

Almeda Post-Fire Water Quality Investigation Toxic Contaminant Evaluation

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ACRONYMS AND ABBREVIATIONS

AHC	Agglomerative Hierarchical Clustering
ALS	ALS Life Sciences Laboratory
Apex Labs	Apex Laboratories, LLC
APPL	APPL Laboratory
BCUC	Bear Creek Sampling Site at US Cellular Park
BCOS	Bear Creek Sampling Site at Oak Street
CR	Colver Road Sampling Site
DEHP	bis(2-ethylhexyl)phthalate
DEQ	Oregon Department of Environmental Quality
DRO	Diesel Range Organics
EDL	Estimated Detection Limit
EMPC	Estimated Maximum Possible Concentration
EPA	Environmental Protection Agency
GRO	Gasoline Range Organics
GP	City of Grants Pass
HpCDD	Heptachlorinated dibenzo- <i>p</i> -dioxin
HpCDF	Heptachlorinated dibenzofuran
J Flag	Lab data qualifier indicating est. value < RL
LOD	Limit of Detection
LOQ	Limit of Quantitation
LQL	Lower Quantification Limit
MCL	EPA Drinking Water Standard (Maximum Contaminant Level)
MDL	Method Detection Limit
mg/L	Milligrams per liter = ppm
MWC	Medford Water Commission
ng/L	Nanograms per Liter = ppt
NPDES	National Pollutant Discharge Elimination System
NRC	Neilson Research Corp Laboratory
NRT	Northridge Terrace Sampling Site
NWTPH-Dx	Northwest Total Petroleum Hydrocarbons-Diesel
OCDD	Octachlorinated dibenzo- <i>p</i> -dioxin
OCDF	Octachlorinated dibenzofuran
ORO	Oil-Range Organics
OWEB	Oregon Watershed Enhancement Board
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Polybrominated Diphenyl Ethers (or Brominated Flame Retardants)
PeCDF	Pentachlorodibenzofuran
PFAS	Per- and Polyfluorinated Alkylated Substances (or Per- and Polyfluoroalkyl Substances)
PFDA	Perfluorodecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid

PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane sulfonic acid
PFPeA	Perfluoropentanoic acid
Pg/L	picograms per liter = ppq
ppb	Part per billion = ug/L
ppm	Part per million = mg/L
ppt	Part per trillion = ng/L
ppq	Part per quadrillion = pg/L
PQL	Practical Quantitation Limit
RL	Reporting Level
RVSS	Rogue Valley Sewer Services
RVCOG	Rogue Valley Council of Governments
SVOC	Semi-Volatile Organic Compound
TCDD	Tetrachlorinated dibenzo- <i>p</i> -dioxin
TEF	Toxic Equivalence Factor
TEQ	Toxicity Equivalent Quantity
TIC	Tentatively Identified Compound
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
ug/L	Micrograms per Liter = ppb
VOC	Volatile Organic Compound
WRD	Water Resources Department
WVV	West Valley View Road Sampling Site

