions regarding trends observed in ΣPFAS as discussed in Section 3.2.3. Factors which have the potential to impact results of the statistical analysis of ΣPFAS between the Study and Portal data may include seasonal variation in concentrations, variability among specific PFAS analyte concentrations for a given time, and variability of the incoming waste stream to facilities.

4.3.2 PFAS6 Concentration Comparison

Per their NPDES permits, small POTWs are only required to report PFAS concentrations for six PFAS compounds: PFHpA, PFOA, PFNA, PFDA, PFHxS, and PFOS, known as "PFAS6". In addition, there are many large POTWs that have Individual NPDES wastewater discharge permits that also only require reporting for PFAS6. With this understanding that the Portal contains sample data for which only 6 of the 40 PFAS compounds have been reported, the next comparison made was between Study data (all 114 POTWs) and Portal data for the sum of PFAS6 compounds reported for all analytical methods. PFAS6 concentrations using sums of these six compounds are presented as "ΣPFAS6".

Differences were observed in median ΣPFAS6 influent concentrations (Mann-Whitney rank sum test, p<0.0001) but not any other sample media (Table 4-11, Figure 4-28). Influent ΣPFAS6 concentrations in the Study were about twice as large as those in the Portal. Although median ΣPFAS6 sludge concentrations analyzed as liquid were about five times larger in the Study as compared with data in the Portal, there was considerable variability in both data sets, likely due to matrix challenges associated with these media yielding a low but non-significant statistic (p=0.083).

TABLE 4-11
Comparison of Study and Portal Median ΣPFAS6 Concentrations

Medium	Study ΣPFAS6	Portal ΣPFAS6
Influent (ng/L)	28.7	13.9
Effluent (ng/L)	17.2	17.2
Sludge, dry (ng/g)	11.9	14.0
Sludge, wet (ng/L)	149.1	33.0

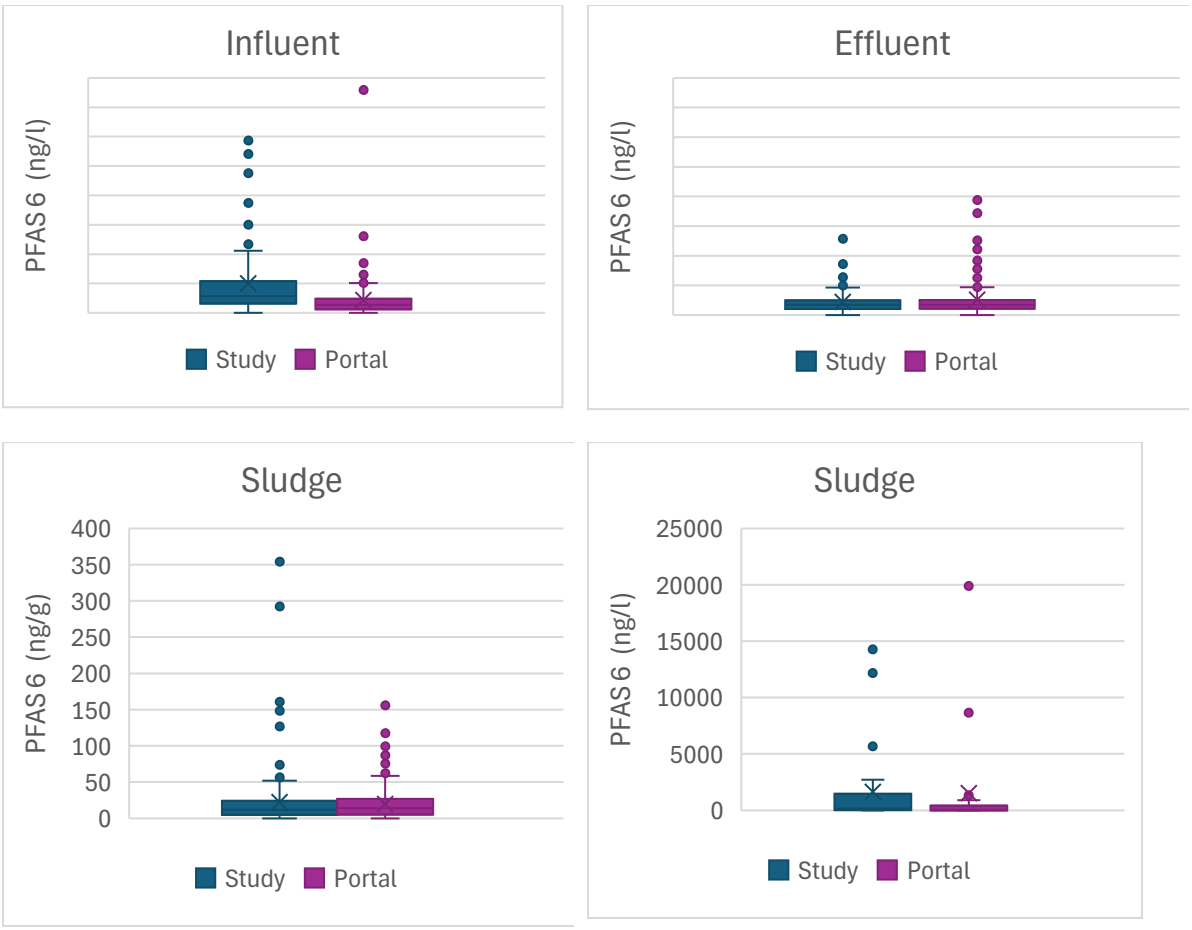


FIGURE 4-28
Median ΣPFAS6 Concentrations in Influent, Effluent, and Sludges (Study and Portal Data)

Figure 4-28 depicts the distribution of ΣPFAS6 concentrations in the Study as compared with the Portal for influent, effluent, and sludges. Note that outliers >400 ng/L are not shown for influent and effluent plots to simplify the graphical representation; however, the outliers are included in the analysis.

4.3.3 PFAS Concentrations via EPA Method 1633 Comparison

A comparison was made between median ΣPFAS concentrations of Study (all 114 POTWs) versus Portal data that were analyzed for all 40 PFAS compounds using EPA Method 1633 only, including 1633 Modified but excluding all other analytical methods (Table 4-12, Figure 4-29). Influent median ΣPFAS concentrations of the Study data were significantly larger than the Portal data (Mann-Whitney rank sum test, $p<0.0001$), while dry sludge ΣPFAS concentrations in the Study were significantly lower than the Portal data (Mann-Whitney rank sum test, $p=0.005$). We detected no difference in the datasets for effluent concentrations and liquid sludges.

TABLE 4-12
Comparison of Study and Portal Median ΣPFAS6 Concentrations via EPA Method 1633 only

Medium	Study Median ΣPFAS	Portal Median ΣPFAS
Influent (ng/L)	59.0	32.1
Effluent (ng/L)	47.3	55.3
Sludge, dry (ng/g)	18.0	32.7
Sludge, wet (ng/L)	342.9	137.4

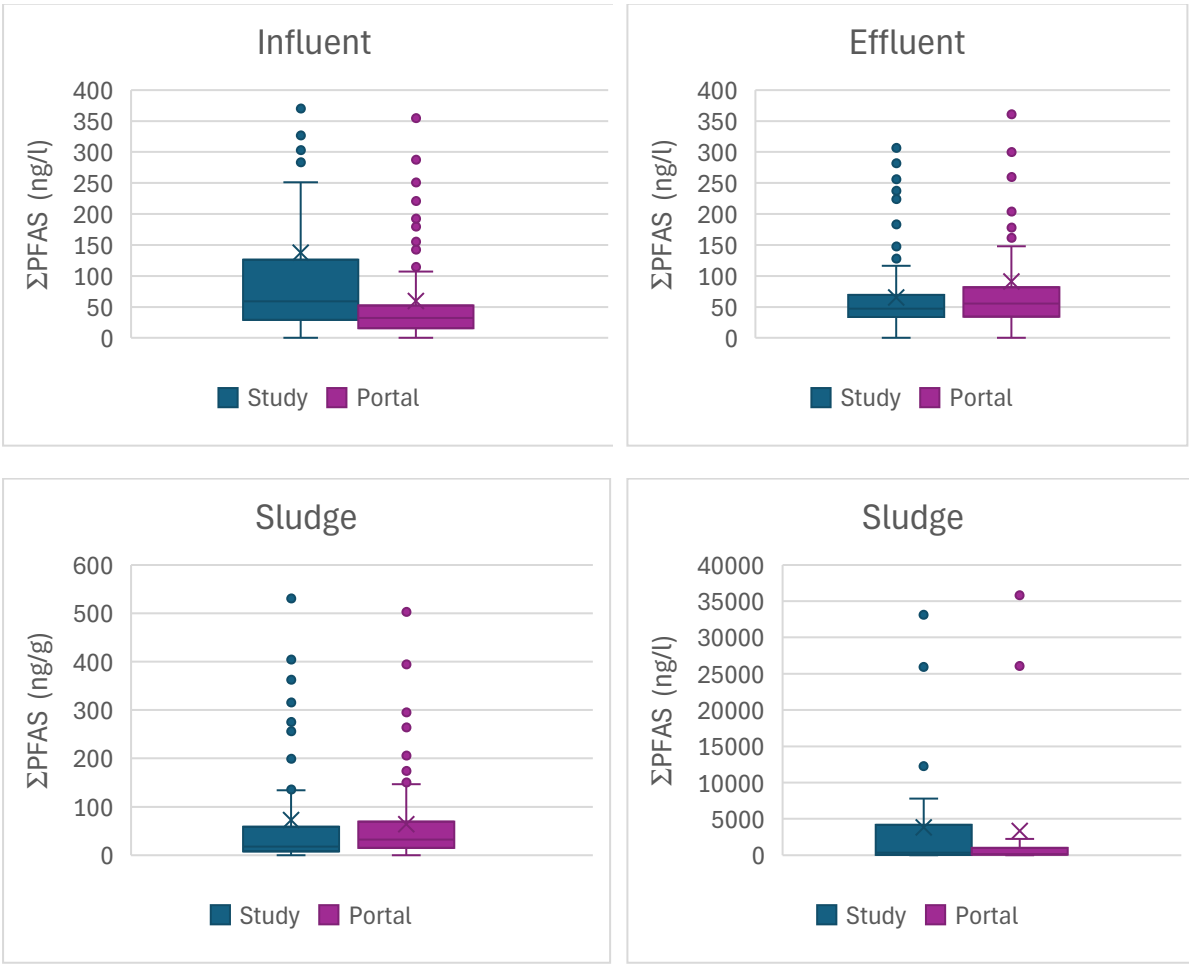


FIGURE 4-29
Median ΣPFAS Concentrations via EPA Method 1633 in Influent, Effluent, and Sludges (Study and Portal Data)

Figure 4-29 depicts the distribution of ΣPFAS concentrations in the Study as compared with the Portal for influent, effluent, and sludges analyzed using EPA Method 1633. Note that outliers >400 ng/L are not shown for influent and effluent plots to simplify the graphical representation; however, the outliers are included in the analysis.

4.4 PFAS Mass Loads (Combined Study and Portal)

4.4.1 Estimated Mass Loads by Facility and Populations

Mass load analyses provide insight into both the extent to which a POTW is impacted by PFAS and the transport and transformation of PFAS within the POTW. For example, a large POTW that treats a very high volume of wastewater with a relatively low PFAS concentration may, in fact, have a PFAS mass load comparable to a small POTW that treats a smaller volume of wastewater if that wastewater has a very high PFAS concentration. Estimating and comparing mass loads can assist with discerning industrial impact and source contribution as well as trends among POTW characteristics.

Estimates of PFAS mass loading were calculated using all available PFAS concentration data from both the Study and the Portal. The $\Sigma PFAS_{1633}$ concentrations for Round 1 and Round 2 of the Study were multiplied by the flow rate at the time of sample collection for each of the 114 POTWs in the Study to estimate a ΣPFAS mass load in pounds per year (lbs/yr) for both influent and effluent. When flow data were not available at the facility, the $\Sigma PFAS_{1633}$ concentration was multiplied by the annual average flow rate reported by the POTW. Portal ΣPFAS concentrations were similarly multiplied by the annual average flow rate reported by the POTW to estimate a ΣPFAS mass load in pounds per year for both influent and effluent. ΣPFAS mass loads in lbs/yr were estimated for sludge using annual sludge generation rates reported on a dry basis in *Current and Near-Term Management of Massachusetts Wastewater Sludge* for 2023, as described in Section 2.1.5. An average estimated mass load was calculated for each POTW's influent, effluent, and sludge across all sample events.

Table B-8 in Appendix B provides a summary of these influent, effluent, and sludge mass load estimates as well as influent, effluent, and sludge mass load estimates per capita based on the population served by each POTW.

Eighty-one percent of POTWs (92 POTWs) are estimated to discharge less than 1 lb/yr of PFAS into receiving water bodies after receiving even larger loads in their influent, and 95% of POTWs (108 POTWs) are estimated to discharge less than 5 lbs/yr. There are several facilities serving relatively large populations that are estimated to discharge considerably larger loads, which is partially influenced by their volumetric flow. Two facilities are estimated to receive and discharge more than 75 lbs/yr, including Brockton AWRF and MWRA Deer Island WWTP, while New Bedford WWTP, Fall River Regional WWF, and Fitchburg East WWTP were estimated to receive loads of more than 12 lbs/yr. The Brockton, MWRA Deer Island, and New Bedford facilities serve populations greater than 100,000 people and are categorized as "large" based on their NPDES-permitted flow rates. The relationship between estimated mass loads, population, and facility size based on its NPDES-permitted flow rate is discussed in Section 4.4.2.

The data presented in Table B-8 in Appendix B provide estimates of mass discharge on a facility-by-facility basis that can be used to estimate regional or statewide loads from POTWs. They can also be used to identify possible regions for targeted source reduction efforts. Table 4-13 provides a summary of the estimated total annual mass load and annual mass load per capita for all 114 POTWs calculated using both Study and Portal data. This report does not evaluate the fate of sludge (e.g., landfilling, incineration, or land application) or the fate of PFAS in that sludge.

TABLE 4-13
Summary of Total Estimated Mass Loads for all 114 POTWs (Study and Portal data)

	Estimated Annual Mass Load (lbs/yr)			Estimated Annual Mass Load per Capita (lbs/yr per person)		
	Influent	Effluent	Sludge*	Influent	Effluent	Sludge*
Totals	366.61	294.62	14.32	0.05	0.01	0.01

*Sludge mass loading was calculated using the estimated annual sludge production for each POTW as reported in Bone et al. (2024) where possible given data availability.[1]

Figures 4-30 and 4-31 provide estimated median influent, effluent, and sludge mass loads per POTW in lbs/yr based on all available data (Study and Portal data). In Figure 4-30, estimated influent loads are to the left (in blue) and estimated effluent loads to the right (in green) for each POTW with facilities sorted from highest to lowest estimated influent mass load. In Figure 4-31, estimated sludge loads are provided with facilities presented in the same order as Figure 4-30. The following subsections discuss these mass loads in greater detail by size, population, regional location, and industrial contributions.

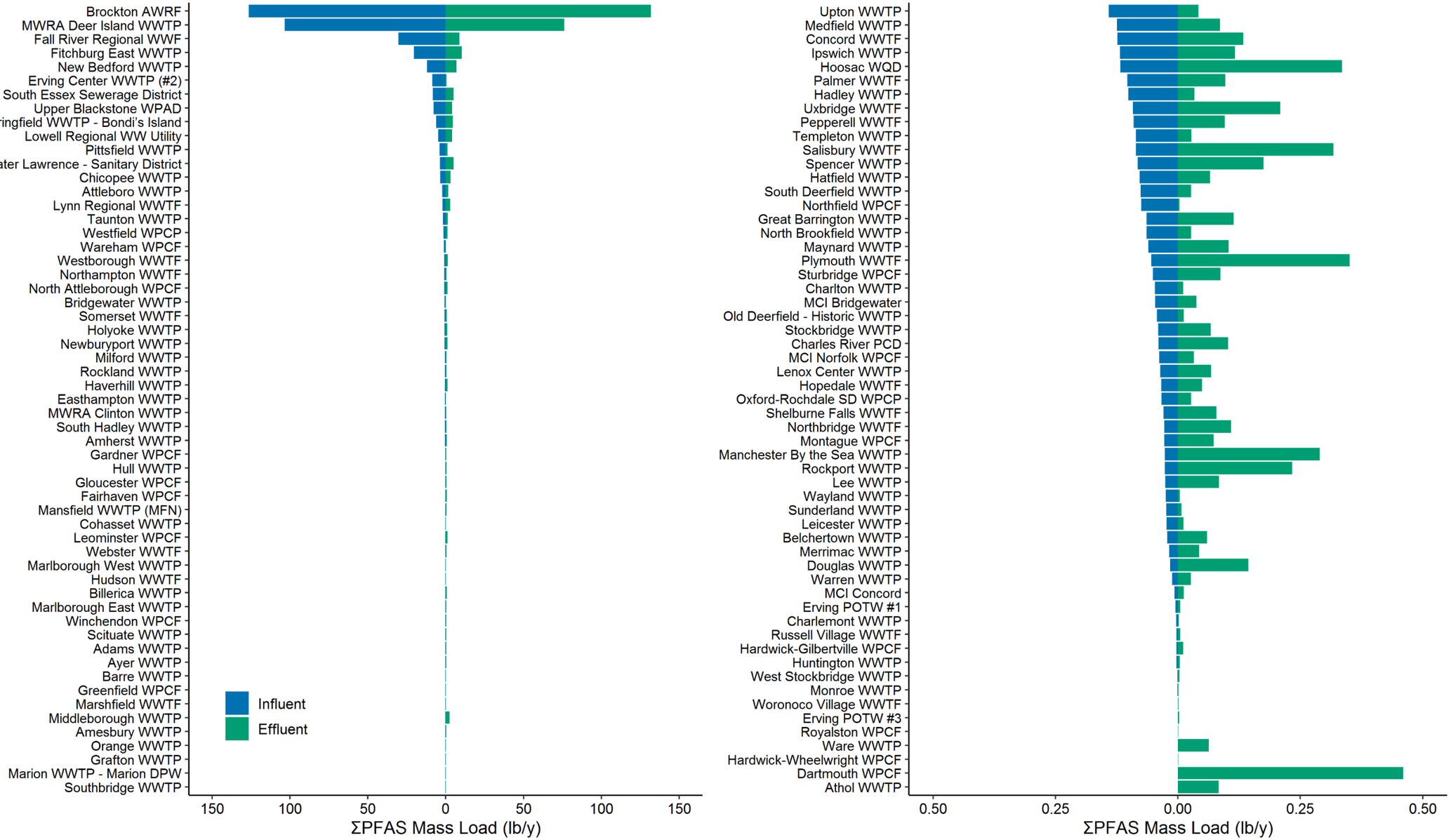


FIGURE 4-30
Estimated ΣPFAS Mass Load for Influent and Effluent (Study and Portal Data)

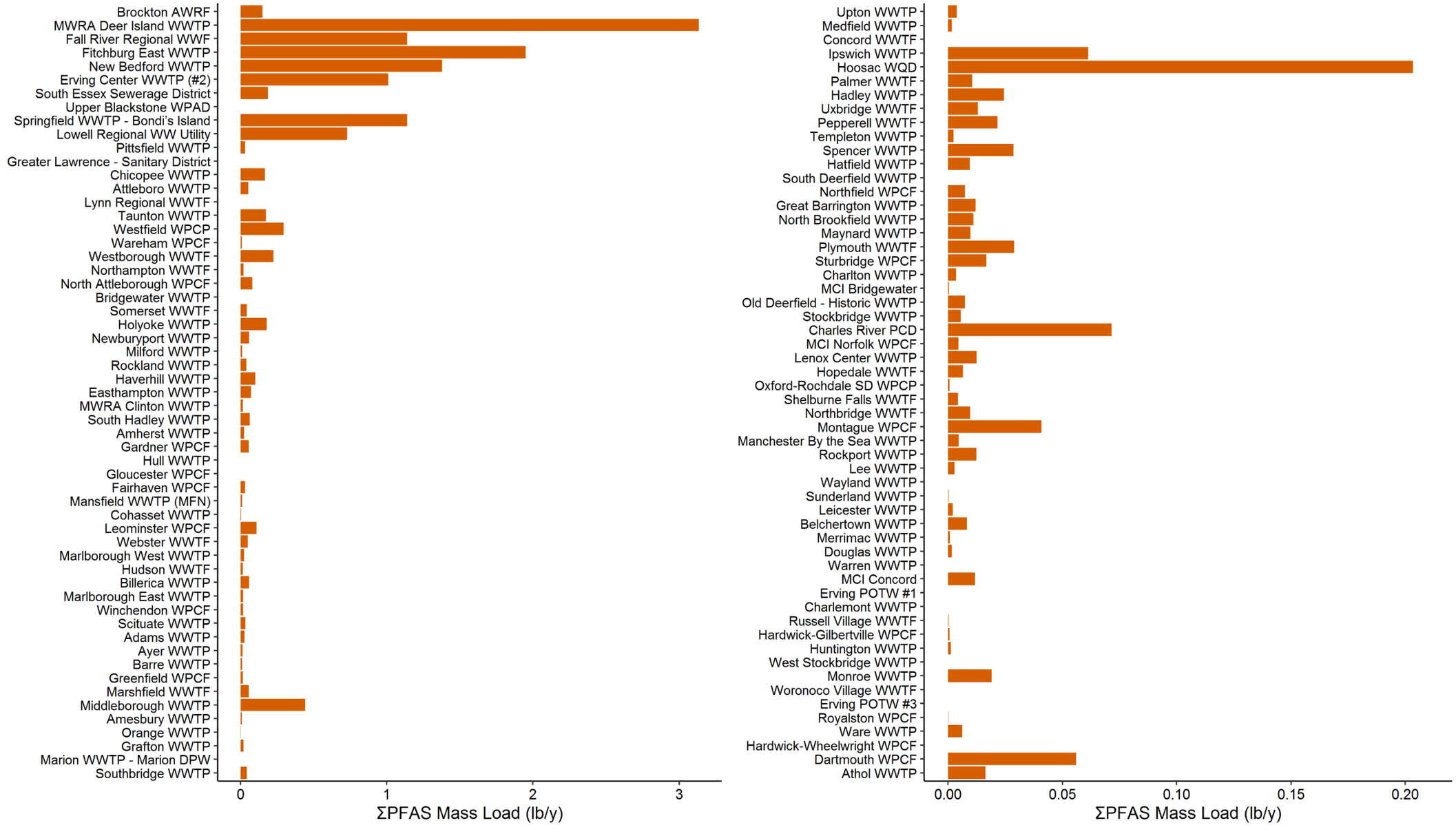


FIGURE 4-31
Estimated ΣPFAS Mass Load for Sludge (Study and Portal Data)

4.4.2 Estimated Mass Loads by Size

Figure 4-32 shows the distribution of estimated total PFAS mass loads (based on all Study and Portal data) on an annual basis (lbs/yr) for Massachusetts POTWs categorized by size. Small POTWs are defined as POTWs with NPDES-permitted flow rates <1 MGD, medium POTWs are those with design flow rates between 1 and 5 MGD, and large POTWs are those with design flow rates >5 MGD. As expected, larger facilities are associated with significantly higher estimated ΣPFAS mass loading in influent, effluent, and sludge on an annual basis (Kruskal-Wallis tests, all $p<0.002$). Figure 4-33 similarly shows the strong relationship between population and ΣPFAS mass loading, with significant positive associations for influent (Spearman's $\rho=0.75$, $p<2\times10^{-16}$), effluent (Spearman's $\rho=0.84$, $p<2\times10^{-16}$), and sludge (Spearman's $\rho=0.55$, $p=9\times10^{-10}$).

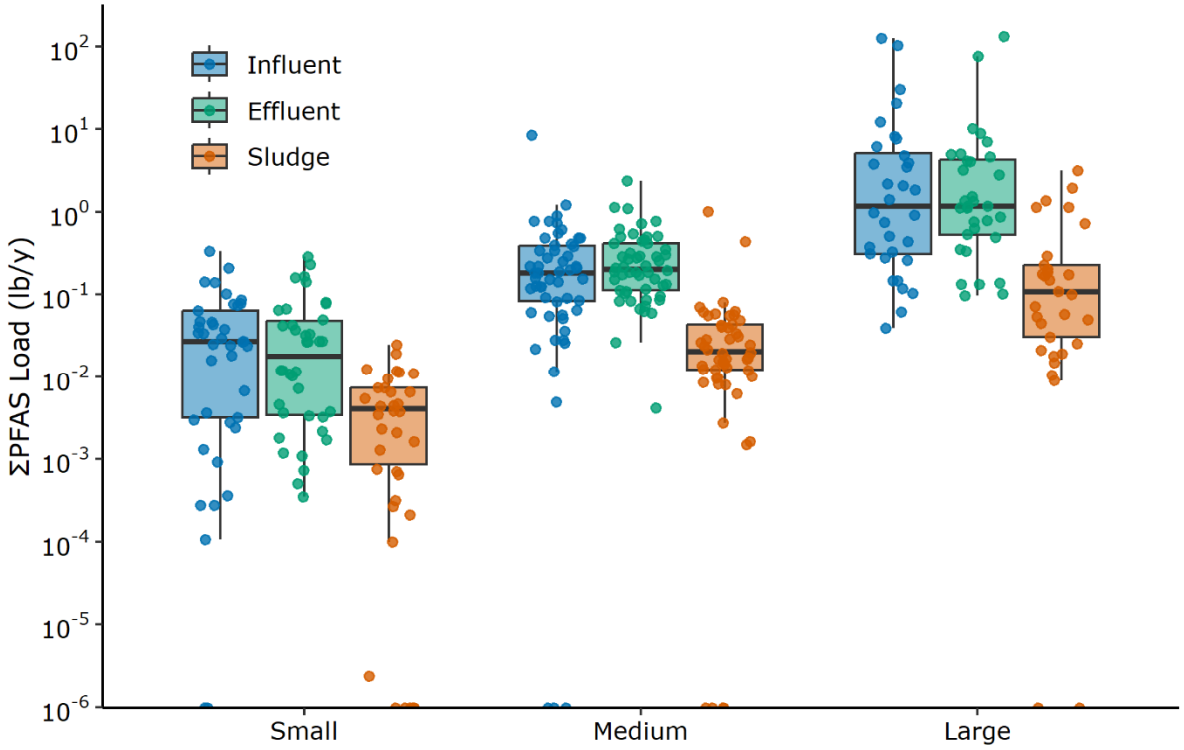


FIGURE 4-32
Estimated Median ΣPFAS Mass Load by POTW Size (Study and Portal Data)

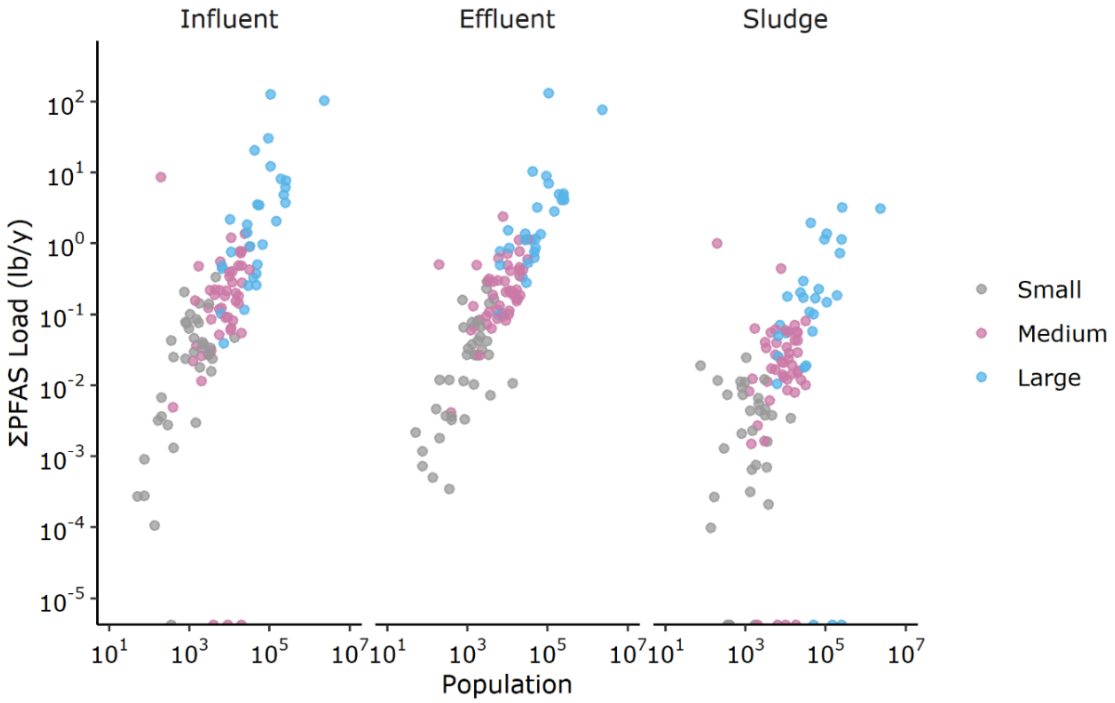


FIGURE 4-33
Estimate Median ΣPFAS Mass Load is Strongly Related to Population (Study and Portal Data)

Figure 4-34 shows the distribution of estimated annual PFAS mass loads per capita for small, medium, and large POTWs. While there were no significant associations between population and estimated ΣPFAS mass loading per capita, pairwise Kruskal-Wallis tests indicated that large POTWs may have a significantly, albeit slightly, higher effluent mass load per capita than small POTWs (p=0.02). This may be a result of several factors including, as discussed in Section 4.3.2, the fact that small POTWs are only required by their NPDES permits to report PFAS6 concentrations and the fact that highly urbanized areas generally have increased commercial activities. These facts together suggest that small POTWs would be expected to show lower mass loads and large POTWs would be expected to show higher mass loads. However, when the dataset was filtered to include only samples for which 40 individual PFAS were reported from samples analyzed by EPA Method 1633, the difference in effluent mass loading per capita between large and small POTWs was sustained (Kruskal-Wallis test, p=0.01).

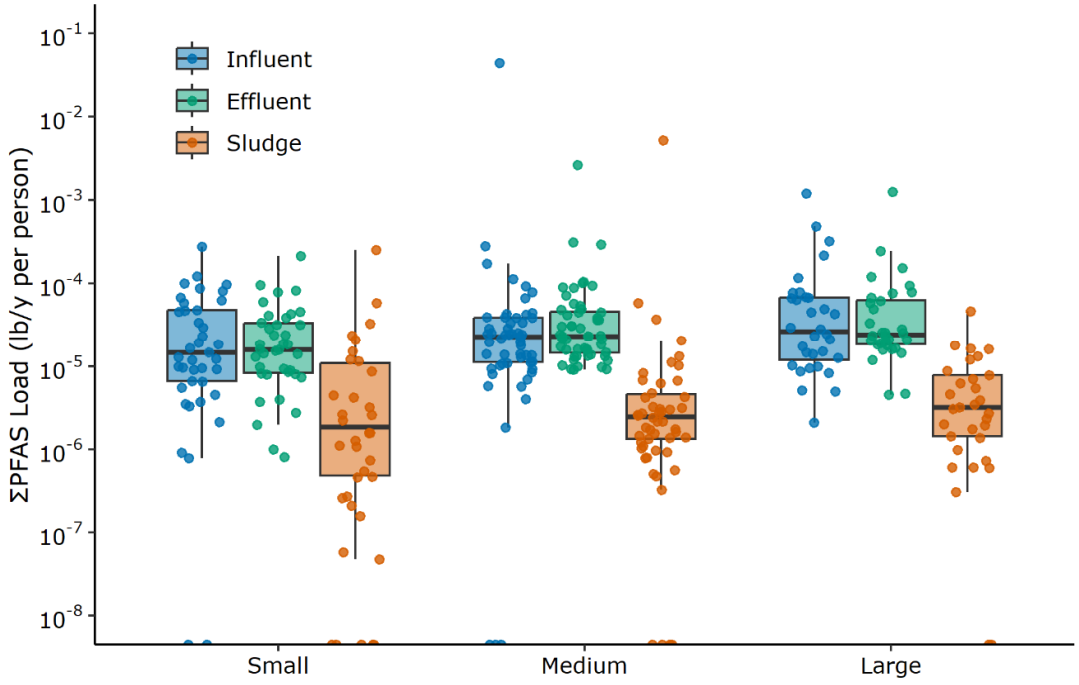


FIGURE 4-34
Estimated Median ΣPFAS Mass Load per Capita by POTW Size
(Study and Portal Data)

4.4.3 Mass Loads by Region

Figure 4-35 presents ΣPFAS mass loads for influent, effluent, and sludge based on geographical regions within Massachusetts, and Figure 4-36 presents these same regional mass loads as per capita. These regions were based on the four MassDEP Administrative Regions: Northeast, Southeast, Central, and West. There are 18 POTWs located in the Northeast Region, 21 in the Southeast, 33 in the Central, and 42 in the West.

Across the state, both median influent and median sludge ΣPFAS mass loads were comparable except that the Southeast region was found to have a significantly higher influent mass load than the Western region (Kruskal-Wallis test, $p=0.0004$). The Western region of the state had significantly lower median effluent ΣPFAS mass loads than both the Northeast and Southeast regions (Kruskal-Wallis tests, both $p \leq 0.001$), although no significant difference in effluent ΣPFAS mass load was detected between the Western and Central regions. The Southeast region also had significantly higher median effluent ΣPFAS mass loads than the Central region (Kruskal-Wallis test, $p=0.01$). The Southeast region also has significantly higher mass loading per capita than all other regions (all Kruskal-Wallis tests, $p=0.01$). However, for areas that accept a lot of septage and have small populations, the per capita metric may be skewed.

These results suggest that POTWs in the Northeast and Southeast may receive and discharge higher loads than other regions. In particular, the Southeast region may receive higher mass loads of short-chain PFAS that do not tend to accumulate in sludge or PFAS precursor compounds that do not tend to oxidize during the treatment process. This may be related to the current and legacy industries in these two regions and the overall degree of urbanization contributing to PFAS mass loads, which aligns with the population and size trends discussed in Section 4.4.1 and Section 4.4.2, respectively.

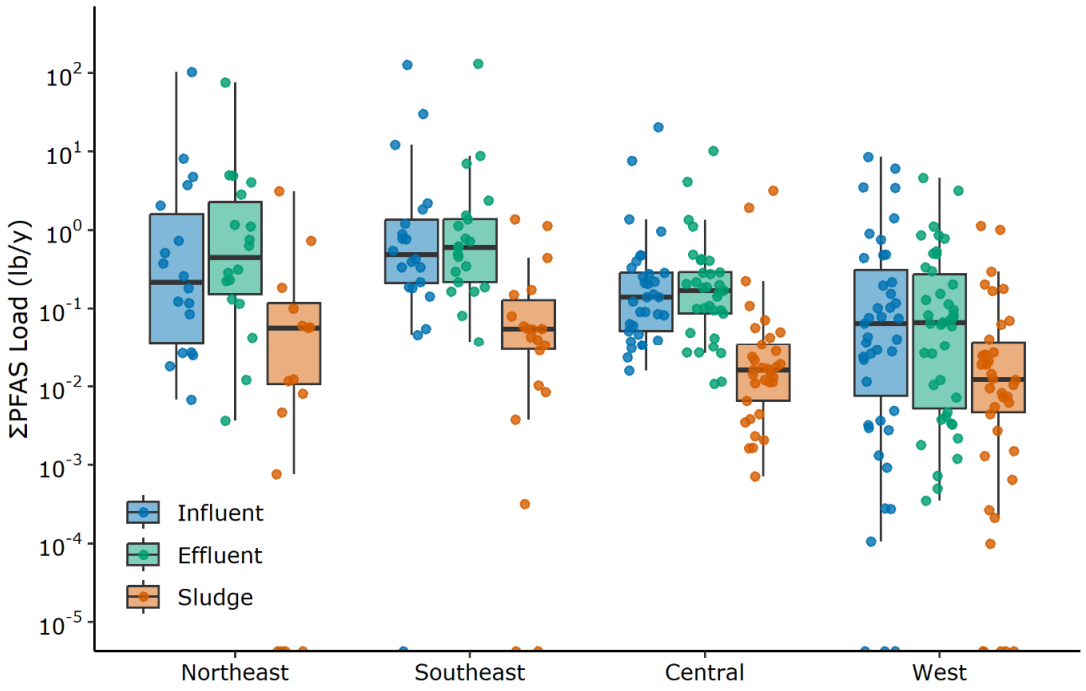


FIGURE 4-35
Estimated Median ΣPFAS Mass Loads based on MassDEP Administrative Regions (Study and Portal Data)

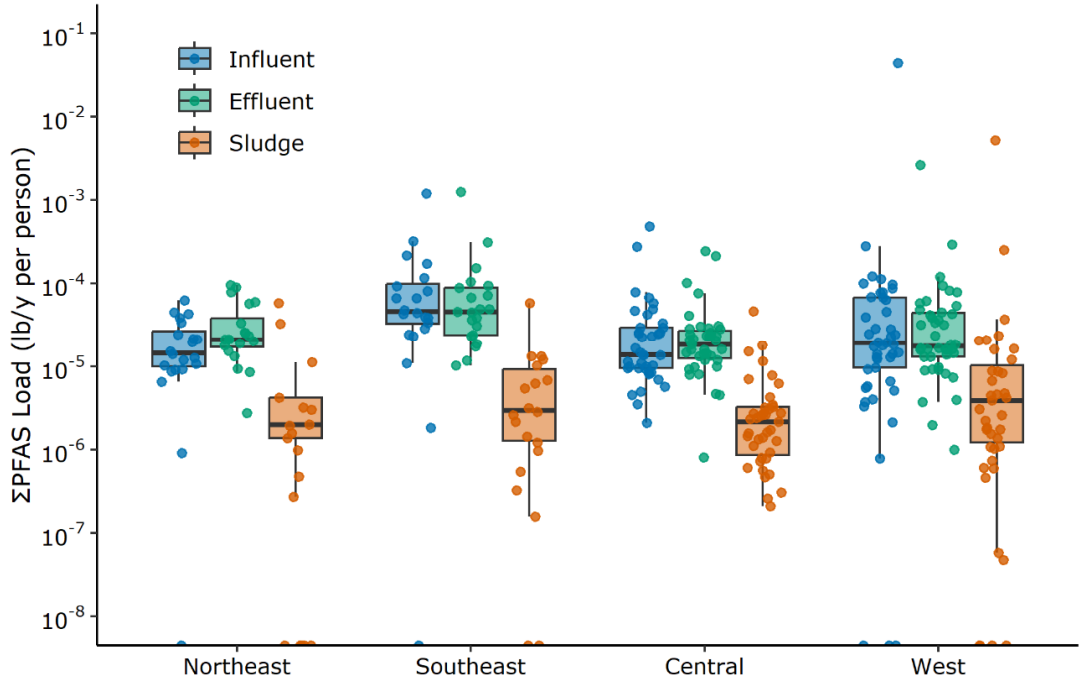


FIGURE 4-36
Estimated Median ΣPFAS Mass Loads per Capita based on MassDEP Administrative Regions (Study and Portal Data)

4.4.4 Mass Loads by Industrial Contribution

PFAS in wastewater can be attributed to residential, industrial, and commercial sources, septage, leachate, and other hauled-in wastes to POTWs. Industrial sources span various categories, such as platers and metal finishers, electronic manufacturers, ceramics and plastics, tanneries and leather manufacturers, carpet treaters, commercial car washes, landfill leachate, coating manufacturers, and more.

Although industrial sampling of PFAS was not a part of this Study, evaluations of potential industrial contributions to estimated PFAS mass loads were conducted. A comparison of POTWs with approved industrial pretreatment programs (IPPs) with those that do not have an IPP (Figure 4-37) indicates that POTWs with IPPs have significantly higher estimated PFAS mass loading in their influent (Mann-Whitney U-test, $p=2\times10^{-11}$), effluent (Mann-Whitney U-test, $p=1\times10^{-13}$), and sludge (Mann-Whitney U-test, $p=5\times10^{-10}$) than do POTWs without IPPs. Therefore, it is apparent that POTWs with more industrial users have significantly higher ΣPFAS mass loading than POTWs with minimal industrial dischargers in their service areas. However, it is important to note that larger POTWs are more likely to have approved IPPs than their smaller counterparts since larger POTWs may have sufficient treatment capacity, personnel, and operational flexibility to treat landfill leachate; fats, oils, grease; or other hauled-in wastes and support an IPP.

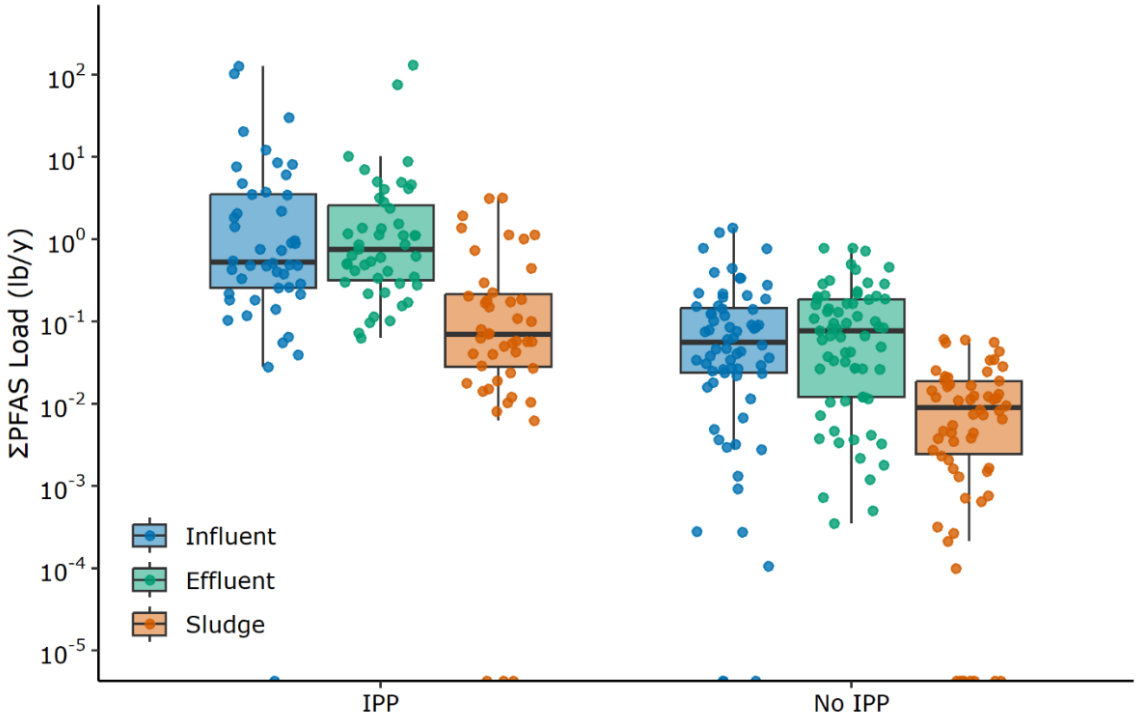


FIGURE 4-37
Estimated Median ΣPFAS Mass Loads based on presence of an IPP (Study and Portal Data)

Nevertheless, the higher estimated ΣPFAS mass loading for POTWs with IPPs than for those without IPPs cannot be solely attributed to the fact that they are likely to serve larger populations. When estimated annual mass load was normalized by population (Figure 4-38), POTWs with IPPs had a significantly higher estimated median ΣPFAS mass load per capita in their sludge than did POTWs without IPPs (Mann-Whitney U-test, p=0.04).

However, this difference appears largely driven by a single extreme observation, as shown in Figure 4-38.

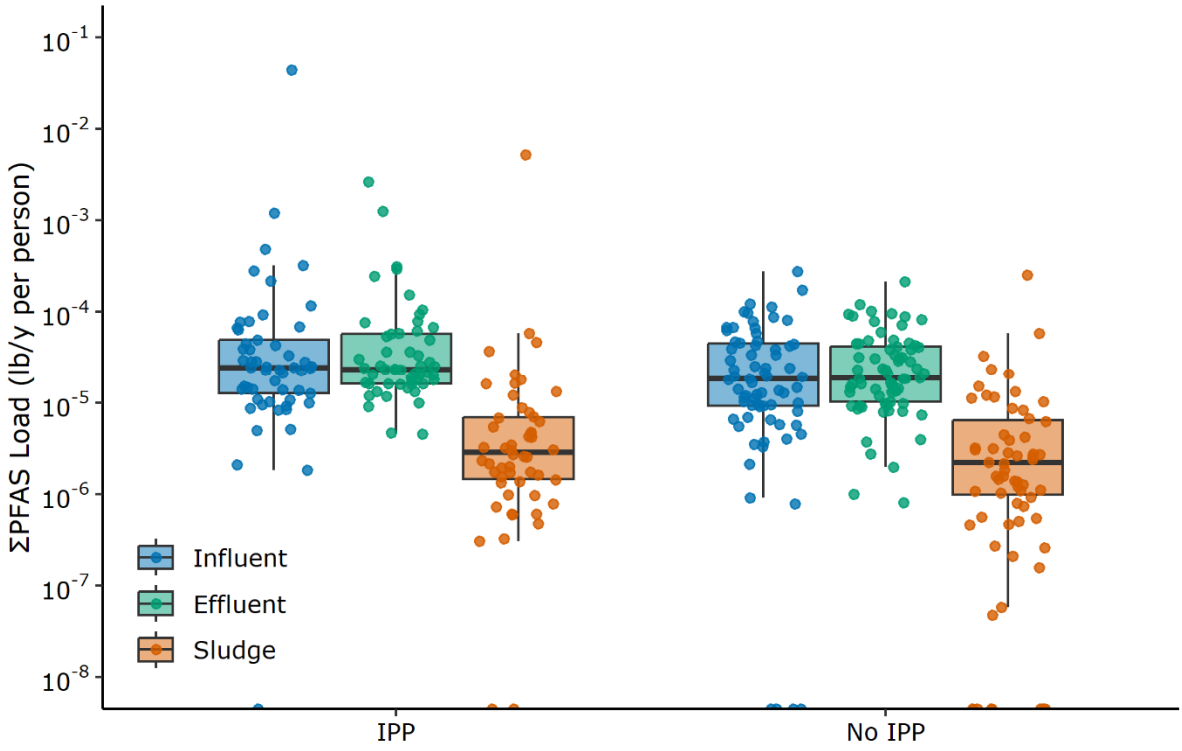


FIGURE 4-38
Estimated Median ΣPFAS Mass Loads per Capita based on presence of an IPP (Study and Portal Data)

A comparison of POTWs that include categorical users with those that do not was also conducted (Figure 4-39). During the Study, each POTW provided information on whether categorical users were present in their service area, and if so, which ones and how many. Categorical users were defined as those industries that EPA may require POTWs to monitor if present in their service area, and include:

- Commercial car washes
- Platers/metal finishers
- Paper and packaging manufacturers
- Tanneries and leather/fabric/carpet treaters
- Manufacturers of parts with polytetrafluoroethylene (PTFE) or Teflon-type coatings (i.e., bearings)
- Landfill leachate
- Centralized waste treaters
- Contaminated sites
- Firefighting training facilities
- Airports
- Any other known or suspected sources of PFAS

Estimated influent, effluent, and sludge annual total PFAS mass loads were all significantly greater for POTWs with categorical users in their sewersheds than POTWs that did not report serving categorical users (Mann-Whitney U-tests, all p<3E-7; Figure 4-39). This result aligns with the comparison between POTWs with and without IPPs. In general, larger POTWs serving larger populations are more likely to have categorical users than smaller POTWs, which likely accounts for a significant portion of the differences shown in Figure 4-40. However, the presence of categorical users in a sewershed does not necessarily drive significant differences in mass loading per capita (Figure 4-40). Although influent and effluent estimated total annual PFAS loading per capita were slightly higher for POTWs serving categorical users than those not serving categorical users, these differences are driven by just a few POTWs (Mann-Whitney U-tests, both p<0.05; Figure 4-40). It is likely that these POTWs are impacted by unique categorical users in their sewershed.

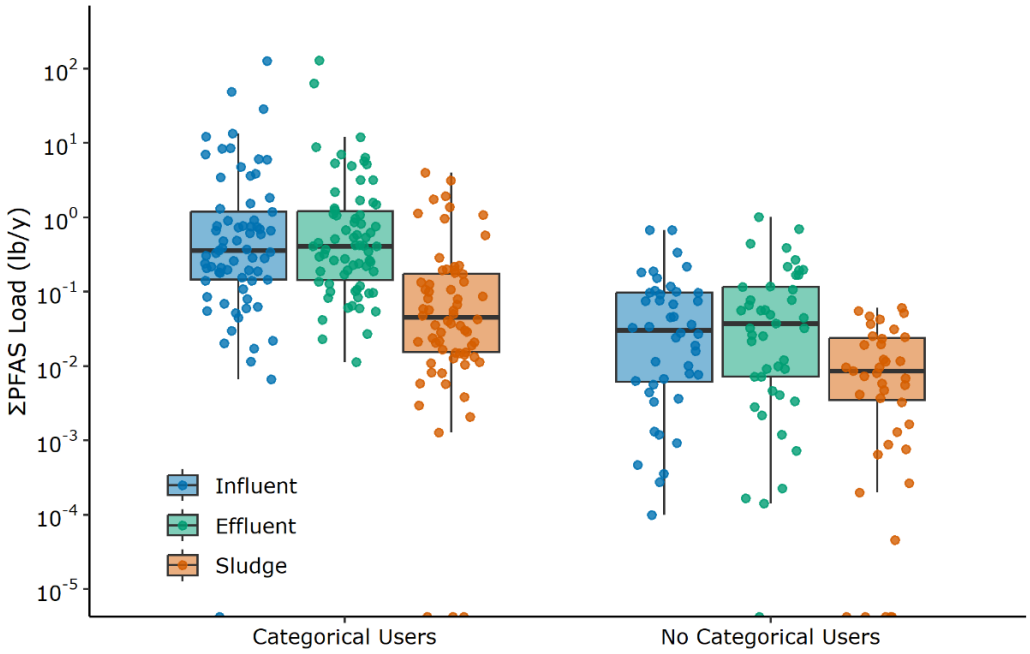


FIGURE 4-39
Estimated Median ΣPFAS Mass Loads based on presence of Categorical Users (Study and Portal Data)

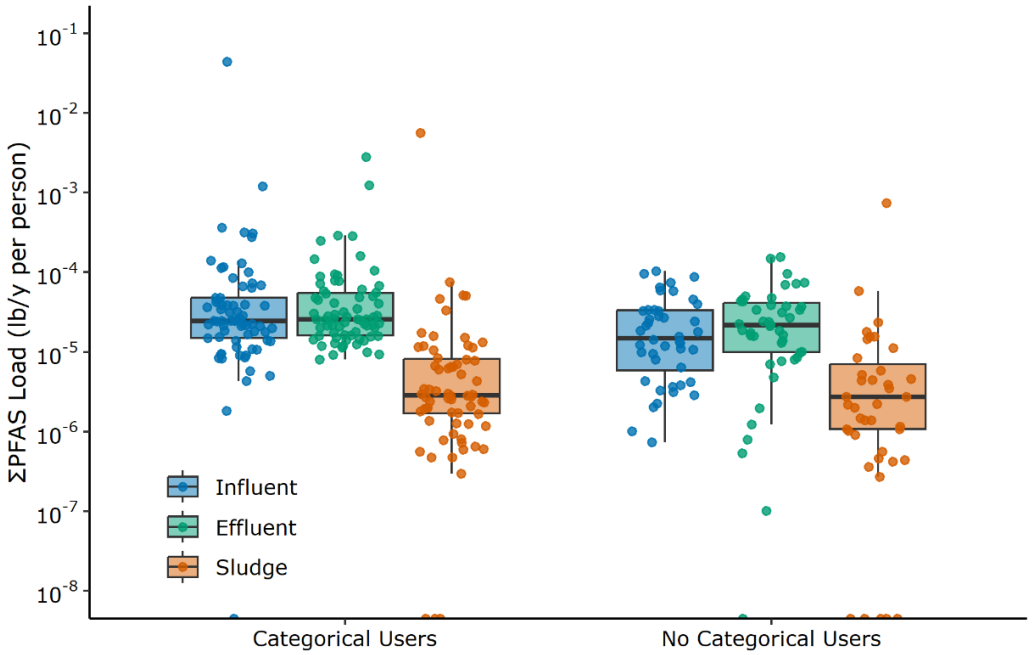


FIGURE 4-40
Estimated Median ΣPFAS Mass Loads per Capita based on presence of Categorical Users (Study and Portal Data)

4.5 PFAS Fingerprinting Analysis

The objective of nonparametric analyses is to examine differences in PFAS "fingerprints," the presence and abundance of PFAS, among wastewater influent, effluent, and sludge. The full dataset of Study and Portal data was filtered to include only data analyzed using EPA Method 1633, and 101 samples with no PFAS detected (i.e., no analytes detected above the MDLs) were removed. Mass concentrations (ng/L or ng/g) were converted to molar concentrations (nmol/L or nmol/g) using each PFAS' molecular weight (ng/nmol). Because the Nonmetric Multidimensional Dimensional Scaling (NMDS) algorithm cannot handle missing data, missing values were defined as zero prior to the calculation of Bray-Curtis dissimilarity. The resulting NMDS figure is included as Figure C-9 in Appendix C.

Differences in PFAS fingerprints are evident across sample locations and differ by medium (Figures 4-41 through 4-44). Although the majority of PFAS in POTW influent are derived from PFCAs, two POTWs are dominated by fluorotelomers (Fitchburg East WWTP and Greater Lawrence – Sanitary District). Sludges (wet or dry mass) were highly variable in terms of their fingerprints, with a greater portion of PFAS mass derived from precursors (both fluorotelomers and FASE/FASA/FASAAs). Effluent fingerprints had the least variability in fingerprints and were heavily dominated by PFCAs and PFSAs.

Permutational analyses of variance (PERMANOVA) based on Bray-Curtis dissimilarity indicated that PFAS profiles are distinct among wastewater media (influent, effluent, and sludge). Pairwise PERMANOVA confirmed that influent, effluent, and sludge (in both ng/g and ng/L) all have significantly different PFAS profiles (all $p \leq 1 \times 10^{-4}$), which is largely driven by the distinction between sludge and both influent and effluent (Figures 4-41 through 4-44). The distinction between sludge data reported on a liquid (Figure 4-43) or dry (Figure 4-44) basis indicates that the differences in sample processing permitted by EPA Method 1633 for sludge samples may not accurately quantify PFAS in sludges.

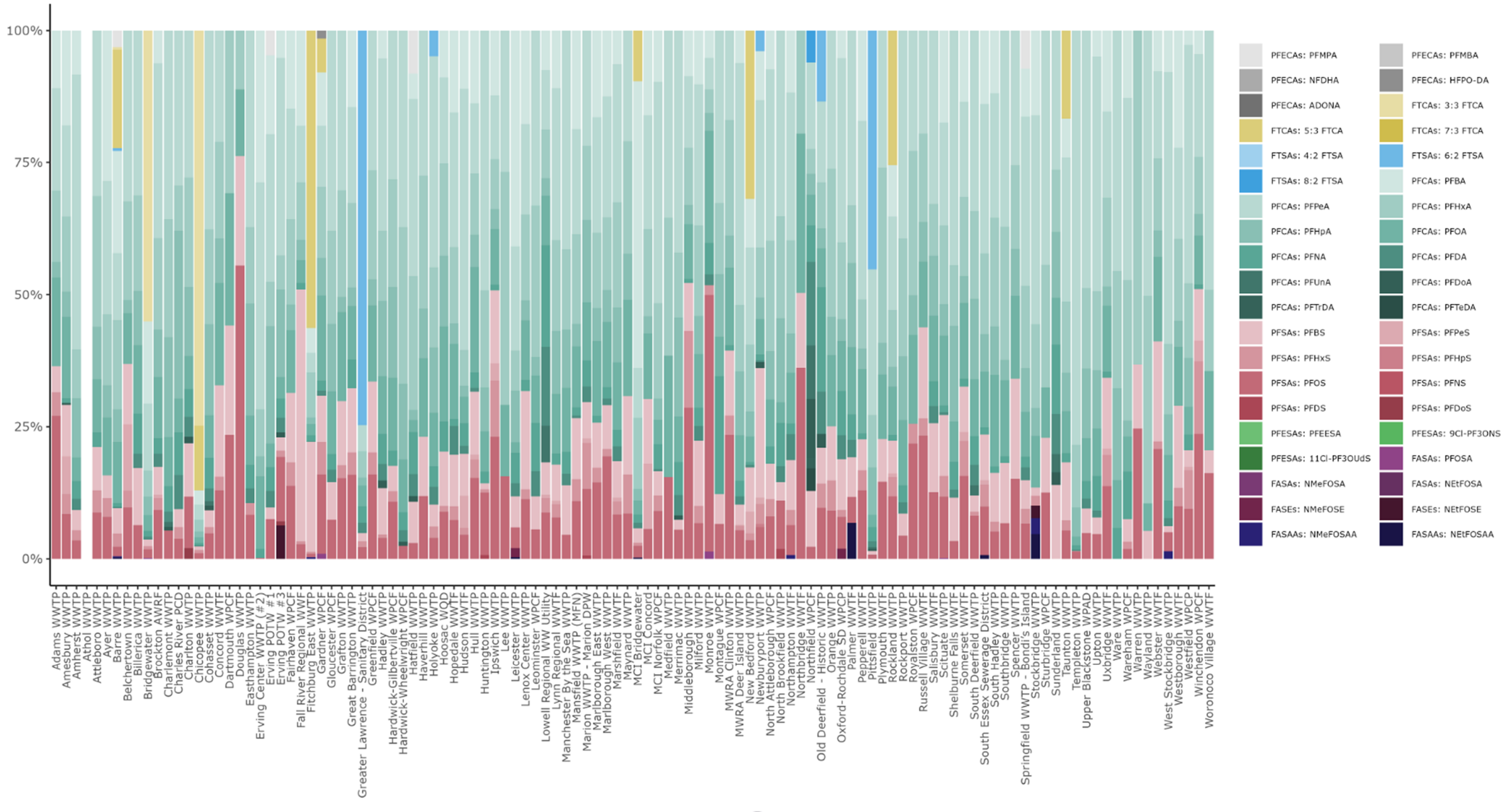


FIGURE 4-41
PFAS Fingerprints - Influent (Study and Portal Data)

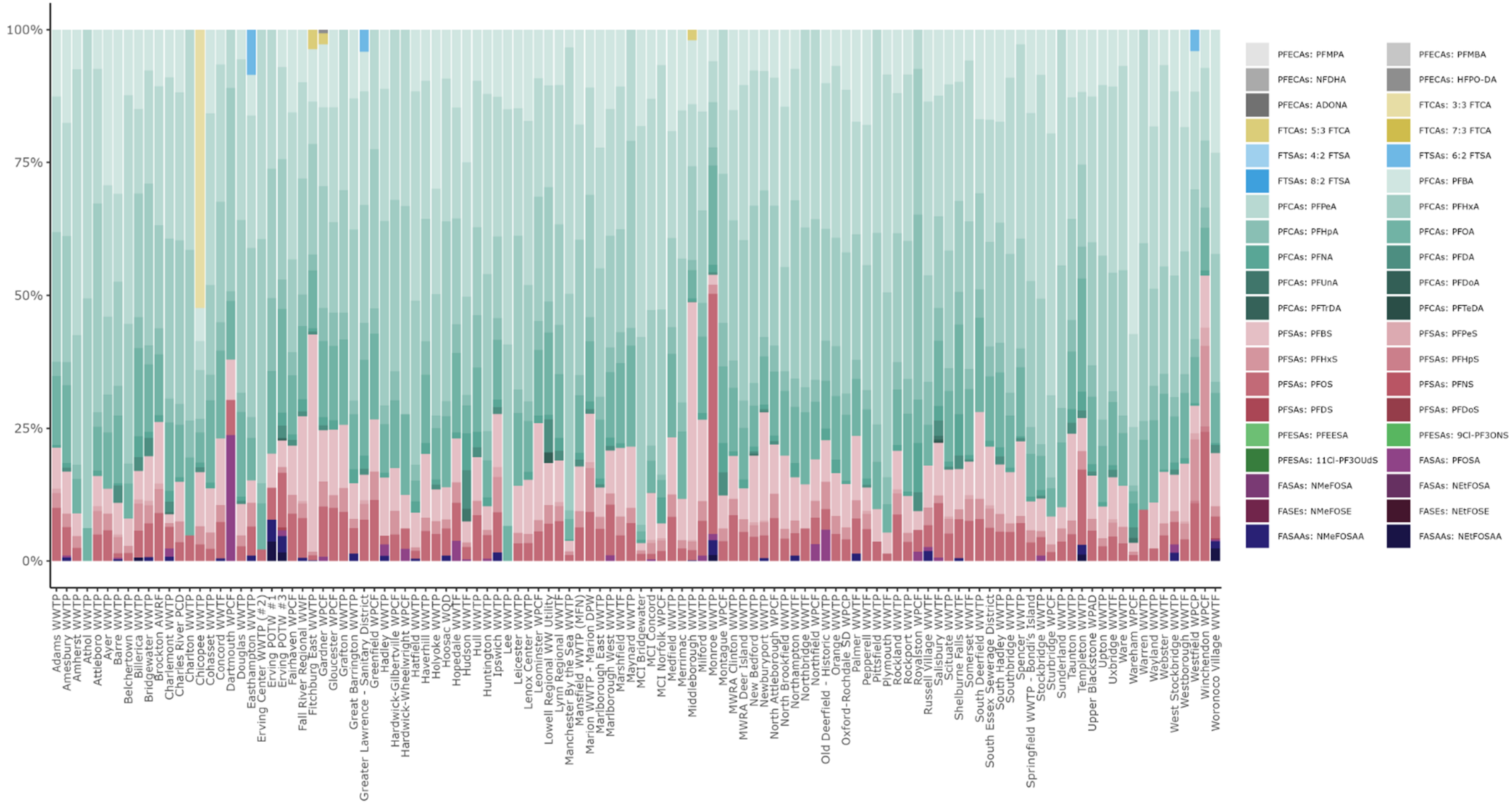


FIGURE 4-42
PFAS Fingerprints - Effluent (Study and Portal Data)

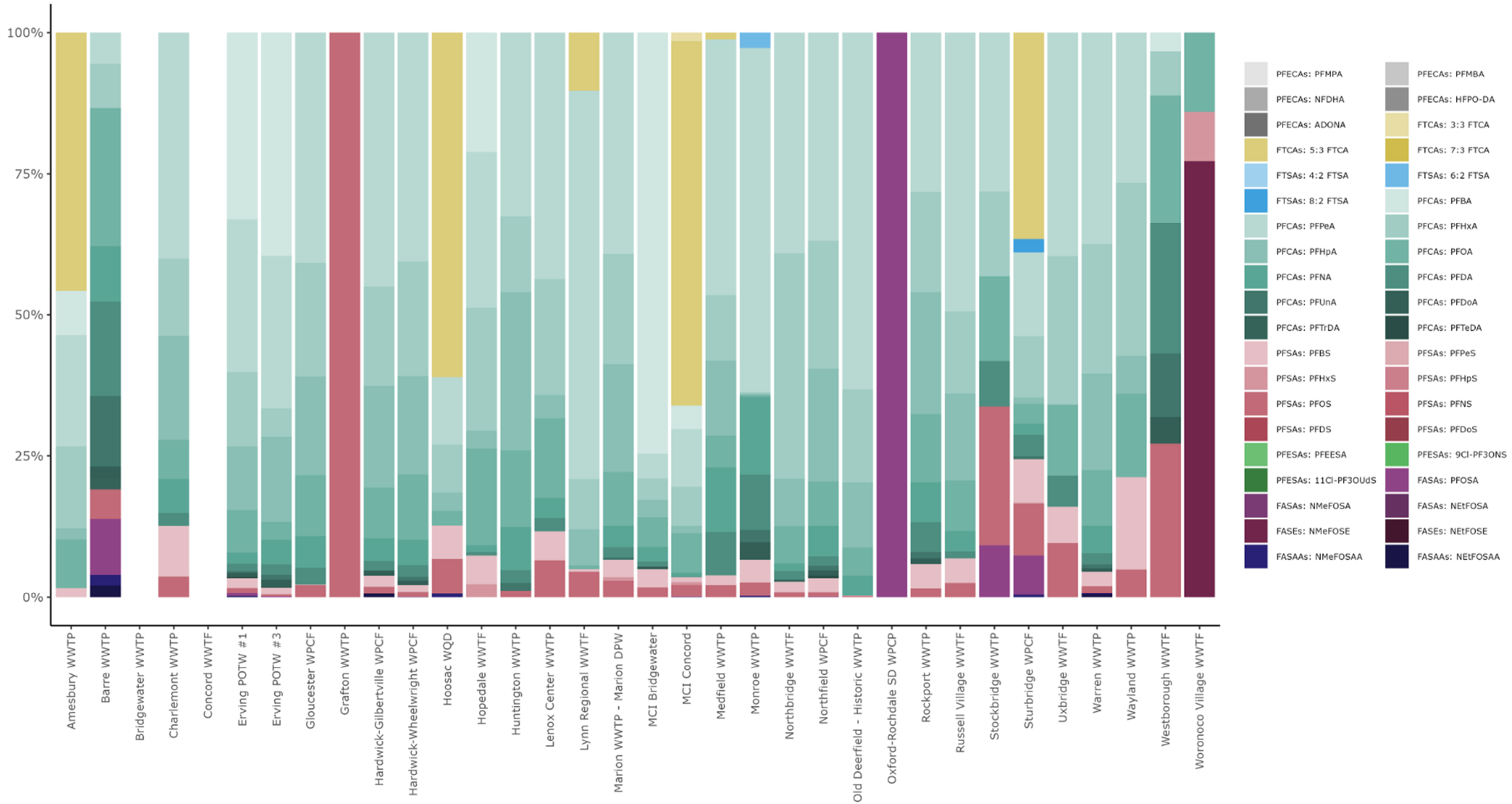


FIGURE 4-43
PFAS Fingerprints – Liquid Mass Sludge (Study and Portal Data)

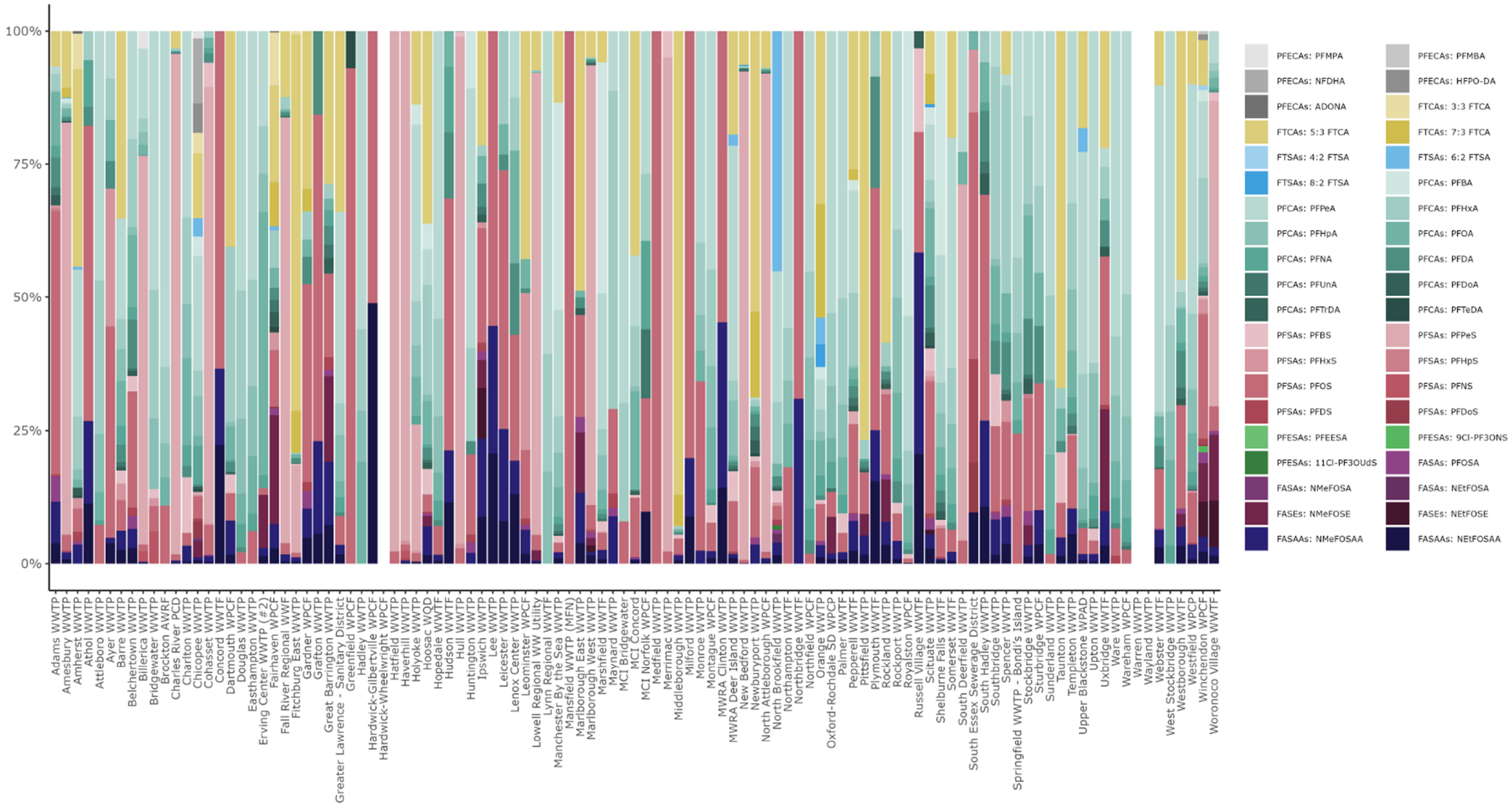


FIGURE 4-44
PFAS Fingerprints – Solid Mass Sludge (Study and Portal Data)

4.6 Interstate Comparisons

Several other states have conducted broad geographic sampling of PFAS in the influent, effluent, and/or sludge of POTWs or industrial facilities. Typically, the facilities sampled in these studies are permitted for discharge into the surface water through NPDES permits, or they are industrial facilities that discharge into sewersheds leading to POTWs regulated by NPDES permits. In the Northeast, Maine, New Hampshire, and Vermont have initiated statewide sampling of POTWs since 2020. Final reports are available for some of these studies while others are still in progress (and noted below). In the Midwest, Michigan and Minnesota have conducted statewide sampling of POTWs while California has also conducted sampling of select POTWs. Given that several of these states have collected similar types of data, in the future we recommend a broader meta-analysis be conducted, possibly focused on upper New England states, to compare typical loadings for different sized communities with differing industrial uses.

A more detailed statistical comparison of the data generated in this Study to the studies conducted in other states is not possible due to the limited access to published datasets from other states. However, a brief summary of how this Study relates to others in terms of general sample scope, sampled media, analytical methods, number of repeat samples, and availability of final report is shown in Table 4-14 below.

TABLE 4-14
Summary of Related Studies Conducted in Other States

State/ Program	Facilities Included	Media Type	Analytical Methods	Number of Repeat Samples	Report Available
MassDEP	All POTW and Industrial NPDES SW Discharge	Influent, Effluent, Sludge	EPA Method 1633, TOP, AOF (EPA Method 1621)	1-2	In Progress
Vermont DEC	All POTW NPDES SW Discharge	Influent, Effluent	537M, TOP	4	In Progress
Vermont DEC	4 Lined landfills, 3 Industrial Dischargers, 20 POTWs	Leachate, Influent, Effluent, Septage, Sludge	537 Version 1.1 (26 compounds)[3]	1	Yes
Maine DEP	105 POTW and 19 Industrial Dischargers	Effluent	537M (24 compounds); Select samples compared to 1633 (40 compounds)	Monthly, 10 months	Report on 6 PFAS complete[4] and data publicly available[5]
New Hampshire DES	58 POTWs and Industrial Dischargers	Influent, Effluent	537 (25 compounds)	1	No
Michigan EGLE	110 WWTPs (95 w/IPPs, 15 non-IPPs) with NPDES permits	Influent, Effluent, not all facilities sampled for both	537M (28 compounds)	1	Yes[6]
Michigan EGLE	42 WWTPs	Influent, Effluent, Sludge	537M (24 compounds)	1	Yes[6]
Minnesota	30 (2007) and 41 (2008) POTWs	Influent, Effluent, Sludge	13 compounds	2	Yes[7]
California	POTWs with >1MGD discharge	Influent, Effluent, Sludge	31 compounds + 7 optional	4 (quarterly)	In Progress
Connecticut DEEP	35 Water Pollution Control Facilities, 4 incinerators	Influent, Effluent, Sludge	34 compounds	1	Yes[13]

Section 5 Conclusions

5.1 Key Findings

In general, the highest ΣPFAS concentrations (sum of the 40 targeted PFAS via EPA Method 1633) from the Study were detected in sludge samples. Influent and effluent ΣPFAS concentrations were generally similar; both were also consistently less than sludge ΣPFAS concentrations, but there were no clear trend between the two. The PFAS analyte detected among the highest concentrations for all sample types (influent, effluent, and sludge) for both EPA Method 1633 and TOP analyses was perfluoropentanoate or perfluoropentanoic acid (PFPeA). Perfluorohexanoate or perfluorohexanoic acid (PFHxA) was detected among the highest concentrations for influent and effluent samples for both EPA Method 1633 and TOP analyses. Both influent and effluent samples with the highest median ΣPFAS concentrations were primarily comprised of PFHxA, PFPeA, and perfluorooctanoic acid (PFOA).

Analysis of duplicate samples collected as part of the Study's sampling efforts showed considerable variability, both in terms of detected analytes and their concentrations. Using the Jaccard Index metric of similarity, primary and duplicate effluent sample pairs had higher similarity in terms of the number and type of PFAS analytes detected, while primary and duplicate influent and sludge sample pairs were lower in similarity. For analytes detected in both the primary and duplicate samples, the average percent difference in concentration was lower in effluent samples (24%) compared with influent (38%) and sludges (33%). This finding affirms the highly variable nature of PFAS in the influent, effluent, and sludge waste streams. In addition, variability between primary and duplicate samples can be heavily influenced by sample heterogeneity. Consideration of data variability for permit-related compliance monitoring at POTWs may lead to supplemental sampling requirements. Building a more robust dataset on a facility-specific basis would enable better understanding of PFAS concentration ranges and PFAS fingerprints in each POTW's waste stream.

Sludge sample results across Massachusetts were observed to have a wide range in detected PFAS compounds and PFAS concentrations. Differences in PFAS detected and overall data quality with respect to laboratory RLs for sludge samples were primarily driven by whether the sample was analyzed as a solid or as a liquid. This finding may warrant guidance with respect to percent solids thresholds and optimum sludge sample collection points for permit compliance purposes.

Comparison of analyte detection frequencies and concentrations highlights the potential poor conversion of PFAS precursors in all samples using the TOP assay and the effects of elevated RLs. As a result, TOP concentrations are likely to underestimate PFAS mass for individual analyte and ΣPFAS levels. Further understanding of the causes of poor TOP conversation and/or when to exclude these data from subsequent analyses is warranted.

When evaluating relative abundance, mean concentrations of PFAS classes were calculated for EPA Method 1633 and TOP analyses by summing mean concentrations of the individual analytes in each class. When these concentrations were compared on a percentage change basis, there were differential changes based on sampling location within the waste stream (influent, effluent, and sludge). Moreover, specific compound classes appear to be obscured using a targeted analytical method. For example, during Round 1, PFCAs increased 23% in influent and 131% in the sludge after oxidation using the TOP assay.

Similarly, FTSAs increased 94% in influent and 1,091% in sludge after oxidation. In contrast, FASAAs decreased in all media by 47% to 91%, highlighting their oxidizable nature. Similar results were observed during Round 2 sampling for PFCAs and FTSAs, although FTCAs were more frequently observed in influent and effluent samples after oxidation.

Results of the 31 paired influent and effluent samples analyzed for AOF using EPA Method 1621 indicate that the use of AOF analysis as a screening tool for some industrial users of wastewater systems can provide insight into the potential presence of PFAS by quantifying organic fluorine within a sample. AOF concentrations in both influent and effluent samples for both Round 1 and Round 2 data were significantly greater than the total PFAS concentrations from EPA Method 1633 and TOP, which were not significantly different from each other. Because the AOF method measures PFAS as well as other fluorinated organic substances, AOF results should always exceed $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ concentrations calculated based on a targeted analytical method such as EPA Method 1633. However, the AOF analytical method is less prone to the matrix interferences commonly encountered when using EPA Method 1633 or the TOP assay and can be a useful analysis for determining specific industrial users that may be contributing PFAS to the POTW's influent.

Comparison of AOF, EPA Method 1633, and TOP analyses provides insight into the prevalence of PFAS, precursor compounds, and organofluorides in aqueous waste streams at Massachusetts POTWs. This information can be used to assess the likelihood of sequestration of organofluoride into sludge, evaluate PFAS precursors and their potential transformation within a POTW, and detect the potential presence of other fluorinated compounds in the waste stream.

An evaluation of PFAS mass load (lb/yr) by facility size resulted in the expected result that larger facilities are associated with significantly higher influent and effluent PFAS mass loading (Kruskal-Wallis tests, all $p<4\times10^{-11}$). That the same trend exists for mass loading normalized by population where larger facilities tend to have larger mass loads per capita in effluent; however, no significant associations can be made for ΣPFAS mass loading per capita for influent samples. In general, most small and medium POTWs are receiving and discharging less than an estimated one lb/yr of PFAS. Facilities serving a population of 100,000 to 250,000 typically received and discharged less than an estimated 5 lbs/yr. Two facilities included as part of this Study were receiving and discharging more than an estimated 75 lbs/yr, including Brockton AWRF and MWRA Deer Island WWTP, while New Bedford WWTP received a load of more than an estimated 12 lbs/yr. All three facilities serve populations greater than 100,000 people, showing a correlation of PFAS mass load to population served.

POTWs with more industrial users have significantly higher ΣPFAS mass loading than POTWs with minimal industrial dischargers in their service areas. A comparison of POTWs with approved industrial pretreatment programs (IPPs) versus those that do not have an IPP indicates that POTWs with IPPs have significantly higher PFAS mass loading in both their influent and effluent, both pre- and post-oxidation, than do POTWs without IPPs.

5.2 Sampling and Analysis Challenges

5.2.1 Sample Extraction and/or Post-Treatment Adjustments May Bias Results with Non-Detects

Elevated RLs were encountered in several samples collected during the Study. After discussions with the laboratory (see Section 2 for further details), it was determined that adjustments to RLs for EPA Method 1633 were a direct result of modifications within method standards and performance criteria made by the laboratory during the extraction phase to accommodate the difficult sample matrix, which further compounded RLs for TOP results. Extraction failures in wastewater and sludge samples were caused by the presence of suspended solids and organic matter in the sample matrix. In order to achieve successful extractions, sample dilutions were completed to account for potential matrix interferences (presence of suspended solids and organic matter) common in wastewater and sludge samples, which then lead to elevated RLs. Other factors which could have influenced front-end decisions by the laboratory affecting sample RLs include time-constraints of the Study with respect to the number of samples received and data delivery deadlines.

The issue of elevated RLs impacts data quality such that low level PFAS may not be detected or reported. MassDEP queried additional laboratories about this issue during the project, and responses indicated that laboratories servicing POTWs routinely make adjustments due to sample matrix issues (e.g., presence of suspended solids and organic matter) but the approach may be laboratory-specific. In addition, it was determined that the percent solids threshold for sludge sample analysis as a solid or liquid was lab-specific and visually dependent.

To better understand PFAS and TOP analytical results for media with the potential for matrix interferences, suggestions for clarification of decision-making related to modifications by the laboratory during sample processing include:

1. Encouraging/requiring laboratories to include in their case narrative a summary of why a modification was made during sample pre-processing, and specifying exactly what modification(s) were made;

2. Encouraging/requiring laboratories to report detected compounds as estimated values (J-flag) down to analytical MDLs for data evaluation purposes; and

3. Encouraging/requiring laboratories to describe in the TOP case narrative that RLs differed for TOP post-treatment samples, potentially biasing comparisons. This is particularly important when adjustments are made to one media and not all samples coming from the facility (e.g., influent and not effluent).

Additional discussions between MassDEP and managers of laboratories serving Massachusetts POTWs on these issues could ensure a similar approach is taken across the state, potentially leading to more consistent data gathering.

5.2.2 Analysis of Sludges as Liquids Rather than Solids May Cause Inconsistencies with Data Evaluation

A review of the analytical results for the 198 sludge samples collected during the project (not including duplicates) highlighted that twenty-eight (28) sludge samples were analyzed as liquids as opposed to solids (14.2% of samples). These liquid sludge samples came from 21 of the 113 facilities where a sludge sample was collected (18.5% of facilities). The percent total solids in the sludge samples analyzed as liquids ranged from 0.07% to 1.93%. Solid samples are processed and reported differently than liquid samples, creating challenges in the comparison of data due to reporting units and detection limits. MassDEP queried several laboratories to determine how common this issue is, and the total solids threshold used by laboratories for shifting to liquid sample processing. Laboratory responses varied considerably in their total solids threshold (e.g., any weighable mass, 2% up to 10% total solids), indicating the potential for introducing variability due to laboratory processing decisions. The analytical technicalities surrounding this issue are further summarized in Section 2. Suggestions for handling this issue related to sludge sample analysis as a liquid versus a solid include:

1. Consideration of an adjusted sample handling approach by the lab for POTWs with watery sludges. For example, allowing solids to settle in a specific sample volume for a pre-determined amount of time, and decanting the water before solids collection. This would need to be coupled with total solids analysis from a sample that was not decanted to adjust dry mass back to wet mass.
2. Encouraging/requiring laboratories to analyze sludges as solids down to a specific total solids content or as the matrix identified by the client.

5.2.3 Recommended Protocol when Samples are Analyzed Out of Method Hold Times

Although appropriate measures were taken by the project team to deliver samples to the laboratory as soon as possible after collection, laboratory issues resulted in three samples analyzed outside hold times. This specifically occurred for three sludge samples with low total solids content (Old Deerfield, Charlemont, and Monroe sludge duplicate) which needed to be analyzed as a liquid matrix rather than a solid. Other unplanned laboratory issues (e.g., staffing, instrument issues) could also cause sample hold times to be exceeded. Because PFAS break down so slowly, a sample analyzed outside of a method's specified hold time may not represent a problem with result accuracy; however, it may cause issues with federal and/or state regulatory compliance programs or permit requirements.

This issue highlights some of the current pressures on analytical laboratory systems that are likely to be confounded as PFAS monitoring needs increase due to new NPDES/SWD permit monitoring requirements across New England. This is especially challenging in the wastewater industry as laboratories are faced with making methodological modifications for the difficult/variable matrix that wastewater and sludges represent. Suggestions for handling this issue include:

1. Development of a standardized flow chart that provides key decision points that facilities could follow when laboratories report samples stored or analyzed out of hold times;

2. MassDEP include permit requirements for facilities to resample following incidents of PFAS not analyzed within the method-specified hold times. While this was not possible for this Study, such a clarification may be appropriate for inclusion in SWD permits due to potential data quality/usability issues.

