Concept Validation: Collecting Soil Samples to Understand the Presence and Concentrations of Per- and Polyfluoroalkyl Substances (PFAS) in Michigan Forested Areas via Composite Sampling

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LIST OF ACRONYMS

ADONA	Trade name for 4,8-dioxa-3H-perfluorononanoate
AFFF	Aqueous film forming foam
DEQ	Department of Environmental Quality
EGLE	Department of Environment, Great Lakes, and Energy
F-53B Maj	Chlorinated polyfluorinated ether sulfonate major
F-53B Min	Chlorinated polyfluorinated ether sulfonate minor
FOSAA	Perfluorooctane sulfonamido acetic acid
FTS	Fluorotelomer sulfonic acids
GenX	Trade name for a polymerization processing aid formulation that contains ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoate
ITRC	Interstate Technology and Regulatory Council
LUC	Land use cover
MDL	Method detection limit
MPART	Michigan PFAS Action Response Team
NEtFOSAA	N-ethyl perfluorooctane sulfonamide
NLP	Northern Lower Peninsula
NMeFOSA	*N*-methyl perfluorooctane sulfonamide
PCA	Principal component analysis
PCCAT	Principal Component and Clustering Analysis Tool
ΣPFAS	Total PFAS
PFAS	Per- and polyfluoroalkyl substances
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutane sulfonic acid
PFDA	Perfluorodecanoic acid
PFDS	Perfluorodecane sulfonic acid
PFCA	Perfluoroalkyl carboxylic acids
PFDoA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid

PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonic acid
PFNA	Perfluorononanoic acid
PFNS	Perfluorononane sulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFPeA	Perfluoropentanoic acid
PFPeS	Perfluoropentane sulfonic acid
PFSA	Perfluoroalkane sulfonic acids
PFTeA	Perfluorotetradecanoic acid
PFTriA	Perfluorotridecanoic acid
PFUnA/ PFUnDA	Perfluoroundecanoic acid
QAPP	Quality assurance project plan
QC	Quality control
RL	Reporting limit
ROS	Regression on order statistics
SAP	Sampling and analysis plan
SLP	Southern Lower Peninsula
SNUR	Significant New Use Rules
TOC	Total organic carbon
µg/kg	Microgram per kilogram
UP	Upper Peninsula
U.S. EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are an emerging group of contaminants that do not break down easily, have the potential to bioaccumulate in the environment, and have proven to be harmful to human health. These compounds have been used in a wide variety of consumer products and industrial processes since the 1940s for their surfactant, water repellant, and temperature and chemical resistant properties (Radjenovic et al., 2020). PFAS have been used in firefighting foams, automotive manufacturing, chrome plating operations, electronics, personal care products, food packaging, waterproof and stain-resistant textiles, and many other products that cannot be exhaustively listed (ITRC, June 2022).

Although perfluorooctane sulfonic acid (PFOS) has been phased out since 2002, and perfluorooctanoic acid (PFOA) and its precursors have been largely phased out of production in the United States (U.S.) since 2015 under the U.S. Environmental Protection Agency (EPA) voluntary Stewardship Program, PFAS may still be present in imported products from other countries. Additionally, the use of PFAS in certain products, such as aqueous film forming foam (AFFF), is still allowed when considered essential. Under the Significant New Use Rules (SNURs), companies in the U.S. are required to report the use of several hundred PFAS in manufacturing to the U.S. EPA (U.S. EPA, 2021). As there are so many compounds in this class, and the SNURs are dependent on voluntary reporting, it is unclear whether PFOA and its precursors have been truly phased out of U.S. manufacturing, as was intended from the voluntary Stewardship Program.

To date, regulatory agencies have focused investigation and regulatory efforts on PFAS in water matrices including drinking water, groundwater, surface water, and wastewater. PFAS occurrence in soil is less understood, although the detection of these compounds in remote areas indicates widescale global distribution (Llorca et al., 2012; Rankin et al., 2016). Some states have developed screening levels or promulgated criteria for soil to be protective of groundwater, surface water, or human health. Criteria and screening levels for PFAS in soil vary widely from state to state and may range from parts per trillion to parts per million. The Interstate Technology and Regulatory Council (ITRC) maintains a table of known criteria and screening levels from the United States and other countries (ITRC, August 2022). The spreadsheet is continually updated to reflect the latest developments and can be found at https://pfas-1.itrcweb.org/fact-sheets/ under Regulations, *PFAS Water and Soil Values Table Excel file*.

1.1 PFAS DISTRIBUTION IN SOILS

Most studies conducted on PFAS in soils to date have been conducted at known contaminated sites, particularly those concerning AFFF, those near chemical manufacturing facilities, or locations where biosolids have been applied (Rankin et al., 2016; Brusseau et al., 2020). Few have assessed concentrations in soils in a variety of land use types, including those that are not known to be directly impacted by contaminated sites. Understanding PFAS concentrations in soils in various land use types may provide insight on atmospheric transport, pathways of contamination, and developing soil criteria. Two studies have detected PFAS in soils of Antarctica, including perfluorohexanoic acid (PFHxA) and PFOS at levels as high as 0.83 µg/kg and 0.54 µg/kg respectively, dry weight (Llorca et al., 2012), and PFOA as high as 0.048 µg/kg (Rankin et al., 2016), which illustrates the potential for these contaminants to reach remote areas around the world.

Two studies were conducted on a global scale that assessed PFAS concentrations in soil in a variety of locations not known to be associated with contaminated sites (Strynar et al., 2012; Rankin et al., 2016). The first study (Strynar et al., 2012) involved analyzing 60 fresh and archived surface soil samples from six countries including the U.S., Mexico, China, Greece, Japan, and Norway. At least one PFAS was detected in 58.3% of the samples, with PFOS, PFOA, PFHxA, perfluorododecanoic acid (PFDoA), and perfluoroheptanoic acid (PFHpA) being the most frequently detected compounds. The second study (Rankin et al., 2016) involved collecting 62 surface soil samples from 22 countries across all continents, in areas where there was expected to be little human impact. PFAS were detected in all samples collected, with PFOA, PFHxA, and PFOS being the most frequently detected compounds. Additionally, concentrations were higher in the northern hemisphere than the southern hemisphere, with the highest concentrations observed in Asia and North America.

Other studies have been smaller in scale, focusing on specific regions, countries, or states, and are briefly summarized. A study by Wang et al. (2018) conducted in forested mountain areas of China involved collecting 54 surface soil samples to be analyzed for PFOA and PFOS only. PFOA was detected more frequently and at higher concentrations than PFOS. The Swedish Forest Soil Survey Inventory collected 31 samples from mature forests in Sweden, and found PFOS, perfluorooctane sulfonamido acetic acid (FOSAA), perfluorobutane sulfonic acid (PFBS), and perfluoroundecanoic acid (PFUnDA) to be the most frequently detected compounds (Sörengård et al., 2022). The Baden-Württemberg State Institute for the Environment collected eight samples in forested areas in Germany, and results showed that PFOS was the most frequently detected and at the highest concentrations, followed by PFOA and perfluorodecanoic acid (PFDA) (Groh et al., 2016). These were the only three compounds detected, but the detection limit (1 µg/kg) is higher than any other study mentioned, so other PFAS may have been present at lesser concentrations.

A state-wide study in Vermont collected 68 samples in shallow soils at state or municipal parks, forests, greens, or building or school lawns. At least one PFAS was detected in all samples, with total PFAS concentrations being most influenced by PFOS and PFOA (Zhu et al., 2022). No consideration appears to have been given to locations of PFAS contaminated sites, or potential nearby sources in this study. Maine conducted a similar state-wide survey that was intended to be used for developing background concentrations and collected 64 samples split between urban and non-urban locations. PFOS was the most frequently detected compound, followed by perfluorobutanoic acid (PFBA) and PFOA, and total PFAS concentrations were generally higher in urban areas over non-urban areas (Sanborn, Head & Associates, Inc., 2022). As the study in Maine was intended to be used for determining background levels, potential PFAS sources were avoided in selecting sample location, and outliers were assessed and excluded as necessary.

Two studies found a significant correlation between total organic carbon (TOC) and concentrations of one or more PFAS in soil (Sörengård et al., 2022; Sanborn, Head & Associates, Inc., 2022). Other correlating factors proposed to be linked to PFAS concentrations include soil type and moisture (Sanborn, Head & Associates, Inc., 2022), latitude and longitude (Sörengård et al., 2022), altitude, precipitation, temperature, and vegetation type (Wang et al., 2018). Perfluoroalkyl carboxylic acids (PFCA), including PFOA, PFHxA, PFDoA, PFUnA, PFBA, PFDA, perfluoropentanoic acid (PFPeA), perfluorononanoic acid (PFNA), perfluorotridecanoic acid (PFTriA), and perfluorotetradecanoic acid (PFTeA), were generally detected more frequently and at greater concentrations than perfluoroalkane sulfonic acids (PFSA), including PFBS, PFOS, perfluoropentane sulfonic acid (PFPeS), perfluorohexane sulfonic acid (PFHxS), perfluorononane sulfonic acid (PFNS), and perfluorodecane sulfonic acid (PFDS), in the studies mentioned here. All these factors may provide insight on how PFAS are transported through the environment.

The highest total PFAS concentrations observed in a single sample ranged widely in these studies, from as low as 0.011 µg/kg (Wang et al., 2018) to as high as 129 µg/kg (Strynar et al., 2012). Results may differ due to the number of compounds analyzed, analytical methods and detection limits, and the location of samples collected. Although many of these studies intended to collect samples away from known contaminated areas, our knowledge and understanding of the use of these compounds in industry has greatly evolved over the last few years. It is possible that some results of these studies were impacted by nearby industry that may not have been known to use and emit PFAS at the time of collection. Additionally, Strynar et al., (2012) and Groh et al., (2016) analyzed samples that had been stored for an unknown number of years. This may have impacted results, particularly for any precursor or volatile compounds that may have been either lost or transformed into other compounds. It is also unknown what material the reserve samples were stored in, and not mentioned if consideration was given to whether the storage containers may have contained PFAS.

1.2 CONCEPT VALIDATION: COLLECTING COMPOSITE SOIL SAMPLES

In August 2019, the Michigan PFAS Action Response Team (MPART) allocated funding to assess the presence and concentrations of PFAS in shallow soils across the state of Michigan. The project was designed by the Michigan Department of Environmental Quality (DEQ), now the Michigan Department of Environment, Great Lakes, and Energy (EGLE) to assess PFAS concentrations in various soil types based on four major land uses across Michigan using a modified incremental sampling method, a type of composite soil sampling (ITRC, 2020). No statewide effort to understand the presence and concentrations of PFAS in soils had previously been conducted in Michigan, and only a few of the PFAS soil studies cited above used composite sampling methods; many used discrete sampling methods.

Site use types were grouped into four categories for four major land uses employing the U.S. Geological Survey National Land Cover Data, 2011 Land Cover (2011 Edition): Forest (FOR), Agriculture and Pasture (AGP), Open and Low Urban (OLU), and Medium and High Urban (MHU). For this study, FOR is defined as at least 85% cumulative coniferous, deciduous, or mixed forest; AGP is defined as at least 85% cumulative cultivated crops or hay/pasture; OLU is defined as at least 85% cumulative open space or low development; and MHU is defined as at least 85% cumulative medium or high intensity development.

Forest samples were only collected on publicly owned properties and were sampled first due to ease of access. Because no privately owned forested areas were sampled, the sampling cannot be considered truly random, and therefore the results of this project may not be representative of all forested areas in Michigan. Additionally, an evaluation of the proximity of these sample locations to PFAS sites and sources was not completed until after collection and analysis. As some samples were collected near known PFAS contaminated sites, the data may be reflective of environmental impacts caused by those sites. A detailed analysis of PFAS soil results in relation to known PFAS contaminated sites is beyond the scope of this report. It is therefore not appropriate to consider the results of this project as “background” concentrations.

As of December 31, 2021, all the planned forest samples have been successfully collected, one sample in each of Michigan’s 83 counties. This report discusses only the PFAS concentrations observed in the forest samples and lessons learned in implementing this concept validation project. Although all samples were analyzed for metals, and a select number of samples were sampled for leachability, those results will not be discussed in this report. Sampling at the remainder of the land use types has not been scheduled at this time.

2.0 FIELD SAMPLING METHODOLOGY

Using the Public Land Survey System, the state was divided into one square mile sections. These sections were then subdivided into quarters twice, yielding sixteen 40-acre parcels per section. Parcels where at least 85% represented cumulative coniferous, deciduous, or mixed forest comprised the population of the forested land use cover. One soil sample was collected from one representative parcel in all 83 counties in Michigan where possible, with one duplicate sample collected for each twenty samples. All forest sample locations were located on state owned forested land in easily accessible areas. While effort was made to collect samples randomly on publicly owned forested areas, sampling staff identified several locations where land use maps did not accurately reflect actual conditions and alternative locations had to be selected. None of the roughly 200 sites of known PFAS contamination, as shown on the MPART website (MPART, 2023), were considered during selection of the forest sampling locations.

EGLE contracted an environmental consulting firm, AECOM, to conduct all composite soil sampling and data validation following procedures specified in the September 2020 *Quality Assurance Project Plan (QAPP) for Collecting Soil Samples to Understand the Nature and Extent of PFAS in Michigan by Land Use and Via Modified Incremental Sampling and September 2020 Sampling and Analysis Plan for Collecting Soil Samples to Understand the Nature and Extent of PFAS in Michigan by Land Use and Via Modified Incremental Sampling (SAP)*, located in **Appendices A** and **B,** respectively. Soil samples were collected from a depth interval of 0 to 6 inches below ground surface using a coring tool with a diameter of 1, 1.5, or 2 inches depending on field conditions. Given the relatively remote conditions for the forest sampling locations, a three-inch bucket auger was employed, which allowed 9 aliquots from the predetermined grid to be collected from the 2,500 square feet (a 50 by 50-foot) decision unit, which yielded more than the minimum 1,800 grams of soil from which the sample was to be constructed. Each aliquot was collected by first removing all surficial vegetation and leaf litter, then the bucket auger was advanced 6 inches and the contents were added to the PFAS-free lined bucket. Each Decision Unit (DU) was photographed from the center in each of the DU's cardinal directions and stored with the point location in ESRI's Collector App. Prior to building the sample, any remaining roots, vegetation, and detritus were removed, then aliquots were homogenized in the PFAS-free lined bucket. Sampling was conducted following the *Michigan DEQ Soil PFAS Sampling Guidance*, which can be found in **Appendix C**.

Due to the significant potential for cross contamination when sampling for PFAS, quality control (QC) samples were collected to ensure data accuracy. QC samples included field blanks, equipment rinsate blanks, and field duplicates. Field duplicates were collected at a rate of one duplicate per 20 samples, at a minimum. The field precision relative percent difference for a soil sample and its duplicate was 50%. Equipment blanks were collected from each lot of disposable equipment unless equipment was certified PFAS free, and from non-disposable equipment at a frequency of one per 20 samples, or one per day, whichever is less. Non-disposable equipment was decontaminated between samples using either Alconox®, Liquinox®, or Citranox®, and either a polyethylene or polyvinyl chloride brush, as specified in the *Michigan DEQ Soil Sampling Guidance*. PFAS-free deionized water provided by the lab was used to triple rinse equipment following decontamination.

Samples were labeled with a sample identification including the geolocation identification number, sampling number, sample date, and sampler initials. Additionally, samples were given a location identification which consisted of the county name, LUC, and sample number. **Table 1** lists the names of each sampling location and where they are located. Samples were stored at 10°C for shipment to the laboratory, complying with the holding times specified in the QAPP.

3.0 LABORATORY METHODOLOGY

The chemical analysis of PFAS, metals, and TOC was conducted by Eurofins TestAmerica Laboratories, while the geotechnical analysis was conducted by SME. PFAS was analyzed using Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) by modified EPA Method 537 with isotope dilution. The aliquot size was doubled from 5 grams to 10 grams for the limits of quantitation to meet the EGLE criterion for groundwater surface water interface protection with respect to PFOS (0.24 µg/kg). This allowed PFAS to be detected at concentrations well below the typical reporting limit (RL) of the lab. TOC was analyzing using the Lloyd Kahn (EPA 9060) Method, and metals were analyzed using EPA Method 6020B, EPA Method 6010D, and EPA Method 7471. Grain size distribution was assessed by sieve and hydrometer per ASTM D7928.

Analytical results were accompanied with qualifiers indicating the reliability of reported values. Results were reported unqualified above the reporting limit (RL)[1], and as estimated values (J flagged) if detected between the method detection limit (MDL)[2] and RL. Dilution was required for some samples due to interference or the presence of high concentrations of analytes, and RLs were adjusted as necessary. Samples were analyzed for 28 PFAS and 26 metals. A complete list of analytes, along with their MDLs and RLs can be found in **Tables 2A-E**.

3.1 QUALITY CONTROL METRICS

Quality assurance (QA) / quality control (QC) procedures were based on applicable U.S. EPA and EGLE requirements, regulations, guidance, and technical standards. Laboratory QC samples were within established control limits, unless otherwise noted in the lab reports. There were no detections of PFAS in any of the four equipment blanks, or the six field blanks that were collected during field sampling. The four field duplicates that were collected were generally in good agreement with the original sample. Differences between duplicate results were typically within 15% for each compound. Due to method blank contamination of PFOS during lab analysis, some samples were reanalyzed for PFOS outside the holding times for PFAS; however, given the stable nature of PFAS, this is not expected to impact results. A review of the analytical data packages was performed by the AECOM Project Chemist and Data Reviewer, as specified in the QAPP, to validate results and confirm usability.

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[1] Reporting Limit: the lowest concentration that can be reliably achieved within specified limits of precision. Reporting limits are often adjusted for sample size, dilution, and percent moisture (QAA, 2019). Also referred to as the limit of quantitation.

[2] Method Detection Limit: the lowest concentration that can be detected by a laboratory instrument. These values are lower than the reporting limit and represent 99% confidence that the analyte concentration is greater than zero (QAA, 2019).

4.0 SUMMARY OF RESULTS

A summary of PFAS results can be found in **Table 3** and are displayed in **Figure 1**. At least one PFAS was detected in all forest samples but one (51-FOR-01). Nine compounds were detected most frequently: PFBA (96% of samples), PFNA (94% of samples), PFOS (92% of samples), PFHpA (87% of samples), PFOA (77% of samples), PFDA (73% of samples), PFUnA (70% of samples), PFBS (60% of samples), and PFHxA (58% of samples). PFOS was generally detected at the highest concentrations, ranging from non-detect to 0.88 µg/kg, followed by PFBA, with concentrations ranging from non-detect to 0.69 µg/kg, and PFOA, with concentrations ranging from non-detect to 0.36 µg/kg.