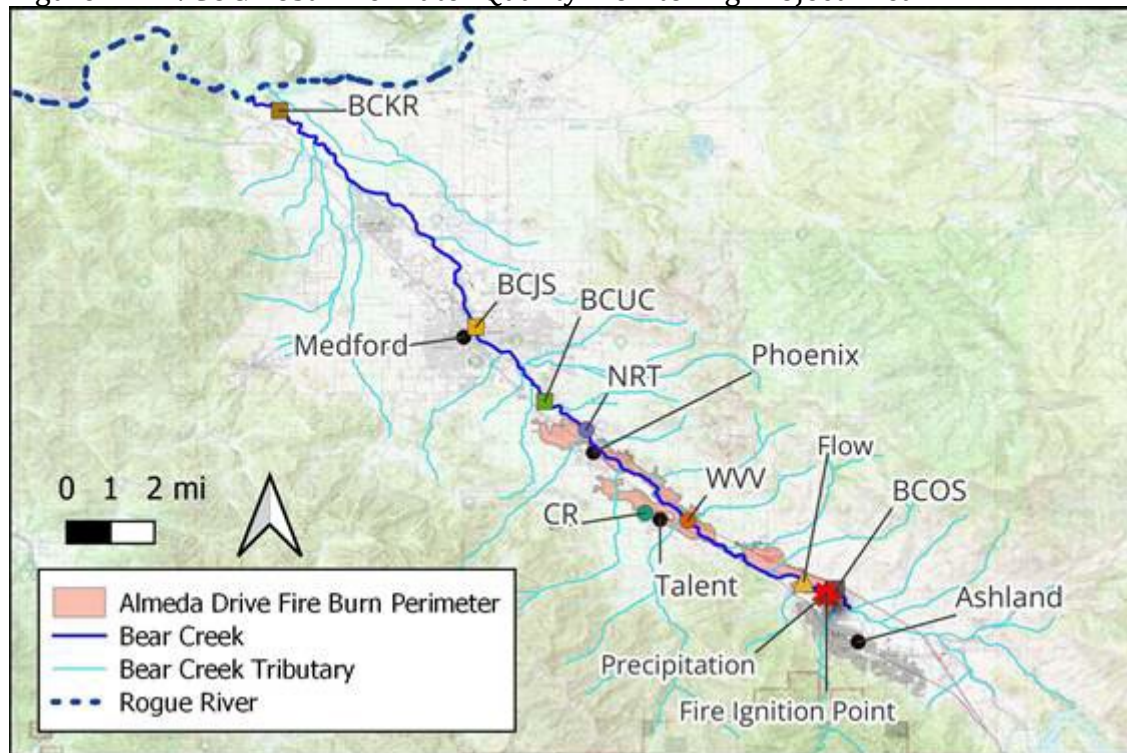
Almeda Post-Fire Water Quality Investigation Toxic Contaminant Evaluation

1.0 INTRODUCTION

1.1 Site Description

The Almeda Fire started on September 8th, 2020 as a small brush fire near Oak Street in the southern Oregon town of Ashland and, stoked by strong winds, quickly spread northwest in a narrow band, burning approximately 3,000 acres and damaging over 2,500 homes and 600 businesses as well as over 11 miles of riparian vegetation along Bear Creek, from Ashland to Medford. The burned area is shown in Figure 1 as a gray shaded area outlined in black. The large number of homes, businesses and vehicles burned to the ground along the way, in the communities of Ashland, Talent, Phoenix, and Medford was unprecedented in Oregon.

Figure 1 – RVCOG Post-Fire Water Quality Monitoring Project Area



Map from Aquatic Ecosystem Sci. LLC, 2024

Concerns about hazardous materials from burned structures and vehicles entering stormwater and Bear Creek resulted in a water quality investigation led by a consortium of Rogue Valley organizations and technical consultants (the RVCOG Team) including the Rogue Valley Council of Governments (RVCOG), Rogue Valley Sewer Services (RVSS), Oregon Department of Environmental Quality (DEQ), Rogue River Watershed Council (RRWC), Oregon Water Resources Department (WRD), Medford Water Commission (MWC), city of Grants Pass (GP), Patton Environmental LLC and Aquatic Ecosystem Sciences LLC.

The City of Grants Pass and RVSS initiated sampling in Bear Creek and at stormwater outfalls in late 2020 and early 2021. Once funding was secured from the Oregon Watershed Enhancement Board (OWEB), RVCOG completed a sampling plan and coordinated continued sampling efforts. It should be noted that, during the sampling period 2021 through 2023, ash and burned debris removal, site clearing, and new housing construction was conducted in the area. Although the end result of burned debris removal would reduce the presence of contaminants in stormwater, it is likely that during the period of debris removal activity, new layers of materials were exposed to wind and rainfall and had the potential to impact sample results.

