



CITY OF PORTLAND ENVIRONMENTAL SERVICES



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Technical Memorandum

July 29, 2021

To: Sarah Miller, Oregon Department of Environmental Quality (DEQ)
Northwest Region Cleanup Program

From: Rod Struck, RG
City of Portland/Bureau of Environmental Services (BES)/Columbia Slough Sediment Program

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Subject: 2020-2021 PFAS Stormwater Sampling Results
Columbia Slough ECSI No.1283

The purpose of this Technical Memorandum is to provide the results of stormwater sampling performed in selected City of Portland (City) outfall basins discharging to the Columbia Slough for per- and polyfluoroalkyl substances (PFAS; also referred to in this document as perfluoroalkyl acids, or PFAAs). These results will be used by DEQ for informational purposes. Specifically, the purpose of collecting these data is to get a first look at the presence of these compounds in stormwater discharging to the Columbia Slough via discharges to the City's stormwater conveyance system from upland residential, commercial, and industrial sources.

Background

The City conducted stormwater PFAS sampling in response to DEQ's requests^{1, 2} to collect and analyze stormwater samples from selected City outfalls discharging to the Columbia Slough. The City understands based on DEQ's comment on the 2019-2020 Sampling and Analysis Plan (SAP) that *"The results will be used by DEQ for informational (only) purposes, specifically to get a first look at the extent to which these compounds might be present in stormwater sourced largely from residential and commercial/industrial sources respectively and discharging to the Slough. The work will complement ongoing investigation of PFAS releases to Columbia Slough from the PDX and Portland Air National Guard facilities in north Portland."*

PFAS are not currently regulated by USEPA or DEQ and DEQ has not established regulatory criteria or screening level values (SLVs) for these compounds. When DEQ requested the City perform PFAS monitoring, DEQ provided the City with a copy of a research article titled *"Perfluoroalkyl acids in urban stormwater runoff: Influence of land use"* conducted by Xiao, Simcik, and Gulliver at the University of Minnesota (Xiao, et al., 2011³) in the Twin Cities (Minneapolis and St. Paul, MN) metropolitan area. The objective of this study was to monitor stormwater runoff and evaluate the concentrations of PFAAs⁴ present in urban runoff from different storm events at various outfall locations corresponding

¹ DEQ comment on 2020 Sampling and Analysis Plan (SAP) - Source Tracing and Stormwater Monitoring For Stormwater Outfall Basins Discharging to the Columbia Slough (August 2020). Prepared by BES and GSI Water Solutions, Inc. for DEQ. DEQ comments provided in an Email from Sarah Miller/DEQ to Rod Struck/BES dated October 4, 2019.

² Follow up request from Sarah Miller/ DEQ to Rod Struck/BES during December 1, 2020 meeting.

³ Xiao, Feng & Simcik, Matt & Gulliver, John. (2011). Perfluoroalkyl acids in urban stormwater runoff: Influence of land use. Water research. 46. 10.1016/j.watres.2011.11.029.

⁴ Xiao, et. al. (2011) use the term PFAAs. It is assumed that the term PFAAs is equivalent to PFAS in this TM.

to different land uses (industrial, residential, and commercial areas). The conclusions of this study indicated the following:

- PFOS and perfluorooctanoic acid (PFOA) are the most frequently detected PFAAs in Twin City stormwater runoff. The frequencies of detection of PFAAs in urban runoff were found to be PFOS (100%), PFOA (100%), perfluorononanoic acid (PFNA) (67%), perfluorodecanoic acid (PFDA) (50%), perfluoroheptanoic acid (PFHpA) (44%), and perfluoroundecanoic acid (PFUnDA) (22%).
- In spite of the announcement by a major US manufacturer to phase out the manufacture of perfluorooctane sulfonate- (PFOS-)⁵ based fluorochemicals, relatively high-levels of PFOS are detected in stormwater runoff from industrial and commercial areas.
- PFAAs were detected in 100% of the Twin Cities' stormwater runoff samples collected from seven storm events (2009-2011).
- Substantially higher runoff concentrations of PFOS (up to 156 ng/L) were found near a suspected industrial source, where PFOS was used in past decades. Relatively high concentrations of PFOS (median concentration = 55.4 ng/L) were measured in the runoff, without any other PFAAs detected. The test results indicate that the median PFOS concentration in stormwater runoff around the industrial area is significantly higher than the median concentration either in the stormwater runoff at the residential/commercial areas or in rainfall.
- Excluding runoff from the industrial area, the median PFAA stormwater runoff concentration in the Twin Cities metropolitan area was estimated at 25.8 ng/L. This value is referred to in this study as "*as a background runoff concentration in this metropolitan area.*"
- The greater PFAA flux from stormwater runoff than from atmospheric inputs implies that PFAAs in the urban environment are solubilized in rain and transported. For vacant/remote areas, the background runoff concentration can be mainly attributed to rainfall.

2020 – 2021 Columbia Slough Stormwater PFAS Sampling Activities

The purpose of this 2020-2021 sampling effort was to provide data to DEQ regarding the presence and occurrence of PFAS in City-owned stormwater conveyance systems for drainage basins with varying land uses. Stormwater grab samples were collected in accordance with the DEQ approved:

- *2020 Sampling and Analysis Plan (SAP) - Source Tracing and Stormwater Monitoring For Stormwater Outfall Basins Discharging to the Columbia Slough (August 2020)*. Prepared by BES and GSI Water Solutions, Inc. for DEQ. DEQ approval letter dated October 8, 2020.
- Amendment 1 to the 2020 SAP. Letter submitted to Sarah Miller/DEQ from Rod Struck/BES on December 17, 2020. DEQ email approval dated December 17, 2020.

Additional sample volume was collected from selected stormwater basins and submitted for PFAS analysis during January, February, and April 2021 sampling events.

Stormwater samples were collected either by using a PFAS-free decontaminated sampler or by a direct grab using laboratory-provided PFAS-free containers. Quality assurance/quality control (QA/QC) procedures were used throughout this sampling, including precautions to prevent potential PFAS cross-contamination.

⁵ PFOS and PFOA are both PFAAs.