PFOS, PFOA, and PFBS concentrations observed in samples across Michigan are shown in **Figures 2 – 7**. Non-detects were treated as a zero value for the purpose of constructing these figures. Total PFAS (ΣPFAS) ranged from non-detect at 51-FOR-01, located in Hillsdale County, to 2.016 µg/kg at 73-FOR-01, located in Saginaw County. The sample location with the highest total PFAS concentration, 73-FOR-01, does not appear to be near any known PFAS contaminated sites. Higher ΣPFAS observed during this project were located throughout the southern half of Michigan's lower peninsula.

The sum of PFCAs (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA) was higher than the sum of PFSAs (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS) in 79% of samples collected. The sum of PFCAs ranged from non-detect to 1.334 µg/kg, while the sum of PFSAs ranged from non-detect to 0.944 µg/kg. There were no detections of fluorotelomer sulfonic acids (4:2 FTS, 6:2 FTS, and 8:2 FTS), fluoroalkylether compounds (F-53B Maj, F-53B Min, ADONA, and GenX), or perfluoroalkane sulfonamides (FOSA, NMeFOSA, and NEtFOSAA) in any samples.

Metals were also analyzed in all 83 samples, and a summary of results can be found in **Table 4**. A detailed analysis of the metals data was not completed as part of this project or report. The metals data were only used for the statistical analysis to determine if there were any correlations between PFAS and metals concentrations in soil samples. All lab reports for PFAS and metals can be found in **Appendix D**. Soil characteristics from the sieve analysis and field parameters for each sample, including TOC and moisture, are summarized in **Table 5**. Of the 83 samples, 40 were classified primarily as sand, while 34 were classified primarily as silty sand, and 3 were classified primarily as silt. Clayey sand and clayey silt only represented 5 samples. Moisture was below 25 percent in most samples (70 out of 83), and percent clay was below 10 percent in most samples (72 out of 83). TOC ranged from 4,300 mg/kg in 01-FOR-01 to 390,000 in 54-FOR-01. All gradation reports can be found in **Appendix E**.

4.1 STATISTICAL ANALYSIS

Analysis of the data focused on ten PFAS that were detected in at least 25% of the samples (PFBA, PFNA, PFOA, PFOS, PFHpA, PFUnA, PFDA, PFHxA, PFBS, and PFPeA) to allow for enough differentiation, as is required by some of the statistical analysis software used for this project. As there are no identifiable sample handling issues, laboratory analytical issues, or data transcription issues, none of the data was excluded from the analysis. Sample results that were J flagged are assumed to be unbiased estimates of the true concentration and were included in the statistical analysis. Data was determined to be lognormally distributed using a probability plot. Due to significant variation in detection limits for non-detect results, which ranged from 0.11

to 37 μg/kg for PFAS in the 83 samples, imputed values were calculated using the lognormal regression on order statistics (ROS) method. Imputed values were also calculated using this method for the non-detect metals data. As non-detect results can cause uncertainty in statistical analyses, imputation was chosen to estimate values for non-detect results, rather than using values of zero, or half the detection limit.

Statistical analysis included principal component analysis (PCA) and regression analysis. PCA was primarily used to assess similarity of PFAS concentrations in samples by observing trends and clusters on score plots. PCA was also useful for indicating whether location may be correlated to PFAS concentrations. Regression analysis was used to determine if the presence and amount of one variable, such as TOC, moisture, clay content, or a specific metal, is correlated to or may be impacting the concentration of any single PFAS. Analyses were performed using Minitab Statistical Software, as well as the Principal Component and Clustering Analysis Tool (PCCAT) developed by Michigan State University Center for Statistical Training and Consulting (Jantre et al., 2020).

4.1.1 PRINCIPAL COMPONENT ANALYSIS

Each column of the data matrix was centered and scaled to mean zero and variance 1 to minimize the effect of highly disparate concentrations among chemical compounds. The principal components were extracted from the correlation matrix of these standardized data. Samples were given one of three regional designations and the principal components were plotted to see how component scores varied across the state. The lower peninsula was divided into a north and south region (NLP and SLP respectively); the northern borders of Oceana, Newaygo, Mecosta, Isabella, Midland, Bay, Tuscola, and Sanilac counties represent the dividing line across the lower peninsula. The upper peninsula (UP) was the third region.

The primary component of variation (PC1) contributed 44.1% to the variance, with PFNA, PFHpA, PFOA, and PFOS having the highest loading factors, and the secondary component (PC2) contributed 14.2% to the variance, with PFUnA, PFBA, PFBS, and PFHxA having the highest loading factors. Four components were required to account for 80% of the variance, and six components were required to account for 90% of the variance.

The score plot generated from PCA is shown in **Figure 8**. A tight cluster of samples is located along the PC1 axis in quadrants 3 and 4, showing little variation between these samples. This cluster contains most of the samples from the NLP and UP, indicating that samples taken from these areas of Michigan are very similar. A second, more loosely spaced cluster, is located at the center of the score plot and runs diagonally from quadrant 3 to quadrant 1 and is mostly made of samples from the SLP. These two clusters account for 63 of the 83 samples. The remaining 20 samples show significant variation from the rest and are located in quadrants 1 and 2. These samples are almost all from the SLP, with the exception of 32-FOR-01. SLP samples varied significantly between one another and from samples located in the other two regions of the state.

4.1.2 REGRESSION ANALYSIS

Regression analysis was used to determine if there was any correlation between PFAS concentrations and TOC, percent clay, moisture, or certain metals. For this analysis, the five PFAS with the lowest number of non-detects were used, including PFBA, PFNA, PFOS, PFHpA, and PFOA, as well as ΣPFAS concentrations. Metals used for this analysis included aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, cobalt, iron, lead, magnesium, manganese, nickel, selenium, strontium, titanium, vanadium, and zinc. Other metals were excluded from the analysis due to a high percentage of non-detect results.

No significant correlations were found between PFAS and TOC, moisture, or percent clay. P-values were greater than the significance level of 0.05 for many of the analyses and R-squared values were typically very low, below 10 percent. Review of the residual plots showed unequal variation, clusters, and large residuals further supporting no significant correlation between PFAS and these soil characteristics.

There were also no significant correlations found between PFAS and each of the metals listed above. P-values were below the 0.05 significance level for PFAS versus iron, chromium, zinc, aluminum, arsenic, barium, magnesium, and nickel, but above the significance level for select PFAS versus manganese, copper, titanium, and vanadium. R-squared values were typically below 20 percent but never higher than 42 percent. Like TOC, moisture, and percent clay, a review of the residual plots showed unequal variation, clusters, and large residuals.

Of the 18 metals analyzed, lead and zinc had the strongest possible positive correlation to PFBA and ΣPFAS, with R-squared values ranging from 32 – 42 percent and correlation coefficients ranging from 0.57 – 0.65. However, review of the residual plots again showed unequal variation and large residuals indicating that no significant correlation exists between these metals and PFAS. **Figure 9** shows the fitted line plots for PFBA and ΣPFAS vs. lead and zinc.

5.0 CONTACT WITH SOILS

As the samples in this project were collected on state-owned forested lands, there may be public questions on the potential impact to human health. The MPART Human Health Workgroup provided the following information on the PFAS concentrations observed in soil in this project:

> The main way that the general population is exposed to PFAS is by eating or drinking contaminated food or water. PFAS are not expected to be easily absorbed through the skin, therefore, activities that involve touching soil or sand containing PFAS, especially at concentrations found to-date (in the data referenced), are not likely to result in a significant exposure to PFAS. While people, particularly children, may accidentally ingest small amounts of soil or sand during play or recreation, these limited exposures (within the context of the forest or dune environment) are not thought to represent a source of significant exposure to PFAS. Overall, for the ways and frequency in which people typically interact with soil and sand recreationally, the PFOS, PFOA and PFBS concentrations reported here (data provided by MPART) are not expected to result in exposures that could harm people’s health.

Although Michigan does not have criteria for direct contact with soils containing PFAS, several other states in the U.S. do. Indiana has Residential Soil Screening Levels for Direct Contact for PFBS and PFBA, each at 1,800 mg/kg. New Hampshire has established Direct Contact Risk-Based Concentrations for PFNA, PFOS, and PFHxS at 0.1 mg/kg each, and for PFOA at 0.2 mg/kg. Connecticut has Additional Polluting Substance Residential Direct Exposure Criteria for PFNA, PFOA, PFOS, PFHxS, and PFHpA each equal to 1.35 mg/kg. The PFAS concentrations observed in this project fall significantly below these values. These values were obtained from the ITRC spreadsheet of criteria and screening levels from the United States and other countries (ITRC, August 2022). As mentioned previously in this report, this list can be found at https://pfas-1.itrcweb.org/fact-sheets/ under Regulations, *PFAS Water and Soil Values Table Excel file*.

6.0 DISCUSSION

PFAS concentrations observed in soils for this project are consistent with the studies mentioned briefly in Section 1.1, and in some cases are significantly lower. The table below shows the range of PFOS, PFOA, and total (Σ) PFAS detected in the PFAS soil studies discussed in Section 1.1. Depths of soil samples were considered surficial or shallow in each study. Concentrations from each study have all been converted to μg/kg for ease of comparison.

Reference	Location	No. PFAS Analytes	PFOS (μg/kg)	PFOA (μg/kg)	∑PFAS (μg/kg)
Llorca et al., 2012	Antarctica	18	0.31 – 0.54	ND	1.26 – 1.76
Strynar et al., 2012	Global	13	ND – 10.1	0.764 – 31.7	7.81 – 129
Rankin et al., 2016	Global	32	ND – 3.13	ND – 3.44	0.055 – 14.47
Groh et al., 2016	Germany	20	2.0 – 8.0	ND – 2	2.0 – 10.0
Wang et al., 2018	China	2	ND – 0.002	ND – 0.009	ND – 0.011
Zhu et al., 2022	Vermont	17	0.106 – 9.79	0.052 – 4.9	0.54 – 35
Sörengård et al., 2022	Sweden	28	ND – 1.7	ND – 0.57	0.29 – 8.63
Sanborn, Head & Associates, Inc., 2022	Maine	28	ND – 5.32[1]	ND – 5.29[1]	ND – 19.64[1]
Michigan Project	Michigan	28	ND – 0.88	ND – 0.36	ND – 2.016

ND = non-detect; not detected above the method detection limit

1. Sample identified as an outlier in Maine study not included in this table

Most of the higher ΣPFAS concentrations observed during this project were located throughout the southern half of Michigan's lower peninsula, which is not unexpected given this is the most populated and heavily industrialized region of the state. Approximately 80% of Michigan's known PFAS contaminated sites are located in this area, and include airports, landfills, military bases, and various current and former manufacturing facilities (MPART, 2023). Some studies have indicated that PFAS have the potential to be released to the atmosphere from these types of sources, and subsequently deposited to off-site areas, from landfill gases (Smallwood et al., 2023; Lin et al., 2022), hydraulic fluids associated with airplanes (Garg et al., 2020), and emissions from manufacturing facilities (D'Ambro et al., 2021).

However, it remains uncertain whether the concentrations observed in Michigan soils are the result of impacts from nearby sources, or due to the presence of PFAS in the atmosphere at a larger scale, in either air or precipitation, or both. Given the widespread distribution of low-level PFAS concentrations observed in Michigan forested soils, atmospheric transport could be a contributing factor to the movement of PFAS through the environment, but the results from this project and the analyses presented in this report are insufficient to draw definitive conclusions alone. Significant data gaps remain on PFAS fate and transport through the atmosphere, and additional research is needed in this area. As results would likely be highly variable depending on location, any atmospheric transport studies would need to be conducted specific to Michigan to provide insight on atmospheric transport and deposition in relation to the results discussed in this report.

Many PFAS soil studies summarized in Section 1.1 found PFCA concentrations to be higher than PFSA concentrations, and the project conducted in Michigan found similar results. This could be due to a possible greater use of PFCA precursors, such as the fluorotelomer alcohols (FTOHs), in manufacturing and industry in the past. It may also provide insight to PFAS fate and transport, such as which compounds are more likely to partition to air molecules and soil particles, and which compounds are likely to migrate to greater depths over time. Although TOC, soil type, and moisture have been linked to impacting fate and transport of PFAS (ITRC, June 2022), this project found no correlations between PFAS and any of these factors. This may be due to the lack of variety of soil types observed during this project. Sand and silty sand were the primary soil type identified for 75 out of the 83 samples, with moisture content below 25% for all but 13 samples, and clay content below 10% in all but 11 samples. Future research in this field would benefit from analyzing a wider variety of soil types to determine if TOC, soil type, and moisture can be linked to fate and transport and PFAS

Most soil studies conducted to date have only assessed PFAS concentrations in surficial soils. Additional research is also needed to assess how PFAS concentrations vary with depth in various land use types to better understand the fate and transport of PFAS in soils. Few studies have assessed PFAS concentrations at various depths, and those have been conducted at known PFAS contaminated sites. While long-chain compounds (≥C7) are typically present in higher concentrations at shallow depths in the subsurface (Baduel et al., 2017; Brusseau et al., 2020), several studies have observed higher concentrations at greater depths, including groundwater (Anderson et al., 2019; Dauchy et al., 2019; Høisæter et al., 2019; Nickerson et al., 2020). Possible causes identified for this include increased water infiltration to these areas and higher impact from source contamination. Additionally, clay content has been linked to increased PFAS concentrations in various studies (Nickerson et al., 2020; Sharifan et al., 2021; Luft et al., 2022).

7.0 CONCLUSIONS

This project demonstrated that it is possible to conduct soil sampling and analysis statewide based on land use type for PFAS using composite soil sampling methodologies. It also demonstrated that significantly lower detection limits were achievable by increasing the aliquot size from 5 grams to 10 grams. Sampling staff observed that land use maps available online do not necessarily reflect actual field conditions, and that flexibility is needed for sample location selection based on criteria in the QAPP. This project further highlighted the questions that remain regarding PFAS fate and transport and data gaps that could be answered through additional research in this field.

The PFAS concentrations observed during this project are consistent with, and in some cases are significantly lower than other soil collection and analysis efforts conducted around the world. Although low concentrations of PFAS were observed in most sampling locations in Michigan, some samples appear to be more influenced by industrial or urban sources than others, such as those located in the southern half of the lower peninsula. No significant correlations were found between PFAS concentrations and TOC, moisture, clay content, or metals concentrations. While largely removed from manufacturing in the U.S., PFOS and PFOA generally continue to be present in the environment at the greatest concentrations compared to other PFAS.

Because samples were only collected on publicly owned forested lands, and no consideration was given to the location of known PFAS contaminated sites when designing this project, this data may not be representative of all forested land in Michigan and should not be taken or used as background levels. Given the current data gaps regarding PFAS fate and transport in the atmosphere, this data alone is insufficient to draw any conclusions on atmospheric deposition. Additional research is needed to better understand the fate and transport of PFAS, both in the atmosphere and subsurface, as well as understanding sources for concentrations observed in soils.

8.0 ACKNOWLEDGMENTS

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Tables

Table 1: Sample Location and Identification Information

Location_ID	Sample_ID	GeoID	County	LP/UP[1]
01-FOR-01	25N09E29SENW-201116GC	25N09E29SENW	Alcona County	LP
02-FOR-01	46N17W31NENW-201114GC	46N17W31NENW	Alger County	UP
03-FOR-01	03N14W12NWNW-201123GL	03N14W12NWNW	Allegan County	LP
04-FOR-01	29N06E11SESE-201116GC	29N06E11SESE	Alpena County	LP
05-FOR-01	29N06W36SWNW-201201GC	29N06W36SWNW	Antrim County	LP
06-FOR-01	19N03E15SWSE-201207GC	19N03E15SWSE	Arenac County	LP
07-FOR-01	48N32W10SENW-201113GC	48N32W10SENW	Baraga County	UP
08-FOR-01	04N09W07NWSW-201027GC	04N09W07NWSW	Barry County	LP
09-FOR-01	15N04E24NWSW-201208GC	15N04E24NWSW	Bay County	LP
10-FOR-01	25N14W15NWNW-201105GA	25N14W15NWNW	Benzie County	LP
11-FOR-01	05S19W32SWSW-201123GC	05S19W32SWSW	Berrien County	LP
12-FOR-01	05S08W21NESW-201214GC	05S08W21NESW	Branch County	LP
13-FOR-01	01S06W16SESE-201125GC	01S06W16SESE	Calhoun County	LP
14-FOR-01	06S13W27SENE-201214GC	06S13W27SENE	Cass County	LP
15-FOR-01	32N05W32SWNE-201201GC	32N05W32SWNE	Charlevoix County	LP
16-FOR-01	33N02W10NENW-201117GC	33N02W10NENW	Cheboygan County	LP
17-FOR-01	45N02W08SWSW-201109GC	45N02W08SWSW	Chippewa County	UP
18-FOR-01	20N05W09NESE-201203GC	20N05W09NESE	Clare County	LP
19-FOR-01	06N01W02NENW-201026SK	06N01W02NENW	Clinton County	LP
20-FOR-01	25N04W26NENW-201202GC	25N04W26NENW	Crawford County	LP
21-FOR-01	40N18W14SENE-201110GC	40N18W14SENE	Delta County	UP
22-FOR-01	44N30W13SESW-201113GC	44N30W13SESW	Dickinson County	UP
23-FOR-01	04N04W03NWSE-201125GC	04N04W03NWSE	Eaton County	LP
24-FOR-01	34N04W20NENW-201117GC	34N04W20NENW	Emmet County	LP
25-FOR-01	08N07E15NWNW-201209GC	08N07E15NWNW	Genesee County	LP
25-FOR-01	08N07E15NWNW-201209GC-FD	08N07E15NWNW	Genesee County	LP
26-FOR-01	19N01W01SENE-201207GC	19N01W01SENE	Gladwin County	LP
27-FOR-01	47N42W20NENE-201111GC	47N42W20NENE	Gogebic County	UP
28-FOR-01	26N10W32NWNE-201105GA	26N10W32NWNE	Grand Traverse County	LP
29-FOR-01	10N01W28NWNW-201028GC	10N01W28NWNW	Gratiot County	LP
30-FOR-01	07S02W15SWNW-201124GC	07S02W15SWNW	Hillsdale County	LP
31-FOR-01	51N35W22SWSE-201111GC	51N35W22SWSE	Houghton County	UP
32-FOR-01	15N14E04NWNW-201030SK	15N14E04NWNW	Huron County	LP
33-FOR-01	02N01E29SWNW-201029SK	02N01E29SWNW	Ingham County	LP
34-FOR-01	07N07W34SENE-201027GC	07N07W34SENE	Ionia County	LP
35-FOR-01	21N06E10NWNE-201116GC	21N06E10NWNE	Iosco County	LP
36-FOR-01	46N33W32NENW-201112GC	46N33W32NENW	Iron County	UP
37-FOR-01	14N05W22NENE-201203GC	14N05W22NENE	Isabella County	LP
38-FOR-01	02S01E14NENW-201029GC	02S01E14NENW	Jackson County	LP
39-FOR-01	02S09W10NWNE-201027SK	02S09W10NWNE	Kalamazoo County	LP
40-FOR-01	25N06W07SWNW-201201GC	25N06W07SWNW	Kalkaska County	LP
41-FOR-01	10N12W23NENE-201103GA	10N12W23NENE	Kent County	LP
42-FOR-01	59N28W32SESE-201112GC	59N28W32SESE	Keweenaw County	UP
43-FOR-01	18N12W07SENE-201104GA	18N12W07SENE	Lake County	LP
44-FOR-01	08N10E05SESW-201209GC	08N10E05SESW	Lapeer County	LP
45-FOR-01	28N14W35NESE-201105GA	28N14W35NESE	Leelanau County	LP
46-FOR-01	07S01E36NWSE-201124GC	07S01E36NWSE	Lenawee County	LP
47-FOR-01	01N04E08SWNE-201029GC	01N04E08SWNE	Livingston County	LP
48-FOR-01	45N09W13SESE-201114GC	45N09W13SESE	Luce County	UP
49-FOR-01	43N07W34NESE-201109GC	43N07W34NESE	Mackinac County	UP