1.2 Sample Locations

In-stream water quality samples discussed in this report were collected from two locations along Bear Creek during the investigation. Initial in-stream sampling was conducted by the city of Grants Pass (GP) at the Bear Creek Greenway Bridge (this site was later called the Bear Creek US Cellular sampling site [BCUC]). For the RVCOG-OWEB project, a reference data collection point for Bear Creek was added upstream from the Alameda Fire at Oak Street (BCOS). These locations are indicated in Figure 1 with their respective initials.

Stormwater samples were collected from three outfall locations during the investigation. Initial stormwater sampling was conducted by RVSS at outfalls along Bear Creek in areas representing two burned neighborhoods, West Valley View (WVV) and North Ridge Terrace (NRT). For the RVCOG-OWEB project, a reference data collection point was added to represent stormwater from an unburned residential area at Colver Road (CR). These locations are indicated in Figure 1 with their respective initials. It is important to note that the Colver Road location was downwind of some of the fire.

1.3 Scope of this Report

RVCOG contracted with Patton Environmental LLC in December of 2021 to provide technical assistance with planning for continued water quality data collection, and analysis and evaluation of data, particularly data regarding potentially toxic analytes such as gas- or diesel-range organic (GRO/DRO) hydrocarbons, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), per- and polyfluoroalkyl substances (PFAS), dioxins and furans, and polybrominated diphenyl ethers (PBDEs). Samples were collected by GP, RVCOG and RVSS and

shipped to various laboratories for analysis. Efforts were made to collect samples during rain events when over 0.25 inches of precipitation had occurred with an antecedent dry period of at least 72 hours.

All laboratory reports and results regarding GRO, DRO, VOCs, SVOCs, PFAS, Dioxins and Furans, and PBDEs, for samples collected by GP, RVSS, and RVCOG, are available in Appendices A through C. Evaluation of detections for these parameters is presented in the subsequent sections of this report. Where the detected parameters were likely present as a result of the urban area fire, potential impacts to aquatic life is considered. No evaluation of potential impacts to drinking water quality is included.

Evaluation of conventional water quality parameters, metals data, and 6PPD quinone results are discussed in a separate report authored by Aquatic Ecosystem Sciences LLC. A complete project report will be provided by RVCOG to the Oregon Watershed Enhancement Board (OWEB).

2.0 DATA INCLUDED IN POST-FIRE WATER QUALITY EVALUATION

2.1 Collection Entities and Laboratories Used for Project

Samples from Bear Creek collected soon after the fire by Grants Pass Water were analyzed through Neilson Research Corporation laboratory (NRC) of Medford, Oregon who subcontracted analyses of PFAS and Dioxins/Furans to APPL laboratory (APPL) in Clovis, California and PBDE analyses to ALS Life Sciences (ALS) laboratory in Burlington, Ontario, Canada. Early RVSS stormwater samples were analyzed by NRC. Later RVSS stormwater samples and all RVCOG stormwater and creek samples were analyzed by Apex Laboratories LLC (Apex) in Portland, Oregon. For consistency of data analysis, subcontracts to APPL and ALS laboratories were continued.

The data collection dates, collection entity, types of samples, and laboratories used for analysis are recorded in Table 1.

2.2 Analytical Suite

Due to the evolving nature of this project following the fire and various entities involved, the analytical suite changed slightly over the course of the investigation. Some analyses were added as budget allowed and others discontinued following non-detectable results in early testing.

Table 2 lists the various analyses which are the focus of this report and the sample collection dates and water source - Creek [C] and/or Stormwater [S] - for each sample set.

Table 1 – Data collection entity, water source and laboratories used per sample date

Sample Date	Collection Entity	Laboratory WO#	Reference Location	Storm-water	Creek	Apex	APPL	ALS	NRC
11/04/2020	GP	20110157			X		X	X	X
11/15/2020	GP	20110721			X		X	X	X
11/15/2020	RVSS	20110729		X					X
12/17/2020	GP	20120951			X		X	X	X
12/30/2020	RVSS	A1A0055		X		X			
03/05/2021	RVSS	A1C0364		X		X	X	X	
11/09/2021	RVCOG	A1K0412	X	X		X	X	X	
01/03/2022	RVCOG	A2A0212	X	X	X	X	X	X	
03/15/2022	RVCOG	A2C0711	X	X		X	X	X	
10/22/2022	RVCOG	A2J0791	X	X	X	X	X	X	
03/13/2023	RVCOG	A3C0537	X	X		X	X	X	
05/02/2023	RVCOG	A3E0957	X	X		X	X	X	