5.2.4 Comparison of RL and MDLs

RLs and MDLs of the data collected as part of this Study were compared with those from available PFAS data on the Portal. This comparison was done by calculating the statistical median, as well as the minimum and maximum, of all RL and MDL values as shown below. The comparison was further analyzed to differentiate between median and range of RL and MDL values for samples analyzed by EPA Method 1633, and by other PFAS analytical methods such as EPA Method 537.1 modified isotope dilution. Table 5-1 presents the median and range of RLs and MDLs for PFAS analytical methods used during this Study and used by POTWs for NPDES permit compliance monitoring (Portal). The statistical median RL and MDL for AOF via EPA Method 1621 is also included in this table for reference. RLs and MDLs for Portal data that did not list a specific method were excluded from this analysis because they were assumed to include a mix of EPA Method 1633 and non-1633 methods.

Results of the statistical median comparison indicate that the median RLs and MDLs were higher for data from the Study than data available on the Portal. Median RLs between the two data sets differed by 28.9% and median MDLs differed by 42.1%. This may be due to some Portal data having only PFAS6 reported. Both Study and Portal data show influent RLs/MDLs that are greater than effluent RLs/MDLs, which would be expected based matrix issues being more likely for influent samples than effluent.

The Portal's median RLs and MDLs for samples analyzed by non-1633 methods were observed to be lower than those from the Portal's EPA Method 1633 RLs and MDLs, highlighting the rigidity of EPA Method 1633 when analyzing difficult matrices of wastewater and sludge samples. However, this may also be due to more of the non-1633 data with only PFAS6 reported.

The calculated statistical median RL and MDL for AOF via Method 1621 from the Study data was observed to be 1 µg/L in both cases, which is aligned with the expected values for the analysis. Our collective experience collecting and analyzing data on PFAS in wastewater and sludges produced by a wide variety of labs and methods, combined with the QC issues discussed throughout this report, leads to the conclusion that the condensed time frame in which all Study samples were required to be collected and analyzed may have affected the RLs and MDLs achieved for the Study data as discussed in Section 2.3.

TABLE 5-1
Summary of Analytical Method RLs and MDLs for Study and Portal Data

Data Source	Analytical Method	Median* (and Range) Method Reporting Limit				Median* (and Range) Method Detection Limit			
		Influent (ng/L)	Effluent (ng/L)	Sludge, dry (ng/g)	Sludge, wet (ng/L)	Influent (ng/L)	Effluent (ng/L)	Sludge, dry (ng/g)	Sludge, wet (ng/L)
Portal**	EPA Method 1633	5.2 (0.492-1,000)	2 (0.491-820)	3.89 (0.0004-1,340)	110 (1.2-37,700)	1.74 (0-900)	1.23 (0-561)	1.66 (0-890)	34.5 (0.11-37,700)
	EPA Method 537.1	1.74 (1.59-5)	1.72 (1.63-1.76)	2.24 (1.77-12.5)	N/A N/A	0.348 (0.159-1.25)	0.326 (0.163-0.966)	0.747 (0.591-4.18)	N/A N/A
	Other Targeted	2.19 (1.8-20)	1.88 (1.77-2.02)	0.581 (0.46-65)	N/A N/A	1.7 (0.203-7.2)	0.35 (0.199-1.96)	0.162 (0.077-40)	N/A N/A
	EPA Method 1621	2,000 (1,900-2,100)	2,000 (1,900-2,000)	N/A N/A	N/A N/A	1,000 (1,000-1,100)	1,000 (1,000-1,100)	N/A N/A	N/A N/A
Study	EPA Method 1633 Modified	12.8 (1.47-8,000)	6.4 (1.42-1,600)	19.7 (1.92-2,580)	128 (6.4-20,000)	4.26 (1.47-8,000)	2.14 (1.42-1,600)	6.57 (1.92-2,580)	53.2 (6.4-20,000)
	TOP	16 (1.49-20,000)	6.4 (1.41-20,000)	39.8 (0.96-6,740)	160 (26.7-80,000)	5.36 (1.49-20,000)	2.14 (1.41-20,000)	13.3 (0.962-6,740)	53.6 (26.7-80,000)
	EPA Method 1621	1,100 (680-2,800)	1,000 (690-2,700)	N/A N/A	N/A N/A	1,000 (680-1,500)	1,000 (690-1,400)	N/A N/A	N/A N/A

*Median RLs and MDLs were calculated using those reported for each PFAS analyte in each analytical method for each sample type
**Excludes Portal RLs and MDLs for data where the method was unspecified

5.3 Recommendations

Recommendations for MassDEP for additional evaluations of PFAS at Massachusetts POTWs and for MassDEP's consideration for future compliance monitoring based on the findings from this Study are included below.

5.3.1 Recommendations for Future Studies/Analyses

Recommendations for future studies and analyses to further evaluate PFAS at NPDES-permitted POTWs include:

- Conduct a meta-analysis of Portal data to assess possible seasonal and regional effects on PFAS presence and compound profiles and/or combine with another longer-term study to include sample collection from Massachusetts NPDES-permitted POTWs which would examine seasonal and regional variation of PFAS concentrations and loads. Mass loading, when analyzed by region, is likely influenced by the size of treatment plants and population served. However, it is possible that there are regional differences in the character of PFAS loading that may warrant further evaluation.

- Compare Massachusetts NPDES-permitted POTW data to POTW data collected by other states. Although some of these data are already publicly available, the release of other information remains in progress.

- Conduct additional mass load evaluations for Study and Portal data based on PFAS6 concentrations and/or based on concentrations of the 18 PFAS compounds that are targeted by EPA Method 537.1. This would allow for a longer time frame for mass load analysis based on historic samples.

- Evaluate the use of split samples and duplicate samples of wastewater and sludge for quality control purposes to determine if PFAS compound and/or concentration variability are due to inherent variability in the waste stream or due to laboratory processing differences.

    - Further compare duplicate and primary samples from this Study with an emphasis on shorter-chain PFAS compounds (8 or fewer carbons in the carbon chain) and carboxylic acids to determine if similar trends are observed regarding percent differences for influent, effluent, and sludge samples.

- Evaluate the use of AOF as a potential PFAS screening tool for industrial users/categorical users of the wastewater system. Recent NPDES and SWD permit renewals for POTWs have included requirements to monitor and report PFAS concentrations for regulated industries in their sewersheds, and some POTWs have been proactively investigating their industrial users or areas of interest within their sewersheds. This Study's results show that AOF analysis offers a conservative estimate of possible PFAS contamination that can be used to identify industrial users or areas for further investigation, allowing POTWs to prioritize resources for targeted analyses.

    - Calculate mass loads based on AOF information, and compare across sample locations both within and among POTWs.

- Conduct additional mass load evaluations based on PFAS concentrations from Study and Portal data for POTWs with specific categorical users.

5.3.2 Recommendations for Laboratory PFAS Analysis and Data Reporting

Recommendations for laboratory data reporting regarding decision-making related to modifications by the laboratory during wastewater sample processing include encouraging/requiring laboratories to:

- Include in their case narrative a detailed description of modifications made during sample processing, why the sample required processing modification(s), and justifications for those modifications.

- Report detected compounds as estimated values (J-flag) down to analytical MDLs for data evaluation purposes.

- Describe in the TOP case narrative when RLs differ for TOP post-treatment samples, potentially biasing comparisons. This is particularly important when adjustments are made to one medium and not all samples coming from the POTW (e.g., influent and not effluent).

- Measure and report percent solids content for all sludge samples including those measured on a liquid mass basis.

The extraction and analysis of PFAS in both the solid and liquid fractions of sludge samples is necessary to quantify overall PFAS concentrations and facilitate comparison among facilities, waste streams, and sample media. It is recommended that MassDEP develop guidance for laboratories for sludge sample processing and analysis. Suggested guidance includes:

- Encourage/require the collection of larger sample volumes for watery sludges to ensure adequate solids content for analysis as a "solid".

- Adjust sample processing protocols for low percent solids (i.e., watery) sludges. For example, allowing solids to settle in a specific sample volume for a pre-determined amount of time, and decanting the water before solids collection. This would need to be coupled with total solids analysis from a sample that was not decanted to adjust dry mass back to wet mass.

- Encourage/require laboratories to analyze sludges as solids down to a specific total solids content threshold or as the matrix identified by the client.

- Encourage/require laboratories to analyze samples from the same POTWs using consistent dilutions and/or sample processing to improve the temporal consistency of results. When sample processing modifications are needed, laboratories should discuss with POTWs prior to making the change so that analytical implications are clear and understood.

5.3.3 Recommendations for Guidance for POTWs

It is recommended that MassDEP develop guidance for POTWs for sample collection and processing to mitigate issues associated with the difficult/variable matrix that wastewater and sludges represent. Suggested guidance content includes:

- Encourage/require POTWs to report their influent and effluent flow rates at the time of sample collection to enable calculation of instantaneous mass loading rate. This may require a modification to the Portal data upload feature.

- Develop a standardized flow chart that provides key decision points and recommendations that POTWs could follow when laboratories report samples stored or analyzed out of hold times.

- Include requirements for resampling when PFAS samples collected for permit compliance are not analyzed within the method-specified hold times.

- Include requirements for collecting and analyzing replicate samples and field and/or equipment blanks to improve data quality.

- Establish "office hours" for POTWs to discuss data quality objectives and challenges with sampling, analytical methods, reporting, data analyses, and interpretation with MassDEP staff.

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Appendix A – Sampling and Analysis Plan

Title Page

Sampling and Analysis Plan for MassDEP PFAS Testing Study for NPDES POTWs (PRF77)
Document Title

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MassDEP Approval Date

June 30, 2025
Expiration Date

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Section A. Project Purpose

Tighe & Bond has prepared this *Sampling and Analysis Plan (SAP)* in accordance with requirements of the Massachusetts Department of Environmental Protection (MassDEP) Request for Quotes (RFQ) Contract PRF77 for the per- and polyfluoroalkyl substances (PFAS) Testing Study for National Pollutant Discharge Elimination System (NPDES) Publicly Owned Treatment Works (POTWs).

PFAS are a family of anthropogenic compounds that do not readily biodegrade or otherwise break down in the environment. Waste streams discharged to POTWs, otherwise known as municipal wastewater treatment plants/facilities (WWTPs/WWTFs) and/or water pollution control facilities (WPCFs), can contain PFAS from residential, commercial, institutional, and industrial operations within their services areas. PFAS can be present in influent and effluent wastewater streams as well as accumulating in treatment sludge/biosolids. PFAS have the potential to be released back into the environment through effluent and sludge/biosolids.

Currently, there are 114 POTWs in Massachusetts with NPDES permits that collectively treat approximately 1 billion gallons of wastewater per day. As NPDES and Surface Water Discharge (SWD) permits are renewed, PFAS testing requirements are being added to the monitoring programs. Due to the timing of these staggered permit renewals, PFAS sample analysis for these media has only recently commenced; therefore, accelerated sample collection of all permitted facilities on a parallel timeline with NPDES compliance monitoring will aid understanding of PFAS fate in these systems in the short term.

The goal of this study is to better understand and evaluate PFAS concentrations within the influent, effluent, and sludge at NPDES permitted POTWs across Massachusetts. Objectives throughout this PFAS Testing Study as summarized in this Sampling and Analysis Plan will include:

- Conduct PFAS sampling of influent, effluent, and sludge at up to 114 NPDES POTWs during Round 1 and at least 50% (or 57) of POTWs during Round 2 in accordance with this Sampling and Analysis Plan.
- Analyze all samples using United States Environmental Protection Agency (EPA) Method 1633[1], and analyze select samples for Total Oxidizable Precursor Assay (TOPA) and Adsorbable Organic Fluorine (AOF) to understand how target PFAS compare to two broader measures of PFAS.
- Compile and analyze data collected from this project alongside data previously collected by POTWs as part of their NPDES and SWD permit requirements.
- Document results in a comprehensive report including PFAS trends within and among POTWs in Massachusetts. PFAS data from this study will be compared to data collected by POTWs for NPDES permit compliance and compared to studies conducted in other states. PFAS loading (pounds per day) into and out of POTWs will be evaluated. Statistical analyses will be conducted to address PFAS fingerprints, loading, per capita

[1] United States Environmental Protection Agency, Method 1633, Analysis of PFAS in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, January 2024.

contributions, regional trends, and industrial contributors. TOPA and AOF data will be analyzed and compared with pre-TOPA identification (ID) results.

This SAP details the approach for assessment and evaluation of PFAS in the wastewater stream. This SAP also includes a description of roles and responsibilities for Tighe & Bond and our partners, field study design and schedule, sampling and analytical procedures, and data quality considerations.

Section B. Project Management

B.1 Project Organization and Personnel

Tighe & Bond understands the process of the SAP for this project, and that approval of the SAP must be given by the MassDEP Project Manager as appropriate, prior to commencement of facility sampling work. Project work involving PFAS testing for NPDES POTWs conducted at individual sites must be conducted according to the processes and procedures outlined in the SAP. If site-specific work requires any modifications and/or additions to the SAP, they will be provided in a SAP Addendum, which must be reviewed and approved by the MassDEP Project Manager. SAP Addendums will be distributed to the following project participants for review and approval prior to conducting modified, or additional site work:

- MassDEP Project Manager and MassDEP project personnel
- Paula Mouser, Ph.D., PE, Lead Project Engineer II, Wright-Pierce, Professor of Civil and Environmental Engineering, University of New Hampshire
- Others as necessary based on specific project requirement

Roles and responsibilities for project personnel have been summarized below. The following individuals within the Tighe & Bond organization involved in major aspects of the PFAS Testing Study for NPDES POTWs project management are provided below:

Project Director

Christopher Bone, PE, Vice President, Tighe & Bond

Project Manager

Jessica Cajigas-Smith, MA WWTP Operator 2-I #19069, MA DW Treatment Operator 2T-OIT #20389, Senior Project Manager, Tighe & Bond

Operations Managers

Sampling Manager - Colleen Brothers Lawson, Senior Environmental Scientist, Tighe & Bond

Sampling Plan Lead - Michael Trovato, PE, Project Manager, Tighe & Bond

Data Analysis Team – Jill Libby, Senior Data Management Specialist, Tighe & Bond
Julia Jackson, Data Management Specialist, Tighe & Bond
Rachel Tenney, Staff Engineer II, Tighe & Bond

Project QA/QC Managers

Suzanne Courtemanche, LSP, CHMM, Vice President and Technical Director, Tighe & Bond

Jeffrey Arps, LSP, Senior Consultant, Tighe & Bond

Technical Advisors

Paula Mouser, PhD, PE, Lead Project Engineer II, Wright-Pierce, Professor of Civil and Environmental Engineering, University of New Hampshire

Tighe & Bond Sampling Team

Ellie Petraccione, Project Environmental Scientist, Tighe & Bond

Alexander DeMarco, Project Environmental Scientist, Tighe & Bond

Peter Topor, Project Compliance Specialist, Tighe & Bond

Ellen Dufraine, Project Environmental Scientist, Tighe & Bond

Joshua Mei, Environmental Scientist I, Tighe & Bond

Anabel Santini, Environmental Scientist I, Tighe & Bond

Austin Cahill, Engineering Technician II, Tighe & Bond

Robert Suter, Jr., Remediation Technician I, Tighe & Bond

Kelley Dolan, Environmental Scientist I, Tighe & Bond

Samuel Evans, Environmental Scientist II, Tighe & Bond

Brandon Bieda, Environmental Scientist I, Tighe & Bond

Christian Salamon, Environmental Scientist I, Tighe & Bond

Richard Ciliberto, Environmental Scientist I, Tighe & Bond

Partner Sampling Team - Stacey DePasquale Engineering, Inc. (SDE)

Nicholas Kaminski, Co-Director of Field Operations, SDE

Colin Brown, Co-Director of Field Operations, SDE

Jillian Henrichon, Co-Director of Field Operations, SDE

Meghan McCudden, Environmental Scientist III, SDE

Rebecca Potter, Environmental Scientist III, SDE

Laboratory Analysis

Pace Analytical Services, LLC (Pace)

The organizational chart included below details the key proposed project personnel. Relevant certifications, experience, and trainings for applicable personnel have also been provided as Attachment A to this SAP.

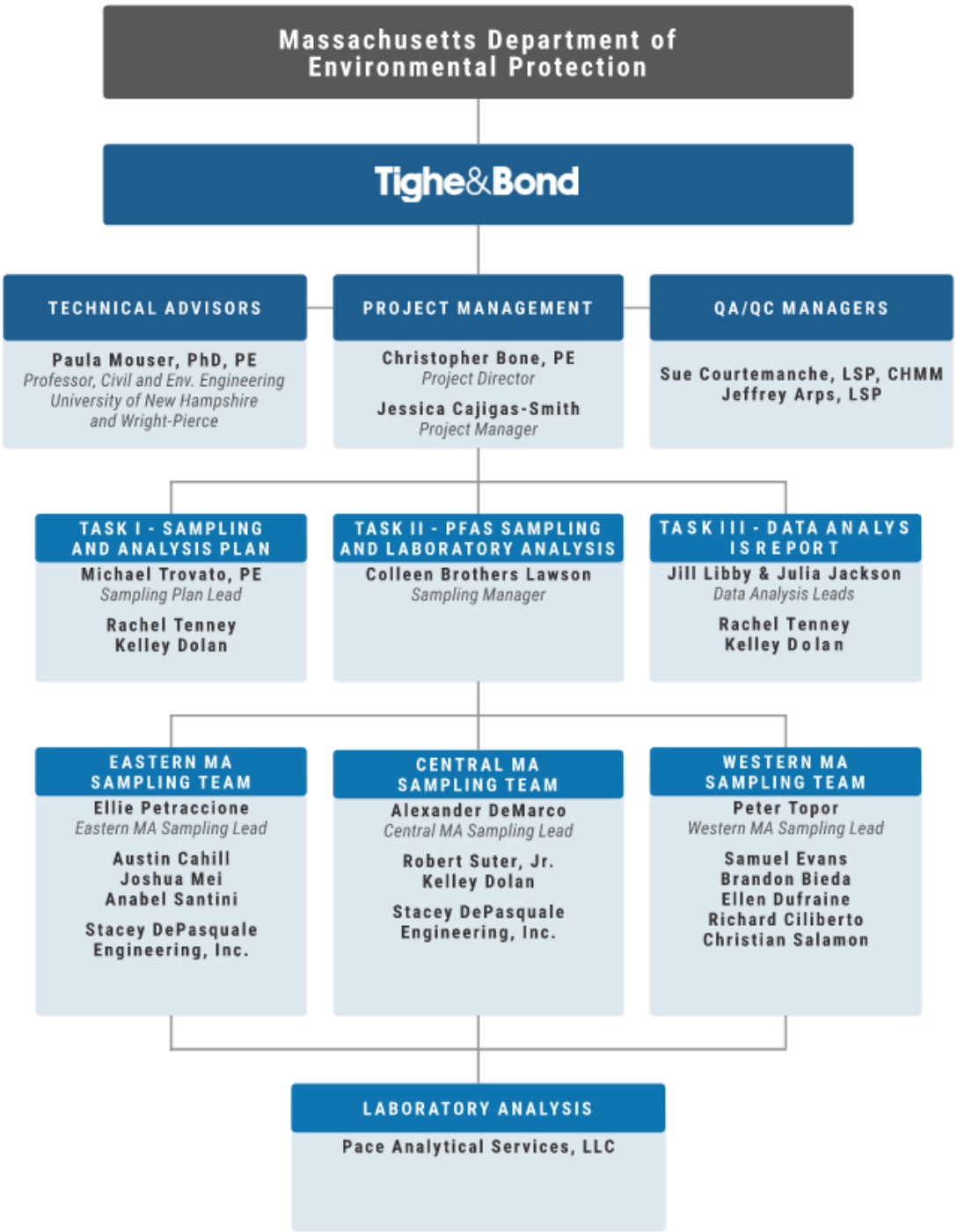


Figure B-1 MassDEP PFAS Testing Study for NPDES POTWs Project organizational chart

B.2 Documentation, Records, and Data Management

B.2.1. Field Documentation and Records

Tighe & Bond has developed a project-specific Field Data Collection Form to be completed by sampling personnel in association with POTW personnel for each sampling event that includes the following:

- Sampler Information:
    - Sampling personnel, sample collection times and locations, including latitude/longitude.
    - Sample collection methods.
    - General conditions on the day of the sampling and for the five (5) days preceding sampling (e.g. weather, temperature, precipitation, etc.) and any other unusual influent or occurrences at the facility.
- POTW Information:
    - Whether partial treatment (e.g., preliminary solids removal or settling, partial nitrification, etc.) is used.
    - Whether combined sewer overflows are present.
    - Volumes of septage/leachate/hauled waste received on the day of sampling, if applicable.
    - Flow rates for influent and effluent at the time of sampling. Annual average and peak design flow rates for the wastewater treatment plant.
    - General description of sources of influent wastewater, such as the number and type of Significant Industrial Users, and percentage of flow from residential and other wastewater types.

A copy of the Field Data Collection Form is attached to this SAP for reference (Attachment B).

In addition to the Field Data Collection Form, a permanently bound notebook with individually numbered pages is maintained by staff for field sampling. All entries into the notebook are made with permanent ink and corrections are made using a single line through the mistake with the date and initials of the individual making the change. Entries include sampling location, time, date, weather conditions, parameters to be measured, and any problems or abnormalities encountered during sampling. Use of only PFAS-free field books and permanent ink (ballpoint pen, fine/ultra-fine-tip Sharpie®[2]) are permitted to be used as part of this project.

[2] "Do not use markers other than Fine or Ultra-Fine point Sharpies® which have been proven to be PFAS-free." *For Technical Staff and Contractors-Residential Well PFAS Sampling,* Michigan Department of Environment, Great Lakes, and Energy (EGLE), December 2019, Page 6.
"Fine and Ultra-Fine point Sharpie® markers are acceptable to label the empty sample bottle while in the staging area provided the lid is on the sample bottle and gloves are changed following sample bottle labeling." *Per- and*

Copies of the Field Data Collection Forms and all field notes are made at the end of each field day and will be included in the project files and maintained by each office in a central location, or the field sheets are scanned into the electronic files maintained at Tighe & Bond. Information from the Field Data Collection Forms will be compiled into a Microsoft Excel spreadsheet by the Tighe & Bond data management team and will be incorporated into a technical report deliverable. Copies of the individual Field Data Collection Forms will be compiled into a Microsoft Excel spreadsheet and submitted to MassDEP on or before June 20, 2025.

Field documentation and/or field data that requires transcription into the respective report(s) will be reviewed by the Operations and Quality Assurance Quality Control (QA/QC) Manager as part of the draft document review, prior to issuing to MassDEP.

B.2.2. Laboratory Documents and Records

Laboratory-provided Chain-of-Custody (COC) forms will be completed to track possession and handling of samples from the time of collection to receipt by the analytical laboratory. As part of this project, pre-printed laboratory COC forms will be provided to sampling staff which includes Company Name and Address, contact information, billing information, relevant project information and data deliverable formats, and will specify the analyses requested. Site-specific sample identifications, sample dates and times will be completed by the sampling staff during each sampling event. When samples are transferred in possession, the individual relinquishing and receiving will sign, date, and note the time on the COC form. Samples are not planned to be shipped as part of this project. The sampling personnel will retain a copy of the COC form documenting required information through to the first change of sample custody. This record will be filed and maintained at the respective Tighe & Bond or SDE office. A copy of the COC form will be included as part of the final data deliverable for reference.

The analytical laboratory will provide a courier service in support of this project. The courier service schedule will be consistent with the confirmed sampling schedule as part of this project, and will complete sample pickups at each respective Tighe & Bond Office (Westwood, Sandwich, Worcester, and/or Westfield, MA) and SDE Office (Lawrence, MA) the day after each sampling date. The analytical laboratory will provide an electronic COC upon sample receipt, which will be cross-checked against the Field Data Collection Forms.

Received samples which are analyzed by the laboratory will be recorded in analytical sequence logs, specific for each instrument. A brief narrative is included at the end of each analytical run that includes any problems encountered with the standards, samples, blanks, or QC samples. In addition, laboratory analytical reports prepared as part of this project will include a case narrative and copies of calibration procedures and results, and will document any deviations from method standards in order to meet the necessary data quality documentation.

Every laboratory analytical report will consist of the same deliverables. The laboratory report will indicate the sample-specific reporting/detection limits in all instances. Method reporting/detection limits (MRL/MDL) will be documented on each laboratory analytical

report, and will be compared with State, Federal, or project-specific criteria. Any deviations from benchmark reporting limits due to specific field conditions or other factors will also be documented.

B.2.3. Post-Laboratory Data Evaluation & Database Management

Upon receipt of analytical reports from the laboratory, the report and associated QA/QC results will be reviewed by the Tighe & Bond Data Analysis Lead and Project Manager. The data will be provided by the laboratory in both a Portable Document Format (PDF) and a project-specific Electronic Data Deliverable (EDD) typically in Microsoft Excel. The EDD will be imported into Tighe & Bond's Database Management software and exported into a cross-tab spreadsheet, comparing the data to applicable regulatory standards. Typically, separate tables are prepared for each medium sampled. Note that data uploaded to the Database Management software is initially reviewed by Tighe & Bond's Data Management Team. It is subsequently reviewed by the Project Manager, and finally by the QA/QC Manager as part of the corresponding report review process.

Standards are maintained within the database and updated when applicable. The tabulated summary tables will include sample identification, date of sample collection, laboratory sample identification number, analyses conducted, analyte list, detected concentration, applicable flag codes, and the applicable standards for comparison. If a detected analyte exceeds an applicable standard, the result is boxed and bolded in the table. If an analyte is not detected above the MRL/MDL the result will be reported as < the MRL/MDL to allow for comparison of the MRL/MDL value to the applicable standard. The laboratory data and EDD output will be reviewed by the QA/QC Manager for accuracy and completeness before being finalized.

Final laboratory reports digitally signed by the laboratory manager are provided to Tighe & Bond in a secured PDF format (e.g., it cannot be modified). Copies of original laboratory reports and project field forms will be included in the final Data Analysis Report. The data set for the project will be provided to MassDEP separately in electronic format.

B.2.4. Project Files

Project files will be maintained by Tighe & Bond for a minimum of five years. This period can be extended at the discretion of the Tighe & Bond Project Manager.

B.3 Assessment, Response Actions, and Oversight

The Tighe & Bond Project Manager, and Operations Managers, will be responsible for scheduling/oversight of field sampling activities and confirming they are consistent with the project requirements as stated in the RFQ, and summarized in this SAP, as approved by MassDEP. Field sampling activities will be conducted in accordance with the Standard Operating Procedure (SOP) prepared by Tighe & Bond as part of this project, and approved by MassDEP. The project-specific SOP is included in Section D.

A project-specific PFAS training program will be developed for the sampling team to establish consistency of sample collection protocols and practices as described herein; and will include review of the project-specific SOP, and laboratory-provided SOP for EPA Method 1633 and AOF analyses by EPA Method 1621. Proper sample handling, preservation, decontamination procedures, and COC and Field Data Collection Form

completion will also be presented. The training will be conducted by Tighe & Bond staff who have extensive PFAS sampling experience. Training documentation records will be saved to the project files.

Oversight and review of field sampling activities and data quality will be performed by Operations Managers, or other qualified individuals designated by the Project Manager. Protocol reviews will also be provided at the initiation of each discrete sampling event to ensure compliance with SOP guidance. If sampling activities deviate from the anticipated schedule, periodic follow-up oversights will also be performed.

Documentation of oversight activities performed by the Operations Managers will be documented in writing, and will include, but not necessarily be limited to, corrective actions implemented in the field, telephone call report logs or field book entries, as appropriate. Telephone call logs and copies of the field book pages will be included in the permanent project files. Corrective actions will be addressed as soon as possible, either upon identification of issues requiring such, or during a follow-up field event conducted within a reasonable period of the original event. The QA/QC Manager will review reports and records prior to submittal to MassDEP.

B.4 Reports to MassDEP

Successful delivery of this project is highly dependent on strong project management and communication.

B.4.1 Meetings

To achieve consistent collaboration with MassDEP, our project management team will conduct the following recurring meetings throughout the project duration, in addition to multiple workshops between MassDEP and stakeholders, Tighe & Bond and our partners, as appropriate.

- **Kick-off Meeting with MassDEP:** A virtual project kick-off meeting was conducted on January 24, 2025. The purpose of the meeting was: to facilitate introductions; review project scope and schedule; discuss schedule for recurring meetings, communication expectations, coordination procedures, and project completion protocols. Attendees included the Tighe & Bond Project Director, Project Manager, and Operations Managers, in addition to our strategic partners (SDE, Dr. Paula Mouser, and Pace).
- **Bi-weekly Check-In Meetings with MassDEP:** Tighe & Bond's Project Director and Project Manager will schedule and participate in virtual bi-weekly check-in calls with MassDEP's Project Manager. The purpose of the bi-weekly meetings is to provide updates on tasks completed, status of ongoing tasks, upcoming planned work, and information and coordination needs.
- **Monthly MassDEP Meetings:** Tighe & Bond will schedule and participate in five monthly progress meetings with MassDEP to discuss project-related items based on the project stage, and will generally include status updates on tasks completed, updates to project schedule, and discussion on planned upcoming work for the following month. These meetings may also be utilized for mini-workshop discussions to align our project team and MassDEP on upcoming tasks and deliverables.

B.4.2 Comprehensive Data Analysis Report

Tighe & Bond will prepare a comprehensive data analysis report that will include PFAS trends within and among POTWs in Massachusetts. PFAS data from this study received prior to May 9, 2025, will be incorporated into the report and compared to data collected by POTWs for NPDES permit compliance, and qualitatively compared to studies conducted in other states.

An analysis of PFAS loading (pounds per day) to POTWs will be conducted. Statistical analyses will also be conducted to address PFAS fingerprints, loading, per capita contributions, regional trends, and industrial contributors. Current TOPA and AOF data will be analyzed and compared to pre-TOPA 1633 results using simple ratio metrics. Components of the data analysis report are detailed below:

Data Compilation

Through our work on the PFAS and Residuals Technology and Management Study, we have developed a robust database that represents influent, effluent and sludge PFAS monitoring data from 51 of the 114 NPDES POTWs in Massachusetts. Available data from the Massachusetts Energy & Environmental Affairs Wastewater NPDES PFAS Data Portal database (PFAS Data Portal) will be included in our analyses to further expand MassDEP's dataset as part of this study. Tighe & Bond will plan to incorporate Q4-2024 PFAS monitoring data into our database and all available Q1-2025 sampling data will be uploaded to the PFAS Data Portal or otherwise provided by MassDEP by April 30, 2025, to allow ample time for data analyses and report completion. These data quality management and sample collection procedures will facilitate direct comparison of data collected as part of this study to existing PFAS monitoring data and results from prior studies.

PFAS Characterization

Tighe & Bond intends to build upon the database and analyses performed as part of the PFAS and Residuals Technology and Management Study, which assessed the relative contributions of sources of PFAS to POTWs in an effort to determine if source control measures can be effective in reducing the presence of PFAS in wastewater influent, effluent, and sludge, and in an effort to identify high-impact approaches to reducing upstream PFAS sources. As part of this effort, the study report may include, but not necessarily be limited to the following:

- Description of PFAS compounds detected, their typical mass and molar concentrations, and their frequency of detection in POTW influent, effluent, and sludge.
- Comparison of the results of targeted PFAS analyses (i.e., ID) with the results of complementary non-targeted PFAS analyses (i.e., TOPA and AOF) used to assess the efficacy of targeted analytical methods in quantifying the true prevalence of PFAS in wastewater influent, effluent, and sludge. This Study will provide the first dataset of this kind for Massachusetts.
- Understanding sources of PFAS to Massachusetts POTWs to facilitate MassDEP's future efforts to address PFAS in wastewater. Comparison of paired influent and effluent samples analyzed by AOF may provide additional insight into the accumulation of influent PFAS in sludge during the treatment process.

PFAS Loading Trend Analysis

Tighe & Bond intends to utilize the same or similar nonparametric analyses to the new dataset that was used as part of the PFAS and Residuals Technology and Management Study, that align with commonly accepted practices in PFAS 'fingerprinting,' 'forensics,' or 'source attribution' studies (Dunn, M. (2024, October 31). *Fate and Transport Challenges for PFAS Forensics* [Webinar]. Environmental Business Council of New England, Inc.). Tighe & Bond may include as applicable, further assessment of additional variables associated with the observed differences in PFAS compositions in influent, effluent, and sludge. Variables of interest include, but may not be limited to:

- Design - flow rates
- Operational - flow rate at the time of sample collection, volumes of septage, landfill leachate, or other hauled-in wastes processed (as applicable)
- Sewershed – relative contribution of domestic flow, land use associated with industrial/commercial uses, region
- Demographic – number of users in service area, population served, median household income, minority population, census block groups within a POTW's sewershed

A copy of the report will be submitted to MassDEP as a draft for review and comment. Following receipt of all comments, the report will be finalized and issued to MassDEP in both hard copy and electronic format. The final report will include, but not necessarily be limited to supporting figures and graphs, laboratory data (in tabulated form and as Certificates of Analysis), laboratory narrative, and a description of any modifications made.

As part of this project, Tighe & Bond will also provide MassDEP with presentation slides summarizing the key findings of the Data Analysis Report.

Section C. Sampling Plan

C.1 Project Sampling Design

The project's sampling design includes the collection of samples for PFAS analyses at up to 114 Massachusetts POTWs that have EPA-authorized NPDES permits for discharges of treated wastewater to surface water. A map of all POTWs sampled as part of this project is included in Attachment C. The project includes the collection of two rounds of sampling at participating POTWs from the following locations:

1. Influent Wastewater,
2. Effluent Wastewater, and
3. Sludge/biosolids.

Sampling locations will be identified by the POTW personnel prior to the sampling event and will coincide with locations actively being used for NPDES permit compliance sampling at that location (where applicable). Tighe & Bond or SDE personnel will note changes to the sampling location and rationale for the change on the Field Data Collection Form for the POTW.

First Round Sampling

During Round 1 of this project, each sampling location will be sampled once for all participating POTWs (up to 114 facilities). Analyses for Round 1 will include at a minimum PFAS ID and TOPA for all influent, effluent, and sludge samples. Note that there is no EPA-approved standard method for TOPA analysis, and few commercial analytical laboratories are offering TOPA on high organic content samples (e.g., sludges). As a result, we expect QA/QC challenges/caveats with this method on sludges. Additionally, up to 18 randomly selected POTWs will have AOF analysis conducted on their influent and effluent samples. Paired influent and effluent samples will be measured for AOF to improve understanding of the potential for PFAS to adsorb to organic matter within a given facility. Sludge samples will not be analyzed for AOF.

Second Round Sampling

POTWs will be selected for Round 2 based on availability of existing PFAS data and POTW size. POTWs that do not conduct PFAS sampling under its NPDES permit will be prioritized for inclusion in Round 2, followed by POTWs that have had PFAS sampling included in their permit requirement only recently. The final selection of POTWs for inclusion in Round 2 will include an approximate equal distribution of small, medium, and large POTWs. Round 2 sampling will occur approximately one month after Round 1 for each POTW. A minimum of 50% of all POTWs participating in Round 1 will be included in Round 2 (57 facilities), up to a maximum of 75% of the facilities if time allows and based on the availability of facilities (86 facilities). Each facility sampling location will be sampled once for all participating POTWs (57 to 86 facilities).

Analyses for Round 2 will include PFAS ID and TOPA for all influent, effluent, and sludge samples at a minimum. Additionally, AOF analysis of influent and effluent samples will be requested for up to 13 randomly selected POTWs. Analytical results for TOPA collected during Round 2 will be used to build a comprehensive dataset since a statewide TOPA database does not exist yet in Massachusetts. Filling this data gap is crucial to furthering understanding of PFAS contributions (and their precursors) to Massachusetts POTWs.

Quality Control (QC) Sampling

The collection of QC samples, including duplicates, field blanks, and equipment blanks, will also be incorporated into each sampling round. The project sampling design includes QC samples randomly selected for duplicate sample collection from 5% of POTWs as follows:

- Round 1: Duplicate sample collection at 6 influent, 6 effluent, and 6 sludge sampling locations, and collection of 6 field blanks, and 6 equipment blanks at sampling locations;
- Round 2: Duplicate sample collection at a minimum of 3 influent, 3 effluent, and 3 sludge sampling locations, and collection of a minimum of 3 field blanks and 3 equipment blanks at sampling locations:
    - If more than 50% of POTWs are included in Round 2 then up to an additional 3 influent, 3 effluent, and 3 sludge sampling locations will also be randomly selected for duplicate sample collection; and
    - The final number of duplicates collected during Round 2 will be based on the final number of POTWs that are determined to be included in Round 2.

All duplicate samples collected during Round 1 and Round 2 will be analyzed for PFAS ID only.

C.2 Sampling Plan

POTW Coordination

The Sampling Plan will include coordination with the 114 POTWs to conduct the PFAS sampling. Each of the 114 POTWs will be placed into a sampling group that will include two to four POTWs per group. Groups will be based on geographical proximity to one another with the expectation that all facilities in a sampling group can be sampled in one day by the same sampler. Each sampling group will be assigned a Group ID number and each sampler will be assigned to a specific sampling group.

Initial outreach to all POTWs will be made by email to each sampling group. The POTWs will be informed of their Group ID, the facilities that are included in their group, and a tentative date for sampling. The email will request that the POTW's confirm their availability on the date requested or propose an alternate date during the same week, and to provide the name and contact information for the POTW staff person that will be available to assist the assigned sampler. In addition, the initial email will include a copy of the Field Data Collection Form that will be used by all samplers. The email will request that the POTW complete and submit the portion of the form that pertains to readily available POTW information (e.g., average annual flow, design flow, percent of flow by customer type, etc.) in advance of the sampling date. If not provided in advance of the sampling date the POTW will provide the information to the sampler on the day of sampling. Remaining items on the form will be completed during the sampling event at each facility.

Follow up outreach will be conducted via email and/or phone based on POTW responses, and will continue as necessary to resolve the following before sampling begins:

- Identifying any timing restrictions that would impact sampling for each plant;
- Confirming the final order the POTWs in each group will be sampled;
- Confirming that there will be no issues with collecting sludge samples from each facility on their assigned date;
- Assisting each POTW as necessary with completing the Field Data Collection Form; and,
- Confirming the name and contact information for the POTW staff personnel to accompany the sampler during sampling.

All sampling will be scheduled in full consideration of POTW sludge management practices to ensure that sludge samples reflect actual sludge outputs (e.g., thickened sludge, dewatered cake, etc.) to the extent practicable. The schedule will be finalized so that all influent, effluent, and sludge samples can be collected on the same day at each facility within the same sampling group, and only when a POTW staff member can accompany the sampler while onsite.

Contingency Plan for Sludge Sample Collection

If sludge processing and/or hauling-away from POTWs occurs on a day other than our scheduled sample date, the POTW personnel will be requested to hold a certain quantity of sludge in reserve for our sampler to collect from. If sludge is not saved, or if final sludge is unable to be collected, samplers will collect the sludge from a component of the sludge processing equipment (e.g., from a holding tank) for analysis. Locations from which the sludge sample is collected from will be documented in on the Field Data Collection Form for each POTW.

Field Data Collection Form

A Field Data Collection Form will be completed for each POTW during each round of sampling. The form is included in Attachment B of this SAP and is intended to be completed by the assigned sampler with input from the POTW personnel. The form will be provided to each POTW during initial outreach to allow POTW staff time to prepare or provide answers to certain questions in advance of sample collection. This should maximize accuracy and efficiency, saving time for both the sampler and POTW staff on the sample collection day. Upon arrival at each POTW, the sampler will meet with POTW staff to review the Field Data Collection Form, answer any questions that have not/could not be completed in advance; and confirm the location of each sample location.

Sample Locations

All samples will be collected from the same NPDES-compliant influent, effluent, and sludge sample locations to ensure samples are collected at the same locations from which POTWs have collected PFAS samples in the past (or plan to in the future). Consistency in sample location selection is critical to ensure that data collected from this study can be evaluated with previous and future data in MassDEP's PFAS database. The Field Data Collection Form will be used to document the geographic coordinates (longitude and latitude) of each sample location and will require that a photograph be taken of each location. POTW staff will identify each location for the sampler. During Round 2, all sample locations will be consistent with those of Round 1, and confirmed by photographs, coordinates, and again by POTW staff.

Sample Collection

SOPs pertaining to PFAS sample collection, field notes, sample labeling and handling, and equipment decontamination are included in Section D. This SOP has also been created as a standalone document that will be provided to all samplers. Sample collection will be conducted in accordance with the SOP in Section D. The SOP incorporates applicable MassDEP and USEPA SOPs, as well as relevant SOPs and guidance documents for other states which are referenced in the document. Samplers will observe required provisions associated with the SOP as well as those related to the analytical methods preservation techniques. All samples collected will be grab samples and will be collected in laboratory-provided bottleware and coolers. The QA/QC Manager will request that the laboratory verify their accreditations and certifications for all selected analyses (as applicable) by providing copies of their certifications/accreditations and/or letters attesting to their certifications/accreditations.

Sampler Training

A training session will be held with all sampling staff including the DBE/WBE subcontractor to review all sampling procedures included in this SAP in addition to the SOP documented

in Section D. The training will be held at least one week prior to the start of sampling to ensure that staff are aware of the requirements and expectations of the project. Experienced PFAS sampling staff will lead training on PFAS sampling practices; proper personal protective equipment (PPE); sample handling and preservation; COC procedures including the specified analytical methods; completion of the Field Data Collection Form; coordination with the laboratory's courier service; and general safety topics for field and POTW staff.

Laboratory Coordination

Tighe & Bond will coordinate with the laboratory throughout the duration of the project regarding:

- Delivery of sample bottles, labels, COCs, and coolers to specific locations in advance of all sampling dates;
- Sample bottle pick-ups at required locations the day after sampling has occurred;
- Confirmation of receipt and log in of samples at the laboratory;
- Communication and correction of errors noted on COCs or sample labels;
- Analysis of all samples within required hold times; and,
- Delivery of all laboratory analytical reports within stated turnaround times.

C.3 Project Schedule

The estimated Project Timelines for sample collection tasks and data analysis tasks are provided in the tables below.

Table C-1 Sample Collection Timeline

Sample Collection Task Description		Estimated Schedule
Task 2.1	POTW Coordination for Round 1	January 21 – March 5, 2025
Task 2.2	POTW Sample Collection Training	February 11, 2025
Task 2.2	POTW Sample Collection Round 1	February 19 – March 5, 2025 (later dates will be added based on POTW availability)
Task 2.3	Laboratory Analyses Round 1	February 19 – April 16, 2025 (provides for 6-week TAT)
Task 2.1	POTW Coordination for Round 2	February 21 – April 8, 2025
Task 2.2	POTW Sample Collection Round 2	No earlier than March 18 – April 5, 2025 (later dates will be added based on POTW availability and MassDEP approval. No samples will be collected after April 25, 2025)
Task 2.3	Laboratory Analyses Round 2	March 19 – May 7, 2025 (provides for rush TAT on final samples)
Task 2.4	Submit Field Data Collection form data	June 20, 2025

Table C-2 Data Evaluation Timeline

Data Analysis Task Description		Estimated Schedule
Task 2.3	Laboratory Analyses - Reports	May 9, 2025 (cutoff date for analytical report data to be included in the project's data analysis)
Task 2.4	Submit Lab Data to eDEP Portal	June 20, 2025
Task 3.1	Draft Data Evaluation Report	May 30, 2025
Task 3.2	Draft Presentation Slides	May 30, 2025
Task 3.3	Workshop with MassDEP	June 13, 2025
Task 3.1	Final Data Evaluation Report	June 30, 2025
Task 3.2	Final Presentation Slides	June 30, 2025

Section D. Standard Operating Procedures

D.1 Purpose

Per- and polyfluoroalkyl substances (PFAS) are a family of anthropogenic compounds that do not completely biodegrade or otherwise break down in the environment. Waste streams discharged to Publicly Owned Treatment Works (POTWs), otherwise known as municipal wastewater treatment plants/facilities (WWTPs/WWTFs) and/or water pollution control facilities (WPCFs), can contain PFAS from residential, commercial, institutional, and industrial operations. PFAS can be present in influent and effluent wastewater streams as well as accumulate in treatment sludge/biosolids.

PFAS concentrations are measured in nanograms per liter (ng/L) for aqueous samples (e.g. drinking water, groundwater, surface water, and wastewater) and nanograms per gram (ng/g) for solid/semi-solid samples (e.g. soil, sediment, or sludge/biosolids). Detections of PFAS compounds at these very low levels can be influenced by the equipment used to collect samples and/or materials present during sampling; therefore, PFAS sample collection requires specific considerations regarding preparation of sampling materials, sample collection techniques, and proper decontamination methods to minimize the potential for sample cross-contamination.

Currently, there are 114 POTWs in Massachusetts with National Pollutant Discharge Elimination System (NPDES) permits that collectively treat approximately 1 billion gallons of wastewater per day. Discharges from POTWs into surface waters are authorized by EPA under facility-specific conditions detailed in NPDES permits and state Surface Water Discharge (SWD) permits. As NPDES and SWD permits are renewed, PFAS testing requirements are being added to the monitoring requirements. The purpose of the study associated with this Standard Operating Procedure (SOP) is to evaluate PFAS concentrations in influent, effluent, and sludge/biosolids at NPDES POTWs (the Project).

This Project includes PFAS sampling of influent, effluent, and sludge at up to 114 NPDES POTWs (pending access permissions) during Round 1, and 50% (or 57 NPDES POTWs) during Round 2 in accordance with the approved Sampling and Analysis Plan (SAP). All

samples will be analyzed by Pace Analytical Services (Pace) using EPA Method 1633. Total Oxidizable Precursor Assay (TOPA) and EPA Method 1621 Adsorbable Organic Fluorine (AOF) will also be used to analyze select samples to understand how the measurable PFAS compares to total PFAS. This SOP provides guidance and a standardized procedure for the collection of wastewater influent, effluent and sludge/biosolids samples from NPDES POTWs for PFAS analysis via EPA Method 1633.

D.2 Sample Collection Methods

This section describes the procedures that will be used to collect influent, effluent, sludge/biosolids samples from POTWs, and to transport those samples to the analytical testing laboratory following standardized COC procedures. Methods to minimize the potential for cross-contamination are discussed in detail in Section D.3.

Details on the specific sampling methods per media are provided in sub-sections below. The following general sampling procedures will be employed at each facility:

1. Prior to sample collection, staff will visually inspect and decontaminate the sampling equipment. Laboratory supplied containers will also be visually inspected for signs of wear/damage or contamination (e.g. missing caps, liquids present). Damaged laboratory bottles will not be used and will be returned to the laboratory. Staff will record observations made during their visual inspections in their field notes for the day.
2. Samples will only be collected into laboratory-provided sample containers appropriate for PFAS analysis and will only come into contact with PFAS-free tubing, beakers, and/or sampling equipment/scoop materials (e.g. stainless steel, uncoated aluminum, HDPE, PVC) required for sample collection purposes.
3. Wastewater influent, effluent and sludge/biosolids sample locations at each POTW will be confirmed with POTW staff knowledgeable about the sampling program upon arrival on-site. Tighe & Bond will rely on POTW staff to identify sampling locations used for their NPDES compliance sampling, or to inform Tighe & Bond that the sampling location has changed from previous sampling rounds. Sampling staff will proceed with sampling at the locations identified provided they can safely access them. Sampling locations should be consistent between sampling rounds for facilities sampled multiple times. If staff anticipate the sampling location being provided access to is inconsistent with previous sampling rounds, they will contact the Tighe & Bond Project Manager for further instruction.
4. Sample collection activities shall proceed from the presumed least contaminated location to the presumed most contaminated location. This is presumed to be effluent sampling, influent sampling, and then sludge/biosolids sampling.
5. Prior to sample collection, staff will affix the completed sample label directly onto the sample containers and place the containers into the laboratory provided clear plastic resealable bag. Immediately following sample collection, the sample containers will be capped, re-sealed and placed into the laboratory-provided clear plastic resealable bag. Samples will immediately be placed into the thermally insulated cooler on ice for temporary preservation and transport to the laboratory.

D.2.1 Influent and Effluent Sampling Methods- Aqueous Media

Influent and effluent samples will be collected as grab samples, using various types of immersion sampling equipment (swing samplers, extension rods, scoops, etc.), peristaltic pumps and tubing which extend into the wastewater, or with direct sampling from a flow channel or in-line sample port. The exact sampling technique used is dependent on the POTW setup/system components. When available and appropriate, samples will be collected with equipment owned by the POTW which has previously been used for their compliance sampling to prevent cross contamination between facilities.

Specific sampling techniques may vary by facility and will be documented in staff field notes. Sampling will be conducted in accordance with the following general methodology:

1. **Locations and Collection Methods:** Identify sampling locations with the knowledgeable POTW staff and ask them to provide access to designated sampling points/locations used for their NPDES compliance sampling. Details of the sampling locations, including the names of POTW staff, will be recorded in field notes, and photographs will be taken of sampling locations to document them for consistency in future sampling events. Samplers will also note any recycling streams introduced prior to the influent sampling location and should select effluent sampling locations prior to disinfection (if applicable).

    a. **Dedicated Tap/Port Sampling**: If the sampling location is a dedicated tap/port, turn the tap/port on and let the system flush for a minimum of 5 minutes. If there is tubing on the tap/port, the tubing must be removed prior to sampling. Once the tap/port is flushed, position the laboratory supplied sample container directly into the wastewater flow stream to collect the sample.

    b. **Peristaltic Pump/Tubing:** If a peristaltic pump and tubing (PFAS free HDPE tubing will be used) are used for sample collection, it may be necessary to fasten the tubing to an extension rod and lower it into the wastewater. Use of uncoated metal hose clamps or cable ties made of natural rubber, nylon or uncoated metal may be necessary to secure the tubing to the rod to facilitate sample collection (see Section D.3 regarding prevention of cross contamination). Once the peristaltic pump and tubing are set within the wastewater stream, turn the pump on and hold the discharge end of the tubing over the laboratory provided sample container.

    c. **Open Channel:** If the sampling location is an open channel, sampling devices (e.g. stainless steel cups or HDPE sampling cups) should be lowered into the wastewater to collect the sample if safe to do so and in accordance with the project's Site Specific Safety Plan (SSSP). Once the sample is collected in the sampling cup, it should be poured directly into the laboratory supplied container.

2. **Filling Laboratory Containers:** Fill each container to the designated fill line or to the shoulder of the container following laboratory-provided sample collection guidance (attached to this SOP for reference). Cap and seal the container immediately following sample collection.

    a. If transferring the sample from equipment to the sample container, ensure that the equipment does not come in contact with the sample container.

3. **Duplicate Samples:** At locations where duplicate samples are collected, the grab sample shall be collected immediately following collection of the initial sample from the same location, and labeled accordingly.

4. **Quality Assurance/Quality Control (QA/QC):** QA/QC samples (field blank, equipment blank) shall be collected at the time of sampling as necessary and in accordance with the approved sampling program. Field blank and equipment blank samples shall be collected prior to sample collection.

    a. **Field blank:** Transfer the laboratory-provided 500 milliliter (mL) container of PFAS-free water from its original container directly into an empty container, cap and seal the container immediately. The field blank should be collected at the time of sampling to replicate sampling/field conditions.

    b. **Equipment blank:** Sampling equipment should be properly decontaminated prior to collection of the equipment blank. Transfer the laboratory-provided 500 mL container of PFAS-free water from its original container into an empty container by running the PFAS-free water through the equipment used to collect samples (i.e. transfer the PFAS-free water into the sampling equipment and then directly into the empty container). Immediately cap and seal the container after sample collection.

D.2.2 Sludge/Biosolids Sampling Methods- Solid or Aqueous Media

Due to the potential variability of sludge/biosolids processing at POTWs, sampling locations and physical sample characteristics (percent solids and viscosity) will vary across POTWs. Sampling protocols should be consistent for each POTW and consider access and sampler safety.

1. **Locations and Collection Methods:** Identify sampling locations with knowledgeable POTW staff and ask them to provide access to the designated sampling points/locations used for their NPDES compliance sampling. Details of the sampling locations, including names of the POTW staff, will be recorded in field notes, and photographs will be taken of the sampling locations to document them for consistency in future sampling events.

    Based on the sludge/biosolids process type, the following sampling guidelines should be followed. In general, grab samples shall be collected by using approved PFAS-free sampling equipment (e.g. stainless-steel trowel/scoop, HDPE scoop, or similar PFAS-free materials), and shall be transferred into laboratory-provided sample containers. Decontamination procedures for equipment are discussed in Section D.4.2.

    a. For **anaerobically digested sludge/biosolids**, samples shall be collected from taps/ports on the discharge portion of the positive displacement pumps.

    b. For **aerobically digested sludge/biosolids**, samples shall be collected from taps/ports on the discharge lines from the pumps. If batch digestion is used, sample directly from the digester. If samples are collected directly

from the digester, record whether the sludge was actively aerated or if aeration was turned off prior to sample collection.

c. For **thickened sludge/biosolids**, samples shall be collected from taps/ports on the discharge portion of the positive displacement pumps.

d. For **heat treatment sludge/biosolids**, samples shall be collected from taps/ports on the discharge portion of the positive displacement pumps after decanting. Take care to record the approximate temperature of the sludge/biosolids if sampling via this process.

e. For **dewatered, dried, or composted sludge/biosolids**, samples shall be collected from material collection conveyors or bulk containers.

Sludge/biosolids samples with a minimum of 5% solids shall be analyzed as a solid by the laboratory. Sludge/biosolids samples with less than 5% solids will be analyzed as an aqueous sample.

1. **Filling Laboratory Containers:** Fill each container to the designated fill line or to the shoulder of the container following laboratory-provided sample collection guidance (attached to this SOP for reference). Cap and seal the container immediately following sample collection.

    a. When transferring the sample from equipment to the sample container, ensure that the equipment does not come in contact with the sample container.

2. **Duplicate Samples**: At locations where duplicate samples are collected, the grab sample shall be collected immediately following collection of the initial sample from the same location, and labeled accordingly.

3. **QA/QC:** QA/QC samples (field blank, equipment blank) shall be collected at the time of sampling as necessary and in accordance with the approved sampling program. Field blank and equipment blank samples shall be collected prior to sample collection.

    a. **Field blank:** Transfer the laboratory-provided 500 milliliter (mL) container of PFAS-free water from its original container directly into an empty container, cap and seal the container immediately. The field blank should be collected at the time of sampling to replicate sampling/field conditions.

    b. **Equipment blank:** Sampling equipment should be properly decontaminated prior to collection of the equipment blank. Transfer the laboratory-provided 500 mL container of PFAS-free water from its original container into an empty container by running the PFAS-free water through the equipment used to collect samples (i.e. transfer the PFAS-free water into the sampling equipment and then directly into the empty container). Immediately cap and seal the container after sample collection.

D.3 Sample Handling

This section describes procedures to minimize the potential for cross-contamination, properly preserve samples, maximize hold times, and transport samples.

D.3.1 Field Work Preparation Best Practices

The following procedures are considered best practices for sample collection:

1. **Appropriate Personal Protective Equipment (PPE):** Before handling laboratory-provided sample containers, appropriate PPE shall be worn as set forth in the SSSP. This may include, but not necessarily be limited to clean powderless nitrile gloves and safety glasses with side shields or goggles. Exposed skin should not contact the sample containers, container labels, or the sample matrix within the sample containers.
2. **Sample Container Management:** Sample containers should be stored upright and transported in the laboratory-provided cooler, and should not be stored on, or come in contact with, potential PFAS-containing materials. Inspect sample containers prior to sampling for visual signs of contamination (e.g. liquids in the containers), or signs of damage (e.g. cracks or missing/loose caps). Sample containers suspected to be visually contaminated or damaged will not be used for sampling. Prior to arrival on-site, ensure that the laboratory-provided sample cooler(s) contain enough ice for temporary preservation.
3. **Sampling Equipment and Decontamination Kits:** Visually inspect sampling equipment for signs of damage. Equipment suspected of being damaged should not be used for sampling. Confirm decontamination kits have sufficient volume to properly decontaminate all equipment for the site-specific scope of work (e.g. staff have sufficient PFAS-free deionized water and Alconox® powdered detergent).

D.3.2 PFAS Sampling Best Practices

The following procedures are considered best practices for sample collection:

1. **Gloves:** Clean powderless nitrile gloves are required for sample collection, handling of sample containers, and handling of sampling equipment. Gloves should be changed in between each sampling and decontamination event, and as deemed necessary in the field to minimize the potential for cross-contamination.
2. **Sample Container Handling:** Only open sample containers immediately before sample collection. Do not place the sample container cap on any surface that could potentially contain PFAS materials, including the ground surface. Prior to sample collection, staff will affix the completed sample label directly onto the sample containers and place the containers into the laboratory-provided clear plastic resealable bag. Immediately following sample collection, the sample containers will be capped, re-sealed and placed into the laboratory-provided clear plastic resealable bag. Samples will immediately be placed into the thermally insulated cooler on ice for temporary preservation and transport to the laboratory.
3. **Decontamination:** Decontaminate equipment before leaving the sample collection location and moving to the next sample.

D.3.2.1 Preventing Cross-Contamination

Because PFAS can be found in many household, commercial and industrial items, care should be taken to prevent PFAS cross-contamination when collecting samples for laboratory analysis of such. The following guidelines in the table below are adapted from various sources including the United States Environmental Protection Agency (EPA)[3], and the Massachusetts Department of Environmental Protection (MassDEP)[4], the New Hampshire Department of Environmental Services (NHDES)[5], Michigan Department of Environmental Quality (MDEQ)[6], and Tighe & Bond to reduce the potential for sample cross-contamination.

The following table provides a summary of allowable items which are intended to be used as part of this project, and items that are likely to contain PFAS (e.g. prohibited items) and therefore, should not be used by the sampling staff, or be present at the sampling site. Sampling staff should take appropriate precautions to avoid items that are likely to contain PFAS at the sampling site and during the sampling process.

Table D-1 Summary of Prohibited and Allowable Items for PFAS Sample Collection

Category	Prohibited Items	Allowable Items
Sampling and Field Equipment	Pumps and tubing that contain Teflon® and other fluoropolymer containing materials. Low-density polyethylene (LDPE). Recycled or chemically treated paper towels. Latex or vinyl gloves. Coated metal clamps, rods or other field equipment.	High-density polyethylene (HDPE), or silicone tubing, peristaltic pumps which do not include PFAS-containing components or materials. Untreated paper towels or cotton clothes. New powderless nitrile gloves or gloves provided by the laboratory. PVC or HDPE extension rods, beakers, and scoops.
Decontamination	Decon 90 Dawn® Dish Detergent	Alconox® mixture with PFAS-free potable water followed PFAS-free water rinse. Decontamination mixtures shall be kept in newly provided spray bottles made of PFAS-free approved materials. PFAS-free water can be supplied by the laboratory upon request.
Sample Bottles, Storage, Preservation and Coolers	Low Density Polyethylene (LDPE) or glass bottles, PTFE-or Teflon®-lined caps, foil, and chemical ice packs. Containers should not come into contact with carpeting or upholstery inside buildings or vehicles.	Sample bottles from accredited laboratory. All sample containers must be HDPE or polypropylene and caps must be unlined polypropylene (no Teflon®-lined caps). Once sealed, sample bottles should be stored in Ziploc® plastic bags and transported in coolers. Regular ice only.

[3] United States Environmental Protection Agency, Method 1633, Analysis of PFAS in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, January 2024.
[4] MassDEP Drinking Water Program, Field Sampling Guidelines for PFAS Using EPA Method 537 or 537.1.
[5] NHDES PFAS Field Sample Collection Guidance for Waste Sites, revised September 2022.
[6] MDEQ Wastewater PFAS Sampling Guidance, Revised October 11, 2018, and Biosolids and Sludge PFAS Sampling Guidance, updated April 2022.

Field Documentation	Waterproof/treated paper or field books, plastic clipboards, spiral bound notebook, non-Sharpie® permanent markers, Post-It®, and other adhesive paper products.	Plain paper, metal clipboard, ballpoint pens, fine/ultra-fine point Sharpie®, and Ziploc® resealable plastic storage bags. Pre-printed, PFAS-free sample bottle labels can be supplied by the laboratory upon request.
Clothing and Personal Protective Equipment (PPE)	Clothing or boots made of, or with, Gore-Tex™, or other synthetic water-resistant and/or stain-resistant materials, Tyvek® material. Clothing and other materials that have been laundered with fabric softeners, chemically treated to be waterproof, water repellent, stain resistant, insect resistant, and/or protective against ultraviolet rays, or anything that has been recently dry cleaned.	Synthetic or cotton material, polyurethane, polyvinylchloride (PVC), rubber, neoprene, powderless nitrile gloves. Previously laundered clothing (preferably previously washed greater than six times) without the use of fabric softeners. Wet weather gear and boots made of polyurethane and PVC only.
Personal Care Products (for the day of sample collection)	Cosmetics, moisturizers, hand cream, perfume, deodorant/antiperspirant, sunscreen, shampoo, insect repellant, or similar products.	Pre-approved PFAS-free items applied prior to arriving at the sample collection area.
Food and Beverage	Pre-packaged food, fast food, wrappers or containers. Also, no food should be consumed in the staging or immediate sampling areas.	Bottled water or hydration drinks can be consumed outside the sampling area.

D.3.3 Sample Hold Times and Preservation

The laboratory-provided PFAS EPA Method 1633 Sampling Instructions Guidance Document (the Laboratory Sampling Guidance Document) for collection of non-potable water and solids has been attached to this SOP for reference (Attachment D). Per the Laboratory Sampling Guidance Document:

- The PFAS sample hold time is 28 days for aqueous samples (influent and effluent) and 90 days for solid samples (sludge/biosolids).

Based on the sample media and laboratory analysis procedures no sample bottle chemical preservatives are necessary.

The laboratory will provide PFAS-free water for use in collection of QA/QC blank samples and for decontamination purposes, and will include certification of this water in writing for report documentation purposes.

D.3.4 Sample Completion and Delivery to the Laboratory

- Iced, thermally-insulated coolers will contain samples from time of sample collection to delivery at the laboratory. Temperatures shall be sustained at 0 – 6 degrees Celsius (°C), and protected from light. Regular ice shall be used to cool and maintain the samples at or below the required temperature. Additional ice shall be added/replaced to the sample coolers following the sampling event once they are back at the consultant's office and awaiting pickup from the laboratory. A temperature blank shall be present within each cooler for sample temperature monitoring. The temperature of the blank upon receipt by the laboratory will be recorded and documented in the appropriate paperwork provided by the laboratory.
- Samples, ice, and COC form(s) shall be in resealable bags inside the coolers.
- Pre-printed COC forms will accompany sampling personnel and will be properly completed prior to sample delivery to the laboratory. Copies of the COC forms and laboratory confirmation receipts will be maintained by Tighe & Bond.
- Unused sample bottles will be returned to the laboratory upon completion of the sampling event.
- All samples for this project will be submitted to Pace. For reference purposes, copies of the reporting limits anticipated to be achieved by Pace are provided in Attachment E. Received samples will be analyzed in batches by Pace.

D.4 Field Equipment/Instrument Cleaning, Inspection, and Maintenance

This section describes equipment that may be used during POTW sampling events, and associated equipment maintenance and decontamination procedures as appropriate.

D.4.1 Equipment

Field equipment will conform with the "allowable items" requirements in Table D-1 and may include the following:

- Personal Protective Equipment (PPE) as required by the Site-Specific Safety Plan (SSSP)
    - Hard hat (if required), safety glasses, boots, reflective vest (if required for walking through the POTW, to be removed prior to sampling), and nitrile gloves
- Field book
- Ball-point pen
- Sharpie® permanent ink marker (fine point only)
- Metal clipboard
- Field Data Collection Sheet
- Peristaltic pump and battery
- HDPE tubing (1/4-inch outer diameter)

- Silicone tubing
- HDPE or stainless-steel extension rod
- HDPE or stainless-steel beaker, container or sampling cup
- HDPE or stainless-steel scoop
- PFAS-free rope to lower sampling equipment into the waste stream

Please note, equipment owned by the facilities and used for their compliance sampling events will be used by samplers for this Project whenever possible. If facilities do not have equipment readily available, the consultant's equipment shall be used.

D.4.2 Decontamination Procedures

Where decontamination is called for in this SOP the following procedure shall be used:

- Use a solution of Alconox® powdered detergent and PFAS-free water, contained in a PFAS-free spray bottle, and apply evenly across the sampling equipment.
- Use untreated paper towels for drying or to remove residue or contamination from the equipment.
- Use PFAS-free water as a rinse step, ensuring that the rinse is evenly applied over the sampling equipment. Decontamination procedures should include triple rinsing with PFAS-free water.

Repeat this process between collection of additional samples for all sampling equipment used. Decontamination procedures will be documented on the associated Field Data Collection Form which is included as Attachment B to this SOP.

D.5 Inspection of Supplies and Services

The following procedures describe how the quality of supplies and services will be addressed and documented to meet the project quality needs.

Prior to each sampling event, field staff will visually inspect all PPE, field equipment, and laboratory-provided sample containers. Sampling containers will be provided directly from the laboratory and orders will be placed based on the POTW sampling schedule. Dedicated equipment, including decontamination kits, will be obtained to support this project and will be kept at Tighe & Bond offices or SDE office. Dedicated equipment will be kept in a designated and secure location to minimize the potential for cross-contamination. When available, equipment owned by the POTW and used for their NPDES compliance sampling will be used to collect samples to mitigate the potential for cross contamination. Prior to use, Facility-owned equipment will be inspected for damage and decontaminated as discussed in this SOP.

A routine schedule will be developed for field/sampling equipment maintenance. This may include, but not necessarily be limited to, weekly review of field/sampling equipment to check for damage, wear, or residue from contamination or previous sampling events. If needed,

supplemental decontamination procedures may be completed and documented as part of the routine maintenance program. If a piece of sampling/field equipment is found to be damaged or is deemed unsafe for use, it will be replaced as necessary.

D.5.1 Visual Observation of PPE and Sampling Equipment

- PPE (including gloves) will be provided to samplers which have been verified to be made of PFAS-free materials (based on PPE labels from the manufacturer). Staff should wear the PFAS-free PPE and will visually inspect PPE for signs of wear, damage or contamination prior to sampling events.
- Equipment will be ordered to support this project that will be made of PFAS-free materials. Staff should visually inspect equipment for signs of wear, damage or contamination prior to sampling events.
- Check for visual residue or contamination on the sampling equipment.
- Check for signs of damage, cracks, or other indications of equipment wear.
- Verify that decontamination supplies are allowable for PFAS sampling prior to use according to Table D-1 in Section D.3.2.1.

D.5.2 Visual Observation of Laboratory-provided Sample Containers and Supplies

- Confirm the proper number of sample containers, QA/QC samples, and PFAS-free deionized water has been provided by the laboratory as requested in the bottle order. Typical bottle order request is anticipated to include the following:
    - Aqueous Samples for PFAS (Method 1633), ID and TOPA analysis:
        - four (4) empty unpreserved 500 mL HDPE containers
    - Aqueous Samples for Adsorbable Organic Fluorine (AOF) analysis:
        - three (3) empty unpreserved 125 mL HDPE containers
    - Sludge/biosolids PFAS analysis:
        - Four (4) empty unpreserved 500 mL HDPE containers
        - Please note, in the event that sludge/biosolids samples require analysis as an aqueous matrix, samples are being collected according to the matrix which requires a greater volume (i.e., aqueous samples).
    - QA/QC Samples:
        - one (1) empty unpreserved 500 mL container and one (1) unpreserved 500 mL container containing PFAS-free water

  Please note that the laboratory-provided SOP included as Attachment D provides required containers for PFAS ID only, additional volume is required for TOPA analysis per guidance provided by Pace.
- Check the PFAS sample containers for signs of damage, or the presence of residue or potential contamination. Sample containers should be made of HDPE or polypropylene and have unlined caps made of similar materials.
- Check the sample containers and labels to confirm they are made of approved PFAS-free materials.

D.5.3 Field Data Collection Form

Tighe & Bond has developed a project-specific Field Data Collection Form, provided in Attachment B, to be completed by sampling personnel in association with POTW personnel for each sampling event that includes the following:

- Sampler Information:
    - Sampling personnel, sample collection times and locations, including latitude/longitude.
    - Sample collection methods.
- POTW Information:
    - Treatment processes used at the POTW, presence of combined sewer overflows, presence of influent holding capacity.
    - Volumes of septage/leachate/hauled waste received on the day of sampling.
    - Flow rates for influent and effluent at the time of sampling. Annual average and peak design flow rates for the wastewater treatment plant.
    - General description of sources of influent wastewater, such as the number and type of Significant Industrial Users, and percentage of flow from residential wastewater.
    - General conditions on the day of the sampling and for the five (5) days preceding sampling (e.g. weather, temperature, precipitation, etc.) and any other unusual influent or occurrences at the facility.

D.5.4 Chain-of-Custody (COC) Form

COC Forms provided by the laboratory will be used for all sampling events. COC Forms will be pre-printed with project-specific information, checked in the field for accuracy and will accompany the samples from collection in the field to delivery to an appropriately accredited laboratory for analysis. Sampling personnel will review the COC forms and sample labels to confirm they contain the required information. Required information will include, at a minimum: the sample ID, sampling date and time, job number, specified turn-around time, data delivery method(s), sample container information, and sampler's name and initials. A copy of the pre-printed COC form for the laboratory is included as Attachment F to this SOP. An example sample label is also included in Attachment F.

D.6 Safety and Training

A Site-Specific Safety Plan (SSSP) has been prepared for sampling personnel assigned to this project. Sampling personnel will be provided with project-specific training regarding the requirements set forth in the SSSP and this SOP pertaining to proper PFAS sampling techniques, equipment operation and sample handling during PFAS sampling practices. Sampling personnel are also required to review the SSSP prior to the sampling event, and bring a complete copy with them for the sampling events. Proper documentation regarding completion of the project-specific training program and adherence to the SSSP will be maintained by Tighe & Bond. A copy of the SSSP has been included as Attachment G to this SOP.

D.7 State and Federal Resources

D.7.1 PFAS Sampling Guidance Documents and References

- United States Environmental Protection Agency, Method 1633, Analysis of PFAS in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, January 2024.

  https://www.epa.gov/system/files/documents/2021-09/method_1633_draft_aug-2021.pdf

- United States Environmental Protection Agency, POTW Sludge Sampling and Analysis Guidance Document (EPA 833-B-89-100), August 1989.

  https://www.epa.gov/sites/default/files/2018-11/documents/potw-sludge-sampling-guidance-document.pdf

- United States Environmental Protection Agency (EPA) Technical Brief, January 2020, and EPA Region 9 (EPA) Directions for PFAS Sample Collection, June 2022.

  https://www.epa.gov/sites/default/files/2020-01/documents/pfas_methods-sampling_tech_brief_7jan2020-update.pdf

- Massachusetts Department of Environmental Protection Drinking Water Program, Field Sampling Guidelines for PFAS Using EPA Method 537 or 537.1.

  https://www.mass.gov/doc/field-sampling-guide-for-pfas/download

- Massachusetts Department of Environmental Protection Sampling and Analysis Plan, Investigation of PFAS Levels in Freshwater Fish at Selected Rivers and Lakes in Massachusetts, March 2023.

  https://www.mass.gov/doc/sampling-and-analysis-plan-for-investigation-of-pfas-levels-in-freshwater-fish-at-selected-rivers-and-lakes-in-massachusetts/download

- North East Biosolids & Residuals Association, Sampling and Analysis of PFAS in Biosolids and Associated Media, Updated January 2018.

  https://static1.squarespace.com/static/54806478e4b0dc44e1698e88/t/5ca2599a002291000145dd88/1554143647366/NEBRA-PFASSamplingAnalysisGuide_v.2-5Jan2018.pdf

- New Hampshire Department of Environmental Services PFAS Field Sample Collection Guidance for Waste Sites, revised September 2022.

  https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/sample-collection-guidance.pdf

- Michigan Department of Environmental Quality Wastewater PFAS Sampling Guidance, Revised October 11, 2018.

  https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/IPP/Wastewater-PFAS-Sampling-Guidance.pdf?rev=e0e621f3b10f44b492ac4a9834698d96

- Michigan Department of Environmental Quality Biosolids and Sludge PFAS Sampling Guidance, updated April 2022.

  https://www.michigan.gov/pfasresponse/-/media/Project/Websites/PFAS-Response/Sampling-Guidance/Biosolids.pdf

- Michigan Department of Environment, Great Lakes, and Energy (EGLE) General PFAS Sampling Guidance, January 2024.

  https://www.michigan.gov/-/media/Project/Websites/PFAS-Response/Sampling-Guidance/General.pdf?rev=6217442052bf4fedb89bbf786560d645.

Section E. Data Quality

E.1 Data Quality

During the activities conducted by Tighe & Bond, sufficient Quality Assurance and Quality Control (QA/QC) procedures will be followed to confirm that the data collected from various sources meet the needs of the project. The objectives for this project, outlined in Section A, require data quality at a minimum to be representative, reproducible, and not contain any gross or compounding failures. This will be measured by assessing the data quality information provided by the laboratory as outlined in Section E.2.

Data usability evaluations will be on-going throughout the project as new data are obtained. Any site figures, maps, charts, and other graphical representations will also be prepared so they may be used during data evaluations. All data tables, graphs, charts, figures, letters, and reports (whether draft for external review or final for submittal) will be reviewed for accuracy, correctness, and completeness by the Project Manager.

Existing data collected by POTWs as part of their NPDES and SWD permit requirements will be evaluated by reviewing the available QA/QC data provided. Due to the limitations of not having the original QA/QC data from the laboratories in an electronic form, Tighe & Bond will make assumptions based on data qualifiers, QA/QC qualifiers, and any additional information provided when necessary. EPA Method 1633 has specific criteria on what internal standards are used for validity which will be outlined by the laboratory. Tighe & Bond's data analysis team will evaluate any failures and discuss with the Project Manager and our technical advisor Dr. Paula Mouser on a case-by-case basis if they should be rejected. Supplemental PFAS monitoring data provided by POTWs voluntarily monitoring PFAS independent of NPDES or SWD permit requirements will not be evaluated as part of this project.

Data quality controls associated with specific statistical methods are discussed further in Section E.2.3.

E.2 Quality Control

E.2.1 Field Quality Control

To ensure the integrity of environmental information obtained from a site, Tighe & Bond has a field quality control program. During sample collection activities, various field quality control samples will accompany the analytical samples to the laboratory. These quality control samples include duplicates and blanks (field blank, equipment blank, temperature blank).

Immediately prior to sampling events, laboratory-provided sample containers and coolers will be delivered to Tighe & Bond and SDE offices, to reduce the potential for contaminants migrating into sample containers over time. Prior to field events, received sample containers from the laboratory will be reviewed to ensure the appropriate number of sample bottles were received and that no damage that would otherwise compromise the integrity of the container and/or sample are observed. QA/QC samples (field blanks and equipment blanks) will be collected at the time of sampling as necessary and in accordance with the approved sampling program. The field blank will be collected at the time of sampling to replicate sampling/field conditions. To prevent inclusion of non-site related contaminants into the data assessment, concentrations reported in blanks will be compared to field sample results. Equipment Blanks will be collected to evaluate if proper decontamination was conducted prior to sampling. To prevent inclusion of non-site related contaminants into the data assessment, concentrations reported in blanks will be evaluated on a case-by-case basis and compared to field sample results to evaluate sampling conditions and corrective actions.

Additional sample containers will be requested from the laboratory for each sampling event so that additional site visits will not be required if a container is broken, lost, or otherwise deemed not usable for the sampling event. If any equipment being used for sampling (i.e., extension rod) becomes damaged it will be removed from service and replaced before the next sample is collected.

Any reported concentrations of analytes from blank samples will be evaluated by the laboratory and Tighe & Bond. Concentrations will be compared to the results of other samples collected and transported with these quality control samples to assess the likelihood of contamination and risk to data quality.

Field data will be evaluated routinely by the Tighe & Bond Project Manager and Operations Managers through the interpretation of field notes, photographs, and any additional field analytical data collected as part of the project. All observations, trends, assumptions, conclusions, and limitations discovered in reviewing the field data will be documented in the final Data Analysis Report.

E.2.2 Laboratory Quality Control

The laboratory data review will be performed internally by the Tighe & Bond data management team. This comprehensive review will consist of an initial check to ensure that the laboratory report is complete and a review of laboratory QA/QC for the project, including laboratory control samples, field and laboratory duplicate analyses, laboratory surrogate samples and percent solids. The review will also include an evaluation of applicable certifications and accreditations included in the laboratory report. A summary of this internal data quality review will be included in the final report. In addition, the Project Manager will be responsible for reviewing the COC forms for completeness and confirming that the sample holding times and preservation methods used are appropriate for the analyses conducted. The Project Manager will also review the laboratory-provided Data Quality Review and documentation.

The laboratory case narrative is required to document any issues associated with each laboratory analysis conducted for received samples collected from a site. Data validation will be performed by the laboratory analyst prior to reporting results to Tighe & Bond, and

data validation procedures will be performed by the laboratory in accordance with EPA Method 1633 (ID and TOPA), and EPA Method 1621 AOF requirements.

The laboratory will be responsible for instituting any required corrective action. Criteria used for accepting or rejecting any data are based on laboratory quality control metrics and specific MassDEP and/or EPA methodology standard operating procedures. Data quality will be validated by reviewing all quality control analyses. Any deviations that cannot be rectified by the laboratory will be documented in the case narrative.

A level four data delivery report will be provided by the laboratory in addition to Electronic Data Deliverables (EDDs). Received EDDs will be imported into a project-specific Environmental Database Management System (EDMS). When sampling is complete, all data will be exported from the EDMS and evaluated by the Project Manager and data management team to determine if they support the data needs for the project. The QA/QC data will be evaluated and assessed through the EDMS's data validation system which evaluates laboratory control samples, matrix spikes, surrogates, recoveries, and relative percent differences (RPDs). A table of this evaluation will be included in the final report. If the review indicates that QC analyses are outside of reproducible range, or if any critical data gaps exist, sample data will be evaluated on a case-by-case basis and individual compound-by-compound as to whether they should be rejected or re-analyzed. In accordance with laboratory procedures, during sampling activities, additional sample matrix beyond the minimum method requirement is provided to the laboratory in order to provide the opportunity for re-extraction and re-analysis if laboratory failures are encountered.

Any problems or deviations identified in the laboratory data will be noted in the final report and the effects on the laboratory data will be discussed. The complete laboratory reports, including the case narratives or other QA/QC data provided by the laboratory, will be appended electronically to the final project report.

E.2.3 Statistics and Analyses

Statistical tools will be used to further evaluate data quality during data analyses. As is common for chemical species in environmental matrices, PFAS data are log-normally distributed, yet they are most commonly measured at extremely low concentrations or not detected at all. Because descriptive statistics, such as mean, can be sensitive to skew in the data, nonparametric methods will be employed when possible. Potential outliers will be identified using the common quantile-based method defined by Equation 1:

$$1.5 \times IQR \qquad (1)$$

Concentrations exceeding 1.5 times the interquartile range (IQR) may be removed from subsequent analyses as potential outliers on a case-by-case basis, and the implications of each decision will be discussed in the final report.

Laboratory method detection limits (MDLs) and method reporting limits (MRLs) for each quantified PFAS, developed according to Sections 9.2.2 and 9.2.3, respectively, of EPA Method 1633 (2024) (U.S. Environmental Protection Agency, 2024), will be reported for each sample. PFAS with measured concentrations below the MDL and reported by the laboratory as not detected in a given sample ("ND") will be reported as such in the final report. These values will be treated as absent in the calculation of descriptive statistics (such as percent detection or median) and treated as zero when calculating the abundance of PF

AS (such as total molar loading or relative abundance). Similarly, measured PFAS concentrations between the MDL and the MRL (commonly noted with the "J" data qualifier) will be treated as equal to their laboratory-estimated value. Existing J-qualified data without available laboratory-estimated concentrations will be defined as the MRL divided by the square root of two, as described by Hornung and Reed (1990), shown in Equation 2 (Hornung & Reed, 1990):

$$\frac{MRL}{\sqrt{2}} \qquad (2)$$

Following initial processing, average PFAS species concentrations will be calculated for duplicate samples. Additional data processing specific to the statistical methods used in subsequent data analyses will be documented in the final report. Briefly:

To facilitate comparison between aqueous and solid samples using nonparametric statistical methods, PFAS concentrations for aqueous samples will be converted from units of ng/L to units of ng/g, assuming a constant density of 998.2 g/L, approximately equal to the density of water at 20°C. Solid samples reported in units of ng/g will be assumed to be reported on a dry-weight basis in accordance with EPA Method 1633 section 15.4.1, which additionally requires sludge data to be reported with percent solids of each sample (U.S. Environmental Protection Agency, 2024). Therefore, sludge samples will be converted from units of ng/g on a dry-weight basis to ng/g on a wet-weight basis. For existing sludge data missing percent solids data, sample percent solids will be assumed to be equal to the average of the percent solids reported for all other samples from the same facility (preferred) or equal to the average percent solids reported via the POTW Sludge Management Survey, part of the PFAS and Biosolids Technology and Management Study, Part 1, depending on data availability.

ATTACHMENT A

CHRISTOPHER BONE, PE

VICE PRESIDENT



Chris Bone serves as Tighe & Bond's Design Manager, as well as principal and project manager on a variety of water and wastewater projects. His experience at Tighe & Bond includes all aspects of project implementation, including planning, permitting, design, cost estimating, and construction phase services. While he has overseen a number of new treatment plants, Chris specializes in challenging upgrades to existing facilities, and finding innovative and cost-effective solutions that meet our client's goals while maintaining facility operations.

EXPERIENCE
30 Years

SPECIALTIES
Wastewater

Water

Treatment Facility Upgrades

Nitrogen & Phosphorus Removal

Chemical Feed System Improvements

Biosolids Drying

EDUCATION
Bachelor of Science
Mechanical Engineering
University of Notre Dame

Master of Science
Environmental Engineering
University of Wisconsin at Madison

LICENSES & REGISTRATIONS
Professional Engineer
MA #45674
CT #25850

PROFESSIONAL AFFILIATIONS
American Water Works Association

New England Water Works Association

Water Environment Federation

WATER RESOURCES

DRY BRIDGE ROAD WATER TREATMENT PLANT—WESTFIELD, MA
Managed design and construction of a 2,600 gpm granular activated carbon (GAC) water treatment plant designed for PFAS treatment. The treatment facility includes sodium hypochlorite, sodium hydroxide, and zinc orthophosphate chemical feed systems. The process is housed in an architecturally interesting building with offices, control room, laboratory, electrical room and mechanical room. A dehumidification system is provided to control environment in the GAC vessel area. The project also included work at the two wells, including well redevelopment, new well pumps, and VFDs.

DAM REPLACEMENT—WESTFIELD, MA
Managed the evaluation and design for replacement of the spillway channel on Westfield, MA's Granville Reservoir Dam, which was damaged due to excessive flows and overtopping during Hurricane Irene. The project included emergency slope stabilization repairs, as well as a development of a Hydrologic/Hydraulic Analysis Report of the watershed. Assisted the City in obtaining NRCS and FEMA funding for the project.

WELL UPGRADES—WESTFIELD, MA
Served as project manager for upgrades to Well No. 2 in Westfield, MA. The project included a new electrical service, a new variable frequency drive, new pump motor, and demolition of a right-angle drive on the pump. The project also included raising of the pump head and installation of a well head seal to prevent well contamination. Miscellaneous chemical feed system, instrumentation, and HVAC upgrades were also included in the project.

WATER TREATMENT PLANT DESIGN—SOUTH CENTRAL, CT
Evaluated and designed the renovation of an abandoned treatment building to install a potassium permangate system for the South-Central Connecticut Regional Water Authority's Lake Gaillard Water Treatment Plant. Developed alternative potassium permangate feed systems, building renovations, and building layouts.