1. LP = Lower Peninsula; UP = Upper Peninsula

Table 1: Sample Location and Identification Information

Location_ID	Sample_ID	GeoID	County	LP/UP[1]
50-FOR-01	04N12E31SESE-201210GC	04N12E31SESE	Macomb County	LP
51-FOR-01	22N16W25NWNE-201105GA	22N16W25NWNE	Manistee County	LP
52-FOR-01	45N26W09NESE-201113GC	45N26W09NESE	Marquette County	UP
53-FOR-01	17N15W31NENW-201104GA	17N15W31NENW	Mason County	LP
54-FOR-01	15N08W36NENW-201103GA	15N08W36NENW	Mecosta County	LP
55-FOR-01	37N25W35SWSW-201110GC	37N25W35SWSW	Menominee County	UP
56-FOR-01	13N02W01SESW-201207GC	13N02W01SESW	Midland County	LP
57-FOR-01	21N06W11SWSE-201106GA	21N06W11SWSE	Missaukee County	LP
58-FOR-01	07S06E15SWNE-201124GC	07S06E15SWNE	Monroe County	LP
59-FOR-01	09N08W29SENW-201028GC	09N08W29SENW	Montcalm County	LP
60-FOR-01	29N02E26NWSW-201130GC	29N02E26NWSW	Montmorency County	LP
61-FOR-01	12N16W25NESW-201215GC	12N16W25NESW	Muskegon County	LP
62-FOR-01	13N11W23SWSE-201103GA	13N11W23SWSE	Newaygo County	LP
63-FOR-01	03N07E27NENE-201210GC	03N07E27NENE	Oakland County	LP
64-FOR-01	14N18W06NENW-201104GA	14N18W06NENW	Oceana County	LP
65-FOR-01	23N01E32SESE-201130GC	23N01E32SESE	Ogemaw County	LP
65-FOR-01	23N01E32SESE-201130GC-FD	23N01E32SESE	Ogemaw County	LP
66-FOR-01	51N42W34SENW-201111GC	51N42W34SENW	Ontonagon County	UP
67-FOR-01	17N09W02SWSW-201104GA	17N09W02SWSW	Osceola County	LP
68-FOR-01	27N01E36SWNE-201130GC	27N01E36SWNE	Oscoda County	LP
69-FOR-01	30N03W31SENW-201202GC	30N03W31SENW	Otsego County	LP
70-FOR-01	07N15W01SWSW-201215GC	07N15W01SWSW	Ottawa County	LP
71-FOR-01	33N02E12SWSW-201117GC	33N02E12SWSW	Presque Isle County	LP
71-FOR-01	33N02E12SWSW-201117GC-FD	33N02E12SWSW	Presque Isle County	LP
72-FOR-01	21N04W27NESE-201202GC	21N04W27NESE	Roscommon County	LP
73-FOR-01	10N03E10SWSW-201028GC	10N03E10SWSW	Saginaw County	LP
74-FOR-01	06N16E09NWNE-201209GC	06N16E09NWNE	Saint Clair County	LP
75-FOR-01	07S12W07SENE-201214GC	07S12W07SENE	Saint Joseph County	LP
76-FOR-01	13N14E06NESE-201208GC	13N14E06NESE	Sanilac County	LP
77-FOR-01	43N16W25NWSW-201110GC	43N16W25NWSW	Schoolcraft County	UP
77-FOR-01	43N16W25NWSW-201110GC-FD	43N16W25NWSW	Schoolcraft County	UP
78-FOR-01	05N01E21NENW-201026SK	05N01E21NENW	Shiawassee County	LP
79-FOR-01	12N09E20SESW-201208GC	12N09E20SESW	Tuscola County	LP
80-FOR-01	01S17W32SENE-201123GL	01S17W32SENE	Van Buren County	LP
81-FOR-01	01S03E16SWNE-201029GC	01S03E16SWNE	Washtenaw County	LP
82-FOR-01	04S09E27SESE-201210GC	04S09E27SESE	Wayne County	LP
83-FOR-01	24N11W25NWSW-201106GA	24N11W25NWSW	Wexford County	LP

1. LP = Lower Peninsula; UP = Upper Peninsula

Table 2A: Target Analytes and Reporting Limits (µg/kg) for PFAS in Soil
LC/MS/MS with Isotope Dilution Modified EPA Method 537

Parameter	Abbrev.	CAS No.	RL[1, 2]	MDL[1, 3]
Perfluorobutanoic acid	PFBA	375-22-4	0.1	0.014
Perfluoropentanoic acid	PFPeA	2706-90-3	0.1	0.0385
Perfluorohexanoic acid	PFHxA	307-24-4	0.1	0.021
Perfluoroheptanoic acid	PFHpA	375-85-9	0.1	0.0145
Perfluorooctanoic acid	PFOA	335-67-1	0.1	0.043
Perfluorononanoic acid	PFNA	375-95-1	0.1	0.018
Perfluorodecanoic acid	PFDA	335-76-2	0.1	0.011
Perfluoroundecanoic acid	PFUnDA	2058-94-8	0.1	0.018
Perfluorododecanoic acid	PFDoDA	307-55-1	0.1	0.0335
Perfluorotridecanoic acid	PFTrDA	72629-94-8	0.1	0.0255
Perfluorotetradecanoic acid	PFTeDA	376-06-7	0.1	0.027
Perfluorobutanesulfonic acid	PFBS	375-73-5	0.1	0.0125
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	0.1	0.01
Perfluorohexanesulfonic acid	PFHxS	355-46-4	0.1	0.0155
Perfluoroheptanesulfonic acid	PFHpS	355-46-4	0.1	0.0175
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.25	0.1
Perfluorononanesulfonic acid	PFNS	68259-12-1	0.1	0.01
Perfluorodecanesulfonic acid	PFDS	335-77-3	0.1	0.0195
Perfluorooctane sulfonamide	FOSA	754-91-6	0.1	0.041
4:2 Fluorotelomer sulfonic acid	4:2 FTS	757124-72-4	1	0.185
6:2 Fluorotelomer sulfonic acid	6:2 FTS	27619-97-2	1	0.075
8:2 Fluorotelomer sulfonic acid	8:2 FTS	39108-34-4	1	0.125
N-ethylperfluoro-1-octanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6	1	0.185
N-methylperfluoro-1-octanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9	1	0.195
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	0.1	0.055
11-chloroeicosafluoro-3-oxaundecane-1-sulfonicacid	11Cl-PF3OUdS	763051-92-9	0.1	0.011
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	0.1	0.0135
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	0.1	0.009

Table 2B: Target Analytes and Reporting Limits (mg/kg) for TOC in Soil by Lloyd Kahn Method

Parameter	Abbrev.	CAS No.	RL[1, 2]	MDL[1, 3]
Total Organic Carbon	TOC	7440-44-0	1000	684

Table 2C: Target Analytes and Reporting Limits (mg/kg) for Metals in Soil by ICP/AES (EPA 6010B)

Parameter	Abbrev.	CAS No.	RL[1, 2]	MDL[1, 3]
Aluminum	Al	7429-90-5	16	5.33
Barium	Ba	7440-39-3	0.8	0.362
Boron	B	7440-42-8	20	0.854
Beryllium	Be	7440-41-7	0.16	0.054
Cadmium	Cd	7440-43-9	0.08	0.048
Cobalt	Co	7440-48-4	0.4	0.2
Chromium	Cr	7440-47-3	0.8	0.151
Copper	Cu	7440-50-8	0.8	0.236
Iron	Fe	7439-89-6	8	6.94
Magnesium	Mg	7439-95-4	80	46.1
Manganese	Mn	7439-96-5	0.8	0.309
Sodium	Na	7440-23-5	80	62.8
Nickel	Ni	7440-02-0	0.8	0.233
Zinc	Zn	7440-66-6	2	1.37

1. Laboratory control limits and detection limits are periodically updated. The latest detection and control limits will be u lized at the time of sample analysis. The allowable lower control limit will not be less than 10%.
2. RL: Reporting Limit
3. MDL: Method Detection Limit

Table 2D: Target Analytes and Reporting Limits (mg/kg) for Metals in Soil by ICP/MS

Parameter	Abbrev.	CAS No.	RL[1, 2]	MDL[1, 3]
Antimony	Sb	7440-36-0	0.16	0.125
Arsenic	As	7440-38-2	0.08	0.06
Molybdenum	Mo	7439-98-7	1	0.249
Lead	Pb	7439-92-1	0.2	0.0623
Selenium	Se	7782-49-2	0.16	0.12
Strontium	Sr	7440-24-6	2	0.434
Thallium	Tl	7440-28-0	0.08	0.048
Vanadium	V	7440-62-2	0.8	0.229
Silver	Ag	7440-22-4	0.08	0.022
Titanium	Ti	7440-32-6	2	0.451
Lithium	Li	7439-93-2	1.6	0.316

Table 2E: Target Analytes and Reporting Limits (mg/kg) for Mercury in Soil by CVAA (EPA Method 7471A)

Parameter	Abbrev.	CAS No.	RL[1, 2]	MDL[1, 3]
Mercury	Hg	7439-97-6	0.04	0.018

1. Laboratory control limits and detection limits are periodically updated. The latest detection and control limits will be utilized at the time of sample analysis. The allowable lower control limit will not be less than 10%.
2. RL: Reporting Limit
3. MDL: Method Detection Limit

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	01-FOR-01	02-FOR-01	03-FOR-01	04-FOR-01	05-FOR-01	06-FOR-01	07-FOR-01	08-FOR-01	09-FOR-01	10-FOR-01	11-FOR-01	12-FOR-01	13-FOR-01	14-FOR-01	15-FOR-01
PFBA	0.054 J	0.097 J	0.11	0.13	0.16	0.23	0.29	0.26	0.3	0.079 J	0.3	0.4	0.24	0.26	0.088 J
PFPeA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	0.056 J	ND (0.12)	0.049 J	ND (0.12)	ND (0.12)	0.069 J	0.059 J	0.047 J	ND (0.12)
PFHxA	ND (0.11)	ND (0.16)	ND (0.11)	0.037 J	0.03 J	0.044 J	0.044 J	0.05 J	0.053J	ND (0.12)	0.062 J	0.079 J	0.064 J	0.045 J	ND (0.12)
PFHpA	0.016 J	ND (0.16)	0.037 J	ND (0.13)	0.034 J	0.053 J	0.087 J	0.07 J	0.09 J	0.02 J	0.086 J	0.098 J	0.061 J	0.048 J	0.023 J
PFOA	ND (0.11)	ND (0.16)	0.1 J	ND (0.13)	0.064 J	0.11	0.11 J	0.17	0.16	ND (0.12)	0.21	0.26	0.17	0.099 J	0.077 J
PFUnA	ND (0.11)	ND (0.16)	0.036 J	0.03 J	ND (0.12)	ND (0.11)	0.048 J	0.071 J	0.044 J	0.079 J	0.12	0.093 J	0.034 J	0.11	ND (0.12)
PFNA	0.032 J	0.049 J	0.099 J	0.063 J	0.062 J	0.086 J	0.13	0.14	0.14	0.043 J	0.16	0.28	0.08 J	0.19	0.047 J
PFDA	ND (0.11)	ND (0.16)	0.025 J	0.027 J	0.013 J	0.024 J	0.028 J	0.038 J	ND (0.12)	0.025 J	0.035 J	0.055 J	ND (0.13)	0.047 J	0.017 J
PFDoA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFTriA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	0.03 J	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFTeA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFBS	0.015 J	ND (0.16)	0.025 J	0.016 J	0.022 J	0.031 J	0.033 J	ND (0.12)	ND (0.12)	0.016 J	0.03 J	0.017 J	0.023 J	0.019 J	ND (0.12)
PFPeS	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFHxS	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	0.022 J	ND (0.12)	ND (0.12)	ND (0.12)	0.032 J	ND (0.12)	0.022 J	ND (0.11)	ND (0.12)
PFHpS	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFOS	0.18 J	0.21 J	0.41	0.16 J	0.36	0.22 J	0.18 J	0.59	ND (0.43)	0.26 J	0.63	0.63	0.51	0.45	0.21 J
PFNS	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
PFDS	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
4:2 FTS	ND (1.1)	ND (1.6)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)
6:2 FTS	ND (1.1)	ND (1.6)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)
8:2 FTS	ND (1.1)	ND (1.6)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)
NEtFOSAA	ND (1.1)	ND (1.6)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.1)	ND (1.2)
NMeFOSAA	ND (1.1)	ND (1.6)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.1)	ND (1.2)
FOSA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
ADONA	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
F-53B Maj	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
F-53B Min	ND (0.11)	ND (0.16)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)
HFPO-DA (GenX)	ND (0.14)	ND (0.2)	ND (0.13)	ND (0.16)	ND (0.15)	ND (0.14)	ND (0.16)	ND (0.15)	ND (0.16)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.16)	ND (0.14)	ND (0.15)
∑PFCA	0.102	0.146	0.407	0.287	0.363	0.547	0.793	0.799	0.836	0.276	0.973	1.334	0.708	0.846	0.252
∑PFSA	0.195	0.21	0.435	0.176	0.382	0.22	0.235	0.59	0	0.276	0.692	0.647	0.555	0.469	0.21
∑PFAS	0.297	0.356	0.842	0.463	0.745	0.798	1.028	1.389	0.836	0.552	1.665	1.981	1.263	1.315	0.462

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	16-FOR-01	17-FOR-01	18-FOR-01	19-FOR-01	20-FOR-01	21-FOR-01	22-FOR-01	23-FOR-01	24-FOR-01	25-FOR-01	25-FOR-01 DUP	26-FOR-01	27-FOR-01	28-FOR-01	29-FOR-01
PFBA	0.1 J	0.12	0.089 J	0.27	0.14	0.2	0.11 J	0.27	0.051 J	0.4	0.39	0.17	0.21	0.11	0.19
PFPeA	ND (0.12)	ND (0.12)	ND (0.12)	0.05 J	ND (0.12)	ND (0.12)	ND (0.12)	0.059 J	ND (0.11)	0.083 J	0.064 J	ND (0.11)	ND (0.13)	ND (0.11)	0.078 J
PFHxA	ND (0.12)	ND (0.12)	ND (0.12)	0.051 J	0.026 J	ND (0.12)	ND (0.12)	0.052 J	ND (0.11)	0.087 J	0.074 J	ND (0.11)	ND (0.13)	0.034 J	ND (0.16)
PFHpA	0.022 J	0.024 J	0.028 J	0.066 J	0.032 J	0.043 J	0.024 J	0.065 J	ND (0.11)	0.094 J	0.086 J	0.046 J	0.026 J	ND (0.11)	0.072 J
PFOA	ND (0.12)	ND (0.12)	0.089 J	0.15	0.091 J	0.11 J	ND (0.12)	0.16	ND (0.11)	0.23	0.2	0.091 J	0.06 J	ND (0.11)	0.16
PFUnA	0.029 J	ND (0.12)	ND (0.12)	0.04 J	ND (0.12)	0.038 J	0.022 J	ND (0.13)	ND (0.11)	0.041 J	0.044 J	ND (0.11)	0.029 J	0.028 J	0.11 J
PFNA	0.067 J	0.074 J	0.072 J	0.1 J	0.072 J	0.091 J	0.049 J	0.13	0.033 J	0.13	0.13	0.081 J	0.064 J	0.041 J	0.15 J
PFDA	0.022 J	0.027 J	ND (0.12)	0.027 J	0.015 J	0.029 J	0.013 J	0.036 J	ND (0.11)	0.042J	0.044 J	ND (0.11)	ND (0.13)	0.025 J	0.056 J
PFDoA	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFTriA	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFTeA	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFBS	ND (0.12)	ND (0.12)	0.015 J	ND (0.12)	0.02 J	ND (0.12)	0.023 J	0.027 J	ND (0.11)	0.023 J	0.014 J	ND (0.11)	ND (0.13)	0.019 J	ND (0.16)
PFPeS	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFHxS	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	0.019 J	0.019 J	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFHpS	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFOS	0.18 J	0.18 J	0.26 J	0.35	0.27 J	0.25 J	0.13 J	0.38	0.15 J	0.45	0.38	0.28	0.15 J	0.18 J	0.7
PFNS	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
PFDS	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
4:2 FTS	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.1)	ND (1.6)
6:2 FTS	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.1)	ND (1.6)
8:2 FTS	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (26)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.1)	ND (1.6)
NEtFOSAA	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.1)	ND (1.6)
NMeFOSAA	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.3)	ND (1.1)	ND (1.6)
FOSA	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
ADONA	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
F-53B Maj	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
F-53B Min	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.11)	ND (0.16)
HFPO-DA (GenX)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.16)	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND (0.16)	ND (0.14)	ND (0.21)
∑PFCA	0.24	0.245	0.278	0.754	0.376	0.511	0.218	0.772	0.084	1.107	1.032	0.388	0.389	0.238	0.816
∑PFSA	0.18	0.18	0.275	0.35	0.29	0.25	0.153	0.407	0.15	0.492	0.413	0.28	0.15	0.199	0.7
∑PFAS	0.42	0.425	0.553	1.104	0.666	0.761	0.371	1.179	0.234	1.599	1.445	0.668	0.539	0.437	1.516