PFAS Sampling Locations

In 2019, DEQ requested PFAS analyses in two samples from City Outfalls (OF) 57 (primarily residential) and 62 (primarily industrial). At the time of the 2020 DEQ sampling request (see Footnote 2), planned sampling from OF57 and OF62 had been completed in accordance with the 2020 SAP. Therefore, the City proposed to collect two samples from each of the following City stormwater basins included in the 2020 SAP:

Outfall Basin	Area (acres)	Industrial	Commercial	Residential	Open
AAL552	19.05	100 %	--	--	--
72	10.28	97 %	--	3 %	--
77	27.01	79 %	14 %	7 %	--
AAP316	11.96	21 %	50 %	26 %	3 %
100	8.55	8 %	33 %	58 %	1 %

Sampling locations are shown on Figure 1. Additional QA/QC samples were collected and analyzed for PFAS, including two duplicate samples, two field blanks, and one equipment blank.

PFAS Analytical Approach

Stormwater and QA/QC samples were analyzed for PFAS compounds by Isotope Dilution Method (formerly EPA 537 modified) or equivalent by ALS in Kelso, Washington including:

- Perfluorobutane sulfonic acid (PFBS);
- Perfluorobutanoic acid (PFBA);
- Perfluoroheptane sulfonic acid (PFHpS);
- Perfluoropentanoic acid (PFPeA);
- Perfluoroheptanoic acid (PFHpA);
- Perfluorohexane sulfonic acid (PFHxS);
- Perfluorohexanoic acid (PFHxA);
- Perfluorooctane sulfonate (PFOS);
- Perfluorooctanoic acid (PFOA);
- Perfluorotetradecanoic acid (PFTeDA);
- Perfluorononanoic acid (PFNA);
- Perfluorodecanoic acid (PFDA);
- Perfluorodecane sulfonic acid (PFDS);
- Perfluoroundecanoic acid (PFUnDA);
- Perfluorododecanoic acid (PFDoA);
- Perfluorotridecanoic acid (PFTrDA);
- N-Ethylperfluoro-1-octanesulfonamidoacetic acid (N-EtFOSAA);
- N-Methylperfluoro-1-octanesulfonamidoacetic acid (N-MeFOSAA);
- Perfluorooctane sulfonamide (PFOSA); and
- Fluorotelomer sulfonate (C4, 4:2 FTS; C6, 6:2 FTS; and C8, 8:2 FTS).

The target PFAS constituents analyzed are consistent with the PFAS compounds included the USEPA draft target analyte list (USEPA, 2018⁶) and used by the Port of Portland⁷ and the Oregon Air National Guard⁸ in their recent evaluations of PFAS in stormwater.

Data Usability

Stormwater data were reviewed to verify that sample collection and laboratory procedures were performed in accordance with the 2020 SAP and Amendment 1 to the SAP. The Data Usability Report (Attachment A) concluded that appropriate sample collection and analytical methods were used, ensuring comparability with other data. Analytical accuracy and precision were determined to be acceptable. The PFAS stormwater data are considered valid as reported, representative of the samples collected, and acceptable for further use.

Analytical Results

The objective of this sampling effort was to provide data to DEQ regarding the presence of PFAS in stormwater from drainage basins with varying percentages of different land uses (see above). The presentation below focuses on this objective and comparing the Columbia Slough data to the Twin Cities data.

Ten (10) stormwater samples and 2 duplicates were analyzed for PFAS and total PCB congeners, metals, PAHs, pesticides, and general parameters⁹ in 5 city-owned outfall basins. 2020-2021 stormwater PFAS sample results and sampling dates are presented in Table 1. Results for other analytes (e.g., PCBs, metals, PAHs, pesticides) will be included in the 2020-2021 annual stormwater report (Target submittal date: Fall 2021/Winter 2022).

PFAS were detected in all the stormwater runoff samples collected from the selected Columbia Slough stormwater basins in the three storm events sampled in 2021. Concentrations of PFAS in stormwater runoff differ from event to event. Between 6 (OF77) and 13 (OF100 and AAP316) of the 23 PFAS analyzed were detected in each sample.

Table 1 presents the frequency of detection (FOD) of the individual PFAS analytes in the 12 stormwater samples (10 samples plus 2 duplicates). Analyte FODs ranged from 0 to 100 percent for analytes reported to be detected or flagged as estimated concentrations:

- 0 percent (0/12 samples): 4 analytes [PFUnDA, PFTTrDA, PFTTeDA, EtFOSA]
- 8 percent (1/12 samples): 4 analytes [PFDS, PFDoDA, MeFOSA, 2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol]
- 17 percent (2/12 samples): 2 analytes [PFHxA, PFDA]
- 33 percent (4/12 samples): 2 analytes [PFHpS, FOSA]
- 42 percent (5/12 samples): 1 analyte [PFNA]
- 50 percent (6/12 samples): 1 analyte [2-(N-methylperfluoro-1-octanesulfonamido)-ethanol]

⁶ USEPA, 2018. *Technical Brief Perfluoroalkyl and Polyfluoroalkyl Substances*. EPA 600/F-17/022d. September.

⁷ Port of Portland, 2020. Letter Report: "Re: PDX PFAS Stormwater Monitoring Data Report - Portland International Airport - Portland, Oregon -2550-00." Prepared by Apex, Portland, Oregon. November.

⁸ Oregon Air National Guard, 2019. *Final Work Plan for the Expanded Site Investigation for Per- and Polyfluoroalkyl Substances (PFAS) at the Portland Air National Guard Base*. Prepared for Restoration Branch, Operations Division, Logistics and Installations Directorate, Air National Guard Readiness Center, Joint Base Andrews, Maryland. Prepared by Parsons, South Jordan, Utah. September.

⁹ General parameters include pH, specific conductivity, temperature, TSS, and TOC.