WEST RIVER WATER TREATMENT PLANT IMPROVEMENTS
SOUTH CENTRAL, CT
Managed design and construction of significant process and electrical improvements to the 10.4 MGD treatment plant in Woodbridge, CT for South Central Connecticut Regional Water Authority. The existing direct filtration facility historically had significant capacity limitations during summer months due to algae-blinding of filters. The project included construction of a new dissolved air flotation (DAF) building with three DAF trains. The DAF process has restored the 10.4 MGD functional capacity of the water treatment plant, and the DAF process successfully reduced turbidity to less

than 1 NTU during high flow and high raw water turbidity testing. The project also included replacement of the existing sodium hypochlorite system with a new on-site chlorine generation system consisting of a brine tank, two chlorine generators, two large day tanks, and metering pumps. Finally, the project included new main electrical switchgear and standby generator.

WASTEWATER

WASTEWATER TREATMENT FACILITY (WWTF) UPGRADE—NORTH ATTLEBOROUGH, MA
Served as project manager for a $22M nitrogen and phosphorus removal upgrade to this WWTF in North Attleborough, MA. Project included construction of a new 5-stage Bardenpho aeration system consisting of baffled aeration tanks with fine bubble aeration, high-speed turbo blowers, and submersible mixers. Phosphorus removal to a 0.1 mg/L permit limit was accomplished with a new coagulation system, and a cloth media filtration system. Also included replacement of the 17 MGD Influent Pump Station and 4.6 MGD Falls Pump Station with new dry pit submersible pumps. Miscellaneous mechanical upgrades were completed at seven remote pumping stations as well.

COMBINED SEWER OVERFLOW (CSO) TREATMENT FACILITY DESIGN—CHICOPEE, MA
Managed the evaluation, design, and construction of the award-winning 41 MGD Jones Ferry CSO Treatment Facility in Chicopee, MA. This facility treats overflows from the City's largest CSO up to 3-month storm events. The design consists of a new CSO diversion structure, automatically cleaned screens, submersible pump station, Parshall flume, chlorine contact chamber, and a GAC odor control system. Sodium hypochlorite and sodium bisulfite facilities are provided for chlorination and dechlorination, respectively.

WASTEWATER IMPROVEMENTS—CHICOPEE, MA
Served as project manager on various projects for the Chicopee, MA wastewater treatment plant and pumping stations. These projects include a bypass disinfection project, sodium hypochlorite conversion project, a headworks improvements project, an odor control project, several projects upgrading sludge handling systems, and pumping station improvements. Each project has included evaluations, design of recommended improvements, and construction administration. The bypass disinfection project included design of a pumping station, chlorine contact chamber, and chemical feed systems. The headworks improvement project involved construction of a new headworks structure and installation of a mechanically cleaned screen. Sludge handling system projects have included installation of dewatering centrifuge and sludge cake pumping systems.

PHOSPHORUS UPGRADE PROJECT—SOUTHINGTON, CT
Served as project manager on the design of a $57M upgrade of the Southington, CT's Water Pollution Control Plant. The project primarily involves design of a new Co-Mag ballasted flocculation system to remove phosphorus. Tighe & Bond assisted the Town in achieving favorable financing on the project, including partial grant funding, so the Town is taking advantage of this financing to perform extensive capital upgrades at the treatment plant. Capital upgrade work includes headworks upgrades, pump replacements, clarifier replacements, aeration system upgrades, sludge holding tank improvements, and odor control. In addition, the project includes major electrical system upgrades, HVAC improvements, and various architectural and structural upgrades to aging buildings.

BIOSOLIDS

SLUDGE DRYER FACILITY—CUMBERLAND, MD
Served as project manager on a design-build team for this facility in Cumberland, MD. Project included centrifuge dewatering, gas-fired dryer drum, various screw and belt conveyors, regenerative thermal oxidizer, and a wet scrubber for odor control.

SLUDGE DRYER FACILITY—DETROIT, MI
Served as project manager on a design-build team for a $130M sludge dryer facility for the City of Detroit, MI, which will be the largest facility in North America of its kind. The project included centrifuge dewatering, a dry polymer feed system, four gas-fired dryer drums, screeners, crushers, pellet coolers, product storage silos, extensive conveying systems, tray scrubbers, regenerative thermal oxidizers, and chemical scrubbers for odor control. A 270-ft x 175-ft structural steel building with architectural precast concrete walls houses the process equipment, offices, chemical storage rooms, and maintenance and storage areas. Tighe & Bond continues to provide on-call engineering assistance for this facility.

BIOSOLIDS PROCESSING FACILITY—WEST PALM BEACH, FL
Served as project manager for two separate upgrade projects for NEFCO's biosolids processing facility in West Palm Beach, FL. The first project involved the design of new screw conveyors. The conveyors included in a metering section to recycle dried biosolids pellets to the drying process. The conveyors were also used to pre-mix dewatered sludge cake with the pellets, which is a sticky, abrasive and high energy process. To improve reliability by eliminating troublesome hanger bearings in the mixing stage, three shorter conveying sections were used to replace one longer conveyor in each drying train. The second project involved replacement of screeners and installation of a new dust collector for the product silos. This project also included minor enhancements to the recycle bins to improve product flow.

BIOSOLIDS PROCESSING FACILITY CAPITAL PROJECTS—QUINCY, MA
Served as principal-in-charge for three capital upgrade projects at the Massachusetts Water Resources Authority (MWRA) Biosolids Processing Facility in Quincy, MA, which serves the Boston-metro region. This project was initiated by our client, NEFCO, as part of a 5-year operating contract extension with MWRA. The capital upgrade contracts included painting of storage silos and sludge holding tanks, electrical improvements (including MCC replacement, VFD replacements, and various controls upgrades), and mechanical upgrades (including conveyor replacements, gas train improvements, and new dust collectors).

SHAKOPEE, MN BIOSOLIDS DRYING FACILITY IMPROVEMENTS
Served as project director for conceptual design of dried product and cake conveyor improvements at a rotary drum drying facility in Shakopee, MN.

MASSACHUSETTS WATER RESOURCES AUTHORITY (MWRA) BIOSOLIDS PROCESSING FACILITY CAPITAL PROJECTS
Served as project director for three capital upgrade projects at the MWRA Biosolids Processing Facility in Quincy, MA, which serves the Boston-metro region. This project was initiated by our client, NEFCO, as part of a 5-year operating contract extension with MWRA. The capital upgrade contracts included painting of storage silos and sludge holding tanks, electrical improvements (including MCC replacement, VFD replacements, and various controls upgrades), and mechanical upgrades (including conveyor replacements, gas train improvements, and new dust collectors).

THERMAL DRYING EVALUATION FOR PAPER MILL (CONFIDENTIAL CLIENT)
Served as project director for evaluation of a thermal drying system for a paper mill in Massachusetts. The paper mill produces approximately 80 DTPD of fiberclay solids and municipal wastewater solids from a municipal WWTP, of which the paper mill is the primary discharge source. Cake was trucked to a pilot dryer in the Midwest to evaluate performance with this unique product and to determine if blending with dried product would be required to produce a viable product. The project evaluated rotary drum drying, paddle drying, and belt drying, and ultimately recommended installation of two large belt dryers. Conceptual drawings and an opinion of probable construction cost were prepared.

BIOSOLIDS MANAGEMENT EVALUATION—GREENFIELD, MA
Served as project director for evaluation of sludge dewatering and thermal drying options for the wastewater treatment facility. The analysis considered life-cycle costs, including electricity, natural gas, polymer, and O&M costs. Based on the size of the facility, the drying evaluation focused on belt drying alternatives. The recommended approach was installation of rotary/screw press dewatering in the near-term, and reserve space for future installation of belt dryers.

THERMAL DRYING FACILITY REPAIR PROJECT—STAMFORD, CT
Served as Project Director for repairs to a thermal drying facility following an extensive dust explosion. The project included replacement of various drying facility vessels and equipment damaged by the explosion, as well as a number of NFPA safety enhancements (deflagration venting, deflagration suppression, and instrumentation and controls enhancements) designed to minimize the risk of future deflagration events and provide enhanced protection in the event of a future event. The project also included various building repairs to windows, louvers and similar architectural elements.

DEWATERING IMPROVEMENTS – WESTFIELD, MA
Managed evaluation, design, and construction of sludge dewatering improvements at the Westfield Water Recovery Facility. The evaluation reviewed performance of alternative dewatering technologies and ultimately recommended replacement of an existing belt filter press with a centrifuge. During design, Tighe & Bond assisted Westfield with an evaluated bid of centrifuge systems considering both cost and non-cost factors. The design includes the centrifuge, monorail above the centrifuge, screw conveyors, new sludge feed pumps, new sludge feed grinders, an overhead door for installation and maintenance removal of centrifuge components, and electrical improvements.



JESSICA CAJIGAS-SMITH

SENIOR PROJECT MANAGER

Jessica Cajigas-Smith offers a broad range of technical, regulatory and management expertise in the environmental/consulting industry. She has employed her in-depth knowledge of local, state and federal environmental and health and safety laws and regulations to successfully complete a wide range of complex projects for both public and private sector clients. Jessica's strengths include team coordination, project management and planning, communication, and regulatory analysis and compliance.

EXPERIENCE
25 Years

SPECIALTIES
Soil & Groundwater Investigations, Site Assessments, and Reporting

Regulatory Compliance Assistance

NPDES / Stormwater Management

Water Resource Protection

ASTM Phase I ESAs

EDUCATION
Bachelor of Science
Environmental and Forest Biology
SUNY College of Environmental Science and Forestry

Master of Public Affairs and Master of Science
Environmental Policy and Natural Resources Management
Indiana University

LICENSES & REGISTRATIONS
Drinking Water Supply Facilities Grade 2 OIT, MA #20389

Wastewater Treatment Plant Operator Grade 2-I Full, MA #19069

Soil Evaluator
MA #SE2941

Title 5 System Inspector
MA #SI4502

OSHA 40 Hour HAZWOPER

OSHA 10 Hour Construction

Incident Command System Training Levels 100, 200, 300, & 400

PROFESSIONAL AFFILIATIONS
New England Water Works Association

Massachusetts Water Works Association

DRINKING WATER

LSL INVENTORY AND REPLACEMENT PLANNING– MASSACHUSETTS
Prepared State Revolving Fund (SRF) applications, proposals, and amendments for Public Water Systems throughout Massachusetts to assist in compliance with the Lead and Copper Rule Revisions. Created project budgets and coordinated with clients and subconsultants while developing scopes of work and application submittals. Created implementation resources for all project managers assigned to inventory and replacement plan services for 42 projects. Serve as project manager for two projects including coordination of all field work for physical verifications via basement inspections and vacuum excavations. Total project cost values of this work exceed $8M.

DRINKING WATER PROGRAM—BOSTON PUBLIC SCHOOLS (BPS)—BOSTON, MA
Implements a program to conduct annual and activation sampling at 134 school buildings including managing a sampling team to collect samples from over 2,300 drinking water sources including water fountains, bottle filler, ice machines, and kitchen taps for analysis of lead and copper in drinking water. Assist Facilities Management to maintain and update its Water Policy and act as regulatory liaison regarding state oversight of the program through the Lead Contamination Control Act (LCCA).

DRINKING WATER ASSET MANAGEMENT PROGRAM—AUBURN, MA
Serving as Project Manager for an asset management plan for Auburn Water District. Work includes building/updating system asset inventories and attributes using GIS, updating the District's hydraulic model and creating a unidirectional hydrant flushing program, risk-based prioritization of asset improvement recommendations based on likelihood or failure and consequence of failure, cost estimating and helping to identify funding strategies to support the needed improvements.

ENVIRONMENTAL COMPLIANCE—WESTFORD WATER DEPARTMENT—WESTFORD, MA
While with the Department, responsibilities included compliance monitoring, data collection, and reporting; designing and implementing outreach education projects; communicating with the public regarding water resource protection and conservation; developing annual statistical reports, consumer confidence reports, and public notification materials; developing vulnerability assessment and emergency response plans and overseeing the EHS program. Manager for compliance requirements under Lead and Copper Rule, Groundwater Rule, Stage 1 and 2 Disinfectant Byproducts Rule, Total Coliform Rule, as well as the Unregulated Contaminant Monitoring Program.

STORMWATER

SMALL MS4 GENERAL PERMIT COMPLIANCE—MASSACHUSETTS
Assisted with the creation of report templates, senior level review, and drafting of MS4 reporting requirements for numerous Massachusetts municipalities. Reports included: local code assessments reviewing guidance/requirements that affect the creation of impervious cover, and the feasibility for making green infrastructure and Low Impact Development (LID) practices allowable; retrofit assessments identifying a minimum of five permittee-owned properties that could be modified or retrofitted with Best Management Practices (BMPs); nutrient source identification reports for watersheds impaired by nitrogen and/or phosphorus; and Phosphorus Control Plan (PCP) funding source assessments, implementation area identification, and baseline phosphorus load and reduction requirements; BMP nutrient removal tracking; and BMP installation schedules.

OUTFALL SAMPLING PROGRAM—WOBURN, MA
Coordinated field staff to perform dry weather outfall inspections and sampling using ArcGIS's Collector and Survey123 Apps to collect outfall inventory and update illicit discharge detection parameters. Performed QC of stormwater database field updates and summarized findings in the summary report required for the U.S. EPA.

STORMWATER ASSET MANAGEMENT PROGRAM—MASHPEE, MA
Coordinated completion of a rapid condition assessment of Town-owned culverts. Assigned a representative condition assessment to the Town's GIS stormwater infrastructure to evaluate the likelihood of failure and result of failure. Results will be used to provide the Town with recommendations for a next steps in implementing an Asset Management Plan. Also coordinated inventory and inspection of Town-owned BMPs and outfalls.

MS4 PROGRAM EMPLOYEE TRAINING—MASSACHUSETTS
Conducted annual training for various Towns' staff on the illicit discharge detection and elimination (IDDE) and good housekeeping and pollution prevention control measures in the MS4 General Permit, and spill prevention control and countermeasure (SPCC) plan content and implementation.

STORMWATER MANAGEMENT AND PUBLIC EDUCATION—WESTFORD, MA
As the Environmental Compliance Manager for the Town of Westford Water Department, wrote a Smart Growth-Smart Energy Technical Assistance Grant Application for which the town was awarded $25,000 to develop a Stormwater Bylaw and Watershed Action Plan (WAP). Participated as a member of the Smart Growth Advisory Committee to complete the WAP for the Stony Brook & Nashoba Brook Watersheds, and the final Stormwater Management Bylaws. Worked with town departments to design and build a raingarden at a local school to control stormwater from roof runoff and paved areas, which also served as a demonstration site for LID implementation and as part of the school system's Living Lab program to increase understanding of pollution prevention concepts.

VPDES PERMIT COMPLIANCE—AIG, RESTON, VA
Project Manager for the completion of services related to the General Virginia Pollutant Discharge Elimination System (VPDES) Permit for Noncontact Cooling Water Discharges for a facility in Reston, VA. Ms. Coordinated quarterly sampling events and completion and submission of the Discharge Monitoring Reports to the Virginia Department of Environmental Quality and to the County of Fairfax, VA.

WASTEWATER

NAVAL AIR STATION—PATUXENT RIVER, MD
Project Manager for the update to the Industrial Wastewater Management Plan (IWMP) for a 6,500-acre Naval installation in Maryland. Activities included the survey and classification of all users (including domestic users, industrial users, and significant industrial users) of the wastewater system which is permitted to discharge to the County treatment plant; site inspections of all significant industrial users (SIUs); sampling of wastewater discharges from SIUs; and completion of an inventory and assessment of all septic systems on the base for Chesapeake Bay Total Maximum Daily Load (TMDL) compliance. SIUs included aircraft hangers, restaurants, laboratories, machine shops and other vehicle maintenance facilities.

GROUNDWATER REMEDIATION WASTEWATER/REMEDIATION GENERAL PERMITS—CT, MA
Project Manager for underground storage tank (UST) removal/replacement projects in New Britain, Connecticut and Walpole, Massachusetts requiring coverage under the Connecticut Department of Energy and Environmental Protection General Permit for the Discharge of Groundwater Remediation Wastewater and the EPA Remediation General Permit, respectively, for the discharge of treated groundwater. Treatment included fractionation tanks for settling, bag filters for silt removal, and high-pressure carbon contactors for removal of petroleum hydrocarbons. Wastewater effluent was ultimately discharged into surface water bodies via local and state stormwater infrastructure.

WATER RESOURCE PROTECTION

SUSTAINABLE WATER MANAGEMENT INITIATIVE—VARIOUS LOCATIONS, MA
Performed pilot analysis of the impact of MassDEP's Sustainable Water Management Initiative (SWMI) Framework on Water Management Act (WMA) permitting for four volunteer water systems: Amherst, Danvers, Dedham-Westwood, and Shrewsbury. Developed tools for calculating allowances for mitigation measures.

WATERSHED EDUCATION PROGRAM—NASHUA, NH
Worked with Pennichuck Water Works and the Nashua School District to develop and implement a Watershed Education Program to increase awareness about watershed protection by teaching students about the water cycle, the Pennichuck Brook Watershed and stormwater pollution prevention. The program was developed to fit into the District's education curriculum and to meet State science standards targeting 5th grade students. The program included classroom presentations, including a hands-on groundwater model used to demonstrate groundwater movement and pollution pathways, and a poster contest for six elementary schools located within the Watershed. In total, the education program reached 10 Nashua elementary schools, including 32 fifth grade classes and over 650 students.

LAKE WATER QUALITY INVESTIGATION—GROTON, MA
Investigated water quality in the Lost Lake area of Groton, MA to update key data from a previous Diagnostic/Feasibility Study and evaluate potential long-term improvement in the water quality of Lost Lake that might occur if a sewer expansion project moves forward. Collected and compiled data from residential drinking water wells, pore water, tributaries, piezometers, and the deep hole of the lake, and estimated septic system contributions of nitrogen and phosphorus loads to the lake.

ENVIRONMENTAL

MCP COMPLIANCE AND REMEDIATION PROJECTS—BOSTON, MA
Project manager for multiple MCP compliance and remediation projects for Boston Public Schools. Responsibilities included scheduling, coordination and oversight of remediation system operation and maintenance activities, soil and groundwater sampling, stormwater treatment system effluent sampling, PCB wipe sampling, and indoor air and soil gas sampling, as well as development of MCP technical reports.

MAJOR OIL COMPANIES—MA, NH, RI, CT
Project Manager for subsurface soil and groundwater investigations of petroleum releases at 20+ retail gasoline stations in MA, NH, RI, and CT in accordance with MassDEP, NHDES, RIDEM and CTDEEP state reimbursement policies and procedures. Responsibilities included scheduling and coordination of technical staff and subcontractors for environmental activities, development of action plans and technical reports, regulatory interaction, development of client's cost to close active site, and reimbursement support. Completed MCP Phase Reports (Phase I, II, III, and IV), permanent solutions, risk characterizations, and site investigations, indoor air evaluations, and remedial activities including soil excavation, enhanced fluid recovery, episodic air sparge/soil vapor extraction events and monitored natural attenuation.

SUPERFUND TECHNICAL ASSESSMENT AND RESPONSE TEAM—US EPA REGION I
START team member provided technical support to the EPA during Removal Actions, Preliminary Assessment/Site Investigations, Emergency Responses, Site Assessments, and team sampling activities. Extensive experience with various types of CERCLA sites including buried drum recovery; PCB, VOC, and metals soil contamination; groundwater contamination; asbestos removal; oil spills; rail car releases; and waterline extensions. Responsibilities included conducting hazardous waste site investigations and assessments, health and safety plan development and monitoring, on-site sampling, analytical support and data management, budget management, and report generation and review. Procurement and oversight of subcontractors for land surveying, geophysical surveys, excavation activities, monitoring well installation, and engineered design plans as requested by the EPA. Member of the Level A Counter-terrorism team.



EXPERIENCE
39 Years

SPECIALTIES
Environmental Assessment and Remediation

Brownfield Development

LSP/MCP Services

Industrial Compliance & Permitting

Auditing

UST Permitting, Closure & Assessment

Wastewater and Storm Water Permitting

Pollutant Discharge Elimination System Permitting

EDUCATION
Bachelor of Science
Civil Engineering
University of Rhode Island

LICENSES & REGISTRATIONS
Licensed Site Professional (LSP)
MA #1078

Certified Hazardous Materials Manager #15087

40-Hour OSHA HazWoper Training

8-Hour OSHA Supervisor Training

10-Hour OSHA Construction Safety Training

PROFESSIONAL AFFILIATIONS
Licensed Site Professionals Association
RI Society of Environmental Professionals

RIDEM Petroleum Workgroup

Environmental Business Council (EBC)–NH/RI Leadership Teams

Pawtucket Foundation (Board 2014-Present)

SUZANNE COURTEMANCHE, LSP, CHMM

TECHNICAL DIRECTOR / VICE PRESIDENT

Sue is the Technical Director of Tighe & Bond's Environmental Business Line in addition to a Certified Hazardous Materials Manager and Massachusetts Licensed Site Professional. She specializes in environmental site investigations and remediation projects, and environmental regulatory compliance and permitting. She actively participates on regulatory agency advisory work groups, is on the Environmental Business Council of NH Leadership Team, and the American Council of Engineering Companies' Environmental Subcommittee (RI Chapter). Sue has diverse and broad experience ranging from regulatory compliance/auditing/permitting, to in-field, hands-on contaminated site remediation, management, and redevelopment.

INDUSTRIAL COMPLIANCE AND PERMITTING

BOSTON COLLEGE—CHESTNUT HILL, MA
Multi-media compliance inspections with focus including, but not limited to, air emissions, hazardous waste management, wastewater management, EPCRA/Tier2, ASTs and UST compliance, and pesticide management. Developed matrix of findings and recommendations for improvement.

VERTEX PHARMACEUTICALS—CAMBRIDGE, MA/PROVIDENCE, RI
Multi-media regulatory compliance inspections with focus including, but not limited to, air emissions, hazardous waste management, wastewater management, SARA Title III, ASTs and UST compliance, oil pollution control/SPCC Plans, and OSHA Hazard Communication. Developed compliance matrix of findings and recommendations for improvement.

DOUGLAS SCHOOLS—DOUGLAS, MA
Inspection of High School and Middle School complexes to conformance with Oil Pollution Control Regulations, development of Spill Pollution Control and Countermeasure (SPCC) Plans for the two campuses. Also provided SPCC Plan training for Facilities personnel. Also, assisted Douglas Schools with preparing and filing EPCRA Tier2 Inventory Reports.

BOURDON FORGE ENVIRONMENTAL ENGINEERING—MIDDLETOWN, CT
Various environmental engineering and permitting projects for the Middletown, CT industrial plant. Services include but are not limited to: environmental site assessment, wastewater discharge permitting and discharge monitoring, sampling, analysis and reporting, stormwater discharge permitting and discharge monitoring, sampling, analysis and reporting, aboveground storage tank engineering design and development of bid specifications, EPCRA Tier2 Inventory Reporting, Toxic Release Inventory (TRI) Reporting, and training services.

SOUTH COUNTY HEALTH—WAKEFIELD, RI
Various environmental engineering and permitting projects for South County Hospital. Services include but are not limited to: EPCRA Tier2 Inventory Reporting and Air Pollution Inventory Reporting, RI Department of Labor and Training State Right-to-Know reporting, and assisting the hospital with various regulatory compliance matters.

MEDICAL WASTE TRANSFER FACILITY PERMITTING—LINCOLN, RI
Project Manager for the permitting of two Medical & Solid Waste Transfer Facilities in Rhode Island for Boston and New York companies. Services included preparation of permit applications, operating plans and site plans, coordination and communication with RIDEM and Town of Lincoln Regulatory Officials, participation in public meetings and public hearings, and procurement of municipal site civil engineering permits for facility modifications. Applicable RIDEM Regulations included Solid Waste Reg. 1-General Requirements; Solid Waste Reg. 3-Transer Stations; and the Rules and Regulations Governing Generation, Transportation, Storage, Treatment, Management and Disposal of Regulated Medical Waste in Rhode Island**.**

ASPEN AEROGELS—EAST PROVIDENCE, RI
Project Manager for hazardous waste and air pollution control services, and oil pollution control requirements for Spill Prevention Control and Countermeasure Plans (SPCC Plans). Sue also managed Soil Management Plan (SMP) conformance of construction activities beneath an engineered cap, proper on-site soil management protocols, off-site transportation and disposal recordkeeping and replacement of the cap in accordance with RIDEM SMP and Remediation Regulation requirements.

PROVIDENCE WATER SUPPLY—PROVIDENCE, RI
Project Manager for various environmental engineering and permitting projects. Services include but are not limited to: EPCRA Tier2 Inventory Reporting and Toxic Release Inventory (TRI) Reporting. Also served as Environmental Project Manager for the assessment and remediation of contaminated soil and river sediments associated with a broken water main replacement crossing the Woonasquatucket River in Providence, RI.

FM GLOBAL WEST—GLOCESTER, RI & NORWOOD, MA
Project Manager for the environmental permitting associated with the redesign and build out of the Factory Mutual Research and Test Center Facility in West Glocester. Oversaw team responsible for the procurement of all environmental permits including air, wetland, surface water discharge, individual sewage disposal system, and storm water management. Conducted environmental compliance audits and provided regulatory compliance assistance at both the test center in West Glocester and FM's former Massachusetts facility in Norwood. Work included oversight of compliance teams, participation in construction and operating meetings, coordination with state and local environmental officials, preparation and procurement of environmental permit, and coordination with project construction teams.*

GLOBAL PARTNERS, OPERATIONAL DUE DILIGENCE LPG FACILITY—PROVIDENCE, RI
Project manager for the evaluation of environmental operating permits and required operation expansion permits as part of a due diligence assessment of a 17M gallon liquid propane gas (LPG) facility. Services included inspection of the property grounds and operations, and a review of existing operating permits; in addition to a review of all operating files available at the Rhode Island Department of Environmental Management (RIDEM) regarding compliance at the location. Developed a Permitting Matrix that identified existing permits, status of compliance with permits/operations, potential additional permits, transferability of the permits, public involvement requirements, and noted or documented violations. Regulatory areas detailed in the Permitting Matrix included the following: Air Pollution, SARA Title III/EPCRA, Storm Water; Wastewater; RI Coastal Resources Management Council (CRMC) and Federal Coastal Zone Management, Marine Security/Homeland Security, Tank Management, and Oil Pollution Control.*

**Work performed prior to Tighe & Bond.*



JEFFREY ARPS, LSP

VICE PRESIDENT

Jeffrey Arps is responsible for the day-to-day management of numerous comprehensive site assessment and remediation projects. The remediation projects have consisted of groundwater recovery and treatment systems, soil vapor extraction and air sparging systems, multi-phase extraction systems, bioremediation, and in-situ chemical oxidation. The majority of the assessment projects are conducted at sites being evaluated for eventual remediation. He also has experience in the assessment and closure of municipal and industrial solid waste facilities and developing hazardous waste contingency plans for construction activities where hazardous materials may be encountered. Jeff served on the Massachusetts Interagency Task Force to develop a state-wide approach to dealing with poly- and perfluoroalkyl substances (PFAS) across the Commonwealth.

EXPERIENCE
32 Years

SPECIALTIES
PFAS Assessments

Site Assessment and Remediation

Groundwater Recovery and Treatment

Soil Vapor Extraction and Air Sparging

In–situ Biological and Chemical Oxidation Treatments

Assessment and Closure of Solid Waste Facilities

EDUCATION
Bachelor of Science
Environmental Engineering
Rensselaer Polytechnic Institute

40-Hour OSHA HAZWOPER Training

LICENSES & REGISTRATIONS
Licensed Site Professional
MA #4589

PROFESSIONAL AFFILIATIONS
National Groundwater Association

Massachusetts Licensed Site Professional Association

SITE INVESTIGATION/REMEDIATION

PFAS ASSESSMENTS

Provided LSP services to three Massachusetts municipalities with significant PFAS contamination in private wells, coordinated bottled water provision and POET system installations, developed Conceptual Site Model for sources and behavior in the environment and evaluated feasibility of various remedial measures. Assisted another municipality with sampling and forensic evaluations to help determine sources of PFAS in Town supply wells and an impacted school property.

INDUSTRIAL SITE INVESTIGATION/REMEDIATION—NORTH CAROLINA

Performed site investigation and remediation of soils impacted by dioxins, metals, and chlorinated solvents at an industrial site. Determined regulatory requirements, prepared specifications for the work, provided field oversight for remediation activities, and prepared a comprehensive report to achieve closure with state regulatory agencies. Also assisted in the design of an extensive groundwater remediation system for the site.

METAL PLATING FACILITY SITE INVESTIGATION—SPRINGFIELD, MA

Performed a comprehensive site investigation at a metal plating facility where plating wastewaters had impacted soils and groundwater at the site and numerous adjacent properties. Conducted a detailed evaluation of remediation alternatives and performed a risk characterization. Responsible for management and regulatory reporting to document progress of ongoing groundwater remediation.

INDUSTRIAL FACILITY SITE INVESTIGATION—WESTFIELD, MA

Performed a complex site investigation at industrial facility where a previous site owner had contaminated soil and groundwater with chlorinated solvents. Delineated the contaminant plume in relation to a major source area and discharges from aged-combined sewer/stormwater lines. Designed a comprehensive chemical oxidation treatment approach using potassium permanganate to address residual on and off-site contamination and operating numerous sub-slab depressurization systems (SSDSs) to mitigate vapor intrusion.

ANAEROBIC BIOREMEDIATION
Developed and implemented a site remediation strategy utilizing anaerobic bioremediation amendments to bioremediate a chlorinated solvent release and sodium persulfate to oxidize a minor petroleum release on the same site, which is located adjacent to a wetland area and is within a drinking water source protection area.

ANAEROBIC BIOREMEDIATION PROGRAM DEVELOPMENT
Developed and implemented an anaerobic bioremediation program to address residual tetrachloroethylene contamination at a former dry cleaner site using remedial additives to establish an anaerobic environment and bioaugmentation to fortify the existing bacteria population and expedite the achievement of groundwater remediation goals.

GROUNDWATER EXTRACTION SYSTEM—VARIOUS LOCATIONS
Assisted in the design of an expansion of an existing groundwater extraction system to recover chlorinated solvents and metals contamination from a large industrial site, and successfully implemented an anaerobic bioremediation program to expedite the rate of contaminant degradation.

LICENSED SITE PROFESSIONAL (LSP)—MASSACHUSETTS
Serves as Project Manager and LSP of record for the ongoing remediation of numerous other sites in Massachusetts, ensuring compliance with various operating permits and the Massachusetts Contingency Plan.

REMEDIAL APPROACH AND COST ESTIMATES
Develops remedial approach/cost estimates to facilitate real estate transactions and provides review services for approach/cost estimates prepared by others.

SOLID WASTE

PAPER SLUDGE LANDFILL SITE INVESTIGATION–MONROE BRIDGE, MA
Performed a site investigation and closure oversight for a 2.5-acre paper sludge landfill in Monroe Bridge, MA. Prepared a closure certification report and performed subsequent post-closure monitoring inspections and prepared reports detailing the findings.

PAPER SLUDGE LANDFILL PROJECT—LEE, MA
Designed, prepared closure specifications, and provided field oversight for the closure of a private paper sludge landfill in Lee, MA. This project included the stabilization and consolidation of paper sludge located in a series of settling lagoons, dewatering pits, and landfill areas into a single 3-acre landfill facility. Closure activities included separate municipal and industrial solid waste landfills located on the same property.

MUNICIPAL SOLID WASTE LANDFILL—MASSACHUSETTS
Provided field oversight of closure activities and prepared closure certification report for an 8-acre municipal solid waste landfill in Belchertown, MA and an 11-acre municipal solid waste landfill in Palmer, MA.

1,4-DIOXANE EVALUATION
1,4-dioxane is often associated with solid waste facilities and is being found at more sites since the MassDEP lowered the “GW-1” standard and Drinking Water Guideline to 0.3 µg/L. Working on several sites with 1,4-dioxane issues, sampling private wells, groundwater and surface water, evaluating the associated risks, and developing comprehensive response actions for these sites.



Paula J. Mouser, PhD, PE

LEAD PROJECT ENGINEER II

Education

Ph.D., Civil & Environmental Engineering, University of Vermont

M.S., Civil & Environmental Engineering, University of Vermont

B.S., Environmental Engineering, Utah State University

Professional Registration

Maine

Experience

17 Years

Joined Firm

2024

Professional Affiliations

American Chemical Society (ACS)

New England Water Environment Association (NEWEA)

Publications

The Fate of SARS-CoV-2 Viral RNA in Coastal New England Wastewater Facilities, *Frontiers in Environmental Science*, Aghababaei, Colosimo, Malley, and P. Mouser, 2023

Distribution and Fate of PFAS in Wastewater Treatment Plants, *Environmental Science: Processes and Impacts*, Tavasoli, Luek, Malley, and P. Mouser, 2022

Experience Summary

Paula joined Wright-Pierce in July as part of her 2024-2025 academic sabbatical through the University of New Hampshire. For the past 6 years, she has been working to characterize PFAS in wastewater and solids in New Hampshire and Vermont. She brings experience in understanding sourcing, fate, and technologies for mitigating emerging contaminants and pathogens in industrial and municipal wastewaters. This includes assessing emerging contaminant fate (PFAS and PPCP) in biosolids and wastewater facilities discharging to Great Bay Estuary and other coastal tributaries.

Over the past 2 years, Paula has been gathering university contacts conducting research in wastewater and biosolids in New England states, and teambuilding with NEIWPCC, policymakers, utilities, practitioners, community members, and other stakeholders to secure federal funding toward PFAS research and biosolids technology development and testing activities.

Relevant Project Experience (With UNH)

PFAS Testing at NPDES Permitted POTWs, VT

Leading data analysis of PFAS sampled from 91 NPDES-permitted publicly owned treatment works (POTWs) in Vermont. Quantifying PFAS composition and mass loads in upstream sewershed sources, and assessing PFAS entering and exiting treatment facilities. Analysis will be used to identify sources and reduce PFAS mass into wastewater facilities.

Wastewater Treatment Processes Influencing Emerging Contaminant Loads to the Great Bay Estuary, NH

Assessed emerging contaminant fate in wastewater facilities discharging to Great Bay Estuary tributaries. Analyzed PFAS and PPCPs in the liquid and solids from 6 wastewater facilities. Identified sinks and transformations during wastewater treatment. See Tavasoli et al., 2022 and Hidrovo et al., 2023.

Wet Deposition of Per- and Polyfluoroalkyl Substances (PFAS), NH

Collected and analyzed PFAS in precipitation at five locations within the Great Bay estuary. Compared PFAS levels based on land use, season, and form (rain versus snow). Quantified PFAS mass loads to surface waters from precipitation.

Fate of Organic Contaminants in Industrial Wastewater, PA, OH and WV

Collected and analyzed surfactants and organohalogens in industrial wastewaters produced from shale gas wells in the Appalachian basin. Identified biotransformation pathways, quantified degradation rates, and determined microorganisms responsible for attenuation.

Presentations
Mouser, P.
"PFAS in the Great Bay,"
Newington, NH, 2024

Wastewater Surveillance of Sars-CoV-2 on College Campus and in Community Wastewater Facilities, NH, ME, and MA

Directed wastewater surveillance program during COVID-19 pandemic for UNH and supported communities through analysis of sewershed and wastewater facility samples. Led sampling efforts, laboratory processing, and reporting to decision makers for epidemiology projections and public health protection. See Aghababaei et al., 2023.

Relevant Project Experience (With Wright Pierce)

New Hampshire NPDES Medium Draft Permit

Review and evaluation of draft NPDES permit requirements to understand impacts to New Hampshire wastewater facilities.

Sludge Drying Feasibility Study, Durham, NH

Evaluating the feasibility of a sludge dryer installation at the Durham Wastewater Treatment Facility.

Water Treatment Processes Analysis, New Hampton, NH

Evaluating alternatives for upgrading the precinct's water treatment plant.



MICHAEL TROVATO, PE

PROJECT MANAGER

Michael Trovato is an environmental engineer who specializes in site assessment and remediation, solid waste landfill assessment and post-closure monitoring, as well as materials management and geotechnical evaluations. His responsibilities incorporate all aspects of project development including coordination and completion of subsurface investigations and sampling programs, evaluation of analytical results and data, regulatory report preparation, and communication with clients and regulatory agencies.

EXPERIENCE
10 Years

SPECIALTIES
Site Assessment & Remediation

Geo-Environmental Investigations

Materials Management

Solid Waste

Stormwater Compliance

Vapor Intrusion

EDUCATION
Bachelor of Science
Environmental Engineering
University of New Hampshire

LICENSES & REGISTRATIONS
Professional Engineer
MA #58550

MADEP Solid Waste Third-Party Inspector

EPA Construction General Permit (CGP) Certified Site Inspector

40-Hour OSHA HAZWOPER Training

10-Hour OSHA Construction Safety & Health Training

Electrical Hazard Safety Training

PROFESSIONAL AFFILIATIONS
Massachusetts Licensed Site Professional Association (LSPA)

Environmental Business Council New Hampshire & Massachusetts

SITE ASSESSMENT AND REMEDIATION

CHLORINATED SOLVENT MIGRATION ASSESSMENT AND REMEDIATION JAFFREY, NH
Assisted with coordination and oversight of subsurface investigation and environmental sampling to assess the extent of solvent migration within overburden groundwater aquifer and presence of DNAPL in bedrock aquifer. Oversaw remedial activities including geo-physical assessment of bedrock fractures, fluorescent dye tracer study, hydrologic assessment of groundwater flow and direction, buffered remedial injection events, and post-remedial groundwater sampling. Assisted with preparation of Remedial Action Plan (RAP) and associated status reports documenting groundwater conditions and effectiveness of remediation alternatives. Prepared Groundwater Management Permit and Environmental Monitoring Plan in accordance with NHDES regulations and guidelines.

SITE ASSESSMENT AND REDEVELOPMENT—WORCESTER, MA
Served as the lead project engineer for the site redevelopment and construction of a new biopharmaceutical manufacturing facility in Worcester, MA. Performed initial property due diligence and responsible for coordination and oversight of site assessment including environmental and geotechnical subsurface investigations, comprehensive soil and groundwater pre-characterization program to support preconstruction design, preparation of soil reuse and disposal documentation, and development of site-specific soil and groundwater management plan and project specifications. Performed construction oversight and environmental monitoring to document soil management practices, conduct stormwater pollution prevention plan (SWPPP) inspections, and complete geotechnical observation during project construction.

ASTM PHASE I AND PHASE II SITE ASSESSMENTS
Performed Phase I and II Environmental Site Assessments (ESA) for undeveloped, residential, commercial, and industrial properties located throughout Massachusetts and New Hampshire in accordance with ASTM standards. Responsibilities include local, state, and federal file reviews and physical inspection of various sites, structures, and the surrounding areas to identify potential site environmental concerns. Coordinated and performed oversight of Phase II Comprehensive Site Assessment (CSA) activities including subsurface drilling and test pitting, monitoring well installations, and collection of soil, groundwater, surface water, soil gas and indoor air samples for laboratory analysis and characterization. Prepared reports summarizing the actions conducted, results of Phase I and II site investigations, and recommendations for site remediation alternatives.

EMERGENCY RESPONSE
Served as 24-hour emergency response personnel for Massachusetts utility companies. This includes the immediate response and observation of remediation contractors for releases of mineral oil dielectric fluid (MODF), polychlorinated biphenyls (PCBs) or hydraulic oil to soil, groundwater, and/or surface water bodies. Prepared site remediation and closure documents and MCP compliance reports.

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) EVALUATION
Served as the lead field engineer for PFAS site investigations for public and private clients in Massachusetts and New Hampshire in accordance with Federal and State guidelines. Responsibilities included coordination and oversight of field sampling activities of soil, groundwater, surface water and other media for PFAS analysis, interpretation of data, evaluation of environmental implications based on potential receptors, and preparation of compliance reports to state regulatory agencies of findings including recommendations for additional assessment and risk mitigation.

SOLID WASTE

LANDFILL ASSESSMENT, POST-CLOSURE MONITORING AND COMPLIANCE—LITTLETON, MA
Serve as project manager and lead project engineer for landfill post-closure environmental monitoring, and off-site landfill gas migration assessment. Responsibilities include development and implementation of post-closure maintenance and monitoring plan, coordination and oversight of installation of environmental monitoring systems in accordance with the Massachusetts Landfill Technical Guidance Manual, coordination and completion of field investigations, sample collection and analysis of groundwater and surface water, and the monitoring of soil gas and landfill gas. In addition, responsible for the preparation of landfill environmental monitoring compliance reports, post-closure use and modification permits, communication with MassDEP for reportable conditions of groundwater and/or surface water contaminant exceedances and landfill gas detections, and serve as the certified Third-Party Inspector to complete landfill cap/cover inspections and associated reports in accordance with Massachusetts Solid Waste Regulations (310 CMR 19.000).

GEOTECHNICAL

GEOTECHNICAL INVESTIGATIONS
Oversaw the completion of geotechnical and environmental (Geo-Environmental) subsurface soil borings and test pits in support of numerous site development projects throughout New England. Responsibilities included the coordination and oversight of exploratory subsurface investigation and drilling programs, characterization of soil and bedrock, collection, and characterization of soil samples, undisturbed shelby tubes, and bedrock cores for various laboratory and geotechnical analyses. In addition, responsible for the preparation of subsurface exploration logs and geotechnical memorandums detailing results and findings of investigations. Responsible for geotechnical construction oversight for excavation, structure subgrade preparation, and backfill in accordance with project specifications, and preparation of daily field reports detailing site observations.



EXPERIENCE
5 Years

SPECIALTIES
Site Assessment & Remediation

Materials Management

Compliance Monitoring

Construction Dewatering Permitting

EDUCATION
Bachelor of Science
Environmental Science: Hydrology
University of New Hampshire

Currently Enrolled- Master of Science
Civil Engineering
University of Massachusetts Lowell

CERTIFICATIONS
40-Hour OSHA HAZWOPER

PROFESSIONAL AFFILIATIONS
Massachusetts Licensed Site Professional Association (LSPA)

Environmental Business Council (EBC)

COLLEEN BROTHERS LAWSON

SENIOR ENVIRONMENTAL SCIENTIST

Colleen Brothers Lawson is a Senior Environmental Scientist in the Site Assessment and Remediation group, working on projects under the Massachusetts Contingency Plan (MCP 310 CMR 40.0000) and Solid Waste Regulations (310 CMR 19.000), and has experience with materials management, and compliance monitoring. Colleen also has experience with materials management, construction dewatering permitting, development and implementation of comprehensive multi-media assessment programs and compliance monitoring.

SITE ASSESSMENT & REMEDIATION

RESIDENTIAL PROPERTY ROXBURY—CVOC ASSESSMENT

Serving as the Assistant Project Manager for the assessment and remediation of a residential property in Roxbury. Environmental assessment activities identified the presence of elevated metals in soil, elevated chlorinated volatile organic compounds (CVOCs) in soil, groundwater, sub-slab soil gas and indoor air and petroleum constituents in soil, groundwater and indoor on-Site. Worked with a remedial contractor to design and install a sub-slab depressurization system (SSDS) to vent contaminated vapors from beneath the building footprint to the exterior of the building. Performing ongoing assessment to delineate the nature and extent of the CVOC groundwater plume, evaluating potential for vapor intrusion pathways at off-Site properties and preparing applicable MCP reports.

FORMER MGP SITE REMEDIATION AND REDEVELOPMENT

Serving as the Assistant Project Manager for the assessment, remediation and redevelopment spanning several parcels of land in Watertown. Historical site usage of these parcels included an electrical switch manufacturer, electroplating and metal finishing company and Manufactured Gas Plants (MGPs) throughout the 1800s. Assisted in developing soil and groundwater sampling plans to delineate the extent of CVOC, metals, and physiologically available cyanide (PAC) soils and groundwater contamination, and developed remediation and management opinions of probable costs (OPCs). Documented remediation, redevelopment, and risk assessments under Release Abatement Measure (RAM) reporting and calculated risk based dust action limits to be protective of off-Site receptors. Concurrent with assessment and remediation, completed Remedial Monitoring Reporting (RMRs) associated with the on-Site SSDS to confirm operation is protective of on-Site receptors.

STATION 131 ASSESSMENT AND REMEDIATION

Served as Assistant Project Manager for the pre-construction remediation of Eversource's proposed Station 131 in East Boston. The Site was primarily tidelands that were filled approximately 15-20 feet with historical fill material. Due to the historical filling of these resource areas, there was widespread soil contamination, consisting of metals and polycyclic aromatic hydrocarbons (PAHs) in soil and groundwater. Developed and implemented soil and groundwater pre-characterization sampling programs, developed risk based dust action limits to be protective of off-site receptors, prepared MCP reports, prepared construction dewatering permits and oversaw implementation of the remediation plan. The remediation included the treatment of approximately 2,300 cubic yards of hazardous waste soils, excavation, and off-site disposal of 5,600 cubic yards of soil and management of 400,000 gallons of construction groundwater.

MCGRATH PARK SALEM ASSESSMENT AND REMEDIATION
Serving as the Assistant Project Manager for McGrath Park assessment and remediation. McGrath Park operated as a municipal, unlined burn dump from approximately 1946 until 1963. Assisted in delineating the nature and extent of the burn dump through the development of soil boring, test pit, wetland sediment sampling, surface water and groundwater sampling plans. Assisted the Project Manager with preparation of applicable MCP reports, remedial alternative evaluations and development of remediation funding requests and construction schedules.

DISPOSAL SITE ASSESSMENT ACTIVITIES
Conducts site assessments to identify the nature and extent of contamination present at disposal site and evaluates response actions and their effectiveness at achieving remedial objectives for the sites. Performs soil, groundwater, surface water and indoor air sampling. Prepares associated MCP Reporting.

UNDERGROUND STORAGE TANK REMOVAL AND CLOSURE ASSESSMENTS
Performs assessment activities in the removal and closure of underground storage tanks (USTs), which includes the collection of soil samples for characterization and the preparation of UST Closure and MCP Compliance Reporting including Permanent Solutions Statements (PSS).

EMERGENCY RESPONSE
Serves as a 24-hour emergency response personnel for Massachusetts utility providers. Emergency response includes the observation of remediation contractions and site remediation activities including sampling of petroleum contaminated soil, surface water, sediment, groundwater and gauging of Light Non-Aqueous Phase Liquids (LNAPLs). Prepares associated MCP Site Reporting including Immediate Response Action (IRA) Reports, Phase I/ Tier Classifications, and Permanent Solutions.

ASTM PHASE I ENVIRONMENTAL SITE ASSESMENTS
Conducts Phase I Site Assessments in accordance with the American Society of Testing and Materials Standards (ASTM E1527-13) in Massachusetts, Maine and Rhode Island. Site assessments included a comprehensive local and state file review, site inspections and reporting.

MATERIALS MANAGEMENT

MYSTIC—EAST EAGLE UNDERGOUND 115KV TRANSMISSION LINE
Served as a Environment Scientist for the installation of a new approximately 15,700± linear feet 115 kV underground transmission line. Oversaw the soil and groundwater pre-characterization program, which included the advancement of 83 soil borings, installation of six groundwater monitoring wells, collection of soil samples for disposal characterization sampling and collection of groundwater samples for MWRA and RGP dewatering permitting requirements. Assisted with the preparation of the Soil and Groundwater Management Plan and MCP Reports.

GROUNDWATER MANAGEMENT
Prepares Notice of Intents (NOIs) for coverage under the National Pollutant Discharge Elimination System (NPDES) Remedaition General Permit (RGP). Preparation included dewatering plans, groundwater characterization and hydraulic conductivity testing. Assists with discharge monitoring requirements including influent/effluent monitoring, discharge monitoring reports via NetDMR, Notices of Change (NOCs), Best Management Practice Plan (BMPP) preparation and Notices of Termination (NOTs).



JILL LIBBY

SENIOR DATA MANAGEMENT SPECIALIST

Jill Libby is a Senior Data Management Specialist who specializes in data management, processing, and visualization. Jill provides a wide range of both routine and unique data management solutions and technical assistance to various sized projects across New England including, but not limited to, analytical data tables, photo logs, graphics, GIS and CAD figures, investigation and remediation sample tracking, boring logs, and cross-sections.

EXPERIENCE
12 Years

SPECIALTIES
Data Management

Data Processing & Visualization

Environmental Site Assessments

Environmental Site Remediation

ArcGIS

AutoCAD

EDUCATION
Bachelor of Science
Geology and Water Resources
SUNY Brockport

Master of Science
Geological Sciences
University of Connecticut

PROFESSIONAL AFFILIATIONS
Environmental Professionals' Organization of Connecticut

Geological Society of America

Sigma Gamma Epsilon (Earth Science Honor Society)

DATA MANAGEMENT AND PROCCESSING

ENVIRO DATA

Administrator for Tighe & Bond's database management system, Enviro Data. Responsible for processing, organizing, and managing environmental related data including laboratory results, site information, exploration results, and regulatory criteria across New England. Experience with data processing on complex sites spanning several different various state and federal regulations. Data processing for long term monitoring sites with thousands of samples. Experience tracking exploration and sampling information to ensure proper processing and quality control.

DATA QUALITY EVALUATION

Responsible for evaluating and summarizing laboratory data quality information for various projects in New England. Compiling information in accordance with state and federal regulations.

LANDFILL MONITORING

Assist with quarterly, semi-annual, and annual reporting for landfill monitoring across Massachusetts, Connecticut, and New Hampshire. Landfill monitoring is completed for over two dozen locations. Criteria includes federal and state regulations.

DATA VISUALIZATION

PFAS ASSESSMENTS

Work with project teams in three Massachusetts municipalities with significant PFAS contamination in private wells. Assisted with data analysis and display, integration between Enviro Data and GIS, trend analysis, reporting requirements, and sample designation. Final Maps and tables were provided to the municipalities and homeowners.

AUTOCAD AND GIS

Provided drafting and mapping support for various environmental projects. Drawings developed from existing data, surveys, and/or field measurements and observations. Support includes data visualizations, data presentation, and general site development. Developed drawings to support various hazardous building materials inspections and abatement plans, including development of bid document packages. Measured buildings and developed scaled floor plans at sites for which adequate architectural documentation could not be found. Sample buildings in Connecticut included the various buildings at the Stratford Army Engine Plant, UConn, and Yale-New Haven Hospital.

BORING LOGS AND CROSS-SECTIONS
Visualize subsurface conditions using boring logs and cross-sections in various programs. Developed various display techniques to display subsurface conditions along with laboratory and field data. Graphics have assisted numerous sites in a better and more comprehensive understanding of subsurface conditions.

EMERGENY RESPONSE
Support emergency response projects for electrical companies across Massachusetts. Services include, but are not limited to, data organizations, communication with field staff, AutoCAD and GIS figures, various data tables, photo logs, boring logs, cross-sections, and groundwater monitoring logs.

SOFTWARE PROGRAMS

Enviro Data, ArcGIS, AutoCAD, Surfer, Aqutesolv, Visual Modflow, M.S. Office Suite, Google Earth

PUBLICATIONS

Libby, Jill L., and Robbins, G.A, “An Unsteady State Tracer Method For Characterizing Fractures in Bedrock Wells,” Groundwater, 52(1): 136-144, 2014.



JULIA JACKSON

ENVIRONMENTAL DATA MANAGEMENT SPECIALIST

Julia Jackson is a Data Management Specialist in the Environmental Business Line. Julia specializes in data management, processing, and visualization. Her data management experience includes managing and maintaining sample results throughout long term projects, as well as drafting figures and drawings for various environmental assessment and remediation sites utilizing ArcGIS and AutoCAD.

EXPERIENCE
Less than 1 Year

SPECIALTIES
Data Management

Data Processing & Visualization

AutoCAD

ArcGIS

EDUCATION
Bachelor of Science
Environmental Engineering
University of Connecticut

PREVIOUS PROJECTS

Data management experience includes managing soil sample results during research for CT DEEP through undergrad design project determining background concentrations of PFAS throughout the state. She also conducted research during undergrad on wind speed patterns off the coast of Long Island to aid in the development of a software to better predict weather for offshore wind farms.

DATA MANAGEMENT

Responsible for organizing and tabulating laboratory, site assessment, and field test data. Provide quality control and maintenance for projects with ongoing monitoring or large datasets. Create summarized and comprehensible representations of data.

ENVIRO DATA
Responsible for processing laboratory results against various regulatory criteria using EnviroData database management system.

AUTOCAD DRAFTING

EMERGENCY RESPONSE FOR STATE OF MASSACHUSETTS UTILITIES
Provide site plans for pad-mounted and pole-mounted transformer mineral oil dielectric fluid releases. Drawings developed from field notes and surveys to support remediation and site development.

ARCGIS DRAFTING

Create arial, priority resource, topography, and groundwater contour maps for emergency response and other site assessments.

STRATER – SOIL BORING LOGS

Generating boring logs from field logs following Modified Burmister Soil Classification using Strater software program.



ELLIE PETRACCIONE

ENVIRONMENTAL SCIENTIST

Ellie Petraccione is an Environmental Scientist in the Site Assessment and Remediation group, working on projects under the Massachusetts Contingency Plan (310 CMR 40.0000) and Solid Waste Regulations (310 CMR 19.000). Ellie has experience with comprehensive multi-media assessments, risk characterizations, materials management, and compliance monitoring. She also provides field support for soil, surface water, groundwater, and indoor air sampling.

EXPERIENCE
4 Years

SPECIALTIES
Site Assessment and Remediation

Materials Management

Compliance Monitoring

Environmental Permitting

Emergency Response

EDUCATION
Bachelor of Science
Environmental Science and Policy
Marist College

LICENSES & REGISTRATIONS
40-Hour OSHA HAZWOPER

PROFESSIONAL AFFILIATIONS
Massachusetts Licensed Site Professional Association – Member of the Emerging Professional Committee

Environmental Business Council (EBC) – Ascending Professional Representative for the TSCA & PCB Working Group

SITE ASSESSMENT AND REMEDIATION

DISPOSAL SITE ASSESSMENT ACTIVITIES

Conducts site assessments to identify the nature and extent of contamination present at disposal site and evaluates response actions and their effectiveness at achieving remedial objectives for the sites. Performs soil, groundwater, surface water and indoor air sampling.

PREPARES ASSOCIATED MCP REPORTING—EMERGENCY RESPONSE

Serves as a 24-hour emergency response personnel for Massachusetts utility providers. Emergency response includes the observation of remediation contractors and site remediation activities including sampling of petroleum contaminated soil, surface water, sediment, groundwater and gauging of Light Non-Aqueous Phase Liquid (LNAPL). Prepares associated MCP Site Reporting including Immediate Response Action (IRA) Reports, Phase I/Tier Classifications, and Permanent Solutions.

ASTM PHASE I ENVIRONMENTAL SITE ASSESMENTS

Conducts Phase I Site Assessments in accordance with the American Society of Testing and Materials Standards (ASTM E1527-13) in Massachusetts and New Hampshire. Site assessments included a comprehensive local and state file review, site inspections and reporting.

MATERIALS MANAGEMENT

SOIL PRE-CHARACTERIZATION AND MANAGEMENT

Develops and conducts soil and groundwater characterization sampling plans to support various construction projects in the greater Boston area. Assists with the preparation of Soil and Groundwater Management Plans (SGMP), technical specifications, and soil reuse requests. Prepares associated MCP Site reporting including Utility-related Abatement Measures (URAMs), Release Abatement Measures (RAMS) and PSS. Identifies soil reuse categories in accordance with the MCP, Massachusetts Hazardous Waste Regulations (310 CMR 30.000), Massachusetts Solid Waste Regualtions 310 CMR 19.0000, facility Soil Management Plans, and MassDEP policy COMM-97-001 and COMM-15-001, RCRA (40 CFR 261) and TSCA (40 CFR 761).

SWPPP INSPECTIONS

Performs Stormwater and Pollution Prevention Plan inspections to monitor compliance with construction best management practices in relation to erosion and sedimentation at multiple sites. Recommends corrective actions to address deficiencies identified during the inspection.

GROUNDWATER MANAGEMENT
Prepares Notice of Intents (NOIs) for coverage under the National Pollutant Discharge Elimination System (NPDES) Dewatering and Remediation General Permit (DRGP). Preparation includes dewatering plans and groundwater characterization. Assists with discharge monitoring requirements including influent/effluent monitoring and discharge monitoring reports via NetDMR.

LANDFILL MONITORING
Performs post-closure municipal landfill assessments to monitor and evaluate landfill conditions. Performs landfill gas and groundwater sampling and prepares associated MassDEP reporting.

RESEARCH

HUDSON RIVER FOUNDATION TIBOR T. POLGAR FELLOWSHIP—MARIST COLLEGE, POUGHKEEPSIE, NY
Studied the interaction between cyanobacteria and the abiotic factors of low-flow tributaries of the Hudson River. Assessed the compounding influence of invasive species and characterized cyanobacteria populations to understand toxicity risk in the Hudson Valley. This research was presented at the American Geophysical Union Fall Meeting in San Francisco, CA in December 2019.



ALEXANDER DEMARCO

PROJECT ENVIRONMENTAL SCIENTIST

Alexander DeMarco is a Project Environmental Scientist in the Site Assessment and Remediation group, working on projects under the Massachusetts Contingency Plan (310 CMR 40.0000). Alexander provides project field support and is experienced in a wide variety of environmental sampling. He has extensive experience with American Society of Testing and Materials Standards (ASTM) Phase II Assessments, underground storage tanks (USTs) removals, and soil vapor extraction systems.

EXPERIENCE
5 Years

SPECIALTIES
Site Assessment & Remediation

Geo-Environmental Investigations

Soil & Groundwater monitoring

Emergency Response

Vapor Intrusion

Solid Waste

EDUCATION
Bachelor of Science
Natural Resource Conservation
University of Massachusetts - Amherst

LICENSES & REGISTRATIONS
40-Hour OSHA HAZWOPER

MADEP Solid Waste Third Party Inspector

EPA's Construction General Permit Site Inspector Training

SITE ASSESSMENT AND REMEDIATION

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) EVALUATION

Since the onset of PFAS compound regulations as an emerging contaminant, served as the lead environmental scientist for a variety of clients for site evaluations in Massachusetts and New Hampshire. Responsibilities include coordination of field sampling activities for PFAS analysis, data interpretation, and compliance reporting to state regulatory agencies.

UNDERGROUND STORAGE TANK REMOVAL AND CLOSURE ASSESSMENTS

Performs assessment activities in the removal and closure of USTs, which includes the collection of soil samples for characterization and the preparation of UST Closure and MCP Compliance Reporting, including Permanent Solutions Statements (PSS).

EMERGENCY RESPONSE

Serves as a 24-hour emergency response personnel for Massachusetts utility providers. Emergency response includes the observation of remediation contractions and site remediation activities including sampling of petroleum contaminated soil, surface water, sediment groundwater and gauging of Light Non-Aqueous Phase Liquids (LNAPLs). Alexander has experience managing highly publicized Emergency Reponses with a variety of stakeholders.

DISPOSAL SITE ASSESSMENT ACTIVITIES

Conducts site assessments to identify the nature and extent of contamination present at disposal site and evaluates response actions and their effectiveness at achieving remedial objectives for the sites. Performs soil, groundwater, surface water and indoor air sampling. Prepares associated MCP Reporting.

COMPLIANCE MONITORING

SWPPP INSPECTIONS

Performs Stormwater and Pollution Prevention Plan inspections to monitor compliance with construction best management practices in relation to erosion and sedimentation at multiple sites. Recommends corrective actions to address deficiencies identified during the inspection.

LANDFILL COMPLIANCE, MONITORING, AND INSPECTIONS

Performs post-closure municipal landfill assessments to monitor and evaluate landfill conditions. Performs landfill gas and groundwater sampling and prepares associated MassDEP reporting. Serves as the certified Third-Party Inspector to complete landfill cap/cover inspections for MADEP Solid Waste compliance.

COMPLIANCE MONITORING

GEOTECHNICAL INVESTIGATIONS

Oversaw the completion of geotechnical and environmental (Geo-Environmental) subsurface soil borings and test pits in support of numerous site development projects in Massachusetts and New Hampshire. Responsibilities included oversight of exploratory subsurface investigation and drilling programs, characterization of soil and bedrock, and the collection and characterization of soil samples, Shelby tubes, and bedrock cores for various laboratory and geotechnical analyses.



PETER TOPOR

PROJECT COMPLIANCE SPECIALIST

Peter Topor is a member of Tighe and Bond's Environmental Business Line with a focus on remediation, occupational safety, and industrial compliance. He has over seven years of experience between his career as a Laboratory Supervisor, and his career as an Environmental Scientist. He has extensive experience with the lab-pack and disposal of hazardous wastes as well as wastewater operations. He has field experience with a variety of media sampling techniques, industrial EHS programs, and MCP site remediation.

EXPERIENCE
7 Years

SPECIALTIES
Industrial Compliance

Site Remediation

Wastewater Operations

UST/AST Inspections

Safety and Health Compliance

Landfill Monitoring

Media Sampling

Utilities Site Testing

Emergency Release Response

Wetland Delineation

EDUCATION
Bachelor of Science
Health Sciences/Chemistry
Western New England University

LICENSES & REGISTRATIONS
OSHA 40 hour HAZWOPER

Eversource Substation Training

Grade 2I Wastewater Operator
License #18870

UST A/B Operator
License # 119150580

AST SP001 Inspector
License # AST-6983

PROFESSIONAL AFFILIATIONS
Massachusetts Associations of Conservation Commissions

Massachusetts Water Environment Association

WATER

PFAS SAMPLING
Perform PFAS sampling of drinking water at a variety of residential and commercial sites, in accordance with EPA Method 537.

REVERSE OSMOSIS SYSTEM OPERATOR
Maintained multistage reverse osmosis systems capable of suppling high volumes of deionized water to facilities.

CONSERVATION COMMISSIONER—TOWN OF WARE, MA
Combined a familiarity of the Wetlands Protection Act and town bylaws, vote on RDA, NOI, and certificate on completion for both public and private sector projects. Acted as mediator between disputing parties. *

REMEDIATION

PHASE IV REMEDIATION SYSTEM MONITORING
Oversaw ongoing recovery of contaminants including PCB containing petroleum contamination and PFAS. Maintained all automated equipment involved, and document and contain breakouts to nearby waterways. Extrapolated optimal recovery location based on historic data and external influencing factors. Installed upgraded petroleum recovery systems.

ON-CALL EMERGENCY SPILL RESPONSE SERVICES
Provided on-call emergency spill response services for a variety of Massachusetts utility companies. This involved coordination with power utility personnel, immediate response to spills of various volumes and PCB levels, evaluation of release, and determination of notification requirements.

WASTEWATER OPERATIONS

PLANT OPERATOR
Served as a Grade 2I wastewater treatment plant operator for industrial and institutional facilities throughout Massachusetts.

WASTEWATER TREATMENT SYSTEMS MAINTENANCE
Conducted facility assessments of wastewater treatment systems including automated chemical feed, and parameter controls pump systems.

WASTEWATER TREATMENT OPERATOR—WESTFIELD ELECTROPLATING
Served as lead operator on a grade 4I electroplating wastewater treatment plant that discharged about 150,000gpd. Aided in implementing PLC controls to automate processes in the treatment facility and experimented to

determine optimal coagulant/flocculant composition and concentration. Modified system to meet changing discharge regulations.

WASTEWATER TREATMENT SYSTEM UPGRADES
Research and implement various pretreatment methods to reduce heavy metal concentrations and meet regulatory requirements.

MEDIA ASSESSMENTS

SOIL SAMPLING
Utilized tools including AMS Sampler, Ponar and Sediment Thickness Probes to test for contamination prior to dam deconstruction or sediment dredging.

SOIL BORING SAMPLING—EVERSOURCE
Sampled soil drill at various depths, obtained samples for lab, and field tested to determine presence of petroleum contamination around the perimeter of a decommissioned substation.

GROUNDWATER SAMPLING—WESTFIELD, MA
Employed PDB bags and ground water testing equipment to test for presence of CVOCs.

INDUSTRIAL

HAZARDOUS WASTE MANIFESTING
Created profiles and generated waste manifests for large quantity generators. Ran qualitative/quantitative testing of known and unknown compounds to properly lab-pack and dispose of, with compatible chemistries.

LANDFILLS
Conduct quarterly inspections and compliance monitoring of several large Massachusetts landfills. Monitoring includes measuring concentration of landfill gases at blower station, gas extractions wells, multi-depth probes, and perimeter gas vents, as well as adjusting flow rates from extraction wells.

EHS COMPLIANCE PROGRAMS
Developed and implemented various EH&S compliance programs for Industrial facilities. Program development included the following: Spill Prevention Controls and Countermeasures Plan, Lockout/Tag-Out Programs, Confined Space Programs and Confined Space Determinations and Procedures, and Job Hazard Analysis.

ELECTROPLATING LABORATORY SUPERVISOR–WESTFIELD, MA
Managed a team of six employees to maintain analytical control of pretreatment and plating baths, using a variety of testing methods. Familiar with a variety of analytical testing methods, including ICP-OES, UV-VIS, potentiometric titrations, and manufacturer provided proprietary testing methods. Experimented with new processes and established their ability to fall within the scope of regulatory compliance.*

TANK INSPECTIONS

AST SP001 INSPECTIONS—COCA-COLA
Perform monthly inspections on eight aboveground storage tanks.

TPI INSPECTIONS
Assist with multiple third-party inspections throughout Massachusetts.

**work performed prior to Tighe & Bond.*



RACHEL TENNEY

STAFF ENGINEER

Rachel specializes in wastewater treatment with an emphasis on biological nutrient removal. She has experience developing and executing hypothesis-driven studies coupled with detailed technical analyses for projects at the laboratory and field scales as well as disseminating results in academic papers, technical memoranda, and conference presentations.

EXPERIENCE
1 Year

SPECIALTIES
Wastewater nutrient management

Resource recovery

Data management & analyses

Technical communication

Education & outreach

EDUCATION
Bachelor of Science
Chemical Engineering
Lafayette College

Master of Science
Civil Engineering
University of Minnesota

Doctor of Philosophy (in progress)
Civil Engineering
University of Minnesota

Certifications
OSHA Construction 10-hour

PROFESSIONAL AFFILIATIONS
New England Water Environment Association (NEWEA)

Water Environment Federation (WEF)

New England Water Works Association (NEWWA)

Out to Innovate

PFAS

PFAS AND RESIDUALS TECHNOLOGY AND MANAGEMENT STUDY, PART 2
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
Identified distinct “PFAS profiles” of POTW influent, effluent, sludge, and industrial sources using nonparametric statistical methods to assess the feasibility of PFAS source reduction. Developed a database of existing PFAS data for NPDS permit-holders. Conducted preliminary investigation of land use and environmental justice indices’ association with PFAS loading. Recommended approaches for municipalities and legislators to address PFAS at POTWs.

BIOSOLIDS

PFAS AND RESIDUALS TECHNOLOGY AND MANAGEMENT STUDY, PART 1
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
Conducted a detailed assessment of sludge disposal practices and viable alternatives in POTWs across Massachusetts. Compiled data on sludge volumes and costs and recommended adjustments to POTW reporting requirements. Recommended strategies for long-term sludge management tailored for utilities of varying sizes.

PRODUCTION OF NITROGEN AND PHOSPHORUS-RICH CRYSTALS FROM MUNICIPAL BIOSOLIDS DEWATERING CENTRATE FOR SUSTAINABLE NUTRIENT RECOVERY
Evaluated several methods for producing magnesium-ammonium-phosphate (MAP) minerals, such as struvite, from sludge-dewatering centrate provided by the Easton (PA) Wastewater Treatment facility. Laboratory experiments, simulations, and a proposed dissolution mechanism showed that ion exchange can stimulate MAP precipitation, recovering nitrogen and phosphorus for use as fertilizer.*****

WASTEWATER

IMPROVING NITROGEN REMOVAL IN GREATER MINNESOTA WASTEWATER TREATMENT PONDS
Designed hypothesis-driven studies at the laboratory and field scales to address small-community wastewater nutrient management needs in Minnesota. Implemented lab experiments by designing parallel bioreactors with robust feedback control systems and managing their operation during time-dependent experiments. Collaborated with industry, state, and municipal stakeholders to successfully execute a one-year field study of facultative wastewater treatment ponds in greater Minnesota. Conducted in-depth technical and statistical analyses and disseminated results to audiences varying from academic to industry operators to the public using R statistical software, Microsoft Office Suite, and Google Suite.*

FUNDED PROPOSALS

Co-authored Sustainable Development Goals: Ensuring Clean Water and Sanitation, Addressing Climate Change, and Improving Sustainable Communities via Predictive Wastewater Treatment in Rural Communities with principal investigator Paige Novak, who was awarded a University of Minnesota Sustainable Development Goals Initiative 2022 Research Grant for $20,000. *

On behalf of Queer Science, a STEM outreach organization for LGBTQ+ youth, co-authored grant applications to the Trans Justice Funding Project to be awarded $15,000 over three grant cycles (2018, 2019, 2022). *

Co-authored the peer-reviewed research addendum as part of the proposal for a three-year grant from Minnesota Environment and Natural Resources Trust Fund stewarded by the Legislative-Citizen Commission on Minnesota Resources (2018) to support graduate study and research. *

PUBLICATIONS

“Dissolved oxygen and microbial abundance: lessons from model laboratory studies aimed at improving winter performance in facultative wastewater treatment ponds” *[In preparation]* *

“Assessment of nitrogen fate and transport in full-scale facultative wastewater treatment ponds in small communities in Minnesota over one year” *[Working title; in preparation]* *

“Microbial communities in facultative wastewater treatment ponds are affected by deterministic and stochastic assembly mechanisms” *[Working title; in preparation]* *

PRESENTATIONS

“Improving Nitrogen Removal in Greater Minnesota Wastewater Treatment Ponds” *
- AEESP Research and Education Conference (June 2023, June 2022)
- Central States Water Environment Association 96th Annual Meeting (May 2023)
- Air & Waste Management Association Upper Midwest Section Conference on the Environment (November 2022)
- Minnesota Wastewater Operators Association Annual Conference (July 2022)

“Grappling with Environmental Injustice” *
- Air & Waste Management Association Upper Midwest Section Conference on the Environment (November 2021)
- University of Minnesota Introduction to Civil, Environmental, and Geo-Engineering (Fall 2021, Spring 2022, Fall 2022)

“Production of Nitrogen- and Phosphorus-Rich Crystals from Municipal Wastewater for Sustainable Nutrient Recovery” *
- Society of Women Engineers Collegiate Research Graduate Poster Competition (November 2018)
- Pennsylvania Water Environment Association Annual Technical Conference (June 2018)
- AWWA Pennsylvania Fresh Ideas Poster Contest (May 2018)
- Lehigh Valley Association of Independent Colleges Campus Sustainability Conference Presentation (February 2018)

* with previous organization(s)

ATTACHMENT B

Field Data Collection Form - PFAS Testing Study for Massachusett NPDES POTWs

1. POTW Information

POTW Name:	
POTW Address:	
POTW Contact:	
Annual Average Flow:	
NPDES Permit Design Flow:	
Do you use partial treatment of your wastewater?	
Do you have CSOs (combined sewer overflows)?	
Do you have holding capacity for influent?	
If so, what is the volume available?	
Do you accept other septage/leachate/hauled-in wastes?	
Do you have any other unusual influent or occurrences at your facility?	
General Description of Influent Wastewater Sources:	
% of flow from residential wastewater	
% of flow from industrial wastewater	
% of flow from septage/hauled in wastewater	
% of flow from inflow/infiltration (I/I)	
# and types of Significant Industrial Users (SIUs)	
Notes:	

2. General Conditions/Information for Day of Sampling

Name of Sampler:	
Date of Sampling:	
Weather Conditions at Sampling Time (Temperature and Precipitation):	
Weather Conditions during Previous 5 days (Temp. and Precip.):	
Photograph taken of Current Site Conditions:	
Volume of Septage/Leachate/Hauled Waste Received Today (if applicable):	
Note any Unusual Influent or Occurrences at POTW Today or Recently:	
Notes:	

3. Effluent Sampling

Sample Location:	
Sample Location Lat and Long:	
Sample Time:	
Sample Collection Method:	
Effluent Flow Rate at Time of Sampling:	
Photograph taken or provided of Effluent Sample Location:	
Notes:	

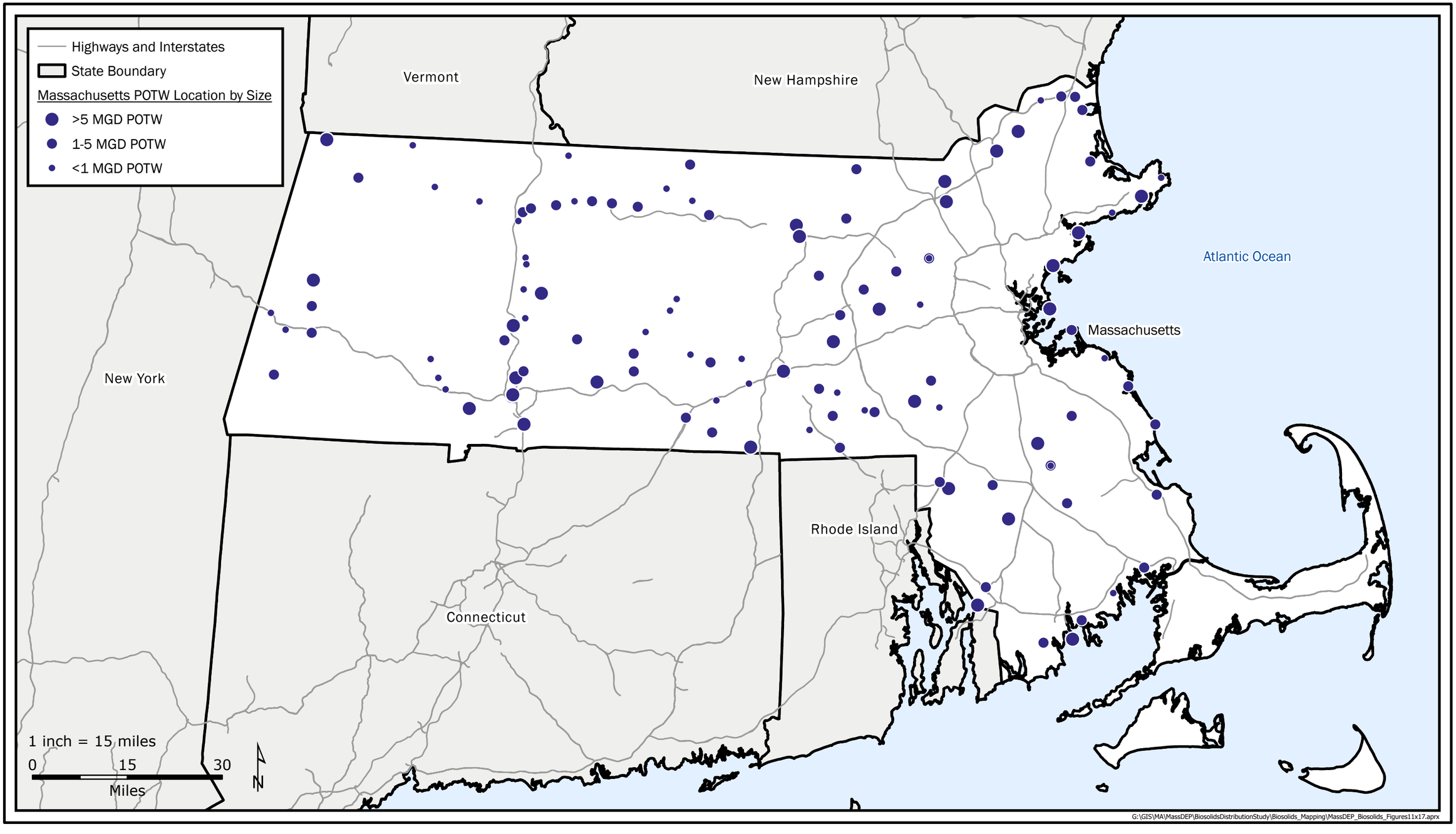
4. Influent Sampling	
Sample Location:	
Sample Location Lat and Long:	
Sample Time:	
Sample Collection Method:	
Influent Flow Rate at Time of Sampling:	
Photograph taken or provided of Influent Sample Location:	
Notes:	

5. Sludge Sampling	
Sample Location:	
Sample Location Lat and Long:	
Sample Time:	
Sample Collection Method:	
Sludge Processing (e.g., Thickening or Dewatering) at Sampling Time:	
Photograph taken or provided of Sludge Sample Location:	
Notes:	

ATTACHMENT C

Massachusetts POTWs Sampled as Part of the MassDEP PFAS Testing Study

Publicly Owned Treatment Works (POTW)



ATTACHMENT D

Pace ANALYTICAL SERVICES	**ENV-SOP-MANS-0111 v01 Preparation and Analysis of PFAS in Aqueous, Solid, and Tissue by EPA Method 1633**
	Effective Date: 08/07/2024

Management Approval:
John Trimble Approved on 8/7/2024 11:55:41 AM
Laura Vanasse Approved on 8/7/2024 11:32:33 AM
Pete Henriksen Approved on 8/7/2024 10:20:05 AM
Jason Hebert Approved on 8/7/2024 12:02:07 PM

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1.0 SCOPE & APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure used by Alpha, a Pace Analytical Laboratory for the determination of the per- and polyfluoroalkyl substances (PFAS) by liquid chromatography/mass spectrometry (LC-MS/MS) following EPA 1633, published January 2024. This SOP is applicable to aqueous (all non-potable water and leachate), solid (soil, biosolids, sediment), and tissue matrices.

The instrumental portion of this method is for use only by analysts experienced with LC-MS/MS or under the close supervision of such qualified persons. The laboratory must demonstrate the ability to generate acceptable results using the procedures in Sections 11.3.1 and 11.3.2.

By their very nature, many components of PFAS present analytical challenges unique to this class of analytes. For example, PFAS analytes readily adhere to the walls of the sample containers and may also stratify in the container.

1.1 Target Analyte List, Limits of Detection & Quantitation (LOD & LOQ)

The target analytes that can be determined by this SOP and the associated LODs and LOQs are provided in Appendix A, Tables 1, 2, and 3.

LOQs are established in accordance with PAS policies and procedures for method validation, determination of detection limits (LOD), and quantitation limits (LOQ). Refer to laboratory SOP ID 1732 (Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ)) for additional information. DL and LOQ are routinely verified and updated when needed. DL and LOQ are always adjusted to account for actual sample amounts used and for dilution.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detect in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detections and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

1.2 Reference Methods & Documents

This SOP is based on reference method EPA 1633 (2024). If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modifications is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.3 Quantitation Range

The quantitation range for each target analyte in this procedure is defined in Appendix A, Table 5: Calibration Standard Concentrations.

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1.4 Program Specific Requirements

Not Applicable.

2.0 SUMMARY OF METHOD

Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification (see Section 9.2.1) using isotopically labeled compounds added to the samples before extraction.

Individual PFAS analytes are identified through peak analysis of the quantification and confirmation ions, where applicable. Where linear and branched isomers are present in the sample and either qualitative or quantitative standards containing branched and linear isomers are commercially available, the PFAS analyte is reported as a single analyte consisting of the sum of the linear and branched isomer concentrations.

Quantitative determination of target analyte concentrations is made with respect to an isotopically labeled PFAS standard; the concentrations are then used to convert raw peak areas in sample chromatograms to final concentrations.

Results for target analytes are recovery corrected by the method of quantification (i.e., either isotope dilution or extracted internal standard quantification, see Section 9.2.1). Recoveries of isotopically labeled extracted internal standards (EIS) are determined by comparison to the responses of one of seven non-extracted internal standards (NIS) and are used as general indicators of overall analytical quality.

The quality of the analysis is assured through reproducible calibration and testing of the extraction, cleanup, and LC-MS/MS systems.

- Aqueous samples are spiked with isotopically labeled standards (EIS), extracted using solid-phase extraction (SPE) cartridges and undergo cleanup using carbon before analysis.

- Solid samples are spiked with EIS, extracted into basic methanol, and cleaned up by carbon and SPE cartridges before analysis.

- Tissue samples are spiked with EIS, extracted in methanol with potassium hydroxide followed by acetonitrile, and cleaned up by carbon and SPE cartridges before analysis.

3.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and elevated baselines causing misinterpretation of chromatograms. Specific selection of reagents and solvents is required.

Clean all equipment prior to, and after, each use to avoid PFAS cross-contamination. Typical cleaning solvents include water, methanol, and methanolic ammonium hydroxide. The residual PFAS content of disposable plasticware and filters must be verified by batch/lot number and may be used without cleaning if PFAS levels are less than the Method Detection Limit (MDL).

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Prior to use, glassware must be solvent rinsed and then air dried. A solvent rinse procedure using methanolic ammonium hydroxide (1%) and methanol is recommended.

Sample manifold ports and transfer tubing should be inspected regularly for signs of wear and/or discoloration. When such observations are made, the associated components should be replaced.

All parts of the SPE manifold must be cleaned between samples by rinsing with methanolic ammonium hydroxide (1%) and air drying prior to use. Smaller parts, like the needles, adapters, reservoirs, transfer lines, and stopcocks associated with the manifold should be rinsed with tap water prior to rinsing with methanolic ammonium hydroxide (1%) and air drying. After loading the samples but prior to elution procedures, the chamber should be rinsed with methanolic ammonium hydroxide (1%).

All materials used in the analysis must be demonstrated to be free from interferences by running method blanks (Section 11.1.1) at the beginning and with each extraction batch (samples started through the extraction process on a given batch to a maximum of 20 field samples).

Reagent water (Section 8.1) can be used to simulate water samples and Ottawa sand and/or reagent-grade sand (Section 7.3) can be used to simulate soils. Fish fillets (tilapia/ cod), chicken breast or other similar animal tissue (see Section 7.3) may be used as the reference matrix for tissue. The laboratory must verify that the source product used does not contain PFAS in detectable amounts.

Interferences co-extracted from samples will vary considerably from source to source, depending on the diversity of the site being sampled. Interfering compounds may be present at concentrations several orders of magnitude higher than the native PFAS. Because low levels of PFAS are measured by this method, elimination of interferences is essential. The cleanup steps given in Section 9.3 can be used to reduce or eliminate these interferences and thereby permit reliable determination of the PFAS at the levels shown in Tables 1, 2 and 3. The most frequently encountered interferences are fluoropolymers; however, bile salts (e.g., Taurodeoxycholic Acid [TDCA]) may be present in various matrices, including fish and wastewaters, and can interfere in the chromatography. For this reason, analysis of a standard containing TDCA is required as part of establishing the initial chromatographic conditions (see Sections 8.3.2 and 8.3.3) and each analytical sequence (see Section 9.4).

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **Extracted Internal Standard (EIS) quantification:** The response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities.
- **Isotope dilution (ID) quantitation:** A means of determining a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. The labeled PFAS are spiked into each sample and allow identification and correction of the concentration of the native compounds in the analytical process.
- **Isotopically labeled compound:** An analog of a target analyte in the method which has been synthesized with one or more atoms in the structure replaced by a stable (non-radioactive) isotope of that atom. Common stable isotopes used are 13C (Carbon-13) or Deuterium (D or 2H). These labeled compounds do not occur in nature, so they can be used for isotope dilution quantitation or other method-specific purposes.