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	30-FOR-01	31-FOR-01	32-FOR-01	33-FOR-01	34-FOR-01	35-FOR-01	36-FOR-01	37-FOR-01	38-FOR-01	39-FOR-01	40-FOR-01	41-FOR-01	42-FOR-01	43-FOR-01	44-FOR-01	45-FOR-01
PFBA	0.35	0.15	0.65 J	0.21	0.24	0.13	0.34	0.18	0.31	0.31	0.095 J	0.22 J	0.12	0.11	0.28	0.11
PFPeA	0.06 J	ND (0.13)	ND (2)	ND (0.11)	0.066 J	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFHxA	0.057 J	0.032 J	ND (2)	0.024 J	0.074 J	0.028 J	0.048 J	0.052 J	0.052 J	0.045 J	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	0.048 J	ND (0.11)
PFHpA	0.086 J	0.021 J	ND (2)	0.039 J	0.073 J	0.037 J	0.085 J	0.047 J	0.054 J	0.055 J	0.027 J	ND (1.2)	ND (0.11)	0.057 J	0.056 J	0.016 J
PFOA	0.16	ND (0.13)	ND (2)	0.13	0.14	0.089 J	0.22	0.1 J	0.31	0.12	ND (0.12)	ND (1.2)	ND (0.11)	0.11	0.13	0.048 J
PFUnA	0.075 J	ND (0.13)	ND (2)	0.12	0.05 J	0.053 J	0.041 J	0.069 J	0.071 J	0.064 J	ND (0.12)	ND (1.2)	0.024 J	0.057 J	0.072 J	0.043 J
PFNA	0.18	0.027 J	ND (2)	0.19	0.12	0.089 J	0.11 J	0.1 J	0.12	0.13	0.046 J	ND (1.2)	0.035 J	0.12	0.1 J	0.074 J
PFDA	0.068 J	ND (0.13)	ND (2)	0.091 J	0.039 J	0.025 J	0.031 J	0.033 J	0.044 J	0.042 J	ND (0.12)	ND (1.2)	ND (0.11)	0.027 J	0.052 J	0.035 J
PFDoA	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFTriA	ND (0.12)	ND (0.13)	ND (2)	0.03 J	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFTeA	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFBS	ND (0.12)	0.018 J	0.31 J	ND (0.11)	ND (0.12)	0.016 J	0.034 J	0.02 J	ND (0.12)	0.022 J	0.019 J	0.93 J	0.015 J	0.036 J	ND (0.11)	ND (0.11)
PFPeS	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFHxS	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	0.022 J	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	0.025 J	ND (0.11)	ND (0.11)
PFHpS	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFOS	0.52	0.17 J	ND (5.1)	0.53	0.57	0.22 J	0.22 J	0.31	0.38	0.88	0.34	ND (2.9)	0.23 J	0.37	0.34	0.44
PFNS	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
PFDS	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
4:2 FTS	ND (24)	ND (1.3)	ND (20)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (12)	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
6:2 FTS	ND (24)	ND (1.3)	ND (20)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (12)	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
8:2 FTS	ND (24)	ND (1.3)	ND (20)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (12)	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
NEtFOSAA	ND (1.2)	ND (1.3)	ND (20)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (12)	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
NMeFOSAA	ND (1.2)	ND (1.3)	ND (20)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (12)	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
FOSA	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
ADONA	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
F-53B Maj	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
F-53B Min	ND (0.12)	ND (0.13)	ND (2)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (1.2)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
HFPO-DA (GenX)	ND (0.15)	ND (0.17)	ND (2.5)	ND (0.14)	ND (0.14)	ND (0.16)	ND (0.18)	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.15)	ND (1.4)	ND (0.14)	ND (0.14)	ND (0.14)	ND (0.14)
∑PFCA	1.036	0.23	0.65	0.834	0.802	0.451	0.875	0.581	0.961	0.766	0.168	0.22	0.179	0.481	0.738	0.326
∑PFSA	0.52	0.188	0.31	0.53	0.57	0.236	0.276	0.33	0.38	0.902	0.359	0.93	0.245	0.431	0.34	0.44
∑PFAS	1.556	0.418	0.96	1.364	1.372	0.687	1.151	0.911	1.341	1.668	0.527	1.15	0.424	0.912	1.078	0.766

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	46-FOR-01	47-FOR-01	48-FOR-01	49-FOR-01	50-FOR-01	51-FOR-01	52-FOR-01	53-FOR-01	54-FOR-01	55-FOR-01	56-FOR-01	57-FOR-01	58-FOR-01	59-FOR-01	60-FOR-01	61-FOR-01
PFBA	0.3	0.21	0.3	0.3	ND (0.11)	ND (1.1)	0.1 J	0.17 J	0.69 J	0.052 J	0.16	0.34	0.25	0.17	0.074 J	0.1 J
PFPeA	0.17	ND (0.12)	0.057 J	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	0.45 J	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	0.043 J
PFHxA	0.065 J	0.038 J	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	0.052 J	ND (1.1)	ND (3.7)	ND (0.13)	0.047 J	ND (0.13)	0.041 J	0.035 J	0.045 J	0.023 J
PFHpA	0.098 J	0.056 J	0.063 J	0.033 J	0.015 J	ND (1.1)	0.029 J	ND (1.1)	ND (3.7)	0.023 J	0.051 J	0.09 J	0.064 J	0.041 J	0.018 J	0.034 J
PFOA	0.25	0.11 J	0.13 J	0.086 J	0.066 J	ND (1.1)	0.053 J	ND (1.1)	ND (3.7)	0.07 J	0.24	0.12 J	0.13	0.11 J	ND (0.12)	0.084 J
PFUnA	0.079 J	0.056 J	ND (0.14)	0.052 J	0.063 J	ND (1.1)	0.024 J	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	0.061 J	0.043 J	0.023 J	0.063 J
PFNA	0.19	0.11 J	0.07 J	0.14	0.069 J	ND (1.1)	0.039 J	ND (1.1)	ND (3.7)	0.065 J	0.079 J	0.088 J	0.12	0.1 J	0.051 J	0.12
PFDA	0.063 J	0.044 J	0.018 J	ND (0.14)	0.062 J	ND (1.1)	0.014 J	ND (1.1)	ND (3.7)	ND (0.13)	0.016 J	0.025	0.053 J	0.039 J	0.018 J	0.052 J
PFDoA	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFTriA	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFTeA	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFBS	0.028 J	ND (0.12)	0.023 J	ND (0.14)	ND (0.11)	ND (1.1)	0.017 J	0.14 J	0.58 J	ND (0.13)	0.033 J	0.022 J	0.025 J	ND (0.12)	ND (0.12)	ND (0.11)
PFPeS	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFHxS	0.024 J	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	0.023 J	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFHpS	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFOS	0.5	0.37	0.17 J	0.38	0.42	ND (2.7)	0.11 J	ND (2.7)	ND (9.2)	0.28 J	0.33	0.21 J	0.35	0.66	0.2 J	0.42
PFNS	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
PFDS	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
4:2 FTS	ND (27)	ND (1.2)	ND (1.4)	ND (1.4)	ND (1.1)	ND (11)	ND (1.1)	ND (11)	ND (37)	ND (1.3)	ND (1.1)	ND (1.3)	ND (24)	ND (1.2)	ND (1.2)	ND (1.1)
6:2 FTS	ND (27)	ND (1.2)	ND (1.4)	ND (1.4)	ND (1.1)	ND (11)	ND (1.1)	ND (11)	ND (37)	ND (1.3)	ND (1.1)	ND (1.3)	ND (24)	ND (1.2)	ND (1.2)	ND (1.1)
8:2 FTS	ND (27)	ND (1.2)	ND (1.4)	ND (1.4)	ND (1.1)	ND (11)	ND (1.1)	ND (11)	ND (37)	ND (1.3)	ND (1.1)	ND (1.3)	ND (24)	ND (1.2)	ND (1.2)	ND (1.1)
NEtFOSAA	ND (1.3)	ND (1.2)	ND (1.4)	ND (1.4)	ND (1.1)	ND (11)	ND (1.1)	ND (11)	ND (37)	ND (1.3)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.1)
NMeFOSAA	ND (1.3)	ND (1.2)	ND (1.4)	ND (1.4)	ND (1.1)	ND (11)	ND (1.1)	ND (11)	ND (37)	ND (1.3)	ND (1.1)	ND (1.3)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.1)
FOSA	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
ADONA	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
F-53B Maj	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
F-53B Min	ND (0.13)	ND (0.12)	ND (0.14)	ND (0.14)	ND (0.11)	ND (1.1)	ND (0.11)	ND (1.1)	ND (3.7)	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.11)
HFPO-DA (GenX)	ND (0.17)	ND (0.15)	ND (0.18)	ND (0.17)	ND (0.13)	ND (1.3)	ND (0.14)	ND (1.3)	ND (4.6)	ND (0.16)	ND (0.14)	ND (0.17)	ND (0.15)	ND (0.15)	ND (0.16)	ND (0.14)
∑PFCA	1.215	0.624	0.638	0.611	0.275	0	0.311	0.62	0.69	0.21	0.593	0.663	0.719	0.538	0.229	0.519
∑PFSA	0.552	0.37	0.193	0.38	0.42	0	0.127	0.14	0.58	0.28	0.386	0.232	0.375	0.66	0.2	0.42
∑PFAS	1.767	0.994	0.831	0.991	0.695	0	0.438	0.76	1.27	0.49	0.979	0.895	1.094	1.198	0.429	0.939

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	62-FOR-01	63-FOR-01	64-FOR-01	65-FOR-01	65-FOR-01 DUP	66-FOR-01	67-FOR-01	68-FOR-01	69-FOR-01	70-FOR-01	71-FOR-01	71-FOR-01 DUP	72-FOR-01	73-FOR-01	74-FOR-01
PFBA	0.4	ND (0.11)	0.16	0.11 J	0.1 J	0.21	0.13	0.15	0.13	0.28	0.15	0.17	0.072 J	0.14 J	0.29
PFPeA	0.058 J	ND (0.11)	ND (0.11)	ND (0.12)	0.047 J	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	0.05 J	0.045 J	ND (0.12)	ND (0.13)	0.091 J	ND (0.12)
PFHxA	0.046 J	0.026 J	0.037 J	ND (0.12)	0.033 J	ND (0.12)	0.036 J	ND (0.13)	0.042 J	0.05 J	ND (0.11)	0.035 J	0.035 J	0.064 J	0.083 J
PFHpA	0.074 J	0.051 J	0.035 J	0.041 J	0.042 J	0.032 J	0.047 J	0.029 J	0.039 J	0.054 J	0.036 J	0.036 J	0.035 J	0.085 J	0.096 J
PFOA	0.16	0.073 J	0.068 J	0.089 J	0.09 J	0.053 J	0.11 J	0.06 J	0.091 J	0.1 J	0.098 J	0.11	0.069 J	0.29	0.32
PFUnA	0.11 J	0.046 J	0.094 J	0.031 J	0.048 J	ND (0.12)	0.024 J	ND (0.13)	0.042 J	0.093 J	ND (0.11)	ND (0.12)	0.026 J	0.089 J	0.058 J
PFNA	0.19	0.1 J	0.08 J	0.093 J	0.11	0.054 J	0.089 J	0.046 J	0.062 J	0.15	0.054 J	0.076 J	0.062 J	0.24	0.14
PFDA	0.06 J	0.054 J	0.034 J	0.026 J	0.032 J	ND (0.12)	0.024 J	ND (0.13)	0.026 J	0.049 J	0.013 J	0.018 J	0.018 J	0.073 J	0.066 J
PFDoA	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFTriA	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	0.032 J	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFTeA	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFBS	0.059 J	0.02 J	0.016 J	0.021 J	0.026 J	0.021 J	0.026 J	0.019 J	0.037 J	0.033 J	0.022 J	0.077 J	0.023 J	0.035 J	0.051 J
PFPeS	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFHxS	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	0.019 J	0.02 J	0.039 J	0.027 J
PFHpS	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFOS	0.51	0.47	0.47	0.28 J	0.41	ND (0.3)	0.28 J	0.16 J	0.23 J	0.5	0.2 J	0.2 J	0.22 J	0.87	0.55
PFNS	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
PFDS	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
4:2 FTS	ND (1.2)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.5)	ND (1.2)
6:2 FTS	ND (1.2)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.5)	ND (1.2)
8:2 FTS	ND (1.2)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.5)	ND (1.2)
NEtFOSAA	ND (1.2)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.5)	ND (1.2)
NMeFOSAA	ND (1.2)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.3)	ND (1.5)	ND (1.2)
FOSA	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
ADONA	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
F-53B Maj	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
F-53B Min	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.11)	ND (0.11)	ND (0.12)	ND (0.13)	ND (0.15)	ND (0.12)
HFPO-DA (GenX)	ND (0.15)	ND (0.13)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.16)	ND (0.16)	ND (0.14)	ND (0.14)	ND (0.14)	ND (0.16)	ND (0.19)	ND (0.15)
∑PFCA	1.098	0.35	0.508	0.39	0.502	0.349	0.46	0.285	0.432	0.858	0.396	0.445	0.317	1.072	1.053
∑PFSA	0.569	0.49	0.486	0.301	0.436	0.021	0.306	0.179	0.267	0.533	0.222	0.296	0.263	0.944	0.628
∑PFAS	1.667	0.84	0.994	0.691	0.938	0.37	0.766	0.464	0.699	1.391	0.618	0.741	0.58	2.016	1.681

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 3: Analytical Data Summary
PFAS Concentrations (µg/kg, dry weight) in Forested Samples

Analyte	75-FOR-01	76-FOR-01	77-FOR-01	77-FOR-01 DUP	78-FOR-01	79-FOR-01	80-FOR-01	81-FOR-01	82-FOR-01	83-FOR-01
PFBA	0.12	0.26	0.3	0.31	0.17	0.25	0.063 J	0.22	0.42	0.2
PFPeA	0.073 J	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	0.066 J	ND (0.13)
PFHxA	0.031 J	0.046 J	ND (0.12)	ND (0.14)	0.031 J	0.062 J	ND (0.11)	0.045 J	0.1 J	ND (0.13)
PFHpA	0.036 J	0.04 J	ND (0.12)	0.056 J	0.043 J	0.067 J	0.017 J	0.052 J	0.11 J	0.025 J
PFOA	0.12	0.076 J	0.061 J	ND (0.14)	0.091 J	0.12	ND (0.11)	0.083 J	0.36	0.067 J
PFUnA	0.073 J	0.044 J	0.027 J	0.027 J	0.052 J	0.049 J	0.024 J	0.049 J	0.046 J	0.057 J
PFNA	0.11	0.065 J	0.078 J	0.073 J	0.1 J	0.082 J	0.041 J	0.12	0.14	0.089 J
PFDA	0.055 J	0.032 J	ND (0.12)	ND (0.14)	0.032 J	ND (0.12)	0.02 J	0.039 J	0.052 J	0.046 J
PFDoA	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFTriA	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFTeA	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFBS	0.027 J	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	0.042 J	0.019 J
PFPeS	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFHxS	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	0.035 J	ND (0.13)
PFHpS	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFOS	0.45	0.28 J	0.19 J	0.16 J	0.55	0.28 J	0.3	0.33	0.58	0.25 J
PFNS	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
PFDS	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
4:2 FTS	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.3)
6:2 FTS	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.3)
8:2 FTS	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.3)
NEtFOSAA	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.3)
NMeFOSAA	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.4)	ND (1.2)	ND (1.2)	ND (1.1)	ND (1.2)	ND (1.2)	ND (1.3)
FOSA	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
ADONA	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
F-53B Maj	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
F-53B Min	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.14)	ND (0.12)	ND (0.12)	ND (0.11)	ND (0.12)	ND (0.12)	ND (0.13)
HFPO-DA (GenX)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.17)	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.16)
∑PFCA	0.618	0.563	0.466	0.466	0.519	0.63	0.165	0.608	1.294	0.484
∑PFSA	0.477	0.28	0.19	0.16	0.55	0.28	0.3	0.33	0.657	0.269
∑PFAS	1.095	0.843	0.656	0.626	1.069	0.91	0.465	0.938	1.951	0.753

J: result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
∑ : sum of compounds
PFCA: perfluoroalkyl carboxylic acids (PFBA, PFPeA, PFHxA, PFOA, PFUnA, PFNA, PFDA, PFDoA, PFTriA, and PFTeA)
PFSA: perfluoroalkane sulfonic acids (PFBS, PFPeS, PFHxS, PFOS, PFNS, and PFDS)

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	01-FOR-01	02-FOR-01	03-FOR-01	04-FOR-01	05-FOR-01	06-FOR-01	07-FOR-01	08-FOR-01	09-FOR-01	10-FOR-01	11-FOR-01	12-FOR-01	13-FOR-01	14-FOR-01	15-FOR-01
Aluminum	1200	1000	3700	1900	1100	2100	7700	6000	1600	980	3100	3900	7300	3800	1800
Antimony	ND (0.17)	ND (0.18)	ND (0.17)	ND (0.19)	ND (0.14)	ND (0.15)	ND (0.21)	ND (0.17)	ND (0.19)	ND (0.15)	0.21	ND (0.17)	ND (0.17)	ND (0.16)	ND (0.18)
Arsenic	0.58	1.1	1.3	0.79	0.54	0.64	3.2	2.1	1.2	0.79	2.3	2.9	3.3	1.5	0.77
Barium	7.8	5.6	18	18	26	16	26	47	10	15	12	50	65	44	5.6
Beryllium	ND (0.17)	ND (0.18)	ND (0.17)	ND (0.19)	ND (0.14)	0.11 J	ND (0.21)	0.28	0.093 J	ND (0.15)	ND (0.20)	0.18	0.25	0.16	ND (0.18)
Boron	ND (22)	ND (23)	ND (21)	ND (24)	0.77 J	ND (18)	ND (27)	2.2	ND (24)	ND (19)	ND (25)	1.3 J	1.9 J	ND (20)	ND (22)
Cadmium	ND (0.087)	ND (0.091)	ND (0.086)	ND (0.095)	0.074	0.082	ND (0.11)	0.17	0.15	ND (0.077)	0.13	0.17	0.11	0.13	ND (0.089)
Chromium (Total)	4.3	2.2	3.3	3	2	2.9	13	10	3	1.4	5.4	6.7	12	4.7	2.1
Cobalt	0.67	ND (0.46)	1.2	0.84	0.48	0.66	2.5	4.8	0.61	0.27	0.36	3.3	9.5	1.9	0.34 J
Copper	0.79	1.1	2.1	1.5	1.1	2.5	5.5	4.8	1.5	1.2	2.2	5.6	8	2.4	1.6
Iron	3100	2700	3900	3500	2200	2200	14000	8600	2400	1900	4500	6700	13000	4700	2900
Lead	2.7	4	5.8	4	2.7	19	7.5	12	6.9	7.4	25	11	16	9.4	2.2
Lithium	0.42 J	0.48 J	1.9	1.8 J	0.47 J	1.9	6.3	6.4	1.4 J	0.67 J	0.55 J	3.1	9.6	2.5	1.4 J
Magnesium	540	140	390	360	140	360	1700	1500	350	170	220	960	1900	550	210
Manganese	25	25	170	120	320	17	190	520	24	120	19	520	640	460	12
Mercury	ND (0.049)	ND (0.062)	ND (0.045)	ND (0.055)	ND (0.051)	0.021 J	0.035	0.029	0.035 J	ND (0.042)	0.057	0.051 J	0.040 J	0.042 J	ND (0.058)
Molybdenum	ND (1.1)	ND (1.1)	0.29	0.81 J	ND (0.85)	ND (0.92)	0.37 J	0.44 J	ND (1.2)	ND (0.96)	0.57 J	0.66 J	1.6	0.27 J	0.53 J
Nickel	1.9	0.58	2.7	1.9	0.97	2.2	8	7.6	1.7	0.79	1.4	6.4	12	3.7	1.6
Selenium	0.23	0.28	0.36	0.33	ND (0.14)	0.14 J	0.31	0.23	0.24	ND (0.15)	1	0.27	0.29	0.19	ND (0.18)
Silver	ND (0.087)	ND (0.091)	ND (0.086)	ND (0.095)	ND (0.068)	ND (0.073)	0.09 J	ND (0.087)	ND (0.096)	ND (0.077)	ND (0.10)	ND (0.085)	0.024 J	ND (0.082)	ND (0.089)
Sodium	ND (87)	ND (91)	ND (86)	ND (95)	ND (68)	ND (73)	ND (110)	ND (87)	ND (96)	ND (77)	ND (100)	ND (85)	ND (87)	ND (82)	ND (89)
Strontium	1.6 J	0.74 J	1.3	1.9 J	1.5 J	2.4	3.2	5.3	5.4	1.7 J	2.7	4.7	5.8	5	1.3 J
Thallium	ND (0.087)	ND (0.091)	ND (0.086)	0.4	0.047 J	ND (0.073)	ND (0.11)	0.12	ND (0.096)	0.053 J	ND (0.10)	0.095	0.16	ND (0.082)	ND (0.089)
Titanium	340	100	100	110	68	57	300	130	77	49	100	90	130	97	65
Vanadium	11	6.9	6.3	7.2	5.1	4.6	25	14	3.8	3.4	13	9.1	20	7.5	5.7
Zinc	4	3.1	14	11	6.5	6.8	28	28	9.4	9	20	29	40	19	5.8