- 58 percent (7/12 samples): 2 analytes [PFHxS, PFBA]
- 67 percent (8/12 samples): 1 analyte [6:2 FTS]
- 92 percent (11/12 samples): 2 analytes [PFPeA, 8:2 FTS]
- 100 percent (11/12 samples): 4 analytes [PFBS, PFOS, PFHpA, PFOA]

PFOS and PFOA are the most frequently detected PFAS in both the Columbia Slough and Twin Cities stormwater runoff. A comparison of the FODs for PFAS analytes detected in Columbia Slough basins and reported by Xiao, et al. (2011) is provided below:

<u>Analyte</u>	<u>Columbia Slough</u>	<u>Twin Cities</u>
PFOS	100%	100%
PFOA	100%	100%
PFBS	100%	Not reported
PFHpA	100%	44%
PFNA	42%	67%
PFDA	17%	50%
PFUnDA	0%	22%

Minimum, maximum, mean, median, and geomean concentrations for each PFAS analyte detected in the Columbia Slough stormwater samples are presented in Table 1. The highest number of maximum concentrations were detected in outfall basins AAP316 and 100 that both have mixed land uses.

PFOA was detected in the Columbia Slough stormwater samples with a concentration range of 0.84J – 17 ng/L (AAP316). This range is less than the PFOA range (up to 30.6 ng/L) reported by Xiao, et al. (2011).

PFOS were detected in the Columbia Slough stormwater samples with a concentration range of 1.5J – 23 ng/L (AAL552). This range is less than the PFOS range (up to 42.5 ng/L) reported by Xiao, et al. (2011).

Xiao, et al. (2011) reported the total concentration of PFAAs¹⁰ in the Twin Cities samples ranged from 14.3 to 96.0 ng/L. The total concentration of PFAS in the Columbia Slough samples (see Table 1) ranged from:

- 6.4 to 95.3 ng/L (using ND = 0), or
- 29.6 to 106.4 ng/L (using ND = MRL); it should be noted that the total concentration in blank samples that were all non-detect have total PFAS concentrations of 25.4 ng/L (see Table 1).

Total PFAS concentrations in the Columbia Slough vary by basin and storm event. The three highest concentrations were detected in basins 100, AAP316, and AAL552 respectively. The total PFAS concentrations (ND = 0) in basins 72 and 77 are similar to the concentrations (up to 30 ng/L) reported by Xiao, et al. (2011) for residential areas.

Excluding runoff from the industrial area, the median PFAS stormwater concentration in the Twin Cities area was estimated at 25.8 ng/L, which was reported “... as a background runoff concentration in this metropolitan area” (Xiao, et al., 2011). This background concentration is roughly the average of the

¹⁰ The Xiao, et al., 2011 study does not report how total concentrations were calculated.

median total PFAS stormwater concentration in the Columbia Slough samples, which ranged from 18.6 (ND = 0) to 38.8 (ND = MRL) ng/L.

PFAS were analyzed in rainfall from six rain events during the Twin Cities study (Xiao, et al., 2011), and from 3 stormwater discharge events during the Columbia Slough study. Median Columbia Slough stormwater concentrations for individual PFAS analytes are generally close to or less than the PFAS values reported in rain by Xiao et al. (2011), as indicated below:

<u>Analyte</u>	<u>Median Twin City Rain Concentration (ng/L)</u>	<u>Median Columbia Slough Stormwater Concentration (ng/L)</u>
PFHpA	1.3	1.7 (FOD = 100%; ND = MRL)
PFOA	8.4	2.2 (FOD = 100%; ND = MRL)
PFNA	1.3	1.1 (ND = MRL)
PFOS	6.7	6.4 (FOD = 100%; ND = MRL)
PFDA	2.6	1.2 (FOD = 17%; ND = MRL)
PFUnDA	ND	ND
Total PFAS	24.8	18.6 (ND = 0) 38.8 (ND = MRL)

In the Xiao, et al. (2011) investigation, monitoring similar to the residential and commercial areas was conducted near a suspected industrial source. Relatively high concentrations of PFOS (median concentration = 55.4 ng/L) were measured in the Twin Cities' runoff, without any other PFAS detected. Comparison of the Columbia Slough stormwater results to the results of the Twin Cities study indicates:

- The median total PFAS concentration (18.6 ng/L; ND = 0) in Columbia Slough is less than the estimated Twin Cities median value of 55.4 ng/L (assuming ND = 0).
- Four samples (AAL552 [2 samples][industrial], 100 [mixed residential/commercial/industrial], and AAP316 [mixed commercial/residential/industrial]) have estimated total PFAS concentrations greater the estimated Twin Cities median industrial concentration value.
- Median PFOS concentrations in the Columbia Slough samples are well below the median value reported by Xiao, et al.
- Unlike the Twin Cities study where only PFOS was detected in the industrial samples, 11 to 13 PFAS analytes were detected in each Columbia Slough stormwater sample.

Concentrations in outfall basins 100 and AAP316 are reported for February and April 2021 sampling events. The April 2021 concentrations were generally 2 to 10 times higher than the February results in both basins. The February stormwater samples were collected after a 2-day antecedent dry period on a day with a daily total rainfall of 0.27 inches, whereas, the April samples were collected after a 15-day antecedent dry period on a day with a daily total rainfall of 0.16 inches. Samples from outfall basin AAL552 were collected in January 2021 and February 2021; concentrations were comparable between these two events.

Findings and Conclusions

The City conducted stormwater PFAS sampling in response to DEQ's requests. The City collected and analyzed stormwater samples from selected City outfalls discharging to the Columbia Slough. The City understands based on DEQ's comment on the 2019-2020 SAP that *"The results will be used by DEQ for informational (only) purposes, specifically to get a first look at the extent to which these compounds might be present in stormwater sourced largely from residential and commercial/industrial sources respectively and discharging to the Slough. The work will complement ongoing investigation of PFAS releases to Columbia Slough from the PDX and Portland Air National Guard facilities in north Portland."*

Key findings and conclusions of the 2021 PFAS Columbia Slough study include:

- PFAS analytes were detected in all Columbia Slough stormwater samples collected.
- PFAS concentrations in Columbia Slough stormwater runoff differ from basin to basin and event to event.
- Median Columbia Slough stormwater concentrations for individual PFAS analytes are generally less than the PFAAS values reported in rain by Xiao et al. This suggests, consistent with the Twin Cities study, that rain and/or air deposition may contribute to the concentrations and/or analytes detected in the Columbia Slough stormwater samples.
- Columbia Slough stormwater sample results are consistent to those reported in the Twin Cities' study (Xiao, et al., 2011)
 - PFOS and PFOA are the most frequently detected PFAAs.
 - PFOS and PFOA concentration ranges in Columbia Slough are less than the ranges for the Twin Cities area.
 - The total PFAS concentration ranges and median concentrations are similar for both studies.
 - The median total PFAS concentration (18.6 ng/L; ND = 0) in Columbia Slough is less than the estimated Twin Cities median industrial value of 55.4 ng/L (assuming ND = 0).
 - Median PFOS concentrations in the Columbia Slough samples are well below the median industrial value reported by Xiao, et al.