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- **Minimum Level of quantitation (ML):** The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The ML represents the lowest concentration at which an analyte can be measured with a known level of confidence. It may be equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH & SAFETY

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate to meet regulatory requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and holding time. Refer to Bottle Order Preparation (ENV-SOP-WEST-0005), or however named, for procedures related to preparation of bottle kits.

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Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
Aqueous (non-potable water)	2 x 500 mL linerless HDPE 1 x 125 mL linerless HDPE[3]	500 mL	Thermal: 0-6°C (or ≤ -20°C)	Collection to Preparation: 28 Days (or 90 Days) Preparation to Analysis: 28 Days
Aqueous (leachate)	2 x 125 mL linerless HDPE	100 mL	Thermal: 0-6°C (or ≤ -20°C)	Collection to Preparation: 28 Days (or 90 Days) Preparation to Analysis: 28 Days
Solid (sediment and soil)	3 oz/ 90 mL linerless polypropylene wide mouth	5 g	Thermal: 0-6°C or ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days
Solid (biosolid)	3 oz/ 90 mL linerless polypropylene wide mouth	0.5 g	Thermal: 0-6°C or ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days
Tissue[4]	3 oz/ 90 mL linerless polypropylene wide mouth	2 g	Thermal: ≤ -20°C	Collection to Preparation: 90 Days Preparation to Analysis: 28 Days

[1] *Default container type provided in sample kit. To allow room for expansion during freezing (if necessary), aqueous sample containers should not be overfilled. Aqueous sample containers should be filled only to the appropriate gradation marked on the container, or to the shoulder of the container if no gradations are provided.*

[2] *Nominal amount of sample required for each discrete test. Solid and biosolid sample amounts reflect dry weight.*

[3] *Used for pre-screening analyses.*

[4] *Container listed here will be used for tissue homogenate; samples may be received at the laboratory as whole fish or filets wrapped in aluminum foil or food grade polyethylene wrap. Ideally fish should be frozen upon collection and shipped to the laboratory as soon as possible.*

Note: Project-specific requirements dictate which storage condition applies. The storage condition to be used for each project must be formally documented in written form (QAPP or otherwise) before samples are received. Without any prior indication from the client, the lab will store all aqueous and solid/biosolid samples at 0-6°C until extraction, with a 28-day holding time (collection to prep) for aqueous matrices and a 90-day holding time (collection to prep) for solid/biosolid matrices.

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Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP (ENV-SOP-WEST-0003, Sample Receipt and Login), or however named.

After receipt, samples are stored as listed above until sample preparation. Prepared sample extracts of all matrices are stored at 0-6°C until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method.

Due to the possibility of adsorption of analytes onto glass, plastic containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

7.1 Instrumentation

- High-performance liquid chromatograph (HPLC) equipped with tandem quadrupole mass spectrometer – Sciex 5500+ or equivalent
- Agilent Zorbax RRHD Eclipse Plus C18, 2.1 x 50 mm (1.8 µm) analytical column (Agilent Part # 959757-902), or equivalent
- Guard cartridge/column – Agilent Zorbax Eclipse Plus C18, 2.1 x 5 mm, 1.8 um (Agilent Part# 821725-901), or equivalent
- Trap/delay column – InfinityLab PFC Delay Column, 4.6 x 30 mm (Agilent Part# 5062-8100), or equivalent

7.2 Support Equipment

- Oven – Capable of maintaining a temperature of 105 ± 5 ºC
- Analytical balance – Capable of weighing 0.0001 g
- Top loading balance – Capable of weighing 0.01 g
- Calibrated mechanical variable volume pipettes with disposable HDPE or polypropylene tips (10 µL to 5 mL) – used for preparation of calibration standards and spiked samples
- Point of Use water preparation system – Thermo Scientific Barnstead E-Pure; model 7119 – Used for QC samples to verify the systems are PFAS free
- Ultrasonic mixer – Fisherbrand; Model CPX3800 – 5.7L, 40 kHZ, 120V, 2.9 Amp with timer
- Analog or digital vortex mixer, single or multi-tube (Fisher Scientific 02-215-452, or equivalent)
- Variable speed mixing table (VWR Model 3500 Orbital Shaker, or equivalent)

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- Centrifuge (Beckman Allegra 6, Hettich Rotanta 460, or equivalent), capable of reaching at least 3000 rpm (~2000 RCF)
- Vacuum Pump – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges. GAST model # DOA-P704-AA, Waters Cat# 725000417, 115V, 60Hz, 4.2A
- Vacuum manifold for SPE Cartridges – Waters Cat# WAT200609: SPE Vacuum manifold, or equivalentCat
- Vacuum tubing – 1/4” ID, 5/8” OD, 3/16” wall; Fisher Scientific part# 14-176-6B or equivalent
- PE Transfer tubing – 1/8” X .062 x 500ft, Freelin Wade part# 1C-109-10 or equivalent.

7.3 Supplies

- Solid Phase Extraction (SPE) cartridges – Phenomenex part# CS0-9216, 250 mg WAX/20mL, or equivalent
- Carbon Cleanup cartridges – Phenomenex part# 8B-S528-CAJ, 50 mg GCB, or equivalent
- SPE reservoirs – 60 mL, Phenomenex part# AH0-7189, or equivalent
- SPE adapter caps – Supelco part# 57267 (Adapter cap for 12, 20 & 60 mL SPE tubes)
- Disposable liners for Vacuum Manifold – Waters part# 20685 or equivalent
- Silanized glass wool (Pyrex 3950 or equivalent)
- Reference matrix: Aqueous – reagent water
- Reference matrix: Solid – Ottawa sand
- Reference matrix: Tissue – fish fillets, chicken breast or similar animal tissue. First preference will be frozen cod fillets.
- Bottles – HDPE or PP, with linerless HDPE or polypropylene caps. Various sizes. QEC item # 6212-Q016/BC-150-PACE (500 mL), 6212-Q008BC-P (250 mL), 6213-U004BC-P (125 mL), 6214-003PPGBC-P (90 mL)
- Screw top vials, Polypropylene 0.7-mL with polypropylene caps – used in sample analysis and pre-screening (Waters Cat # 186005219 and 186004169 or equivalent)
- 15- and 50-mL conical polypropylene tubes with polypropylene screw caps for preparing and storing extract solutions and for collection of eluents (Fisher Scientific 05-527-90 and 14-432-22, or equivalent)
- 500-mL conical polypropylene centrifuge bottles for sample centrifugation (Fisher Scientific 07-200-621 or equivalent)
- Extract/Standard storage containers – 15-mL, 8-mL, or 4-mL narrow-mouth HDPE container - Thermo Scientific item# 2002-9050, 2002-9025, 2002-9125; 2.0-mL screw-top polypropylene cryogenic vials – Grainger item# 6EMV1/ Wheaton item# W985872;1.5-mL snap-cap polypropylene microcentrifuge tubes - Fisher item# 05-408-129; or equivalent
- pH Paper, range 0-14 - (VWR Cat# BD3539.606 or equivalent), 0.5-unit readability

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- Disposable glass and plastic pipets

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP (ENV-SOP-MANS-0112, Reagent, Solvent, and Standard Control), or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared, when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method.

- Acetic acid – ACS grade or equivalent, store at room temperature; VWR cat# BDH3098-3.8LP or equivalent
- Acetonitrile – UV grade or equivalent, verified before use, store at room temperature; Honeywell Cat# 018-4 or equivalent (for extraction)
- Ammonium acetate – ACS or equivalent, store at 2-8° C, replace 2 years after opening date; VWR BDH9204-500G or equivalent.
- 1M aqueous ammonium acetate (Waters Cat# 186006693-1) used for mobile phase additive; store as indicated by manufacturer.
- Ammonium hydroxide – certified ACS+ grade or equivalent, 30% in water, store at room temperature; Fisher A470-500 or equivalent
- Formic acid – greater than 96% purity or equivalent, store at room temperature; Acros 147930010 or equivalent
- Methanol – HPLC grade or better, 99.9% purity, store at room temperature; Honeywell CAT# 230-4 or equivalent
- Mobile Phase A – 2 mM ammonium acetate in 95:5 water/acetonitrile. Aliquot 0.4 mL of aqueous 5M ammonium acetate in 949.6 mL of water and 50 mL of acetonitrile. Alternatively, dissolve 0.154 g of neat ammonium acetate into 950 mL of water and 50 mL of acetonitrile. Store at room temperature; shelf life is 2 months.
- Mobile Phase B – Acetonitrile, Ultra HPLC grade or equivalent; OmniSolv AX0142-1 or equivalent
- Potassium hydroxide – certified ACS or equivalent, store at room temperature, replace after 2 years; Fisher P250-500 or equivalent.
- Reagent water – Laboratory reagent water, test by lot/batch number for residual PFAS content.

8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available. Follow manufacturer's recommended storage conditions and expiration dates.

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8.2.1 Primary PFAS Standard

- EPA Method 1633 Native PFAS Standard mix from Wellington Laboratories (item# EPA-1633STK) – used to prepare the calibration standards and to spike the reference QC samples prepared/analyzed with every batch of samples. Also used to prepare an intermediate standard for calibration standard preparation and low-level QC sample spiking, as described below.

8.2.2 Secondary PFAS Standard

- Method 1633-PFCs-Calibration Standard mix from Absolute Standards (item# 65735) – used to prepare the ICV standard as described below.

8.2.3 Extracted Internal Standard (EIS)

- Mass-labelled PFAS Extraction Standard mix from Wellington Laboratories (item# MPFAC-HIF-ES) – used to prepare analytical standards and spike each sample prior to extraction.

8.2.4 Non-extracted Internal Standard (NIS)

- Mass-labelled PFAS Injection Standard mix from Wellington Laboratories (item# MPFAC-HIF-IS) – used to prepare analytical standards and spike sample extracts prior to instrumental analysis.

8.2.5 Bile Salt (TDCA) Standard

- Neat Taurodeoxycholic acid from Cayman Chemical (item# 15935), or equivalent – used to prepare analytical standards for bile salt interference check.

8.3 Formulations

Prepare standard solutions from materials of known purity and composition or purchase as solutions or mixtures with certification to their purity, concentration, and authenticity. Observe the safety precautions in Section 5.

Purchase of commercial standard solutions or mixtures is highly recommended for this method; however, when these are not available, preparation of stock solutions from neat materials may be necessary. If the chemical purity is 98% or greater, the weight may be used without correction to calculate the concentration of the standard.

When not being used, store standard solutions in the dark at 4 °C, unless the vendor recommends otherwise, in tightly sealed screw-capped vials. Place a mark on the vial at the level of the solution so that solvent loss by evaporation can be detected. Replace the solution if solvent loss has occurred.

Note: 18O-mass labeled perfluoroalkyl sulfonates may undergo isotopic exchange with water under certain conditions, which lowers the isotopic purity of the standards over time.

The laboratory must maintain records of the certificates for all standards for traceability purposes. Copies of the certificates should be provided as part of the data packages in order to check that proper calculations were performed.

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8.3.1 Analytical and Preparation Reagents

Analytical and Preparation reagents are stored in plastic or glass containers under ambient conditions. Expiries are listed with each reagent.

- Instrument Blank Mix (IBLK Mix) – Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid – add ammonium hydroxide (3.3 mL, 30%), reagent water (1.67 mL) and acetic acid (0.625 mL) to methanol (94.4 mL); store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank (Sections 8.3.3.3 and 9.2.5) and sample extract dilutions.
- Mobile Phase A – 2 mM ammonium acetate in 95:5 water: acetonitrile. Aliquot 2.0 mL of aqueous 1M ammonium acetate in 948 mL of water and 50 mL of acetonitrile. Store at room temperature; replace after 2 months or less.
- Mobile Phase B – Acetonitrile, HPLC grade or equivalent; Omnisolv AX0142-1 or equivalent
- Acetic acid (0.1%) - dissolve acetic acid (1 mL) in reagent water (1 L); store at room temperature, replace after 3 months.
- Aqueous ammonium hydroxide (3%) – add ammonium hydroxide (10 mL, 30%) to reagent water (90 mL), store at room temperature, replace after 3 months.
- Methanolic ammonium hydroxide (0.3%) – add ammonium hydroxide (1 mL, 30%) to methanol (99 mL), store at room temperature, replace after 1 month.
- Methanolic ammonium hydroxide (1%) – add ammonium hydroxide (3.3 mL, 30%) to methanol (97 mL), store at room temperature, replace after 1 month.
- Methanolic ammonium hydroxide (2%) – add ammonium hydroxide (6.6 mL, 30%) to methanol (93.4 mL), store at room temperature, replace after 1 month.
- Formic acid (aqueous, 0.1 M) – dissolve formic acid (4.6 g / 3.77 mL) in reagent water (1 L), store at room temperature, replace after 2 years.
- Formic acid (aqueous, 0.3 M) – dissolve formic acid (13.8 g / 11.31 mL) in reagent water (1 L), store at room temperature, replace after 2 years.
- Formic acid (aqueous, 5% v/v) – mix 5 mL formic acid with 95 mL reagent water, store at room temperature, replace after 2 years.
- Formic acid (aqueous, 50% v/v) – mix 50 mL formic acid with 50 mL reagent water, store at room temperature, replace after 2 years.
- Formic acid (methanolic 1:1, 0.1 M formic acid/methanol) – mix equal volumes of methanol and 0.1 M formic acid, store at room temperature, replace after 2 years.
- Methanolic potassium hydroxide (0.05 M KOH) – add 3.3 g of potassium hydroxide to 1 L of methanol, store at room temperature, replace after 3 months.

8.3.2 Intermediate Standards

Intermediate standards are stored in plastic containers as listed below. Expiries are listed with each formulation.

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- TDCA Stock Solution: Dissolve 10 mg of neat TDCA into 5 mL of MeOH; final concentration equals 2000 µg/mL. Store frozen (<0°C) when not in use; replace after 1 year, or sooner if degradation is observed.
- STK-10X Solution: Dilute 200 µL of EPA-1633STK with 1.8 mL of MeOH for a final volume of 2 mL; final concentrations vary by analyte – 25, 50, 100, 125, 250, or 625 ng/mL. Store at 0-6°C when not in use; replace every time a new lot of 1633STK is used, or after 1 month.

8.3.3 Working Solutions

Working solutions are stored in plastic containers under refrigerated conditions at 0-6°C and expire 1 month from the date of preparation.

8.3.3.1 Calibration Standards

A series of calibration solutions containing the target analytes and the EIS and NIS is used to establish the initial calibration of the analytical instrument. The concentration of the method analytes in the solutions varies to encompass the working range of the instrument, while the concentrations of the EIS and NIS (and TDCA) remain constant. The calibration solutions are prepared using the standards and intermediate standards described above. The final solvent composition will match the solvent mix of sample extracts, which contain methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid. Calibration standard solutions do not undergo solid phase extraction/cleanup. Prepare the calibration standard solutions according to the table below. Following all formulations listed in this SOP will require 3 ampoules of the 1633STK mix to prepare a full calibration set; other final volumes may be prepared. If the lab follows all formulations in this SOP as written, the remaining volumes of 1633STK and STK-10X solutions after preparing the calibration should be enough to spike approximately 40 sets of aqueous batch QC. The remainder of MPFAC-HIF-ES and MPFAC-HIF-IS mixes should provide enough volume to spike approximately 40-45 samples.

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Component[1]	L1	L2 (LOQ)	L3	L4	L5 (CCV)	L6	L7	L8	L9
STK-10X	20	16	40						
EPA-1633STK				20	100	100	200	400	500
MPFAC-HIF-ES	25	10	10	10	25	10	10	10	10
MPFAC-HIF-IS	25	10	10	10	25	10	10	10	10
TDCA Stock	25				25				10
IBLK Mix	4905	1964	1940	1960	4825	1880	1780	1580	1470
Final Volume	5000	2000	2000	2000	5000	2000	2000	2000	2000

[1]*All values listed are µL*

8.3.3.2 Initial Calibration Verification Standard (ICV)

Prepare the ICV standard using the Absolute Standards 1633 PFC Mix, following the table below; expected concentration for all compounds in the ICV will be 10 ng/mL. The ICV is prepared from a separate, second source (or separate manufacturer lot) than that used for the calibration solutions. If a second source or lot is unavailable, a separate preparation using the same stocks is acceptable.

Component	Volume used (µL)
1633 PFC Mix	20
MPFAC-HIF-ES	20
MPFAC-HIF-IS	20
IBLK Mix	3940
ICV Final Volume	4000

8.3.3.3 Instrument Blank

A solvent blank is analyzed at the beginning of each analytical sequence, to demonstrate clean instrumental background, and after samples containing high levels of target compounds (e.g., calibration, CCV) to monitor carryover from the previous injection. The instrument blank consists of clean reagent fortified with the EIS and NIS for quantitation purposes. Prepare the IBLK using the IBLK mix (Section 8.3.1) and an appropriate volume of EIS and NIS; alternatively, prep the IBLK from 1887 µL of 1% Methanolic ammonium hydroxide, 80 µL of reagent water, 12.5 µL of acetic acid, and 10 µL each of EIS and NIS.

9.0 PROCEDURE

9.1 Equipment Preparation

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9.1.1 Instrument Setup

9.1.1.1 Routine Instrument Operating Conditions

Example LC Gradient

Step	Total Time (min)	Flow Rate (µL/min)	A: 5% Acetonitrile w/ 10mM Ammonium Acetate (%)	B: Acetonitrile (%)
1	0.00	400	80	20
2	6.00	400	0	100
3	6.50	400	0	100
4	6.51	400	80	20
5	8.50	400	80	20

Example MS Parameters

MS Parameter	Setting or Value
Sample Loop	100 µL
Injection Volume	2 µL
Column Oven Temperature	40° C
MRM Scan Window	60 sec
Curtain Gas (CUR)	30.0
Collision Gas (CAD)	9
Ion Spray Voltage (IS)	-4500 V
Source Temperature (TEM)	450° C
Ion Source Gas 1 (GS1)	30.0
Ion Source Gas 2 (GS2)	50.0

9.1.1.2 Mass Calibration

The mass spectrometer must undergo mass calibration to ensure accurate assignments by the instrument. This mass calibration must be performed at least annually to maintain instrument sensitivity and stability. Mass calibration must be repeated on an as-needed basis (e.g., QC failures, ion masses fall outside of the instrument required mass window, major instrument maintenance, or if the instrument is moved). Mass calibration must be performed using the calibration compounds and procedures prescribed by the manufacturer. The procedures used for mass calibration and mass calibration verification must evaluate an ion range that encompasses the ion range (Q1 and Q2 m/z) of the analytes of interest of this method.

9.1.1.3 Mass Calibration Verification

A mass calibration verification must be performed following mass calibration, prior to standard and sample analyses. Mass verification checks must also be performed after any subsequent mass calibrations. The laboratory must follow the instructions for the individual instrument software to confirm the mass calibration, mass resolution and peak relative response. If the manufacturer's

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instructions include options for evaluation of mass resolution, the tightest resolution requirements (typically called unit resolution) must be met.

9.1.1.4 Retention Time (RT) calibration

Once RT windows have been confirmed for each target analyte, EIS, and NIS compound, then once per ICAL and at the beginning of the analytical sequence, the position of all target analyte, EIS, and NIS peaks shall be set using the midpoint standard of the ICAL curve when ICAL is performed. When an ICAL is not performed, the initial CCV retention times or the midpoint standard of the ICAL curve can be used to establish the RT window position.

The RTs for the target analytes, EIS, and NIS compounds must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. All branched isomer peaks identified in either the calibration standard or the qualitative (technical grade) standard also must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV. For all target analytes with exact corresponding isotopically labeled analogs, target analytes must elute within 0.1 minutes of the associated EIS compound.

When establishing the chromatographic conditions, it is important to consider the potential interference of bile salts (i.e. TDCA) during analyses of samples. Analytical conditions must be set to allow a separation of at least 1 minute between TDCA and the retention time window of PFOS. The method requires this evaluation when establishing the chromatographic conditions, regardless of the sample matrices to be analyzed.

9.1.2 Support Equipment

Refer to laboratory SOP (ENV-SOP-WEST-0036 Balance Calibration Verification, ENV-SOP-WEST-0123 Pipette and Bottle Top Verification), or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

Prior to the analysis of samples, and after a successful mass calibration check, each LC-MS/MS system must be calibrated at a minimum of 6 standard concentrations (Section 8.3.3.1 and Appendix A, Table 5). This method procedure calibrates and quantifies 40 PFAS target analytes, using the isotopically labeled compounds added to the sample prior to extraction, by one of two approaches (see Appendix A, Table 4 for quantitation associations):

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- Isotope Dilution quantification (ID), whereby the response of the target compound is compared to the response of its isotopically labeled analog; twenty-four target compounds are quantified in this way.
- Extracted Internal Standard quantification (EIS), whereby the response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities; sixteen target compounds are quantified in this way.

Each LC-MS/MS system must be calibrated whenever the laboratory takes corrective action that might change or affect the initial calibration criteria, or if either the CCV or ISC acceptance criteria have not been met.

Each time a modification is made to this method, the laboratory is required to repeat the procedure in Sections 11.3.1 and 11.3.2. If calibration will be affected by the change, the instrument must be recalibrated.

9.2.2 Calibration Levels

Calibration standards are stored in plastic containers under refrigerated conditions (0-6°C).

Concentrations for calibration solutions are presented in Appendix A, Table 5. A minimum of six contiguous calibration standards are required for a valid analysis when using a linear calibration model, with at least five of the six calibration standards being within the quantitation range (e.g., from the LOQ to the highest calibration standard). If a second-order calibration model is used, then a minimum of seven calibration standards are required, with at least six of the seven calibration standards within the quantitation range. The lowest level calibration standard must be at a concentration less than or equal to the Limit of Quantitation (LOQ) and must meet a signal-to-noise ratio of 3:1 for the quantitation and confirmation ions that exist and must meet ion ratio requirements described in Section 10.1.1.3. If the analyte has no confirmation ion, then a 10:1 signal to noise ratio is required. All initial calibration requirements listed in Section 9.2.4 and 9.2.5 must be met.

Note: Additional calibration standards, at levels lower than the lowest calibration standard listed in the method, may be added to accommodate a lower limit of quantitation if the instrument sensitivity allows. Calibration standards at the high end of the calibration may be eliminated if the linearity of the instrument is exceeded or at the low end if those calibration standards do not meet the S/N ratio criterion of 3:1 (for quantitation and confirmation ions that exist; 10:1 for analytes with no confirmation ion), so long as the required number of calibration points is met. All analytes with commercially available stable isotope analogues must be quantified using isotope dilution.

9.2.3 Calibration Sequence

Calibration standards must be analyzed in sequence from lowest to highest concentration to minimize the chance that carryover from a higher concentration standard will boost the area of a lower concentration standard. A typical sequence for days when calibration is required is shown below.

Description	Comment
ICAL L1	

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Description	Comment
ICAL L2	Also used as ISC (Section 9.2.4.4)
ICAL L3	
ICAL L4	
ICAL L5	Also used as bracketing/closing CCV (Section 9.2.4.5)
ICAL L6	
ICAL L7	
ICAL L8	
ICAL L9	
IBLK	Any detections must be <MDL
ICV	%R must be 70 – 130%
CCV (ISC)	%R must be 70-130%; begins and ends Analytical Sequence

9.2.4 Calibration Evaluation

If the criteria for initial calibration are not met, inspect the system for problems and take corrective actions to achieve the criteria. This may require the preparation and analysis of fresh calibration standards. All initial calibration criteria must be met before any samples or required blanks are analyzed.

9.2.4.1 Curve Fit

One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or 1/x2) is allowed for linear and non-linear regressions.

- Option 1: Calculate the relative standard deviation (RSD) of the Relative Response (RR) or Response Factor (RF) values of the initial calibration standards for each native compound and isotopically labeled compound. See Section 10.2.1 for calculation of RR and RF. The RSD must be ≤ 20% to establish instrument linearity.
- Option 2: Calculate the relative standard error (RSE) for each native compound and EIS compound for all the initial calibration standards that were analyzed. The RSE for all method analytes must be ≤ 20% to establish instrument linearity.

If these criteria cannot be met, corrective action should be taken to restrict the range of calibration, reanalyze and/or reprepare the ICAL standards, or perform instrument maintenance and/or re-optimization.

If more than the minimum number of standards are analyzed and levels are excluded from the calibration, only the lowest or highest standards may be excluded, except as noted here. The removal of calibration levels from the interior of the curve is allowed only when there is sound technical reason for doing so and when the level is removed for all analytes; for example, when it can be proven that the wrong standard was analyzed for the calibration level or there is obvious evidence that the instrument malfunctioned during injection of the standard. The removal of any calibration level from the interior of the curve must be approved by the department supervisor/manager. Management approval and

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the rationale for the level removal must be documented and kept with the technical record.

9.2.4.2 Relative Error (% RE)

Although not required by the method, it may be useful to compare the actual responses for each standard to the calibration model; percent error of >30% between the calculated and expected concentrations of an analyte in any standard may be cause for concern.

9.2.4.3 Initial Calibration Verification (ICV)

As part of the IDOC and once after each ICAL, analyze an ICV sample prepared from a second source (different from the source of the ICAL standards). If a second vendor is not available, then a different lot of the standard from the same vendor should be used. The ICV should be prepared and analyzed just like a CCV. Acceptance criteria for the ICV are identical to the CCVs: the calculated concentration for each analyte must be within ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, correct the problem and rerun the ICV. If the problem persists, repeat the ICAL. Samples are not to be analyzed until the ICAL has been verified by acceptable ICV accuracy.

9.2.4.4 Instrument Sensitivity Check (ISC)

The lowest calibration standard within the quantitation range must be analyzed at the beginning of the analytical sequence. The signal-to-noise ratio of the ISC must be ≥ 3:1 for the quantification ions and the confirmation ions, or ≥ 10:1 if the analyte only has a quantification ion. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem should be corrected before analyses can proceed.

The lowest calibration standard within the quantitation range must be analyzed at the beginning of the analytical sequence. The signal-to-noise ratio of the ISC must be ≥ 3:1 for the quantification ions and the confirmation ions, or ≥ 10:1 if the analyte only has a quantification ion. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem should be corrected before analyses can proceed.

9.2.4.5 Continuing Calibration Verification (CCV)

After a passing MS resolution and a successful initial calibration is achieved and prior to the analysis of any samples, the calibration is verified by injecting an aliquot of the appropriate concentration ICAL standard, analyzed with the same conditions used during the ICAL. CCV is performed at the beginning of each analytical sequence, after every ten samples, and at the end of the analytical sequence. In this context, a “sample” is defined as a field sample: MBs, CCVs, LCSs, MSs, FDs, TBs and MSDs are not counted as samples. All CCV analyses are performed using a mid-level ICAL standard, except for the daily Instrument Sensitivity Check, as noted above.

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Calculate concentration for each native and EIS compound in the CCV; the recovery of native and EIS compounds for the CCVs must be within 70 – 130%. If the CCV criteria are not met, take corrective action (possibly including recalibration) and reanalyze any extracts that were analyzed between the last passing CCV and the one that failed. Alternately, the analyst may immediately analyze two CCVs for confirmation. If both confirmation CCV analyses meet the recovery criteria, analysis may proceed; however, the analyst must rerun any samples that were analyzed after the failing CCV and before the 2 passing CCVs. If either of the 2 confirmation CCV analyses fails to meet the acceptance criteria take corrective action and recalibrate the LC-MS/MS.

If an individual target compound recovery in a CCV is above the upper control limit and all associated samples are ND for that compound, the data for those samples may be reported. In such cases, a narrative statement must be included in the report indicating the specific compound result that was biased high in the CCV, and that samples were ND for that compound and thus reportable.

9.2.5 Initial Calibration Blank (ICB) / Continuing Calibration Blank (CCB)

One instrument blank (IBLK) is analyzed immediately following the highest ICAL standard analyzed (ICB), each analysis day prior to sample analysis, and following each bracketing CCV in a sequence (CCB), to check for carryover and instrument contamination. The concentration of each analyte must be ≤ the MDL-equivalent concentration in each IBLK/ICB/CCB. If the IBLK does not pass this requirement after the highest ICAL standard, the acquisition method should be adjusted to reduce the amount of carryover observed. Alternately, the calibration should be performed using a lower concentration for the highest standard until the acceptance criteria is met.

If unacceptable contamination is persistent in blanks, analyze additional instrument blanks until the response of the analyte is no longer detectable, or perform additional troubleshooting steps to identify and minimize other potential sources of PFAS contamination.

9.3 Sample Preparation

This section describes the sample preparation procedures for aqueous samples (Section 9.3.3), solid samples (soil, sediment or biosolid; Section 9.3.6), and tissue samples (Section 9.3.9). For solid samples, percent solids are determined using the procedures in Section 9.3.2. This section also describes the solid phase extraction (SPE) and extract cleanup protocols for all matrices.

Note: The laboratory may choose to pre-screen some samples prior to performing the analysis, following the protocol described in Appendix D. For aqueous samples, use the smaller secondary container to perform the pre-screening. If high levels of PFAS are present in the sample, a lower volume is required for analysis.

Do not use any fluoropolymer articles or task wipes in these extraction procedures. Use only HDPE or polypropylene wash bottles and centrifuge tubes. Reagents and solvents for cleaning may be kept in glass containers.

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9.3.1 Homogenization & Subsampling

Refer to laboratory SWI ENV-SWI-WEST-0128, Subsampling of Soil / Solid Samples, or however named, for information regarding the handling, homogenization, and splitting of samples to ensure that a representative aliquot is used for preparation.

The laboratory may subsample the aqueous samples as described in Appendix E; however, subsampling must meet project-specific requirements. The laboratory must notify the client that subsampling has occurred. Subsampling is acceptable for samples which require greater than a 10X dilution for over-range detections (or are known/expected to be highly contaminated), and for samples which fail the acceptance criteria for EIS compounds (see Appendix B, Tables 10-12). Other sample matrix characteristics which may require subsampling are described in Appendix G. When subsampling is required to manage high concentrations, no less than 250 µL of aqueous or leachate samples may be subsampled - if greater dilution is required, serial dilution must be employed. When subsampling is required to manage challenging matrices, no less than 1 mL of samples may be subsampled. For solid and tissue samples, no less than 10% of the target sample mass should be used for reduced-mass extractions, to help ensure the extracted mass is representative of the bulk sample. This means no less than 0.5 g for solids and no less than 0.2 g for tissues may be used for sample preparation.

Tissue sample homogenization will be performed in the Pace Green Bay facility, following SOP ENV-SOP-GBAY-0129 v05 *Sample Homogenization Compositing and Sub-Sampling*.

9.3.2 Determination of Percent Solids

Aqueous samples received with visually observable solids will be handled following the decision tree presented in Appendix G. No TSS pre-test will be performed on aqueous samples prior to preparation.

Percent solids analysis must be performed on all solid samples (excluding tissues) prior to preparation and analysis. All solid samples will be logged in for both 1633 and percent solids analysis. The percent solids analysis will follow the Method SM2540G protocol.

9.3.3 Aqueous Sample Processing

Per the parent method, this protocol is applicable to aqueous samples containing up to 100 mg/L solids per sample, and the procedure requires the preparation of the entire sample where possible. Smaller sample volumes may be analyzed for samples containing solids greater than specified for this method, or when unavoidable due to high levels of PFAS. The typical sample size is 500 mL; however, sample size may vary, depending on project requirements, applicable regulations, and sample characteristics. The sample is to be analyzed in its entirety and should not be filtered.

Leachate samples are analyzed using a 100 mL sample volume. Therefore, they must not be included in the same sample preparation batch as aqueous samples analyzed using 500 mL sample volumes. Otherwise, leachate samples are handled identically to all other aqueous samples.

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1) Visually inspect each sample and note any matrix characteristics which may pose challenges during SPE and require additional processing; see Appendix G for more information.

2) Weigh each sample bottle (with the lid) to the nearest 0.1 g. The volume of the aqueous sample analyzed is determined by weighing the full sample bottle and then the empty sample bottle after extraction is complete.

3) Prepare a method blank and two LCSs using PFAS-free water in HDPE bottles. Select a volume of water that is typical of the samples in the batch (i.e., 500 mL; 100 mL for leachate samples). Spike one LCS sample with native standard solution at 2x the LOQ (64 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA-1633STK). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

4) Spike 20 µL of EIS solution (Section 8.2.3) directly into the sample in the original bottle (or subsampled bottle) as well as to the bottles prepared for the QC samples. Mix by capping and inverting the sample containers.

5) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The sample is now ready for solid phase extraction (SPE) and cleanup.

9.3.4 Solid Phase Extraction of Aqueous Samples

Note: Carbon cleanup is required. Carbon cleanup may remove analytes if the sample has a very low organic carbon content (this is unusual for non-drinking water environmental samples). This will be apparent if the isotope dilution standard recoveries are significantly higher on the reanalysis.

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through

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the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.5).

Note: In the event the SPE cartridge begins to clog during aqueous sample loading, abandon the loading step and attempt to rinse and dry the clogged cartridge, following the protocol below. The cartridge is then ready for elution. If the clogging prevents the rinse from passing through the cartridge, it will not be possible to collect an extract for the associated sample. See Appendix G for more information.

5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.5 Elution of Aqueous Sample Extracts

1) Place clean collection tubes inside the manifold, ensuring that the extract delivery tips do not touch the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Add 5 mL of 1% methanolic ammonium hydroxide to each empty sample bottle. Cap the bottle and rotate to ensure all internal surfaces of each bottle are rinsed; avoid vigorous shaking when rinsing the 500 mL aqueous sample bottles with only 5 mL of methanol – any evaporation/vaporization will contribute to loss of extract here. After rinsing the inside of the sample bottle, pour the rinse from the bottle or use a plastic transfer pipette to transfer the rinse to the SPE reservoir, using it to wash the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes before using vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Air dry the empty sample bottle after the rinse is transferred. Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in Section 9.3.3, step 2.

4) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

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9.3.6 Solid Sample (excluding tissues) Processing

Any solid sample received containing <50% solids (>50% moisture; >10 g target mass for 5 g dry weight) should be re-logged and prepared as a biosolid, using a target dry weight of 0.5 g. Any solid or biosolid sample received containing <5% solids (>95% moisture; >10 g target mass for 0.5 g dry weight) should be re-logged and prepared as a leachate sample, using no more than 100 mL of sample for extraction.

1) Mix the sample in its original jar. If it is impractical to mix the sample within its container, transfer the sample to a larger container. Mix the sample thoroughly, stirring from the bottom to the top and in a circular motion along the sides of the jar, breaking particles up by pressing against the side of the container. The homogenized sample should be even in color and have no separate layers. Store the homogenized material in its original container or in multiple smaller containers.

2) Determine the percent solids as per Section 9.3.2.

Note: The target sample weight for sediment or soil is 5 g dry weight. The target sample weight for biosolids is 0.5 g dry weight. Small amounts of reagent-free water used for method blanks (10% of sample weight or less) can be added to unusually dry samples. This is an option, not a requirement.

3) Check the LIMS system for the percent solids data associated with the samples to be prepared. Using the percent solids data and the calculation below, weigh out an aliquot of each solid sample, not dried, into a 50 mL polypropylene centrifuge tube. Sample mass should be within ±0.2 g of target mass for soil and sediment samples, and within ±0.02 g of target mass for biosolids samples. Sample aliquot should provide 5 g dry weight (Wi_{Dry} below) for soil and sediment or 0.5 g dry weight for biosolids. Because biosolid samples are analyzed with a 0.5 g sample mass, they must not be included in the same sample preparation batch as solid samples analyzed with 5 g sample masses. Any solid sample received containing <50% solids (>50% moisture; >10 g target mass for 5 g dry weight) should be re-logged and prepared as a biosolid, using a target dry weight of 0.5 g. Any solid or biosolid sample received containing <5% solids (>95% moisture; >10 g target mass for 0.5 g dry weight) should be re-logged and prepared as a leachate sample, using no more than 100 mL of sample for extraction.

$$Solid\ Sample\ Target\ Mass\ (g) = \frac{Wi_{Dry}\ (g)}{\%\ solids\ (decimal)}$$

4) Prepare batch QC samples using 5 g of reference solid wetted with 2.5 g of reagent water for the method blank and two LCSs (use 0.5 g of reference solid with 0.25 g of reagent water for biosolid extraction batches). The addition of reagent water to the sand provides a matrix closer in composition to real-world samples. Spike one LCS sample with native standard solution at 2x the LOQ (80 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA-1633STK). This aliquot will serve as the traditional LCS.

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Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

5) Spike 20 µL of EIS solution (Section 8.2.3) directly into each centrifuge tube containing the aliquoted field and QC samples. Vortex or shake the sample to disperse the standard and allow to equilibrate for approximately 30 minutes.

6) Add 15 mL of 0.3% methanolic ammonium hydroxide to each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and transfer the supernatant to a clean, labeled 50 mL polypropylene centrifuge tube.

7) Add 15 mL of 0.3% methanolic ammonium hydroxide to the remaining solid sample in each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and decant the supernatant from the second extraction into the centrifuge tube with the supernatant from the first extraction.

8) Dilute to approximately 40 mL with reagent water. A separate centrifuge tube marked at the 40 mL level may be kept for a visual reference to get the approximate volume. Samples containing excess water may yield extracts that are greater than 40 mL in volume; therefore, do not add water to these.

9) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid phase extraction (SPE) and cleanup.

9.3.7 Solid Phase Extraction of Solid Samples

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.8).

5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using

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vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.8 Elution of Solid Sample Extracts

1) Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Rinse the inside of each sample's centrifuge tube using 5 mL of 1% methanolic ammonium hydroxide. Then pour the rinse from each bottle (or use a plastic transfer pipette) to transfer the rinse to the associated SPE reservoir, washing the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

9.3.9 Tissue Sample Processing

Prior to processing tissue samples, the laboratory must determine the exact tissue to be analyzed. Common requests for analysis of fish tissue include whole fish with the skin on, whole fish with the skin removed, edible fish fillets (filleted in the field or by the laboratory), specific organs, and other portions. Once the appropriate tissue has been determined, the samples must be prepared and homogenized.

Pace utilizes the Green Bay location for tissue homogenization, following ENV-SOP-GBAY-0129 (Sample Homogenization, Compositing, and Subsampling; specifically, Section 9.4).

1) For each sample, weigh a 2 g aliquot of homogenized tissue into a 50 mL polypropylene centrifuge tube. Reseal the container with the remaining homogenized portion of the sample and return it to frozen storage in case it needs to be used for reanalysis. The default sample weight for tissue is 2 g wet weight; however, a 1 g sample may be used. Higher sample weights are not recommended for this method.

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2) Prepare the batch QC samples using 2 g of reference tissue matrix for the method blank and two LCSs. Spike one LCS sample with native standard solutions at 2x the LOQ (80 µL of STK-10X mix). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (40 µL of EPA1633-STK). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples in the same manner as the LCS.

3) Spike 20 µL of EIS solution (Section 8.2.3) directly into each field and QC sample. Vortex and allow to equilibrate for approximately 30 minutes.

4) Add 15 mL of 0.05M KOH in methanol to each sample. Vortex to disperse the tissue then place tubes on a variable speed mixing table to shake for 1 hour. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and collect the supernatant in a 125mL sample bottle.

5) Add 10 mL of acetonitrile to remaining tissue in the centrifuge tube, vortex to mix and disperse the tissue. Sonicate for 30 minutes. Centrifuge at 3000 rpm (~2000 RCF) for 10 minutes and collect the supernatant, adding it to the 125mL bottle containing the initial extract.

6) Dilute to approximately 75 mL with reagent water. A separate bottle marked at the 75 mL level may be used to get the approximate volume.

7) Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid phase extraction (SPE) and cleanup.

9.3.10 Solid Phase Extraction of Tissue Samples

1) Pack clean silanized glass wool to half the height of a WAX SPE cartridge barrel; repeat for the total number of samples in the batch.

2) For each sample and QC aliquot, set up the vacuum manifold with one WAX SPE cartridge plus a reservoir adaptor and reservoir for each cartridge; label each reservoir with the associated sample ID. If using plastic transfer lines instead of reservoirs, ensure the connecting caps are snug in each cartridge and the transfer lines are placed within the appropriate sample; label each cartridge tube with the associated sample ID.

3) Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid. Perform each rinse separately. Do not allow the WAX SPE to go dry. Discard the wash solvents.

4) Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading; or, if using transfer lines, begin opening the stopcocks on the vacuum manifold. Adjust the vacuum/stopcocks to pass each sample through the cartridge at approximately 5-10 mL/min; discard the eluate. Retain the empty sample bottle for later rinsing (Section 9.3.8).

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5) Rinse the walls of the reservoir with 5 mL reagent water twice, followed by 5 mL of 1:1 0.1M formic acid/methanol and pass those rinses through the cartridge using vacuum. If using sample transfer lines for loading, add the 3 rinses to the bottle and load through the transfer lines to the cartridge, one reagent at a time. Dry the cartridge by pulling air through for approximately 5 minutes. Discard the rinse solution.

6) After the WAX cartridges are sufficiently dry, rinse the GCB cartridges with 5 mL of 1% methanolic ammonium hydroxide; discard the rinsate. Do not allow the GCB to go completely dry.

7) Connect the outlet of the WAX cartridges to the inlet of the GCB cartridges to stack them on the manifold and allow for cleanup of the extract as part of elution. Ensure that the WAX cartridges are returned to their original locations on the manifold to avoid cross contamination. Continue to the elution steps in the next section.

9.3.11 Elution of Tissue Sample Extracts

1) Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

2) Rinse the inside of each sample's centrifuge tube using 5 mL of 1% methanolic ammonium hydroxide. Then pour the rinse from each bottle (or use a plastic transfer pipette) to transfer the rinse to the associated SPE reservoir, washing the walls of the reservoir. If using sample transfer lines, simply transfer this rinse from each sample container to its associated cartridge using vacuum. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

3) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

9.4 Analysis

9.4.1 Sequence Preparation

Analysis of sample extracts for PFAS by LC-MS/MS is performed running manufacturer's data acquisition software. The mass spectrometer is run with unit mass resolution in the multiple reaction monitoring (MRM) mode.

1) Perform mass calibration and mass calibration verification, establish the operating conditions, and perform an initial calibration prior to analyzing samples. Only after all performance criteria are met may blanks, MDLs, IDOC/LCS, and samples be analyzed.

2) Each day of analysis, the column must be thoroughly flushed with 100% Acetonitrile for at least 30 minutes to clear any accumulated impurities and interferences from the sample pathway and equilibrate the system. It is also good practice to open the purge valve(s) on the pumps for the first ~1 minute of flush time and/or use the "purge"

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function available as part of the pump functionality. Additionally, it is good practice to purge the autosampler injector flow path daily prior to analysis by using the "purge" function, if available. The column should then be equilibrated to the analysis starting conditions by flushing for approximately 15 mins with 50:50 Mobile Phase A: Mobile Phase B and finally approximately 15 mins with 80:20 Mobile Phase A: Mobile Phase B (acquisition starting conditions). Ensure that system pressure is stable.

3) Following any initial priming injections on days when a calibration is not needed, an ISC and an instrument blank will be analyzed to demonstrate system suitability and the absence of system contamination prior to sample analysis.

4) After acceptable ISC and IBLK results are confirmed, load and submit extracted samples for analysis, typically starting with batch QC with field samples following. A CCV and CCB must be analyzed after every 10 (or fewer) field samples.

9.4.2 Routine Analytical Sequence

After a successful initial calibration has been completed, samples may be analyzed; an example analytical sequence is provided below. The volume injected for samples and QCs must be identical to the volume used for calibration. Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial to ensure homogeneity of the extract.

- ISC
- CCV
- Instrument Blank
- Method Blank
- LLLCS
- LCS
- Samples (10 or fewer)
- CCV
- CCB
- Samples (10 or fewer)
- CCV

If the results are acceptable, the closing CCV analysis may be used as the opening solution for the next analytical sequence.

If the response exceeds the calibration range for any sample, extracts are diluted as per Section 9.4.3 to bring all target responses within the calibration range.

Note: If the analytes that exceed the calibration range in the original analysis are known to not be of concern for the specific project (e.g., are not listed in a discharge permit), then the laboratory may consult with the client regarding the possibility of reporting that sample from the undiluted analysis.

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9.4.3 Sample Dilutions

If the measured concentration for any compound exceeds the calibration range of the system, dilute an aliquot of the sample extract with the IBLK mix solution by a factor no greater than 10x, refortify the NIS compounds to initial concentration, and analyze the diluted extract. If the responses for each applicable EIS in the diluted extract meet the S/N and retention time requirements in Section 10.1.1, and the EIS recoveries from the analysis of the diluted extract, corrected for the dilution, are within the limits presented in Table 10, 11 or 12 (according to sample matrix), then the compounds associated with those EISs may be quantified. The EIS recoveries, compound concentrations, detection limits, and LOQs are adjusted to account for the dilution.

If the EIS responses in the diluted extract do not meet the S/N and retention time requirements listed in Section 10.1.1, then the compound cannot be measured reliably in the diluted extract. In such cases, subsample a smaller aliquot of any affected aqueous sample and dilute it to 500 mL with reagent water and re-extract the sample. For solid sample matrices, prepare a smaller aliquot of soil, biosolid, sediment, or tissue and re-extract the sample. The reduced sample volume (or mass) chosen for the re-extraction should reflect the dilution applied to the original extract (i.e., if the original aqueous sample extract was analyzed at a 10X dilution, 50 mL should be subsampled for the re-extraction). See Section 9.3.1 for more guidance. The reported compound concentrations, detection limits, and LOQs are adjusted to account for the reduced sample volume (or mass) that is extracted.

If the recovery of any isotopically labeled compound is outside of the acceptance limits (Appendix B) in the original, undiluted analysis, a diluted aqueous sample or smaller aliquot (for solids and tissue) should be prepared and analyzed.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

10.1.1 Qualitative Identification

A native, EIS, or NIS compound is positively identified in a standard, blank, sample, or QC sample when all criteria in Sections 10.1.1.1 through 10.1.1.3 are met.

10.1.1.1 Signal-to-Noise Ratio (S/N)

Peak responses of the quantitation and confirmation ions must be at least three times the background noise level (S/N 3:1). The quantitation ion must have a S/N ≥ 10:1 if there is no confirmation ion. If the S/N ratio is not met in a standard or QC sample due to high background noise, the laboratory must correct the issue (e.g., perform instrument troubleshooting). If the S/N ratio is not met in a blank or sample, then the analyte is to be considered a non-detect.

10.1.1.2 RT Criteria

Target analyte, EIS analyte, and NIS analyte RTs must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the

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analytical batch. The retention time window used must be of sufficient width to detect earlier-eluting branched isomers. For all method analytes with exact corresponding isotopically labeled analogs, method analytes must elute within 0.1 minutes of the associated EIS.

10.1.1.3 Ion Ratio Criteria

For any reported compound detection, the ratio of the total (branched and linear isomer) quantification ion response to the total (branched and linear isomer) confirmation ion response – referred to as the Ion Ratio – must fall within ± 50% of the ratio observed in the mid-point ICAL standard. The ion ratio requirement does not apply for PFBA, PFPeA, NMeFOSE, NEtFOSE, PFMPA, and PFMBA because suitable secondary transitions are unavailable (not detectable or inadequate S/N).

10.1.2 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration*. Refer to this SOP for guidance on manual integration techniques and required procedures.

10.1.2.1 Branched Isomer Integration

The response of all isomers in the quantitative standards should be used to define integration parameters and ion ratios. In samples, the total integrated response should include the branched isomer peaks that have been identified in the quantitative standard, if present. For compounds with identified branched and linear isomer peaks, the reported concentration is the sum of all isomers. If standards (either quantitative or qualitative) containing a mix of isomers are not available for purchase for a particular compound, only the linear isomer can be identified and quantitated in samples.

10.1.2.2 Qualification

If the field sample result does not meet all criteria stated in Section 10.1.1, and all sample preparation avenues (e.g., extract cleanup, sample dilution, etc.) have been exhausted, the result may only be reported with a data qualifier alerting the data user that the result could not be confirmed because it did not meet the method-required criteria and therefore should be considered an estimated value. If the criteria listed above are not met for the standards, the laboratory must stop analysis of samples and correct the issue.

10.2 Calculations

Refer to laboratory SOP (ENV-SOP-WEST-0124, Common Laboratory Calculations), or however named, for equations used to perform common calculations.

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10.2.1 ICAL Relative Response (RR) and Response Factor (RF)

The response ratio (RR) for each native compound calibrated by isotope dilution is calculated according to the equation below, separately for each of the calibration standards, using the areas of the quantification ions shown in Table 4. RR is used for the 24 compounds measured by true isotope dilution quantification.

$$RR = \frac{Area_t M_{EIS}}{Area_{EIS} M_t}$$

Where:

$Area_t$ = Measured area of the quantitation ion for the target analyte.

$Area_{EIS}$ = Measured area of the quantitation ion for the corresponding labeled PFAS used as the EIS in the calibration standards.

M_{EIS} = Concentration of the isotopically labeled PFAS uses as the EIS in the calibration standards (ng/L)

M_t = Concentration of the target analyte in the calibration standard (ng/L)

Similarly, the response factor (RF) for each native compound calibrated by extracted internal standard is calculated according to the equation below. RF is used for the 16 compounds measured by extracted internal standard quantification.

$$RF = \frac{Area_t M_{EIS}}{Area_{EIS} M_t}$$

Where:

$Area_t$ = Measured area of the quantitation ion for the target analyte.

$Area_{EIS}$ = Measured area of the quantitation ion for the corresponding labeled PFAS used as the EIS in the calibration standards.

M_{EIS} = Concentration of the isotopically labeled PFAS uses as the EIS in the calibration standards (ng/L)

M_t = Concentration of the target analyte in the calibration standard (ng/L)

A response factor (RF_S) is calculated for each EIS compound in the calibration standard using the equation below. RF_S is used for the 24 isotopically labeled compounds measured by non-extracted internal standard quantification.

$$RF_S = \frac{Area_{EIS} M_{NIS}}{Area_{NIS} M_{EIS}}$$

Where:

$Area_{EIS}$ = Measured area of the quantitation ion for the EIS compound added to the sample before extraction.

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$Area_{NIS}$ = Measured area of the quantitation ion for the NIS compound in the calibration standard.

M_{NIS} = Concentration of the NIS compound in the calibration standard (ng/L).

M_{EIS} = Concentration of the EIS compound in the calibration standard (ng/L).

10.2.2 Target Analyte Concentration

Concentrations of the target analytes are determined with respect to the extracted internal standard (EIS) which is added to the sample prior to extraction (see Table 4). Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equation below.

$$\boldsymbol{Concentration\ (ng/Lor ng/g) = \frac{Area_N M_{EIS}}{Area_{EIS}(\overline{RR}\ or\ \overline{RF})}\ x\ DF\ x \frac{Vf}{Vi}}$$

Where:

$Area_N$ = The measured area of the quantitation ion for the native (unlabeled) PFAS.

$Area_{EIS}$ = The measured area of the quantitation ion for the EIS.

M_{EIS} = The expected concentration of the EIS in the extract (ng/L)

$\boldsymbol{\overline{RR}}$ = Average response ratio used to quantify target compounds by the isotope dilution method.

$\boldsymbol{\overline{RF}}$ = Average response ratio used to quantify target compounds by the extracted internal standard method.

DF = Dilution Factor. If no extract dilution was performed, then DF=1.

Vf = Final extract volume (L)

Vi = Initial sample volume (L) or weight (g)

10.2.3 EIS Concentration

The EIS compounds are quantitated with respect to an NIS, as shown in Table 4, using the response ratios or response factors from the most recent initial calibration. Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equation below.

$$Concentration\ (ng/L\ or\ ng/g) = \frac{Area_{EIS} M_{NIS}}{Area_{NIS}\overline{RF_S}}\ x\ DF\ x \frac{Vf}{Vi}$$

Where:

$Area_{EIS}$ = The measured area of the quantitation ion for the EIS.

$Area_{NIS}$ = The measured area of the quantitation ion for the associated NIS.

M_{NIS} = The expected concentration of the NIS in the extract (ng/L)

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$\overline{RF_S}$ = Average response factor used to quantify the EIS compound by the non-extracted internal standard method.

DF = Dilution Factor. If no extract dilution was performed, then DF=1.

Vf = Final extract volume (L)

Vi = Initial sample volume (L) or weight (g)

10.2.4 Relative Error (%RE)

$$\%\ Relative\ Error = \left(\frac{x'i - xi}{xi}\right) x\ 100$$

Where:

xi = True value of the calibration standard

x'i = Measured concentration of the calibration standard

10.2.5 Percent Relative Standard Deviation

$$\%\ Relative\ Standard\ Deviation = \left(\frac{S}{\bar{\bar{x}}}\right) x\ 100$$

Where:

S = Standard Deviation

X = Mean

10.2.6 Standard Deviation

$$S = \left(\frac{\sum (x_i - \bar{x})^2}{(n-1)}\right)$$

Where:

S = standard deviation

n = size of the population

x_i = each value of the population

$\bar{x}$ = population mean

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10.2.7 Mean

$$\bar{x} = \frac{\left(\sum_{i=1}^{n} x_i\right)}{n}$$

Where:

$\bar{x}$ = population mean

x_i = each value of the population

n = number of values in the population

10.3 Reporting

All results for aqueous samples will be reported in ng/L. All results for solid samples will be reported in ng/g, on a dry-weight basis, and the percent solids for each sample will be reported separately. All results for tissue samples will be reported in ng/g, on a wet-weight basis. All QC data will be reported with the sample results. See Appendix A for specific reporting limits in all matrices.

Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria are reported down to the concentration of the LOQ established by the laboratory.

Results for any analyte found in a sample or extract that has been diluted will be reported at the least dilute level for which the measured concentration is within the calibration range (e.g., above the LOQ for the analyte and below the highest calibration standard) and in which isotopically labeled compound recoveries are within their respective QC acceptance criteria. This may require reporting results for some analytes from different analyses.

Recoveries of all associated EIS compounds will be reported for all field samples and QC Quality Control & Method Performance

10.4 Quality Control

Prepare and analyze the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

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QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.
Low Level Laboratory Control Sample	LLLCS	1 per batch of 20 or fewer samples.
Matrix Spike	MS	1 pair per batch of 20 or fewer samples (if required/requested)
MS Duplicate	MSD	
Sample Duplicate	DUP	1 per AFFF or F3 sample.
Extracted Internal Standard	EIS	All CAL standards, batch QC and field samples.
Non-extracted Internal Standard	NIS	All CAL standards, batch QC and field samples.

The minimum quality control requirements of this method consist of an initial demonstration of laboratory capability, analysis of samples spiked with isotopically labeled compounds to evaluate and document data quality, and analysis of standards and blanks as tests of continued performance. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

If the method is to be applied to a sample matrix other than water (e.g., soils, biosolids, tissue), the appropriate alternative reference matrix is substituted for the reagent water matrix in all performance tests.

The laboratory must make an initial demonstration of the ability to generate acceptable precision and recovery with this method. This demonstration is described in Section 11.3.2.

Analyses of method blanks (MBs) are required on an on-going basis to demonstrate the extent of background contamination in any reagents or equipment used to prepare and analyze field samples. The procedures and criteria for analyses of MBs are described in Section 11.1.1.

The laboratory must spike all samples with isotopically labeled compounds to monitor method performance. These evaluations are described in Sections 11.1.4 and 11.1.5. When results of these spikes indicate atypical method performance for samples, the samples are diluted to evaluate whether the performance issue is caused by the sample matrix. Procedures for dilution are given in Section 9.4.3.

The laboratory must, on an ongoing basis, demonstrate that the analytical system is in control through calibration verification (CCV) and the analysis of blanks and ongoing precision and recovery standards spiked at low (LLLCS) and mid-level concentrations (LCS). These procedures are given in Sections 9.2.4.5, 11.1.1 and 11.1.2.

10.4.1 Method Blank (MB)

A method blank is analyzed with each extraction batch to demonstrate freedom from contamination. The matrix for the method blank must be similar to the sample matrix for the batch (e.g., reagent water blank, solids matrix blank, or tissue blank [Section 7.3]).

Analyze the extract of the method blank aliquot before the analysis of the LCSs.

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If any PFAS is found in the MB 1) at a concentration greater than the LOQ for the analyte, 2) at a concentration greater than one-third the regulatory compliance limit, or 3) at a concentration greater than one-tenth the concentration in a sample in the extraction batch, whichever is greatest, analysis of samples must be halted, and the problem corrected. Other project-specific requirements may apply; therefore, the laboratory may adopt more stringent acceptance limits for the method blank at their discretion. If the contamination is traceable to the extraction batch, samples affected by the blank must be re-extracted and analyzed along with a new MB and LCS/LLLCS, provided enough sample volume is available and the samples are still within holding time. Reanalysis or re-extraction is not required if the samples are not impacted. Samples are not impacted when the MB detection is not present in the sample, or the sample concentration is ≥10x the concentration of the detection in the MB.

If the new blank also exhibits contamination and additional volume of the associated sample(s) is not available for re-extraction and analysis, the laboratory must document and report the failures (e.g., as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority.

10.4.2 Laboratory Control Sample (LCS) / Low-Level LCS (LLLCS)

Analyze the extract of the LCS and LLLCS to ensure the analytical process is under control.

Compute the percent recovery of the native compounds by the appropriate quantification method depending on the compound. Compute the percent recovery of each isotopically labeled compound by the non-extracted internal standard quantitation method.

For the target analytes and EIS compounds, compare the recovery to the LCS and LLLCS limits given in Tables 7 through 10 (or 12). LCS, LLLCS, and EIS results must meet the acceptance criteria in these tables. If all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and aqueous samples may proceed. If, however, any individual concentration falls outside of the given range, the extraction/concentration processes are not being performed properly for that compound. In this event correct the problem, re-extract all affected samples, including any QC samples, and repeat the analysis. Samples are unaffected if the LCS or LLLCS recovery is above the acceptance criteria and the sample is ND for the failing compound.

10.4.3 Matrix Spike (MS)

Matrix spikes generally are not required for methods that employ isotope dilution quantification because deleterious effects of the matrix should be evident in the recoveries of the EIS compounds spiked into every sample. The analysis of matrix spike samples may help diagnose the potential impact of matrix interferences for specific target analytes or sample matrices. See Appendix E for MS/MSD, MS/DUP sample selection guidance.

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10.4.4 Extracted Internal Standard (EIS)

To assess method performance on the sample matrix, the laboratory must spike all samples with the EIS solution. Analyze each sample according to the procedures in this SOP. Compute the percent recovery of the EIS compound concentration using the NIS quantitation method and the equation in Section 10.2.3.

The recovery of each EIS compound in an aqueous sample must be within the limits in Table 10, which are the required QC acceptance limits for aqueous samples, including landfill leachates. The recovery of each EIS compound in soil, sediment, or biosolid samples must be within the limits in Table 11. The recovery of each EIS compound in tissue samples must be within the limits in Table 12. The limits presented in Tables 10, 11, and 12 are the required QC acceptance limits for these matrices derived from the multi-laboratory validation study. If the recovery of any EIS falls outside of these limits, method performance is unacceptable for that EIS in that sample. Additional cleanup procedures or limited dilution of the sample extract may be employed to attempt to bring the EIS recovery within the acceptance normal range.

If the recovery cannot be brought within the acceptance limits after extract dilution or additional cleanup procedures have been employed, then the laboratory must take a smaller aliquot of any affected aqueous sample, dilute it to 500 mL with reagent water and prepare and analyze the diluted sample, or must prepare and analyze a smaller aliquot of soil, sediment, biosolid, or tissue sample, per Section 9.4.3.

10.4.5 Non-extracted Internal Standard (NIS)

To assess method performance, the laboratory must spike all sample extracts with the NIS solution. Analyze each sample extract according to the procedures in this SOP. Percent recovery of the NIS compound is calculated by comparing the measured response in each analysis to the average response of the same compound measured in the ICAL.

Calculate the ratio of the NIS peak areas from the QC and field samples relative to the mean area of the corresponding NIS in the most recent initial calibration to check for possible bad injections of NIS solution or loss of instrument sensitivity.

The NIS areas in the field samples and QC samples must be within 50 to 200% of the mean area of the corresponding NIS in the most recent initial calibration (i.e., within a factor of 2). If the areas are low for all the field samples and QC samples in the batch, it suggests a loss of instrument sensitivity, while low areas in only some field or QC samples suggests a possible bad injection.

10.5 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix B for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Mass Calibration		Annually and on as-needed basis
Mass Calibration Verification		After mass calibration

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Instrument Check	Acronym	Frequency
Initial Calibration	ICAL	Prior to analysis, and on as-needed basis
Initial Calibration Verification	ICV	Following each ICAL
Instrument Blank	IBLK/ICB	Daily prior to analysis and after high standards
Instrument Sensitivity Check	ISC	Daily prior to analysis
Continuing Calibration Verification	CCV	At the beginning (ISC) and every 10 samples
Continuing Calibration Blank	CCB	After each bracketing CCV
RT Window	RTW	During ICAL and at the beginning of each analytical sequence

10.6 Method Performance

10.6.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

Establish Detection Limit (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

10.6.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-WEST-0122 Demonstration of Capability, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

Prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis (see below for details). Successful means the initial or on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee’s training file.

Each DOC requires the extraction and analysis of four aliquots of the reference matrix type to be tested, prepared in the same way as the mid-level LCS. At least one method blank, matching the matrix being analyzed, must be prepared with the DOC batch. If more than one MB was prepared and analyzed with the DOC batch, all blank results must be reported. All sample processing steps that are to be used for processing samples, including preparation and extraction, must be included in this test.

Using the results of the four analyses, compute the average percent recovery (%REC) and the relative standard deviation (RSD) of the concentration of each target compound. There are no mean or RSD criteria for EIS compounds in the DOC; %REC of each DOC sample should meet the criteria in Appendix B, Tables 10, 11, or 12, depending on the matrix.

For each target compound, compare RSD and %REC to the corresponding limits for initial precision and recovery in Appendix B, Tables 7, 8, or 9, depending on the matrix.

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If RSD and %REC for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. If, however, any individual RSD exceeds the precision limit or any individual %REC falls outside the range for recovery, system performance is unacceptable for that compound. Correct the problem and repeat the test.

11.0 DATA REVIEW & CORRECTIVE ACTION

11.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed. This process, known as secondary review, is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified, documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SWI ENV-SWI-WEST-0087 SVOA Data Review Work Instructions for specific instructions and requirements for each step of the data review process.

11.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix B for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range. Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the working concentration range

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of the instrument calibration. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

12.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Refer to laboratory guide ENV-GUI-WEST-0020 Hazardous Waste Management and Disposal, or however named, for waste handling and management practices pertaining to the waste streams created at this facility.

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

13.0 MODIFICATIONS

The procedures in this SOP have been modified from the reference test method as follows:

Modification	Section of Reference Method Modified	Justification for Modification	Validation of Modification
Updated EIS quantitation matching for select compounds (PFMPA, 7:3FTCA, ADONA, 9Cl-PF3ONS, 11Cl-PF3OUdS)	Section 20, Table 10	Improved performance, more appropriate correlation	MDL, IDOC, PT
Updated product ion used for measurement of 13C4-PFOA from m/z 172 to m/z 372	Section 20, Table 10	Match ion transition used for EIS 13C8-PFOA and native PFOA	MDL, IDOC, PT
Increased SPE sorbent bed to 250mg, tube size to 20mL	Section 6.7.1	Wider cartridge improves sample loading, reduces chances of clogs	MDL, IDOC, PT
Increased allowable sample loading rate to 5-10 mL/min	Section 12.1.4	Reduced Sample processing time	MDL, IDOC, PT
Omit TSS for aqueous samples	Section 11.1 (11.1.1.5), 11.2.4	Reduced sample processing time	MDL, IDOC, PT
Solid matrix extraction: reduced liquid-solid shake/decant steps to 2; omitted concentration step	Section 11.3 (11.3.4, 11.3.6, 11.3.9)	Improved performance & reduced sample processing time	MDL, IDOC, PT
GCB cartridges: eliminated dGCB + syringe filtration	Section 11.3.7, 11.4.7, 12.1, 12.2.3, 12.2.4, 12.3.3, 12.4.3	Improved performance, reduced sample processing time, & ease of use	MDL, IDOC, PT

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Modification	Section of Reference Method Modified	Justification for Modification	Validation of Modification
Tissue matrix extraction: reduced liquid-solid shake/decant steps to 2; reduced shake time; omitted concentration step	Section 11.4.4, 11.4.6, 11.4.8	Improved performance & reduced sample processing time	MDL, IDOC, PT
Clearly defined the characteristics used to distinguish Aqueous vs. Biosolid vs. Solid matrices	n/a	Increased clarity in process decision making, improved first-run performance	MDL, IDOC, PT

When applicable, comparability and/or equivalency studies necessary to validate the modification as required per corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, are retained by local quality personnel for historical reference.

14.0 RESPONSIBILITIES

- PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

15.0 ATTACHMENTS

- Appendix A: Routine Analyte Limits (DL, LOQ), Analytical Parameters, and Calibration
- Appendix B: QC Summary & Corrective Action; Table: Method Acceptance Criteria
- Appendix C: State/Program Specific Requirements
- Appendix D: Sample Pre-screening Instructions
- Appendix E: Aqueous Sample Subsampling Instructions
- Appendix F: MS/MSD, MS/DUP Selection Protocols
- Appendix G: Aqueous Sample Management Decision Guide
- Appendix H: Aqueous Sample Centrifugation Protocol

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- Appendix I: Separation and Analysis of Liquid-Solid Biphasic Matrices
- Appendix J: TCLP/SPLP by 1633
- Appendix K: Wipe Analysis by 1633
- Appendix L: Articles of Commerce Analysis via Cryomill Processing
- Appendix M: Procedure for Total Oxidizable Precursors (TOP)

16.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.
- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- ENV-MAN-WEST-0001, *Quality Manual*, current version.
- TNI Standard, “Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis”, current version.
- “Working with Carcinogens,” Department of Health, Education, & Welfare, Public Health Service, Centers for Disease Control, NIOSH, Publication 77-206, August 1977, NTIS PB-277256.
- “OSHA Safety and Health Standards, General Industry,” OSHA 2206, 29 CFR 1910.
- “Safety in Academic Chemistry Laboratories,” ACS Committee on Chemical Safety, 1979.
- “Standard Methods for the Examination of Water and Wastewater,” 18th edition and later revisions, American Public Health Association, 1015 15th St, NW, Washington, DC 20005, 1-35: Section 1090 (Safety), 1992.
- “Standard Practice for Sampling Water,” ASTM Annual Book of Standards, ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, 1980.
- “Handbook of Analytical Quality Control in Water and Wastewater Laboratories,” USEPA EMSL, Cincinnati, OH 45268, EPA 600/4-79-019, April 1979.
- “Less is Better: Laboratory Chemical Management for Waste Reduction,” American Chemical Society, 1993. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.
- “Environmental Management Guide for Small Laboratories,” USEPA, Small Business Division, Washington DC, EPA 233-B-00-001, May 2000.

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- "The Waste Management Manual for Laboratory Personnel," American Chemical Society, 1990. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.
- SERDP. Single-Laboratory Validation Study of PFAS by Isotope Dilution LC-MS/MS. ER19-1409. January 26, 2022.
- Woudneh, Million B., Bharat Chandramouli, Coreen Hamilton, Richard Grace, 2019, "Effects of Sample Storage on the Quantitative Determination of 29 PFAS: Observation of Analyte Interconversions during Storage", Environmental Science and Technology 53(21): 12576-12585.
- EPA. Method 1633, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. January 2024.
- Standard Method for the Examination of Water and Wastewater, 23rd Edition, 2017 – Total, Fixed, and Volatile Solids in Solid and Semisolid Samples, Method 2540.

17.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
	N/A: new document

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
N/A	N/A	N/A	N/A

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Appendix A: Routine Analyte Limits (DL, LOQ), Analytical Parameters, and Calibration

DL and LOQ are always adjusted to account for actual amounts used and for dilution. Values listed are as of effective date of this SOP. DL and LOQ are subject to change. Contact quality personnel for current information. See Table 4 below for more information regarding analyte detection and quantitation.

Table 1: Standard Analyte List – Aqueous and Landfill Leachate Matrices

Analyte Abbreviation	CAS #	Aqueous (ng/L)		Leachate (ng/L)	
		DL	LOQ	DL	LOQ
PFBA	375-73-5	0.527	6.4	2.64	32
PFPeA	2706-91-4	0.359	3.2	1.79	16
PFHxA	355-46-4	0.245	1.6	1.22	8
PFHpA	375-92-8	0.238	1.6	1.19	8
PFOA	1763-23-1	0.263	1.6	1.31	8
PFNA	68259-12-1	0.266	1.6	1.33	8
PFDA	335-77-3	0.210	1.6	1.05	8
PFUnA	79780-39-5	0.178	1.6	0.892	8
PFDoA	375-73-5	0.214	1.6	1.07	8
PFTrDA	2706-91-4	0.187	1.6	0.934	8
PFTeDA	355-46-4	0.160	1.6	0.801	8
PFBS	375-73-5	0.402	1.6	2.01	8
PFPeS	2706-91-4	0.206	1.6	1.03	8
PFHxS	355-46-4	0.133	1.6	0.665	8
PFHpS	375-92-8	0.201	1.6	1.00	8
PFOS	1763-23-1	0.264	1.6	1.32	8
PFNS	68259-12-1	0.203	1.6	1.02	8
PFDS	335-77-3	0.140	1.6	0.699	8
PFDoS	79780-39-5	0.242	1.6	1.21	8
4:2 FTS	757124-72-4	0.910	6.4	4.55	32
6:2 FTS	27619-97-2	4.82	6.4	24.1	32
8:2 FTS	39108-34-4	1.22	6.4	6.11	32
PFOSA	754-91-6	0.097	1.6	.484	8
NMeFOSA	31506-32-8	0.226	1.6	1.13	8
NEtFOSA	4151-50-2	0.351	1.6	1.76	8

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Analyte Abbreviation	CAS #	Aqueous (ng/L)		Leachate (ng/L)	
		DL	LOQ	DL	LOQ
NMeFOSAA	2355-31-9	0.483	1.6	2.41	8
NEtFOSAA	2991-50-6	0.478	1.6	2.39	8
NMeFOSE	24448-09-7	1.30	16	6.52	80
NEtFOSE	1691-99-2	1.10	16	5.50	80
HFPO-DA	13252-13-6	1.60	6.4	8.02	32
ADONA	919005-14-4	0.376	6.4	1.88	32
PFMPA	377-73-1	0.244	3.2	1.22	16
PFMBA	863090-89-5	0.360	3.2	1.80	16
NFDHA	151772-58-6	0.541	3.2	2.71	16
9Cl-PF3ONS	756426-58-1	0.442	6.4	2.21	32
11Cl-PF3OUdS	763051-92-9	0.447	6.4	2.23	32
PFEESA	113507-82-7	0.330	3.2	1.65	16
3:3 FTCA	356-02-5	0.535	8	2.68	40
5:3 FTCA	914637-49-3	4.26	40	21.3	200
7:3 FTCA	812-70-4	3.18	40	15.9	200

Table 2: Standard Analyte List – Solid and Biosolid Matrices

Analyte Abbreviation	CAS #	Solid (ng/g)		Biosolid (ng/g)	
		DL	LOQ	DL	LOQ
PFBA	375-73-5	0.028	0.8	0.28	8
PFPeA	2706-91-4	0.038	0.4	0.38	4
PFHxA	355-46-4	0.016	0.2	0.16	2
PFHpA	375-92-8	0.012	0.2	0.12	2
PFOA	1763-23-1	0.026	0.2	0.26	2
PFNA	68259-12-1	0.012	0.2	0.12	2
PFDA	335-77-3	0.035	0.2	0.35	2
PFUnA	79780-39-5	0.013	0.2	0.13	2
PFDoA	375-73-5	0.021	0.2	0.21	2
PFTrDA	2706-91-4	0.016	0.2	0.16	2
PFTeDA	355-46-4	0.024	0.2	0.24	2
PFBS	375-73-5	0.020	0.2	0.20	2

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Analyte Abbreviation	CAS #	Solid (ng/g)		Biosolid (ng/g)	
		DL	LOQ	DL	LOQ
PFPeS	2706-91-4	0.027	0.2	0.27	2
PFHxS	355-46-4	0.020	0.2	0.20	2
PFHpS	375-92-8	0.045	0.2	0.45	2
PFOS	1763-23-1	0.031	0.2	0.31	2
PFNS	68259-12-1	0.029	0.2	0.29	2
PFDS	335-77-3	0.015	0.2	0.15	2
PFDoS	79780-39-5	0.022	0.2	0.22	2
4:2 FTS	757124-72-4	0.078	0.8	0.78	8
6:2 FTS	27619-97-2	0.148	0.8	1.48	8
8:2 FTS	39108-34-4	0.259	0.8	2.59	8
PFOSA	754-91-6	0.011	0.2	0.11	2
NMeFOSA	31506-32-8	0.026	0.2	0.26	2
NEtFOSA	4151-50-2	0.022	0.2	0.22	2
NMeFOSAA	2355-31-9	0.086	0.2	0.86	2
NEtFOSAA	2991-50-6	0.044	0.2	0.44	2
NMeFOSE	24448-09-7	0.121	2.0	1.21	20
NEtFOSE	1691-99-2	0.081	2.0	0.81	20
HFPO-DA	13252-13-6	0.039	0.8	0.39	8
ADONA	919005-14-4	0.030	0.8	0.30	8
PFMPA	377-73-1	0.017	0.4	0.17	4
PFMBA	863090-89-5	0.024	0.4	0.24	4
NFDHA	151772-58-6	0.083	0.4	0.83	4
9Cl-PF3ONS	756426-58-1	0.029	0.8	0.29	8
11Cl-PF3OUdS	763051-92-9	0.040	0.8	0.40	8
PFEESA	113507-82-7	0.046	0.4	0.46	4
3:3 FTCA	356-02-5	0.092	1.0	0.92	10
5:3 FTCA	914637-49-3	0.236	5.0	2.36	50
7:3 FTCA	812-70-4	0.365	5.0	3.65	50

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Table 3: Standard Analyte List – Tissue Matrices

Analyte Abbreviation	CAS #	DL (ng/g)	LOQ (ng/g)
PFBA	375-73-5	0.215	2.0
PFPeA	2706-91-4	0.088	1.0
PFHxA	355-46-4	0.044	0.5
PFHpA	375-92-8	0.062	0.5
PFOA	1763-23-1	0.070	0.5
PFNA	68259-12-1	0.099	0.5
PFDA	335-77-3	0.102	0.5
PFUnA	79780-39-5	0.093	0.5
PFDoA	375-73-5	0.052	0.5
PFTrDA	2706-91-4	0.067	0.5
PFTeDA	355-46-4	0.039	0.5
PFBS	375-73-5	0.044	0.5
PFPeS	2706-91-4	0.029	0.5
PFHxS	355-46-4	0.075	0.5
PFHpS	375-92-8	0.093	0.5
PFOS	1763-23-1	0.084	0.5
PFNS	68259-12-1	0.065	0.5
PFDS	335-77-3	0.056	0.5
PFDoS	79780-39-5	0.062	0.5
4:2 FTS	757124-72-4	0.222	2.0
6:2 FTS	27619-97-2	0.934	2.0
8:2 FTS	39108-34-4	0.249	2.0
PFOSA	754-91-6	0.051	0.5
NMeFOSA	31506-32-8	0.139	0.5
NEtFOSA	4151-50-2	0.115	0.5
NMeFOSAA	2355-31-9	0.089	0.5
NEtFOSAA	2991-50-6	0.106	0.5
NMeFOSE	24448-09-7	0.598	5.0
NEtFOSE	1691-99-2	0.410	5.0
HFPO-DA	13252-13-6	0.072	2.0

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Analyte Abbreviation	CAS #	DL (ng/g)	LOQ (ng/g)
ADONA	919005-14-4	0.139	2.0
PFMPA	377-73-1	0.078	1.0
PFMBA	863090-89-5	0.086	1.0
NFDHA	151772-58-6	0.113	1.0
9Cl-PF3ONS	756426-58-1	0.179	2.0
11Cl-PF3OUdS	763051-92-9	0.228	2.0
PFEESA	113507-82-7	0.069	1.0
3:3 FTCA	356-02-5	0.145	2.5
5:3 FTCA	914637-49-3	1.54	12.5
7:3 FTCA	812-70-4	1.26	12.5

Table 4: Identification and Quantification Information for Target Analytes, Extracted Internal Standards and Non-extracted Internal Standards.

Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluorobutanoic acid	375-73-5	PFBA	213	169	NA	13C4-PFBA
Perfluoropentanoic acid	2706-91-4	PFPeA	263	219	69	13C5-PFPeA
Perfluorohexanoic acid	355-46-4	PFHxA	313	269	119	13C5-PFHxA
Perfluoroheptanoic acid	375-92-8	PFHpA	363	319	169	13C4-PFHpA
Perfluorooctanoic acid	1763-23-1	PFOA	413	369	169	13C8-PFOA
Perfluorononanoic acid	68259-12-1	PFNA	463	419	219	13C9-PFNA
Perfluorodecanoic acid	335-77-3	PFDA	513	469	219	13C6-PFDA
Perfluoroundecanoic acid	79780-39-5	PFUnA	563	519	269	13C7-PFUnA
Perfluorododecanoic acid	375-73-5	PFDoA	613	569	319	13C2-PFDoA
Perfluorotridecanoic acid	2706-91-4	PFTrDA	663	619	169	13C2-PFDoA
Perfluorotetradecanoic acid	355-46-4	PFTeDA	713	669	169	13C2-PFTeDA
Perfluorobutanesulfonic acid	375-73-5	PFBS	299	80	99	13C3-PFBS
Perfluoropentansulfonic acid	2706-91-4	PFPeS	349	80	99	13C3-PFHxS
Perfluorohexanesulfonic acid	355-46-4	PFHxS	399	80	99	13C3-PFHxS

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Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoroheptanesulfonic acid	375-92-8	PFHpS	449	80	99	13C8-PFOS
Perfluorooctanesulfonic acid	1763-23-1	PFOS	499	80	99	13C8-PFOS
Perfluorononanesulfonic acid	68259-12-1	PFNS	549	80	99	13C8-PFOS
Perfluorodecanesulfonic acid	335-77-3	PFDS	599	80	99	13C8-PFOS
Perfluorododecanesulfonic acid	79780-39-5	PFDoS	699	80	99	13C8-PFOS
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	757124-72-4	4:2 FTS	327	307	81	13C2-4:2FTS
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	27619-97-2	6:2 FTS	427	407	81	13C2-6:2FTS
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	39108-34-4	8:2 FTS	527	507	81	13C2-8:2FTS
Perfluorooctanesulfonamide	754-91-6	PFOSA	498	78	478	13C8-PFOSA
N-methyl perfluorooctanesulfonamide	31506-32-8	NMeFOSA	512	219	169	D3-NMeFOSA
N-ethyl perfluorooctanesulfonamide	4151-50-2	NEtFOSA	526	219	169	D5-NEtFOSA
N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9	NMeFOSAA	570	419	483	D3-NMeFOSAA
N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6	NEtFOSAA	584	419	526	D5-NEtFOSAA
N-methyl perfluorooctanesulfonamidoethanol	24448-09-7	NMeFOSE	616	59	NA	D7-NMeFOSE
N-ethyl perfluorooctanesulfonamidoethanol	1691-99-2	NEtFOSE	630	59	NA	D9-NEtFOSE
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	HFPO-DA	285	169	185	13C3-HFPODA
4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	ADONA	377	251	85	13C4-PFHpA
Perfluoro-3-methoxypropanoic acid	377-73-1	PFMPA	229	85	NA	13C4-PFBA
Perfluoro-4-methoxybutanoic acid	863090-89-5	PFMBA	279	85	NA	13C5-PFPeA
Nonafluoro-3,6-dioxaheptanoic acid	151772-58-6	NFDHA	295	201	85	13C5-PFHxA

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Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	9Cl-PF3ONS	531	351	533→353	13C8-PFOS
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	11Cl-PF3OUdS	631	451	633→453	13C8-PFOS
Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7	PFEESA	315	135	83	13C5-PFHxA
3-Perfluoropropyl propanoic acid (FPrPA)	356-02-5	3:3FTCA	241	177	117	13C5-PFPeA
2H,2H,3H,3H-Perfluorooctanoic acid (FPePA)	914637-49-3	5:3FTCA	341	237	217	13C5-PFHxA
3-Perfluoroheptyl propanoic acid (FHpPA)	812-70-4	7:3FTCA	441	337	317	13C9-PFNA
Extracted Internal Standard Compounds (EIS)						
Perfluoro-n-[13C4] butanoic acid	NA	13C4-PFBA	217	172	NA	13C3-PFBA
Perfluoro-n-[13C5] pentanoic acid	NA	13C5-PFPeA	268	223	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4,6-13C5] hexanoic acid	NA	13C5-PFHxA	318	273	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4-13C4] heptanoic acid	NA	13C4-PFHpA	367	322	NA	13C2-PFHxA
Perfluoro-n-[13C8] octanoic acid	NA	13C8-PFOA	421	376	NA	13C4-PFOA
Perfluoro-n-[13C9] nonanoic acid	NA	13C9-PFNA	472	427	NA	13C5-PFNA
Perfluoro-n-[1,2,3,4,5,6-13C6] decanoic acid	NA	13C6-PFDA	519	474	NA	13C2-PFDA
Perfluoro-n-[1,2,3,4,5,6,7-13C7] undecanoic acid	NA	13C7-PFUnA	570	525	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] dodecanoic acid	NA	13C2-PFDoA	615	570	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] tetradecanoic acid	NA	13C2-PFTeDA	715	670	NA	13C2-PFDA
Perfluoro-1-[2,3,4-13C3] butanesulfonic acid	NA	13C3-PFBS	302	80	NA	18O2-PFHxS
Perfluoro-1-[1,2,3-13C3] hexanesulfonic acid	NA	13C3-PFHxS	402	80	NA	18O2-PFHxS

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Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoro-1-[13C8] octanesulfonic acid	NA	13C8-PFOS	507	80	NA	13C4-PFOS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] hexanesulfonic acid	NA	13C2-4:2FTS	329	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] octanesulfonic acid	NA	13C2-6:2FTS	429	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] decanesulfonic acid	NA	13C2-8:2FTS	529	81	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonamide	NA	13C8-PFOSA	506	78	NA	13C4-PFOS
N-methyl-D3-perfluoro-1-octanesulfonamide	NA	D3-NMeFOSA	515	219	NA	13C4-PFOS
N-ethyl-D5-perfluoro-1-octanesulfonamide	NA	D5-NEtFOSA	531	219	NA	13C4-PFOS
N-methyl-D3-perfluoro-1-octanesulfonamidoacetic acid	NA	D3-NMeFOSAA	573	419	NA	13C4-PFOS
N-ethyl-D5-perfluoro-1-octanesulfonamidoacetic acid	NA	D5-NEtFOSAA	589	419	NA	13C4-PFOS
N-methyl-D7-perfluorooctanesulfonamidoethanol	NA	D7-NMeFOSE	623	59	NA	13C4-PFOS
N-ethyl-D9-perfluorooctanesulfonamidoethanol	NA	D9-NEtFOSE	639	59	NA	13C4-PFOS
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	NA	13C3-HFPO-DA	287	169	NA	13C2-PFHxA
Non-extracted Internal Standard Compounds (NIS)						
Perfluoro-n-[2,3,4-13C3] butanoic acid	NA	13C3-PFBA	216	172	NA	NA
Perfluoro-n-[1,2-13C2]hexanoic acid	NA	13C2-PFHxA	315	270	NA	NA
Perfluoro-n-[1,2,3,4-13C4]octanoic acid	NA	13C4-PFOA	417	172	NA	NA
Perfluoro-n-[1,2,3,4,5-13C5] nonanoic acid	NA	13C5-PFNA	468	423	NA	NA

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Analyte Name	CAS #	Analyte Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluoro-n-[1,2-13C2]decanoic acid	NA	13C2-PFDA	515	470	NA	NA
Perfluoro-1-hexane[18O2]sulfonic acid	NA	18O2-PFHxS	403	84	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanesulfonic acid	NA	13C4-PFOS	503	80	NA	NA

Table 5: Calibration Standard Concentrations (ng/mL)

Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
Perfluoroalkyl carboxylic acids									
PFBA	0.4	0.8	2	10	20	50	100	200	250
PFPeA	0.2	0.4	1	5	10	25	50	100	125
PFHxA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFHpA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFOA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFNA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFUnA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFDoA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFTrDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
PFTeDA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluoroalkyl sulfonic acids									
PFBS	0.089	0.178	0.444	2.22	4.44	11.1	22.2	44.4	55.5
PFPeS	0.094	0.188	0.470	2.35	4.70	11.8	23.5	47.0	58.8
PFHxS	0.091	0.182	0.456	2.28	4.56	11.4	22.8	45.6	57.0
PFHpS	0.095	0.190	0.476	2.38	4.76	11.9	23.8	47.6	59.5
PFOS	0.093	0.186	0.464	2.32	4.64	11.6	23.2	46.4	58.0
PFNS	0.096	0.192	0.480	2.40	4.80	12.0	24.0	48.0	60.0
PFDS	0.096	0.193	0.482	2.41	4.82	12.1	24.1	48.2	60.3
PFDoS	0.097	0.194	0.484	2.42	4.84	12.1	24.2	48.4	60.5
Fluorotelomer sulfonic acids									
4:2FTS	0.375	0.750	1.87	9.37	18.7	46.9	93.7	187	234
6:2FTS	0.380	0.761	1.90	9.51	19.0	47.6	95.1	190	238
8:2FTS	0.384	0.768	1.92	9.6	19.2	48	96	192	240
Perfluorooctane sulfonamides									

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Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
PFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NMeFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NEtFOSA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamidoacetic acids									
NMeFOSAA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
NEtFOSAA	0.1	0.2	0.5	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamide ethanols									
NMeFOSE	1	2	5	25	50	125	250	500	625
NEtFOSE	1	2	5	25	50	125	250	500	625
Per- and polyfluoroether carboxylic acids									
HFPO-DA	0.4	0.8	2	10	20	50	100	200	250
ADONA	0.378	0.756	1.89	9.45	18.9	47.25	94.5	189	236.25
PFMPA	0.2	0.4	1	5	10	25	50	100	125
PFMBA	0.2	0.4	1	5	10	25	50	100	125
NFDHA	0.2	0.4	1	5	10	25	50	100	125
Ether sulfonic acids									
9Cl-PF3ONS	0.373	0.746	1.87	9.33	18.7	46.7	93.3	187	233
11Cl-PF3OUdS	0.377	0.754	1.89	9.43	18.9	47.2	94.3	189	236
PFEESA	0.178	0.357	0.892	4.46	8.92	22.3	44.6	89.2	112
Fluorotelomer Carboxylic Acids									
3:3FTCA	0.5	1	2.5	12.5	25	62.5	125	250	312.5
5:3FTCA	2.5	5	12.5	62.5	125	312.5	625	1250	1560
7:3FTCA	2.5	5	12.5	62.5	125	312.5	625	1250	1560
Extracted Internal Standards (EIS)									
13C4-PFBA	10	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
13C3-PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
13C8-PFOS	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
13C2-4:2FTS	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69

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Compound	L1	L2 (ISC)	L3	L4	L5 (CCV)	L6	L7	L8	L9
13C2-6:2FTS	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
13C2-8:2FTS	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
13C8-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSAA	5	5	5	5	5	5	5	5	5
D5-NEtFOSAA	5	5	5	5	5	5	5	5	5
D7-NMeFOSE	25	25	25	25	25	25	25	25	25
D9-NEtFOSE	25	25	25	25	25	25	25	25	25
13C3-HFPODA	10	10	10	10	10	10	10	10	10
Non-Extracted Internal Standards (NIS)									
13C3-PFBA	5	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
13C4-PFOS	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40

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Appendix B: QC Summary & Corrective Action Table; Method Acceptance Criteria

Table 6: QC Summary & Corrective Action

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Demonstration of Capability (DOC)	Initially, prior to analyzing field samples and annually thereafter.	See Method Acceptance Criteria for each matrix in the Tables below.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration	Annually and on as-needed basis.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration Verification	After each Mass Calibration performed.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat Mass Calibration.	None. Do not proceed with analysis.
Initial Calibration (ICAL)	At instrument set up, after CCV failure and/or major maintenance.	Must meet one of the curve fit options presented in Section 9.2.4.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Initial Calibration Verification (ICV)	After Each ICAL.	All analytes must be within ± 30% of their true values. (%R)	Identify and correct source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria when results are unaffected; otherwise, correct the problem and repeat ICV.
Initial Calibration Blank (ICB)	After highest concentration ICAL standard.	Must meet criteria specified in Section 9.2.5: all detections ≤MDL concentration.	Identify and correct source of contamination or performance issue. Alternately, calibrate using a lower concentration standard for the highest point.	No samples shall be analyzed until ICB has met acceptance criteria.
RT Window Position	Once per ICAL and at the beginning of the analytical window.	Position is set using the mid-point of the ICAL on the day ICAL is performed; otherwise, opening CCV is used. RT Window is ± 60 secs from RT position.	NA	NA
Instrument Sensitivity Check (ISC)	Daily before sample analysis.	All native and isotopically labelled compounds within ± 30% recovery.	Identify and correct source of problem and reanalyze ISC. If problem persists, repeat ICAL.	No samples shall be analyzed until ISC has met acceptance

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QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
				criteria. See Section 9.2.4.5 for exceptions.
Bile Salts Check	With each ICAL and daily with each CCV	Bile Salt peak detected >1 min outside RT window for PFOS.	Identify and correct source of problem, then reevaluate Bile Salts separation from PFOS.	No samples shall be analyzed until Bile Salts Check has met acceptance criteria.
Continuing Calibration Verification (CCV)	Daily before sample analysis, after every 10 samples, and at end of analytical sequence.	All native and isotopically labelled compounds within ±30% recovery.	See Section 9.2.4.5 for required corrective actions based on circumstance.	Qualify analytes with CCV out of criteria.
Instrument Blank (IBLK) / Continuing Calibration Blank (CCB)	Daily prior to analysis and after high standards, including CCV.	Must meet criteria specified in Section 9.2.5: all detections ≤MDL concentration.	Identify and correct source of contamination or performance issue. Reanalyze IBLK.	No samples shall be analyzed until IBLK has met acceptance criteria.
Extracted Internal Standards (EIS)	Every field sample, standard and QC sample.	See Method Acceptance Criteria for each matrix in the Tables below.	If batch QC is acceptable, reanalyze to confirm. If confirmed, re-extract and reanalyze samples. If reprep is within acceptance, report reprep data. If failure is confirmed by reprep, qualify as matrix impacted.	Qualify outages and explain in case narrative.
Non-extracted Internal Standards (NIS)	Every field sample, standard and QC sample.	NIS areas in all samples must be within 50 – 200% of the average area of the corresponding NIS in the ICAL.	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Method Blank (MB)	1 per batch of 20 or fewer samples.	Must meet criteria specified in Section 10.4.1: all detections ≤MDL concentration.	If IBLK is acceptable, reanalyze MB to confirm. If confirmed, re-extract and reanalyze associated impacted samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated with unacceptable MB. See Section 10.4.1 for more details.	Qualify outages and explain in case narrative.

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QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
LCS/LLLCS	1 pair per batch of 20 or fewer samples.	See Method Acceptance Criteria for each matrix in the Tables below; must meet criteria specified in Section 10.4.2.	If most recent ISC/CCV is acceptable, reanalyze LCS to confirm. If low-failure results are confirmed, re-extract and reanalyze associated samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated with low-failure LCS. If high-failure results are confirmed and sample(s) is ND for failing compound, narrate and report sample data.	Qualify outages and explain in case narrative.
MS/MSD	1 pair per batch of 20 or fewer samples. (If requested)	RSD ≤30% between MS/MSD	If possible, reprep to confirm.	Qualify outages and explain in case narrative.
Laboratory Duplicate	1 per AFFF sample; 1 per prep batch for all other matrices (if requested).	RSD ≤30% between parent/DUP	If possible, reprep to confirm.	Qualify outages and explain in case narrative.

Table 7: DOC/LCS/LLLCS Acceptance Limits for Aqueous & Landfill Leachate Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-135	21	70-140
PFPeA	70-135	23	65-135
PFHxA	70-135	24	70-145
PFHpA	70-135	28	70-150
PFOA	65-155	27	70-150
PFNA	70-140	28	70-150
PFDA	65-140	26	70-140
PFUnA	70-135	29	70-145
PFDoA	70-130	21	70-140
PFTrDA	60-145	29	65-140
PFTeDA	70-145	27	60-140
PFBS	70-140	23	60-145
PFPeS	70-135	25	65-140
PFHxS	70-135	27	65-145
PFHpS	70-140	30	70-150
PFOS	70-140	29	55-150
PFNS	70-135	29	65-145
PFDS	70-135	30	60-145

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Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFDoS	45-135	35	50-145
4:2FTS	70-135	27	70-145
6:2FTS	70-135	32	65-155
8:2FTS	70-140	33	60-150
PFOSA	70-135	22	70-145
NMeFOSA	70-135	30	60-150
NEtFOSA	70-130	26	65-145
NMeFOSAA	65-140	32	50-140
NEtFOSAA	70-135	28	70-145
NMeFOSE	70-135	29	70-145
NEtFOSE	70-130	21	70-135
HFPO-DA	70-135	23	70-140
ADONA	70-135	23	65-145
PFMPA	60-140	23	55-140
PFMBA	65-145	27	60-150
NFDHA	65-140	37	50-150
9Cl-PF3ONS	70-145	30	70-155
11Cl-PF3OUdS	50-150	35	55-160
PFEESA	70-135	25	70-140
3:3FTCA	70-130	23	65-130
5:3FTCA	70-130	24	70-135
7:3FTCA	55-130	34	50-145

Table 8: DOC/LCS/LLLCS Acceptance Limits for Solid & Biosolid Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-140	17	70-140
PFPeA	70-140	26	60-150
PFHxA	70-135	23	65-140
PFHpA	70-140	21	65-145
PFOA	70-140	23	70-150
PFNA	65-145	24	70-155
PFDA	70-145	26	70-155
PFUnA	70-145	26	70-155
PFDoA	70-145	25	70-150
PFTrDA	55-160	26	65-150
PFTeDA	70-145	24	65-150
PFBS	60-145	25	65-145
PFPeS	65-140	29	55-160
PFHxS	65-145	28	60-150
PFHpS	70-140	27	65-155
PFOS	70-135	27	65-160
PFNS	70-140	27	55-140

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Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFDS	50-150	31	40-155
PFDoS	40-140	40	25-160
4:2FTS	70-135	27	60-150
6:2FTS	60-160	50	55-200
8:2FTS	70-140	27	70-150
PFOSA	70-140	19	70-140
NMeFOSA	65-145	26	70-155
NEtFOSA	70-135	19	70-140
NMeFOSAA	65-145	31	65-155
NEtFOSAA	60-150	31	65-165
NMeFOSE	70-140	19	70-140
NEtFOSE	70-135	17	70-135
HFPO-DA	70-140	25	70-145
ADONA	70-155	26	70-160
PFMPA	70-140	25	30-140
PFMBA	55-145	33	60-150
NFDHA	45-145	27	60-155
9Cl-PF3ONS	65-135	23	70-150
11Cl-PF3OUdS	50-135	31	45-160
PFEESA	70-140	20	70-140
3:3FTCA	45-155	32	45-130
5:3FTCA	70-135	28	60-130
7:3FTCA	70-145	39	60-150

Table 9: DOC/LCS/LLLCS Acceptance Limits for Tissue Matrix

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-135	20	60-140
PFPeA	70-130	20	60-145
PFHxA	70-140	20	60-160
PFHpA	70-140	20	60-145
PFOA	70-130	25	60-150
PFNA	70-140	20	60-145
PFDA	70-135	20	60-150
PFUnA	70-135	20	60-155
PFDoA	70-135	20	60-140
PFTrDA	55-160	20	60-150
PFTeDA	70-140	25	60-140
PFBS	70-145	20	60-150
PFPeS	70-150	20	60-145
PFHxS	70-140	25	60-155
PFHpS	70-145	20	60-140
PFOS	70-135	30	60-160

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Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFNS	60-130	20	45-140
PFDS	55-135	20	50-140
PFDoS	25-145	45	25-140
4:2FTS	65-140	30	55-150
6:2FTS	70-140	25	60-150
8:2FTS	70-150	25	60-170
PFOSA	70-140	20	60-150
NMeFOSA	70-140	30	60-160
NEtFOSA	70-140	40	60-150
NMeFOSAA	70-140	20	60-145
NEtFOSAA	70-140	25	60-145
NMeFOSE	60-150	20	40-180
NEtFOSE	70-145	40	60-205
HFPO-DA	70-140	25	60-145
ADONA	70-145	20	55-165
PFMPA	70-145	40	25-145
PFMBA	70-140	20	60-150
NFDHA	70-155	30	60-180
9Cl-PF3ONS	70-140	20	60-170
11Cl-PF3OUdS	65-140	20	50-170
PFEESA	70-145	25	50-150
3:3FTCA	55-130	25	30-140
5:3FTCA	70-145	20	60-160
7:3FTCA	70-155	20	60-200

Table 10: Acceptance Limits for EIS and NIS Compounds in Aqueous & Landfill Leachate Matrices

Labeled Compound	Aqueous Recovery (%)	Landfill Leachate Recovery (%)
13C4-PFBA	5-130	5-130
13C5-PFPeA	40-130	40-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-130
13C6-PFDA	40-130	40-130
13C7-PFUnA	30-130	40-130
13C2-PFDoA	10-130	35-130
13C2-PFTeDA	10-130	25-130
13C3-PFBS	40-135	40-130
13C3-PFHxS	40-130	40-130
13C8-PFOS	40-130	40-130

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Labeled Compound	Aqueous Recovery (%)	Landfill Leachate Recovery (%)
13C2-4:2FTS	40-200	40-220
13C2-6:2FTS	40-200	40-170
13C2-8:2FTS	40-300	40-145
13C8-PFOSA	40-130	40-130
D3-NMeFOSA	10-130	40-130
D5-NEtFOSA	10-130	35-130
D3-NMeFOSAA	40-170	35-130
D5-NEtFOSAA	25-135	30-130
D7-NMeFOSE	10-130	20-130
D9-NEtFOSE	10-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

Table 11: Acceptance Limits for EIS and NIS Compounds in Solid & Biosolid Matrices

Labeled Compound	Solids Recovery (%)	Biosolids Recovery (%)
13C4-PFBA	8-130	5-130
13C5-PFPeA	35-130	35-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-145
13C6-PFDA	40-130	40-130
13C7-PFUnA	40-130	40-130
13C2-PFDoA	40-130	40-130
13C2-PFTeDA	20-130	10-160
13C3-PFBS	40-135	40-150
13C3-PFHxS	40-130	40-140
13C8-PFOS	40-130	40-130
13C2-4:2FTS	40-165	40-300
13C2-6:2FTS	40-215	40-300
13C2-8:2FTS	40-275	40-300

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Labeled Compound	Solids Recovery (%)	Biosolids Recovery (%)
13C8-PFOSA	40-130	20-140
D3-NMeFOSA	10-130	20-130
D5-NEtFOSA	10-130	20-130
D3-NMeFOSAA	40-135	30-150
D5-NEtFOSAA	40-150	20-140
D7-NMeFOSE	20-130	25-130
D9-NEtFOSE	15-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

Table 12: Acceptance Limits for EIS and NIS Compounds in Tissue Matrices

Labeled Compound	Tissue Recovery (%)
13C4-PFBA	5-130
13C5-PFPeA	10-185
13C5-PFHxA	25-170
13C4-PFHpA	25-150
13C8-PFOA	25-150
13C9-PFNA	35-185
13C6-PFDA	30-150
13C7-PFUnA	30-180
13C2-PFDoA	35-180
13C2-PFTeDA	20-160
13C3-PFBS	25-190
13C3-PFHxS	35-175
13C8-PFOS	40-160
13C2-4:2FTS	30-300
13C2-6:2FTS	35-300
13C2-8:2FTS	40-365
13C8-PFOSA	25-180
D3-NMeFOSA	5-130
D5-NEtFOSA	5-130

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Labeled Compound	Tissue Recovery (%)
D3-NMeFOSAA	30-250
D5-NEtFOSAA	30-235
D7-NMeFOSE	5-160
D9-NEtFOSE	5-130
13C3-HFPODA	20-185
13C3-PFBA	50-200
13C2-PFHxA	50-200
13C4-PFOA	50-200
13C5-PFNA	50-200
13C2-PFDA	50-200
18O2-PFHxS	50-200
13C4-PFOS	50-200

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Appendix C: State/Program Specific Requirements

This appendix provides program specific requirements that supersede or supplement the main body of the SOP. When analyzing samples under DoD compliance, these requirements are applicable.

QC Item	SOP Section	Requirement
Instrument Blank	9.2.5	No analytes detected > ½ LOQ.
Method Blank	11.1.1	No analytes detected > ½ LOQ.
AFFF Sample Duplicate	Appendix E	All AFFF samples shall be prepared and analyzed in duplicate in the same manner as aqueous samples (e.g., solid phase extraction, extracted internal standards, carbon cleanup, etc.).
Laboratory Duplicate	Appendices B & F	One per preparatory batch. RPD of all analytes should be ≤ 30% between sample and DUP. RPD criterion does not apply if both results are below the LOQ.

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Appendix D: Sample Pre-screening Instructions

Samples that are known or suspected to contain high levels of analytes may be pre-screened using the following procedure. These are example procedures using smaller sample aliquots spiked with EIS and NIS and no clean up procedures. Other pre-screening procedures may be used.

Aqueous Samples

1) Weight out 10 (±0.1) g of sample into a 50-mL centrifuge tube.
2) Add 50 µL of EIS to the sample and vortex to mix.
3) Filter 1 mL of the sample through 0.2-µm membrane filter into a microvial. Sample is ready for instrumental analysis.

Solid and Tissue Samples

1) Weigh 1.0 (±0.1) g sample into 50-mL polypropylene centrifuge tubes.
2) Add 20 mL of 0.3% methanolic ammonium hydroxide to the sample. Vortex and mix on a shaker table (or equivalent) for 10 min. Allow to settle and/or centrifuge to produce a clear extract.
3) Filter using a filter vial:
    a. Add 20 µL of EIS to a clean filter vial (chamber).
    b. Add 400 µL of clear extract from step 2 (e.g., by adding extract until it reaches the fill line), carefully vortex to mix.
    c. Use filter/plunger part and filter.
4) Transfer 30 µL of filtrate to a ~300 µL polypropylene microvial and dilute to 300 µL with 0.3% methanolic ammonium hydroxide. Add NIS (1.5 µL) to the resulting solution.
5) The extract is now a 10x dilution.
6) Sample is ready for instrumental screening analysis.
7) Calculate results using the equivalent sample weight computed as follows:

$$Equivalent\ Weight = Sample\ weight\ (g) x \frac{0.4\ mL}{20\ mL}$$

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Appendix E: Aqueous Sample Subsampling Instructions

Note: Because some target analytes may be stratified within the sample (e.g., AFFF-contaminated media, surfactants), or adhere to the walls of the sample container, subsampling may only be done on a project-specific basis. Subsampling has been shown to increase uncertainty in PFAS analysis, especially on foaming samples.

If a reduced sample size is required, transfer a weighed subsample using the following subsampling procedure to a 60-mL HDPE bottle and dilute to approximately 60 mL using reagent water. This container is now considered the "sample bottle."

1) Gently invert sample 3-4 times being careful to avoid foam formation and subsample immediately (do not let stand).
2) If foam forms and more than 5 mL is required – pour sample, avoiding any foam.
3) If foaming forms and a volume less than 5 mL is required – pipette from ½ cm below the foam.
4) If no foam forms – pour or pipette based on volume required.

Required Protocol for AFFF and FFF (F3) Concentrates

Samples composed of AFFF or F3 will be subsampled consistently, with approximately **0.02 g of AFFF/F3 material** aliquoted for each discrete sample preparation/analysis; each AFFF or F3 concentrate sample analyzed under DoD direction **must be prepared in duplicate**. After creating and documenting the subsample aliquot, add approximately 60 mL of reagent water, cap the vessel, and shake vigorously by hand for 20-30 seconds. After adding the reagent water and agitating, allow **at least 3 hours** for the subsample aliquot to fully dissolve in the water. If dissolution is incomplete after 3 hours, agitate again and wait another 3 hours; consider applying continuous agitation (orbital shaker) if full dissolution of the aliquot into water requires extended time. Following the extended dissolution time, prepared AFFF/F3 samples should be prepared and analyzed following the routine protocols for aqueous sample processing. Aqueous reporting limits (MDL/LOD/LOQ) will be used, with values adjusted to account for the actual sample aliquot, assuming 1 g/mL; this constitutes a 25,000X nominal adjustment factor for AFFF/F3 reporting limits, relative to nominal aqueous reporting limits.

Pace **STRONGLY DISCOURAGES** clients from sending AFFF concentrate material for analysis; this protocol is designed for "as-prepared" AFFF materials (i.e. pre-diluted to application concentration) and newer generation 'Fluorine Free Foam' (F3) concentrates. If F3 material (concentrate or as-prepared) or as-prepared AFFF material is received, follow the normal routines described in the first paragraph above. If an AFFF concentrate material (usually of a thick gel-like consistency) is received for analysis, the lab shall prepare a 3% (w/w) aqueous solution from the received sample (in the smallest volume feasible) prior to subsampling and diluting 0.02 g for extraction. Handling of AFFF concentrate should ideally be done in an isolated area outside of the PFAS processing area to prevent gross lab contamination. Following the two dilution steps, the nominal adjustment factor for AFFF concentrate material is 833,333X (8.33×10^5) relative to nominal aqueous reporting limits.

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Appendix F: MS/MSD, MS/DUP SAMPLE SELECTION PROTOCOL

Project-specific requirements may include that matrix spikes (MS), matrix spike duplicates (MSD), and/or laboratory duplicates (DUP) be prepared and analyzed with project samples. The client/field team should identify those samples which are designated for these additional QC procedures and provide additional sample material for them. In the event that samples are received for such a project without additional containers for MS/MSD/DUP, prep analysts will select samples to be used for this purpose following a hierarchy of preference, as defined below.

Note: Any kind of blank (Field Blank, Trip Blank, Equipment Blank, Rinsate Blank, etc.) will not be used for MS/MSD/DUP analysis.

1) First preference is to use client-designated samples as MS/MSD samples. This designation should show up on the prep worklist, in the comments. It is possible that SR will miss adding this comment to the sample, but this designation will be present in the COC from the client, on the right side of the COC under “Comments/Remarks/Cooler ID.” When a client designates a sample to be used for MS/MSD analysis, they will typically provide us with more than 2 bottles (often 4, sometimes as many as 6).

2) Lacking a client-designated MS/MSD sample, the next preference is to use any sample received with more than 2 bottles provided. If an analyst selects a set of samples for prep in which none of the samples are client-designated for MS/MSD, the analyst should check for any samples in the set that were received with 3 or more bottles. If there is a sample with 3 or more bottles, pull 3 of them and use one for the parent sample and spike the other two for analysis as MS/MSD samples.

3) Lacking any samples received with 3 or more bottles, the prep analyst must use two different parent samples to create an MS/DUP pair. Find two samples out of the set of samples selected for prep which were received with 2 bottles and pull both bottles for each sample. Pick one sample (pair of bottles) to be used for parent/MS prep and the other sample (pair of bottles) to be used for parent/DUP. The sample selected for parent/MS will have one bottle spiked with targets and one prepped as normal, with no added spiking. The bottle which is spiked should be identified in the LIMS as MS. The sample selected for parent/DUP will have both bottles prepared following normal procedures but one of the two should be identified in the LIMS as DUP.

4) If all samples in a particular prep batch were all received in just one bottle, analysis of an MS/MSD or MS/DUP pair will not be possible. This should be an uncommon occurrence, as prep analysts will attempt to adjust batching to ensure that every prep batch contains an MS/MSD or MS/DUP for projects which require the additional QC.

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Appendix G: Aqueous Sample Management Decision Guide

NOTE: No TSS pre-test will be performed on aqueous samples received for 1633 analysis.

Per Method 1633, Section 11.1.1.5, “laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions.” Follow the guide below to evaluate aqueous sample matrices for solid material and determine the appropriate preparation approach; a matching decision tree is included at the end of this appendix.

If potential interferences other than settled solids are observed, take action to mitigate the impacts on data quality. Examples of other sample characteristics that could lead the lab to take precautionary measures with a field sample (i.e., prepare from reduced volume) include: presence of standing foam in the sample after shaking, thick/viscous matrix, collected from a known highly contaminated site/project, client notes indicating potential high concentrations, and knowledge of potential hazards to safety, equipment performance, or process integrity due to sample composition. Consider any visible indications of particulate matter including settled solids collected on the bottom of the container, cloudiness and/or dark color of the sample, suspended solids within the sample, increased viscosity, etc. If uncertain, seek a second opinion from another analyst, supervisor, or operations director; these matrix characteristics may require reduced-volume extraction. The lab will attempt to use the largest volume possible (i.e., the smallest reduction possible) when performing a reduced-volume extraction to manage challenging matrix characteristics, and no less than 1 mL of sample will be used in this case.

1) Allow samples to sit for at least 15 minutes to allow solids in the matrix to settle to the bottom of the container.

2) Visually inspect each sample for settled solids collected in the bottom of the container and follow the appropriate protocol based on observation:

    a. If no solids are observed in the bottom of the container, proceed to step 3.

    b. If solids are observed in the bottom of the container with an approximate depth <1/2 cm (<5 mm), proceed to step 5.

    c. If solids are observed in the bottom of the container with an approximate depth >1/2 cm (>5 mm), proceed to step 7.

    d. If solids observed in the container make up approximately 5% or more of the total sample volume, proceed to step 9.

No Settled Solids Observed:

3) Do not take any additional action to prepare for extraction and follow routine protocols.

4) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

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a. Document the inability to load the entire sample volume due to cartridge clogging. If the resulting EIS recoveries are below the method acceptance ranges, this documentation provides the rationale for re-extraction from reduced volume.

b. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample. Submit the sample for re-extraction from reduced volume. Notify the group leader and prep team of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.).

Settled Solids Depth <1/2 cm Observed:

5) Do not take any additional action to prepare for extraction and follow routine protocols; however, be aware that there is a higher probability that the SPE cartridge will clog, and care must be taken in sample loading to attempt to pass the entire sample through the sorbent.

6) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

a. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

b. Document the inability to load the entire sample volume due to cartridge clogging. If the resulting EIS recoveries are below the method acceptance ranges, this documentation provides the rationale for re-extraction following centrifugation; however,

c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample. Submit the sample for re-extraction with sample centrifugation (See Aqueous Sample Centrifugation Protocol in Appendix H). Notify the group leader and prep team of this necessity.

i. If, in the judgment of an experienced analyst, the nature of the solids present in the sample is of a nature that would preclude successful centrifugation and decantation, the decision should be confirmed with the group supervisor and/or another experienced analyst; once confirmed, the sample is submitted for re-extraction from reduced volume. Notify the group of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.).

ii. If the centrifuged sample clogs the cartridge in the second extraction, see step 6 above; if there is sufficient sample remaining for another re-extraction, submit the sample for re-extraction from reduced volume as described in (i) above. If there is not sufficient sample remaining for another re-extraction, narrate any quality exceedances and report data for all runs.

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Settled Solids Depth >1/2 cm Observed:

7) The sample will need to be centrifuged before performing SPE. Instead of following the routine sample extraction procedures, refer to Appendix H for the Aqueous Sample Centrifugation Protocol.

8) Document the decision to centrifuge the sample prior to SPE.

    a. If resulting EIS recoveries are below the method acceptance ranges, this documentation provides evidence that the results are impacted by matrix interference.

        i. Report the data with a narrative statement explaining that the results are matrix-impacted.

        ii. Alternately, submit the sample for re-extraction from reduced volume to attempt to provide data with compliant EIS recoveries.

    b. If the decanted sample clogs the SPE and prevents successful collection of the extract, document that detail and submit the sample for re-extraction from reduced volume. Notify the group of this necessity and, based on the total volume loaded in the first extraction attempt, provide a suggested reduction factor (i.e., reduce volume 5X, 10X, 20X, etc.) for the re-extraction.

Settled Solids Observed to be ≥ 5% of Total Volume:

9) Shake the sample to thoroughly homogenize it, then immediately subsample 1 mL into a pre-labeled 50mL centrifuge tube and add reagent water to approximately 40 mL. At 5% solids, a sample contains 50,000 mg/L, so 1 mL contains 50 mg of solid material.

10) Spike the diluted subsample with EIS as normal and proceed with extraction.

11) If the SPE cartridge begins to clog during sample loading (see Identifying Cartridge Clogging section below), abandon loading of the remaining sample volume and proceed to the cartridge rinsing and drying described in step 10 of Section 9.3.4.

    a. Document the inability to load the entire sample volume due to cartridge clogging.

    b. The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.

    c. If the cartridge clog prevents the cartridge rinses or elution solvent from passing through the cartridge, document that an extract could not be collected for that sample.

12) If the cartridge clogs during extraction and causes failing results, the lab will contact the client and notify them that sample extraction failed due to the nature of the matrix, and that they must decide between two options for reprocessing the sample:

    a. Apply biosolid matrix protocols, following Sections 9.3.6 through 9.3.8 of this SOP. Use 0.5 g of sample for extraction; do not submit for % solids analysis and report results as ng/g, on a wet weight basis.

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b. Attempt to separate and analyze the aqueous and solid phases separately. If the client selects this option, follow the protocol detailed in Appendix I.

Identifying Cartridge Clogging

During the loading phase of the SPE process, some samples may cause their cartridges to clog, preventing the entire sample from being loaded through, and sometimes preventing an extract from being collected. If you have a sample that slows down considerably during the loading process, you may need to abandon loading the remainder of the sample. The goal is to stop the process before the cartridge seizes up completely, so that a sample extract can still be collected from the cartridge.

When Clogs Start

Some of the first visual indications of a cartridge becoming clogged include: discoloration of the cartridge frit and/or sorbent bed, reduced drip rate of the sample through the cartridge, and coloration or sedimentation on the bottom of the reservoir.

When a cartridge starts to clog, it is important to stop the process before the cartridge seizes up completely. Take the actions listed below; an evaluation must be made to decide whether each cartridge can reasonably be used further without seizing up completely.

- Do not continue to add any more sample volume to the reservoir of the clogging cartridge.
- If there is substantial volume remaining in the reservoir (i.e., > 10 mL) and the cartridge is in apparent imminent danger of seizing completely, close the manifold port to stop sample loading. Carefully remove the cartridge-adaptor-reservoir assembly for the sample in question and pour whatever sample volume remains in the reservoir back into the original sample bottle. This volume will be included in the evaluation of extracted sample volume (initial volume).
- If the reservoir on the clogging cartridge empties before the other samples have finished loading, close the manifold port to prevent the cartridge from drying.
- If sample volume remains in any of the slowed cartridges after the loading of the other samples is finished, close all the manifold ports and focus pressure on the slowed cartridge in an attempt to load the volume remaining in the reservoir. (Do this one at a time for multiple clogs.) If the cartridge appears to be in imminent danger of seizing up completely, do not attempt to load the volume remaining in the reservoir; follow the steps in the second bullet of this section.

Abandoning Sample Loading

If the decision is made to abandon sample loading, take the following actions. Some of these are partial duplicates of the actions listed in the section above.

- If any sample remains in the reservoir, carefully remove the cartridge-adaptor-reservoir assembly for the sample in question and pour whatever sample volume remains in the reservoir back into the

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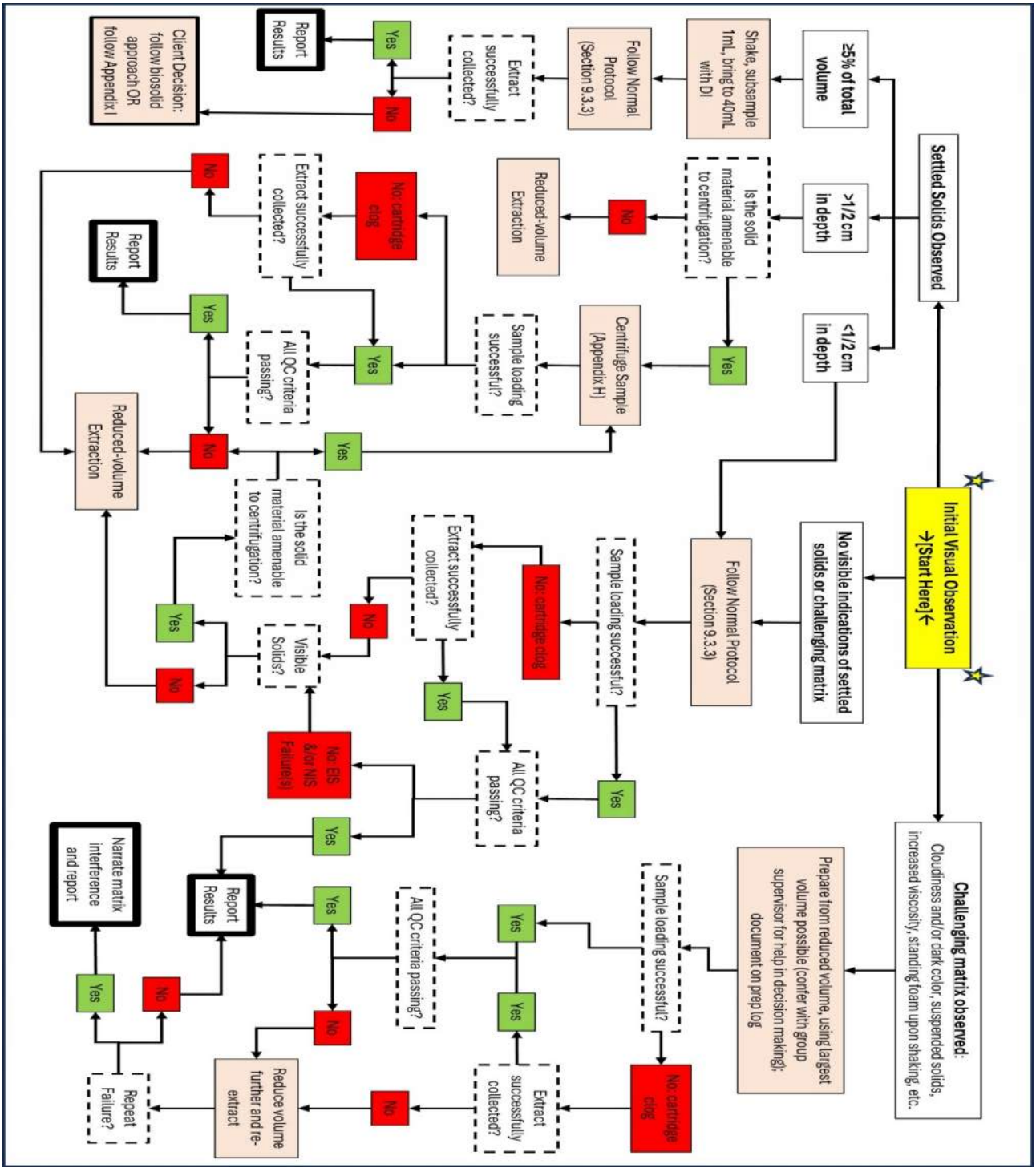
original sample bottle. This volume will be included in the evaluation of extracted sample volume (initial volume).

- Use the cartridge from the abandoned sample and finish the SPE process to collect what extract is available.
- The sample bottle rinse described in step 12 of Section 9.3.5 must be omitted; simply add the 5 mL of 1% methanolic ammonium hydroxide directly to the reservoir/cartridge.
- Weigh the sample in its original bottle to establish the “empty bottle” weight (aka post-extraction weight).

Fully Clogged Cartridges

Samples will have to be re-extracted when cartridges clog so fully that the extraction process cannot be taken to completion to collect a sample extract. Based on the total volume loaded in the failed extraction attempt, provide a suggested reduction factor for the re-extraction (i.e., reduce volume 5X, 10X, 20X, etc.) The sample should be shaken up before subsampling for the reduced volume re-extraction. However, for samples containing solids that are very fine and easily suspended, the analyst may consider allowing the sample to settle before subsampling an aliquot for reduced volume re-extraction; this may help prevent cartridge clogging in the re-extraction process.

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Appendix H: Aqueous Sample Centrifugation Protocol

Method 1633 states “laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions,” and “a trained analyst should be able to distinguish samples with very low TSS and focus…on only those samples that might present a risk of clogging.” Therefore, whether an individual sample will require centrifugation for proper preparation will be determined and documented by the preparation analyst, following the guidance in Appendix G. Additionally, the method states “If centrifugation is used to prevent samples with high TSS from clogging the SPE, the EIS compounds must be spiked into the original sample container prior to centrifugation.” This protocol complies with that dictate.

1) Follow Appendix G to evaluate the sample for the presence of solids. Inspect the sample and consider the necessity of centrifuging.
2) If the sample is determined to require centrifugation/decantation, contemporaneously make a note on the prep batch log indicating this fact.
3) Spike samples requiring centrifugation in the same manner and with the same standard volume as samples which will not be centrifuged.
4) Label a 500mL conical centrifuge bottle with the sample ID for each sample that will be centrifuged. Set them in an appropriate rack with the caps removed.
5) Vigorously shake the spiked sample and then quickly pour it into the appropriately labeled centrifuge bottle. Try to ensure that the original sample bottle is devoid of any solid material after the transfer. Be careful to avoid spilling sample during the transfer process. Tightly cap each centrifuge bottle after transfers are complete.
6) Transfer capped centrifuge bottles to the centrifuge rotor, ensuring that the carousel is symmetrically balanced. Close the top and centrifuge at 3000 RPM (~2000 RCF) for 6 minutes.
7) Remove centrifuge bottles and decant the centrifuged liquid from the condensed solids by transferring it back into the original sample bottle. Try to avoid transferring any of the condensed solids from the centrifuge bottle back to the original sample bottle, while maximizing the amount of liquid collected in the sample bottle.
8) Weigh the full, decanted original sample bottle and document in the prep batch log.
9) Extract the decanted sample as normal alongside un-centrifuged samples, through the cartridge rinsing and drying (step 10 of Section 9.3.4).
10) When the SPE cartridges have been dried, rinse the original sample bottle following the protocol in step 12 of Section 9.3.5. Additionally, add 5mL of 1% methanolic ammonium hydroxide (1%-MeOH) to each centrifuge bottle to rinse the inside of them as well as the solids they contain. If the condensed solids become re-suspended while rinsing the bottles, centrifugation may be required. Using a transfer pipet or mechanical pipet, transfer the 1%-MeOH rinse from the centrifuge bottle into the reservoir/SPE cartridge and elute with the original sample bottle rinse into a 15mL conical centrifuge tube.

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11) Add 5 mL of additional 1%-MeOH directly to the SPE reservoir of all batch QC samples (MB/LCS/LLLCS) and elute with the normal bottle rinse. This is to match the volume used for elution of centrifuged field samples in the prep batch.

12) After elution, all sample extracts (client and QC) with additional elution volume shall be concentrated to ~3.5 mL and brought to a final volume of ~4 mL with 1%-MeOH. Concentrate each extract at approximately 55 ºC with N2 flow of approximately 1.2 L/min. Use a reference elution tube to reconstitute to the appropriate volume, like the protocol in step 8 of Section 9.3.6 of this SOP. This extract concentration and reconstitution must be done BEFORE adding acetic acid and NIS to the extracts, as directed in step 14 of Section 9.3.5.

13) Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in step 8 of this appendix, to determine initial sample volume.

14) Add 25 µL of concentrated acetic acid and 20 µL of NIS mix to each sample extract in its collection tube and vortex to mix. Transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

15) Generate a narrative statement noting which samples in the prep batch included centrifugation in the extraction process. Include any additional observations and/or deficiencies that were noted during the centrifugation or extraction process, particularly if any issues were encountered during the sample loading step of the SPE process.

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Appendix I: Separation & Analysis of Liquid-Solid Biphasic Matrices

Method 1633 states “laboratories may utilize other documented strategies for minimizing the disruptions due to SPE clogging and slow extractions, including centrifuging the sample before adding the EIS and treating the supernatant aqueous phase and the solid phase as separate samples.” This will be done only according to client direction or project requirement; see Appendix G for more information regarding management of solids in aqueous samples.

1) If the client has requested to have the sample separated into aqueous and solid phases for analysis, the sample must be logged into the LIMS system separately for both matrices. The resulting solid phase will be reported on a wet weight basis and will not be analyzed for percent solids (aka percent moisture).

NOTE: The LOQ for the resulting solid analysis will depend on the amount of solid material available after decanting – the lab will use ~5 g of material if available, but any reduction in available solids will result in an increase in the reported LOQ.

2) Label a 500mL conical centrifuge bottle with the sample ID for each sample that will be centrifuged. Set them in an appropriate rack with the caps removed.

3) Vigorously shake the sample and then quickly pour it into the appropriately labeled centrifuge bottle. Try to ensure that the original sample bottle is devoid of any solid material after the transfer. Be careful to avoid spilling sample during the transfer process. Tightly cap each centrifuge bottle after transfers are complete.

4) Transfer capped centrifuge bottles to the centrifuge rotor, ensuring that the carousel is symmetrically balanced. Close the top and centrifuge at 3000 RPM (~2000 RCF) for 6 minutes.

5) Remove centrifuge bottles and decant the centrifuged liquid from the condensed solids by transferring it back into the original sample bottle. Try to avoid transferring any of the condensed solids from the centrifuge bottle back to the original sample bottle, while maximizing the amount of liquid collected in the sample bottle.

6) Weigh the full, decanted original sample bottle and document in the prep batch log.

7) Extract the decanted aqueous sample as normal alongside un-centrifuged samples, starting with EIS addition.

8) Label a 50 mL centrifuge tube with the sample ID for each solid phase sample generated from phase separation. Using a wooden tongue depressor or a pre-cleaned metal scoopula, transfer the solid material from the decanted 500 mL centrifuge bottle to the labeled 50 mL tube, targeting 5 g of total sample mass. Record the sample mass transferred to the 50 mL tube – this will be the extracted sample mass used for calculations and reporting. In many cases, re-extraction will not be possible due to limited solid material.

9) Spike the collected solid material with EIS and extract as normal alongside solid samples which were not generated from phase separation.

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Appendix J: TCLP/SPLP by 1633

Clients may submit samples (solid or aqueous) for PFAS following TCLP or SPLP procedures. For solid samples, the TCLP and SPLP procedures are used to simulate the leaching of environmental contaminants over extended periods of time from a solid material into the environment. A subsample of the client's sample is weighed out and combined with a leaching solution and mechanically tumbled for a set period. Each leachate prep method (TCLP: Method 1311 or SPLP: Method 1312) employs a unique leaching solution dictated by the parent methods. After the sample has been tumbled/leached by the Organic prep department, the leachate is filtered by the Organic Prep department and delivered to the PFAS sample holding area. The PFAS department is notified by email when the leachate solutions are ready for PFAS prep. The filtered leachate solutions are prepared by the PFAS prep analysts using the 1633 aqueous prep method, at a 1:5 dilution (100 mL of leachate solution).

1) Samples requested for PFAS by SPLP/TCLP analysis will be batched and leached by the normal SPLP/TCLP procedures used by the Westborough Alpha Organic Prep department. Organic Prep will be the initial responsible party for samples analyzed for PFAS by SPLP/TCLP.

2) When the leaching process is complete, Organic Prep will collect approximately 500mL (at minimum 100mL) of the leachate solutions in clean HDPE containers provided by the Emerging Contaminants department.

3) After collecting the leachate solution, an Organic Prep analyst will filter approximately 500 mL (at minimum 100mL) of each leachate solution using a Flipmate apparatus, using normal protocols for Flipmate filtration.

4) After filtering the leachates, the Organic Prep analyst will deliver the filtrates to the Sample management department for transport to the Emerging Contaminants Department (EC) at the Alpha Mansfield Facility. Leachates will be transferred to the EC department's designated sample storage refrigerator.

5) Samples to be analyzed for PFAS following TCLP/SPLP will appear on a separate PFAS prep worklist, the title of which will contain "SPLP" or "TCLP." From these worklists, PFAS analysts will select the samples to be extracted.

6) Pour ~100 mL of filtrate solution into a pre-labeled HDPE PFAS sample bottle, using the gradations marked on the bottle as a guide. Record the actual amount of filtrate by weighing the sample bottle. LOQs for samples prepared in this way will be ~5X higher than normal Aqueous matrix LOQs.

7) Following the instructions in step 7, use the leachate blank solution (typically has sample ID L0000000-01) to prepare three bottles for use as batch QC. Volume for the leachate blank, LLLCS, and LCS will be recorded as 100 mL.

8) Label and fill a clean 125 mL HDPE bottle with ~125 mL of pre-tested reagent water for use as a typical 1633 MB sample. Volume for the 1633 MB sample will be recorded as 100 mL.

9) After preparing the diluted filtrate, filtrate batch QC, and 1633 MB bottles, follow the normal extraction steps for aqueous matrices. Each sample will be spiked with EIS as normal. The filtrate

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LLLCS and LCS will be spiked with target analytes according to the routine aqueous protocol for LLLCS and LCS target spiking.

10) Leachate batch QC (MB/LLLCS/MS/MSD) are documented in LIMS as leachate blank (MB), and LLLCS (LCS).

11) Following the SPE process, the instrumental analyst will analyze the extracts by the 1633 method, as normal.

12) After processing, reviewing, generating reports for the data, and importing the data into LIMS, the TCLP/SPLP tumble date must be input into the analytical results from the leachate logs.

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Appendix K: Surface Wipe PFAS Analysis by 1633

Clients may submit wipe samples for PFAS analysis by 1633; wipes can be used as a proxy measurement of surface contamination in production facilities, labs, etc. The lab provides sampling kits for users which consist of a 50 mL centrifuge tube paired with a packaged ghost wipe for each surface to be sampled (ghost wipes: Environmental Express Part# SC5000). The wipe is used to swab a defined area of the surface or item of interest and is placed in the accompanying centrifuge tube, which is then capped, labeled, and shipped back to the lab for preparation and analysis.

Used wipe samples are prepared directly in the container in which they are received, following the protocols for solid matrices described in Sections 9.3.6 through 9.3.8; analysis follows normal 1633 routines. No correction will be made for percent solids, and results are reported as ng/wipe.

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Appendix L: Articles of Commerce Analysis via Cryomill Processing

Clients may submit samples of various consumer product materials and 'articles of commerce' for analysis of PFAS contained in the products. To effectively mobilize any PFAS that may be present within the structure of the material, samples must be milled to a fine powder using a cryogenic mill (or Cryomill).

This appendix provides strategies for processing samples obtained from an article of commerce. Common techniques are covered for mechanical size reduction of articles and their sub-units or portions thereof prior to the determination of PFAS in the article or article components via extraction and quantitative analysis. Polymer powders, nanomaterials, fibers, pastes, fluorinated ionomers etc. may not require size reduction if they are known to be sufficiently homogenous and more than 95% of the material passes a 250 µm sieve. Examples of common articles requiring milling prior to extraction and analysis are compacted cakes, melt extruded pellets and molded articles, elastomers and agglomerates, coated wire, textiles, paper, leather, food, and LDPE and polypropylene.

The user shall elect to apply one or more of the approaches, or compendium of approaches, to create homogenous samples suitable for extraction and analysis. Selection of the appropriate technique(s) depends on the article. Alternative methods of mechanical sample preparation can be used, provided that the required particle size (avg. particle size approx. 100 µm) of the sample is achieved without contaminating or compromising the sample.

Sample Processing Equipment and Materials

The following sample processing equipment and materials are required, subject to the type of material being prepared. Conditions for cryogenic fine milling are provided for the Retsch CryoMill, however, alternative cryomilling equipment like the SPEX ® Freezer/Mill may be used for most products.

1) Scissors, heavy plate shears or RetschTM ZM 200 Grinding Mill (Centrifugal Mill) with 6 or 12 tooth stainless steel (SS) rotor and 1 mm stainless steel bottom sieve.
2) Retsch CryoMill (Ball Mill), with SS grinding cartridge and 25 mm grinding ball (50 mL grinding cartridge, 5 g fill), or equivalent cryogenic mill capable of grinding to approximately 100 µm particles.
3) Cleaning brushes (different sizes) and polishing cloths, or cotton balls/swabs
4) Liquid nitrogen (LN2)
5) High purity methanol and ASTM Type I water for cleaning mill parts
6) Ventilated hood, to minimize exposure to fine particles/dusts/aerosols and chemical vapors
7) Ventilated drying oven capable of > 200°C
8) Precision sieves and accessories, nickel mesh, 50 µm and 150 µm sizes

Manual Cutting

If possible, manual cutting with pre-cleaned shears or scissors is suitable for rough cutting and preparation of samples for further reduction by grinding, etc. Recommended maximum sample size is 10

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x 10 mm but will depend on the specification of the equipment used in the subsequent preparation processes.

Fine Grinding by Cryomill

Fine grinding via cryomill is suitable for further mechanical breakdown of samples, grinding material to pieces ~100 µm in diameter. Be careful not to allow the LN2 to come into direct contact with the sample to prevent spattering and sample loss. Thorough cleaning of the mill components between samples is crucial to avoid cross-contamination; see steps 7-11 below for details.

Cryomilling will be performed using a Retsch CryoMill (ball mill) with automatic LN2 feed, as described below:

Sample Type[1]	Cycles	Preset	Frequency (Hz)	PCT (minutes)	MT (minutes)	ICT (minutes)
Elastomers (FKM, FFKM, FEPM, and agglomerates)	1	1	30	Auto	2	NA
Compacted Cake	5	NA	30	Auto	2	2
Melt Extruded Pellets and Molded Articles	7	2	30	Auto	4	2
Coated Wire	3	3	30	Auto	2	2
Textiles, Paper, Leather	3	4	25	10	2.5	0
Food (meat, cheese)	1	5	25	8	2	NA
LDPE and PP	2	6	25	10	2	2

[1] *In most applications, a feed mass of 5 g is used.*
PCT: Precooling time (automatic set)
MT: Milling time
ICT: In-between cooling time

1) In the case of FFKM compounds and articles, care must be taken to avoid excessive energy input as it may lead to cryo-mechanical degradation of the polymer and the creation of mechanoradicals, which can inflate the amount of target substance detected. Filling levels will impact the energy applied in the grinding process and can inflate test results as well.

2) In the case of cured FFKM elastomeric articles, pulverizing the product in a 2-roll mill as commonly used for compounding of elastomers can be an alternate sample preparation method to avoid or reduce the risk of mechanical degradation. Alternative methods for FFKM compounds and articles that do not require cryo-grinding are being investigated.

3) Cryogenically mill the sample powder and sweep out the milled material to collect all the powder. The collected plastic-based sample material should be precision sieved to obtain a sufficiently homogeneous portion of known particle size range of 50 µm to 150 µm, by first sieving material

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through the 150 µm sieve, then the 50 µm sieve (keep contents captured on 50 µm sieve). Size range is 100 + 50 µm (i.e. ~ 100 µm).

4) The collected FKM-, FFKM- and FEPM-based samples are visually inspected for homogenous size, verification via light-scattering is beneficial. Sieving of the samples is not recommended due to materials' elastomeric nature and the potential for particles to re-agglomerate into larger segments over time.

NOTE: Freshly cryomilled samples should either be extracted ASAP (same day) OR placed under frozen conditions (-10° C) ASAP and held under frozen conditions until ready to extract.

5) Make sure to follow the User Manual for installing and removing the grinding jar. This includes the two lock rings on the left side of the mechanism.

    a. Make sure outer LOCK RINGS are loosened.

    b. Screw in the grinding jar (from the right side of the mechanism). Tighten with black plastic tightening aid.

    c. TIGHTEN TWO LOCK RINGS: Outside ring tightened first (hand-tighten only); inner ring tightened second (snug), using the tool.

    d. Perform grinding cycle.

    e. LOOSEN THOSE TWO LOCK RINGS: Inside ring loosened first, outer ring loosened second. To loosen either ring, the tool will be needed because of icing.

    f. Unscrew grinding jar.

    g. When cryomill is not in use, make sure to replace the cooling jacket seal.

6) For extraction of cryomilled materials, follow the solid matrix extraction protocol listed in Sections 9.3.6-9.3.8, using 2 g as the target sample mass instead of 5 g. Sample results will be reported as ng/g, with no moisture correction.

Cleaning Procedure for Mill Components

Thorough cleaning of the mill components between samples is crucial to avoid cross-contamination. The following cleaning procedure is recommended.

7) Remove residual polymer thoroughly with DI water and brush.

8) If necessary, wipe away last polymer residue with clean polish cloth or cotton ball/swab.

9) Rinse all parts with methanol, use an ultrasonic bath as needed.

10) Rinse all parts with DI Water, use an ultrasonic bath as needed.

11) Repeat steps 7-10 as needed.

Analysis and Holding Time

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Matrix	Routine Container	Minimum Sample Amount	Preservation	Holding Time
Fluoropolymers, molded articles, coated wire, pellets, or other Articles of Commerce[1]	Any container or packaging that does not contain PFAS. Target container is a 125 mL PFAS container; however, clients will often send in Ziploc bags or other packaging.	5 g (target weight for clients to send is 20 g).	Can be shipped at any temperature (being an Article of Commerce). Once received in the lab: <6°C (prior to cryomill) Once cryomilled: Frozen Extract storage: <6°C	Sample receipt (or dated collected)[2] to cryomill: 1 year From cryomilling to extraction: 14 days Once extracted: 30 days

[1] Almost any "solid" material is applicable to this approach, as long as it can be manually coarse cut to approximately 5-10 mm in size (half a pea). If the matrix is soft (e.g., gummy bear), a larger feed size can be used.

[2] Often clients do not include "date collected." If none provided, "date collected" becomes "date received."

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Appendix M: Procedure for Total Oxidizable Precursors (TOP)

The following modifications to the referenced SOP are as follows:

Section 7: Water Bath – Capable of monitoring recording to .1 C maintaining 85 C.

Section 8.1: Sodium Hydroxide (NaOH, CAS#: 1310-73-2) – High purity, demonstrated to be free of analytes and interferences.

Potassium Persulfate ($K_2S_2O_8$, CAS#: 7727-21-1) - High purity, demonstrated to be free of analytes and interferences.

Hydrochloric Acid (HCl, CAS#: 7647-01-0) - High purity, demonstrated to be free of analytes and interferences.

Additional table to be added to Section 8

Table 1

Isotope Labeled Standard	Conc. Top Surr Stock (ng/mL)	Vol. of Top Surr Stock (µl)	Final Vol. of Top Surr PDS (mL)	Final Conc. of Top Surr PDS (ng/mL)
$^{13}C_2$-PFOA	50,000	40	4.0	500
$^{13}C_2D_4$-4:2FTS	50,000	80	4.0	1000

For Aqueous samples, prior to Section 10 of SOP 45852, add to each 125 ml sample with Potassium Persulfate until 60 mM (about 2 grams). Add Sodium Hydroxide until the sample is 125 mM (about .625 grams).

Sample should have a pH >12.

Fortify each sample with 20 µl of TOP pre-assay surrogate containing 1 negative control surrogates and 1 positive control surrogates from table 1.

Place sample in a water bath at 85 C for 6 hours.

Remove sample from water bath and adjust pH 6-8 with Hydrochloric Acid.

Following pre-treatment, follow the aqueous extraction protocol from section 10 of SOP 45852 unaltered.

Section 11, An additional calculation is added for the final reporting of the TOP assay results.

TOP Assay = Result of Post TOP assay extraction – Result of analysis from Pre-Top Assay extraction.

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1.0 SCOPE & APPLICATION

This Standard Operating Procedure (SOP) describes the laboratory procedure used by PAS-ELON for the determination of total and adsorbable organic fluorine by combustion ion chromatography (CIC) following EPA 1621 – January 2024. This SOP is applicable to drinking water, surface water, wastewater, groundwater, and other non-potable water solid for the determination adsorbable organic fluorine (AOF) and for solid matrices undergoing direct combustion (i.e., without adsorption) for the determination of total fluorine (TF).

1.1 Target Analyte List, Limits of Detection & Quantitation (LOD & LOQ)

The target analyte(s) that can be determined by this SOP and the associated LOD, LOQ, and RL are provided in the table below:

Analyte	Matrix (units)	LOQ[1]
Total Fluorine (TF)	Solid (mg/kg)	4[2]
Adsorbable Organic Fluorine (AOF)	Water (µg/L)	2[3]

[1] *LOD, LOQ, and RL are always adjusted to account for actual amounts used and for dilution. Values as of effective date of this SOP. LOD, LOQ, and RL are subject to change. Contact quality personnel for current information.*

[2] *Based on 50 mg sample size.*

[3] *Based on 100 mL sample size.*

LOQ's are established in accordance with PAS policies and procedures for method validation, determination of detection limits (LOD), and quantitation limits (LOQ). Refer to laboratory SOP ENV-SOP-ELON-0132 *LOQ_LOD_MDL Determination*, or however named, for additional information.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detected in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detections and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

1.2 Reference Methods & Documents

This SOP is based on reference method EPA 1621 - January 2024. If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modification is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

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1.3 Quantitation Range

The quantitation range for each target analyte in this procedure is defined in Section 9.3.2 Calibration Levels.

2.0 SUMMARY OF METHOD

Aqueous Samples: 100mL of sample is pH adjusted to 5 or above and passed through two 50mg carbon columns placed in series. Inorganic fluoride is removed from the activated carbon by washing with a nitrate solution. The activated carbon is then loaded onto a combustion IC for analysis and reported on a mass/volume basis.

Total Fluorine (TF) Analysis: Between 50 and 100mg of either a liquid or solid sample is weighed out directly onto a ceramic combustion boat and analyzed by combustion IC (no prep or removal of inorganic fluorine). Weights can be adjusted to ensure values within the calibration range. Results are always reported on a mass/mass basis, even if the sample matrix is “liquid” (e.g., AFFF concentrate).

3.0 INTERFERENCES

Solvents, reagents, glassware or plasticware, and other sample processing hardware may yield artifacts and elevated baselines causing misinterpretation of chromatograms. Specific selection of reagents and solvents may be required. All items must be routinely demonstrated to be free from interferences through the analysis of matrix blanks prepared with each batch.

Clean all equipment prior to, and after each use, to avoid fluoride cross-contamination. Typical cleaning solvents used include water, methanol, and methanolic ammonium hydroxide (1%). The residual AOF content of disposable plasticware and filters must be verified by batch/lot number.

The combustion boats must be cleaned by soaking in methanol for at least one hour, scrubbing with cotton swabs, rinsing with reagent water, and stored submerged in reagent water until use to prevent contamination from fluoride present in air particles. Boats must be prebaked before use.

All removable parts of the APU Sim must be cleaned before sample analysis begins, between samples, and at the end of the analysis batch using methanol and then followed by rinsing with reagent water.

All reusable plasticware must be washed with methanol followed by a minimum of two reagent water rinses. When possible, single-use consumables should be utilized.

It is highly recommended that the laboratory record and track which adsorption unit ports are used to process each sample. This may assist the laboratory in tracking possible sources of contamination for individual samples.

All materials used in the analysis must be demonstrated to be reasonably free from interferences by running method blanks with each sample batch (samples started through the extraction process on a given analytical batch to a maximum of 10 field samples).

Each lot of granular active carbon (GAC) adsorption tubes must be tested by analyzing method blanks to ensure that contamination does not preclude AOF quantitation at the reporting limit. There may be background variation within a lot number; therefore, at least four columns from each new lot number must be tested prior to putting the lot number into use.

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Matrix interferences may be caused by contaminants that are co-adsorbed from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water. High levels of co-adsorbed non-fluorine-containing contaminants can cause breakthrough of organofluorine analytes on the GAC.

Samples containing total suspended solids above 100mg/L may clog the GAC columns and adsorption unit lines, which may prevent proper adsorption of the sample. These types of samples will need to be pretreated by following the instructions in Section 9.4.1.

Alcohols, aromatic substances and carboxylic acids may lead to negative interference. Organic carbon above 140mg/L may lead to negative interference by inhibiting quantitative adsorption of halogen bound organic substances to the activated carbon. These effects may be assessed by dilution of the initial sample or spiking the sample with a standard solution at a known concentration.

Inorganic fluoride in the sample may lead to biased high results. The nitrate wash step in this method removes inorganic fluoride at a concentration up to 8mg/L inorganic fluoride in the sample. Samples containing more than 8mg/L of inorganic fluoride should be diluted prior to analysis. In addition, chloride elutes closely with fluoride in the ion chromatography portion of the analysis, which may cause an interference when chloride is present at concentrations greater than 500mg/L. At concentrations higher than 500mg/L, chloride may also compete for adsorption sites in the carbon and prevent fluoride from being adsorbed.

Some organofluorines readily adsorb to surfaces. This method does not mitigate surface adsorption because the use of solvents to rinse sample bottles, tubing, or other surfaces in the adsorption unit also would elute AOF from the GAC. Thus, results may be biased low for organofluorines that are prone to surface adsorption. Additionally, analytical results between different manufacturer's adsorption apparatus may not be comparable due to differences in the numbers of surfaces (e.g., tubing, syringes, etc.) with which the sample comes in contact during sample loading onto the GAC.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and

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environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).

- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

***NOTE**: Perfluorooctanoic acid has been described as likely to be carcinogenic to humans. Pure standards should be handled by trained personnel, with suitable protection for skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.*

It is recommended that the laboratory purchase dilute standard solutions of the analytes in this method. However, if primary solutions are prepared, they must be prepared in a hood, following universal safety measures.

Samples suspected to contain PFAS or other organofluorine compounds are handled using essentially the same techniques employed in handling infectious materials. Well-ventilated, controlled access laboratories are required. Assistance in evaluating the health hazards of particular laboratory conditions may be obtained from State Departments of Health or Labor, many of which have an industrial health service. Each laboratory must develop a strict safety program for handling these compounds.

Personal hygiene – Hands and forearms should be washed thoroughly after each manipulation and before breaks (coffee, lunch, and shift). Avoid the use of hand lotions.

Confinement – Isolated work areas posted with signs, segregated glassware and tools, and plastic absorbent paper on bench tops will aid in confining contamination.

Samples that may contain high concentrations of biohazards must be handled with PFAS- and fluoride-free gloves and opened in a fume hood or biological safety cabinet to prevent exposure. Laboratory staff should know and observe the safety procedures required in a microbiology laboratory that handles pathogenic organisms when handling highly contaminated samples.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate to meet regulatory requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and

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holding time. Refer to laboratory SOP ENV-SOP-ELON-0017 *Bottle Prep*, or however named, for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
Aqueous	3 x 125mL HDPE	100mL	Thermal: ≤6°C Chemical: N/A	Collection to Analysis: 90 Days
Solid	1 x 90mL PP or 1 x 125mL HDPE	10grams	Thermal: ≤6°C Chemical: N/A	Collection to Analysis: 90 Days

[1] *Default container type provided in sample kit.*

Note: Because the method consumes the entire volume of sample, aqueous samples must be collected at least in triplicate to allow sufficient volume for the determination of total suspended solids, inorganic fluoride, residual chlorine, and pH, as well as having sufficient volume for matrix spikes or reanalysis. If a specific program requires the analysis of field replicates and/or spiked samples, additional containers must be collected.

[2] *Amount of sample required for each discrete test. Excludes QC. If lower volume than minimum is available of is provided, then LOQs will be increased proportionally.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-ELON-0100 *Sample Log-in Procedure*, or however named.

After receipt, samples are stored at ≤6°C until sample preparation.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method(s).

7.1 Instrumentation

- Ion Analyzer (Orion Expandable Ion analyzer, EA 920)
  - Fluoride electrode (Orion)
- Adsorption Unit – Analytic Jena APU Sim, Trace Elemental Instruments XPREP A-6, Mitsubishi TXA-04, or equivalent: Capable of loading 125 mL of aqueous sample at a flowrate no higher than 3mL/min on up to three adsorption columns in series. The apparatus must also be capable of washing the columns with sodium nitrate. The apparatus must allow for either manual or automated rinsing of the columns with at least 3mL of reagent water and drying with air.
- CIC Combustion Oven

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  - Software – NSX-2100 v.20.0.3
  - Autosampler – ASC-270LS
  - Automatic Quick Furnace AQF-2100H - HF-210
  - Solution Selector – ES-211
  - Adsorption Unit – GA-211
- Dionex Integrion HPIC
  - Software – Dionex Chromeleon Chromatography Management System, V. 7.2.10 ES
  - Guard Column – Dionex IonPac AG20; P/N 063066
  - Analytical Column – Dionex IonPac AS20; P/N 063065
  - Suppressor – Dionex ADRS 600 2 mm; P/N 088667
  - Carbonation Removal Device – Dionex CRD 200 – 2 mm; P/N 062986
  - Conductivity Detector; P/N 22153-60036

7.2 Support Equipment

- Balances (Mettler Toledo, Model ME104E)
  - Analytical – Capable of weighing 0.1mg
  - Top loading – Capable of weighing 10mg
- Oven – Capable of maintaining a temperature of 103 – 105°C
- Desiccator - Used to store open packages of GAC columns and combustion boats (Bel-ArtTM Cat# F420310000 or equivalent). If storing combustion boats in a desiccator, the GAC columns and combustion boats must be stored separately (i.e., in a different desiccator) to prevent possible cross contamination.
- Vacuum Filtration apparatus

7.3 Supplies

Supplies	Description
Aqueous Sample Collection Bottles	Sample collection bottles—HDPE wide-mouth bottles with screw cap. **Note:** Do not use fluorinated or Teflon® bottles or autovials or lined caps.
Soil Sample Collection Jars	Sample collection bottles—HDPE wide-mouth bottles with screw cap. **Note:** Do not use fluorinated or Teflon® bottles or autovials or lined caps.
Volumetric Flasks	Glass volumetric flasks 100mL, 50mL, and 10mL flasks for CIC analysis.
Pipettes	Eppendorf or plastic disposable pipettes (various sizes).

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Supplies	Description
Ceramic Combustion Boats	Compatible with the combustion system that can accommodate up to 100mg of carbon.
Clear snap cap, polyethylene, 11 mm	Fisher Scientific Cat# 03-375-24E or equivalent
Polypropylene crimp/snap vials, 1 mL	Vials for storing methanol-based PFAS standards (Agilent Cat# 5182-0567 or equivalent)
47 mm Glass Fiber Filters	Used for TSS filtration.
pH paper	Range 0-14, 0.5-unit readability (Whatman® Panpeha™ or equivalent).
Centrifuge Tubes	Polypropylene, with polypropylene caps for storing standards (Fisher Cat# 14-959-49A or equivalent).
Quartz Wool	Used as a pre-filter of samples with > 100mg/L of suspended solids (Fisher Cat# AC451040500 or equivalent).
Graduated Cylinder	Polypropylene, 100mL (Fisher Cat# 3664-0100 or equivalent) used to measure the reagent water used to prepare QC samples.
Pipets and Tips	Pipets with disposable polypropylene or polyethylene tips used for preparing calibration standards.
Glass Columns	Containing 40mg and 50mg GAC with a particle size of 50-150µm (Metrohm Cat# SNG-ICT0008 or equivalent) and compatible GAC column holder assemblies (Metrohm Cat# SNG-ICT0013, or equivalent) Other brands of GAC may be used as long as the background levels are below one-third the regulatory compliance limit and there is no visible carbon migration from the column. Each new lot of GAC columns must be tested prior to using for sample analysis.
Steel Rod	To transfer GAC into combustion boats (Mandel Cat# NS-TX3SCR, or equivalent).

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP ENV-SOP-ELON-0008 *Inventory and Chemical Receipt,* or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared, when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method(s).

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Reagents prepared must be stored in HDPE or polypropylene containers. Proper cleaning procedures must be followed prior to using the containers.

- Methanol – (HPLC grade or better, 99.9% purity), verified by lot number before use, store at room temperature.
- Ammonium Hydroxide, 28-30% w/w purity – ACS Grade, Fisher Chemical (A669S-500 equivalent)
- Methanolic Ammonium Hydroxide, 1% - Add 3.3mL Ammonium Hydroxide (38-30%) to 97mL methanol. Store at room temperature. Replace monthly. Used for rinsing plasticware, glassware, and equipment.
- Potassium hydroxide (KOH), fluoride free, (Fisher Cat# P250-500 or equivalent)
- Potassium hydroxide, 0.5M - dissolve 2.81g KOH in 100mL of reagent water. Store at room temperature, replace after 6 months. Used to adjust sample pH.
- Sodium nitrate (Sigma-Aldrich Cat# 221341 or equivalent)
- Sodium nitrate, 2M – Dissolve 170g of NaNO3 in 1L reagent water, store at room temperature in an amber container or protected by light, replace after 1 year.
- Sodium nitrate wash, 0.01M – Dilute 5mL of 2M NaNO3 into 1L reagent water, store at room temperature in an amber container or protected from light and replace after 6 months.
- Sodium thiosulfate (Alfa AesarTM Cat# A1762936 or equivalent) used to dechlorinate samples.
- Gases
  - Oxygen – 99.999%
  - Argon – 99.999%
- Eluent - Dionex EGC 500 KOH Eluent Generator Cartridge; P/N 075778
- Reagent water – Use MilliQ DI System Type I
- Diethyl-p-phenylenediamine (DPD) Test Kit (Fisher Cat# S72367 or equivalent) or chlorine test strips (Hach Cat# 2745050 or equivalent), for determination of residual chlorine.

8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available.

Standard solutions – Prepare from materials of known purity and composition or purchase as solutions or mixtures with certification to their purity, concentration, and authenticity.

> Note: Standards for the PFAS compounds used in this method are available from Cambridge Isotope Laboratories, Wellington Laboratories, and other suppliers. Listing of specific suppliers does not constitute a recommendation or endorsement for use. All diluted solutions must be stored in HDPE or polypropylene containers that have been thoroughly rinsed with methanol.

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Purchase of commercial standard solutions or mixtures is highly recommended for this method; however, when these are not available, preparation of stock solutions from neat materials may be necessary. If the chemical purity is 98% or greater, the weight may be used without correction to calculate the concentration of the standard. Dissolve an appropriate amount of assayed reference material in the required solvent. For example, weigh 10 to 20mg of an individual compound to three significant figures in a 10mL stoppered volumetric flask and fill to the mark with the required solvent. Once the compound is completely dissolved, transfer the solution to a clean container and cap.

When not being used, store standard solutions as recommended by the vendor. Place a mark on the container at the level of the solution for standards prepared in methanol so that solvent loss by evaporation can be detected. Replace the solution if solvent loss has occurred.

- Sodium Fluoride Stock Standard, 1000mg F-/L, 1mL = 1mg F- (Reagents Specialty Chemicals and Solutions Cat# CF135100-120A or equivalent
- Chloride Stock Standard, 1000 mg Cl-/L (Sigma-Aldrich Cat# 1198970500 or equivalent). Used for peak resolution.
- PFAS Standards – Sodium perfluoro-1-hexanesulfonate (PFHxS) (Wellington Laboratories Cat# L-PFHxS or equivalent) or Potassium perfluoro-1-hexanesulfonate (Cambridge Isotope Laboratories Cat# ULM-12310-1.2, or equivalent)
- AOF is calculated as a concentration of fluoride ion; therefore, the fluoride concentration for the PFAS standard used in the initial demonstration of capability and for spiking samples must be calculated for the compound as follows:

$$C_F = \frac{C_{PFAS} \times \eta_F \times 18.998}{MW_{PFAS}}$$

where,

C_F = Concentration of fluoride ion in PFAS (or non-PFAS) compound in µg/mL

C_{PFAS} = Concentration of the PFAS (or non-PFAS) compound in µg/mL

MW_{PFAS} = Molecular weight of the PFAS (or non=PFAS) compound in g/mol

n_F = Number of fluorine atoms in the compound

18.998 = Atomic weight of fluorine, g/mol

- Fluoride Working Standard, 50mg F-/L – Dilute 5mL of fluoride standard in 100mL reagent water.
- Calibration standard solutions – At least 5 fluoride calibration concentrations spanning the AOF concentration range of interest for linear regression, and 6 concentrations for a second-order calibration model, are required to prepare the initial calibration curve. The lowest level calibration standard must meet a signal-to-noise ratio of 10:1. Prepare the calibration standards by diluting the fluoride working standard in reagent water. A fluoride calibration range of approximately 2.0 µg F-/L to 100 µg F-/L (assuming a 100-mL sample volume) may be used as a starting point for determining the calibration range.
- Adsorption Tube Cleaning Reagents

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- Sodium hydroxide, 1 M – Dissolve 20 g of NaOH (Fisher Cat# S318-100 or equivalent) in 500 mL reagent water, store at room temperature, replace after 1 year.
- Isopropanol (Fisher Cat# A416-1 or equivalent)
- Aluminum oxide powder

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Instrument Setup

9.1.1.1 Routine Instrument Operating Conditions

Dionex IC Parameters	
Separator column:	Dionex IonPac AS20, 2 x 250 mm
Guard column:	Dionex IonPac AG 20, 2 x 50 mm
Flow rate:	0.3 mL/min
Injection volume:	100 µL
Column temperature:	30 °C
Detector cell temperature:	35 °C
Combustion Parameters	
Furnace inlet temperature:	900 °C
Furnace outlet temperature:	1000 °C
Pyrolysis tube:	Quartz tube with ceramic insert and quartz wool
Argon carrier flow:	200 mL/min
Oxygen flow:	400 mL/min
Humidified oxygen flow:	100 mL/min
Water supply scale:	2
Sample boat:	Ceramic
Adsorption solution:	Reagent Water

9.1.2 Support Equipment

Refer to laboratory SOP ENV-SOP-ELON-0129 *Calibration of Support Equipment and Reference Standards*, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.2 Chromatographic Conditions

The chromatographic conditions must be optimized for compound separation and sensitivity. Fluoride must be adequately resolved chromatographically from the water dip (if present). A resolution of at least 1.0 minute is necessary between the fluoride peak and the water dip for proper peak integration. Hydroxide-based eluents do not produce a water dip. Potential

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interferents include chloride concentrations over 500mg/L, constituents in the eluent, and other potential interferences found in the field samples that can elute very close to the fluoride peak; therefore, the chromatographic conditions must be optimized to give a resolution of at least 1.0 minute between the fluoride peak end and the beginning of the chloride and other interfering peaks. A chloride standard with a concentration above the mid-point of the calibration range must be injected together with a mid-level fluoride standard to demonstrate the chloride and fluoride peaks are properly resolved prior to initial calibration.

9.2.1 Dionex Instrument Method with Combustion

Flow	
Type:	Isocratic
Column Flow:	0.300 mL/min
Pressure Limits:	Lower Limit: 200.00 psi Upper Limit: 5000.00 psi

9.2.2 Eluent Generator Options: Multi-Step Gradient

Time	Concentration [mM]	Curve
0.000	8.00	5
3.500	8.00	5
9.000	75.00	9
10.250	75.00	5
10.251	8.00	5
20.000	8.00	5

9.2.3 Combustion Program

Position	Wait Time (sec)	Speed (mm/sec)
90 mm	60	10
End	600	10
Cool	60	40
Home	120	20

9.3 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.3.1 Calibration Frequency

Each IC system must be calibrated after instrument and chromatographic conditions have been established before analysis of samples can take place. The initial calibration must

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be repeated whenever the laboratory takes corrective action that might change or affect the initial calibration criteria (e.g., replacing IC column, replacing suppressor), or if the CCV acceptance criteria have not been met. Otherwise, calibrate every 6 months.

9.3.2 Calibration Levels

Calibration standards are prepared fresh for each calibration.

Calibration Curve Example (may be adjusted to meet LOQ and linear range needs):

CAL Level	Concentration (In Standard // Amt per 200µL Combusted)	Amt 18.2MΩ Water Added (mL)	Amt 50ppm F- Added (mL)	Combusted Concentration (µg/L)[2]
CAL1	0.5 ppm // 100 ng	9.9	0.1	1
CAL2 (LOQ)	1.0 ppm // 200 ng	9.8	0.2	2
CAL3	2.5 ppm // 500 ng	9.5	0.5	5
CAL4	5.0 ppm // 1000 ng	9.0	1.0	10
CAL5	12.5 ppm // 2500 ng	7.5	2.5	25
CAL6	25 ppm // 5000 ng	5.0	5.0	50
CAL7	37.5 ppm // 7500 ng	2.5	7.5	75
CAL8[1]	50 ppm // 10000 ng	0.0	10.0	100

[1] 50ppm standard made from 1000ppm Fluoride Standard Absolute Cat# 54102 100mL, 5mL of standard up to 100mL with 18.2MΩ Water.

[2]200µL of each standard was added and combusted in ceramic boats.

Below is a second calibration table indicating final concentration after combustion.

Cal Level	Equivalency	Amt spiked on boat 0.2 mL (combusted)	Amt of Sample Used	Final Calculation
0.5 ppm // 100 ng	0.5 ppm = 0.5 mg/L or 0.5 µg/mL	0.5 µg/mL x 0.2 mL = 0.1 µg	0.1 L	0.1 µg/0.1 L = 1 µg/L
1.0 ppm // 200 ng (LOQ)	1 ppm = 1 mg/L or 1 µg/mL	1 µg/mL x 0.2 mL = 0.2 µg	0.1 L	0.2 µg/0.1 L = 2 µg/L
2.5 ppm // 500 ng	2.5 ppm = 2.5 mg/L or 2.5 µg/mL	2.5 µg/mL x 0.2 mL = 0.5 µg	0.1 L	0.5 µg/0.1 L = 5 µg/L
5.0 ppm // 1000 ng	5.0 ppm = 5.0 mg/L or 5.0 µg/mL	5.0 µg/mL x 0.2 mL = 1 µg	0.1 L	1 µg/0.1 L = 10 µg/L
12.5 ppm // 2500 ng	12.5 ppm = 12.5 mg/L or 12.5 µg/mL	12.5 µg/mL x 0.2 mL = 2.5 µg	0.1 L	2.5 µg/0.1 L = 25 µg/L

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Cal Level	Equivalency	Amt spiked on boat 0.2 mL (combusted)	Amt of Sample Used	Final Calculation
25 ppm // 5000 ng	25 ppm = 25 mg/L or 25 µg/mL	25 µg/mL x 0.2 mL = 5 µg	0.1 L	5 µg/0.1 L = 50 µg/L
37.5 ppm // 7500 ng	37.5 ppm = 37.5 mg/L or 37.5 µg/mL	37.5 µg/mL x 0.2 mL = 7.5 µg	0.1 L	7.5 µg/0.1 L = 75 µg/L-
50 ppm // 10,000 ng	50 ppm = 50 mg/L or 50 µg/mL	50 µg/mL x 0.2 mL = 10 µg	0.1 L	10 µg/0.1 L = 100 µg/L

9.3.3 Calibration Evaluation

Prior to the analysis of samples, each IC system must be calibrated with a minimum of 5 standard concentrations. The lowest concentration CAL standard should be at approximately three times the MDL. This method calibrates and quantifies using the external standard technique. Standards are injected onto a clean ceramic boat and go through combustion, but not through carbon adsorption. By combusting the calibration standards instead of doing a direct injection into the IC, the calibration compensates for any bias produced by loss of analyte that may happen during combustion of field samples. The calibration model should be either a linear regression (minimum 5 calibration points required) or a quadratic (minimum 6 calibration points required), no higher than 2nd order, and not forced through zero.

Note: More standards for the calibration curve may be used if all calibration criteria can be met. Additional calibration standards at levels lower than the lowest calibration standard listed in the method, may be added to accommodate a lower limit of quantitation if the instrument sensitivity allows. Calibration standards at the high end of the calibration may be eliminated if the linearity of the instrument is exceeded, or at the low end if those calibration standards do not meet the signal to noise ratio criterion of 10:1, as long as the required number of calibration points is met.

9.3.3.1 Curve Fit

Prepare 8 calibration standards with a quadratic or linear fit using the working fluoride standard. Analyze each calibration standard by injecting 200µL into a clean combustion boat. The calculated concentrations of the calibration standards should be within 80 –120% of the concentration true value.

9.3.3.2 Relative Error (% RE)

If using average response factor, RSD (analogous to RSE) is the measure of relative error, and no additional calculations are required. When using average response factor the %RSD for all target analytes in the initial calibration must be ≤20%.

- If quadratic fit is used the %RSE for all target analytes in the ICAL must be ≤20%.

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Refer to Appendix A for acceptance criteria and to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for additional information and calculations.

9.3.3.3 Initial Calibration Corrective Actions

If the instrument linearity or recovery criteria for initial calibration are not met, inspect the system for problems and take corrective actions to achieve the criteria. This may require the preparation and analysis of fresh calibration standards. All initial calibration criteria must be met before any samples or required blanks are analyzed.

9.3.3.4 Initial Calibration Verification (ICV)

After the calibration standards have been analyzed, analyze an ICV. ICV should be the midlevel calibration point. Derived from a secondary standard. Accuracy must be between 80-120% of the intended concentration.

9.3.3.5 Continuing Calibration Verification (CCV)

Prior to the analysis of any samples, analyze a low-level calibration standard. The calibration must be verified by analyzing a continuing calibration verification (CCV) standard at the beginning and at the end of the analytical sequence. The calibration must be verified by analyzing CCV standards prepared from a secondary source. A low-level CCV standard at the concentration of the lowest calibration standard must be analyzed at the beginning of the analytical sequence. A CCV standard at a concentration in the middle of the calibration range must be analyzed every 10 field samples, and at the end of the analytical batch. The percent recovery for both CCV standards should be within 80-120%.

If the CCV criterion is not met, recalibrate the instrument.

9.3.3.6 Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD)

After the CCV and the method blank, analyze the LCS prior to analysis of samples from the same batch to ensure the analytical process is under control. Compute the percent recovery of the analyte.

The LCS recovery should be within 70-130%. If the fluoride recovery meets the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may proceed. If, however, the concentration falls outside of the given range, the adsorption processes are not being performed properly. In this event, correct the problem, re-prepare the sample batch and LCS if sample volume allows.

LCSD will be run every 10 samples only if a client does not request an MS/MSD or if there is not enough sample sent to run MS/MSD. The LCSD will count as the Batch QC duplicate. The LCSD recovery should be within 70-130%.

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9.4 Sample Preparation

Samples containing high levels of suspended solids (e.g., visible particulates) can clog the GAC columns and prevent proper sample adsorption. Therefore, for aqueous samples from unfamiliar sources that contain particulates, total suspended solids can be determined using the procedures in Section 9.4.1.4. Other analytical interferences are residual chlorine, sample pH, and inorganic fluoride. To check for these interferences in samples from unfamiliar sources, follow the sample pre-treatment steps in Section 9.4.1. One sample container must be selected to check for interferences. Any necessary adjustments to the sample based on results from Section 9.4.1 must be made on the container reserved for AOF analysis.

Note: Do not use any fluoropolymer-containing articles or task wipes in these extraction procedures. Use only HDPE or polypropylene wash bottles and centrifuge tubes. Reagents and solvents for cleaning may be kept in glass containers.