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	16-FOR-01	17-FOR-01	18-FOR-01	19-FOR-01	20-FOR-01	21-FOR-01	22-FOR-01	23-FOR-01	24-FOR-01	25-FOR-01	25-FOR-01 DUP	26-FOR-01	27-FOR-01	28-FOR-01	29-FOR-01
Aluminum	3500	2800	3000	6400	2700	2300	2000	5500	240	5000	4300	2000	4200	460	5200
Antimony	ND (0.17)	ND (0.16)	ND (0.16)	ND (0.17)	ND (0.17)	ND (0.18)	ND (0.15)	ND (0.20)	ND (0.15)	0.11 J	ND (0.16)	ND (0.14)	ND (0.24)	ND (0.18)	ND (0.21)
Arsenic	1.5	0.81	0.52	3.9	0.54	0.73	0.91	2.6	0.27	8.3	7.3	0.65	1.1	0.46	2.1
Barium	24	15	11	37	29	12	23	33	5.2	41	35	9.8	29	8.2	45
Beryllium	ND (0.17)	ND (0.16)	ND (0.16)	0.32	0.059 J	ND (0.18)	ND (0.15)	0.10 J	ND (0.15)	0.27	0.25	0.067 J	ND (0.24)	ND (0.18)	0.25
Boron	ND (21)	ND (20)	ND (20)	2.6	ND (22)	ND (23)	ND (19)	1.8 J	ND (19)	4.2 J	3.3	ND (17)	ND (30)	ND (22)	1.4
Cadmium	ND (0.083)	0.047	0.065 J	0.18	0.069 J	ND (0.091)	ND (0.077)	0.076 J	ND (0.077)	0.29	0.25	0.063 J	ND (0.12)	ND (0.088)	0.25
Chromium (Total)	4.4	3.4	2.2	9.7	2.9	2.8	2.9	8	0.68	12	9.1	2	7.8	0.78	7
Cobalt	1.1	0.63	0.39 J	4.1	0.78	ND (0.46)	0.67	3.4	ND (0.38)	3.7	3.5	0.34	2.1	ND (0.44)	1.3
Copper	2.2	2.6	1.3	6.6	1.4	1	1.3	4.8	0.43	9.5	10	1	5.7	0.77	11
Iron	4700	4600	2500	11000	3000	3900	4600	8600	590	10000	9400	2300	10000	1000	4900
Lead	5.9	9.3	2.4	11	3.6	4.4	3.9	12	2	34	26	3.4	5.9	3.3	12
Lithium	3	1.4 J	1.4 J	8.5	1.5 J	2.6	1.3 J	7.3	ND (1.5)	6.7	6.2	1.2 J	4.2	ND (1.8)	3.4
Magnesium	580	260	190	1500	270	160	260	1200	ND (77)	7600	6000	100	1100	ND (88)	860
Manganese	150	33	34	210	230	11	180	150	46	240	210	37	81	93	29
Mercury	ND (0.064)	ND (0.053)	0.025 J	0.045	ND (0.046)	ND (0.053)	ND (0.045)	0.039 J	ND (0.052)	0.053	0.049	0.02 J	0.037	ND (0.047)	0.073
Molybdenum	ND (1.0)	ND (0.99)	ND (1.0)	0.52 J	ND (1.1)	ND (1.1)	ND (0.96)	0.56 J	ND (0.96)	0.63 J	0.46	ND (0.86)	ND (1.5)	ND (1.1)	0.37 J
Nickel	2.7	1.7	1.6	7.8	2.2	1	1.5	6.5	ND (0.77)	11	9	0.9	5.2	0.31	6.6
Selenium	0.33	0.18	0.13 J	0.29	ND (0.17)	ND (0.18)	ND (0.15)	0.26	0.13 J	0.25	0.2	0.16	ND (0.24)	ND (0.18)	1.2
Silver	ND (0.083)	0.029 J	ND (0.081)	0.032 J	ND (0.087)	ND (0.091)	0.044 J	0.028 J	ND (0.77)	0.029 J	0.034	ND (0.068)	0.059	ND (0.088)	0.038 J
Sodium	ND (83)	ND (79)	ND (81)	ND (83)	ND (87)	ND (91)	ND (77)	ND (100)	ND (77)	ND (73)	ND (78)	ND (68)	ND (120)	ND (88)	ND (110)
Strontium	2.4	2	0.93 J	5	2.5	0.95 J	2.5	5.6	0.71 J	15	14	0.91 J	5.2	0.91 J	23
Thallium	0.053	ND (0.079)	ND (0.081)	0.16	ND (0.087)	ND (0.091)	ND (0.077)	0.12	ND (0.077)	0.08	0.077	0.068	ND (0.12)	ND (0.088)	0.081 J
Titanium	150	160	72	110	87	110	120	180	37	120	100	75	730	39	110
Vanadium	7.8	10	4.9	16	5.3	7.5	9.1	16	1.7	14	12	4.7	24	2.2	16
Zinc	13	9.1	5.4	29	9.5	4.4	8.4	29	1.6	59	49	7.4	17	1.8	14

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	30-FOR-01	31-FOR-01	32-FOR-01	33-FOR-01	34-FOR-01	35-FOR-01	36-FOR-01	37-FOR-01	38-FOR-01	39-FOR-01	40-FOR-01	41-FOR-01	42-FOR-01	43-FOR-01	44-FOR-01
Aluminum	5400	2800	7400	5000	6000	3800	6600	3300	3300	4100	450	2800	4300	1500	4400
Antimony	0.15 J	ND (0.19)	ND (0.30)	ND (0.16)	ND (0.20)	ND (0.22)	ND (0.21)	ND (0.18)	ND (0.17)	ND (0.13)	ND (0.17)	ND (0.18)	ND (0.17)	ND (0.18)	ND (0.18)
Arsenic	4.2	0.77	9.6	4	2.8	1.4	2.7	2.4	3.1	2.1	0.24	1.3	1.6	0.65	2.9
Barium	35	24	120	40	51	19	28	33	50	50	13	18	14	21	27
Beryllium	0.14 J	ND (0.19)	0.33	0.13	0.26	ND (0.22)	ND (0.21)	0.13 J	0.15	0.17	ND (0.17)	ND (0.18)	0.1	ND (0.18)	0.19
Boron	1.5 J	1.1	14	ND (20)	1.6	ND (28)	ND (27)	1.5 J	ND (21)	0.78	ND (21)	ND (23)	2.4	ND (22)	ND (22)
Cadmium	0.079 J	ND (0.095)	0.52	ND (0.081)	0.16	ND (0.11)	ND (0.11)	0.17	0.064	0.12	0.069 J	0.086	ND (0.085)	ND (0.088)	0.13
Chromium (Total)	8.1	5.6	11	7.5	10	7	13	5.6	5.4	5.9	0.71 J	2.7	16	1.6	7.2
Cobalt	4.5	1.3	4.4	4.7	4.6	1	4.2	2.4	2.3	2.2	ND (0.42)	0.4	5.2	ND (0.44)	2.4
Copper	7.3	5.8	20	7.3	6.3	2.5	5.9	4	3.9	3.3	0.81 J	2	15	1.1	4
Iron	9800	6600	16000	13000	9500	5900	16000	6300	11000	5700	620	3100	14000	2100	7200
Lead	14	5	14	12	12	6.9	9.3	11	12	9.7	3.4	18	5	8.4	12
Lithium	5.4	2.4	10	4.4	5.8	2.4	6.4	3.2	2.3	2.8	ND (1.7)	1.6 J	9.1	0.55 J	3.6
Magnesium	1200	920	4100	990	1800	570	1700	920	550	750	57	170	3100	83	810
Manganese	450	75	510	550	600	42	350	510	580	520	33 J	31	120	12	290
Mercury	0.031 J	ND (0.057)	0.12	0.03	0.032	0.026	0.1	0.03 J	0.039	0.028	ND (0.047)	0.032	ND (0.050)	ND (0.053)	0.025 J
Molybdenum	1.4	ND (1.2)	4.2	0.57 J	0.46 J	0.35 J	0.42 J	0.37 J	0.69 J	0.39 J	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)	0.5 J
Nickel	8.8	3.3	17	7	7.1	2.9	9.7	4.7	5.5	4.1	0.48 J	1.5	13	0.75	5.1
Selenium	0.28	ND (0.19)	2.5	0.24	0.25	0.73	0.3	0.17 J	0.21	0.17	ND (0.17)	0.24	ND (0.17)	0.15 J	0.18
Silver	ND (0.097)	0.042 J	0.046 J	ND (0.081)	ND (0.10)	ND (0.11)	0.066 J	0.025 J	ND (0.085)	ND (0.067)	ND (0.084)	ND (0.092)	0.027 J	ND (0.088)	ND (0.090)
Sodium	ND (97)	ND (95)	140	ND (81)	ND (100)	ND (110)	ND (110)	ND (91)	ND (85)	ND (67)	ND (84)	ND (92)	ND (85)	ND (88)	ND (90)
Strontium	4.3	4	180	3.7	4.7	5.1	3.7	3.6	3.6	3.2	0.65 J	2 J	4.5	1.5 J	2.3
Thallium	0.2	ND (0.095)	0.13 J	0.11	0.1	0.075 J	ND (0.11)	0.067 J	0.074 J	0.09	ND (0.084)	ND (0.092)	ND (0.085)	ND (0.088)	0.056 J
Titanium	150	260	150	180	230	130	410	130	95	93	31	84	1200	63	150
Vanadium	15	12	25	20	17	15	27	9.3	9.7	8	1.3	5.5	36	4.5	12
Zinc	35	15	71	35	31	13	26	26	31	25	2.7	27	17	5.9	26

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	45-FOR-01	46-FOR-01	47-FOR-01	48-FOR-01	49-FOR-01	50-FOR-01	51-FOR-01	52-FOR-01	53-FOR-01	54-FOR-01	55-FOR-01	56-FOR-01	57-FOR-01	58-FOR-01	59-FOR-01
Aluminum	2100	5100	4100	6300	1000	3900	1500	4900	1500	10000	460	4200	1900	3600	3600
Antimony	ND (0.14)	ND (0.16)	ND (0.13)	ND (0.18)	ND (0.24)	ND (0.16)	ND (0.15)	ND (0.14)	ND (0.17)	ND (0.45)	ND (0.19)	ND (0.12)	ND (0.17)	ND (0.19)	ND (0.16)
Arsenic	1.1	2.7	2.7	1.3	0.68	2.5	0.8	1.3	0.87	3.4	0.22	0.8	0.75	0.88	1.1
Barium	17	34	26	38	9.6	15	9.7	21	14	99	6.7	7.8	26	18	22
Beryllium	ND (0.14)	0.17	0.12	0.15	ND (0.24)	0.17	ND (0.15)	0.063	ND (0.17)	0.15	ND (0.19)	0.075 J	ND (0.17)	ND (0.19)	ND (0.16)
Boron	ND (18)	1.2 J	1	2.9	ND (30)	ND (20)	ND (19)	ND (18)	ND (21)	7.2	ND (24)	ND (15)	ND (21)	ND (24)	ND (20)
Cadmium	ND (0.071)	0.098	0.069	0.084	ND (0.12)	0.083	ND (0.076)	ND (0.071)	ND (0.085)	1.7	ND (0.096)	0.048 J	0.054	ND (0.096)	ND (0.082)
Chromium (Total)	2.4	7.3	7.1	11	1.3	5.5	1.8	6.6	1.8	11	0.42	2.1	2.7	4.4	3.8
Cobalt	0.62	4	2.9	6.3	ND (0.61)	1.6	0.21	2.1	0.47	1.6	ND (0.48)	0.21 J	1.1	0.72	1.1
Copper	1.1	5	4.8	4.3	1	3.2	1	3	1	13	0.29	0.88	1.4	2.3	2.7
Iron	2800	7100	7800	9900	800	5100	2200	8700	2400	5900	190	1600	3300	2400	4300
Lead	4.1	11	8	9.4	7.5	11	7.4	4.7	6.6	27	2.7	2.9	5.8	8	9.4
Lithium	2.1	7.1	3.9	5.4	ND (2.4)	2.6	1.1 J	3.8	1.8	4.4 J	ND (1.9)	1.3	1.9	2.7	2.5
Magnesium	300	970	1300	1600	160	690	150	600	220	3100	ND (96)	66	300	480	530
Manganese	290	340	280	360	16	110	73	260	220	160	5.9	3.9	400	23	180
Mercury	ND (0.037)	0.049 J	0.02	0.039	0.051	0.019 J	ND (0.053)	0.028	ND (0.044)	0.51	ND (0.048)	0.033 J	ND (0.061)	0.028 J	0.026
Molybdenum	ND (0.89)	1.7	0.47 J	0.5 J	ND (1.5)	0.36 J	ND (0.95)	0.25 J	ND (1.1)	1.5 J	ND (1.2)	0.22 J	ND (1.1)	ND (1.2)	0.26 J
Nickel	1.3	6.8	7	5	0.59	4.3	0.79	4.3	0.87	6.2	ND (0.96)	0.79	1.7	2.4	2.8
Selenium	0.11 J	0.38	0.15	0.69	0.2 J	0.15 J	0.16	0.23	ND (0.17)	4	ND (0.19)	0.25	0.13 J	0.21	0.15 J
Silver	ND (0.071)	0.033 J	ND (0.065)	0.051 J	ND (0.12)	ND (0.082)	ND (0.076)	0.036 J	ND (0.085)	0.084 J	ND (0.096)	ND (0.061)	ND (0.085)	ND (0.096)	ND (0.082)
Sodium	ND (71)	ND (82)	ND (65)	110	ND (120)	ND (82)	ND (76)	ND (71)	ND (85)	ND (230)	ND (96)	ND (61)	ND (85)	ND (96)	ND (82)
Strontium	1 J	4.4	10	11	2.6 J	1.9 J	1.4 J	1.9	1.1 J	41	0.69 J	0.58 J	2.3	4.6	2.5
Thallium	0.049 J	0.21	0.071	0.092	ND (0.12)	0.049 J	0.1	0.044 J	ND (0.085)	0.21 J	ND (0.096)	0.07	ND (0.085)	0.073 J	0.053 J
Titanium	82	100	130	300	72	140	66	190	68	150	76	65	92	100	110
Vanadium	5.5	14	11	24	2	8.5	3.8	17	4	16	1	4.1	5.6	6.5	6
Zinc	9	24	24	26	2.8	23	6	15	7	84	ND (2.4)	2.3	12	9.4	19