Differences between the Columbia Slough and Twin Cities PFAS results areas may be the result of, but not limited to, the following:

- Improvements in analytical testing methodologies or analyte method detection/reporting limits over the past 10+ years
- Stormwater sampling methodologies (e.g., grab, composite, time weighted average)
- Stormwater sampling criteria (e.g., antecedent dry period, storm size, storm duration)
- Sample set size
- Method of total PFAS calculations (ND = 0, ND = ½ MRL; ND = MRL; other)
- Proximity to PFAS sources
- Number of PFAS stormwater samples analyzed (i.e., data set sample size)
- Differences in specific land uses beyond the general categories of industrial, commercial, and residential.

Table 1: Columbia Slough 2020-2021 Stormwater PFAS Results ¹

Analytes			General Stormwater Statistics ⁷						72			AAL552		77		100			AAP316	
									72-SW1			AAL552-SW1		77-SW1		100-SW1			AAP316-SW1	
Analytes (ng/L)	Analyte Abbreviaton	CAS #	Minimum	Maximum	Median	Mean	Geomean	Frequency of Detection	1/12/2021	Duplicate	2/18/2021	1/12/2021	2/18/2021	1/12/2021	2/18/2021	2/18/2021	Duplicate	4/24/2021	2/18/2021	4/24/2021
									AAL341			AAL541		AMY609		AAS509			AAP316	
									Outfall			Near outfall		Outfall		Outfall				
Perfluoroalkyl Sulfonic Acids (PFASs)																				
Perfluorobutane Sulfonic Acid	PFBS	375-73-5	0.3	4.4	1.0	1.5	1.1	100%	0.65 J	0.52 J	0.7 J	1.4 J	2.9 J	0.3 J	0.54 J	0.91 J	1.2 J	3.1 J	1 J	4.4 J
Perfluorohexane Sulfonic Acid	PFHxS	355-46-4	1.3	6.0	2.0	2.9	2.4	58%	1.3 U	1.5 J	1.3 U	5.3	5.7	1.3 U	1.3 U	2.4 J	3.4 J	3.5 J	1.3 U	6
Perfluoroheptane Sulfonate	PFHpS	375-92-8	0.4	1.6	0.4	0.7	0.6	33%	0.44 U	0.44 U	0.44 U	1.1 J	1.6 J	0.44 U	0.44 U	0.68 J	1.2 J	0.44 U	0.44 U	0.44 U
Perfluorooctane Sulfonic Acid	PFOS	1763-23-1	1.5	23.0	6.4	9.3	5.9	100%	2.4 J	1.8 J	2.8 J	23	17	1.5 J	1.9 J	8.4	8.1	20	4.7 J	20
Perfluorodecane Sulfonate	PFDS	335-77-3	0.3	0.33	0.3	0.3	0.3	8%	0.3 U	0.33 J	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Perfluoroalkyl Carboxylic Acids (PFCAs)																				
Perfluorobutanoic Acid	PFBA	375-22-4	0.4	10.0	2.1	2.8	1.5	58%	3.3 J	3.1 J	2.4 J	10	8.8	2.6 J	1.8 J	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Perfluoropentanoic Acid	PFPeA	2706-90-3	1.7	21.0	2.3	5.4	3.6	92%	2.2 J	1.9 J	2 J	6.9	9.6	2.1 J	1.7 U	2.1 J	2.3 J	21	2.7 J	9.7
Perfluorohexanoic Acid	PFHxA	307-24-4	8.8	14.0	8.8	9.3	9.2	17%	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	14	8.8 U	9.6
Perfluoroheptanoic Acid	PFHpA	375-85-9	1.0	8.3	1.7	3.1	2.3	100%	1.4 J	0.97 J	1.3 J	5.7	5.9	1.3 J	1.1 J	1.7 J	1.7 J	8.3	2 J	6
Perfluorooctanoic Acid	PFOA	335-67-1	0.8	17.0	2.2	4.5	2.7	100%	1.1 J	1 J	1.5 J	6	7.2	0.99 J	0.84 J	2.2	2.2	11	2.7	17
Perfluorononanoic Acid	PFNA	375-95-1	1.1	3.9	1.1	1.7	1.5	42%	1.1 U	1.1 U	1.1 U	1.7 J	2.5 J	1.1 U	1.1 U	1.1 U	1.3 J	3.9 J	1.1 U	3.7 J
Perfluorodecanoic Acid	PFDA	335-76-2	1.2	6.3	1.2	1.8	1.5	17%	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	3.4 J	1.2 U	6.3
Perfluoroundecanoic Acid	PFUnDA	2058-94-8	1.5	1.5	1.5	1.5	1.5	0%	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Perfluorododecanoic Acid	PFDoDA	307-55-1	1.3	1.9	1.3	1.4	1.3	8%	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.9 J
Perfluoro-n-tridecanoic Acid	PFTTrDA	72629-94-8	1.3	1.3	1.3	1.3	1.3	0%	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Perfluorotetradecanoic Acid	PFTeDA	376-06-7	2.0	2.0	2.0	2.0	2.0	0%	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Perfluoroalkyl Sulfonamido Substances																				
Perfluorooctane sulfon amide	FOSA	754-91-6	0.5	0.68	0.52	0.56	0.6	33%	0.52 U	0.52 U	0.52 U	0.63 J	0.52 U	0.52 U	0.52 U	0.52 U	0.6 J	0.68 J	0.52 U	0.62 J
N-methylperfluoro-1-octanesulfonamide	MeFOSA	31506-32-8	0.5	0.49	0.46	0.46	0.5	8%	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.49 J	0.46 U	0.46 U
N-ethylperfluoro-1-octanesulfonamide	EtFOSA	4151-50-2	0.3	0.27	0.27	0.27	0.3	0%	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	--	24448-09-7	0.3	0.77	0.30	0.40	0.4	50%	0.3 U	0.3 U	0.58 J	0.3 U	0.3 U	0.3 U	0.3 U	0.48 J	0.33 J	0.77 J	0.5 J	0.3 J
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	--	1691-99-2	0.1	0.24	0.13	0.14	0.1	8%	0.13 U	0.24 J	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
n:2 Fluorotelomer Sulfonic Acids (n:2 FTSA)																				
6:2 Fluorotelomer Sulfonate	6:2 FTS	27619-97-2	0.6	7.0	1.0	1.9	1.3	67%	0.55 U	0.55 U	0.99 J	0.55 U	0.99 J	2 J	0.55 U	2.3 J	2 J	7	0.61 J	4.2
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	39108-34-4	0.2	1.6	0.5	0.6	0.5	92%	0.17 J	0.15 U	0.36 J	0.5 J	0.52 J	0.15 J	0.26 J	1.4 J	1.4 J	1.6 J	0.44 J	0.84 J
Estimated Total Concentrations																				
Total of PFOA and PFOS			2.3	40.0	8.9	13.8	8.6	--	3.5	2.8	4.3	29.0	24.2	2.5	2.7	10.6	10.3	31.0	7.4	37.0
Total PFAS (ND = 0)			6.4	95.3	18.6	35.5	23.8	--	11.2	11.4	12.6	62.2	62.7	10.9	6.4	22.6	25.7	95.3	14.7	90.6
Total PFAS (ND = MRL)			29.6	106.4	38.8	53.7	47.7	--	32.7	31.3	33.3	80.3	80.8	31.9	29.6	41.9	43.4	106.4	35.7	97.4