9.4.1 Samples Pretreatment

9.4.1.1 pH Verification

Before adsorption, sample pH must be verified to be ≥ 5. Record result on bench sheet, but this value is not reported in the lab report. Using the same sample container used for pre-screening, take an aliquot and check the sample pH with pH paper. If the pH of the sample is below 5, adjust the pH of the sample in the container to be used for AOF analysis with 0.5M potassium hydroxide. Lower molarities of KOH may be used; however, make sure that the final volume of solution used to adjust the pH does not exceed 1mL to prevent diluting the sample.

9.4.1.2 Dechlorination

Test sample for the presence of chlorine using an aliquot from the sample container used for pre-screening and either DPD test kit or chlorine test strip. Record result on bench sheet, but this value is not reported in the lab report. If chlorine is detected, dechlorinate the sample in the container that was designated for AOF analysis using sodium thiosulfate at 5mg of thiosulfate per every 1mg/L of chlorine, prior to sample adsorption.

9.4.1.3 Determination of Inorganic Fluoride

Determine the concentration of inorganic fluoride in the sample, if needed. This may be done by directly injecting a diluted aliquot of well-mixed sample from the pre-screening container used into the IC using the same instrument parameters and procedure as for the calibration standards. A 1:10 sample dilution using reagent water is recommended to prevent damage to the column and minimize the matrix effects for the chromatographic peaks. Alternatively, other recognized procedures for determining fluoride in aqueous samples may be employed, including off-line 300.0, or ion-selective electrode procedures (sample distillation is not required). Calculate the concentration of inorganic fluoride in mg/L.

Levels of inorganic fluoride > 8mg F-/L may bias the AOF results high. If inorganic fluoride concentration exceeds 8mg F-/L, transfer an aliquot of the sample from the container designated to be used for AOF analysis, to a new

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PFAS-free HDPE or polypropylene container, and dilute it with reagent water (final volume of sample must be 100 mL) to reduce the concentration of inorganic fluoride to just below 8mg F-/L. The lowest dilution possible must be targeted to prevent overdiluting the analytes of interest.

Note: Transferring a sample aliquot between the parent container and a secondary container for the purpose of sample dilution may result in loss of analyte due to the propensity of organofluorines to adhere to surfaces.

Follow the local lab method for Inorganic Fluoride refer to SOP ENV-SOP-ELON-0090 *Fluoride*

9.4.1.4 Determination of Total Suspended Solids (TSS)

Aqueous liquids or multi-phase samples consisting of mainly an aqueous phase. Choose one sample container to perform TSS analysis as described below. Separate this container and do not use the leftover sample for AOF sample processing.

- Desiccate a glass-fiber filter and weigh to three significant figures.
- Filter 20.0 ± 1.0mL of well-mixed sample through the filter.

***Note**: The purpose of this analysis is simply to minimize the risk of clogging the GAC column from samples with TSS content on the order of 100mg/L. Therefore, the volume of sample employed here was selected to identify samples high in TSS and still be representative of the bulk sample collected. The TSS result is not used in calculation of the AOF result itself.*

Follow the local lab method for TSS calculation refer to SOP ENV-SOP-ELON-0095 *TSS SM 2540D*.

9.5 Sample Processing

The procedure requires the preparation of the entire sample. Smaller sample volumes may be analyzed for samples containing solids greater than specified for this method, or when unavoidable due to high levels of organofluorine; however, subsampling should be avoided whenever possible. Typical sample size is approximately 100mL.

For samples containing > 100mg/L of TSS, a piece of quartz wool should be placed inside an empty column holder ahead of the GAC columns and used as a prefilter to prevent the GAC columns from clogging. The prefilter must be washed with the nitrate wash solution and combusted in the same manner as the GAC columns. The concentration from the prefilter must be added to the concentration of the GAC columns.

When a sample is processed using quartz wool as prefilter, a quartz wool blank is required to be prepared with the batch because the prefilter material will add to the background fluoride levels in the sample. A piece of quartz wool of similar size as that used for the sample, rinsed with 25mL of 0.01M sodium nitrate and 20mL reagent water, must be combusted separately as a prefilter blank. The total fluoride of the prefilter blank and the method blank must be subtracted from the sample results.

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Prepare the method blank and one LCS using reagent water in HDPE or polypropylene bottles. Select a volume of reagent water that is typical of the samples in the batch. Spike the LCS sample with PFHxS at the concentration of the mid-level calibration point.

Spike the MS and MSD samples directly in the original bottles at the mid-level calibration point using PFHxS. Adjust the spiking level and the sample dilution to keep the expected results for these two aliquots within the calibration range of the instrument.

Weigh each sample and MS/MSD bottle (with the lid) to 0.1g. The final volume of the aqueous sample analyzed is determined by weighing the full sample bottle and then the empty sample bottle.

Add 0.5mL of 2M sodium nitrate to each field sample, method blank, LCS, MS, MSD, and any other QC sample containers. Mix by inverting the containers 3–4 times.

Place two GAC columns in tandem in the column holder apparatus of the adsorption unit. Opened packages of GAC columns must be kept tightly sealed and stored in a desiccator to minimize possible contamination from laboratory air.

Load the sample onto the GAC columns at a flowrate of no more than 3mL/min. The typical volume of sample is 100mL, but because the sample containers allow collection of volumes up to 125mL, the adsorption unit should be set up to consume the entire volume of sample if possible. Monitor for leaks throughout the column holder assembly.

After sample loading is complete, wash both GAC columns and the pre-filter material, if used, with 25mL of 0.01M sodium nitrate to remove inorganic fluoride.

Rinse both columns and quartz wool, if used, with approximately 20mL of reagent water to remove any residual nitrate. This rinse also helps to prolong the life of the pyrolysis tube by decreasing the potential for devitrification. Dry the columns and quartz wool, if used, using at least 3mL of air using the syringe. Remove the GAC columns from the column holders. If samples are not to be combusted immediately, store columns in a desiccator at room temperature no longer than 5 days.

Determine the final volume of each field and QC sample used by weighing the empty sample bottle (with the lid) to 0.1g and subtracting the final weight from the initial weight. In calculating the sample volume, assume a sample density of 1.0g/mL.

Flush the sample transfer lines with 40mL DI water, 40mL of methanol and another 40mL reagent water to ensure that all surfaces in contact with samples are free from contamination from previous samples/QC.

Push active carbon into ceramic weigh boats for analysis. Remove glass wool from boat.

9.6 Sample Analysis

***Note**: Because short-chain PFAS compounds are poorly retained on GAC, whenever the laboratory analyzes samples from new sources or new clients, at least one sample must be analyzed by separate combustions of the top and bottom columns. Likewise, projects involving mass balance requests must be analyzed by separate combustion of the top and bottom columns. In these cases, the laboratory must calculate and assess percent breakthrough to confirm that the GAC column capacity has not been exceeded.*

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In addition, whenever a new lot number of GAC columns is received, it must be lot tested for the presence of AOF, and all such testing must be performed with separate combustions of the top and bottom columns and the percent breakthrough calculated.

However, when the laboratory consistently analyzes samples from the same sources for the same clients, a single combustion of the top and bottom GAC columns is permitted.

Instrument operating conditions must have been set, and an initial calibration performed prior to analyses of any field samples. The same instrument operating conditions used for the initial calibration must be used to analyze field and QC samples.

Equilibrate the IC system by priming the IC, setting the pump flow rate with eluent, suppressor, and CR-TC on until a stable baseline is obtained, typically 1 hour. The gas and the water to the combustion unit needs to be turned and let stabilize for about 30 minutes. Because fluoride from the air can accumulate in the combustion tube while the instrument sits idle for any period of time, at least two empty combustion boats must be combusted prior to analysis of any sample to clear fluoride from the system.

Perform a calibration verification check prior to sample analysis.

9.6.1 Sequence Preparation

Transfer the carbon from each column into separate combustion boats using the column rod. When pushing the carbon into the combustion boats, push from the bottom of the column to ensure that the transfer rod does not come in contact with any particulates that may have collected on the capping material at the top of the carbon column. If doing separate combustions of the columns, do not mix the order of the columns (top column vs. bottom column) so that the percent breakthrough can be properly calculated. If quartz wool was used for prefiltration, it must be combusted in a separate combustion boat. Place the combustion boats in the autosampler of the CIC using clean forceps.

The combustion boats must be cleaned using the pre-bake setting on the CIC. Clean combustion boats should be stored in a desiccator or submerged in reagent water to reduce buildup of organofluorine on the boats from laboratory air. If boats are not immediately reused from the previous night's run, 2 or 3 should be verified to be still clean by running them as boat blank runs through the combustion IC program/sequence. Boats should be used within 3 days of baking.

9.6.2 Routine Analytical Sequence

The analytical sequence for a batch of samples analyzed during the same time period is as follows. Standards must be brought to room temperature before use.

1. Boat Blank Checks (at least 2)
2. Continuing Calibration Verification (CCV) – Low Level
3. Method Blank
4. LCS
5. Samples (10 or fewer)
6. MS
7. MSD
8. Continuing Calibration Verification – Mid Level

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If the results are acceptable, the results from the closing calibration verification analysis (#10 above) may be used as the opening analysis for the next analytical sequence, beginning with a new method blank. If 24 hours have passed since the beginning of the analytical sequence, the next analytical sequence must begin with a low level CCV.

If the fluoride response exceeds the calibration range for any sample, the sample must be re-adsorbed using a lower sample volume, if there is sufficient volume available.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

Organofluorine is positively identified in a blank, sample, or QC sample if the retention time (RT) falls within the window established in Section 10.2.4 of EPA Method 1621, centered on the RT from the opening CCV.

10.1.1 Estimating sample concentration

EPA has classified this procedure as a screening method that may be used to estimate the aggregate contributions of the organofluorine compounds in the sample. Because of the common occurrence of background levels of fluoride in the sorption media, the method subtracts the amount of fluoride observed in the method blank from the fluoride in the sample to estimate the AOF attributable to the sample itself. This type of background subtraction, while not permitted in many other EPA methods, is not unique to this procedure, and is a fundamental aspect of the method-defined parameter that is AOF. Moreover, the fluoride background levels in the GAC are likely to result in a method detection limit driven by the MDLb rather than the spiked sample MDLs value.

***Note**: The blank subtraction process inherent in this method may yield negative concentrations for samples that have low concentrations. See section 10.3 for instructions on how to report such results.*

10.1.1.1 Reporting of Analytical Results

The data reporting practices described here are focused on using a screening method for NPDES monitoring needs and may not be relevant to other uses of the method. Because of the inherent blank subtraction involved in this screening method, the calculation may yield negative values. Therefore, the reporting practices below differ from those in most other EPA methods.

Report results in µg F-/L. Other units may be used if required in a permit or for a project. Report all QC data with the sample results.

10.1.2 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006,

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Manual Integration. Refer to this SOP for guidance on manual integration techniques and required procedures.

10.2 Calculations

10.2.1 Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n} \frac{\left[\frac{x_i' - x_i}{x_i}\right]^2}{n-p}}$$

Where,
x_i = Nominal concentration (true value) of each calibration standard
x'_i = Measured concentration of each calibration standard
n = Number of standard levels in the curve
p = Type of curve (2 = linear, 3 = quadratic)

10.2.2 Method Blank AOF Concentration

AOF (*µg* F-/L) = (C_{MB} x V_{abs} / V_{MB})

Where:

AOF = Concentration of adsorbable organic fluorine in µg F-/L
C_{MB} = Method blank measured concentration (sum of top and bottom GAC) reported without volume corrections
V_{abs}= Total volume of absorption solution in mL of the sample prior to injection to IC
V_{MB} = Volume in mL of method blank adsorbed

10.2.3 Percent Recovery

Laboratory Spike

$$\text{Recovery (\%)} = \frac{Concentration\ found}{Concentration\ Spiked} \text{ X } 100$$

Matrix **S**pike

$$\%R = C_{MS} - C_n/C_s(DF \text{ X } 100)$$

Where:

C_{MS} = MS measured concentration (top and bottom GAC, blank corrected)
C_n = Concentration of the unfortified sample (top and bottom GAC, blank corrected)
C_s = Spiked concentration
DF = Dilution factor. If no dilution was performed, DF = 1.

10.2.4 Relative Percent Difference

$$RPD = \frac{|MS - MSD|}{(MS + MSD)/2} \text{ x } 100$$

Where:

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MS = Percent recovery of the MS
MSD = Percent recovery of the MSD

10.2.5 Single Combustion

For single combustion analysis, calculate the AOF concentration as a sum of the fluoride mass on the GAC columns and prefilter (if used), adjusted by subtracting the method blank and prefilter blank (if used), using the data software package for the CIC and the multipoint calibration. Alternatively, the equation below can be used to calculate the AOF concentration if the data software package will not perform the calculation. Do not use the daily calibration verification data to quantitate AOF in samples.

$$AOF\ (\mu gF^{-}/L) = \frac{(M + QW_s)}{V_s} - \frac{(B + QW_B)}{V_B} \times DF$$

where,
M = Mass measured for field sample, µg F^-
B = Mass measured for method blank, µg F^-
QW_s = Mass measured for sample quartz wool, if used, µg F^-
QW_B = Mass measured for blank quartz wool, if used, µg F^-
V_s = Sample volume adsorbed onto column, L
V_B = Method blank volume adsorbed onto column, L
DF = Dilution factor. If no dilution was performed, DF = 1

10.2.6 Separate Combustions

Calculate the AOF concentration as a sum of the top and bottom GAC columns (and prefilter(s) if used) masses, adjusted by subtracting the sum of the top and bottom columns of the method blank, using the data software package for the CIC and the multipoint calibration.

***Note**: When blank subtracting, the GAC columns of the samples should not be corrected individually by subtracting the individual blank GAC column results (e.g., top sample GAC – top blank GAC) because this may result in negative values if the bottom blank GAC column has a higher concentration than the bottom sample GAC column.*

Alternatively, the equation below can be used to calculate the AOF concentration if the data software package will not perform the calculation. Do not use the daily calibration verification data to quantitate AOF in samples. Adjust the final AOF concentrations to reflect the actual sample volume used.

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$$AOF\ (\mu gF^-/L) = \frac{(M_1 + M_2 + QW_s)}{V_s} - \frac{(B_1 + B_2 + QW_B)}{V_B} \times DF$$

where,
M_1 = Mass measured for first column, µg F-
M_2 = Mass measured for second column, µg F-
B_1 = Mass measured for first column of the method blank, µg F-
B_2 = Mass measured for second column of the method blank, µg F-
QW_s = Mass measured for sample quartz wool, if used
QW_B = Mass measured for blank quartz wool, if used
V_s = Sample volume adsorbed onto column, L
V_B = Method blank volume adsorbed onto column, L
DF = Dilution factor. If no dilution was performed, DF=1

Calculate the percent breakthrough for each column pair, per sample, as follows:

$$\%\ Breakthrough = \frac{(M_2 - B_2)}{[(M_1 - B_1) + (M_2 - B_2)]} \times 100$$

where,
M_1 = Mass measured for the first column, µg F-
M_2 = Mass measured for the second column, µg F-
B_1 = Mass measured for first column of the method blank, µg F-
B_2 = Mass measured for second column of the method blank, µg F-

Percent breakthrough must not exceed 50%. If % breakthrough exceeds the limit, the sample is exceeding the GAC capacity and must be reanalyzed at a lower volume, if sufficient sample volume is available. In situations where the % breakthrough exceeds the limit, but the blank-corrected sample result is less than 3x the laboratory's MDL, reanalysis is not necessary, and the data may be reported with an appropriate qualifier.

10.3 Reporting

Because of the inherent blank subtraction involved in this method, the calculations may yield negative values. Therefore, the reporting practices below differ from those in most other EPA methods. Report results in ug F-/L. Other units may be used if required in a permit or for a project. Report all QC data with the sample results.

10.3.1 Reporting Level

Report adsorbable organofluorine as fluoride in each field sample or QC standard at or above the MDL determined in the laboratory to 2 significant figures. Report any value below the ML and any negative value in a field sample as "<ML," where ML is the concentration of the analyte at the ML, or as required by the regulatory/control authority or permit.

Although the samples are blank corrected, the blank results also must be reported with the data. Report organofluorine as fluoride in a method blank at or above the MDL to 2 significant figures. Report a result for the method blank below the MDL as "<MDL" where the MDL is the concentration of the analyte at the MDL, or as required by the regulatory/control authority or permit.

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11.0 QUALITY CONTROL & METHOD PERFORMANCE

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix A for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 10 or fewer samples. If batch exceeds 10 samples, every 10 samples.
Laboratory Control Sample	LCS	1 per batch of 10 or fewer samples. If batch exceeds 10 samples, every 10 samples.
Laboratory Control Sample Duplicate	LCSD	As required
Matrix Spike	MS	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
MS Duplicate	MSD	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.

11.1.1 Method Blanks

One method blank must be prepared and analyzed with each sample batch to demonstrate freedom from contamination.

Because fluoride contamination in the GAC columns is a significant problem, maintaining a historical record of method blank data is highly recommended. Use the equation, see section 10.2.2, to calculate the method blank AOF concentration if the data system software package does not perform the calculation automatically. Analyze the method blank before the LCS.

The method blank should not exceed 4ug F-/L.

***If Blank is higher than 2ug/L but less than 4ug/L, Blank is reportable with B-flag qualifier. If Blank is higher than 4ug/L, please follow instructions below.**

If AOF is found in the blank: 1) at a concentration greater than the RL for the analyte (*See Above), 2) at a concentration greater than one-third of the regulatory compliance limit, or 3) at a concentration greater than one-tenth of the concentration in a sample in the preparation batch, whichever is greatest, analysis of samples must be halted, and the problem corrected. Other project-specific requirements may apply; therefore, the laboratory may adopt more stringent acceptance limits for the method blank at their discretion. If the contamination is traceable to the lot number of GAC columns, or to contamination of the adsorption unit (e.g., a dirty column position), all affected samples must be re-adsorbed and reanalyzed, provided that enough sample volume is available.

If after sample reanalysis, the new blank still shows contamination, the laboratory must document and report the failures (e.g., as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority. Results associated with blank contamination for an analyte regulated in a discharge cannot be

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used to demonstrate regulatory compliance. QC failures does not relieve a discharge or permittee of reporting timely results.

11.1.2 Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD)

After the CCV and the method blank, analyze the LCS prior to analysis of samples from the same batch to ensure the analytical process is under control. Compute the percent recovery of the analyte, see section 10.2.3.

The LCS recovery should be within 70 – 130%. If the fluoride recovery meets the acceptance criteria, system performance is acceptable, and analysis of samples may proceed. If, however, the concentration falls outside of the given range, the adsorption processes are not being performed properly. In this event, correct the problem, re-prepare the sample batch, and repeat the ongoing precision and recovery test if sample volume allows.

LCSD will be run every 10 samples only if a client does not request an MS/MSD or if there is not enough sample sent to run MS/MSD. The LCSD will count as the Batch QC duplicate. The LCSD recovery should be within 70-130%.

11.1.3 Matrix Spike (MS)

Required at a frequency of one set per adsorption batch of no more than 20 field samples, analyzed after the samples, prior to the closing CCV. Calculate the percent recovery, see section 10.2.3. The matrix spike recovery must be within 50-150%. It is recommended that MS aliquots be spiked at a concentration at or above the mid-level of the calibration curve.

If a client does not request MS/MSD and/or does not send enough sample to run, no MS/MSD will be run, and a case narrative will be added. A LCSD will be ran as the Batch QC duplicate.

11.1.4 Matrix Spike Duplicate (MSD)

Analyzed the MSD after the MS. Calculate the relative percent difference of the recoveries. Calculate the relative percent difference (RPD), see section 10.2.4. The RPD must be ≤30%.

If a client does not request MS/MSD and/or does not send enough sample to run, no MS/MSD will be run, and a case narrative will be added. A LCSD will be ran as the Batch QC duplicate.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	After each ICAL
Continuing Calibration Verification	CCV	Daily, before sample analysis, every 10 samples, and at the end of analytical window.

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Retention Time/Retention Time Window	RT/RTW	New IC column installed and after major maintenance.

11.2.1 Retention Time (RT) & Retention Time Window (RTW)

Establish the retention time (RT) of fluoride by combusting the mid-level standard from the ICAL in triplicate and analyzed under the established IC conditions. The RT windows must be re-established when a new IC column is installed and after major instrument maintenance.

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

Establish Limit of Detection (LOD) and limits of quantitation (LOQ) at initial method set up and verify the LOD and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for LOD and LOQ requirements and procedures.

11.3.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-ELON-0134 *Training Requirements*, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

To establish the ability to generate acceptable precision and recovery, the laboratory must perform the following operations for each sample matrix type to which the method will be applied.

Adsorb and analyze four aliquots of reagent water, spiked with sufficient volume of PFHxS solution to achieve a concentration at or above the mid-point of the calibration curve. One method blank must be prepared with the IDOC batch. All sample processing steps that are to be used for processing samples must be included in this test.

For the IDOC, the RSD must be ≤20% and the average percent recovery between 80-120%. If the RSD and average percent recovery meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. If, however, the RSD exceeds the precision limit or the average percent recovery falls outside the range for recovery, system performance is unacceptable. Correct the problem and repeat the test.

12.0 Data Review & Corrective Action

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

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The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-ELON-0035 *Data Review* for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 Pollution Prevention & Waste Management

Refer to laboratory SOP ENV-SOP-ELON-0013 *Hazardous Waste*, or however named, for waste handling and management practices pertaining to the waste streams created at this facility.

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

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The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

15.0 RESPONSIBILITIES

- PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

16.0 ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table
- Appendix B: EPA 1621 – Combined Combustion
- Appendix C: Total Fluorine by CIC

17.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.
- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.

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- ENV-MAN-ELON-0001, *Quality Manual*, current version.
- TNI Standard, "Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis", current version.
- 40 CFR Appendix B to Part 136, *Definition and Procedure for the Determination of the Method Detection Limit* - Rev 2, August 28, 2017.
- Federal Register/Vol. 77, No. 96/Friday, May 18, 2012/Rules and Regulations – Page 54, section (x.)
- Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, Method 300.0, Revision 2.1, August 1993.
- U.S. Environmental Protection Agency, Method 1621 Determination of Adsorbable Organic Fluorine (AOF) in Aqueous Matrices by Combustion Ion Chromatography (CIC), January 2024, EPA 821-R-24-002.
- Instrument Manual, Thermo Scientific Dionex Integrion HPIC system operator's manual, Rev. 4, August 2016.

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
Appendix D	Addition of AOF Prep Instructions

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
ENV-SOP-ELON-0085	02	Adsorbable Organic Fluorine (AOF) by Combustion IC	05/28/2024

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Appendix A: QC Summary & Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ICAL	As needed	r ≥ 0.995 %RSE ≤20% for all levels of the calibration	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
ICV	After Each ICAL	80-120% of the true value	Identify source of problem, re-analyze. If repeat failure, repeat ICAL.	None. Do not proceed with analysis.
CCV	Daily, low level CCV before sample analysis and mid point CCV at end of analytical window.	± 20% of the true value.	Identify source of problem, re-analyze. Analysis may proceed if it can be demonstrated that the CCV exceedance has no impact on analytical measurements. For example, the CCV %R is high, and the analyte is not detected in sample(s).	Qualify analytes with CCV out of criteria.
Method Blank	One per 10 samples; the method blank value is subtracted from all subsequent sample results (blank subtracted).	Result must be less than 4ug/L per method.	If >LOQ and less than 4ug/L, report with B-flag qualifier. If blank is higher than 4ug/L, reanalyze sample batch and batch QC provided sufficient sample volume remains. If insufficient sample volume remains, consult with the project manager and client on how to proceed. If sample(s) non-detect, report the data. If sample result >10x MB detections, report the data.	Qualify outages and explain in case narrative.

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QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Laboratory Control Sample (LCS)	One per 10 samples	70-130% of the true value	If LCS is <70% all samples affected by the failing LCS need to be re-analyzed. If LCS recovery is > QC limits and these compounds are non-detect in the associated samples, report the data.	Qualify analytes with LCS out of criteria.
Laboratory Control Sample Duplicate (LCSD)	One per 10 samples if there is not enough sample to run for MS/MSD	70-130% of the true value	If LCSD is <70% all samples affected by the failing LCS need to be re-analyzed. If LCSD recovery is > QC limits and these compounds are non-detect in the associated samples, report the data.	Qualify analytes with LCSD out of criteria
MS/MSD	A pair of MS/MSD must be analyzed once per batch of no more than 20 samples.	50-150% of the true value RPD ≤ 20%	If the MS recovery is not within the criteria, and the LCS is shown to be in control, the recovery problem is judged to be matrix related and the results may be accepted. If the concentration of matrix spike is less than 25% of the background concentration of the matrix, the matrix spike recovery should not be calculated. If insufficient volume is received, this will be documented in the case narrative and an LCSD will be performed as Batch QC duplicate.	Qualify analytes with MS/MSD out of criteria.

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Appendix B: EPA 1621 – Combined Combustion

Background:

There will be many instances where a client does not need (or want) the individual combustion option in the method regardless of the sample origin being a new source (for example). This decision will be made with the client PRIOR TO sample receipt and thus affirmed on the COC. In these instances, Pace® will offer to run and report "EPA 1621 – Combined Combustion." Notably, this offering maintains the same procedure, calibration curve, LOQs and DLs as EPA 1621.

- Samples would be logged in and reported using the EPA 1621 – Combined Combustion ACODE.
- The entirety of the base procedure described in this SOP would be followed, with the following exceptions:
  - The two carbon columns would be combined and combusted in a single boat.
  - A breakthrough evaluation would therefore not be determined.

Single (combined) combustion:

For single (combined) combustion analysis, calculate the AOF concentration as a sum of the fluoride mass on the GAC columns and prefilter (if used), adjusted by subtracting the method blank and prefilter blank (if used), using the data software package for the CIC and the multipoint calibration. Alternatively, the equation below can be used to calculate the AOF concentration if the data software package will not perform the calculation. Do not use the daily calibration verification data to quantitate AOF in samples.

$$AOF\ (\mu g F^{-}/L) = \frac{(M + QW_s)}{V_s} - \frac{(B + QW_B)}{V_B} \times DF$$

M = Mass measured for field sample, µg F-
B = Mass measured for method blank, µg F-
QWs = Mass measured for sample quartz wool, if used, µg F-
QWB = Mass measured for blank quartz wool, if used, µg F-
Vs = Sample volume adsorbed onto column, L
VB = Method blank volume adsorbed onto column, L
DF = Dilution factor. If no dilution was performed, DF = 1

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Appendix C: Total Fluorine (TF) by CIC

Background:

There will be instances where a client desires to know the total fluorine content in a solid matrix. Pace® will offer to run and report "Total Fluorine (TF) by CIC." This procedure can be performed using the essential elements of EPA Method 1621 because:

- The solid sample is combusted in the exact same manner as the individual (or combined) 50mg carbon columns.
- The ONLY difference is that if this appendix is used, the results will be presented on a mg/kg basis.
- Being solid matrices and not liquids and being total fluorine and not total (or adsorbable) organofluorine, there is no extraction, adsorption, or need to remove or isolate the inorganic fluoride contribution to the result.
- The calibration curve is the same curve used for EPA Method 1621.

Calculation:

Total fluorine (mg/kg) = M/Vm

Where:

M = Mass measured for sample, µg F-
Vm = Sample mass combusted, mg

Note that the LOQ for this, assuming 50mg of solid material is combusted, is 4mg/kg.

Use of this appendix will not include MDL determination. As such, results will always be reported to the LOQ.

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Appendix D: AOF Prep Instructions:

*Make sure to check waste for module and AOF instrument before starting prep and analysis. Fill up the water container. Check oxygen and argon before putting the instrument to equilibrate.

1. Begin by cleaning APU Sim: add 40 mL of DI to each syringe used.
2. Set sample volume to 45 mL and wash at 0. Press “start”.
3. Add 40 mL of Methanol to each syringe used.
4. Set sample volume to 45 mL and wash at 0. Press “start”.
5. Add 40 mL of DI to each syringe used.
6. Set sample volume at 45 mL and wash at 0. Press “start”.
7. Put carbon columns in column holder.
8. Take beginning weight of bottle of samples and QC’s and enter in Volume by Weight excel.
9. Pour off 100mLs of sample into syringe.
10. Set sample volume on module at 110mLs, wash at 25mLs and flow rate at 3.0 mL/min.
11. Press “start” button on module positions being prepped.
12. Without removing carbon columns, add 10mLs of DI, set sample volume to 20 mL and wash to 0. Press “start”.
13. Remove carbon columns and set in its designated boat.
14. Clean O-rings and Column holders with Methanol and deionized water.
15. Clean APU Sim using the procedure outlined in above steps 1 through 6.

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ATTACHMENT E

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PFAAs via EPA 1633 (SLUDGE)

Holding Time: 90 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	8	2.664	ng/g	70-140	30	70-140	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	4	1.336	ng/g	60-150	30	60-150	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	2	0.6664	ng/g	65-145	30	65-145	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	8	2.664	ng/g	60-150	30	60-150	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	2	0.6664	ng/g	65-140	30	65-150	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	2	0.6664	ng/g	55-160	30	55-160	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	2	0.6664	ng/g	65-145	30	65-145	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	2	0.6664	ng/g	60-150	30	60-150	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	2	0.6664	ng/g	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	8	2.664	ng/g	55-200	30	55-200	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	2	0.6664	ng/g	65-155	30	65-155	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	2	0.6664	ng/g	70-155	30	70-155	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	2	0.6664	ng/g	65-160	30	65-160	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	2	0.6664	ng/g	70-155	30	70-155	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	8	2.664	ng/g	70-150	30	70-150	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	2	0.6664	ng/g	55-140	30	55-140	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA	2355-31-9	2	0.856	ng/g	65-155	30	65-155	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	2	0.6664	ng/g	70-155	30	70-155	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	2	0.6664	ng/g	40-155	30	40-155	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	2	0.6664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	2	0.6664	ng/g	65-165	30	65-165	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	2	0.6664	ng/g	70-150	30	70-150	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	2	0.6664	ng/g	65-150	30	65-150	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	2	0.6664	ng/g	65-150	30	65-150	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pro	13252-13-6	8	2.664	ng/g	70-145	30	70-145	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	8	2.664	ng/g	70-160	30	70-160	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	2	0.6664	ng/g	25-160	30	25-160	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3	756426-58-1	8	2.664	ng/g	70-150	30	70-150	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-	763051-92-9	8	2.664	ng/g	45-160	30	45-160	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	2	0.6664	ng/g	70-155	30	70-155	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	2	0.6664	ng/g	70-140	30	70-140	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	20	6.664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	20	6.664	ng/g	70-135	30	70-135	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	4	1.336	ng/g	30-140	30	30-140	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	4	1.336	ng/g	60-150	30	60-150	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	4	1.336	ng/g	70-140	30	70-140	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	4	1.336	ng/g	60-155	30	60-155	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	10	3.336	ng/g	45-130	30	45-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	50	16.64	ng/g	60-130	30	60-130	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	50	16.64	ng/g	60-150	30	60-150	30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*8-130*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*36-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***

Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

PFAAs via EPA 1633 (SLUDGE)

Holding Time: 90 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-135*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4	*NONE*									*40-165*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-130*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6	*NONE*									*40-215*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8	*NONE*									*40-275*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*40-135*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*40-130*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d	*NONE*									*40-150*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*40-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*20-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13	*NONE*									*40-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*10-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-130*		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol	*1265205-95-5*									*20-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d	*NONE*									*15-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2D4]Hexanesulfonic Acid (13	*NONE*									*0-25*		
Perfluoro-[1,2-13C2]octanoic Acid (13C2-PFOA)	*NONE*									*50-150*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

Date Created: 02/10/25
Created By: Kim L. Bailey
File: PM18601-1
Page: 1

PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	6.4	2.136	ng/l	70-140	30	70-140	30	30			
Perfluorobutanoic Acid (PFBA)	375-22-4	8	2.664	ng/g	70-140	30	70-140	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	4	1.336	ng/g	60-150	30	60-150	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	3.2	1.064	ng/l	65-135	30	65-135	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	2	0.6664	ng/g	65-145	30	65-145	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	1.6	0.536	ng/l	60-145	30	60-145	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	8	2.664	ng/g	60-150	30	60-150	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	6.4	2.136	ng/l	70-145	30	70-145	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	2	0.6664	ng/g	65-140	30	65-140	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	2	0.6664	ng/g	55-160	30	55-160	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	2	0.6664	ng/g	65-145	30	65-145	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	2	0.6664	ng/g	60-150	30	60-150	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	1.6	0.536	ng/l	65-145	30	65-145	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	2	0.6664	ng/g	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	8	2.664	ng/g	55-200	30	55-200	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	6.4	4.816	ng/l	65-155	30	65-155	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	2	0.6664	ng/g	65-155	30	65-155	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	2	0.6664	ng/g	70-155	30	70-155	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	1.6	0.536	ng/l	55-150	30	55-150	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	2	0.6664	ng/g	65-160	30	65-160	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	1.6	0.536	ng/l	70-140	30	70-140	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	2	0.6664	ng/g	70-155	30	70-155	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	8	2.664	ng/g	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	6.4	2.136	ng/l	60-150	30	60-150	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	2	0.6664	ng/g	55-140	30	55-140	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA	2355-31-9	2	0.856	ng/g	65-155	30	65-155	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA	2355-31-9	1.6	0.536	ng/l	50-140	30	50-140	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	2	0.6664	ng/g	70-155	30	70-155	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	1.6	0.536	ng/l	60-145	30	60-145	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	2	0.6664	ng/g	40-155	30	40-155	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	2	0.6664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	2	0.6664	ng/g	65-165	30	65-165	30	30			

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PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorododecanoic Acid (PFDoA)	307-55-1	1.6	0.536	ng/l	70-140	30	70-140	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	2	0.6664	ng/g	70-150	30	70-150	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	2	0.6664	ng/g	65-150	30	65-150	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	2	0.6664	ng/g	65-150	30	65-150	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	1.6	0.536	ng/l	60-140	30	60-140	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pro	13252-13-6	8	2.664	ng/g	70-145	30	70-145	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pro	13252-13-6	6.4	2.136	ng/l	70-140	30	70-140	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	6.4	2.136	ng/l	65-145	30	65-145	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	8	2.664	ng/g	70-160	30	70-160	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	2	0.6664	ng/g	25-160	30	25-160	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	1.6	0.536	ng/l	50-145	30	50-145	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3	756426-58-1	8	2.664	ng/g	70-150	30	70-150	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3	756426-58-1	6.4	2.136	ng/l	70-155	30	70-155	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-	763051-92-9	6.4	2.136	ng/l	55-160	30	55-160	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-	763051-92-9	8	2.664	ng/g	45-160	30	45-160	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	2	0.6664	ng/g	70-155	30	70-155	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	1.6	0.536	ng/l	60-150	30	60-150	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	2	0.6664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	16	5.36	ng/l	70-145	30	70-145	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	20	6.664	ng/g	70-140	30	70-140	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	16	5.36	ng/l	70-135	30	70-135	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	20	6.664	ng/g	70-135	30	70-135	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	3.2	1.064	ng/l	55-140	30	55-140	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	4	1.336	ng/g	30-140	30	30-140	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	4	1.336	ng/g	60-150	30	60-150	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	3.2	1.064	ng/l	60-150	30	60-150	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	3.2	1.064	ng/l	70-140	30	70-140	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	4	1.336	ng/g	70-140	30	70-140	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	3.2	1.064	ng/l	50-150	30	50-150	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	4	1.336	ng/g	60-155	30	60-155	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	10	3.336	ng/g	45-130	30	45-130	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	8	2.664	ng/l	65-130	30	65-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	50	16.64	ng/g	60-130	30	60-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	40	13.36	ng/l	70-135	30	70-135	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	50	16.64	ng/g	60-150	30	60-150	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	40	13.36	ng/l	50-145	30	50-145	30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*5-130*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*35-130*		
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*5-130*		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-150*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
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Date Created: 02/10/25
Created By: Kim L. Bailey
File: PM18601-1

PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4	*NONE*									*40-300*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*40-130*		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-135*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4	*NONE*									*40-200*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-140*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6	*NONE*									*40-300*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-145*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6	*NONE*									*40-200*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8	*NONE*									*40-300*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*30-150*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8	*NONE*									*40-300*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*20-140*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*40-170*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d	*NONE*									*20-140*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*30-130*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*40-130*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*40-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*10-160*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d	*NONE*									*25-135*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*10-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13	*NONE*									*40-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*10-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*20-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13	*NONE*									*40-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*20-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*10-130*		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol	*1265205-95-5*									*25-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d	*NONE*									*20-130*		

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PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol	*1265205-95-5*									*10-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (c	*NONE*									*10-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. (Soil/Solids only)
Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

Date Created: 02/10/25
Created By: Kim L. Bailey
File: PM18601-1
Page: 1

PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	6.4	2.136	ng/l	70-140	30	70-140	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	3.2	1.064	ng/l	65-135	30	65-135	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	1.6	0.536	ng/l	60-145	30	60-145	30	30			
1H,1H,2H,2H-Perfluorohexanesulfonic Acid (4:2FTS)	757124-72-4	6.4	2.136	ng/l	70-145	30	70-145	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluoropentanesulfonic Acid (PFPeS)	2706-91-4	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	1.6	0.536	ng/l	65-145	30	65-145	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	6.4	4.816	ng/l	65-155	30	65-155	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	1.6	0.536	ng/l	70-150	30	70-150	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	1.6	0.536	ng/l	55-150	30	55-150	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	1.6	0.536	ng/l	70-140	30	70-140	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	6.4	2.136	ng/l	60-150	30	60-150	30	30			
Perfluorononanesulfonic Acid (PFNS)	68259-12-1	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA	2355-31-9	1.6	0.536	ng/l	50-140	30	50-140	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	1.6	0.536	ng/l	60-145	30	60-145	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	1.6	0.536	ng/l	70-145	30	70-145	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	1.6	0.536	ng/l	70-140	30	70-140	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	1.6	0.536	ng/l	65-140	30	65-140	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	1.6	0.536	ng/l	60-140	30	60-140	30	30			
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-Pro	13252-13-6	6.4	2.136	ng/l	70-140	30	70-140	30	30			
4,8-Dioxa-3h-Perfluorononanoic Acid (ADONA)	919005-14-4	6.4	2.136	ng/l	65-145	30	65-145	30	30			
Perfluorododecane Sulfonic Acid (PFDoDS)	79780-39-5	1.6	0.536	ng/l	50-145	30	50-145	30	30			
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid (9Cl-PF3	756426-58-1	6.4	2.136	ng/l	70-155	30	70-155	30	30			
11-Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid (11Cl-	763051-92-9	6.4	2.136	ng/l	55-160	30	55-160	30	30			
N-Methyl Perfluorooctane Sulfonamide (NMeFOSA)	31506-32-8	1.6	0.536	ng/l	60-150	30	60-150	30	30			
N-Ethyl Perfluorooctane Sulfonamide (NEtFOSA)	4151-50-2	1.6	0.536	ng/l	65-145	30	65-145	30	30			
N-Methyl Perfluorooctanesulfonamido Ethanol (NMeFOSE)	24448-09-7	16	5.36	ng/l	70-145	30	70-145	30	30			
N-Ethyl Perfluorooctanesulfonamido Ethanol (NEtFOSE)	1691-99-2	16	5.36	ng/l	70-135	30	70-135	30	30			
Perfluoro-3-Methoxypropanoic Acid (PFMPA)	377-73-1	3.2	1.064	ng/l	55-140	30	55-140	30	30			
Perfluoro-4-Methoxybutanoic Acid (PFMBA)	863090-89-5	3.2	1.064	ng/l	60-150	30	60-150	30	30			
Perfluoro(2-Ethoxyethane)Sulfonic Acid (PFEESA)	113507-82-7	3.2	1.064	ng/l	70-140	30	70-140	30	30			
Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)	151772-58-6	3.2	1.064	ng/l	50-150	30	50-150	30	30			
3-Perfluoropropyl Propanoic Acid (3:3FTCA)	356-02-5	8	2.664	ng/l	65-130	30	65-130	30	30			
2H,2H,3H,3H-Perfluorooctanoic Acid (5:3FTCA)	914637-49-3	40	13.36	ng/l	70-135	30	70-135	30	30			
3-Perfluoroheptyl Propanoic Acid (7:3FTCA)	812-70-4	40	13.36	ng/l	50-145	30	50-145	30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*5-130*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*40-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***

Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

PFAAs via EPA 1633 (WATER)

Holding Time: 28 days
Container/Sample Preservation: 2 - Plastic 500ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*40-135*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Hexanesulfonic Acid (M2-4	*NONE*									*40-200*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*40-130*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*40-130*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*40-130*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-6	*NONE*									*40-200*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*40-130*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*40-130*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*40-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-8	*NONE*									*40-300*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*40-170*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*30-130*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*40-130*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (d	*NONE*									*25-135*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*10-130*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*10-130*		
2,3,3,3-Tetrafluoro-2-[1,1,2,2,3,3,3-Heptafluoropropoxy]-13	*NONE*									*40-130*		
N-Methyl-d3-Perfluoro-1-Octanesulfonamide (d3-NMeFOSA)	*NONE*									*10-130*		
N-Ethyl-d5-Perfluoro-1-Octanesulfonamide (d5-NEtFOSA)	*NONE*									*10-130*		
2-(N-Methyl-d3-Perfluoro-1-Octanesulfonamido)ethan-d4-ol	*1265205-95-5*									*10-130*		
2-(N-Ethyl-d5-Perfluoro-1-Octanesulfonamido)ethan-d4-ol (d	*NONE*									*10-130*		
1H,1H,2H,2H-Perfluoro[1,2-13C2D4]Hexanesulfonic Acid (13	*NONE*									*0-25*		
Perfluoro-[1,2-13C2]octanoic Acid (13C2-PFOA)	*NONE*									*50-150*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
EPA 1621 in Water (EPA 1621)								
Preservation: None								
Container: 125 mL plastic			**Amount Required:** 100 mL			**Hold Time:** 90 days		
Adsorbable Organic Fluorine (AOF)	1.1	2.0 µg/L			50 - 150	20	70 - 130	
EPA 1621 in Drinking Water (EPA 1621)								
Preservation: Cool 4°C								
Container: 125 mL plastic			**Amount Required:**			**Hold Time:** 90 days		
Adsorbable Organic Fluorine (AOF)	1.1	2.0 µg/L			50 - 150	20	70 - 130	

ATTACHMENT F

Pace® Location Requested (City/State): **Mansfield, Massachusetts**

CHAIN-OF-CUSTODY Analytical Request Document

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevant fields

LAB USE ONLY- Affix Workorder/Login Label Here

Scan QR Code for instructions

Company Name: Tighe & Bond, Inc.	Contact/Report To: Jessica Cajigas-Smith
Street Address: 1 University Avenue, Westwood, MA 02090	Phone #: (781) 708-9855
	E-Mail: JCajigas-Smith@tighebond.com, CBrothers@tighebond.com
	Cc E-Mail: environmentaldm@tighebond.com
Customer Project #: M-1837-016	Invoice to: Tighe & Bond - Accounts Payable
Project Name: MassDEP PRF77 PFAS Testing Study for NPDES POTWs	Invoice E-mail: AP@tighebond.com
Site Collection Info/Facility ID (as applicable):	Purchase Order # (if applicable):
	Quote #: 30219
Time Zone Collected: [ ] AK [ ] PT [ ] MT [ ] CT [X] ET	County / State origin of sample(s): Massachusetts

Data Deliverables: [ ] Level II [ ] Level III [X] Level IV [ ] EQUIS [X] Other Enviro-data EDD

Regulatory Program (DW, RCRA, etc.) as applicable: Massachusetts Maximum Contaminant Levels (MMCLs) — Reportable [ ] Yes [ ] No

Rush (Pre-approval required): [ ] Same Day [ ] 1 Day [ ] 2 Day [ ] 3 Day Other _____

Date Results Requested: Standard TAT

DW PWSID # or WW Permit # as applicable:

Field Filtered (if applicable): [ ] Yes [X] No

Analysis:

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SS), Oil (OL), Wipe (WP), Tissue (TS), Bioassay (B), Vapor (V), Surface Water (SW),Sediment (SED), Sludge (SL), Caulk (CK), Leachate (LL), Biosolid (BS), Other (OT)

Specify Container Size **

Identify Container Preservative Type***

Analysis Requested

Customer Sample ID	Matrix *	Comp / Grab	Composite Start Date	Composite Start Time	Collected or Composite End Date	Collected or Composite End Time	# Cont.	Residual Chlorine Result	Residual Chlorine Units	TOPA - EPA Method 1633	Adsorbable Organic Fluorine (AOF)	PFAS-EPA Method 1633	Container Size **	Preservative Type ***	Sample Comment
Influent	WW	G								X			2,10	1	
Effluent	WW	G								X			4	1	
Sludge	OT	G								X					
Influent-Duplicate	WW	G										X			
Effluent-Duplicate	WW	G										X			
Sludge- Duplicate	OT	G										X			
Field Blank	WW	G										X			
Equipment Blank	WW	G										X			

**Container Size: (1) 1L, (2) 500mL, (3) 250mL, (4) 125mL, (5) 100mL, (6) 40mL vial, (7) EnCore, (8) TerraCore, (9) 90mL, (10) Other

*** Preservative Types: (1) None, (2) HNO3, (3) H2SO4, (4) HCl, (5) NaOH, (6) Zn Acetate, (7) NaHSO4, (8) Sod. Thiosulfate, (9) Ascorbic Acid, (10) MeOH, (11) Other

Lab Use Only: Proj. Mgr: / AcctNum / Client ID: / Table #: / Profile / Template: / Prelog / Bottle Ord. ID:

Preservation non-conformance identified for sample.

Additional Instructions from Pace®:
Report ID and TOPA for all influent, effluent, sludge samples.
Report ID only for QA/QC blanks and duplicate samples.

Collected By:
Printed Name
Signature

Customer Remarks / Special Conditions / Possible Hazards:

# Coolers:	Thermometer ID:	Correction Factor (°C):	Obs. Temp. (°C):	Corrected Temp. (°C):	[ ] On Ice

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:

Tracking Number:

Delivered by: [ ] In- Person [ ] Courier [ ] FedEx [ ] UPS [ ] Other

Submitting a sample via this chain of custody constitutes acknowledgment and acceptance of the Pace® Terms and Conditions found at https://info.pacelabs.com/hubfs/pas-standard-terms.pdf.

Chain of Custody Instructions

***Pace Location Requested**: City and State of Pace Laboratory testing is to be performed at.
***Company Name**: Client's company name
***Street Address**: Client's mailing address
***City, State, Zip**: Client's city, state and zip code for mailing
***Contact/ Report to**: Person to receive results
Customer Project # and Project Name: Client's reference to the project or work involved with these samples.
Site Collection Info/ Facility ID: Client's location of project
Time Zone: Check time zone of sample to ensure proper hold times are met.
Purchase Order #: Client specific number to be listed on project invoice for client billing purposes.
Invoice To: Client contact the project invoice needs to be emailed to.
Invoice Email: Email address that project invoice will need to be emailed to
***Phone #**: Client's contact phone number
E-mail: Client's e-mail for correspondence and final report
Regulatory Program: List the program that is guiding the work to ensure proper regulations are followed: DW, RCRA, etc.
Data Deliverable: Please select or enter required deliverables.
***County/State Origin of Samples**: Enter the county to ensure proper handling of regulated soils. State required to ensure proper reporting.
Field Filtered: Indicate if samples have been filtered in the field. If samples are required to be field filtered and filtering is not indicated, a qualifier will be added to all associated data.

***Customer Sample ID**: The unique sample ID you want to appear on the analytical report
***Collected Date**: Date sample was collected. For composite samples, please fill in both beginning and end date.
***Collected Time**: Time sample was collected. For composite samples, please fill in both beginning and end time.
***Comp/Grab**: Please denote "GRAB" if the sample was collected at one time from one specific location. Please denote "COMP" if the sample is a composite of samples collected at one or more times or locations and combined to make one sample.
***Matrix**: Select from list provided list. If prepopulated chain is provided for you matrix codes may vary.
***Number and Type of Containers**: Total number of containers per container type submitted for the samples
***Container Size:** Specify container size from list.
***Container Preservation Type**: Specify sample preservation from provided list.
***Analysis Requested**: Write the analysis name (or an abbreviation), the name of a group of tests, or the method number you would like us to perform. Examples are BOD, TCLP Metals, PCBs, Method 624, etc. Place a check mark in the small boxes that correspond to the sample(s) on which you want these tests performed.

Sample Comment: List any notes or important information about the individual sample here. Please identify in the sample comment if a sample should be used for MS/MSD.

Customer Remarks/Special Conditions/Possible Hazards: List special instructions about the sample here. If the sample is known or suspected to be hazardous indicate that here and attach SDS if possible. This space can also be used for listing additional analyses, or to request an extra copy of the report to be sent to an alternate person/address, etc.

Rush request: If faster than standard turnaround time results are needed. Circle one of the rush options and note the day the results are requested by. All rush requests require preapproval by the laboratory. Surcharges will apply for non- standard turnaround times. Results will be due by the end of business on the date due based on standard turnaround time unless other arrangements have been made with your Project Manager.

Summarized Sample Acceptance Policy Requirements:

- Proper, full and completed chain-of-custody documentation
- Readable unique sample container identification written in indelible ink
- Appropriate sample container
- Sufficient sample volume to perform requested tests
- Received within required holding time
- Received within temperature preservation requirements
- Sample containers received in good condition (not leaking or broken)
- Any custody seal intact
- Properly preserved
- No headspace in volatile water samples
- **Note:** When sample specific Quality Control is required (e.g. MS/MSD) please ensure necessary sample containers and sample volume is provided.

A data qualifier and/or case narrative will be added to the final test report when the above sample acceptance requirements are not met.

Location Specific Sample Acceptance Policy available from your Project Manager

***Collected By**: Printed name of sample collector
***Collected By Signature**: Signature of sample collector

***Relinquished By/Received By:** This form **must be signed** each time the sample(s) changes hands. Custody seals are available upon request if needed.

***Required field**: Failure to fill in a required field may result in a sample(s) being put on hold until information can be obtained. This may result in a delay in receiving results.

Pace

Client: Tighe & Bond, Inc.

Site : / FACILITY NAME

Sample ID: INFLUENT

Analysis : A2 – 1633

Preservative: NONE

Date: 02/19/2025 Time: 0830 By: SAMPLER INITIALS

PLASTIC – A.5

Pace

Client: Tighe & Bond, Inc.

Site : / FACILITY NAME

Sample ID: EFFLUENT

Analysis : A2 – 1633

Preservative: NONE

Date: 02/19/2025 Time: 0900 By: SAMPLER INITIALS

PLASTIC – A.5

Pace

Client: Tighe & Bond, Inc.

Site : / FACILITY NAME

Sample ID: SLUDGE (CAKE, PELLETS, etc.)

Analysis : A2 – 1633

Preservative: NONE

Date: 02/19/2025 Time: 0930 By: SAMPLER INITIALS

PLASTIC – A.5

ATTACHMENT G

Tighe & Bond SSSP

Project / Site Information

Person Developing SSSP:	Colleen Brothers Lawson	Creation Date:	1/31/2025	Business Line:	**Water**
Project Number:	M1837-016	Client Name:	Mass DEP		
Project Manager:	Jessica Cajigas-Smith				
Project Description:	PFAS sampling at wastewater treatment plants				
Project Address:	Southeast, Central, and Western MA				
Project Members (ALL):	Collen Brothers, Ellie Petraccione, Austin Cahill, Josh Mei, Alex DeMarco, Robert Suter, Kelley Dolan, Anabel Santini, Peter Topor, Sam Evans, Brandon Bieda, Ellie Dufraine, Ricky Ciliberto, Christian Salamon				
Plan Applicability:	**Tighe & Bond Employees Only**				
Reminder to Project Managers:	Always update this SSSP when new risks are identified on site not originally captured or when near miss or injury events indicate a need to do so.				
Reminder to Observers on Contractor and Site Safety:	Always stay alert and aware of safety risks to you and your team. If you observe a contractor working unsafely or in a manner that puts you or the site at risk of injury, immediately alert your project or site manager and document the event.				

Tighe & Bond employees working at this site must read, understand, agree to follow, and sign the SSSP prior to the start of work. This SSSP must be maintained at the site in either paper or electronic copy with associated chemical SDS. If a digital copy is used, a paper signoff for T&B employees and visitors must be kept onsite.

A. Emergency and Contact Information

Emergency Contacts

Responder Type	Town/City/3rd Party (Fire, Police)	Contact Number
General Emergency:	Local Town/City Police Department	911 or local non-emergency number
Fire Department:	Local Town/City Fire Department	911 or local non-emergency number
Police Department:	Local Town/City Police Department	911 or local non-emergency number
Emergency or Ambulance:		911
Utility/Other (Specify):		N/A

To help find a medical provider near your project, click this link and enter your project address in search box.

https://www.hospitalsineachstate.com/find-nearest-hospital/

Emergency Care	Location, address, and Phone Number		Travel Time and Distance		
Closest Hospital with ER: (Remember to check if hospital has ER services under the "Services:" section of the hospital finder)	Name:	*See attached Hospital Map by region*	Distance:	Miles	XX
	Address:		Travel Time:	Time	XX
Closest Urgent care Facility: (Remember to check if clinic is operational)	Name:	*See attached Hospital Map by region*	Distance:	Miles	XX
	Address:		Travel Time:	Time	XX

To contact the 24-7 TravCARE Nurse Line, simply call 800.238.6225 and follow the prompts • Press 1 • Press 1 • Press 4 • Press 2 • Press 2 • Press 1

Emergency Plan Summary (Make changes to response below based on project and site conditions)

Outline client or existing evacuation plan if in place	Follow evacuation plan at POTW facility
Site Evacuation Assembly Area/Point (must be determined):	Follow evacuation plan at POTW facility

Detail Tighe & Bond Emergency Headcount Procedure: (A specific person must be selected)	On-site Tighe & Bond staff	will conduct a head count at the assembly area and report to the site's emergency contact and/or the Fire Department. Site personnel will remain at the area until released by the site's emergency point of contact and/or the Fire Department.

Emergency Type	Communications / Notifications Means	Response
ALL EMERGENCIES	Phone, verbal, visual signals	• Move away from the emergency area • Protect yourself • Follow all local fire and response incident commander directions
Fire/Explosion:	Phone, verbal, visual signals	• Follow existing emergency response plans if required by client or site otherwise follow T&B plan outlined above. • Immediately evacuate the area and take shelter. Contact police and follow their instructions. Once safe, contact PM and T&B Safety.
Chemical Release	Phone, verbal, visual signals	• Small Release: Contain and remove the released material if you can do so safely and you are properly trained. • Large Release: Evacuate the spill area, notify site contact, project PM, and T&B Safety. Keep others from entering spill area.
Chemical Exposure	Phone, verbal, visual signals	• Non-Hazardous Materials: Wash / flush the affected area for at least 15 minutes. • Hazardous Materials: Notify all local persons of spill. Review the Safety Data Sheet and initiate appropriate first-aid treatment
Injury / Illness	Phone, Verbal	• Minor: Alert site contact and PM • Non-Minor: Treat with first aid, alert site contact, PM, complete a T&B injury report, and notify the client project contact. • Serious Injury: Call for an ambulance, notify site contact, PM, T&B Safety. When treated, complete a T&B Injury Report and notify the client project contact.
Weather Emergency	Phone, verbal, visual signals	• Follow emergency instructions as provided by the on-site Supervisor or emergency notifications.
Other (Specify:		

NOTE: *Immediately contact the Project Manager when site conditions indicate a potential chemical exposure risk*

Additional Emergency Information

Does the Site Have Cell Service:	Yes	☐	Not Available	☐	If Cell Service is not available: Detail how communication will be managed:

Location of Emergency Response Equipment:	First Aid Kit	Kit Kept in Employees Car
	Tick Repellent/Removal Kit	Kit Kept in Employees Car
	Fire Extinguisher	Available on-site
	Spill Response Tools	Kit Kept in Employees Car
	Decontamination Tools	Kit Kept in Employees Car
List project T&B personnel with	First-aid	

List project T&B personnel with specialized training:	CPR	
	Spill Response	

B. Key Project Personnel (Use Full Names)

Tighe & Bond Contacts

Role	Name	Contact Number
Project Manager:	Colleen Brothers	(781) 708-9839
Project Emergency Contact:	Colleen Brothers	(781) 708-9839
Tighe & Bond Safety Director:	Scott Smith CSP, LPD	413-642-8684 (O) 781-888-8330 ©
All On-Site Tighe & Bond Staff:	Ellie Petraccione	(518) 708-7465
	Austin Cahill	(508) 802-8941
	Josh Mei	(781) 856-3694
	Alex DeMarco	(508) 331-5841
	Robert Suter	(732) 644-0595
	Kelley Dolan	(978) 868-3869
	Anabel Santini	(207) 274-0969
	Peter Topor	(413) 668-4054
	Sam Evans	(860) 205-2704
	Brandon Bieda	(413) 888-7257
	Ellie Dufraine	(413) 297-5514
	Ricky Ciliberto	(617) 599-9481
	Christian Salamon	(413) 636-2656

Key Client Contacts

Role	Name	Contact Number
Name of Client:	Towns / Cities with participating POTWs	
Primary Client Contact:	Provided contact person at participating POTWs	
Report Emergencies to:	Provided contact person at participating POTWs	
Other Key Contacts:		

On-Site Client Contractor Contacts

Role	Name	Contact Number
Name of Contractor:	N/A	
Primary Client Contact:		
Report Emergencies to:		
Other Key Contacts:		

On-Site or On-Call Tighe & Bond Subcontractors	Approved On Call Vendors	On-Site Services Authorized Vendors
Role	**Name**	**Contact Number**
Name of Subcontractor:	N/A	
Is this a Tighe & Bond Subcontractor?	Yes ☐	No ☐
Has the Subcontractor Safety Qualification form been completed?	Yes ☐	No ☐
Has a contractor Safety Plan been developed, (if required)?	Yes ☐ No ☐	NA ☐

Subcontractor Supervisor:		
Report Emergencies To:		
Other Key Contacts:		

C. Project Details

Site Address:	Publically Owned Treatment Works facilities across Southeast, Central, and Western MA
Special site conditions and or access details:	POTW-specific, details provided to Tighe & Bond staff prior to sampling event
Description of project work:	PFAS sampling
Brief but detailed description of tasks being performed by Tighe & Bond staff:	Sample collection of influent, effluent and sludge for PFAS ID, TOPA, and/or Adsorbable Organic Fluorine (AOF) anayses.
Anticipated State Date and Site Work Schedule:	February 19, 2025 - June 30, 2025

If the project requires the purchase of or the need to bring hazardous or potentially hazardous materials back to an office, you must read and follow the Waste Management Protocol. Examples include but are not limited to: HBMA, soil or water samples, sample preservatives, etc.	APPENDIX B: Potential Hazardous Materials Disposal Protocol

Detail any additional information below:

Work Hazards (Check all that apply) All Risks Selected Will Appear In Section H Below

Actual or Potential Exposure to: (PLACE AN "X" NEXT TO EACH THAT APPLIES)

Taking Photos/Videos During Field Work	x	Working Near Heavy Construction Equipment (Cranes, Loaders, Earth Movers, etc.)	x	Working near Forklifts	
Working near vehicle traffic		Temperature extreme (Cold) (Includes Lightning and Wind Safety)	x	Temperature extreme (Heat) (Includes Lightning and Wind Safety)	
Potential Falling Objects (over head construction, bridges, dams, platforms, scaffolds, Drill Rig cranes, etc.)		Working Near Railroad Tracks		Working with non powered Hand Tools (meters, sampling media and tools.	x
High noise - Sporadic noise ≥85 dBA (Roadways, construction, manufacturing, industrial, demo, airports, motorized tools, etc.)		Working with or Around Live / Exposed Electrical Equipment	x	Overhead power lines (posing a hazard to staff)	
Exposures to contaminated soils or water- If PFAS see dedicated PFAS risk box (Sampling, Surveying, Foot Traffic, URAM)		Chemical Use/Exposure (list chemicals in section below and add SDS to SSSP)	x	Ergonomic Injuries (sprain/strain, ankle, knee, back) and Impacts to Hands and Fingers	x
Slips, trips, and falls (Indoors)	x	Exhaust Gases from Fuel Burning Equipment (street traffic, generators, burners, trucks, etc.)		Working at Sites Containing Fall Hazards (>4 feet)	
Slips, trips, and falls (Outdoors)	x	Hunters		Poisonous plants (Poison ivy, oak, sumac, etc.)	

Potential exposure to mosquitos, animal droppings, rodent bites, birds nests, standing water in ventilation. (HVAC inspection, water systems, sewage or unprocessed wastewater, rodent or bird nests, under bridges, roofs, sewers, and soils contaminated with animal wastes.)	x	Wildlife animal OR animal TRAP encounters (dog wild or domestic, bears, deer, moose, potential traps for animals, snakes, etc.)		Hazardous ticks or insects (Bees, Wasps and Hornets)	
Work Hazards (Check all that apply) All Risks Selected Will Appear In Section H Below					
Driving Company Vehicle and/or Trailer		Work near a Trench (With Entry)		Working Near a Trench (Without Entry)	
Working In or Directly Adjacent Water Bodies (Next to or in streams, rivers, standing water, reservoirs, etc.)	x	Work Near Water – Lower Hazard (adjacent water bodies, above on bridges or structures, etc.)	x	Entry into an abandoned, non powered, or dilapidated building	
Cutting/drilling/grinding (Rock, natural formations, concrete, all masonry products) (You must also check Respirable Crystalline Silica Risk)		Respirable Crystalline Silica Exposure (General) (Must be checked if cutting/drilling risk is selected)		Ground Disturbance, Including Borings, Test Pits and Excavations	
Work in High Crime Rate Area: (Click here for ADT crime maps by address)	x	Work with Contractors and Subcontractors		Working on Private property	X
Working from a boat (includes all craft types)		Observation of UST removal or excavation		Work in remote locations	
Using a Respirator (Half Mask, Full Face, Supplied Air)		Working alone (Either alone on a project or in a remote location from a project partner)	x	Wastewater/Sewage Exposures	x
Using a Dust Mask		Use of fixed ladders	x	Working on Scaffolds	
Working with sharp objects		Use of portable ladders		Work with Portable Electrical Equipment (Drills, tools, meters, PID, FID, etc.) Does not include XRF.	
Passenger on an Elevated Work Platform (aerial, boom or scissor lift)		Working around rotating mechanical equipment (Turbines, compressors, pumps, blowers, etc.)		Head strike risks: (low pipes, ceilings, dams, bridges)	x
Driver Safety (Your own Vehicle-Driving to a site)	x	Sample collection with chemical preservatives or hazardous materials. (Add to Chemical List below) Read APPENDIX B: Potential Hazardous Materials Disposal Protocol	x	Work in heavy vegetation, forested, or other heavy growth area. (forests, swampy or marshy areas, wetlands, soil / rock piles, etc.)	
Chemical / Hazard / Radiation (XRF) Specific Exposures					
Hazardous Building Material (NON HBMA STAFF) (Asbestos, lead, PCBs, etc. in soil, water, or sample media, exposure to damaged ACM or other HBMA risks).		Mold or microbial Exposures	x	Lead Exposure	
Asbestos Exposure for HBMA Staff (Project Monitoring work requires an SSSP)		Benzene Exposure		Hydrogen Sulfide Exposure	

Asbestos Exposure (NON HBMA STAFF) (Asbestos, lead, or PCBs in soil or sample media, exposure to damaged ACM or other HBMA risks in sampling, etc.)		Cadmium Exposure		Hexavalent Chromium Exposure. (welding or high heating of stainless steel).	
Cyanide Exposure		Per- and polyfluoroalkyl substances (PFAS) (Sampling)	x	Per- and polyfluoroalkyl substances (PFAS) (Potential Contact)	
Cannabis Exposures (bud, processed, raw, etc.…)		Exposure to Cured in Place Pipe (CIPP) operations		Using an XRF (X-Ray Fluorescence) Analyzer	
Nanoparticle exposure Risks					
This Project Involves the Following Higher Hazard Work Activity*					
Use of fall protection equipment (Personal Fall arrest Harness at Height)		Use of lift (i.e. scissor/aerial lift as an OPERATOR)		Confined Spaces (Entry into or working at sites that have (tanks/manway/pipe /vault, etc.)	
Work within an Electrical Substation		Working with Hazardous Energy - Lockout-Tagout (Control of Hazardous Energy)		Working Around Downed Utility Lines or Transformers	
Infectious Diseases Exposure, Symptoms, or Client Requirements (i.e. COVID-19)	x	Exposures to Hot Work (riveting, welding, flame cutting, brazing, fire or sparking)		Working at Night (Outdoor or roadway work requires Class 3, Type R vest)	

*All work under the Hazardous Work Activity Section requires additional training and/or documentation – Review with the Project Manager

List all actual or potential Hazardous Chemical Exposures:

A List of SDS on Record can be reached at this address:	SHAREPOINT SDS LIST
Name of Chemical	ALL SDS MUST BE KEPT WITH THIS SSSP ONSITE

List any and all work hazards not captured above in this section below:

D. Personal Protection Equipment

Define Tasks Requiring PPE		Detail PPE Required (See Programs & Trainings for PPE Guidance)
Traffic Control	☐	
Body	☑	Hi-Vis Vest
Head	☑	Hard Hat (Type I, Class E)
Eyes	☑	Safety Glasses with side shield
Ears	☐	

Feet	☑	Safety toed work boots
Respiratory	☐	
Skin	☑	Nitrile gloves
Insect/Plant	☐	
Electrical	☐	
Night Work	☐	

E. Project and/or Client-Specific Provisions & Training

Note: See Programs & Trainings Worksheet for listing of programs and trainings.

Applicable Tighe & Bond Safety and Health Programs and Training Requirements	CBT 100T - General Safety & Health: Part 1
	CBT 101T - General Safety & Health: Part 2
	CBT 108T - Hazardous Materials Awareness
	CBT 110T - Project Safety & Health Planning
	Program 100 - General Safety & Health
	Program 101 - Hazard Communication
	Program 104 - Personal Protective Equipment (PPE)
	Program 106 - Hearing Conservation
	Program 107 - Site Work - General Safety
	Program 115 - Project Safety & Health Planning
	Program 117 - Site Work - Hazardous Materials
Required Specialized Training ***(i.e., OSHA 10/30/40 and/or Specialized Tighe & Bond training)***	
Client, Contractor, and/or State-specific safety and health requirements: ***(Include items such as client-specific safety and health requirements, Dig-Safe #, Contractor safety orientation, and specifically required state/local licenses or permits)***	

Link to Client Specific Safety Program

F. Site-Specific Safety Plan Review and Approvals

1. Person Developing SSSP:

Name:	Colleen Brothers

Completion Date:	1/31/2025
2. Project Manager or Project Director:	
Name:	Jessica Cajigas-Smith
Approval Date:	2/10/2025
Save the file including the project number and Client or Street Address, then chick the **SUBMIT** button for final review. Always save file before clicking submit button.	Submit
3. Safety & Health Department Reviewer:	
Name:	Scott Smith
Review Date:	1/31/2025

G. Site-Specific Safety Plan Communications and Sign Off

All Tighe & Bond Employees working at this site must read, understand, and agree to follow this SSSP, prior to the start of work. This signed plan and all associated SDS must be kept at the job site in hard or digital copy. A HARD COPY must be kept if there is risk of poor connection or a fixed trailer is available.

ACKNOWLEDGMENT

By signing below, you acknowledge that you have read and understand the Site-Specific Safety Plan for this project. You agree to stop work when conditions or hazards change, when you encounter unexpected conditions during the execution of work, when work cannot be performed as written, or when instructions become unclear during execution. You further agree to abide by the provisions contained within this plan, are qualified and fit to perform the assigned work, and understand that any violation may result in removal from the field effort.

Tighe & Bond Employee Name	Signature	Date

H. Potential Hazards / Hazard Controls

Do not perform any task if it is deemed to be unsafe.
For hazards which cannot be safely controlled:

- **Do not initiate the task**
- **Inform your Project Manager and/or Project Director and assist in the development of an alternate and acceptable work plan**
- **Immediately report work-related Safety Incidents and Near Miss Incidents to your Project Manager and/or Project Director**

INCIDENT / NEAR MISS REPORT FORMS ARE AVAILABLE ON SHAREPOINT BY SELECTING DEPARTMENTS THAN SAFETY & HEALTH AND CLICKING ON THE NEAR MISS REPORTING FORM ICON UNDER QUICK LINKS

DO NOT DELETE ROWS - ENSURE ALL RISKS HAVE BEEN CAPTURED BELOW

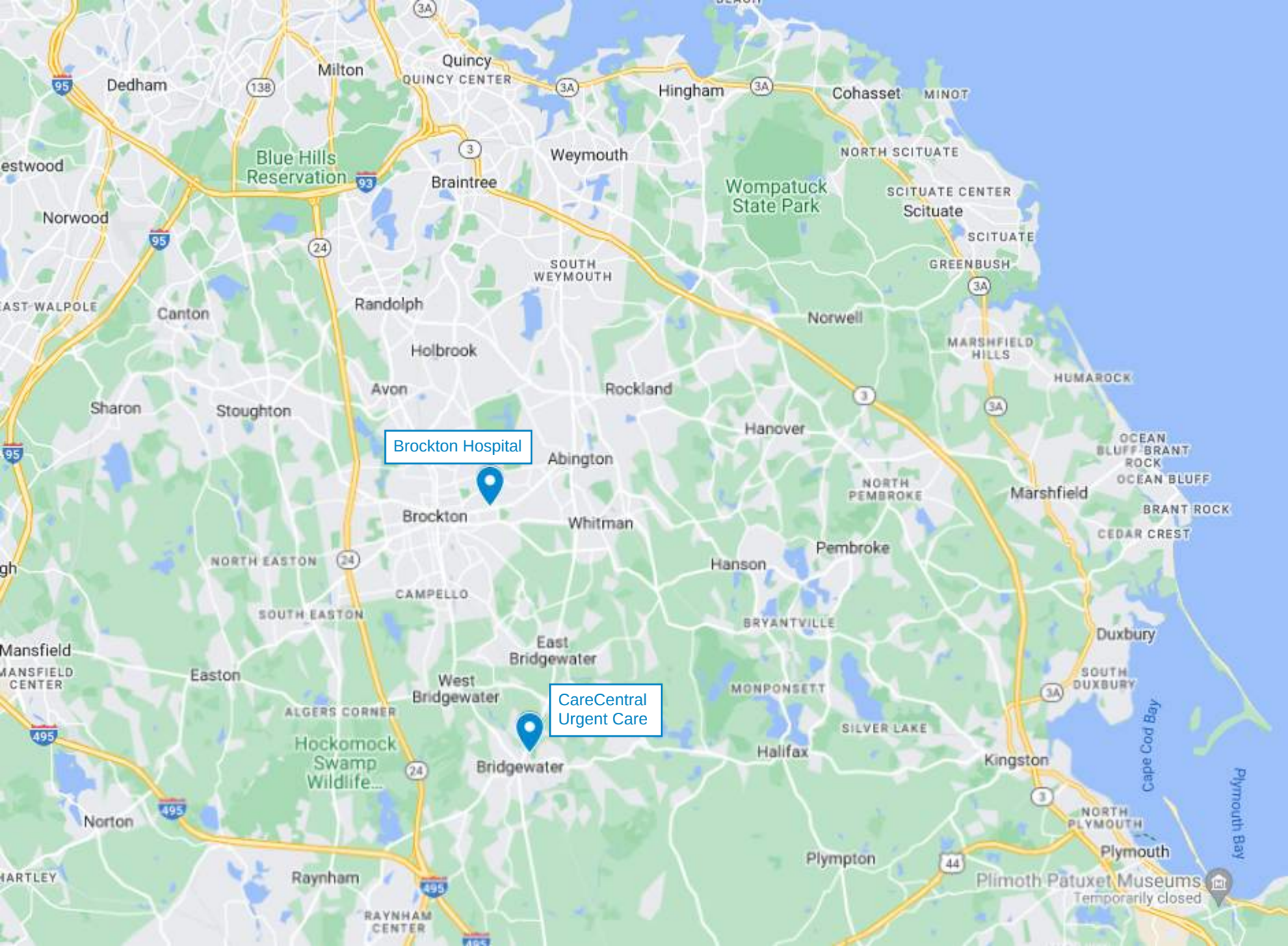
Enter a brief description of task that triggers the hazard

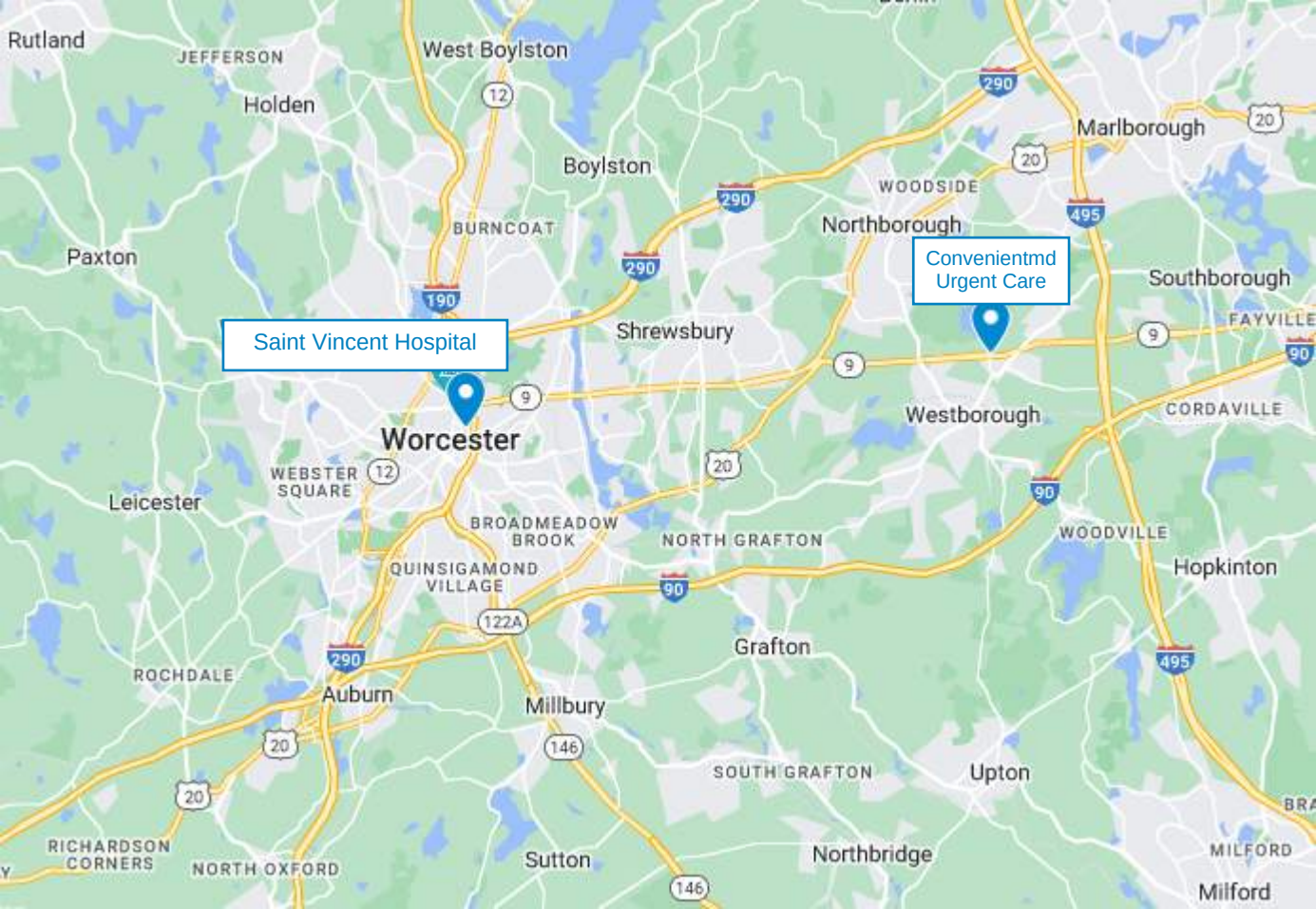
	Detail Task	Hazard	Hazard Control
	PFAS Sampling	Slips, trips, and falls (indoors)	▪ Maintain good housekeeping. ▪ Be aware of your surroundings. ▪ Note and avoid slip and trip hazards. ▪ Ensure there is adequate illumination to safely walk through the work area and perform work. ▪ Place caution tape or orange cones near hazards. ▪ Avoid wet surfaces. ▪ Be aware and take extreme care on muddy/wet/Slippery surfaces. ▪ Be aware and take extreme care on unstable surfaces and ramps.
		Slips, trips, and falls (outdoors)	▪ Wear sturdy shoes/boots with good traction. ▪ Before starting, assess the work area and the projected pathway. ▫ Reassess the route if the pathway is not safe to transverse (i.e., waterbodies, dense underbrush, uneven terrain, etc.). ▪ While walking, be aware of your surroundings. ▫ Look up, avoid dead branches, trees or other hazards. ▫ Look down, avoid impediments and slip/trip/fall hazards. ▫ Look ahead, take short strides and traverse a safe path. ▪ Be aware and avoid or take extreme care on: ▫ Surfaces containing snow or ice. ▫ Surfaces which are wet, muddy or slippery. ▫ Surfaces which could be unstable. ▫ Ramps, which may be slippery. ▪ Turn sideways when traversing steep slopes.

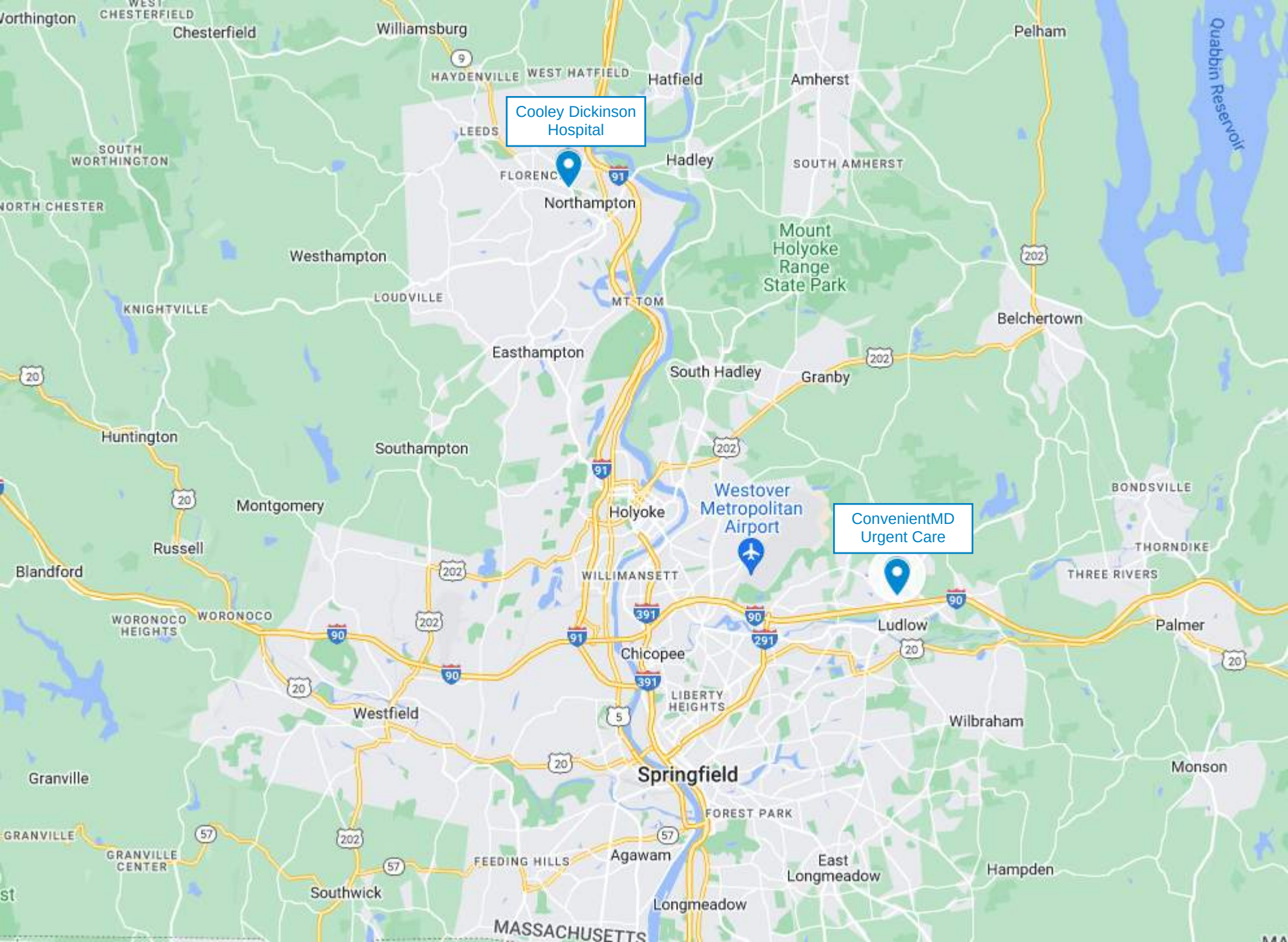
		Working Near Heavy Construction Equipment (Cranes, Loaders, Earth Movers, etc.)	▪ Always wear a reflective vest. ▪ Stay clear of moving equipment. ▪ Maintain constant awareness of your surroundings. ▪ Avoid blind spots – especially behind construction equipment. ▪ Use spotters when backing equipment. ▪ Pay attention to all backup alarms. ▪ Be aware of the swing zone of excavators, cranes, backhoes and other similar equipment and stay out of this zone. ▪ When near heavy equipment or vehicles, make eye contact with the operator before entering a swing or operating zone. ▪ Be mindful unattended equipment can roll downhill. ▪ Do not perform stationary work downhill or near unattended equipment on inclines, or if the equipment has the potential to
		Temperature extreme (Cold)	ALWAYS CHECK NOAA AND LOCAL WEATHER REPORTS BEFORE PERFORMING OUTDOOR WORK https://www.weather.gov/ COLD WEATHER RISKS ▪ Pace your work based on environmental conditions. ▪ Schedule work during warmer times of day, if possible. ▪ Drink plenty of fluids. ▪ Take frequent breaks in warm/dry/calm areas as necessary. ▪ Wear layers of warm clothing. 3 layers are recommended. ▪ Monitor self and others for cold stress. ▪ Immediately address signs/symptoms of cold stress. (e.g. reddening skin, tingling, pain, swelling, leg cramps, numbness, and blisters) ▪ If extreme cold weather is in the forecast, or if field exposures become extreme, contact your PM for direction to
		Temperature extreme (Lightning)	LIGHTNING RISKS ▪ Follow all NOAA and public safety instructions ▪ Always check for lightning storm/risks before using boats or working near water bodies - never work from a boat or near water if lightning is a risk ▪ If you hear thunder or see lightning while working in a boat or near water, clear the area immediately ▪ Never work outdoors from ladders, scaffolding, walls, roof tops, cranes, or hoists during lightning events ▪ Immediately take shelter at the sound of thunder (remain in cover for 30 minutes "after" you hear the last thunder strike) ▪ Avoid sheltering in sheds, pavilions, tents, or covered porches as they do not provide adequate protection from lightning ▪ Avoid isolated tall trees, hilltops, utility poles, cell phone towers, cranes, large equipment, ladders, scaffolding, or rooftops ▪ Avoid open areas, wiring, plumbing, fencing, water, or fields. Never lie flat on the ground. ▪ Never leave a site during high electrical, rain, wind, or other environmental conditions that impact driver safety ▪ If thunderstorms are forecast, or if in the field they last

		Temperature extreme (High Winds)	HIGH WINDS ▪ Follow all NOAA and public safety instructions ▪ High winds generally refers to speeds above 40 miles per hour (MPH) or 30 MPH if material handling is being performed ▪ Do not work on scaffolding, walls, ladders, hoist, cranes, or any elevated structure if winds are above 20 MPH or are gusting 25 - 30 MPH ▪ If wind speeds result in materials, tools, equipment, or heavy equipment to blow around or tip, take shelter in a rigid structure or your vehicle ▪ Do not stand or position yourself in an area where a crane, elevated structure, power lines, or other objects subject to tipping may fall ▪ If high winds / wind advisory are forecast or winds become elevated while on site, contact your PM for direction to either stay at or not go to the project Extreme: Sustained winds > 58 MPH High: Sustained winds 40 – 57 MPH
		Working with or Around Live / Exposed Electrical Equipment	▪ Only qualified persons can perform electrical work on energized equipment. ▪ Work on or near energized equipment operating at 50 volts or greater must be avoided unless authorized ▪ If electrical work is being performed, follow Electrical Safety Program (Safety and Health Program #114) for protection. ▪ Follow arc flash boundary limits and other safety precautions set forth in arc flash labeling. ▪ Do not enter spaces containing electrical hazards unless authorized and with adequate illumination. ▪ Remove conductive items of jewelry and clothing if they may present an electrical contact hazard. ▪ Inspect tools and meters prior to each day's use.
		Chemical Use/Exposure	▪ Ensure all containers of hazardous chemicals are labeled with a minimum of the container contents and chemical hazards. ▪ Verify a Safety Data Sheets (SDS) is readily available for reference - SDSs should be filed in the Tighe & Bond, SDS database. ▪ Wear appropriate personal protective equipment, based on the recommendations of the SDS. ▪ Communicate hazards and provide a copy of the SDS to potentially affected, workers, including non-Tighe & Bond workers, as appropriate. ▪ Refer to OSHA's Hazard Communication standard and Tighe & Bond's Hazard Communication Program (Safety and Health Program #101) for additional hazard controls.