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	60-FOR-01	61-FOR-01	62-FOR-01	63-FOR-01	64-FOR-01	65-FOR-01	65-FOR-01 DUP	66-FOR-01	67-FOR-01	68-FOR-01	69-FOR-01	70-FOR-01	71-FOR-01	71-FOR-01 DUP
Aluminum	2300	2600	3800	4200	2500	2900	3200	5300	2400	2200	1600	4300	2400	2900
Antimony	ND (0.19)	ND (0.13)	ND (0.16)	ND (0.17)	ND (0.20)	ND (0.15)	ND (0.20)	ND (0.19)	ND (0.14)	ND (0.16)	ND (0.18)	ND (0.17)	ND (0.19)	ND (0.20)
Arsenic	0.7	0.76	1.1	2.4	2.1	1.1	1.1	1.8	0.87	0.48	0.64	1.4	0.61	0.88
Barium	16	9.2	47	30	23	11	16	40	19	8.7	12	47	15	22
Beryllium	ND (0.19)	ND (0.13)	0.056	0.24	ND (0.20)	0.058 J	0.08	0.07	ND (0.14)	ND (0.16)	ND (0.18)	0.1 J	ND (0.19)	ND (0.20)
Boron	ND (24)	ND (17)	ND (20)	ND (21)	ND (25)	ND (19)	ND (24)	1.7	ND (18)	ND (20)	ND (23)	ND (22)	ND (24)	ND (25)
Cadmium	0.096	ND (0.066)	0.092	0.12	ND (0.099)	0.05 J	0.085	0.2	ND (0.072)	ND (0.079)	0.062 J	0.16	ND (0.097)	ND (0.099)
Chromium (Total)	3.1	2.4	5.2	7	3.3	3.8	3.9	15	2.7	2	2	5.7	3.1	3.3
Cobalt	0.8	0.3 J	1.4	2.1	1.4	0.55	0.78	4.6	0.84	0.53	0.34 J	1.8	0.61	0.77
Copper	1.3	0.78	2.5	3.5	2.1	1.1	1.4	45	1.3	0.75 J	1.1	3.1	0.93	1.3
Iron	3200	2700	5600	7700	4300	4400	4500	16000	3300	2200	2400	6000	3200	3700
Lead	4.2	8	9.8	12	11	4	4.2	8.8	5	2.3	3.6	12	2.2	3.8
Lithium	1.7 J	0.99 J	3	2.6	3.1	2.1	2	11	1.6	1.2 J	0.7 J	2.2	1.8	2
Magnesium	320	180	610	860	420	230	300	2400	240	170	150	650	270	300
Manganese	140	9.5	330	370	350	64	92	190	230	95	110	450	72	160
Mercury	ND (0.058)	0.026 J	0.027	0.028 J	ND (0.048)	ND (0.053)	0.022	ND (0.058)	ND (0.042)	ND (0.047)	ND (0.045)	0.037 J	ND (0.055)	ND (0.054)
Molybdenum	0.31 J	0.26 J	0.25 J	0.75 J	ND (1.2)	0.24 J	ND (1.2)	0.31 J	ND (0.90)	ND (0.98)	ND (1.1)	0.36 J	ND (1.2)	ND (1.2)
Nickel	2.3	1.2	2.9	5.7	2.2	2.4	2.3	9.2	1.6	1.6	1.2	3.5	1.5	2
Selenium	ND (0.19)	0.14	0.14 J	0.16 J	0.17 J	0.17	0.15	0.19	0.14	ND (0.16)	ND (0.18)	0.23	0.32	0.4
Silver	ND (0.095)	ND (0.066)	ND (0.080)	ND (0.085)	ND (0.099)	ND (0.077)	ND (0.098)	0.089 J	ND (0.072)	ND (0.079)	ND (0.091)	ND (0.086)	ND (0.097)	ND (0.099)
Sodium	ND (95)	ND (66)	ND (80)	ND (85)	ND (99)	ND (77)	ND (98)	ND (97)	ND (72)	ND (79)	ND (91)	ND (86)	ND (97)	ND (99)
Strontium	1.7 J	0.87 J	4.1	2.8	1.5 J	1.1 J	1.5	7.8	1.6 J	0.93 J	1.3 J	3.9	1.6	1.8
Thallium	ND (0.095)	ND (0.066)	0.056 J	0.072 J	ND (0.099)	0.1	0.062	0.1	ND (0.072)	0.065 J	ND (0.091)	ND (0.086)	ND (0.097)	ND (0.099)
Titanium	110	57	140	140	100	130	160	1100	92	75	77	140	120	130
Vanadium	6.9	4.8	11	11	8	10	10	32	5.1	4.5	4.9	9.9	6.3	6.8
Zinc	13	6.4	24	29	18	11	11	33	14	8.1	7.3	25	5.4	7.5

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 4: Analytical Data Summary
Metals Concentrations (mg/kg, dry weight) in Forested Samples

	72-FOR-01	73-FOR-01	74-FOR-01	75-FOR-01	76-FOR-01	77-FOR-01	77-FOR-01 DUP	78-FOR-01	79-FOR-01	80-FOR-01	81-FOR-01	82-FOR-01	83-FOR-01
Aluminum	3200	16000	5700	3800	5600	1300	1400	3600	3000	670	4400	3900	1800
Antimony	ND (0.17)	ND (0.21)	ND (0.17)	ND (0.15)	ND (0.19)	ND (0.17)	ND (0.16)	ND (0.19)	ND (0.15)	ND (0.19)	ND (0.18)	ND (0.16)	ND (0.18)
Arsenic	0.96	5.9	1.7	1.8	6.1	0.62	0.5	2.1	9.4	0.68	3.5	2.2	1.1
Barium	11	110	19	20	36	19	15	26	21	5.4	29	19	51
Beryllium	ND (0.17)	0.75	0.12 J	0.095 J	0.29	ND (0.17)	ND (0.16)	0.15	0.15	ND (0.19)	0.11	0.2	ND (0.18)
Boron	ND (21)	12	ND (21)	ND (19)	ND (24)	ND (21)	ND (20)	1.1	ND (18)	ND (24)	ND (22)	ND (20)	ND (23)
Cadmium	0.063 J	0.29	0.15	0.054 J	0.2	ND (0.085)	ND (0.081)	0.11	0.2	ND (0.097)	ND (0.089)	0.27	0.12
Chromium (Total)	2.9	27	4.3	5.3	8	1.9	1.7	5.8	3.8	1.6	6.9	4.4	2.5
Cobalt	0.4 J	10	0.49	1.2	3.8	0.33	ND (0.40)	1.5	1.1	ND (0.48)	2.6	0.96	1
Copper	1.1	25	3.1	2	4.7	1.5	0.88	2.8	1.9	0.83	4.2	4.3	2
Iron	3800	24000	5100	5400	10000	2500	2300	5900	8000	2300	8300	5100	3500
Lead	3.3	21	7.8	11	12	5.3	5.3	8.9	8.9	4.8	10	12	8.4
Lithium	1.6 J	32	2.3	2.9	8.9	0.66 J	0.49	3.3	2.6	ND (0.19)	4	3.1	1.9
Magnesium	160	9400	210	540	1200	170	120	760	400	78	870	480	270
Manganese	31	240	21	100	190	110	100	110	40	10	280	55	670
Mercury	ND (0.053)	0.086	0.048 J	0.047	0.031 J	ND (0.054)	ND (0.050)	0.03	0.033 J	ND (0.050)	0.032	0.044	ND (0.050)
Molybdenum	ND (1.1)	0.52 J	0.52 J	0.49 J	0.54 J	ND (1.1)	ND (1.0)	0.37 J	0.48 J	ND (1.2)	0.55 J	0.89 J	ND (1.1)
Nickel	1.6	32	2.3	2.8	7.1	1	0.61	3.2	2.3	0.53	6	3	1.6
Selenium	0.15 J	0.83	0.38	0.22	0.24	0.13 J	0.12	0.22	0.22	0.22	0.2	0.35	0.14 J
Silver	ND (0.084)	0.088 J	ND (0.084)	ND (0.077)	ND (0.097)	0.035 J	0.031	ND (0.094)	ND (0.073)	ND (0.097)	ND (0.089)	0.026 J	ND (0.091)
Sodium	ND (84)	110	ND (84)	ND (77)	ND (97)	ND (85)	ND (81)	ND (94)	ND (73)	ND (97)	ND (89)	ND (80)	ND (91)
Strontium	1.3 J	32	2.1	2	3.2	3.8	2.6	3.9	3	0.9	3.3	6.5	3.5
Thallium	ND (0.084)	0.22	0.057 J	0.09	0.076 J	ND (0.085)	ND (0.081)	0.1	0.052 J	ND (0.097)	0.082 J	0.069 J	0.06 J
Titanium	110	220	130	100	65	82	77	120	75	130	130	100	93
Vanadium	7.9	38	11	7.8	17	4.2	4.4	9.9	14	6.9	13	9	6.8
Zinc	6.3	86	13	16	32	6.3	6.1	22	18	4.2	26	24	18

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Table 5: Sieve Analysis and Field Parameters

Location		01-FOR-01	02-FOR-01	03-FOR-01	04-FOR-01	05-FOR-01	06-FOR-01	07-FOR-01	08-FOR-01
Description		SAND with Silt and Gravel	SAND with Silt	SAND with Silt and Clay	SILTY SAND with Gravel and Clay	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	3.6
% Fine Gravel	%	6	0.9	0	4	0.9	0.6	0.8	1
% Coarse Sand	%	2.4	1.2	0.4	3.4	2.7	0.5	2.6	2.2
% Medium Sand	%	17.4	30	12.5	17.4	23	8.9	10.5	11.2
% Fine Sand	%	66.9	58.5	81.7	56.7	58	79.3	42	46.2
% Silt	%	6.1	6.5	2.7	12.1	11.7	9.5	35.5	25.1
% Clay	%	1.3	2.9	2.8	6.4	3.6	1.3	8.5	10.7
Field Parameters									
Moisture	%	11	41.4	8.5	23.3	17.3	13.5	24.7	17.5
Total Organic Carbon	mg/kg	4300	9500	10000	16000	5000	21000	25000	15000

Location		09-FOR-01	10-FOR-01	11-FOR-01	12-FOR-01	13-FOR-01	14-FOR-01	15-FOR-01	16-FOR-01
Description		SAND with Silt, Clay, and Gravel	SAND with Silt and Clay	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SILT with Clay, Sand, and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	0
% Fine Gravel	%	0.3	0.4	0.5	6.4	1.9	0.5	1.2	0.5
% Coarse Sand	%	0.4	0.7	1.8	5.6	1.9	0.4	0.9	1.1
% Medium Sand	%	14.9	24.4	16.8	23.9	7.9	14.3	17.9	10.6
% Fine Sand	%	78.6	66	68.2	53	36.7	70.4	64.1	68.5
% Silt	%	1.6	3.9	10.5	7.3	37.5	12.6	12.9	14
% Clay	%	4.2	4.7	2.2	3.9	14.1	1.9	2.9	5.3
Field Parameters									
Moisture	%	20.6	12.7	20.3	15.6	22.3	14.9	18.6	13.9
Total Organic Carbon	mg/kg	38000	18000	50000	19000	17000	12000	6900	7600

Table 5: Sieve Analysis and Field Parameters

Location		17-FOR-01	18-FOR-01	19-FOR-01	20-FOR-01	21-FOR-01	22-FOR-01	23-FOR-01	24-FOR-01
Description		SAND with Silt, Clay, and Gravel	SAND with Silt and Clay	SILTY SAND with Clay	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay	SAND with Silt and Clay	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	0
% Fine Gravel	%	1.2	0.3	0.4	0.6	0.8	0	1.2	0.2
% Coarse Sand	%	2.9	0.3	1.4	0.5	1	0.4	2.1	0.4
% Medium Sand	%	36.9	21.1	6.4	21.3	5.9	11.2	8.1	27.4
% Fine Sand	%	48.7	72.2	46.5	66.8	80.2	76.9	47.8	65.6
% Silt	%	6.5	4.3	28.5	7.8	8.3	7	31.9	5.4
% Clay	%	3.8	1.8	16.7	3	3.9	4.6	8.9	1
Field Parameters									
Moisture	%	16	19.4	18.4	20.9	17.7	13.9	23.1	11.6
Total Organic Carbon	mg/kg	18000	13000	16000	9600	12000	6500	22000	5700

Location		25-FOR-01	25-FOR-01 DUP	26-FOR-01	27-FOR-01	28-FOR-01	29-FOR-01	30-FOR-01	31-FOR-01
Description		SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt	CLAYEY SAND with Silt and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel
Sieve Analysis									
% Cobbles	%	0	---	0	0	0	0	0	0
% Coarse Gravel	%	0	---	0	0	0	0	0	0
% Fine Gravel	%	13	---	1.4	5.2	0.6	1.5	3.9	0.5
% Coarse Sand	%	7.9	---	1.6	4.9	0.4	2.3	2.9	1.3
% Medium Sand	%	12.6	---	12.2	14.1	21.4	18.3	12.1	9.4
% Fine Sand	%	46.3	---	79	40.6	70.7	64.5	50.6	43
% Silt	%	13.3	---	2.1	23.1	4.5	5.2	22.8	29.1
% Clay	%	6.8	---	3.8	12	2.5	8.2	7.7	16.7
Field Parameters									
Moisture	%	17.3	14.4	8.7	24	11.2	39.7	17.9	26.1
Total Organic Carbon	mg/kg	28000	21000	6800	26000	7300	100000	13000	20000

Table 5: Sieve Analysis and Field Parameters

Location		32-FOR-01	33-FOR-01	34-FOR-01	35-FOR-01	36-FOR-01	37-FOR-01	38-FOR-01	39-FOR-01
Description		SILT with Sand, Clay, and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Gravel and Clay	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	15	0	0	0	0	0
% Fine Gravel	%	0.1	3.5	4.3	1.3	9.1	6.6	0.3	0
% Coarse Sand	%	0.9	3.6	7.8	1.2	7.1	8.7	0.5	0.6
% Medium Sand	%	17.4	13.2	11.4	21.5	11.2	28.9	14.3	26.4
% Fine Sand	%	25.1	54.8	30.6	68.6	35.3	44.9	69.3	57.3
% Silt	%	29.5	17.1	22.8	3.3	30.7	8.3	11.3	11.7
% Clay	%	27.1	7.8	8.1	4.1	6.6	2.7	4.3	4
Field Parameters									
Moisture	%	54.3	9.1	15.7	22.3	32.5	17.5	19.7	11.2
Total Organic Carbon	mg/kg	180000	26000	19000	30000	32000	29000	16000	13000

Location		40-FOR-01	41-FOR-01	42-FOR-01	43-FOR-01	44-FOR-01	45-FOR-01	46-FOR-01	47-FOR-01
Description		SAND with Silt and Clay	SAND with Silt, Clay, and Gravel	SAND with Silt	SAND with Silt and Clay	SILTY SAND with Clay and Gravel	SAND with Silt	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	0
% Fine Gravel	%	0	0.2	4.4	0.9	2.6	0.6	0.3	2.8
% Coarse Sand	%	0.2	0.8	4.5	0.7	3.5	0.8	1.1	2.2
% Medium Sand	%	23.5	12.9	18.1	23.6	12.2	19.3	12.2	12.6
% Fine Sand	%	69.9	74.1	65.5	64.8	60.4	72	59.6	60.7
% Silt	%	4.7	7	3.3	3.6	15.8	4.4	14.4	15.4
% Clay	%	1.6	4.9	4.2	6.5	5.4	2.9	12.6	6.3
Field Parameters									
Moisture	%	18.3	27.3	13.6	25.1	14.5	6.6	26.3	16.1
Total Organic Carbon	mg/kg	5500	29000	21000	18000	16000	6400	16000	18000

Table 5: Sieve Analysis and Field Parameters

Location		48-FOR-01	49-FOR-01	50-FOR-01	51-FOR-01	52-FOR-01	53-FOR-01	54-FOR-01	55-FOR-01
Description		SILT with Sand and Clay	SAND with Silt and Clay	SAND with Silt, Clay, and Gravel	SAND with Silt and Clay	SILTY SAND with Clay	SAND with Silt and Clay	CLAYEY SAND with Silt, Gravel, and Peat	SILTY SAND with Clay
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	0
% Fine Gravel	%	0	0.3	0.8	0	0.6	0.9	0.1	0
% Coarse Sand	%	1.2	1.6	0.8	0.8	1.4	1.1	16.3	0.1
% Medium Sand	%	5.2	13.9	8.1	19.6	17.9	21.8	41	1.4
% Fine Sand	%	15	75	82	72.8	61.8	70.3	9.3	79.5
% Silt	%	53	5	5	1.9	14.8	2.7	12.3	13.8
% Clay	%	25.6	4.3	3.3	4.9	3.5	3.3	20.9	5.1
Field Parameters									
Moisture	%	32.3	26.6	7.5	25	15.4	12.8	74.4	22.6
Total Organic Carbon	mg/kg	26000	39000	6200	15000	13000	13000	395000	9200

Location		56-FOR-01	57-FOR-01	58-FOR-01	59-FOR-01	60-FOR-01	61-FOR-01	62-FOR-01	63-FOR-01
Description		SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt and Clay	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel
Sieve Analysis									
% Cobbles	%	0	0	0	0	0	0	0	0
% Coarse Gravel	%	0	0	0	0	0	0	0	0
% Fine Gravel	%	0.1	3.1	0.2	0.3	3.7	0.1	0.3	2.1
% Coarse Sand	%	0.4	1.6	0.2	0.6	3.3	0.4	1	2.2
% Medium Sand	%	12.9	15.5	7.6	22.3	29.5	5.6	15.8	17.2
% Fine Sand	%	80	60	76.6	66.3	53.5	88.3	67.9	70.5
% Silt	%	3.1	14.3	11.1	7.5	6.8	4.4	11.1	6
% Clay	%	3.6	5.4	4.3	3	3.2	1.3	4	2.1
Field Parameters									
Moisture	%	10.7	24.9	19.5	19.4	20.4	8.8	13.6	10.1
Total Organic Carbon	mg/kg	12000	19000	19000	11000	9100	9100	17000	8800

Table 5: Sieve Analysis and Field Parameters

Location		64-FOR-01	65-FOR-01	65-FOR-01 DUP	66-FOR-01	67-FOR-01	68-FOR-01	69-FOR-01	70-FOR-01
Description		SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SAND with Silt, Clay, and Gravel	SILTY SAND with Clay and Gravel
Sieve Analysis									
% Cobbles	%	0	0	---	0	0	0	0	0
% Coarse Gravel	%	0	0	---	0	0	0	0	0
% Fine Gravel	%	2.4	0.7	---	13.7	0.1	2.2	0.7	4
% Coarse Sand	%	1.8	0.7	---	14.1	0.5	0.6	1	3.5
% Medium Sand	%	11.8	12.6	---	23.8	5.5	15.1	22.3	17.4
% Fine Sand	%	74.8	79.1	---	35.8	83.6	75.2	65.4	61.6
% Silt	%	5.2	4.3	---	7.4	5.7	3	6.4	10.1
% Clay	%	4	2.6	---	5.3	4.6	3.9	4.2	3.4
Field Parameters									
Moisture	%	23.2	21.5	21.9	20.8	10.5	21.7	21.9	14.8
Total Organic Carbon	mg/kg	13000	8400	8100	30000	11000	7400	8900	18000

Location		71-FOR-01	71-FOR-01 DUP	72-FOR-01	73-FOR-01	74-FOR-01	75-FOR-01	76-FOR-01	77-FOR-01
Description		SILTY SAND with Gravel and Clay	SILTY SAND with Gravel and Clay	SAND with Silt, Clay, and Gravel	CLAYEY SILT with Sand and Gravel	SAND with Silt and Clay	SILTY SAND with Clay and Gravel	SILTY SAND with Clay and Gravel	SILTY SAND with Clay
Sieve Analysis									
% Cobbles	%	0	---	0	0	0	0	0	0
% Coarse Gravel	%	0	---	0	0	0	0	0	0
% Fine Gravel	%	1.7	---	0.1	0.4	0	7.4	1.5	0.1
% Coarse Sand	%	1.6	---	0.6	0.8	0.7	3.6	3	0.7
% Medium Sand	%	14.6	---	19.3	8.4	7.6	22.7	8.1	11.4
% Fine Sand	%	66.7	---	70.8	14.1	83	51.5	52.8	72.1
% Silt	%	10.8	---	5.4	46	4	10.3	18.5	11.1
% Clay	%	4.5	---	3.8	30.3	4.6	4.5	16.1	4.5
Field Parameters									
Moisture	%	12.9	13.5	21.7	33.3	17.3	11.7	23.2	18.5
Total Organic Carbon	mg/kg	8100	8400	8800	55000	23000	14000	19000	26000