Table 1: Columbia Slough 2020-2021 Stormwater PFA

Analytes			Blanks							
			EQ Blank		Field		Direct		Direct	
Analytes (ng/L)	Analyte Abbreviaton	CAS #	2/18/2021	2/18/2021	1/12/2021	2/18/2021	1/12/2021	2/18/2021	1/12/2021	2/18/2021
			Blank		Blank		Blank			
Perfluoroalkyl Sulfonic Acids (PFSA)										
Perfluorobutane Sulfonic Acid	PFBS	375-73-5	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U	0.28 U
Perfluorohexane Sulfonic Acid	PFHxS	355-46-4	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Perfluoroheptane Sulfonate	PFHpS	375-92-8	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U
Perfluorooctane Sulfonic Acid	PFOS	1763-23-1	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U	0.44 U
Perfluorodecane Sulfonate	PFDS	335-77-3	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Perfluoroalkyl Carboxylic Acids (PFCA)										
Perfluorobutanoic Acid	PFBA	375-22-4	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Perfluoropentanoic Acid	PFPeA	2706-90-3	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U
Perfluorohexanoic Acid	PFHxA	307-24-4	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U
Perfluoroheptanoic Acid	PFHpA	375-85-9	0.63 U	0.63 U	0.63 U	0.63 U	0.63 U	0.63 U	0.63 U	0.63 U
Perfluorooctanoic Acid	PFOA	335-67-1	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U
Perfluorononanoic Acid	PFNA	375-95-1	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Perfluorodecanoic Acid	PFDA	335-76-2	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Perfluoroundecanoic Acid	PFUnDA	2058-94-8	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Perfluorododecanoic Acid	PFDoDA	307-55-1	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Perfluoro-n-tridecanoic Acid	PFTTrDA	72629-94-8	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Perfluorotetradecanoic Acid	PFTeDA	376-06-7	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Perfluoroalkyl Sulfonamido Substances										
Perfluorooctane sulfon amide	FOSA	754-91-6	0.52 U	0.52 U	0.52 U	0.52 U	0.52 U	0.52 U	0.52 U	0.52 U
N-methylperfluoro-1-octanesulfonamide	MeFOSA	31506-32-8	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U	0.46 U
N-ethylperfluoro-1-octanesulfonamide	EtFOSA	4151-50-2	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	--	24448-09-7	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	--	1691-99-2	0.13 U	0.13 U	0.14	J	0.13 U	0.13 U	0.13 U	0.13 U
n:2 Fluorotelomer Sulfonic Acids (n:2 FTSAs)										
6:2 Fluorotelomer Sulfonate	6:2 FTS	27619-97-2	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
8:2 Fluorotelomer Sulfonic Acid	8:2 FTS	39108-34-4	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U
Estimated Total Concentrations										
Total of PFOA and PFOS			0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U
Total PFAS (ND = 0)			0.0 U	0.0 U	0.1	0.0 U	0.0 U	0.0 U	0.0 U	0.0 U
Total PFAS (ND = MRL)			25.4 U	25.4 U	25.4	25.4 U	25.4 U	25.4 U	25.4 U	25.4 U

Notes:

Green shading indicates maximum stormwater concentration detected in 2020-2021 stormwater samples.

Bold text and gray shading indicates concentration detected.

¹ Data collected for informational purposes.

² Summary of values from other states. Lowest level from "State-by-State Regulation of PFAS Substances in Drinking Water" Prepared by J.R Kindschuh and T.S. Lee of Bryan Cave Leighton Paisner Law Firm. Dated January 22, 2021.

³ Summary of values from other states.

⁴ See Footnotes 4 and 5 in Technical Memorandum.

⁵ Non-detected values (U) estimated at the method reporting limit.

⁶ Non-detected values (U) estimated at the method reporting limit.

⁷ Identification and calculation of the minimum, maximum, median, mean and geomean concentrations assume nondetect values (i.e., U values) are present at the method reporting limit (MRL) shown on the table.

J indicates value reported by laboratory as an estimated concentration.