		Ergonomic Injuries (strains/sprains) and Impacts to Hands, Fingers, and extremities. (Lifting or moving heavy objects, working in confined spaces, on unstable ground / Earth, rocky or soft soils, climbing or working on or around earthen or rock mounds, etc.)	▪ Wear sturdy, ankle supported, steel toe shoes or boots to protect against slips and feet injury. ▪ Although this task can be completed by one person, two people are recommended. ▪ If lifting multiple covers or grates, consider renting a levered manhole lifter. ▪ Be aware that manhole cover or grate can weigh as much as 150 pounds. ▪ Wear high visibility clothing. ▪ Be aware of your surroundings. ▪ Use a pick and shovel. ▪ Use traffic cones in vehicular traffic areas. ▪ Use gloves. ▪ Prior to removing, plan a location to place the cover or grate to avoid tripping. ▪ Secure loose objects before looking down into hole. ▪ When placing cover or grate back into place, slide use the shovel. ▪ Do not use hands to pick up a cover or grate. ▪ Wash hands before eating.
		Work with Hand Tools	▪ Wear safety glasses and work gloves. ▪ Check tools for defects prior to use – Do not use defective equipment. ▪ Use the correct tool for the job.


Brockton Hospital
CareCentral Urgent Care
Dedham
Milton
Quincy
QUINCY CENTER
Hingham
Cohasset
MINOT
Blue Hills Reservation
Weymouth
Braintree
NORTH SCITUATE
Wompatuck State Park
SCITUATE CENTER
Scituate
SCITUATE
GREENBUSH
Norwood
SOUTH WEYMOUTH
Randolph
Canton
Norwell
MARSHFIELD HILLS
HUMAROCK
Holbrook
Avon
Rockland
Sharon
Stoughton
Hanover
OCEAN BLUFF-BRANT ROCK
OCEAN BLUFF
Abington
NORTH PEMBROKE
Marshfield
BRANT ROCK
CEDAR CREST
Brockton
Whitman
Pembroke
NORTH EASTON
Hanson
CAMPELLO
SOUTH EASTON
BRYANTVILLE
Duxbury
East Bridgewater
Mansfield
MANSFIELD CENTER
Easton
West Bridgewater
MONPONSETT
SOUTH DUXBURY
ALGERS CORNER
SILVER LAKE
Hockomock Swamp Wildlife...
Halifax
Kingston
Bridgewater
Cape Cod Bay
Plymouth Bay
Norton
NORTH PLYMOUTH
Plymouth
Plympton
Raynham
Plimoth Patuxet Museums
Temporarily closed
RAYNHAM CENTER


Saint Vincent Hospital
Convenientmd Urgent Care
Rutland
JEFFERSON
West Boylston
Holden
Boylston
Marlborough
WOODSIDE
Northborough
BURNCOAT
Paxton
Southborough
Shrewsbury
FAYVILLE
Westborough
CORDAVILLE
Worcester
WEBSTER SQUARE
Leicester
BROADMEADOW BROOK
NORTH GRAFTON
WOODVILLE
Hopkinton
QUINSIGAMOND VILLAGE
Grafton
ROCHDALE
Auburn
Millbury
SOUTH GRAFTON
Upton
RICHARDSON CORNERS
NORTH OXFORD
Sutton
Northbridge
MILFORD
Milford
290
12
20
495
190
9
90
122A
146


Cooley Dickinson Hospital
ConvenientMD Urgent Care
Northampton
Westover Metropolitan Airport
Springfield
Holyoke
Chicopee
Westfield
Ludlow
Palmer
Wilbraham
Monson
Hampden
East Longmeadow
Longmeadow
Agawam
Southwick
Granville
Blandford
Russell
Huntington
Montgomery
Southampton
Easthampton
Westhampton
Williamsburg
Chesterfield
Hatfield
Amherst
Pelham
Hadley
South Hadley
Granby
Belchertown
Mount Holyoke Range State Park
Quabbin Reservoir
WILLIMANSETT
LIBERTY HEIGHTS
FOREST PARK
FEEDING HILLS
WORONOCO
WORONOCO HEIGHTS
THREE RIVERS
THORNDIKE
BONDSVILLE
LOUDVILLE
MT TOM
KNIGHTVILLE
SOUTH AMHERST
WEST HATFIELD
HAYDENVILLE
LEEDS
SOUTH WORTHINGTON
NORTH CHESTER
GRANVILLE
GRANVILLE CENTER
MASSACHUSETTS

Appendix B – Supplemental Tables

TABLE B-1
Summary of 114 POTWs and Samples Collected from them During Study Round 1 and Round 2

	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
Facility Name	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633
Adams WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge							4/2/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup			
Amesbury WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank	3/19/2025	1 Influent 1 Effluent 1 Sludge						
Amherst WWTP	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/27/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup		
Athol WWTP	2/27/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Attleboro WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/21/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Ayer WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup			N/A							
Barre WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						
Belchertown WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent		1 Effluent Dup				3/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Billerica WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup			3/19/2025	1 Influent 1 Effluent 1 Sludge						
Bridgewater WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Brockton AWRF	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/18/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup		1 Equipment Blank	
Charlemont WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						
Charles River PCD	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank	
Charlton WWTP	2/24/2025	1 Influent 1 Effluent 1 Sludge							3/24/2025	1 Influent 1 Effluent 1 Sludge						
Chicopee WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Cohasset WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/18/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Concord WWTF	2/20/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup				N/A							
Dartmouth WPCF	2/20/2025	1 Influent 1 Effluent 1 Sludge							3/20/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup				

TABLE B-1
Summary of 114 POTWs and Samples Collected from them During Study Round 1 and Round 2

	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
Facility Name	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633
Douglas WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Easthampton WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Erving Center WWTP (#2)	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/31/2025	1 Influent 1 Effluent 1 Sludge						
Erving POTW #1	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/31/2025	1 Influent 1 Effluent 1 Sludge						
Erving POTW #3	2/27/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/31/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Fairhaven WPCF	2/20/2025	1 Influent 1 Effluent 1 Sludge							3/20/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup			
Fall River Regional WWF	2/20/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup			3/20/2025	1 Influent 1 Effluent 1 Sludge						
Fitchburg East WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						
Gardner WPCF	2/26/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Gloucester WPCF	2/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Grafton WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Great Barrington WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank	N/A							
Greater Lawrence - Sanitary District	2/19/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank		3/19/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup				
Greenfield WPCF	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/27/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank	
Hadley WWTP	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/27/2025	1 Influent 1 Effluent 1 Sludge						
Hardwick-Gilbertville WPCF	2/26/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Hardwick-Wheelwright WPCF	2/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						N/A							
Hatfield WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup				

TABLE B-1
Summary of 114 POTWs and Samples Collected from them During Study Round 1 and Round 2

	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
Facility Name	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633
Haverhill WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Holyoke WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						
Hoosac WQD	3/5/2025	1 Influent 1 Effluent 1 Sludge							4/2/2025	1 Influent 1 Effluent 1 Sludge						
Hopedale WWTF	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						
Hudson WWTF	2/25/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Hull WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/18/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank	
Huntington WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						
Ipswich WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Lee WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Leicester WWTP	2/24/2025	1 Influent 1 Effluent 1 Sludge							3/24/2025	1 Influent 1 Effluent 1 Sludge						
Lenox Center WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge							4/2/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup		1 Field Blank
Leominster WPCF	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank
Lowell Regional WW Utility	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Lynn Regional WWTF	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Manchester By the Sea WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					1 Field Blank
Mansfield WWTP (MFN)	2/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					1 Field Blank	3/21/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Marion WWTP - Marion DPW	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Marlborough East WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup				N/A							

TABLE B-1
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	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
Facility Name	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633
Marlborough West WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Marshfield WWTF	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/18/2025	1 Influent 1 Effluent 1 Sludge						
Maynard WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge							N/A							
MCI Bridgewater	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
MCI Concord	2/20/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank		N/A							
MCI Norfolk	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Medfield WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Merrimac WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup	1 Effluent Dup				3/19/2025	1 Influent 1 Effluent 1 Sludge						
Middleborough WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/19/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Milford WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						
Monroe WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup	1 Equipment Blank		4/2/2025	1 Influent 1 Effluent 1 Sludge						
Montague WPCF	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/27/2025	1 Influent 1 Effluent 1 Sludge						
MWRA Clinton WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge							N/A							
MWRA Deer Island WWTP	2/19/2025	2 Influent 1 Effluent 1 Sludge							3/19/2025	2 Influent 1 Effluent 1 Sludge						
New Bedford WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent			1 Sludge Dup			3/20/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Newburyport WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge							N/A							
North Attleborough WPCF	2/20/2025	1 Influent 1 Effluent 1 Sludge							3/21/2025	1 Influent 1 Effluent 1 Sludge						
North Brookfield WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank	3/25/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup			

TABLE B-1
Summary of 114 POTWs and Samples Collected from them During Study Round 1 and Round 2

	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
Facility Name	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633	Sampling Date	Influent, Effluent, Sludge for TOP via 1633	Influent, Effluent for AOF via 1621	Influent Dup for PFAS ID via 1633	Effluent Dup for PFAS ID via 1633	Sludge Dup for PFAS ID via 1633	Equipment Blank for PFAS ID via 1633	Field Blank for PFAS ID via 1633
Northampton WWTF	2/27/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank	3/27/2025	1 Influent 1 Effluent 1 Sludge						
Northbridge WWTF	2/20/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Northfield WPCF	2/27/2025	1 Influent 1 Effluent 1 Sludge							3/27/2025	1 Influent 1 Effluent 1 Sludge						
Old Deerfield - Historic WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank		4/1/2025	1 Influent 1 Effluent 1 Sludge						
Orange WWTP	2/27/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						N/A							
Oxford-Rochdale SD WPCP	2/24/2025	1 Influent 1 Effluent 1 Sludge							3/24/2025	1 Influent 1 Effluent 1 Sludge						
Palmer WWTF	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Pepperell WWTF	2/25/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Pittsfield WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank	4/2/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup		1 Sludge Dup		
Plymouth WWTF	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
Rockland WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/18/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Rockport WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank		3/20/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup		
Royalston WPCF	2/27/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Russell Village WWTF	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank
Salisbury WWTF*	2/20/2025	1 Influent 1 Effluent							3/19/2025	1 Influent 1 Effluent						
Scituate WWTP	2/19/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent	1 Influent Dup					3/18/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Shelburne Falls WWTF	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						
Somerset WWTF	2/20/2025	1 Influent 1 Effluent 1 Sludge							3/20/2025	1 Influent 1 Effluent 1 Sludge						

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	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
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South Deerfield WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup		
South Essex Sewerage District	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge						
South Hadley WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Southbridge WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/25/2025	1 Influent 1 Effluent 1 Sludge						1 Field Blank
Spencer WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup					3/25/2025	1 Influent 1 Effluent 1 Sludge						
Springfield WWTP - Bondi's Island	2/26/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup					3/26/2025	1 Influent 1 Effluent 1 Sludge						
Stockbridge WWTP	3/5/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Sturbridge WPCF	2/25/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						3/25/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent					
Sunderland WWTP	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge						
Taunton WWTP	2/20/2025	1 Influent 1 Effluent 1 Sludge							3/20/2025	1 Influent 1 Effluent 1 Sludge						
Templeton WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge						
Upper Blackstone WPAD	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Upton WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge				1 Sludge Dup			3/25/2025	1 Influent 1 Effluent 1 Sludge						
Uxbridge WWTF	2/20/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup				N/A							
Ware WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge							N/A							
Wareham WPCF	2/19/2025	1 Influent 1 Effluent 1 Sludge							3/19/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank	
Warren WWTP	2/26/2025	1 Influent 1 Effluent 1 Sludge					1 Equipment Blank		3/26/2025	1 Influent 1 Effluent 1 Sludge						
Wayland WWTP	2/25/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						N/A							

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	ROUND 1 Conducted between February 19 and March 5, 2025								ROUND 2 Conducted between March 18 and April 2, 2025							
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Webster WWTF	2/25/2025	1 Influent 1 Effluent 1 Sludge							3/25/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup				
West Stockbridge	3/5/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup					4/2/2025	1 Influent 1 Effluent 1 Sludge						
Westborough WWTF	2/26/2025	1 Influent 1 Effluent 1 Sludge		1 Influent Dup	1 Effluent Dup				3/26/2025	1 Influent 1 Effluent 1 Sludge						
Westfield WPCP	2/26/2025	1 Influent 1 Effluent 1 Sludge							3/26/2025	1 Influent 1 Effluent 1 Sludge						
Winchendon WPCF	2/26/2025	1 Influent 1 Effluent 1 Sludge	1 Influent 1 Effluent						N/A							
Woronoco Village WWTF	3/4/2025	1 Influent 1 Effluent 1 Sludge							4/1/2025	1 Influent 1 Effluent 1 Sludge			1 Effluent Dup			

* Salisbury WWTP has a lagoon system which was frozen during the Round 1 and Round 2 sampling events; therefore, no sludge samples were collected from this POTW during the Study.

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2509324	2/19/2025	WG2035461	L2509324-01	BRIDGEWATER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	229		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	286		-	potential high bias
			L2509324-02	BRIDGEWATER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	209		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	220		-	potential high bias
		WG2036160	L2509324-01	BRIDGEWATER-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509324-02	BRIDGEWATER-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509327	2/19/2025	WG2038693	L2509327-04	MCI BRIDGEWATER-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	61	>100%	-	potential high bias
					PERFLUORO-[1,2-13C2]OCTANOIC ACID (13C2-PFOA)	Surrogate Low	50-150	31		-	potential low bias
		WG2039759	L2509327-01	MCI BRIDGEWATER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	310	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	342	>50%	-	potential high bias
			L2509327-02	MCI BRIDGEWATER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	210		-	potential high bias
			L2509327-04	MCI BRIDGEWATER-SLUDGE	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	37		-	potential low bias
L2509330	2/19/2025	WG2035461	L2509330-01	MIDDLEBOROUGH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	275		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	350	>50%	-	potential high bias
			L2509330-02	MIDDLEBOROUGH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	243		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	226		-	potential high bias
		WG2036160	L2509330-01	MIDDLEBOROUGH-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509330-02	MIDDLEBOROUGH-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509335	2/19/2025	WG2035461	L2509335-01	ROCKLAND-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	227		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	291		-	potential high bias
			L2509335-02	ROCKLAND-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	255		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	268		-	potential high bias
		WG2036160	L2509335-01	ROCKLAND-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509335-02	ROCKLAND-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509339	2/19/2025	WG2035461	L2509339-01	BROCKTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	270		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	336	>50%	-	potential high bias
			L2509339-02	BROCKTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	266		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	276		-	potential high bias
		WG2036160	L2509339-01	BROCKTON-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509339-02	BROCKTON-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509341	2/19/2025	WG2035461	L2509341-01	MARSHFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	304	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	420	>100%	-	potential high bias
			L2509341-02	MARSHFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	249		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	245		-	potential high bias
		WG2036160	L2509341-01	MARSHFIELD-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509341-02	MARSHFIELD-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509343	2/19/2025	WG2035473	L2509343-01	SCITUATE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	226		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509343-02	SCITUATE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509343-04 D	SCITUATE-INFLUENT DUPLICATE	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
		WG2036160	L2509343-01	SCITUATE-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509343-02	SCITUATE-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509352	2/19/2025	WG2035473	L2509352-01	HULL-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509352-02 D	HULL-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
		WG2036160	L2509352-01	HULL-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509352-02	HULL-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509354	2/19/2025	WG2035473	L2509354-01 D	COHASSET-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509354-02	COHASSET-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	223		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
		WG2036160	L2509354-01	COHASSET-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509354-02	COHASSET-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509361	2/19/2025	WG2035473	L2509361-01	MARION-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509361-02	MARION-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2509364	2/19/2025	WG2035473	L2509364-01	WAREHAM-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	219		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509364-02	WAREHAM-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	297		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
		WG2036160	L2509364-01	WAREHAM-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509364-02	WAREHAM-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509366	2/19/2025	WG2035473	L2509366-01 D	PLYMOUTH-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509366-02	PLYMOUTH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	225		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
		WG2036160	L2509366-01	PLYMOUTH-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
			L2509366-02	PLYMOUTH-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	153		ND	potential high bias
L2509528	2/19/2025	WG2035473	L2509528-01 D	MWRA DEER ISLAND-INFLUENT 1 (SOUTH)	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	208		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	147		-	potential high bias
			L2509528-02 D	MWRA DEER ISLAND-INFLUENT 2 (NORTH)	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509528-03 D	MWRA DEER ISLAND-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
L2509530	2/19/2025	WG2039759	L2509530-02	BILLERICA-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	211		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	231		-	potential high bias
		WG2040732	L2509530-01 RE	BILLERICA-INFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	140		-	potential high bias
L2509534	2/19/2025	WG2035473	L2509534-01	MERRIMAC-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	258		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509534-02	MERRIMAC-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	235		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509534-04 D	MERRIMAC-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	273		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
			L2509534-05	MERRIMAC-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	246		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	148		ND	potential high bias
								156		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	197		-	potential high bias
L2509536	2/19/2025	WG2039759	L2509536-01 D	AMESBURY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	211		-	potential high bias
			L2509536-02	AMESBURY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	289		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	306	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	163		-	potential high bias
L2509538	2/19/2025	WG2040266	L2509538-01	SESD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	309	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	399	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
			L2509538-02	SESD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	277		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	358	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	258	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	214		-	potential high bias
L2509542	2/19/2025	WG2040266	L2509542-01	LOWELL-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	290		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	386	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
			L2509542-02	LOWELL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	323	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	249	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	211		-	potential high bias
L2509544	2/19/2025	WG2040266	L2509544-01	LYNN-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	247		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	405	>100%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
			L2509544-02	LYNN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	238		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	336	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2509703	2/20/2025	WG2040266	L2509703-01	FALL RIVER REGIONAL-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	247		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	289		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
					PERFLUORO[1,2-13C2]DODECANOIC ACID (MPFDOA)	Surrogate high	10-130	156		-	potential high bias
			L2509703-02	FALL RIVER REGIONAL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	231		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	225		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	136		-	potential high bias
L2509706	2/20/2025	WG2039759	L2509706-02	TAUNTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	287		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	180		-	potential high bias
L2509708	2/20/2025	WG2037066	L2509708-01	SOMERSET-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	278		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	319	>50%	-	potential high bias
			L2509708-02	SOMERSET-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	242		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	219		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	243	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	193		-	potential high bias
L2509710	2/20/2025	WG2037277	L2509710-02	DARTMOUTH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	270		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	277		-	potential high bias
		WG2043139	L2509710-01 R	DARTMOUTH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	207		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	255		-	potential high bias
L2509712	2/20/2025	WG2037277	L2509712-01	NEW BEDFORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	291		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	419	>100%	-	potential high bias
			L2509712-02	NEW BEDFORD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	212		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
L2509715	2/20/2025	WG2037482	L2509715-01	FAIRHAVEN-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	317	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	375	>50%	-	potential high bias
L2509717	2/20/2025	WG2039231	L2509717-01	MANSFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	372	>50%	-	potential high bias
			L2509717-02	MANSFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	237		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	258		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	227	>50%	-	potential high bias
L2509719	2/20/2025	WG2039231	L2509719-01 D	ATTLEBORO-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	217		-	potential high bias
			L2509719-02	ATTLEBORO-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	224		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	219	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	174		-	potential high bias
L2509721	2/20/2025	WG2039231	L2509721-02	NORTH ATTLEBORO-EFFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	155		-	potential high bias
L2509725	2/20/2025	WG2039231	L2509725-01	DOUGLAS-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	302	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	318	>50%	-	potential high bias
			L2509725-02	DOUGLAS-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	255		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	296		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	237	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	207		-	potential high bias
L2509728	2/20/2025	WG2039231	L2509728-01	UXBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	325	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	371	>50%	-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	141		-	potential high bias
			L2509728-02	UXBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	288		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	277		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	165		-	potential high bias
			L2509728-04	UXBRIDGE-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	232		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	214		-	potential high bias
L2509730	2/20/2025	WG2037913	L2509730-04	NORTHBRIDGE-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	42	>50%	-	potential high bias
		WG2040502	L2509730-02	NORTHBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	357		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	235		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	272		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	236	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	231		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2509820	2/20/2025	WG2039231	L2509820-01	CONCORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	292		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	371	>50%	-	potential high bias
			L2509820-02	CONCORD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	223		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	221		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	193		-	potential high bias
		WG2040502	L2509820-04	CONCORD-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate Low	40-300	28		-	potential low bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate Low	40-200	39		-	potential low bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate Low	40-130	37		-	potential low bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate Low	25-135	19		-	potential low bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	15	>50%	-	potential low bias
					PERFLUORO[1,2,3,4,5,6,7-13C7]UNDECANOIC ACID (M7-PFUDA)	Surrogate Low	30-130	25		-	potential low bias
					PERFLUORO[1,2,3,4,5,6-13C6]DECANOIC ACID (M6PFDA)	Surrogate Low	40-130	25		-	potential low bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate Low	40-130	33		-	potential low bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate Low	40-130	30		-	potential low bias
					PERFLUORO[1,2,3-13C3]HEXANESULFONIC ACID (M3PFHXS)	Surrogate Low	40-130	21		-	potential low bias
					PERFLUORO[13C5]PENTANOIC ACID (M5PFPEA)	Surrogate Low	40-130	31		-	potential low bias
					PERFLUORO[13C8]OCTANESULFONIC ACID (M8PFOS)	Surrogate Low	40-130	21		-	potential low bias
					PERFLUORO[13C8]OCTANOIC ACID (M8PFOA)	Surrogate Low	40-130	29		-	potential low bias
					PERFLUORO[13C9]NONANOIC ACID (M9PFNA)	Surrogate Low	40-130	27		-	potential low bias
					PERFLUORO[2,3,4-13C3]BUTANESULFONIC ACID (M3PFBS)	Surrogate Low	40-135	20		-	potential low bias
L2509821	2/20/2025	WG2039486	L2509821-02	NEWBURYPORT-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	227		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	278		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	144		-	potential high bias
L2509823	2/20/2025	WG2039486	L2509823-01 D	SALISBURY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	221		-	potential high bias
			L2509823-02	SALISBURY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	230		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	235		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	215	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	193		-	potential high bias
L2509824	2/20/2025	WG2039486	L2509824-01 D	GLOUCESTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	208		-	potential high bias
			L2509824-02	GLOUCESTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	276		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	348	>50%	-	potential high bias
		WG2043139	L2509824-04 RE	GLOUCESTER-SLUDGE	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	142		-	potential high bias
L2509826	2/20/2025	WG2039486	L2509826-01	MCI CONCORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	364	>50%	-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	160		-	potential high bias
		WG2039740	L2509826-02 RE	MCI CONCORD-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
L2509828	2/20/2025	WG2039486	L2509828-02	IPSWICH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	220		-	potential high bias
		WG2040266	L2509828-01	IPSWICH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	262		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	327	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
L2509829	2/20/2025	WG2039486	L2509829-01 D	ROCKPORT-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	229		-	potential high bias
			L2509829-04	ROCKPORT-EQUIPMENT BLANK	PERFLUORO[13C8]OCTANOIC ACID (M8PFOA)	Surrogate high	40-130	134		-	potential high bias
		WG2043139	L2509829-05 RE	ROCKPORT-SLUDGE	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	31		-	potential low bias
L2509831	2/20/2025	WG2040266	L2509831-01 D	MAYNARD-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
			L2509831-02 D	MAYNARD-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	146		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	160		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	171		-	potential high bias
L2510220	2/25/2025	WG2040245	L2510220-01 D	WEBSTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	201		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	214		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510220-02	WEBSTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	217		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	172		-	potential high bias
L2510224	2/25/2025	WG2039740	L2510224-01	STURBRIDGE-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510224-02	STURBRIDGE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510224-01	STURBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	339	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	396	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510224-02	STURBRIDGE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2510228	2/25/2025	WG2039740	L2510228-01	SOUTHBRIDGE-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510228-02	SOUTHBRIDGE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510228-01 D	SOUTHBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	243		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	211		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510228-02	SOUTHBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	245		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
L2510234	2/24/2025	WG2039740	L2510234-01	CHARLTON-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510234-02	CHARLTON-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510234-01	CHARLTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	250		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	324	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
L2510236	2/24/2025	WG2039740	L2510236-01	LEICESTER-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510236-02	LEICESTER-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510236-01	LEICESTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	339	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	389	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510236-02	LEICESTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	222		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	214		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
L2510239	2/24/2025	WG2039740	L2510239-01	OXFORD-ROCHDALE-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510239-02	OXFORD-ROCHDALE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510239-02	OXFORD-ROCHDALE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	352	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	365	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	144		-	potential high bias
L2510241	2/25/2025	WG2039740	L2510241-01	SPENCER-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510241-02	SPENCER-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510241-01	SPENCER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	352	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	447	>100%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510241-02	SPENCER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	243		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	244		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	142		-	potential high bias
			L2510241-04	SPENCER-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	264		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	310	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
L2510245	2/25/2025	WG2039740	L2510245-01	BARRE-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510245-02	BARRE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510245-02	BARRE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	219		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	250		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
L2510247	2/25/2025	WG2039740	L2510247-01	NORTH BROOKFIELD-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
			L2510247-02	NORTH BROOKFIELD-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	132		ND	potential high bias
		WG2040245	L2510247-01	NORTH BROOKFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	236		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	268		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510247-02	NORTH BROOKFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	293		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias
			L2510247-04	NORTH BROOKFIELD-FIELD BLANK	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								145		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2510252	2/25/2025	WG2043647	L2510252-01 RE	HOPEDALE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	204		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	138		-	potential high bias
L2510254	2/25/2025	WG2043647	L2510254-01 RE	UPTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	236		-	potential high bias
L2510257	2/25/2025	WG2040502	L2510257-01	MILFORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	297		-	potential high bias
			L2510257-02	MILFORD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	221		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	224		-	potential high bias
L2510520	2/25/2025	WG2042115	L2510520-02	MARLBOROUGH EAST-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	227		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	227		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	162		-	potential high bias
			L2510520-04	MARLBOROUGH EAST-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	204		-	potential high bias
L2510524	2/25/2025	WG2042115	L2510524-02	WAYLAND-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	256		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	236		-	potential high bias
L2510526	2/25/2025	WG2040732	L2510526-01	LEOMINSTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	318	>50%	-	potential high bias
			L2510526-02	LEOMINSTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	230		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	204		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	185		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	182		-	potential high bias
L2510528	2/25/2025	WG2040732	L2510528-01	MWRA CLINTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	331	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	361	>50%	-	potential high bias
			L2510528-02	MWRA CLINTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	302		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	227		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	220		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	198		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	221		-	potential high bias
L2510530	2/25/2025	WG2040732	L2510530-01	HUDSON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	289		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	324	>50%	-	potential high bias
			L2510530-02	HUDSON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	379		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	307	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	327	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	160		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	187		-	potential high bias
L2510533	2/25/2025	WG2042115	L2510533-01	PEPPERELL-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	301	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	323	>50%	-	potential high bias
			L2510533-02	PEPPERELL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	268		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	298		-	potential high bias
L2510537	2/25/2025	WG2043647	L2510537-02	AYER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	207		-	potential high bias
L2510539	2/25/2025	WG2043647	L2510539-01 D	FITCHBURG EAST-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	267		-	potential high bias
L2510542	2/25/2025	WG2043647	L2510542-01	MARLBOROUGH WEST-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	280		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	279		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	147		-	potential high bias
			L2510542-02	MARLBOROUGH WEST-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	204		-	potential high bias
L2510798	2/26/2025	WG2044505	L2510798-01 D	WESTBOROUGH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	268		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	261		-	potential high bias
			L2510798-05	WESTBOROUGH-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	206		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	245		-	potential high bias
L2510803	2/26/2025	WG2043647	L2510803-01	WINCHENDON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	256		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	282		-	potential high bias
			L2510803-02	WINCHENDON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	327		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	276		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	191		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	178		-	potential high bias
L2510807	2/26/2025	WG2044505	L2510807-01 D	TEMPLETON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	206		-	potential high bias
		WG2045632	L2510807-01 RE/D	TEMPLETON-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	28		-	potential low bias
L2510811	2/26/2025	WG2044505	L2510811-02	GARDNER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	223		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	207		-	potential high bias
		WG2045632	L2510811-01 RE	GARDNER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
L2510813	2/26/2025	WG2044505	L2510813-01 D	CHARLES RIVER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	261		-	potential high bias
L2510821	2/26/2025	WG2041654	L2510821-01	MCI NORFOLK-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510821-02	MCI NORFOLK-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2510823	2/26/2025	WG2041654	L2510823-01	UPPER BLACKSTONE-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510823-02	UPPER BLACKSTONE-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044505	L2510823-01 D	UPPER BLACKSTONE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	239		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
L2510826	2/26/2025	WG2041654	L2510826-01	GRAFTON-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510826-02	GRAFTON-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
L2510858	2/27/2025	WG2041654	L2510858-01	MONTAGUE-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510858-02	MONTAGUE-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044777	L2510858-01	MONTAGUE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	322	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	396	>50%	-	potential high bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	131		-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	132		-	potential high bias
L2510860	2/27/2025	WG2041654	L2510860-01	NORTHFIELD-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510860-02	NORTHFIELD-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510860-04	NORTHFIELD-SLUDGE	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044913	L2510860-01	NORTHFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	304	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	382	>50%	-	potential high bias
			L2510860-02	NORTHFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	261		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	266		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	207	>50%	-	potential high bias
L2510862	2/27/2025	WG2041654	L2510862-01	GREENFIELD-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510862-02	GREENFIELD-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044913	L2510862-01	GREENFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	309	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	390	>50%	-	potential high bias
			L2510862-02	GREENFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	308	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	345	>50%	-	potential high bias
L2510866	2/26/2025	WG2041654	L2510866-01	SPRINGFIELD-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510866-02	SPRINGFIELD-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044777	L2510866-01	SPRINGFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	266		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	288		-	potential high bias
			L2510866-02	SPRINGFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	282		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	331	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	198		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	223		-	potential high bias
			L2510866-04	SPRINGFIELD-IFF DUPLICATE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	320	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	342	>50%	-	potential high bias
L2510869	2/26/2025	WG2041654	L2510869-01	CHICOPEE-INFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
			L2510869-02	CHICOPEE-EFFLUENT	N-ETHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NETFOSAA)	LCS High	70-145	148		ND	potential high bias
		WG2044777	L2510869-01	CHICOPEE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	302	>50%	-	potential high bias
			L2510869-02	CHICOPEE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	294		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	272		-	potential high bias
L2510873	2/26/2025	WG2044777	L2510873-01	WESTFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	368	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	378	>50%	-	potential high bias
			L2510873-02	WESTFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	352	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	324	>50%	-	potential high bias
L2510879	2/26/2025	WG2041657	L2510879-01	HARDWICK-WHEELWRIGHT-INFLUENT	PERFLUORO-[1,2-13C2]OCTANOIC ACID (13C2-PFOA)	Surrogate Low	50-150	28		-	potential low bias
			L2510879-02	HARDWICK-WHEELWRIGHT-EFFLUENT	PERFLUORO-[1,2-13C2]OCTANOIC ACID (13C2-PFOA)	Surrogate Low	50-150	27		-	potential low bias
		WG2044913	L2510879-01	HARDWICK-WHEELWRIGHT-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	230		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	286		-	potential high bias
			L2510879-02	HARDWICK-WHEELWRIGHT-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	360	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	384	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	159		-	potential high bias
			L2510879-04	HARDWICK-WHEELWRIGHT-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	211		-	potential high bias
L2510883	2/26/2025	WG2041657	L2510883-04	HARDWICK-GILBERTVILLE-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	44	>50%	-	potential high bias
		WG2044913	L2510883-01 D	HARDWICK-GILBERTVILLE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	296		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	307	>50%	-	potential high bias
			L2510883-02	HARDWICK-GILBERTVILLE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	301	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	343	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	184		-	potential high bias
L2510887	2/26/2025	WG2044777	L2510887-02	WARE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	327	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	436	>100%	-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2510901	2/27/2025	WG2041657	L2510901-02	ERVING #3-EFFLUENT	PERFLUORO-[1,2-13C2]OCTANOIC ACID (13C2-PFOA)	Surrogate Low	50-150	38		-	potential low bias
		WG2044913	L2510901-01	ERVING #3-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	317	>50%	-	potential high bias
			L2510901-02	ERVING #3-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	328	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	380	>50%	-	potential high bias
L2510905	2/27/2025	WG2041657	L2510905-01	ERVING #1-INFLUENT	PERFLUORO-[1,2-13C2]OCTANOIC ACID (13C2-PFOA)	Surrogate Low	50-150	48		-	potential low bias
			L2510905-04	ERVING #1-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	27		-	potential high bias
		WG2044913	L2510905-01	ERVING #1-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	280		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	275		-	potential high bias
L2510907	2/27/2025	WG2044913	L2510907-01	ERVING CENTER #2-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	211		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	271		-	potential high bias
			L2510907-02 D	ERVING CENTER #2-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	273		-	potential high bias
L2510909	2/26/2025	WG2045043	L2510909-01 D	SOUTH HADLEY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	231		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	209		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
			L2510909-02	SOUTH HADLEY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	275		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	293		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	156		-	potential high bias
L2510912	2/26/2025	WG2045043	L2510912-01 D	HOLYOKE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	346		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	258		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	331	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
			L2510912-02	HOLYOKE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	229		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	281		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
L2510916	2/26/2025	WG2045043	L2510916-01	EASTHAMPTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	342	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	398	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	131		-	potential high bias
			L2510916-02	EASTHAMPTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	245		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	259		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	152		-	potential high bias
L2510920	2/26/2025	WG2045043	L2510920-02	BELCHERTOWN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	212		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
			L2510920-04	BELCHERTOWN-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	263		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
L2510925	2/26/2025	WG2044223	L2510925-02	WARREN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	309	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	335	>50%	-	potential high bias
		WG2045043	L2510925-01 RE	WARREN-INFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
L2510929	2/26/2025	WG2045043	L2510929-01	PALMER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	312	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	374	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
			L2510929-02	PALMER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	276		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	291		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	189		-	potential high bias
L2510932	2/27/2025	WG2045480	L2510932-01 D	HADLEY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	259		-	potential high bias
			L2510932-02	HADLEY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	307		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	282		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	319	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	213	>50%	-	potential high bias
L2510934	2/27/2025	WG2045480	L2510934-01 D	AMHERST-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	204		-	potential high bias
			L2510934-02	AMHERST-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	306		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	246		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	262		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	169		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2510938	2/27/2025	WG2045043	L2510938-01	NORTHAMPTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	311	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	398	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
			L2510938-02	NORTHAMPTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	249		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	283		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	137		-	potential high bias
L2511194	2/27/2025	WG2045284	L2511194-02	ATHOL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	226		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	219		-	potential high bias
L2511196	2/27/2025	WG2045284	L2511196-01	ROYALSTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	393	>50%	-	potential high bias
			L2511196-02	ROYALSTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	277		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	297		-	potential high bias
L2512378	3/4/2025	WG2046539	L2512378-02	HATFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	290		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	312	>50%	-	potential high bias
		WG2047596	L2512378-01	HATFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	325	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	372	>50%	-	potential high bias
L2512380	3/4/2025	WG2046539	L2512380-01	OLD DEERFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	308	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	342	>50%	-	potential high bias
			L2512380-02	OLD DEERFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	296		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	321	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	232	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	213		-	potential high bias
		WG2054788	L2512380-05	OLD DEERFIELD-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	314		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	201		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	264		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	177	>100%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	154		-	potential high bias
		WG2057077	L2512380-05	OLD DEERFIELD-SLUDGE	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	134		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	158		-	potential high bias
					PERFLUORO[1,2,3,4,5,6-13C6]DECANOIC ACID (M6PFDA)	Surrogate high	40-130	133		-	potential high bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	133		-	potential high bias
					PERFLUORO[1,2-13C2]TETRADECANOIC ACID (M2PFTEDA)	Surrogate high	10-130	134		-	potential high bias
					PERFLUORO[13C8]OCTANESULFONAMIDE (M8FOSA)	Surrogate high	40-130	135		-	potential high bias
					PERFLUORO[13C9]NONANOIC ACID (M9PFNA)	Surrogate high	40-130	131		-	potential high bias
L2512382	3/4/2025	WG2046539	L2512382-01	WORONOCO VILLAGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	306	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	326	>50%	-	potential high bias
L2512384	3/4/2025	WG2046539	L2512384-02	RUSSELL VILLAGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	290		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	271		-	potential high bias
		WG2048938	L2512384-01 RE\D	RUSSELL VILLAGE-INFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2512386	3/4/2025	WG2046539	L2512386-01	SOUTH DEERFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	284		-	potential high bias
			L2512386-02	SOUTH DEERFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	208		-	potential high bias
L2512388	3/4/2025	WG2046637	L2512388-01	SUNDERLAND-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	246		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	294		-	potential high bias
			L2512388-02	SUNDERLAND-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	275		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	269		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	167		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	185		-	potential high bias
L2512390	3/4/2025	WG2046637	L2512390-01	SHELBURNE FALLS-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	310	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	136		-	potential high bias
L2512392	3/4/2025	WG2046637	L2512392-01	CHARLEMONT-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	272		-	potential high bias
					PERFLUORO[1,2,3,4,5,6,7-13C7]UNDECANOIC ACID (M7-PFUDA)	Surrogate high	30-130	157		-	potential high bias
					PERFLUORO[1,2-13C2]TETRADECANOIC ACID (M2PFTEDA)	Surrogate high	10-130	145		-	potential high bias
			L2512392-02	CHARLEMONT-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	272		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	281		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	137		-	potential high bias
		WG2054414	L2512392-04	CHARLEMONT-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	299		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	376	>50%	-	potential high bias
		WG2054788	L2512392-04	CHARLEMONT-SLUDGE	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	215	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	171		-	potential high bias
L2512394	3/4/2025	WG2046637	L2512394-01	HUNTINGTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	203		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	292		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2512396	3/5/2025	WG2045632	L2512396-01 RE	LEE-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2046637	L2512396-01	LEE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	210		-	potential high bias
			L2512396-02	LEE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	238		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	233		-	potential high bias
L2512398	3/5/2025	WG2046637	L2512398-02	GREAT BARRINGTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	288		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	285		-	potential high bias
L2512400	3/5/2025	WG2046637	L2512400-01	STOCKBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	222		-	potential high bias
			L2512400-02	STOCKBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	211		-	potential high bias
L2512578	3/5/2025	WG2046848	L2512578-01	LENOX CENTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	222		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	277		-	potential high bias
			L2512578-02	LENOX CENTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	282		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	278		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	147		-	potential high bias
L2512581	3/5/2025	WG2046848	L2512581-01	WEST STOCKBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	323	>50%	-	potential high bias
			L2512581-02	WEST STOCKBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	221		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	212		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	159		-	potential high bias
			L2512581-04	WEST STOCKBRIDGE-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	291		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	311	>50%	-	potential high bias
L2512594	3/5/2025	WG2047462	L2512594-01	HOOSAC-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	249		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	214		-	potential high bias
L2512597	3/5/2025	WG2047462	L2512597-01 D	MONROE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	202		-	potential high bias
			L2512597-02	MONROE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	225		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	236		-	potential high bias
L2515867	3/18/2025	WG2048673	L2515867-01	SCITUATE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	248		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	266		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515867-02	SCITUATE-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
L2515872	3/18/2025	WG2045632	L2515872-01	COHASSET-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2515872-02	COHASSET-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2515872-01 D	COHASSET-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	215		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515872-02	COHASSET-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	222		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	246		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	149		-	potential high bias
L2515876	3/18/2025	WG2045632	L2515876-02	HULL-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2515876-01	HULL-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	239		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	279		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515876-02	HULL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	237		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	328	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515876-04	HULL-EQUIP BLANK	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
					PERFLUORO[1,2,3,4,5,6,7-13C7]UNDECANOIC ACID (M7-PFUDA)	Surrogate high	30-130	143		-	potential high bias
		WG2050196	L2515876-01 RE	HULL-INFLUENT	2-(N-ETHYL-D5-PERFLUORO-1-OCTANESULFONAMIDO)ETHAN-D4-OL (D9-NETFOSE)	Surrogate high	10-130	136		-	potential high bias
					2-(N-METHYL-D3-PERFLUORO-1-OCTANESULFONAMIDO)ETHAN-D4-OL (D7-NMEFOSE)	Surrogate high	10-130	142		-	potential high bias
L2515879	3/18/2025	WG2045632	L2515879-01	MARSHFIELD-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2515879-02	MARSHFIELD-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2515879-01	MARSHFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	284		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	348	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515879-02	MARSHFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	275		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	173		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2515882	3/18/2025	WG2045632	L2515882-01	ROCKLAND-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2515882-02	ROCKLAND-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2515882-01	ROCKLAND-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	299		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	404	>100%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515882-02	ROCKLAND-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	203		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
L2515885	3/18/2025	WG2045632	L2515885-01	BROCKTON-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2515885-02	BROCKTON-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2515885-01	BROCKTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	320	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	409	>100%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2515885-02	BROCKTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	238		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	256		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	168		-	potential high bias
			L2515885-04	BROCKTON-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	219		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	256		-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	153		-	potential high bias
			L2515885-05	BROCKTON-EQUIPMENT BLANK	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
L2516201	3/19/2025	WG2045632	L2516201-01	MIDDLEBOROUGH-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2516201-02	MIDDLEBOROUGH-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048938	L2516201-01	MIDDLEBOROUGH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	301	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	286		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	132		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		4.68J	potential high bias
			L2516201-02	MIDDLEBOROUGH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	228		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	215		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2516204	3/19/2025	WG2045632	L2516204-01	BRIDGEWATER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2516204-02	BRIDGEWATER-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048673	L2516204-01	BRIDGEWATER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	271		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	343	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
			L2516204-02	BRIDGEWATER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	291		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	313	>50%	-	potential high bias
					3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
L2516210	3/19/2025	WG2045632	L2516210-01	MCI BRIDGEWATER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
			L2516210-02	MCI BRIDGEWATER-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	153		ND	potential high bias
		WG2048938	L2516210-01	MCI BRIDGEWATER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	236		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	265		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516210-02	MCI BRIDGEWATER-EFFLUENT	N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2516427	3/19/2025	WG2048687	L2516427-02	WAREHAM-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	220		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	249		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	147		-	potential high bias
L2516433	3/19/2025	WG2048687	L2516433-01	MARION-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	270		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	252		-	potential high bias
			L2516433-02	MARION-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
		WG2054206	L2516433-04	MARION-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	64	>100%	-	potential high bias
L2516578	3/19/2025	WG2048687	L2516578-02	AMESBURY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	263		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	219		-	potential high bias
L2516580	3/19/2025	WG2048687	L2516580-02	LYNN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	268		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	263		-	potential high bias
		WG2052783	L2516580-04	LYNN-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	252		-	potential high bias
		WG2054206	L2516580-04	LYNN-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	109	>100%	-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2516583	3/19/2025	WG2048687	L2516583-02	SESD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	236		-	potential high bias
L2516585	3/19/2025	WG2048687	L2516585-02	MWRA DEER ISLAND-INFLUENT NORTH	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	239		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	234		-	potential high bias
			L2516585-03	MWRA DEER ISLAND-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	210		-	potential high bias
L2516589	3/19/2025	WG2048687	L2516589-01 D	MERRIMAC-INFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	138		-	potential high bias
			L2516589-02	MERRIMAC-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	228		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	150		-	potential high bias
L2516591	3/19/2025	WG2048687	L2516591-02	HAVERHILL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	257		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	303	>50%	-	potential high bias
L2516594	3/19/2025	WG2048938	L2516594-01	SALISBURY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516594-02	SALISBURY-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	229		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	208		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2516596	3/19/2025	WG2048938	L2516596-01	BILLERICA-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	203		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	231		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516596-02	BILLERICA-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	210		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	131		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2516598	3/19/2025	WG2048938	L2516598-01	LOWELL-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	241		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	293		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516598-02	LOWELL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	285		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	226		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
		WG2050196	L2516598-02	LOWELL-EFFLUENT	2-(N-METHYL-D3-PERFLUORO-1-OCTANESULFONAMIDO)ETHAN-D4-OL (D7-NMEFOSE)	Surrogate high	10-130	137		-	potential high bias
L2516600	3/19/2025	WG2048938	L2516600-01	GREATER LAWRENCE SD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	210		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516600-02	GREATER LAWRENCE SD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	243		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	244		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516600-04	GREATER LAWRENCE SD-INFLUENT DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	218		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	259		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
L2516638	3/20/2025	WG2050196	L2516638-01	ROCKPORT-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	141		-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	134		-	potential high bias
					PERFLUORO[13C5]PENTANOIC ACID (M5PFPEA)	Surrogate high	40-130	132		-	potential high bias
		WG2050323	L2516638-02	ROCKPORT-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	257		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	253		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	185		-	potential high bias
L2516641	3/20/2025	WG2050323	L2516641-02	GLOUCESTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	350	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	411	>100%	-	potential high bias
		WG2052783	L2516641-04	GLOUCESTER-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	371		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	264		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	395	>50%	-	potential high bias
		WG2054206	L2516641-04	GLOUCESTER-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	43	>50%	-	potential high bias
L2516643	3/20/2025	WG2048710	L2516643-02	MANCHESTER BY THE SEA-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	217		-	potential high bias
L2516812	3/20/2025	WG2048938	L2516812-01	DARTMOUTH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	230		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	252		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
			L2516812-02	DARTMOUTH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	211		-	potential high bias
					N-METHYL PERFLUOROOCTANESULFONAMIDOACETIC ACID (NMEFOSAA)	LCS High	50-140	158		ND	potential high bias
		WG2051041	L2516812-04	DARTMOUTH-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	335	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	309	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	34		-	potential low bias
			L2516812-04 D	DARTMOUTH-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	314	>50%	-	potential high bias
					PERFLUORO[13C8]OCTANOIC ACID (M8PFOA)	Surrogate high	40-130	134		-	potential high bias
					PERFLUORO[13C9]NONANOIC ACID (M9PFNA)	Surrogate high	40-130	138		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2516816	3/20/2025	WG2050196	L2516816-02	NEW BEDFORD-EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	132		-	potential high bias
		WG2050870	L2516816-01	NEW BEDFORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	237		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	282		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	131		-	potential high bias
			L2516816-02	NEW BEDFORD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	296		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	241		-	potential high bias
L2516819	3/20/2025	WG2051041	L2516819-02	FAIRHAVEN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	260		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	218		-	potential high bias
			L2516819-04	FAIRHAVEN-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	247		-	potential high bias
L2516821	3/20/2025	WG2050870	L2516821-01	TAUNTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	280		-	potential high bias
L2516826	3/20/2025	WG2050870	L2516826-01	SOMERSET-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	306	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	277		-	potential high bias
			L2516826-02	SOMERSET-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	251		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	207		-	potential high bias
L2516828	3/20/2025	WG2050870	L2516828-02	FALL RIVER REGIONAL-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	247		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	220		-	potential high bias
L2517099	3/21/2025	WG2050870	L2517099-01	NORTH ATTLEBORO-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	280		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	225		-	potential high bias
			L2517099-02	NORTH ATTLEBORO-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	215		-	potential high bias
L2517101	3/21/2025	WG2051203	L2517101-01	ATTLEBORO-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	248		-	potential high bias
L2517104	3/21/2025	WG2050870	L2517104-02	MANSFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	273		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	230		-	potential high bias
L2517315	3/24/2025	WG2051432	L2517315-01	OXFORD-ROCHDALE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	393	>50%	-	potential high bias
			L2517315-02	OXFORD-ROCHDALE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	285		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	320	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	227	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	216		-	potential high bias
L2517318	3/24/2025	WG2051432	L2517318-01 D	LEICESTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	251		-	potential high bias
			L2517318-02	LEICESTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	280		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	366	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	294	>100%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	274	>50%	-	potential high bias
L2517321	3/24/2025	WG2051432	L2517321-01 D	CHARLTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	232		-	potential high bias
L2517728	3/25/2025	WG2050257	L2517728-01	SOUTHBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	48	>50%	-	potential high bias
L2517731	3/25/2025	WG2050258	L2517731-01	WEBSTER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517731-02	WEBSTER-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517731-01	WEBSTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	344	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	402	>100%	-	potential high bias
			L2517731-02	WEBSTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	244		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	222		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	141		-	potential high bias
			L2517731-04	WEBSTER-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	315	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	366	>50%	-	potential high bias
L2517733	3/25/2025	WG2050258	L2517733-02	STURBRIDGE-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517733-01 D	STURBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	201		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	216		-	potential high bias
			L2517733-02	STURBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	245		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	305	>100%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	328	>50%	-	potential high bias
		WG2054206	L2517733-01 RE	STURBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	37		-	potential high bias
			L2517733-04	STURBRIDGE-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	46	>50%	-	potential high bias
L2517739	3/25/2025	WG2050258	L2517739-01	MILFORD-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517739-02 D	MILFORD-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517739-01	MILFORD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	287		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	381	>50%	-	potential high bias
			L2517739-02	MILFORD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	255		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	325	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	195		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	173		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2517741	3/25/2025	WG2050258	L2517741-01	HOPEDALE-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517741-02	HOPEDALE-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517741-01	HOPEDALE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	317	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	387	>50%	-	potential high bias
			L2517741-02	HOPEDALE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	253		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	306	>100%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	295	>50%	-	potential high bias
L2517744	3/25/2025	WG2050258	L2517744-01	UPTON-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517744-02	UPTON-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517744-01	UPTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	335	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	407	>100%	-	potential high bias
			L2517744-02	UPTON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	210		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	202		-	potential high bias
L2517746	3/25/2025	WG2050258	L2517746-01	BARRE-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051432	L2517746-01	BARRE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	318	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	419	>100%	-	potential high bias
			L2517746-02	BARRE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	278		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	162		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	200		-	potential high bias
L2517748	3/25/2025	WG2050258	L2517748-01	NORTH BROOKFIELD-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517748-02 D	NORTH BROOKFIELD-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051972	L2517748-01	NORTH BROOKFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	269		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	266		-	potential high bias
			L2517748-02	NORTH BROOKFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	238		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	234		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	142		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	173		-	potential high bias
			L2517748-04	NORTH BROOKFIELD-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	262		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	251		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	142		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	184		-	potential high bias
L2517751	3/25/2025	WG2050258	L2517751-01	SPENCER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517751-02 D	SPENCER-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051972	L2517751-01	SPENCER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	234		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	330	>50%	-	potential high bias
					PERFLUORO[13C8]OCTANESULFONAMIDE (M8FOSA)	Surrogate high	40-130	132		-	potential high bias
			L2517751-02	SPENCER-EFFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	138		-	potential high bias
L2517785	3/25/2025	WG2050258	L2517785-01	FITCHBURG EAST-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517785-02	FITCHBURG EAST-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051972	L2517785-01	FITCHBURG EAST-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	268		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	330	>50%	-	potential high bias
			L2517785-02	FITCHBURG EAST-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	231		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	293		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	147		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	194		-	potential high bias
L2517788	3/25/2025	WG2050258	L2517788-01 D	LEOMINSTER-INFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
			L2517788-02	LEOMINSTER-EFFLUENT	4,8-DIOXA-3H-PERFLUORONONANOIC ACID (ADONA)	LCS High	65-145	147		ND	potential high bias
		WG2051972	L2517788-02	LEOMINSTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	309	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	162		-	potential high bias
L2517792	3/25/2025	WG2051274	L2517792-01	TEMPLETON-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	134		-	potential high bias
					PERFLUORO[1,2,3-13C3]HEXANESULFONIC ACID (M3PFHXS)	Surrogate high	40-130	131		-	potential high bias
			L2517792-02	TEMPLETON-EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	140		-	potential high bias
		WG2051972	L2517792-01	TEMPLETON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	277		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	390	>50%	-	potential high bias
			L2517792-02	TEMPLETON-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	277		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	298		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	229	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	216		-	potential high bias
					PERFLUORO[13C8]OCTANESULFONAMIDE (M8FOSA)	Surrogate high	40-130	132		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2518186	3/26/2025	WG2051274	L2518186-01	MCI NORFOLK-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	143		-	potential high bias
		WG2051972	L2518186-01	MCI NORFOLK-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	253		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	360	>50%	-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	134		-	potential high bias
			L2518186-02	MCI NORFOLK-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	229		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	187		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	183		-	potential high bias
L2518190	3/26/2025	WG2051274	L2518190-01	MEDFIELD WWTP-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	139		-	potential high bias
		WG2051972	L2518190-02	MEDFIELD WWTP-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	276		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	301	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	149		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	179		-	potential high bias
		WG2054206	L2518190-04	MEDFIELD WWTP-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	55	>100%	-	potential high bias
L2518194	3/26/2025	WG2051274	L2518194-01	CHARLES RIVER-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	131		-	potential high bias
		WG2052543	L2518194-01	CHARLES RIVER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	260		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	342	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	140		-	potential high bias
			L2518194-02	CHARLES RIVER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	254		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	231		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	184		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	194		-	potential high bias
L2518196	3/26/2025	WG2052543	L2518196-01	WESTBOROUGH-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	271		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
			L2518196-02	WESTBOROUGH-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	236		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	227		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	219	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	220		-	potential high bias
L2518199	3/26/2025	WG2052543	L2518199-01	UPPER BLACKSTONE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	220		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	292		-	potential high bias
			L2518199-02	UPPER BLACKSTONE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	234		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	237		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	253	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	243		-	potential high bias
L2518201	3/26/2025	WG2048673	L2518201-02	GRAFTON-EFFLUENT	3-PERFLUOROPROPYL PROPANOIC ACID (3:3FTCA)	LCS High	65-130	136		ND	potential high bias
								140		ND	potential high bias
		WG2052914	L2518201-01 RE/D	GRAFTON-INFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	136		-	potential high bias
L2518216	3/26/2025	WG2052543	L2518216-01	CHICOPEE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	215		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	313	>50%	-	potential high bias
L2518221	3/26/2025	WG2052914	L2518221-01	SPRINGFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	202		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	164		-	potential high bias
			L2518221-02	SPRINGFIELD-EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	148		-	potential high bias
L2518223	3/26/2025	WG2052543	L2518223-01	WESTFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	235		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	335	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	142		-	potential high bias
			L2518223-02	WESTFIELD-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	268		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	275		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	176		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	183		-	potential high bias
L2518515	3/27/2025	WG2052914	L2518515-01	AMHERST-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	236		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	133		-	potential high bias
L2518521	3/27/2025	WG2052914	L2518521-01 R	HADLEY-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	328	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	401	>100%	-	potential high bias
L2518523	3/27/2025	WG2052914	L2518523-01	NORTHFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	250		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	140		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2518526	3/27/2025	WG2052543	L2518526-01	GREENFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	202		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	220		-	potential high bias
		WG2054788	L2518526-01	GREENFIELD-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	187		-	potential high bias
					PERFLUORO[1,2,3,4,5,6-13C6]DECANOIC ACID (M6PFDA)	Surrogate high	40-130	136		-	potential high bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	180		-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	174		-	potential high bias
					PERFLUORO[1,2,3-13C3]HEXANESULFONIC ACID (M3PFHXS)	Surrogate high	40-130	189		-	potential high bias
					PERFLUORO[13C4]BUTANOIC ACID (MPFBA)	Surrogate high	5-130	182		-	potential high bias
					PERFLUORO[13C5]PENTANOIC ACID (M5PFPEA)	Surrogate high	40-130	198	>50%	-	potential high bias
					PERFLUORO[13C8]OCTANESULFONIC ACID (M8PFOS)	Surrogate high	40-130	136		-	potential high bias
					PERFLUORO[13C8]OCTANOIC ACID (M8PFOA)	Surrogate high	40-130	177		-	potential high bias
					PERFLUORO[13C9]NONANOIC ACID (M9PFNA)	Surrogate high	40-130	164		-	potential high bias
					PERFLUORO[2,3,4-13C3]BUTANESULFONIC ACID (M3PFBS)	Surrogate high	40-135	201		-	potential high bias
			L2518526-02	GREENFIELD-EFFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate Low	40-170	32		-	potential low bias
L2518532	3/27/2025	WG2052914	L2518532-01	MONTAGUE-INFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	136		-	potential high bias
			L2518532-02	MONTAGUE-EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	133		-	potential high bias
L2518684	3/26/2025	WG2052543	L2518684-01	BELCHERTOWN-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	245		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	353	>50%	-	potential high bias
			L2518684-02	BELCHERTOWN-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	216		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	248	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	241		-	potential high bias
L2518701	3/26/2025	WG2051972	L2518701-01	PALMER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	273		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	268		-	potential high bias
			L2518701-02	PALMER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	265		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	281		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	141		-	potential high bias
L2518707	3/26/2025	WG2051972	L2518707-01	WARREN-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	281		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	338	>50%	-	potential high bias
			L2518707-02	WARREN-EFFLUENT	N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	185		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	173		-	potential high bias
		WG2054206	L2518707-04	WARREN-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	28		-	potential high bias
L2519387	3/31/2025	WG2052914	L2519387-01	ERVING #1- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	244		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	141		-	potential high bias
			L2519387-02	ERVING #1- EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	134		-	potential high bias
		WG2054788	L2519387-04	ERVING #1- SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	31		-	potential high bias
L2519392	3/31/2025	WG2052914	L2519392-01	ERVING #3- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	257		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	142		-	potential high bias
		WG2054414	L2519392-04	ERVING #3- SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	306	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	373	>50%	-	potential high bias
		WG2055806	L2519392-02	ERVING #3- EFFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	196		-	potential high bias
		WG2056325	L2519392-04	ERVING #3- SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	72	>100%	-	potential high bias
L2519397	4/1/2025	WG2054414	L2519397-01	CHARLEMONT- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	218		-	potential high bias
			L2519397-02	CHARLEMONT- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	250		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	150		-	potential high bias
		WG2055806	L2519397-04	CHARLEMONT- SLUDGE	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	198		-	potential high bias
L2519402	4/1/2025	WG2054414	L2519402-01	SHELBURNE FALLS- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	210		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	252		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	149		-	potential high bias
			L2519402-02	SHELBURNE FALLS- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	293		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	311	>50%	-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	158		-	potential high bias
		WG2055806	L2519402-01	SHELBURNE FALLS- INFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	180		-	potential high bias
			L2519402-02	SHELBURNE FALLS- EFFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	214		-	potential high bias
L2519404	4/1/2025	WG2055448	L2519404-01 D	HOLYOKE- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	212		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519404-02	HOLYOKE- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	354		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	250		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	398	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2519412	4/1/2025	WG2052914	L2519412-01 R	RUSSELL VILLAGE- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	246		-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	147		-	potential high bias
			L2519412-04	RUSSELL VILLAGE- FIELD BLANK	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	132		-	potential high bias
		WG2055806	L2519412-05	RUSSELL VILLAGE- SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	94	>100%	-	potential high bias
		WG2056613	L2519412-05	RUSSELL VILLAGE- SLUDGE	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	178		-	potential high bias
L2519416	4/1/2025	WG2055448	L2519416-01 D	HUNTINGTON-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	331	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	356	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519416-02	HUNTINGTON- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	356		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	267		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	305	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	194		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	191		-	potential high bias
		WG2056613	L2519416-04	HUNTINGTON- SLUDGE	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	175		-	potential high bias
L2519417	4/1/2025	WG2055448	L2519417-01 D	WORONOCO VILLAGE- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	304	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	357	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519417-02	WORONOCO VILLAGE- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	338		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	252		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	329	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519417-04	WORONOCO VILLAGE- EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	257		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	304	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
		WG2055806	L2519417-02	WORONOCO VILLAGE- EFFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	200		-	potential high bias
L2519418	4/1/2025	WG2055448	L2519418-01	OLD DEERFIELD- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	310		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	298		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	401	>100%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519418-02	OLD DEERFIELD- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	291		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	349	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
		WG2055806	L2519418-01	OLD DEERFIELD- INFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	186		-	potential high bias
			L2519418-02	OLD DEERFIELD- EFFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	190		-	potential high bias
L2519423	4/1/2025	WG2055448	L2519423-01	SOUTH DEERFIELD- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	297		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	399	>50%	-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	131		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519423-02	SOUTH DEERFIELD- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	355		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	248		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	320	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	173		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	201		-	potential high bias
		WG2056325	L2519423-02 D	SOUTH DEERFIELD- EFFLUENT	2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	152		-	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	156		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	266	>50%	-	potential high bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	172		-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	152		-	potential high bias
					PERFLUORO[1,2,3-13C3]HEXANESULFONIC ACID (M3PFHXS)	Surrogate high	40-130	149		-	potential high bias
					PERFLUORO[13C4]BUTANOIC ACID (MPFBA)	Surrogate high	5-130	134		-	potential high bias
					PERFLUORO[13C5]PENTANOIC ACID (M5PFPEA)	Surrogate high	40-130	165		-	potential high bias
					PERFLUORO[13C8]OCTANOIC ACID (M8PFOA)	Surrogate high	40-130	146		-	potential high bias
					PERFLUORO[2,3,4-13C3]BUTANESULFONIC ACID (M3PFBS)	Surrogate high	40-135	151		-	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2519425	4/1/2025	WG2055448	L2519425-01	HATFIELD- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	299		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	391	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
			L2519425-02	HATFIELD- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	346		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	294		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	316	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	198		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	182		-	potential high bias
			L2519425-04	HATFIELD- INFLUENT DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	313	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	409	>100%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
L2519428	4/1/2025	WG2055448	L2519428-01	SUNDERLAND- INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	376		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	294		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	390	>50%	-	potential high bias
					2,3,3,3-TETRAFLUORO-2-[1,1,2,2,3,3,3-HEPTAFLUOROPROPOXY]-13C3-PROPANOIC ACID (M3HFPO-DA)	Surrogate high	40-130	133		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	131		-	potential high bias
			L2519428-02	SUNDERLAND- EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	444		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	288		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	232	>50%	-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	227		-	potential high bias
		WG2056325	L2519428-01	SUNDERLAND- INFLUENT	N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	175		-	potential high bias
L2519550	3/31/2025	WG2055448	L2519550-01	ERVING CENTER #2-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	227		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	140		-	potential high bias
			L2519550-02 D	ERVING CENTER #2-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	231		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	165		ND	potential high bias
								203		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	165		-	potential high bias
L2519802	4/2/2025	WG2055506	L2519802-01	LENOX CENTER-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	243		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	282		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519802-02	LENOX CENTER-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	304	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	290		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519802-05	LENOX CENTER-FIELD BLANK	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	225		-	potential high bias
			L2519802-06	LENOX CENTER-SLUDGE-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	278		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	232		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
		WG2056340	L2519802-01	LENOX CENTER-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	200		-	potential high bias
			L2519802-02	LENOX CENTER-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
L2519805	4/2/2025	WG2055506	L2519805-01	PITTSFIELD-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	284		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	274		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519805-02 D	PITTSFIELD-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	205		-	potential high bias
			L2519805-04	PITTSFIELD-INFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	296		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	278		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
		WG2056340	L2519805-01	PITTSFIELD-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
			L2519805-02	PITTSFIELD-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias

Table B-2
Summary of Data Usability Evaluation

SDG	Date	Batch ID	Lab Sample ID	Sample ID	Parameters	QC Non-Conformances	Valid Range	Recovery/RPD (%)	Flag	Result	DQ Assessment
L2519809	4/2/2025	WG2055506	L2519809-01	WEST STOCKBRIDGE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	352	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	400	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519809-02	WEST STOCKBRIDGE-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	277		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	301	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
					N-DEUTERIOETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D5-NETFOSAA)	Surrogate high	25-135	197		-	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	180		-	potential high bias
		WG2056340	L2519809-01	WEST STOCKBRIDGE-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
			L2519809-02	WEST STOCKBRIDGE-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
L2519811	4/2/2025	WG2055506	L2519811-01 D	ADAMS-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519811-02	ADAMS-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	244		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	262		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519811-04	ADAMS-EFFLUENT-DUP	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	227		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
					N-DEUTERIOMETHYLPERFLUORO-1-OCTANESULFONAMIDOACETIC ACID (D3-NMEFOSAA)	Surrogate high	40-170	181		-	potential high bias
		WG2056340	L2519811-01 R	ADAMS-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
			L2519811-02	ADAMS-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
L2519814	4/2/2025	WG2056098	L2519814-01	MONROE-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	233		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	258		-	potential high bias
		WG2056340	L2519814-01	MONROE-INFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
			L2519814-02	MONROE-EFFLUENT	3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
			L2519814-04 R	MONROE-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	58	>100%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias
		WG2056613	L2519814-04	MONROE-SLUDGE	PERFLUORO[1,2,3,4,6-13C5]HEXANOIC ACID (M5PFHXA)	Surrogate high	40-130	132		-	potential high bias
					PERFLUORO[1,2,3,4-13C4]HEPTANOIC ACID (M4PFHPA)	Surrogate high	40-130	145		-	potential high bias
L2519817	4/2/2025	WG2055506	L2519817-01	HOOSAC-INFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	303	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	320	>50%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519817-02	HOOSAC-EFFLUENT	1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	224		-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
			L2519817-04	HOOSAC-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2]DECANESULFONIC ACID (M2-8:2FTS)	Surrogate high	40-300	328		-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]HEXANESULFONIC ACID (M2-4:2FTS)	Surrogate high	40-200	363	>50%	-	potential high bias
					1H,1H,2H,2H-PERFLUORO[1,2-13C2]OCTANESULFONIC ACID (M2-6:2FTS)	Surrogate high	40-200	446	>100%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	149		ND	potential high bias
		WG2056340	L2519817-04	HOOSAC-SLUDGE	1H,1H,2H,2H-PERFLUORO[1,2-13C2D4]HEXANESULFONIC ACID (13C2D4-4:2FTS)	Surrogate high	0-25	110	>100%	-	potential high bias
					3-PERFLUOROHEPTYL PROPANOIC ACID (7:3FTCA)	LCS High	50-145	152		ND	potential high bias

TABLE B-3
Summary Information for the 114 NPDES-Permitted POTWs

Facility	Size	Industrial Pretreatment	Region	Population Served
Adams WWTP	Medium	IPP	West	5,580
Amesbury WWTP	Medium	IPP	Northeast	17,000
Amherst WWTP	Large	No IPP	West	6,500
Athol WWTP	Medium	No IPP	West	9,000
Attleboro WWTP	Large	IPP	Southeast	10,099
Ayer WWTP	Medium	IPP	Central	8,479
Barre WWTP	Small	No IPP	Central	750
Belchertown WWTP	Medium	No IPP	West	1,230
Billerica WWTP	Large	IPP	Northeast	30,000
Bridgewater WWTP	Medium	No IPP	Southeast	18,082
Brockton AWRF	Large	IPP	Southeast	105,000
Charlemont WWTP	Small	No IPP	West	200
Charles River PCD	Large	IPP	Central	4,000
Charlton WWTP	Small	No IPP	Central	13,391
Chicopee WWTP	Large	IPP	West	54,838
Cohasset WWTP	Small	No IPP	Southeast	7,000
Concord WWTF	Medium	No IPP	Northeast	6,330
Dartmouth WPCF	Medium	No IPP	Southeast	19,762
Douglas WWTP	Small	No IPP	Central	3,489
Easthampton WWTP	Medium	IPP	West	17,000
Erving Center WWTP (#2)	Medium	IPP	West	192
Erving POTW #1	Medium	No IPP	West	250
Erving POTW #3	Small	No IPP	West	50
Fairhaven WPCF	Medium	No IPP	Southeast	10,000
Fall River Regional WWF	Large	IPP	Southeast	94,000
Fitchburg East WWTP	Large	IPP	Central	42,000
Gardner WPCF	Medium	IPP	Central	18,000
Gloucester WPCF	Large	IPP	Northeast	30,000
Grafton WWTP	Medium	No IPP	Central	14,000
Great Barrington WWTP	Medium	IPP	West	7,000
Greater Lawrence - Sanitary District	Large	IPP	Northeast	250,000
Greenfield WPCF	Medium	No IPP	West	14,100
Hadley WWTP	Small	No IPP	West	1,041
Hardwick-Gilbertville WPCF	Small	No IPP	West	1,406
Hardwick-Wheelwright WPCF	Small	No IPP	West	351
Hatfield WWTP	Small	No IPP	West	785
Haverhill WWTP	Large	IPP	Northeast	50,000
Holyoke WWTP	Large	IPP	West	11,000
Hoosac WQD	Large	IPP	West	23,000
Hopedale WWTF	Small	No IPP	Central	2,052
Hudson WWTF	Medium	No IPP	Central	20,364
Hull WWTP	Medium	No IPP	Southeast	10,072
Huntington WWTP	Small	No IPP	West	287
Ipswich WWTP	Medium	No IPP	Northeast	5,500
Lee WWTP	Medium	No IPP	West	2,013
Leicester WWTP	Small	No IPP	Central	800
Lenox Center WWTP	Medium	No IPP	West	1,498
Leominster WPCF	Large	IPP	Central	40,000
Lowell Regional WW Utility	Large	IPP	Northeast	228,285
Lynn Regional WWTF	Large	IPP	Northeast	148,300
Manchester By the Sea WWTP	Small	No IPP	Northeast	3,000
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300
Marion WWTP - Marion DPW	Small	No IPP	Southeast	1,760
Marlborough East WWTP	Large	IPP	Central	29,600
Marlborough West WWTP	Medium	IPP	Central	11,500
Marshfield WWTF	Medium	No IPP	Southeast	4,200
Maynard WWTP	Medium	No IPP	Central	10,604
MCI Bridgewater	Small	No IPP	Southeast	2,000
MCI Concord	Small	No IPP	Northeast	200
MCI Norfolk WPCF	Small	No IPP	Central	4,000
Medfield WWTP	Medium	No IPP	Central	2,939
Merrimac WWTP	Small	No IPP	Northeast	2,800
Middleborough WWTP	Medium	IPP	Southeast	7,608
Milford WWTP	Medium	No IPP	Central	24,000
Monroe WWTP	Small	No IPP	West	75
Montague WPCF	Medium	IPP	West	2,000

TABLE B-3
Summary Information for the 114 NPDES-Permitted POTWs

Facility	Size	Industrial Pretreatment	Region	Population Served
MWRA Clinton WWTP	Medium	IPP	Central	19,557
MWRA Deer Island WWTP	Large	IPP	Northeast	2,296,046
New Bedford WWTP	Large	IPP	Southeast	104,000
Newburyport WWTP	Medium	IPP	Northeast	19,000
North Attleborough WPCF	Medium	IPP	Southeast	31,210
North Brookfield WWTP	Small	No IPP	Central	950
Northampton WWTF	Large	IPP	West	32,075
Northbridge WWTF	Medium	No IPP	Central	3,510
Northfield WPCF	Small	No IPP	West	850
Old Deerfield - Historic WWTP	Small	No IPP	West	352
Orange WWTP	Medium	No IPP	West	1,370
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400
Palmer WWTF	Large	IPP	West	6,000
Pepperell WWTF	Medium	No IPP	Central	8,000
Pittsfield WWTP	Large	IPP	West	50,101
Plymouth WWTF	Medium	IPP	Southeast	30,000
Rockland WWTP	Medium	IPP	Southeast	5,900
Rockport WWTP	Small	No IPP	Northeast	2,940
Royalston WPCF	Small	No IPP	West	135
Russell Village WWTF	Small	No IPP	West	250
Salisbury WWTF	Medium	No IPP	Northeast	3,500
Scituate WWTP	Medium	No IPP	Southeast	3,287
Shelburne Falls WWTF	Small	No IPP	West	2,000
Somerset WWTF	Medium	No IPP	Southeast	20,000
South Deerfield WWTP	Small	No IPP	West	1,666
South Essex Sewerage District	Large	IPP	Northeast	190,000
South Hadley WWTP	Medium	IPP	West	1,700
Southbridge WWTP	Medium	IPP	Central	17,000
Spencer WWTP	Medium	No IPP	Central	11,911
Springfield WWTP – Bondi's Island	Large	IPP	West	250,000
Stockbridge WWTP	Small	No IPP	West	2,110
Sturbridge WPCF	Medium	No IPP	Central	5,500
Sunderland WWTP	Small	No IPP	West	3,663
Taunton WWTP	Large	IPP	Southeast	27,740
Templeton WWTP	Small	No IPP	Central	1,480
Upper Blackstone WPAD	Large	IPP	Central	260,000
Upton WWTP	Small	No IPP	Central	3,000
Uxbridge WWTF	Medium	No IPP	Central	9,000
Ware WWTP	Medium	IPP	West	4,000
Wareham WPCF	Medium	No IPP	Southeast	7,000
Warren WWTP	Medium	No IPP	West	2,007
Wayland WWTP	Small	No IPP	Northeast	395
Webster WWTF	Large	IPP	Central	6,383
West Stockbridge WWTP	Small	No IPP	West	398
Westborough WWTF	Large	IPP	Central	65,800
Westfield WPCP	Large	IPP	West	18,000
Winchendon WPCF	Medium	No IPP	Central	2,800
Woronoco Village WWTF	Small	No IPP	West	75

TABLE B-4
Summary of $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations for 114 POTWs Influent, Effluent, and Sludge (Study Round 1)

					$\Sigma PFAS_{1633}$			$\Sigma PFAS_{TOP}$		
					Influent	**Effluent**	**Sludge**	**Influent**	**Effluent**	**Sludge**
Facility	**Size**	**Industrial Pretreatment**	**Region**	**Population Served**	ng/L		ng/g*	ng/L		ng/g*
Adams WWTP	Medium	IPP	West	5,580	173.91	46.68	36.90	0.00	33.56	42.23
Amesbury WWTP	Medium	IPP	Northeast	17,000	0.00	37.46	0.00	67.56	180.38	130.30
Amherst WWTP	Large	No IPP	West	6,500	93.97	95.08	0.00	0.00	64.93	20.36
Athol WWTP	Medium	No IPP	West	9,000	70.22	40.87	21.66	0.00	37.40	185.10
Attleboro WWTP	Large	IPP	Southeast	10,099	51.76	72.91	8.17	100.97	82.43	63.34
Ayer WWTP	Medium	IPP	Central	8,479	86.29	42.92	21.89	32.54	56.33	146.80
Barre WWTP	Small	No IPP	Central	750	803.30	449.66	36.51	789.01	335.21	331.80
Belchertown WWTP	Medium	No IPP	West	1,230	42.98	38.16	22.87	0.00	35.03	155.50
Billerica WWTP	Large	IPP	Northeast	30,000	0.00	115.82	25.01	103.67	178.53	86.20
Bridgewater WWTP	Medium	No IPP	Southeast	18,082	47.38	55.59	38.03	258.02	122.51	131.40
Brockton AWRF	Large	IPP	Southeast	105,000	45.12	52.43	18.60	172.56	51.48	89.95
Charlemont WWTP	Small	No IPP	West	200	201.28	98.32	58.74	11.60	69.35	276.20
Charles River PCD	Large	IPP	Central	4,000	224.10	47.07	11.20	0.00	50.34	631.00
Charlton WWTP	Small	No IPP	Central	13,391	118.85	31.53	34.47	24.70	0.00	166.39
Chicopee WWTP	Large	IPP	West	54,838	36.28	58.89	85.26	96.68	80.41	44.96
Cohasset WWTP	Small	No IPP	Southeast	7,000	220.75	71.39	14.70	25.40	78.29	164.00
Concord WWTF	Medium	No IPP	Northeast	6,330	46.61	45.56	0.00	189.32	70.47	199.23
Dartmouth WPCF	Medium	No IPP	Southeast	19,762	124.04	56.36	0.00	27.64	54.45	52.60
Douglas WWTP	Small	No IPP	Central	3,489	32.46	51.75	12.73	0.00	69.44	179.40
Easthampton WWTP	Medium	IPP	West	17,000	106.43	47.24	77.45	26.40	35.95	11.90
Erving Center WWTP (#2)	Medium	IPP	West	192	0.00	45.16	50.92	2,905.30	78.44	20.22
Erving POTW #1	Medium	No IPP	West	250	13.65	0.00	7,783.80	72.77	20.13	0.00
Erving POTW #3	Small	No IPP	West	50	44.26	90.89	0.00	142.06	93.24	8,582.80
Fairhaven WPCF	Medium	No IPP	Southeast	10,000	40.10	80.03	0.00	94.52	24.31	1,370.00
Fall River Regional WWF	Large	IPP	Southeast	94,000	90.26	116.32	134.08	137.03	205.14	482.60
Fitchburg East WWTP	Large	IPP	Central	42,000	1,765.64	624.57	929.16	695.30	657.00	1,399.90
Gardner WPCF	Medium	IPP	Central	18,000	30.00	34.41	13.36	29.60	36.02	314.50
Gloucester WPCF	Large	IPP	Northeast	30,000	22.05	46.50	5,744.00	75.07	55.60	0.00
Grafton WWTP	Medium	No IPP	Central	14,000	0.00	17.15	9.04	89.29	39.66	222.70
Great Barrington WWTP	Medium	IPP	West	7,000	47.60	42.44	15.41	0.00	36.17	139.42
Greater Lawrence - Sanitary District	Large	IPP	Northeast	250,000	64.40	53.63	37.04	330.28	155.94	16.13
Greenfield WPCF	Medium	No IPP	West	14,100	32.39	34.68	0.00	41.57	62.07	210.30
Hadley WWTP	Small	No IPP	West	1,041	76.65	33.84	0.00	5.37	22.92	386.40
Hardwick-Gilbertville WPCF	Small	No IPP	West	1,406	12.60	9.86	85.20	71.21	15.62	3,265.40
Hardwick-Wheelwright WPCF	Small	No IPP	West	351	11.70	5.40	6.00	153.54	26.20	6,355.80
Hatfield WWTP	Small	No IPP	West	785	302.83	150.84	0.00	157.35	113.10	14.00
Haverhill WWTP	Large	IPP	Northeast	50,000	0.00	27.80	25.56	37.11	62.83	387.00
Holyoke WWTP	Large	IPP	West	11,000	84.73	39.11	104.78	0.00	35.86	0.00
Hoosac WQD	Large	IPP	West	23,000	186.74	52.87	5.24	22.51	39.06	80.13
Hopedale WWTF	Small	No IPP	Central	2,052	154.39	43.84	17.58	13.44	24.80	189.89
Hudson WWTF	Medium	No IPP	Central	20,364	34.22	23.78	15.51	93.91	164.50	0.00
Hull WWTP	Medium	No IPP	Southeast	10,072	53.92	132.18	7.36	88.74	42.41	674.00
Huntington WWTP	Small	No IPP	West	287	197.23	34.08	10.70	0.00	0.00	304.40
Ipswich WWTP	Medium	No IPP	Northeast	5,500	43.63	41.36	11.20	46.06	43.63	230.20

TABLE B-4
Summary of $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations for 114 POTWs Influent, Effluent, and Sludge (Study Round 1)