Table 5: Sieve Analysis and Field Parameters

Location		77-FOR-01	78-FOR-01	79-FOR-01	80-FOR-01	81-FOR-01	82-FOR-01	83-FOR-01
Description		SILTY SAND with Clay	CLAYEY SAND with Silt and Gravel	SAND with Silt, Clay, and Gravel	SAND with Silt and Clay	SILTY SAND with Clay and Gravel	CLAYEY SAND with Silt	SILTY SAND with Clay and Gravel
Sieve Analysis								
% Cobbles	%	---	0	0	0	0	0	0
% Coarse Gravel	%	---	0	0	0	0	0	0
% Fine Gravel	%	---	0.6	0.7	0	5.8	0	5.7
% Coarse Sand	%	---	1.2	1.4	0.1	2.3	0.2	2.6
% Medium Sand	%	---	10.4	5.3	1.4	7.8	7.2	24.4
% Fine Sand	%	---	73.2	83.3	94.6	62.5	80.3	54
% Silt	%	---	6.9	4.4	1.6	13.7	5.4	8.6
% Clay	%	---	7.7	4.8	2.3	7.9	6.9	4.7
Field Parameters								
Moisture	%	28.3	17	19.1	9.4	20.7	17.3	22.3
Total Organic Carbon	mg/kg	23000	18000	25000	11000	14000	26000	17000

Figures

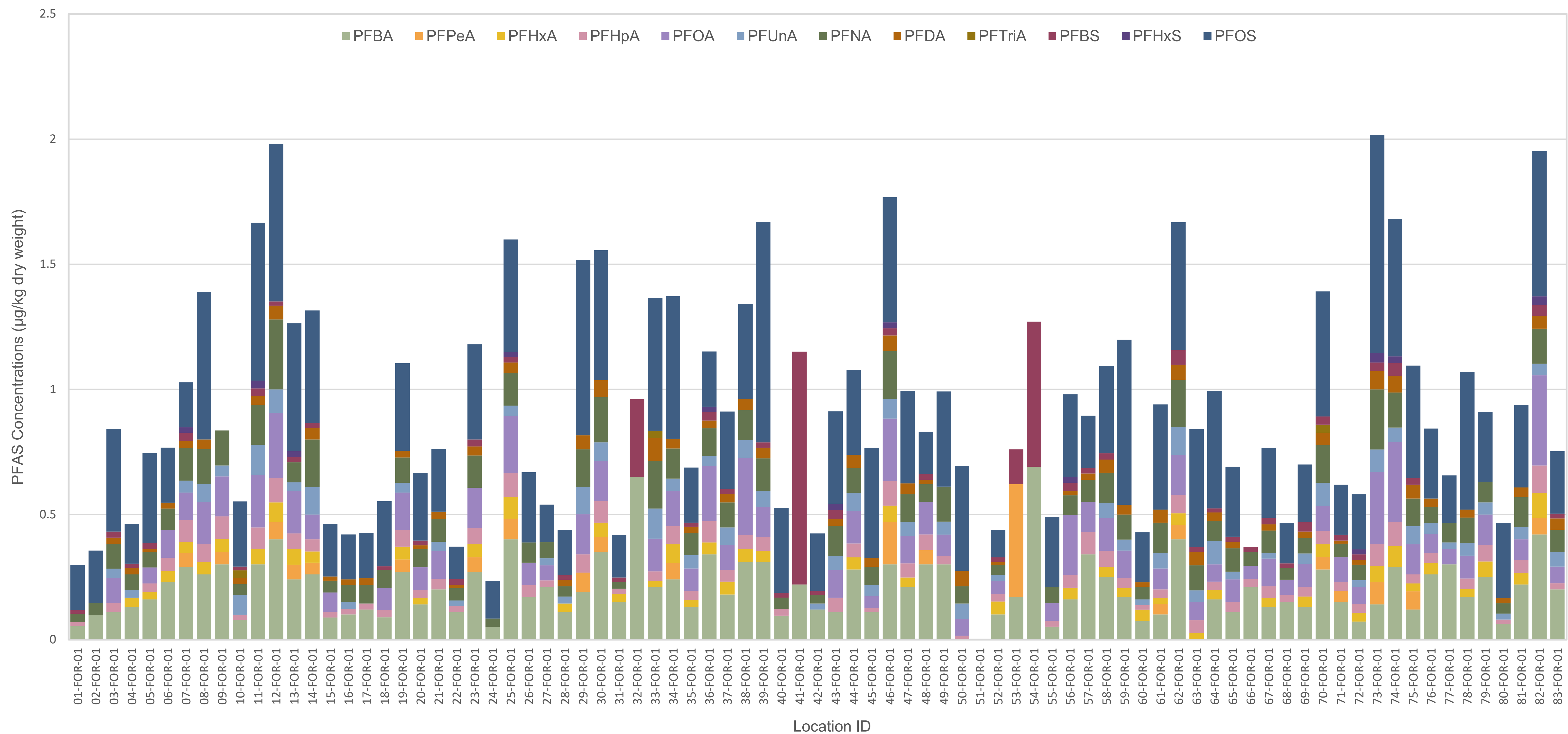


Figure 1: PFAS Concentrations in Michigan Shallow Forested Soil Samples

Figure 2:
PFOS Concentrations in Michigan's Lower Peninsula
Concentrations range from non-detect to 0.88 micrograms per kilogram dry weight

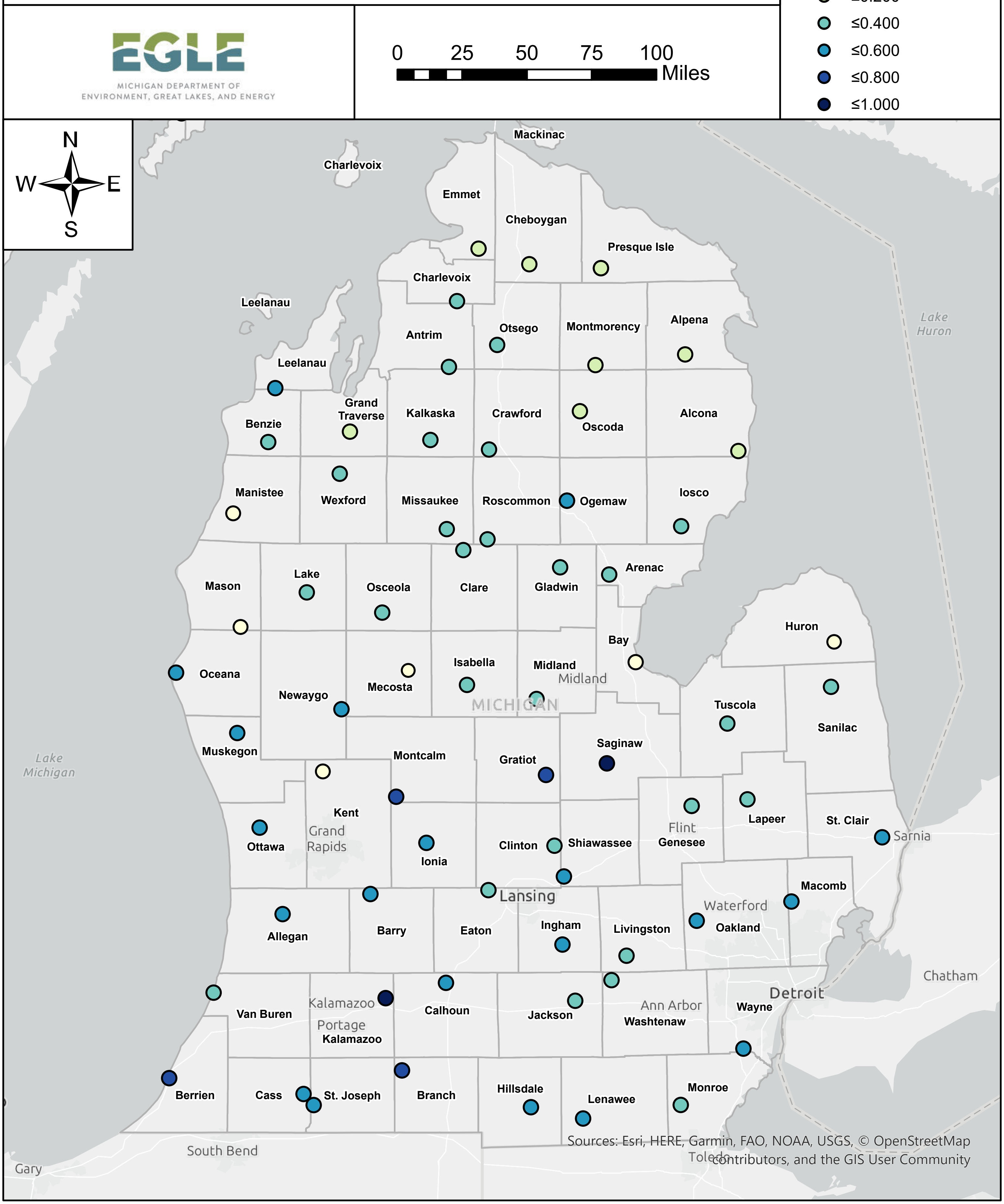


Figure 3:
PFOS Concentrations in Michigan's Upper Peninsula

Concentrations range from non-detect to 0.38 micrograms per kilogram dry weight

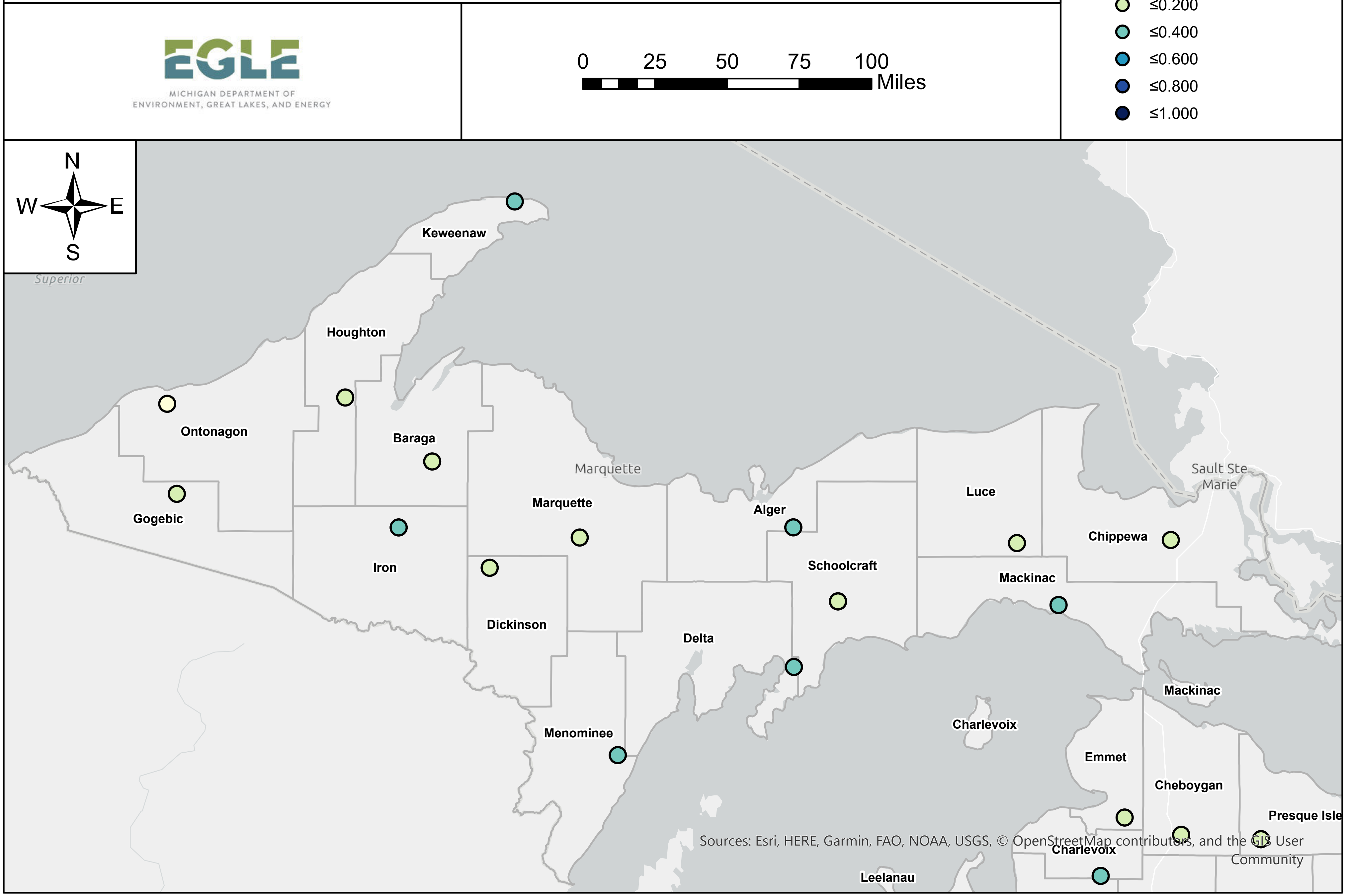


Figure 4:
PFOA Concentrations in Michigan's Lower Peninsula
Concentrations range from non-detect to 0.36 micrograms per kilogram dry weight