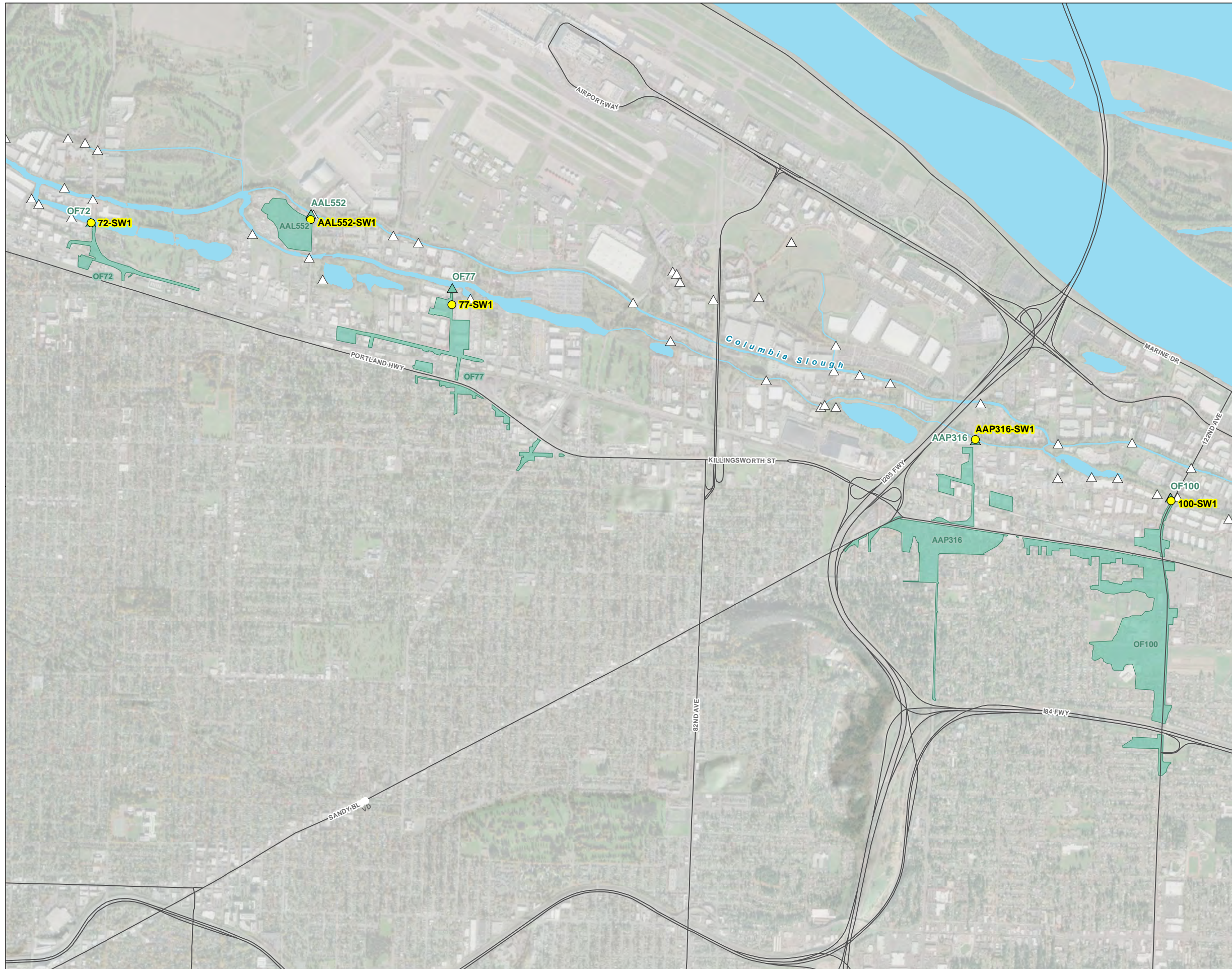
B indicates laboratory reported analyte in laboratory blank.

U indicates analyte not detected above the method reporting limit.

ng/l = nanograms per liter

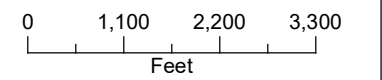
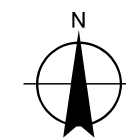
FIGURE 1
FY21 Stormwater PFAS
Sampling Locations

Columbia Slough Sediment Program



LEGEND

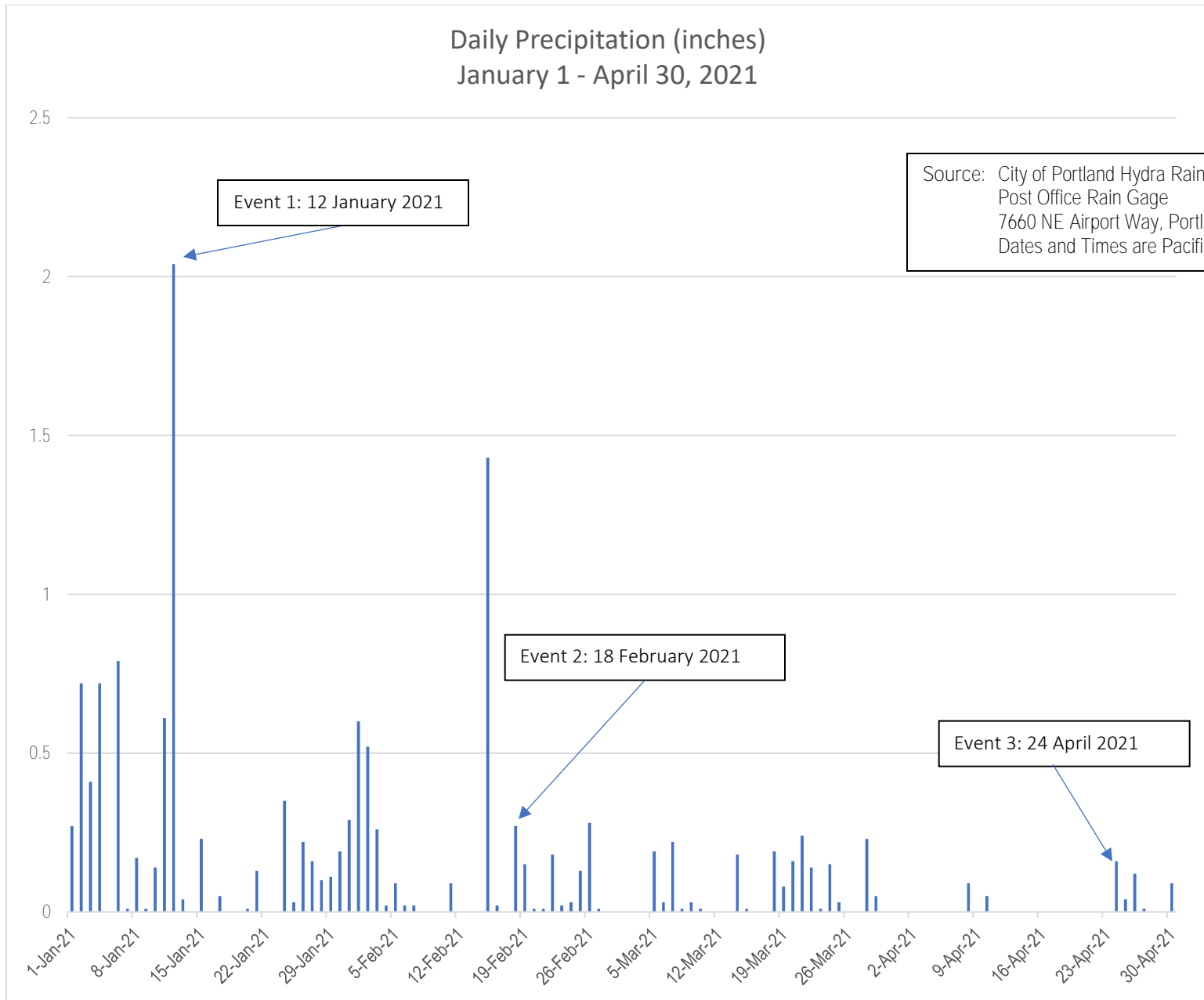
- Sample Location
- △ City Outfall
- Outfall Basin
- Major Road
- Watercourse
- Waterbody