					$\Sigma PFAS_{1633}$			$\Sigma PFAS_{TOP}$		
					Influent	**Effluent**	**Sludge**	**Influent**	**Effluent**	**Sludge**
Facility	**Size**	**Industrial Pretreatment**	**Region**	**Population Served**	ng/L		ng/g*	ng/L		ng/g*
Lee WWTP	Medium	No IPP	West	2,013	30.00	35.16	14.02	81.39	39.65	81.76
Leicester WWTP	Small	No IPP	Central	800	125.00	25.99	0.00	35.12	16.56	0.00
Lenox Center WWTP	Medium	No IPP	West	1,498	133.69	23.52	8.33	7.48	23.31	0.00
Leominster WPCF	Large	IPP	Central	40,000	33.99	54.20	43.62	165.24	0.00	32.10
Lowell Regional WW Utility	Large	IPP	Northeast	228,285	58.84	46.58	48.73	39.45	257.83	284.00
Lynn Regional WWTF	Large	IPP	Northeast	148,300	70.43	58.89	0.00	130.12	131.26	74.50
Manchester By the Sea WWTP	Small	No IPP	Northeast	3,000	20.66	281.68	51.60	103.56	353.21	609.35
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300	151.63	45.21	42.89	57.16	46.27	708.00
Marion WWTP - Marion DPW	Small	No IPP	Southeast	1,760	92.73	50.54	2,468.20	44.12	47.06	39.20
Marlborough East WWTP	Large	IPP	Central	29,600	13.15	33.90	16.67	98.95	37.10	37.40
Marlborough West WWTP	Medium	IPP	Central	11,500	112.86	37.59	11.60	33.84	45.29	471.60
Marshfield WWTF	Medium	No IPP	Southeast	4,200	46.65	51.79	106.86	194.63	58.41	416.60
Maynard WWTP	Medium	No IPP	Central	10,604	14.46	38.08	9.84	197.27	69.02	139.22
MCI Bridgewater	Small	No IPP	Southeast	2,000	71.49	91.34	382.70	523.12	86.82	3,956.00
MCI Concord	Small	No IPP	Northeast	200	72.47	76.84	76.29	36.58	0.00	104.40
MCI Norfolk WPCF	Small	No IPP	Central	4,000	26.31	32.00	26.00	0.00	39.36	0.00
Medfield WWTP	Medium	No IPP	Central	2,939	130.43	24.20	12,276.00	5.70	24.73	0.00
Merrimac WWTP	Small	No IPP	Northeast	2,800	36.38	28.88	0.00	230.78	32.92	330.10
Middleborough WWTP	Medium	IPP	Southeast	7,608	1,163.62	306.88	826.18	757.72	303.65	897.91
Milford WWTP	Medium	No IPP	Central	24,000	46.20	47.17	14.28	100.13	0.00	0.00
Monroe WWTP	Small	No IPP	West	75	283.27	28.80	316.24	366.50	84.10	45.70	528.00
Montague WPCF	Medium	IPP	West	2,000	12.87	66.92	101.44	32.98	0.00	12.60
MWRA Clinton WWTP	Medium	IPP	Central	19,557	68.75	39.56	58.30	0.00	61.10	200.50
MWRA Deer Island WWTP	Large	IPP	Northeast	2,296,046	133.98	71.14	48.16	39.92	0.00	43.93
New Bedford WWTP	Large	IPP	Southeast	104,000	131.60	96.97	120.97	78.24	74.30	1,110.00
Newburyport WWTP	Medium	IPP	Northeast	19,000	169.67	95.30	0.00	56.18	100.55	0.00
North Attleborough WPCF	Medium	IPP	Southeast	31,210	18.93	46.18	19.43	122.62	52.83	672.00
North Brookfield WWTP	Small	No IPP	Central	950	90.30	38.14	7.81	19.36	24.48	216.20
Northampton WWTF	Large	IPP	West	32,075	114.73	52.86	0.00	31.93	38.35	39.02
Northbridge WWTF	Medium	No IPP	Central	3,510	124.48	89.96	369.56	19.70	73.85	0.00
Northfield WPCF	Small	No IPP	West	850	68.96	12.57	194.40	791.81	19.46	17,678.00
Old Deerfield - Historic WWTP	Small	No IPP	West	352	380.95	57.07	47.26	23.38	30.27	0.00
Orange WWTP	Medium	No IPP	West	1,370	175.48	49.09	10.80	0.00	6.12	13.20
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400	88.85	33.58	6.33	0.00	30.34	182.70
Palmer WWTF	Large	IPP	West	6,000	56.42	20.93	11.26	19.08	18.17	97.70
Pepperell WWTF	Medium	No IPP	Central	8,000	41.65	33.38	0.00	138.95	30.93	79.85
Pittsfield WWTP	Large	IPP	West	50,101	326.77	47.44	113.98	310.24	10.60	29.86
Plymouth WWTF	Medium	IPP	Southeast	30,000	218.72	83.30	59.60	0.00	88.77	210.43
Rockland WWTP	Medium	IPP	Southeast	5,900	64.80	69.37	0.00	209.34	70.52	41.38
Rockport WWTP	Small	No IPP	Northeast	2,940	22.99	72.02	25,944.00	113.41	31.20	652.00
Royalston WPCF	Small	No IPP	West	135	17.98	85.30	14.19	8.37	14.11	1,200.00
Russell Village WWTF	Small	No IPP	West	250	131.05	43.40	0.00	22.40	16.41	360.50
Salisbury WWTF	Medium	No IPP	Northeast	3,500	33.83	77.40		102.25	85.26	
Scituate WWTP	Medium	No IPP	Southeast	3,287	55.04	57.17	37.22	196.16	59.84	429.17

TABLE B-4
Summary of $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations for 114 POTWs Influent, Effluent, and Sludge (Study Round 1)

					$\Sigma PFAS_{1633}$			$\Sigma PFAS_{TOP}$		
					Influent	**Effluent**	**Sludge**	**Influent**	**Effluent**	**Sludge**
Facility	**Size**	**Industrial Pretreatment**	**Region**	**Population Served**		ng/L	ng/g*		ng/L	ng/g*
Shelburne Falls WWTF	Small	No IPP	West	2,000	108.15	150.89	116.27	7.84	48.68	828.70
Somerset WWTF	Medium	No IPP	Southeast	20,000	53.71	54.35	16.60	100.50	57.60	209.36
South Deerfield WWTP	Small	No IPP	West	1,666	135.50	27.22	0.00	22.19	20.96	94.40
South Essex Sewerage District	Large	IPP	Northeast	190,000	81.54	60.16	24.07	89.09	70.63	13.80
South Hadley WWTP	Medium	IPP	West	1,700	44.46	49.27	116.58	121.35	62.99	64.26
Southbridge WWTP	Medium	IPP	Central	17,000	77.12	32.56	11.37	0.00	30.81	107.82
Spencer WWTP	Medium	No IPP	Central	11,911	181.25	90.65	0.00	46.90	74.62	325.61
Springfield WWTP - Bondi's Island	Large	IPP	West	250,000	37.08	35.03	97.68	103.73	47.12	81.40
Stockbridge WWTP	Small	No IPP	West	2,110	97.48	49.56	93.60	0.00	47.63	642.70
Sturbridge WPCF	Medium	No IPP	Central	5,500	139.52	50.22	22.76	26.44	51.35	171.80
Sunderland WWTP	Small	No IPP	West	3,663	159.87	30.34	6.60	0.00	20.71	239.20
Taunton WWTP	Large	IPP	Southeast	27,740	28.92	58.37	17.19	120.49	101.29	0.00
Templeton WWTP	Small	No IPP	Central	1,480	41.60	59.64	73.90	0.00	52.58	175.26
Upper Blackstone WPAD (Worcester area)	Large	IPP	Central	260,000	27.98	21.72	135.95	140.62	58.88	45.07
Upton WWTP	Small	No IPP	Central	3,000	90.63	49.14	22.33	14.24	49.59	293.30
Uxbridge WWTF	Medium	No IPP	Central	9,000	46.17	33.10	15.07	164.02	34.59	467.20
Ware WWTP	Medium	IPP	West	4,000	0.00	41.47	18.29	191.00	44.35	140.51
Wareham WPCF	Medium	No IPP	Southeast	7,000	65.92	25.90	15.00	61.11	273.17	402.40
Warren WWTP	Medium	No IPP	West	2,007	460.98	52.76	0.00	0.00	21.03	394.80
Wayland WWTP	Small	No IPP	Northeast	395	249.30	37.65	4,158.00	56.58	34.71	0.00
Webster WWTF	Large	IPP	Central	6,383	77.14	45.36	48.34	26.44	37.00	179.90
West Stockbridge WWTP	Small	No IPP	West	398	152.22	36.24	0.00	0.00	27.81	627.80
Westborough WWTF	Large	IPP	Central	65,800	97.60	66.13	55.63	37.22	19.20	218.73
Westfield WPCP	Large	IPP	West	18,000	52.63	65.42	142.89	207.30	74.84	66.50
Winchendon WPCF	Medium	No IPP	Central	2,800	124.47	42.50	30.40	61.06	40.85	250.50
Woronoco Village WWTF	Small	No IPP	West	75	18.53	47.90	7.76	6.86	13.40	105.88

* Sludge concentrations reported on a dry mass basis

TABLE B-5
Summary of $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations for 86 POTWs Influent, Effluent, and Sludge (Study Round 2)

					$\Sigma PFAS_{1633}$			$\Sigma PFAS_{TOP}$		
					Influent	Effluent	Sludge	Influent	Effluent	Sludge
Facility	Size	Industrial Pretreatment	Region	Population Served		ng/L	ng/g*		ng/L	ng/g*
Adams WWTP	Medium	IPP	West	5,580	0.00	35.64	19.10	64.96	23.62	41.92
Amesbury WWTP	Medium	IPP	Northeast	17,000	168.20	65.59	8.27	7.03	45.95	0.00
Amherst WWTP	Large	No IPP	West	6,500	34.24	51.47	13.77	74.72	59.23	0.00
Attleboro WWTP	Large	IPP	Southeast	10,099	186.10	108.29	7.80	68.56	96.33	12.20
Barre WWTP	Small	No IPP	Central	750	370.30	223.94	373.72	442.27	167.20	75.40
Belchertown WWTP	Medium	No IPP	West	1,230	15.40	71.40	256.47	89.90	75.45	29.91
Billerica WWTP	Large	IPP	Northeast	30,000	38.68	56.62	8.06	61.50	46.14	352.94
Bridgewater WWTP	Medium	No IPP	Southeast	18,082	130.71	63.43	0.00	41.66	44.62	0.00
Brockton AWRF	Large	IPP	Southeast	105,000	126.60	54.32	14.30	53.22	49.11	20.74
Charlemont WWTP	Small	No IPP	West	200	16.40	60.75	29.24	122.40	73.88	318.20
Charles River PCD	Large	IPP	Central	4,000	59.06	54.68	26.04	25.88	47.35	43.85
Charlton WWTP	Small	No IPP	Central	13,391	57.70	19.97	7.43	19.00	0.00	106.49
Chicopee WWTP	Large	IPP	West	54,838	98.83	128.21	39.58	40.06	76.78	24.88
Cohasset WWTP	Small	No IPP	Southeast	7,000	181.44	57.96	28.75	42.41	60.05	63.89
Dartmouth WPCF	Medium	No IPP	Southeast	19,762	38.36	45.66	14.68	87.30	48.06	27.29
Erving Center WWTP (#2)	Medium	IPP	West	192	4,003.00	183.08	15.44	0.00	144.90	89.32
Erving POTW #1	Medium	No IPP	West	250	13.08	9.92	3,918.60	36.86	12.00	95.70
Erving POTW #3	Small	No IPP	West	50	30.92	237.66	57.18	72.37	241.79	2,134.00
Fairhaven WPCF	Medium	No IPP	Southeast	10,000	22.68	37.44	87.40	49.33	54.80	42.98
Fall River Regional WWF	Large	IPP	Southeast	94,000	706.88	115.35	90.44	623.70	103.42	0.00
Fitchburg East WWTP	Large	IPP	Central	42,000	208.84	256.06	530.63	400.68	248.40	501.06
Gloucester WPCF	Large	IPP	Northeast	30,000	32.04	40.70	39.16	76.92	45.44	4,281.00
Grafton WWTP	Medium	No IPP	Central	14,000	105.50	28.54	21.65	0.00	31.73	10.20
Greater Lawrence - Sanitary District	Large	IPP	Northeast	250,000	38.28	79.34	0.00	224.06	89.26	88.89
Greenfield WPCF	Medium	No IPP	West	14,100	17.56	17.96	10.90	12.74	48.71	0.00
Hadley WWTP	Small	No IPP	West	1,041	32.77	36.70	275.70	138.66	46.63	0.00
Hatfield WWTP	Small	No IPP	West	785	37.93	74.61	362.59	35.70	59.77	0.00
Haverhill WWTP	Large	IPP	Northeast	50,000	29.43	42.64	0.00	23.70	49.72	0.00
Holyoke WWTP	Large	IPP	West	11,000	15.78	28.96	46.44	58.27	35.63	0.00
Hoosac WQD	Large	IPP	West	23,000	18.40	25.60	169.20	14.91	31.58	504.70
Hopedale WWTF	Small	No IPP	Central	2,052	41.48	32.76	32.21	23.97	38.37	180.70
Hull WWTP	Medium	No IPP	Southeast	10,072	61.99	89.87	0.00	0.00	62.26	34.78
Huntington WWTP	Small	No IPP	West	287	10.90	18.07	2,344.70	70.98	40.49	39.30
Leicester WWTP	Small	No IPP	Central	800	186.22	21.07	15.69	6.06	22.30	19.80
Lenox Center WWTP	Medium	No IPP	West	1,498	10.56	28.29	15.44	0.00	30.59	20.10	0.00
Leominster WPCF	Large	IPP	Central	40,000	0.00	45.60	13.85	24.04	55.30	8.97
Lowell Regional WW Utility	Large	IPP	Northeast	228,285	44.20	54.32	0.00	644.20	63.36	267.20
Lynn Regional WWTF	Large	IPP	Northeast	148,300	122.56	94.72	120.92	40.07	60.61	771.40
Manchester By the Sea WWTP	Small	No IPP	Northeast	3,000	7.88	49.30	199.37	60.20	40.77	517.88
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300	14.70	44.27	6.16	122.22	51.45	18.32
Marion WWTP - Marion DPW	Small	No IPP	Southeast	1,760	93.18	54.13	112.00	40.23	45.35	901.00
Marshfield WWTF	Medium	No IPP	Southeast	4,200	110.43	49.79	72.29	46.42	48.38	352.50
MCI Bridgewater	Small	No IPP	Southeast	2,000	157.03	94.30	0.00	24.32	101.98	97.70

TABLE B-5
Summary of $\Sigma PFAS_{1633}$ and $\Sigma PFAS_{TOP}$ Concentrations for 86 POTWs Influent, Effluent, and Sludge (Study Round 2)

					$\Sigma PFAS_{1633}$			$\Sigma PFAS_{TOP}$			
					Influent	Effluent	Sludge	Influent	Effluent	Sludge	
Facility	Size	Industrial Pretreatment	Region	Population Served	ng/L		ng/g*	ng/L			ng/g*
MCI Norfolk WPCF	Small	No IPP	Central	4,000	17.11	45.91	27.99	7.72	51.01	14.75	
Medfield WWTP	Medium	No IPP	Central	2,939	25.15	20.23	2,898.20	17.20	32.44	124.00	
Merrimac WWTP	Small	No IPP	Northeast	2,800	0.00	36.35	7.22	94.60	45.09	0.00	
Middleborough WWTP	Medium	IPP	Southeast	7,608	1,708.64	582.51	1,715.19	1,910.94	535.37	1,892.13	
Milford WWTP	Medium	No IPP	Central	24,000	124.22	39.00	11.63	37.77	0.00	5.42	
Monroe WWTP	Small	No IPP	West	75	43.11	52.56	100.60	35.85	49.21	8,953.00	
Montague WPCF	Medium	IPP	West	2,000	19.96	20.99	16.34	103.30	31.68	0.00	
MWRA Deer Island WWTP	Large	IPP	Northeast	2,296,046	251.36	79.69	53.64	62.43	59.70	125.60	
New Bedford WWTP	Large	IPP	Southeast	104,000	203.86	88.28	67.66	11,188.74	209.10	29.97	
North Attleborough WPCF	Medium	IPP	Southeast	31,210	73.90	70.07	103.44	42.98	59.20	9.79	
North Brookfield WWTP	Small	No IPP	Central	950	47.60	30.98	44.62	9.92	27.93	0.00	
Northampton WWTF	Large	IPP	West	32,075	34.79	34.29	17.63	74.90	44.10	0.00	
Northfield WPCF	Small	No IPP	West	850	9.55	15.34	328.67	32.43	17.44	0.00	
Old Deerfield - Historic WWTP	Small	No IPP	West	352	25.39	22.04	4,273.00	31.90	67.91	0.00	
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400	30.85	21.26	41.93	69.78	25.50	149.90	
Palmer WWTF	Large	IPP	West	6,000	26.30	19.02	6.92	9.00	23.84	0.00	
Pittsfield WWTP	Large	IPP	West	50,101	16.64	34.40	14.42	216.50	42.73	0.00	
Plymouth WWTF	Medium	IPP	Southeast	30,000	132.38	82.14	7.95	126.00	79.30	17.77	
Rockland WWTP	Medium	IPP	Southeast	5,900	110.18	72.67	71.74	117.97	73.14	46.03	
Rockport WWTP	Small	No IPP	Northeast	2,940	0.00	55.35	86.67	111.70	54.55	515.80	
Russell Village WWTF	Small	No IPP	West	250	17.84	9.78	1,747.60	19.56	20.02	0.00	
Salisbury WWTF	Medium	No IPP	Northeast	3,500	36.40	147.65		0.00	151.29		
Scituate WWTP	Medium	No IPP	Southeast	3,287	230.70	61.18	43.56	44.44	61.52	77.97	
Shelburne Falls WWTF	Small	No IPP	West	2,000	14.11	111.50	404.63	0.00	122.42	1,663.17	
Somerset WWTF	Medium	No IPP	Southeast	20,000	74.64	109.24	93.93	41.90	98.34	172.63	
South Deerfield WWTP	Small	No IPP	West	1,666	24.63	22.75	0.00	266.60	0.00	43.06	
South Essex Sewerage District	Large	IPP	Northeast	190,000	95.88	68.78	0.00	41.56	60.47	0.00	
Southbridge WWTP	Medium	IPP	Central	17,000	20.24	28.57	12.14	84.90	29.57	0.00	
Spencer WWTP	Medium	No IPP	Central	11,911	76.48	0.00	315.54	28.88	41.39	0.00	
Springfield WWTP - Bondiâ€™s Island	Large	IPP	West	250,000	72.73	48.02	15.30	39.55	46.67	92.20	
Sturbridge WPCF	Medium	No IPP	Central	5,500	0.00	27.93	5,636.00	3,262.40	32.19	410.40	
Sunderland WWTP	Small	No IPP	West	3,663	33.44	17.57	0.00	12.73	20.43	219.00	
Taunton WWTP	Large	IPP	Southeast	27,740	75.00	60.65	78.34	61.79	36.75	119.02	
Templeton WWTP	Small	No IPP	Central	1,480	1,486.60	30.47	42.50	28.80	42.07	59.70	
Upper Blackstone WPAD (Worcester area)	Large	IPP	Central	260,000	111.92	53.90	42.45	40.44	55.54	42.36	
Upton WWTP	Small	No IPP	Central	3,000	158.98	28.85	40.69	28.31	26.98	7.78	
Wareham WPCF	Medium	No IPP	Southeast	7,000	233.60	65.30	14.60	0.00	132.50	28.77	
Warren WWTP	Medium	No IPP	West	2,007	16.68	35.47	33,146.00	46.10	10.76	500.20	
Webster WWTF	Large	IPP	Central	6,383	49.07	44.37	15.00	31.84	41.15	39.55	
West Stockbridge WWTP	Small	No IPP	West	398	61.75	34.61	0.00	328.46	29.78	240.10	
Westborough WWTF	Large	IPP	Central	65,800	76.88	60.51	74.22	22.92	62.98	13.60	
Westfield WPCP	Large	IPP	West	18,000	185.02	113.64	136.30	67.64	99.00	24.30	
Woronoco Village WWTF	Small	No IPP	West	75	35.20	30.64	643.92	13.51	48.46	32.20	

* Sludge concentrations reported on a dry mass basis

TABLE B-6
Summary of POTW Information for the 66 POTWs with data from the Portal included in this Study's analyses

Facility	Size	Industrial Pretreatment	Region	Population Served
Adams WWTP	Medium	IPP	West	5,580
Amesbury WWTP	Medium	IPP	Northeast	17,000
Amherst WWTP	Large	No IPP	West	6,500
Athol WWTP	Medium	No IPP	West	9,000
Ayer WWTP	Medium	IPP	Central	8,479
Barre WWTP	Small	No IPP	Central	750
Belchertown WWTP	Medium	No IPP	West	1,230
Bridgewater WWTP	Medium	No IPP	Southeast	18,082
Charlton WWTP	Small	No IPP	Central	13,391
Chicopee WWTP	Large	IPP	West	54,838
Concord WWTF	Medium	No IPP	Northeast	6,330
Dartmouth WPCF	Medium	No IPP	Southeast	19,762
Fairhaven WPCF	Medium	No IPP	Southeast	10,000
Gardner WPCF	Medium	IPP	Central	18,000
Grafton WWTP	Medium	No IPP	Central	14,000
Great Barrington WWTP	Medium	IPP	West	7,000
Greenfield WPCF	Medium	No IPP	West	14,100
Hardwick-Gilbertville WPCF	Small	No IPP	West	1,406
Hardwick-Wheelwright WPCF	Small	No IPP	West	351
Holyoke WWTP	Large	IPP	West	11,000
Hoosac WQD	Large	IPP	West	23,000
Hopedale WWTF	Small	No IPP	Central	2,052
Hudson WWTF	Medium	No IPP	Central	20,364
Huntington WWTP	Small	No IPP	West	287
Ipswich WWTP	Medium	No IPP	Northeast	5,500
Lee WWTP	Medium	No IPP	West	2,013
Leicester WWTP	Small	No IPP	Central	800
Lenox Center WWTP	Medium	No IPP	West	1,498
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300
Marlborough East WWTP	Large	IPP	Central	29,600
Marlborough West WWTP	Medium	IPP	Central	11,500
Maynard WWTP	Medium	No IPP	Central	10,604
MCI Bridgewater	Small	No IPP	Southeast	2,000
MCI Concord	Small	No IPP	Northeast	200
MCI Norfolk WPCF	Small	No IPP	Central	4,000
Medfield WWTP	Medium	No IPP	Central	2,939
Middleborough WWTP	Medium	IPP	Southeast	7,608
Milford WWTP	Medium	No IPP	Central	24,000
Monroe WWTP	Small	No IPP	West	75
MWRA Clinton WWTP	Medium	IPP	Central	19,557
Newburyport WWTP	Medium	IPP	Northeast	19,000
North Brookfield WWTP	Small	No IPP	Central	950
Northbridge WWTF	Medium	No IPP	Central	3,510
Orange WWTP	Medium	No IPP	West	1,370
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400
Pepperell WWTF	Medium	No IPP	Central	8,000
Plymouth WWTF	Medium	IPP	Southeast	30,000
Rockland WWTP	Medium	IPP	Southeast	5,900
Royalston WPCF	Small	No IPP	West	135
Russell Village WWTF	Small	No IPP	West	250
Scituate WWTP	Medium	No IPP	Southeast	3,287
Somerset WWTF	Medium	No IPP	Southeast	20,000
South Hadley WWTP	Medium	IPP	West	1,700
Southbridge WWTP	Medium	IPP	Central	17,000
Spencer WWTP	Medium	No IPP	Central	11,911
Stockbridge WWTP	Small	No IPP	West	2,110
Sturbridge WPCF	Medium	No IPP	Central	5,500
Templeton WWTP	Small	No IPP	Central	1,480
Uxbridge WWTF	Medium	No IPP	Central	9,000
Warren WWTP	Medium	No IPP	West	2,007
Wayland WWTP	Small	No IPP	Northeast	395
Webster WWTF	Large	IPP	Central	6,383
West Stockbridge WWTP	Small	No IPP	West	398
Westborough WWTF	Large	IPP	Central	65,800
Winchendon WPCF	Medium	No IPP	Central	2,800
Woronoco Village WWTF	Small	No IPP	West	75

TABLE B-7
Summary of ΣPFAS Concentrations for 66 POTWs Influent, Effluent, and Sludge (Portal)

					ΣPFAS			
Facility	**Size**	**Industrial Pretreatment**	**Region**	**Population Served**	**Influent ng/L**	**Effluent ng/L**	**Sludge ng/L**	**ng/g***
Adams WWTP	Medium	IPP	West	5,580	55.65	32.35		87.44
Amesbury WWTP	Medium	IPP	Northeast	17,000	37.98	70.74	189.30	32.44
Amherst WWTP	Large	No IPP	West	6,500	32.52	12.79		17.64
Athol WWTP	Medium	No IPP	West	9,000	29.05	0.00		33.28
Ayer WWTP	Medium	IPP	Central	8,479				
Barre WWTP	Small	No IPP	Central	750	77.39	52.50		51.35
Belchertown WWTP	Medium	No IPP	West	1,230	1,247.80	1,293.34	35,840.00	105.00
Bridgewater WWTP	Medium	No IPP	Southeast	18,082	74.20	55.89		47.92
Charlton WWTP	Small	No IPP	Central	13,391	32.85	321.20	0.00	0.00
Chicopee WWTP	Large	IPP	West	54,838	16.89	8.65		21.40
Concord WWTF	Medium	No IPP	Northeast	6,330	108.50	427.13		57.28
Dartmouth WPCF	Medium	No IPP	Southeast	19,762	55.56	35.65	0.00	5.73
Fairhaven WPCF	Medium	No IPP	Southeast	10,000	64.07	17.84		42.45
Gardner WPCF	Medium	IPP	Central	18,000				
Grafton WWTP	Medium	No IPP	Central	14,000	48.54	28.15		47.06
Great Barrington WWTP	Medium	IPP	West	7,000	52.90	38.30		38.40
Greenfield WPCF	Medium	No IPP	West	14,100				
Hardwick-Gilbertville WPCF	Small	No IPP	West	1,406	38.94	26.09	489.00	17.83
Hardwick-Wheelwright WPCF	Small	No IPP	West	351	44.68	23.42		44.77
Holyoke WWTP	Large	IPP	West	11,000	21.40	19.16		19.15
Hoosac WQD	Large	IPP	West	23,000	34.10	9.80		16.30
Hopedale WWTF	Small	No IPP	Central	2,052	16.50	0.00		0.00
Hudson WWTF	Medium	No IPP	Central	20,364	40.50	18.13		32.74
Huntington WWTP	Small	No IPP	West	287	46.72	8.94		141.16
Ipswich WWTP	Medium	No IPP	Northeast	5,500	0.00	24.59	26,070.00	
Lee WWTP	Medium	No IPP	West	2,013	53.85	94.45		22.60
Leicester WWTP	Small	No IPP	Central	800	121.72	29.16		64.99
Lenox Center WWTP	Medium	No IPP	West	1,498	77.88	52.71		81.52
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300	52.07	28.08		12.12
Marlborough East WWTP	Large	IPP	Central	29,600	27.16	39.10		18.50
Marlborough West WWTP	Medium	IPP	Central	11,500	42.56	20.58	101.92	44.13
Maynard WWTP	Medium	No IPP	Central	10,604	203.67	64.92	137.00	
MCI Bridgewater	Small	No IPP	Southeast	2,000	41.00	23.27	758.45	19.16
MCI Concord	Small	No IPP	Northeast	200	61.29	58.14		32.10
MCI Norfolk WPCF	Small	No IPP	Central	4,000	50.08	69.17		22.83
Medfield WWTP	Medium	No IPP	Central	2,939				
Middleborough WWTP	Medium	IPP	Southeast	7,608	82.08	68.39		10.21
Milford WWTP	Medium	No IPP	Central	24,000	47.74	31.65		6.80
Monroe WWTP	Small	No IPP	West	75	55.14	40.03		28.48
MWRA Clinton WWTP	Medium	IPP	Central	19,557	36.55	26.77		147.39
Newburyport WWTP	Medium	IPP	Northeast	19,000	36.65	45.30	69.00	5.03
North Brookfield WWTP	Small	No IPP	Central	950	615.72	50.50		378.90
Northbridge WWTF	Medium	No IPP	Central	3,510	44.64	67.19		3.78
Orange WWTP	Medium	No IPP	West	1,370	29.33	17.86	78.84	126.40
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400				
Pepperell WWTF	Medium	No IPP	Central	8,000	239.29	116.08		62.73
Plymouth WWTF	Medium	IPP	Southeast	30,000	34.30	14.37		49.46
Rockland WWTP	Medium	IPP	Southeast	5,900	61.35	12.27	0.00	13.34
Royalston WPCF	Small	No IPP	West	135	58.41	31.84		156.97
Russell Village WWTF	Small	No IPP	West	250	49.59	17.75	2,200.00	3.90
Scituate WWTP	Medium	No IPP	Southeast	3,287	191.68	98.25		336.59
Somerset WWTF	Medium	No IPP	Southeast	20,000	128.90	18.00		15.13
South Hadley WWTP	Medium	IPP	West	1,700	71.70	76.90		68.29
Southbridge WWTP	Medium	IPP	Central	17,000	0.00	0.00		0.00
Spencer WWTP	Medium	No IPP	Central	11,911	13.09	2.94		16.34
Stockbridge WWTP	Small	No IPP	West	2,110	74.50	59.86		78.87
Sturbridge WPCF	Medium	No IPP	Central	5,500	46.37	61.50		60.40
Templeton WWTP	Small	No IPP	Central	1,480	72.85	73.57		36.07
Uxbridge WWTF	Medium	No IPP	Central	9,000	48.42	23.06		46.62
Warren WWTP	Medium	No IPP	West	2,007	63.53	15.00		65.04
Wayland WWTP	Small	No IPP	Northeast	395	55.54	26.92	568.00	57.66
Webster WWTF	Large	IPP	Central	6,383	158.04	193.07	1,093.58	86.87
West Stockbridge WWTP	Small	No IPP	West	398	56.90	95.55		42.21
Westborough WWTF	Large	IPP	Central	65,800	74.05	34.41	93.48	38.13
Winchendon WPCF	Medium	No IPP	Central	2,800	77.31	57.40		1.81
Woronoco Village WWTF	Small	No IPP	West	75	11.90	3.95		0.00

* Sludge concentrations assumed to have been reported on a dry mass basis

TABLE B-8
Summary of Estimated PFAS Mass Loads by Influent, Effluent, and Sludge for 114 POTWs (Study and Portal data)

Facility	Size	Industrial Pretreatment	Region	Population Served	Estimated Annual Mass Load (lbs/yr)			Estimated Annual Mass Load per Capita (lbs/yr per person)		
					Influent	Effluent	Sludge*	Influent	Effluent	Sludge*
Adams WWTP	Medium	IPP	West	5,580	0.22	0.30	0.03	3.93E-05	5.44E-05	4.75E-06
Amesbury WWTP	Medium	IPP	Northeast	17,000	0.18	0.23	0.01	1.07E-05	1.33E-05	4.71E-07
Amherst WWTP	Large	No IPP	West	6,500	0.44	0.78	0.03	6.79E-05	1.20E-04	3.91E-06
Athol WWTP	Medium	No IPP	West	9,000	0.00	0.08	0.02	0.00E+00	9.23E-06	1.82E-06
Attleboro WWTP	Large	IPP	Southeast	10,099	2.20	1.54	0.05	2.17E-04	1.53E-04	5.39E-06
Ayer WWTP	Medium	IPP	Central	8,479	0.21	0.26	0.01	2.47E-05	3.03E-05	1.62E-06
Barre WWTP	Small	No IPP	Central	750	0.21	0.16	0.01	2.79E-04	2.15E-04	1.51E-05
Belchertown WWTP	Medium	No IPP	West	1,230	0.02	0.06	0.01	1.78E-05	4.86E-05	6.68E-06
Billerica WWTP	Large	IPP	Northeast	30,000	0.26	0.76	0.06	8.64E-06	2.53E-05	1.93E-06
Bridgewater WWTP	Medium	No IPP	Southeast	18,082	0.78	0.19	0.00	4.30E-05	1.03E-05	0.00E+00
Brockton AWRF	Large	IPP	Southeast	105,000	126.58	131.89	0.15	1.21E-03	1.26E-03	1.43E-06
Charlemont WWTP	Small	No IPP	West	200	0.00	0.00		1.84E-05	8.98E-06	
Charles River PCD	Large	IPP	Central	4,000	0.04	0.10	0.07	9.89E-06	2.56E-05	1.79E-05
Charlton WWTP	Small	No IPP	Central	13,391	0.05	0.01	0.00	3.52E-06	8.07E-07	2.59E-07
Chicopee WWTP	Large	IPP	West	54,838	3.49	3.20	0.17	6.36E-05	5.84E-05	3.07E-06
Cohasset WWTP	Small	No IPP	Southeast	7,000	0.34	0.17	0.00	4.80E-05	2.38E-05	5.43E-07
Concord WWTF	Medium	No IPP	Northeast	6,330	0.12	0.13	0.00	1.96E-05	2.10E-05	0.00E+00
Dartmouth WPCF	Medium	No IPP	Southeast	19,762	0.00	0.46	0.06	0.00E+00	2.33E-05	2.83E-06
Douglas WWTP	Small	No IPP	Central	3,489	0.02	0.14	0.00	4.53E-06	4.12E-05	4.66E-07
Easthampton WWTP	Medium	IPP	West	17,000	0.49	0.16	0.07	2.86E-05	9.14E-06	4.16E-06
Erving Center WWTP (#2)	Medium	IPP	West	192	8.54	0.51	1.01	4.45E-02	2.64E-03	5.27E-03
Erving POTW #1	Medium	No IPP	West	250	0.00	0.00		1.97E-05	1.67E-05	
Erving POTW #3	Small	No IPP	West	50	0.00	0.00	0.00	5.52E-06	4.34E-05	4.77E-08
Fairhaven WPCF	Medium	No IPP	Southeast	10,000	0.34	0.73	0.03	3.40E-05	7.25E-05	3.13E-06
Fall River Regional WWF	Large	IPP	Southeast	94,000	30.39	8.89	1.14	3.23E-04	9.46E-05	1.21E-05
Fitchburg East WWTP	Large	IPP	Central	42,000	20.44	10.28	1.95	4.87E-04	2.45E-04	4.64E-05
Gardner WPCF	Medium	IPP	Central	18,000	0.41	0.41	0.06	2.26E-05	2.28E-05	3.16E-06
Gloucester WPCF	Large	IPP	Northeast	30,000	0.38	0.64		1.26E-05	2.12E-05	
Grafton WWTP	Medium	No IPP	Central	14,000	0.15	0.19	0.02	1.10E-05	1.34E-05	1.39E-06
Great Barrington WWTP	Medium	IPP	West	7,000	0.06	0.11	0.01	9.21E-06	1.62E-05	1.73E-06
Greater Lawrence - Sanitary District	Large	IPP	Northeast	250,000	3.77	5.06	0.00	1.51E-05	2.02E-05	0.00E+00
Greenfield WPCF	Medium	No IPP	West	14,100	0.20	0.20	0.01	1.41E-05	1.39E-05	1.03E-06
Hadley WWTP	Small	No IPP	West	1,041	0.10	0.03	0.02	9.78E-05	3.21E-05	2.35E-05
Hardwick-Gilbertville WPCF	Small	No IPP	West	1,406	0.00	0.01	0.00	2.12E-06	7.39E-06	4.61E-07
Hardwick-Wheelwright WPCF	Small	No IPP	West	351	0.00	0.00	0.00	0.00E+00	1.00E-06	0.00E+00
Hatfield WWTP	Small	No IPP	West	785	0.08	0.07	0.01	1.00E-04	8.33E-05	1.20E-05
Haverhill WWTP	Large	IPP	Northeast	50,000	0.51	1.17	0.10	1.02E-05	2.34E-05	2.01E-06
Holyoke WWTP	Large	IPP	West	11,000	0.75	0.87	0.18	6.86E-05	7.91E-05	1.62E-05
Hoosac WQD	Large	IPP	West	23,000	0.12	0.34	0.20	5.13E-06	1.46E-05	8.84E-06
Hopedale WWTF	Small	No IPP	Central	2,052	0.03	0.05	0.01	1.66E-05	2.41E-05	3.20E-06

TABLE B-8
Summary of Estimated PFAS Mass Loads by Influent, Effluent, and Sludge for 114 POTWs (Study and Portal data)

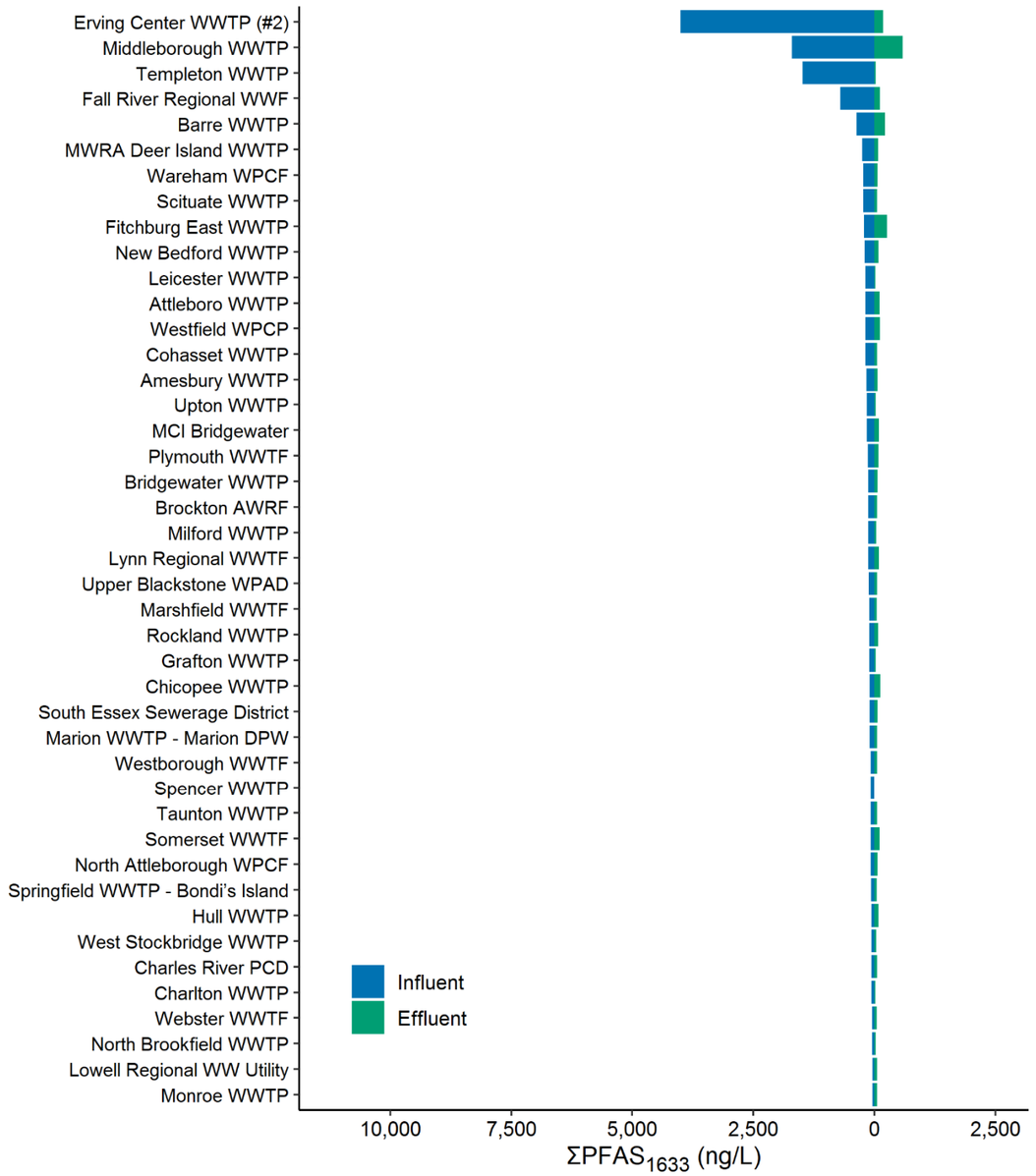
Facility	Size	Industrial Pretreatment	Region	Population Served	Estimated Annual Mass Load (lbs/yr)			Estimated Annual Mass Load per Capita (lbs/yr per person)		
					Influent	Effluent	Sludge*	Influent	Effluent	Sludge*
Hudson WWTF	Medium	No IPP	Central	20,364	0.28	0.19	0.02	1.37E-05	9.17E-06	7.98E-07
Hull WWTP	Medium	No IPP	Southeast	10,072	0.39	0.50	0.00	3.91E-05	4.96E-05	0.00E+00
Huntington WWTP	Small	No IPP	West	287	0.00	0.00	0.00	9.70E-06	1.31E-05	4.49E-06
Ipswich WWTP	Medium	No IPP	Northeast	5,500	0.12	0.12	0.06	2.15E-05	2.11E-05	1.11E-05
Lee WWTP	Medium	No IPP	West	2,013	0.03	0.08	0.00	1.29E-05	4.18E-05	1.36E-06
Leicester WWTP	Small	No IPP	Central	800	0.02	0.01	0.00	2.95E-05	1.44E-05	2.61E-06
Lenox Center WWTP	Medium	No IPP	West	1,498	0.04	0.07	0.01	2.42E-05	4.49E-05	8.33E-06
Leominster WPCF	Large	IPP	Central	40,000	0.33	1.13	0.11	8.28E-06	2.81E-05	2.72E-06
Lowell Regional WW Utility	Large	IPP	Northeast	228,285	4.82	4.09	0.73	2.11E-05	1.79E-05	3.20E-06
Lynn Regional WWTF	Large	IPP	Northeast	148,300	2.08	2.83	0.00	1.40E-05	1.91E-05	0.00E+00
MCI Bridgewater	Small	No IPP	Southeast	2,000	0.05	0.04	0.00	2.32E-05	1.88E-05	1.58E-07
MCI Concord	Small	No IPP	Northeast	200	0.01	0.01	0.01	3.40E-05	6.03E-05	5.87E-05
MCI Norfolk WPCF	Small	No IPP	Central	4,000	0.04	0.03	0.00	9.52E-06	8.04E-06	1.11E-06
MWRA Clinton WWTP	Medium	IPP	Central	19,557	0.49	0.42	0.02	2.48E-05	2.14E-05	7.81E-07
MWRA Deer Island WWTP	Large	IPP	Northeast	2,296,046	103.47	76.11	3.13	4.51E-05	3.31E-05	1.37E-06
Manchester By the Sea WWTP	Small	No IPP	Northeast	3,000	0.03	0.29	0.00	9.01E-06	9.65E-05	1.56E-06
Mansfield WWTP (MFN)	Medium	IPP	Southeast	31,300	0.34	0.54	0.01	1.09E-05	1.73E-05	3.26E-07
Marion WWTP - Marion DPW	Small	No IPP	Southeast	1,760	0.14	0.08		8.12E-05	4.60E-05	
Marlborough East WWTP	Large	IPP	Central	29,600	0.26	0.28	0.02	8.65E-06	9.42E-06	6.05E-07
Marlborough West WWTP	Medium	IPP	Central	11,500	0.29	0.22	0.02	2.48E-05	1.89E-05	2.08E-06
Marshfield WWTF	Medium	No IPP	Southeast	4,200	0.19	0.19	0.06	4.48E-05	4.53E-05	1.32E-05
Maynard WWTP	Medium	No IPP	Central	10,604	0.06	0.10	0.01	5.72E-06	9.79E-06	9.26E-07
Medfield WWTP	Medium	No IPP	Central	2,939	0.12	0.09	0.00	4.23E-05	2.93E-05	5.60E-07
Merrimac WWTP	Small	No IPP	Northeast	2,800	0.02	0.04	0.00	6.47E-06	1.54E-05	2.71E-07
Middleborough WWTP	Medium	IPP	Southeast	7,608	0.18	2.40	0.44	2.42E-05	3.15E-04	5.80E-05
Milford WWTP	Medium	No IPP	Central	24,000	0.61	0.45	0.01	2.56E-05	1.86E-05	5.01E-07
Monroe WWTP	Small	No IPP	West	75	0.00	0.00	0.02	1.23E-05	1.59E-05	2.55E-04
Montague WPCF	Medium	IPP	West	2,000	0.03	0.07	0.04	1.40E-05	3.64E-05	2.04E-05
New Bedford WWTP	Large	IPP	Southeast	104,000	12.16	7.02	1.38	1.17E-04	6.75E-05	1.33E-05
Newburyport WWTP	Medium	IPP	Northeast	19,000	0.74	1.10	0.06	3.88E-05	5.78E-05	3.01E-06
North Attleborough WPCF	Medium	IPP	Southeast	31,210	0.90	1.14	0.08	2.87E-05	3.65E-05	2.58E-06
North Brookfield WWTP	Small	No IPP	Central	950	0.06	0.03	0.01	6.75E-05	2.85E-05	1.16E-05
Northampton WWTF	Large	IPP	West	32,075	0.91	0.54	0.02	2.84E-05	1.67E-05	5.94E-07
Northbridge WWTF	Medium	No IPP	Central	3,510	0.03	0.11	0.01	8.01E-06	3.09E-05	2.76E-06
Northfield WPCF	Small	No IPP	West	850	0.07	0.00	0.01	8.79E-05	3.96E-06	8.73E-06
Old Deerfield - Historic WWTP	Small	No IPP	West	352	0.04	0.01	0.01	1.23E-04	3.41E-05	2.10E-05
Orange WWTP	Medium	No IPP	West	1,370	0.16	0.13	0.00	1.14E-04	9.47E-05	1.09E-06
Oxford-Rochdale SD WPCP	Small	No IPP	Central	3,400	0.03	0.03	0.00	9.95E-06	7.90E-06	2.08E-07
Palmer WWTF	Large	IPP	West	6,000	0.10	0.10	0.01	1.73E-05	1.62E-05	1.75E-06
Pepperell WWTF	Medium	No IPP	Central	8,000	0.09	0.10	0.02	1.14E-05	1.20E-05	2.70E-06

TABLE B-8
Summary of Estimated PFAS Mass Loads by Influent, Effluent, and Sludge for 114 POTWs (Study and Portal data)

Facility	Size	Industrial Pretreatment	Region	Population Served	Estimated Annual Mass Load (lbs/yr)			Estimated Annual Mass Load per Capita (lbs/yr per person)		
					Influent	Effluent	Sludge*	Influent	Effluent	Sludge*
Pittsfield WWTP	Large	IPP	West	50,101	3.93	1.18	0.03	7.84E-05	2.35E-05	6.06E-07
Plymouth WWTF	Medium	IPP	Southeast	30,000	0.05	0.35	0.03	1.83E-06	1.17E-05	9.65E-07
Rockland WWTP	Medium	IPP	Southeast	5,900	0.55	0.62	0.04	9.37E-05	1.06E-04	6.79E-06
Rockport WWTP	Small	No IPP	Northeast	2,940	0.03	0.23	0.01	9.15E-06	7.94E-05	4.19E-06
Royalston WPCF	Small	No IPP	West	135	0.00	0.00	0.00	7.85E-07	3.72E-06	7.39E-07
Russell Village WWTF	Small	No IPP	West	250	0.00	0.00	0.00	1.28E-05	1.85E-05	1.07E-06
Salisbury WWTF	Medium	No IPP	Northeast	3,500	0.09	0.32		2.44E-05	9.07E-05	
Scituate WWTP	Medium	No IPP	Southeast	3,287	0.22	0.30	0.03	6.68E-05	8.98E-05	1.03E-05
Shelburne Falls WWTF	Small	No IPP	West	2,000	0.03	0.08	0.00	1.48E-05	3.91E-05	2.21E-06
Somerset WWTF	Medium	No IPP	Southeast	20,000	0.77	0.78	0.04	3.85E-05	3.90E-05	2.17E-06
South Deerfield WWTP	Small	No IPP	West	1,666	0.08	0.03	0.00	4.59E-05	1.60E-05	0.00E+00
South Essex Sewerage District	Large	IPP	Northeast	190,000	8.18	4.93	0.19	4.30E-05	2.59E-05	9.81E-07
South Hadley WWTP	Medium	IPP	West	1,700	0.48	0.50	0.06	2.83E-04	2.94E-04	3.71E-05
Southbridge WWTP	Medium	IPP	Central	17,000	0.14	0.17	0.04	8.37E-06	1.00E-05	2.53E-06
Spencer WWTP	Medium	No IPP	Central	11,911	0.08	0.17	0.03	6.92E-06	1.47E-05	2.41E-06
Springfield WWTP – Bondi's Island	Large	IPP	West	250,000	6.14	4.63	1.14	2.46E-05	1.85E-05	4.56E-06
Stockbridge WWTP	Small	No IPP	West	2,110	0.04	0.07	0.01	1.93E-05	3.17E-05	2.60E-06
Sturbridge WPCF	Medium	No IPP	Central	5,500	0.05	0.09	0.02	9.37E-06	1.58E-05	3.04E-06
Sunderland WWTP	Small	No IPP	West	3,663	0.02	0.01	0.00	6.56E-06	1.97E-06	5.81E-08
Taunton WWTP	Large	IPP	Southeast	27,740	1.85	1.38	0.17	6.67E-05	4.96E-05	6.26E-06
Templeton WWTP	Small	No IPP	Central	1,480	0.09	0.03	0.00	5.82E-05	1.84E-05	1.57E-06
Upper Blackstone WPAD	Large	IPP	Central	260,000	7.70	4.12		2.96E-05	1.58E-05	
Upton WWTP	Small	No IPP	Central	3,000	0.14	0.04	0.00	4.71E-05	1.40E-05	1.28E-06
Uxbridge WWTF	Medium	No IPP	Central	9,000	0.09	0.21	0.01	1.02E-05	2.32E-05	1.45E-06
Ware WWTP	Medium	IPP	West	4,000	0.00	0.06	0.01	0.00E+00	1.58E-05	1.55E-06
Wareham WPCF	Medium	No IPP	Southeast	7,000	1.22	0.22	0.01	1.74E-04	3.11E-05	1.22E-06
Warren WWTP	Medium	No IPP	West	2,007	0.01	0.03	0.00	5.77E-06	1.31E-05	0.00E+00
Wayland WWTP	Small	No IPP	Northeast	395	0.03	0.00	0.00	6.34E-05	9.29E-06	0.00E+00
Webster WWTF	Large	IPP	Central	6,383	0.31	0.49	0.05	4.93E-05	7.73E-05	7.85E-06
West Stockbridge WWTP	Small	No IPP	West	398	0.00	0.00	0.00	3.31E-06	8.21E-06	0.00E+00
Westborough WWTF	Large	IPP	Central	65,800	0.97	1.35	0.23	1.48E-05	2.06E-05	3.44E-06
Westfield WPCP	Large	IPP	West	18,000	1.42	1.11	0.29	7.91E-05	6.18E-05	1.64E-05
Winchendon WPCF	Medium	No IPP	Central	2,800	0.22	0.29	0.02	7.93E-05	1.03E-04	6.17E-06
Woronoco Village WWTF	Small	No IPP	West	75	0.00	0.00		3.71E-06	9.73E-06	
				Total	366.61	294.62	14.32	0.05	0.01	0.01

* Sludge mass loading was calculated using the estimated annual sludge production for each POTW as reported in Bone et al. (2024) where possible given data availability.[1]

Appendix C – Supplemental Figures



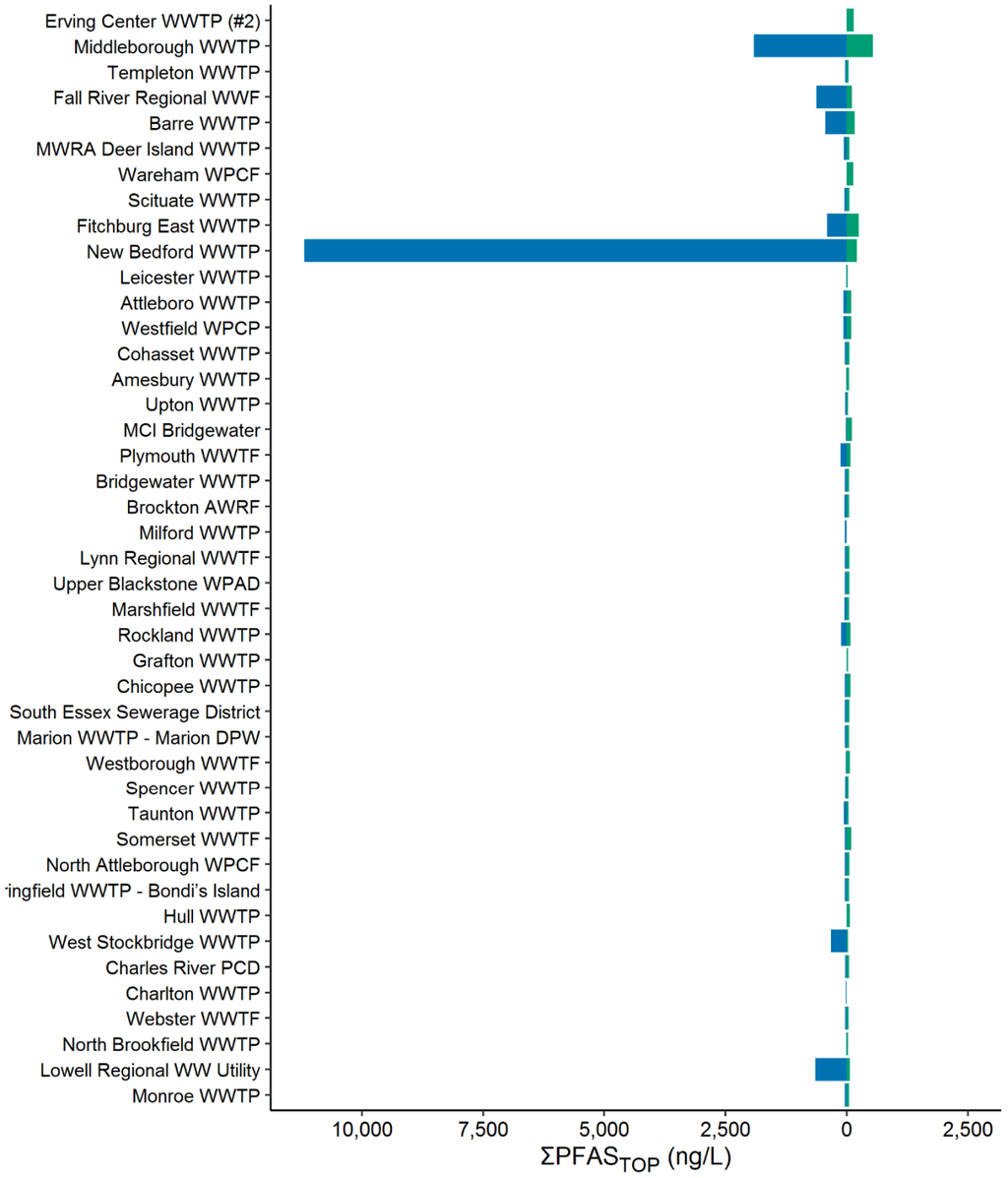


FIGURE C-1
Total PFAS Concentrations for EPA Method 1633 and TOP analysis for the Upper 43 POTWs (Study Round 2 influent and effluent data)

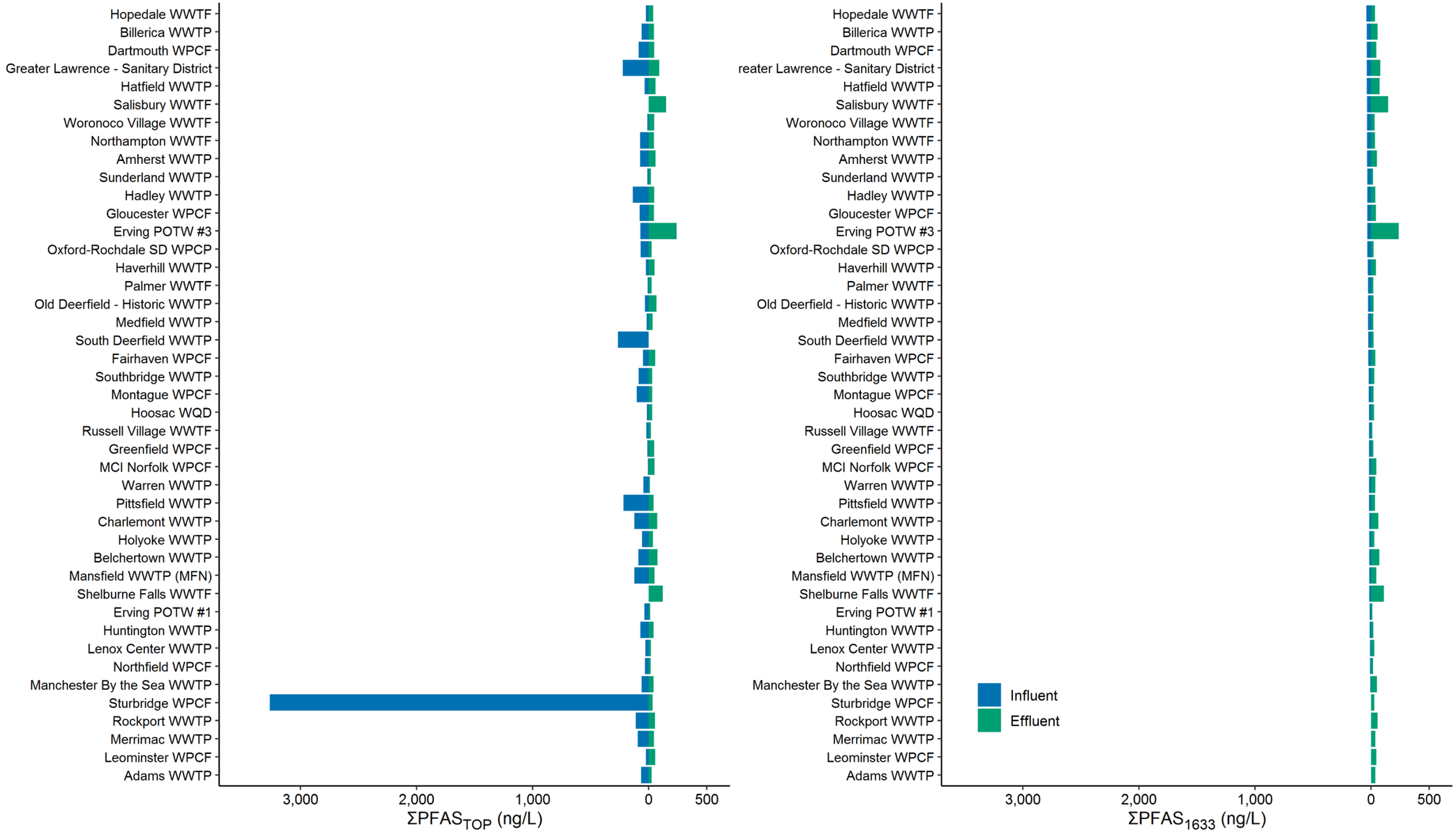


FIGURE C-2
Total PFAS Concentrations for EPA Method 1633 and TOP analysis for the Lower 43 POTWs (Study Round 2 influent and effluent data)

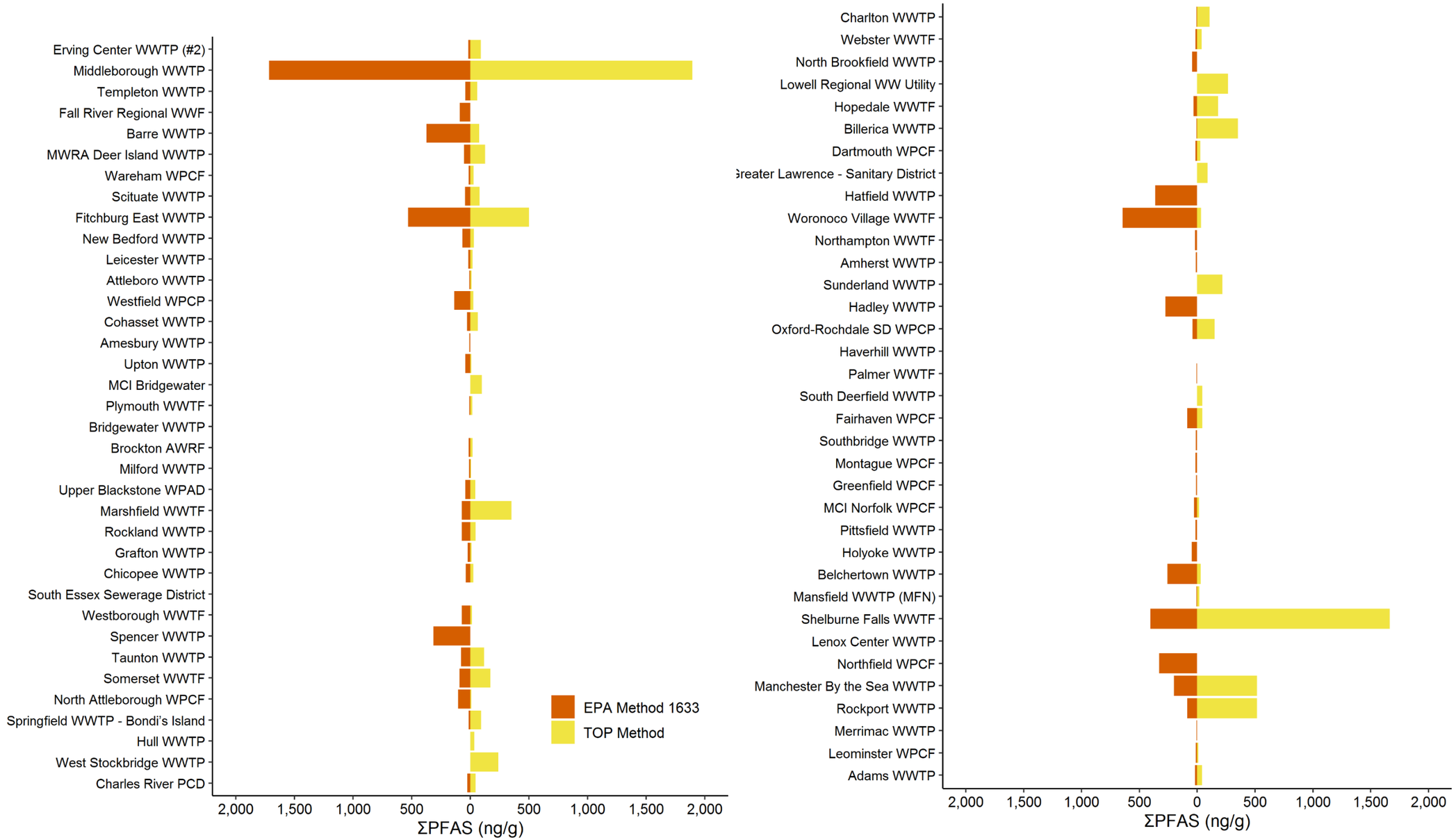


FIGURE C-3
Total PFAS Concentrations for EPA Method 1633 and TOP (Study Round 2 Dry Mass Sludge data)
(POTWs are presented in the same order as they are presented in Figures C-1 and C-2)

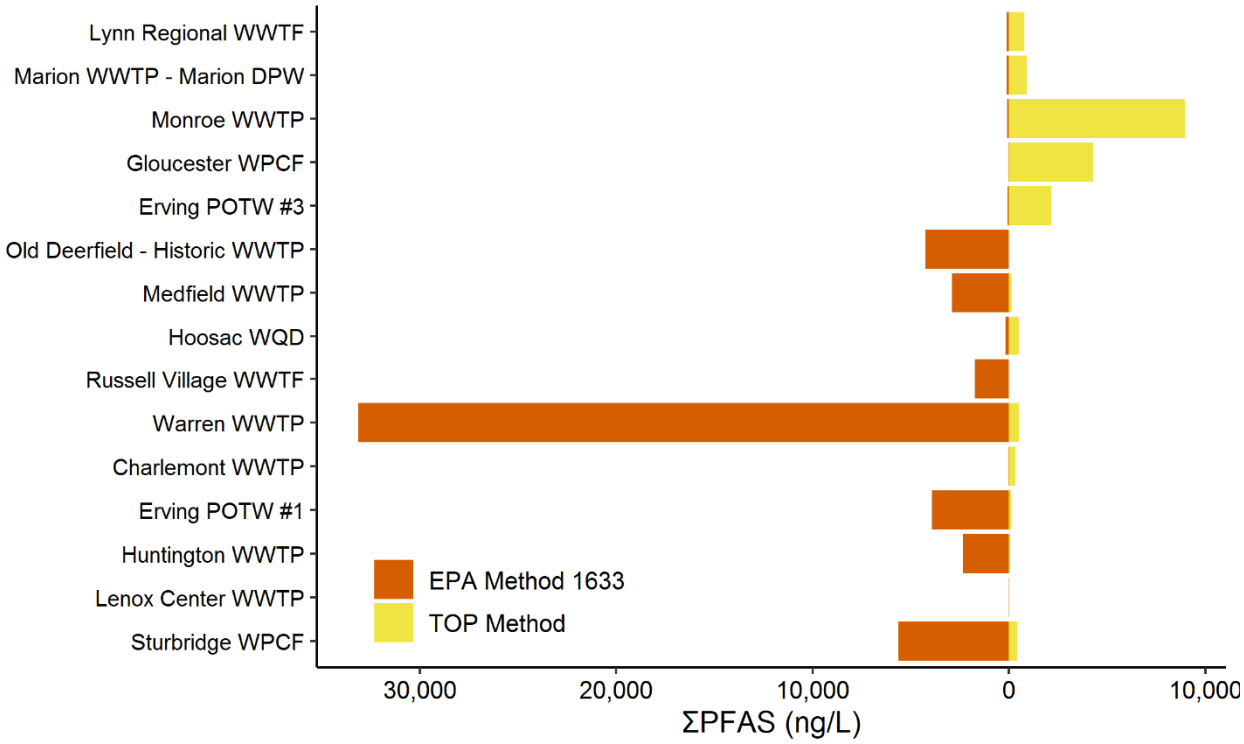


FIGURE C-4
Total PFAS Concentrations for EPA Method 1633 and TOP (Study Round 2 Liquid Mass Sludge data)

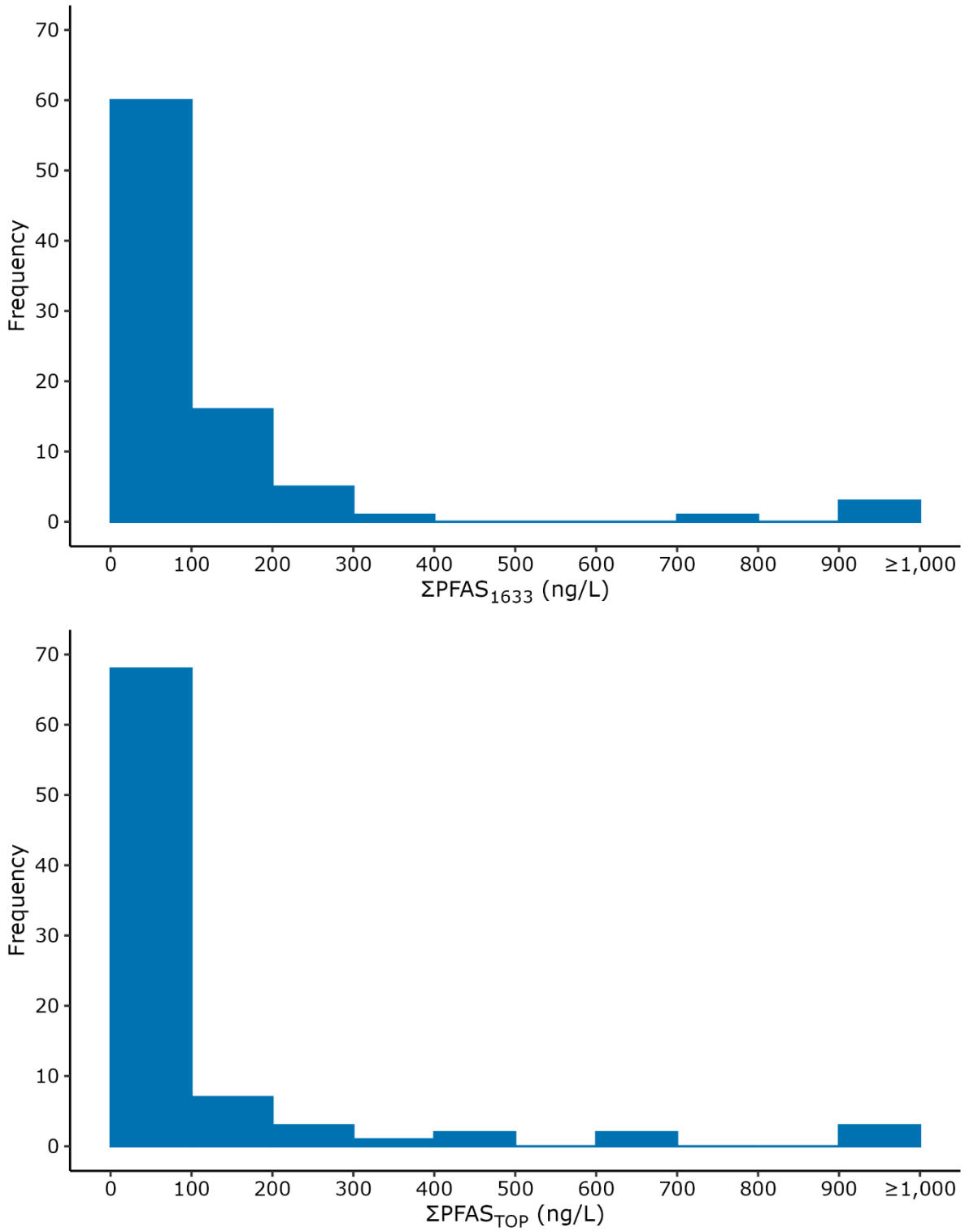


FIGURE C-5
Relative Abundance of ∑PFAS Concentration Ranges for EPA Method 1633 and TOP
(Study Round 2 Influent data)

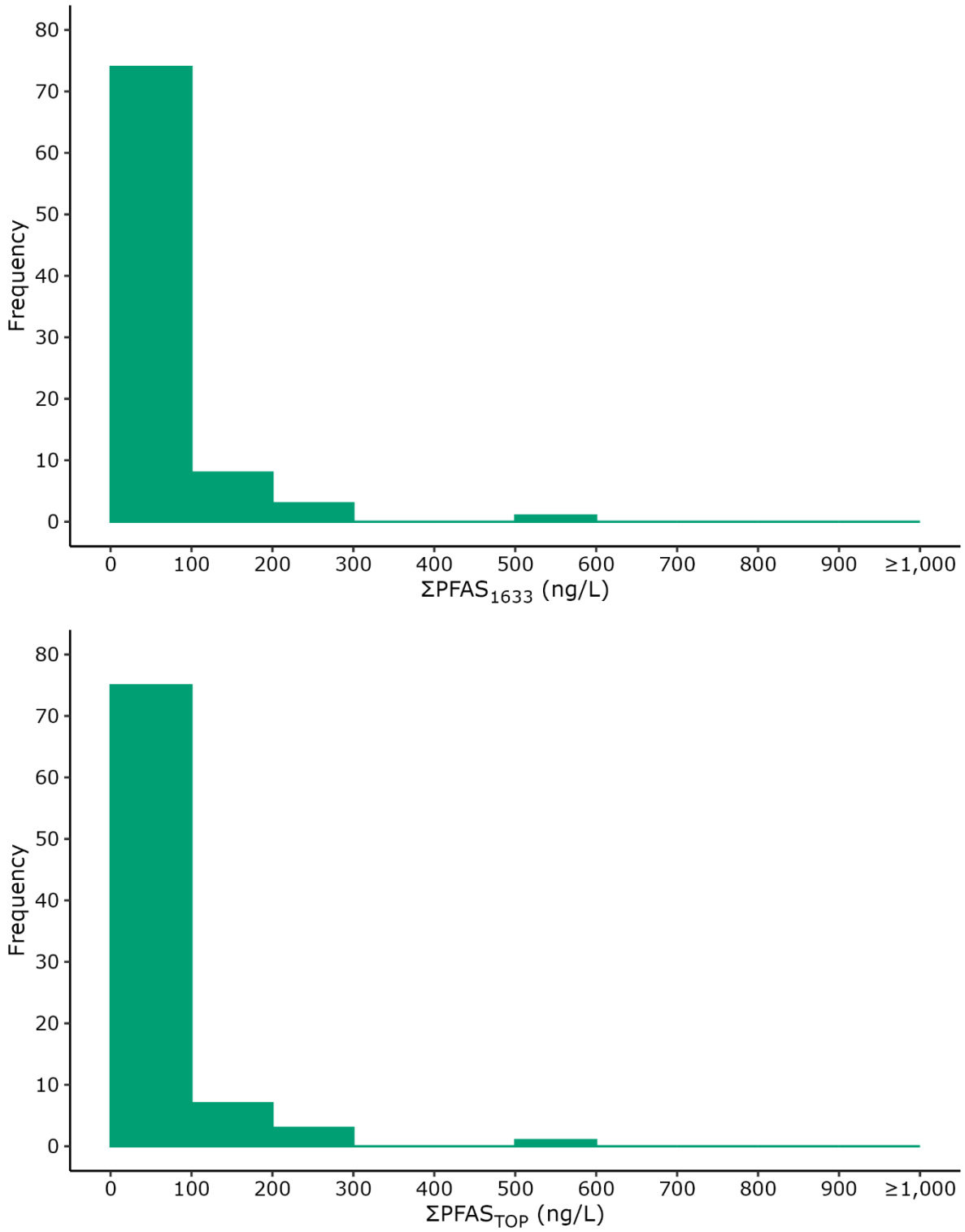


FIGURE C-6
Relative Abundance of ∑PFAS Concentration Ranges for EPA Method 1633 and TOP
(Study Round 2 Effluent data)

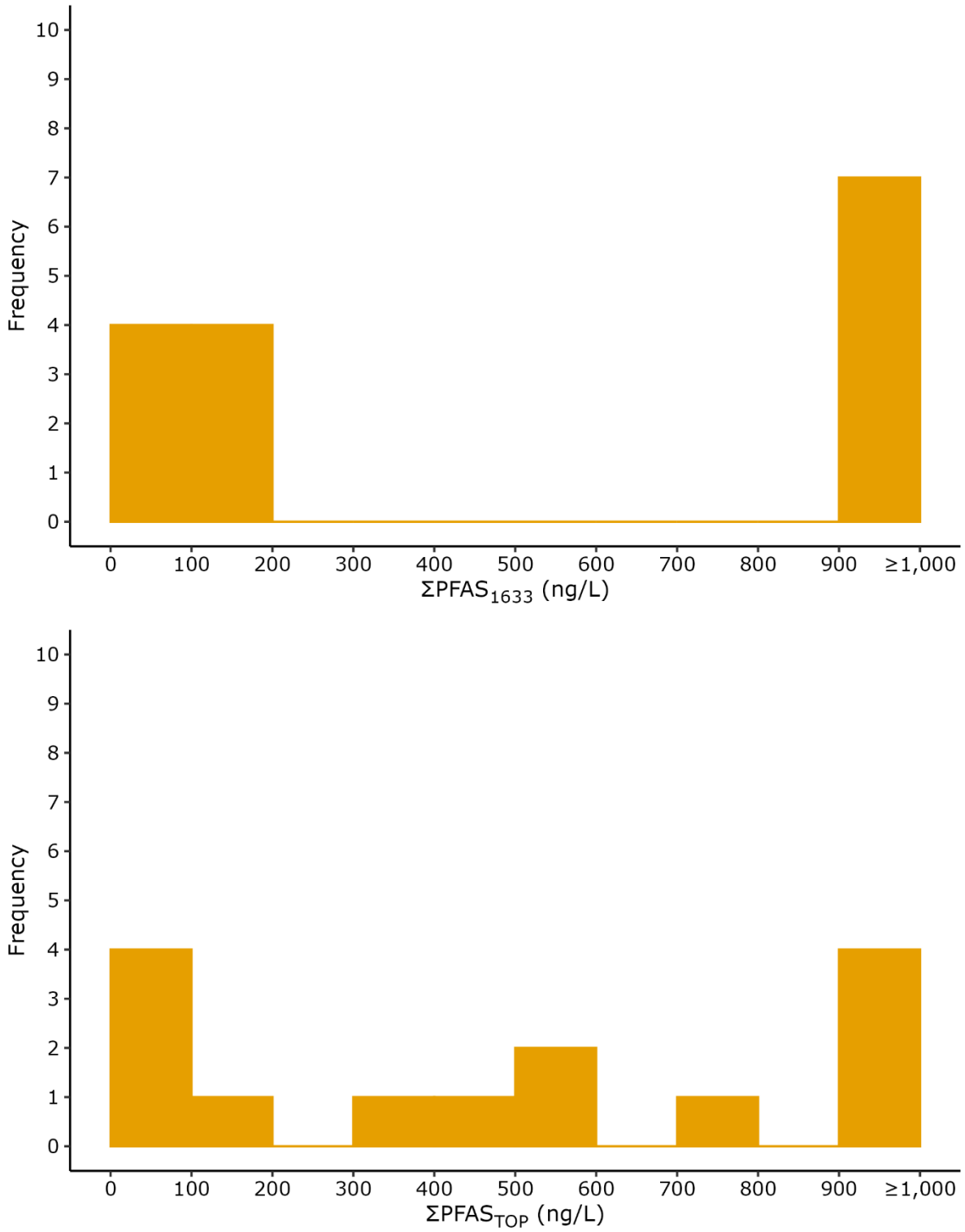


FIGURE C-7
Relative Abundance of ∑PFAS Concentration Ranges for EPA Method 1633 and TOP
(Study Round 2 Liquid Mass Sludge data)

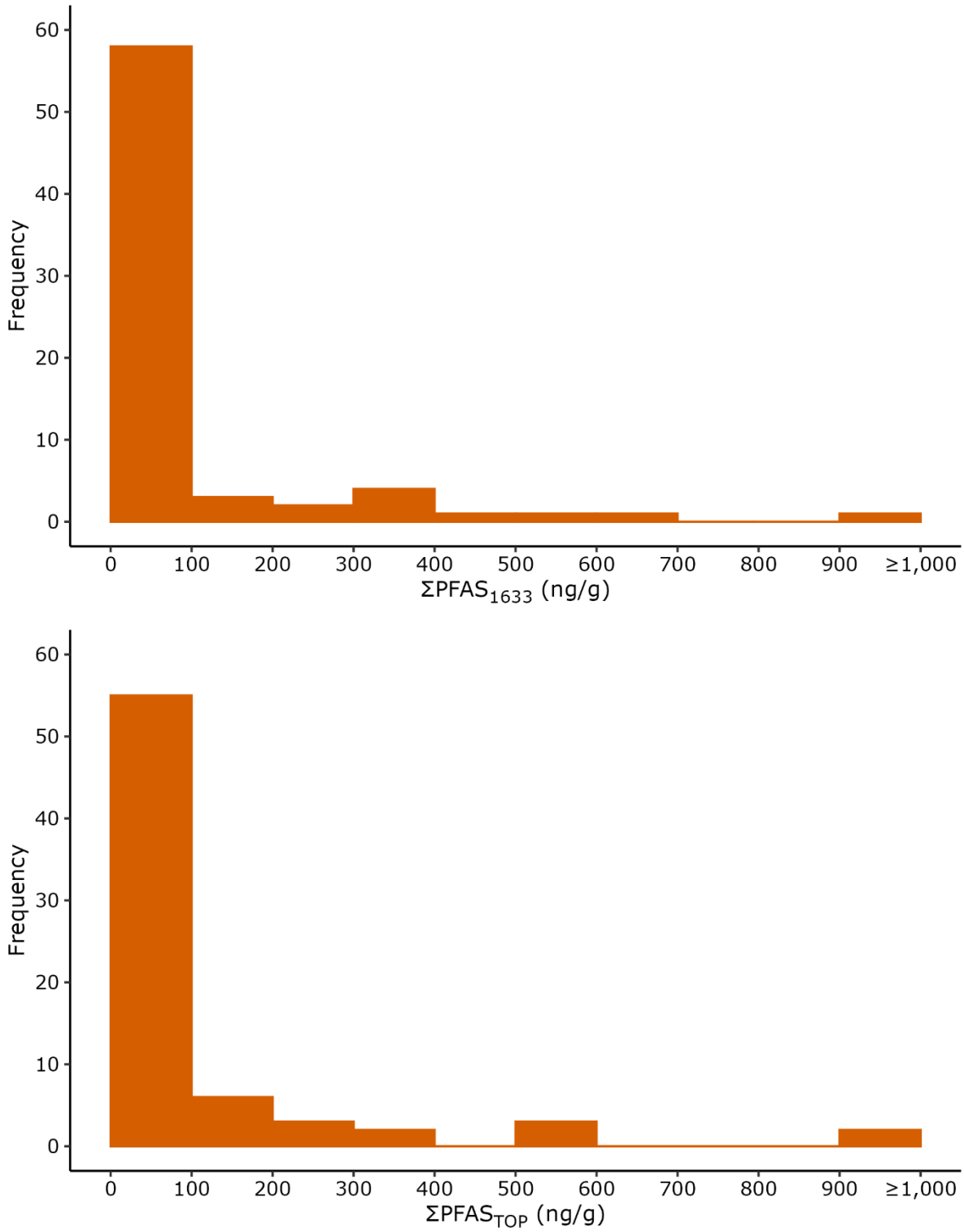


FIGURE C-8
Relative Abundance of ∑PFAS Concentration Ranges for EPA Method 1633 and TOP
(Study Round 2 Dry Mass Sludge data)

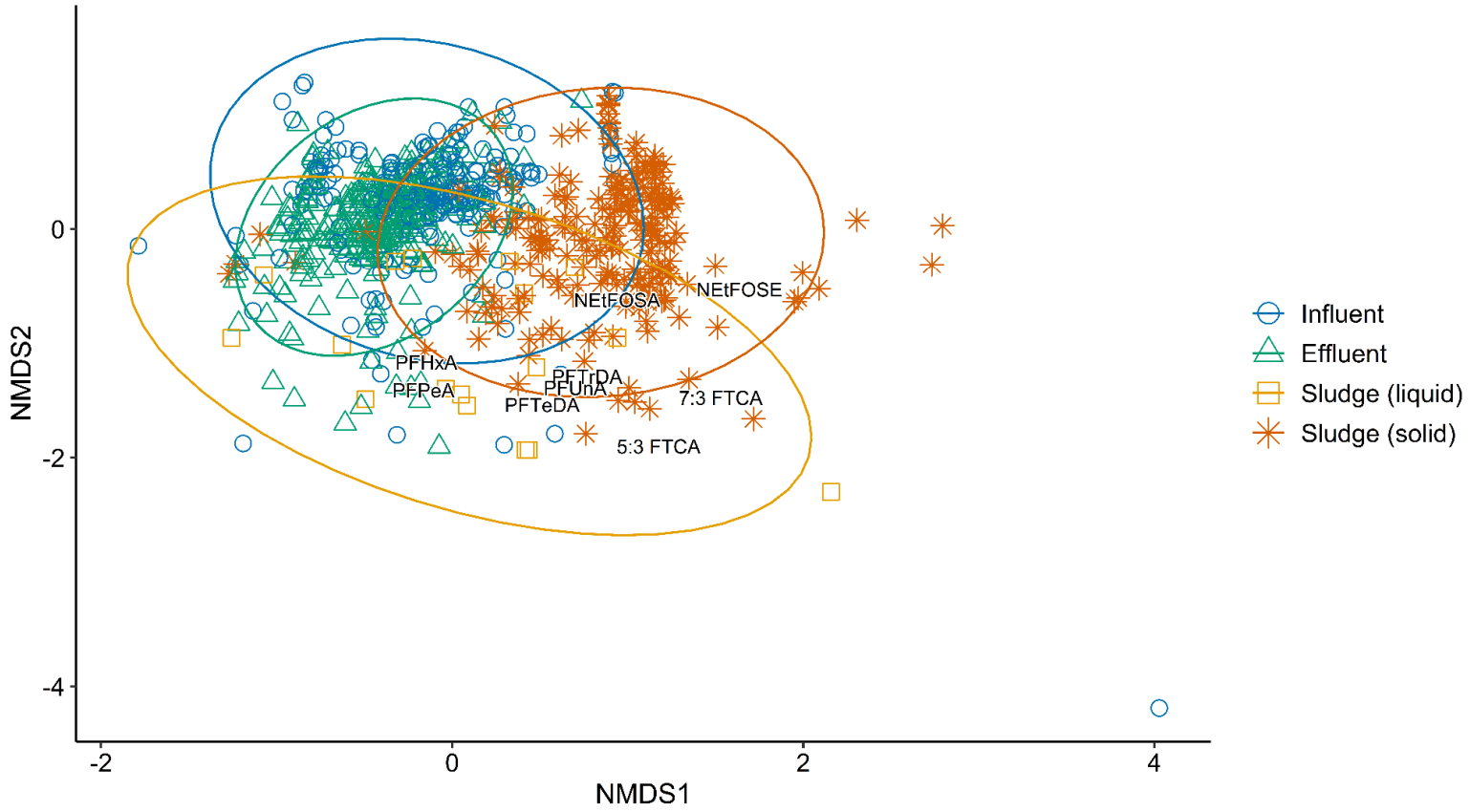


FIGURE C-9
Qualitative depiction of POTW influent, effluent, and sludge PFAS 'fingerprints'

Note: The NMDS algorithm with three dimensions did not converge after 1,998 iterations, although the figure depicts the best solution (stress = 0.12). PFAS both strongly (Spearman's $\rho>0.5$) and significantly ($p<0.05$) correlated with NMDS1 or NMDS2 are shown.

Appendix D – Laboratory Reports (delivered electronically)

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