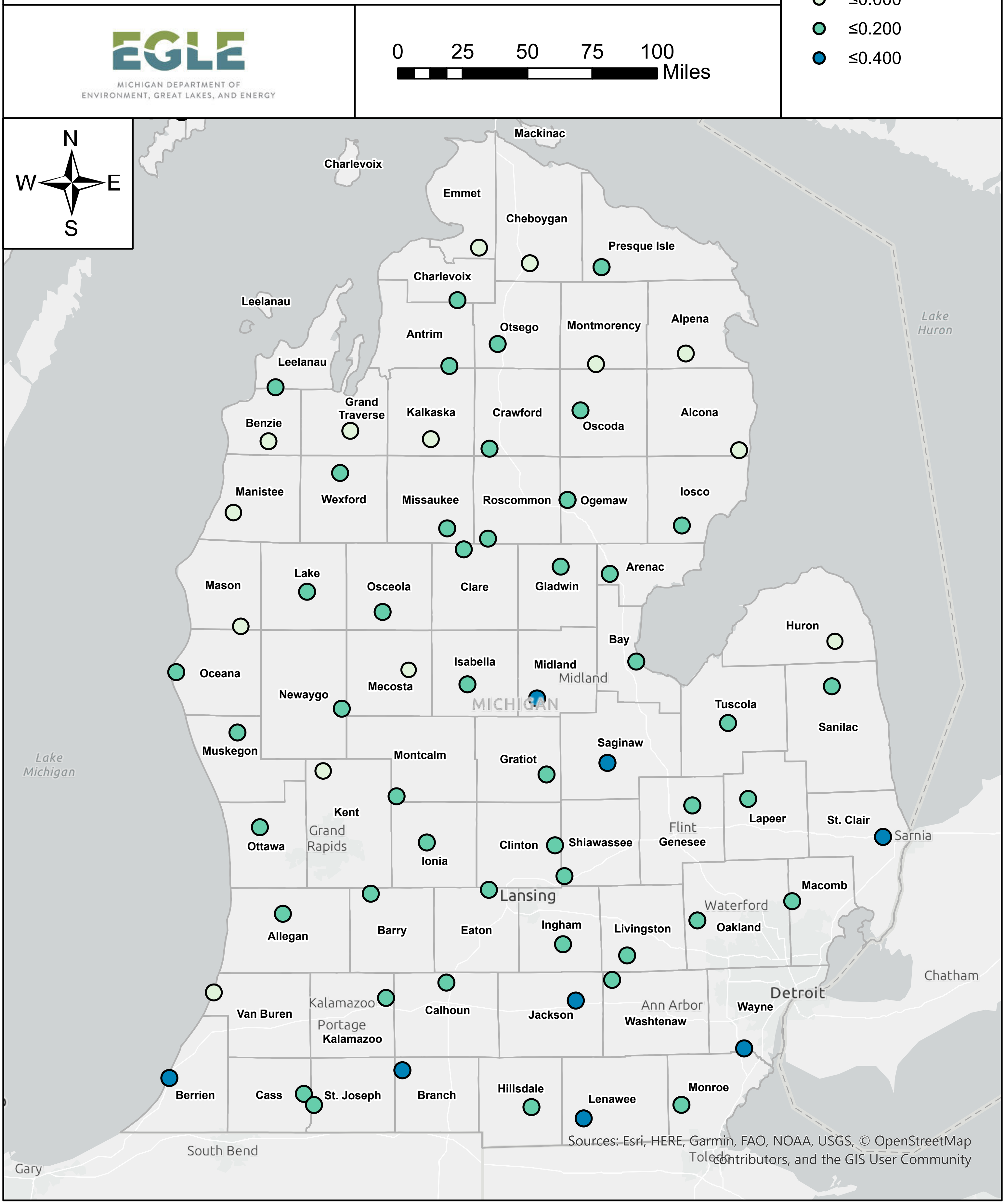


Figure 5:
PFOA Concentrations in Michigan's Upper Peninsula

Concentrations range from non-detect to 0.22 micrograms per kilogram dry weight

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

0 25 50 75 100 Miles

County Boundary

PFOA µg/kg

≤0.000

≤0.200

≤0.400

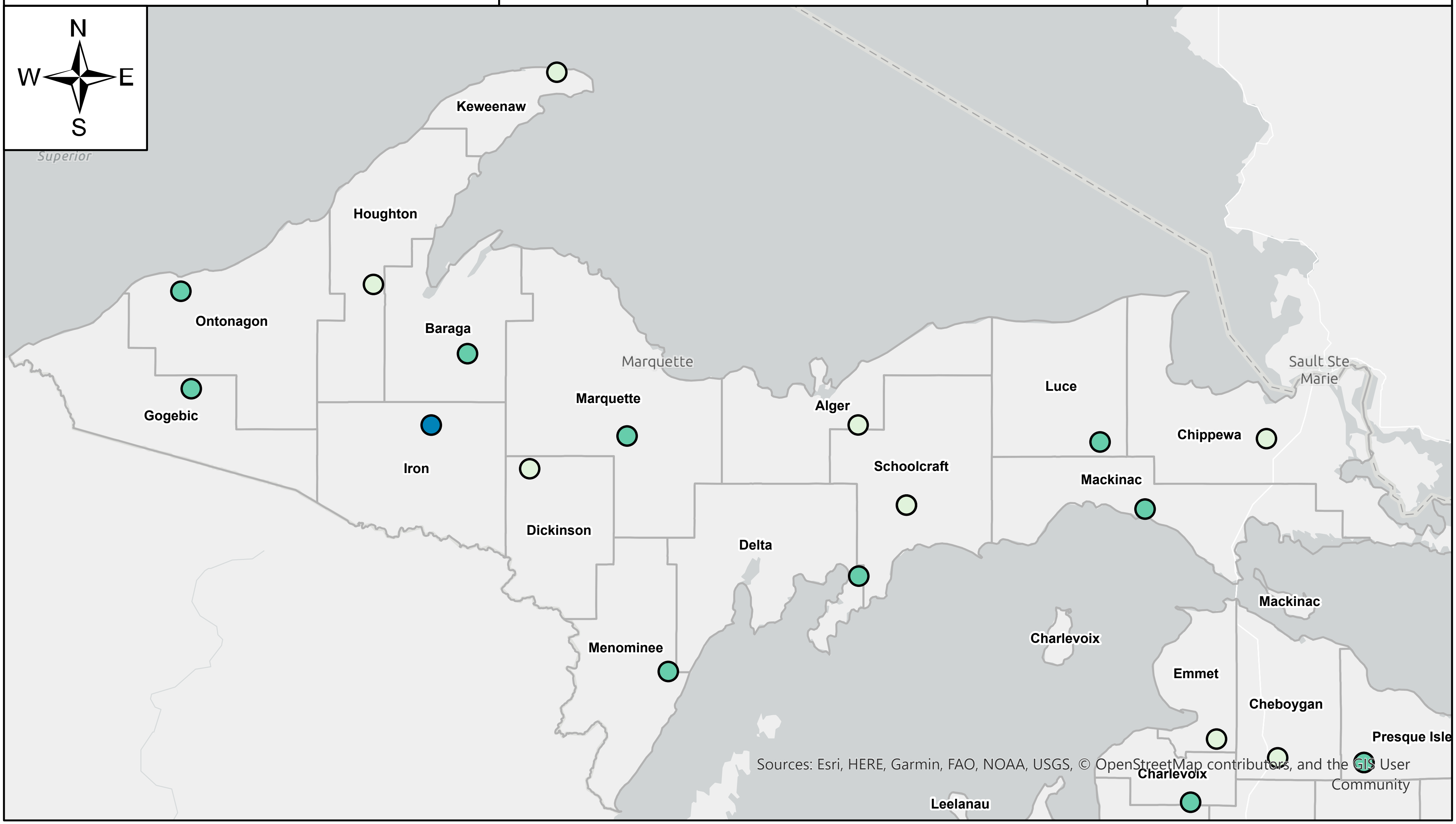


Figure 6:
PFBS Concentrations in Michigan's Lower Peninsula

Concentrations range from non-detect to 0.93 micrograms per kilogram dry weight

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

0 25 50 75 100 Miles

County Boundary

PFBS µg/kg

- ≤0.000
- ≤0.200
- ≤0.400
- ≤0.600
- ≤0.800
- ≤1.000

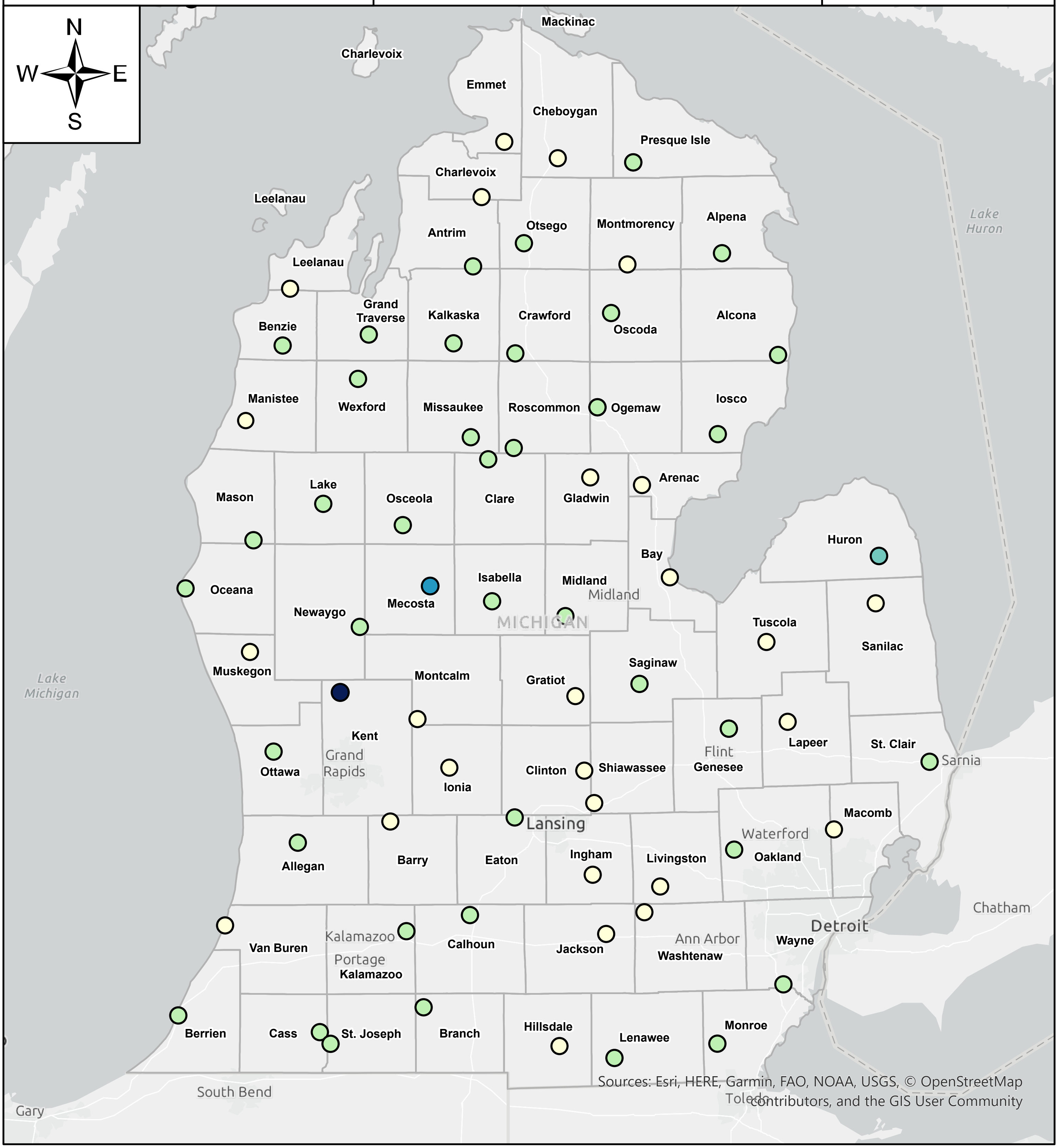


Figure 7:
PFBS Concentrations in Michigan's Upper Peninsula
Concentrations range from non-detect to 0.034 micrograms per kilogram dry weight

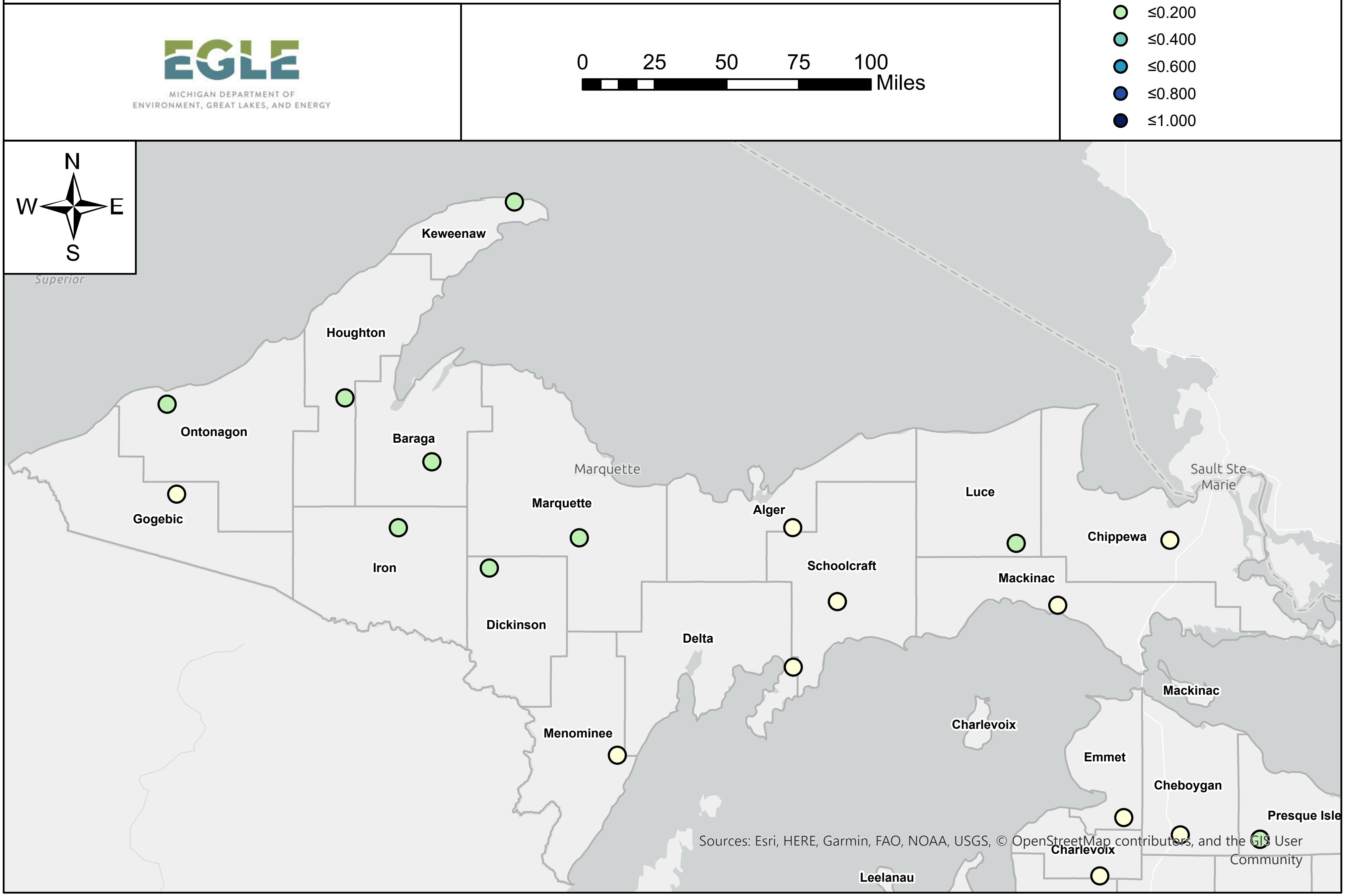
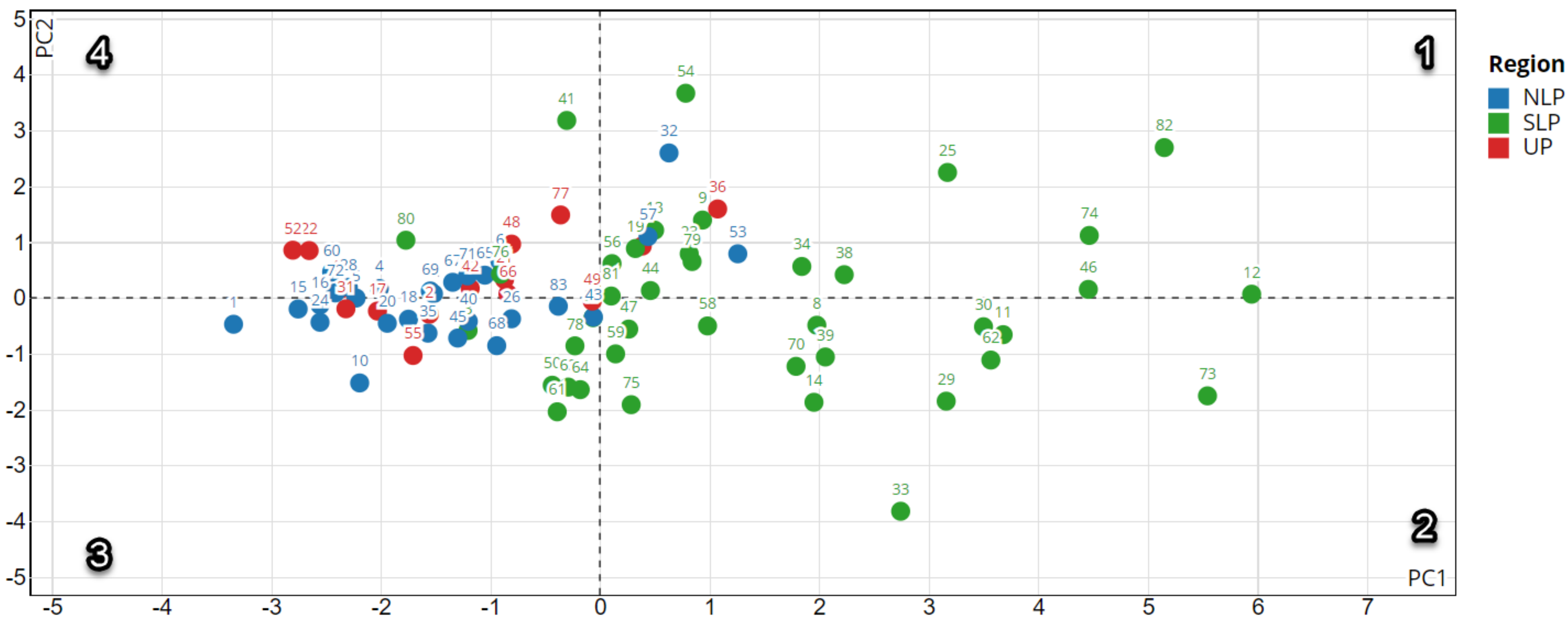
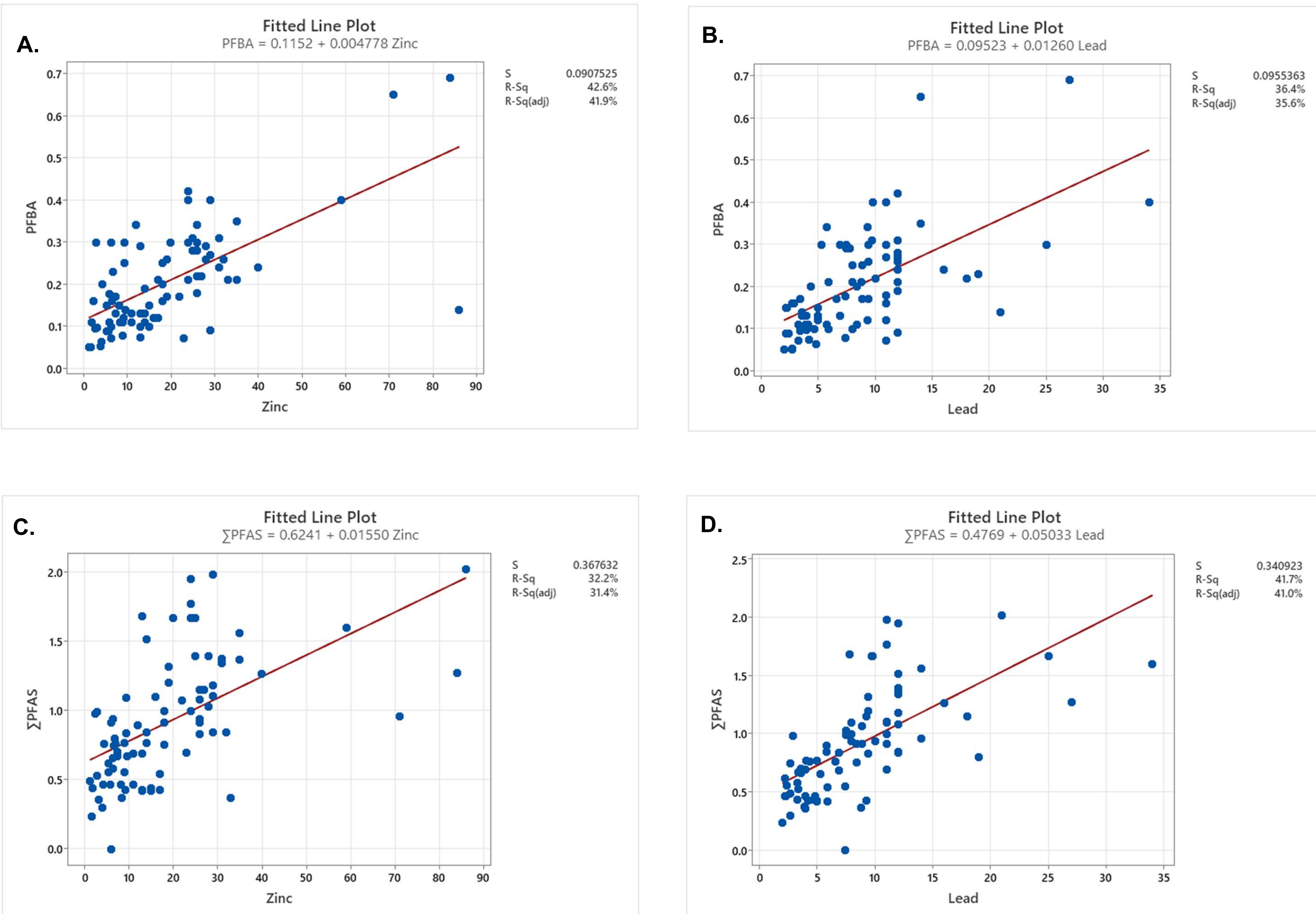


Figure 8: Principal Component Score Plot of Forested Samples



NLP = Northern Lower Peninsula
SLP = Southern Lower Peninsula
UP = Upper Peninsula
*See report for boundaries of each region

Figure 9: Fitted line plots for A) PFBA vs. Zinc, B) PFBA vs. Lead, C) ∑PFAS vs. Zinc, and D) ∑PFAS vs. Lead



AVAILABLE UPON REQUEST

Appendix A:

Concept Validation: Quality Assurance Project Plan for Collecting Soil Samples to Understand the Nature and Extent of PFAS in Michigan by Land Use and Via Modified Incremental Sampling

AVAILABLE UPON REQUEST

Appendix B:

Concept Validation: Sampling and Analysis Plan for Collecting Soil Samples to Understand the Nature and Extent of PFAS in Michigan by Land Use and Via Modified Incremental Sampling

AVAILABLE UPON REQUEST

Appendix C:

Michigan DEQ Soil PFAS Sampling Guidance

AVAILABLE UPON REQUEST

Appendix D:

Laboratory Analytical Reports

AVAILABLE UPON REQUEST

Appendix E:

Gradation Reports

AVAILABLE UPON REQUEST

Appendix F:

AECOM Technical Memorandum