Date: April 7, 2021
 Data Sources: BES, METRO, USGS,
 DigiGlobe 2020



Figure 2: Stormwater Sampling Events, Columbia Slough, Portland, Oregon



Attachment A
Data Useability Report

**CITY OF PORTLAND BUREAU OF ENVIRONMENTAL SERVICES
COLUMBIA SLOUGH SEDIMENT PROGRAM
DATA USABILITY REPORT**

**COLUMBIA SLOUGH SOURCE INVESTIGATION
PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) MONITORING
JANUARY - APRIL 2021**

1.0 BACKGROUND

Supplemental Per- and Polyfluoroalkyl Substances (PFAS) stormwater monitoring was requested by DEQ and completed by the City of Portland in January through April 2021. This data usability report presents the data quality review of the City of Portland (City) PFAS stormwater sampling activities in major public stormwater outfall basins discharging to the Columbia Slough. Samples were collected at the same time as, and recorded on chains-of-custody with, Columbia Slough Source Tracing stormwater samples. Data quality review for standard Columbia Slough Source Tracing Investigation parameters will be included in the 2021 Source Tracing Report.

2.0 SAMPLING SUMMARY

The City Bureau of Environmental Services (BES) Field Operations section performed sample collection at all sample locations. Samples were collected in general accordance with the City's Amended Programmatic Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for the City of Portland Outfalls Project (BES 2007, 2007a) and Columbia Slough Sediment Program 2020 SAPs (2020a, 2020b). Stormwater samples were collected at manholes using sampling poles and decontaminated stainless-steel beakers or by filling sample bottles directly at stormwater outfalls.

A total of ten stormwater samples were collected from five locations during two events. Samples were collected using standard "clean hands/dirty hands" Standard Operating Procedures (SOPs) intended for collection of samples for trace-level organics analysis. Additional blank samples were collected to evaluate potential sources of background contamination including two equipment blanks collected in the laboratory, two field equipment blanks, and two field blanks. In general, field equipment blanks were collected at locations where decontaminated stainless-steel beakers were used for sample collection, and field blanks were collected at locations where samples were collected by directly filling samples bottles.

Field notes will be presented in Appendix B of the 2021 Source Tracing Investigation for the Columbia Slough. BES Water Pollution Control Laboratory (WPCL), and Columbia/ALS chain-of-custody (COC) forms will be presented with the Analytical Laboratory Reports (Appendix D of the Stormwater Solids & Source Tracing report).

3.0 ANALYTICAL SUMMARY

This data usability report only addresses PFAS data quality, data quality review for standard Columbia Slough Source Tracing Investigation parameters will be included in the 2021 Source

Tracing Report. PFAS samples were analyzed by ALS in Kelso, Washington using EPA Method PFC/537M.

4.0 WORK PLAN COMPLIANCE AND DATA USABILITY

BES Monitoring Coordination and Analysis (MCA) conducted an independent data usability assessment to ensure the data are usable. All data were evaluated using the project Work Plan, U.S. EPA Contract Laboratory Program National Functional Guidelines (NFGs) for Data Review (EPA 2017) for guidance in evaluating the following:

- Field practices, field quality control (QC) samples, daily activity logs, and sample collection logs;
- Sample COC and receipt documentation, preparation and analytical holding times, and reporting and detection limits for chemicals of interest; and
- Laboratory data quality, in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC) as described in Section 2.6 of the QAPP.

4.1 Field Practices

Daily Activity Logs

Daily activity logs consist of field data sheets (FDSs) and daily field reports (DFRs) which are included in Appendix B of the Source Tracing Investigation for the Columbia Slough. FDSs are used to record general and sample-specific information regarding site conditions, time of sample collection, visual stormwater observations, sample collection difficulties, deviations from the SAP, and any information relating to potential pollutant sources. DFRs are used to record other observations or events such as unsuccessful sampling attempts. These logs were reviewed by both the Field Operations team leader and by MCA for completeness and consistency. Where any discrepancies are noted, forms are returned to field samplers for review and correction, if necessary. Corrections are made such that original notes are still legible, and changes are initialed, as appropriate.

Field and Lab QC Samples

Field QC samples are used to assess sample collection procedures, environmental conditions during sample collection and shipment, and the adequacy of equipment decontamination. They are also used to estimate field precision and accuracy. Laboratory QC is used to assess analytical performance, analytical method precision and accuracy, and sample matrix effects. Matrix spike (MS) and MS duplicate (MSD) samples are routine laboratory QC samples used to evaluate whether matrix effects may affect analytical results.

The results of field and/or laboratory duplicate samples are used to assess overall sample precision. The relative percent difference (RPD) is used to estimate the combination of field (sampling) and laboratory (analytical) precision. Precision goals are presented in the SAP & QAPP. No issues with field practices were encountered during monitoring that required corrective actions.

4.2 Data Usability Assessment

General

Stormwater grab samples were collected at five sampling locations for two Events at each stormwater sampling location. Samples were delivered to WPCL on the same business day that they were collected. Laboratory sample receipt forms indicate that all sample containers arrived intact, and all container labels matched the COC documentation.

Some data were flagged by the laboratories as estimated using various flags to illustrate specific laboratory QC failures. Following review of laboratory reports, case narratives, and field QC data by MCA, some of these flags were carried through as appropriate, and replaced with qualifiers presented below. Additional qualifiers were added, where necessary. Qualified data are still considered valid and usable (though should be used with caution), except for results that may have been qualified with an “R” (rejected). Qualifiers used for PFAS sample reporting are listed below:

- B Estimated due to blank contamination
- J Estimated concentration
- U Not detected above method detection limit (MDL)

A detailed summary of all QC issues by analysis group is provided by analysis below. Note that many QC issues are specific to individual laboratory analytical batches. Batch numbers are noted as appropriate in Sections 4.2.1 through 4.2.6 below and on Laboratory Reports presented in Appendix D of the Source Tracing Report.

Matrix Spikes

Where the laboratory does not have sufficient volume for matrix spike analysis, an LCS duplicate sample is analyzed in accordance with the method.

4.2.1 Holding Times

All holding times were met for all samples.

4.2.2 Blanks

In accordance with EPA guidelines, positive sample results should be reported unless the concentration of the compound in the project sample is less than or equal to 10 times (10x) the amount in any blank for metals, dioxins/furans, and the common organic laboratory contaminants (methylene chloride, acetone, 2-butanone, cyclohexane, and phthalate esters), or 5 times (5x) the amount for other target compounds. Based on pervasive presence of PFAS in the environment, the common laboratory criterion of 10x was applied to positive blank. Target compounds were not detected in associated blank samples prepared and analyzed concurrently with the project samples, except for the following:

Analysis Batch	Samples Affected	Analyte	Concentration	Comments
KQ2100622	72-SW1, 72-SW1 DUP, 77-SW1	Perfluorooctanoic acid	0.36 ng/l	Sample results < 10x blank concentration qualified with “B” for estimated due to blank contamination.
KQ2100622	72-SW1 DUP	2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	0.36 ng/l	Sample result < 10x blank concentration qualified with “B” for estimated due to blank contamination, analyte not detected on other samples.
KQ2108112	none	N-methylperfluoro-1-octanesulfonamide, N-ethylperfluoro-1-octanesulfonamide, 2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	0.85 ng/l, 0.29 ng/l, 0.29 ng/l	Analytes not detected, no action taken.

4.2.3 System Monitoring Compounds

System monitoring/surrogate compounds are added to each sample prior to analysis of organic parameters to confirm the efficiency of the sample preparation procedure. The calculated recovery for each surrogate compound was evaluated to confirm the accuracy of the reported results. All surrogate recoveries were within laboratory acceptance limits except as follows:

Batch	Samples Affected	Comments
KQ2102444	none	D7-MeFOSE and D9-EtFOSE recoveries above acceptance limits in various samples, associated analytes not detected, no action taken.

4.2.4 Laboratory Control Samples

For Laboratory Control Samples (LCSs—organics analysis) are analyzed following the addition of a known amount of analyte to Laboratory deionized water in order to confirm the ability of the analytical instrument to accurately quantify target compounds. LCSs were analyzed at the appropriate SAP-specified frequency. Additionally, all LCS and CRM recoveries were within the acceptance limits.

4.2.5 Matrix Spike/Matrix Spike Duplicates

For Matrix Spikes (MS)/Matrix Spike Duplicates (MSD), sediment samples are analyzed following the addition of a known amount of analyte to a field sample in order to evaluate any matrix effects that interfere with the ability of the analytical instrument to accurately quantify target compounds. Typically, results are not qualified based on MS/MSD results alone unless recoveries are well outside control limits. LCSs were analyzed in lieu of MS/MSDs due to insufficient sample volume.

4.2.6 Duplicates

Laboratory duplicate samples were analyzed at the appropriate frequency and all recoveries were within laboratory acceptance limits.

4.3 Data Usability Summary

Appropriate sample collection and analytical methods were used for all samples and analyses, ensuring good comparability with other data. Analytical accuracy and precision were determined to be generally acceptable, with noted exceptions. Qualifiers were assigned based on other analytical QC results that exceeded project data quality criteria and the project completeness goal has been met.

All other data reported should be considered valid as reported, representative of the samples collected, and acceptable for further use.

5.0 REFERENCES

- City of Portland Bureau of Environmental Services (BES). 2007. *Amended Programmatic Quality Assurance Project Plan – Outfalls Investigation*, Portland Harbor Source Control project. Prepared for Oregon Department of Environmental Quality (ODEQ). August 2007.
- City of Portland BES. 2007a. *Amended Programmatic Sampling and Analysis Plan – Outfalls Investigation*, Portland Harbor Source Control project. Prepared for Oregon Department of Environmental Quality (ODEQ). July 2007.
- City of Portland BES. 2020a. *2020 Source Tracing Investigation for Potential Contaminant Sources to Stormwater Outfall Basins Discharging to the Columbia Slough*. Prepared by the City of Portland Bureau of Environmental Services. August 2020.
- City of Portland BES. 2020b. *Amendment 1 to the 2020 Source Tracing Investigation for Potential Contaminant Sources to Stormwater Outfall Basins Discharging to the Columbia Slough*. Prepared by the City of Portland Bureau of Environmental Services. December 2020.
- EPA 2002. *Guidance on Environmental Data Verification and Data Validation*. EPA-240-R-02-004 (EPA QA/G-8). Office of Environmental Information. November 2002.
- EPA 2017. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Superfund Data Review*. EPA-540-R-2017-002 (OLEM 9335.0-136). Office of Superfund Remediation and Technology Innovation (OSTRI). January 2017.

6.0 GENERAL

This summary report was prepared by the MCA section of BES. For any questions concerning this report, contact Aaron Wieting at 503-823-5437.

Date of Final Report: June 30, 2021

Prepared by: Aaron B. Wieting, BES MCA