Table 2 – Analytes and water source per sample collection date

Analyses	Method	Collection Date										
C=Creek		2020				2021		2022			2023	
S=Stormwater		11/04	11/15	12/17	12/30	03/05	11/09	01/03	03/15	10/22	03/13	05/02
TPH-GRO/DRO/ORO	NWTPH-GRO/DRO/ORO				S	S	S	C/S	S	C/S	S	S
TPH-DRO/ORO w/SG	NWTPH-Dx-SGC				S	S	S	C/S				
VOC	EPA 524.2	C	C	C								
VOC	EPA 8260D				S	S						
PAH by SIM	EPA 8270C	C	C	C								
SVOC	EPA 8270C				S	S	S	C/S	S	C/S	S	S
PFAS	DoD QSM Table B-15	C	C	C		S	S	C/S	S	C/S	S	S
Dioxin/Furans	EPA 1613B	C	C	C		S	S	C/S	S	C/S	S	S
PBDEs	EPA 1614	C	C	C		S	S	C/S	S	C/S	S	S

2.2.1 TOTAL PETROLEUM HYDROCARBONS – GAS RANGE AND DIESEL/OIL RANGE ORGANICS

Gas and Diesel/Oil range organic (GRO and DRO/ORO)/Hydrocarbon analyses were conducted on the samples since these parameters are present in vehicles, heating oil tanks, and homes and were expected as post-fire contaminants. Diesel range organic analysis with silica gel column cleanup was conducted on some of the samples to evaluate the potential that some of the DRO/ORO detections were from plant matter versus synthetic oils.

2.2.2 VOLATILE ORGANIC COMPOUNDS AND SEMI-VOLATILE ORGANIC COMPOUNDS

A list of commonly tested Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs) and a much longer list of VOC and SVOC Tentatively Identified Compounds (TICs) were analyzed for project samples. These parameters have been identified in previous areas impacted by structural fires and the burning of construction materials. (Proctor 2020; City of Santa Rosa, 2018; EPA. 2019)

2.2.3 PER-AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Per-and Polyfluoroalkyl substances (PFAS) are a set of emerging contaminants associated with fire-fighting foam, anti-stick and fire-retardant chemicals used for cookware, clothing, and household furnishings and are ubiquitous in water, tissue and blood samples across the country. They were included in this study to evaluate their presence post-fire.

2.2.4 DIOXINS AND FURANS

Dioxins and furans are combustion byproducts and known to be persistent organic pollutants. Dioxins and furans have been detected as a result of incineration of municipal waste, tobacco, diesel fuel, sewage, medical waste and industrial chemicals as well as from forest fires (Kirkok 2020). They were included in this study to evaluate their presence in water post-fire.

2.2.5 POLYBROMINATED DIPHENYL ETHERS (PBDEs)

Polybrominated diphenyl ethers (PBDEs) are fire retardants commonly used in vehicles and household materials such as carpets, furniture pads, mattresses, plastics, and electronics. The congeners used in flame retardants have between 4 and 10 bromine atoms (Tetra BDE through Deca BDE). PBDEs have been detected in air and in biological specimens from firefighters (Fent 2020). They were included in this study to evaluate their presence in water post-fire.

3.0 DATA QUALITY AND DATA REDUCTION

Since some of the contaminants analyzed are known to be of concern at very low concentrations, it was important to achieve sufficiently low detection levels to determine if the chemicals were present or not, and at what concentrations, in the soils or waters analyzed. For the RVCOG project, laboratories were requested to report at the lowest possible detection levels. In addition to quality controls necessary for reliable low detection levels at the laboratory, quality-controlled sample collection and handling is also critical to the assurance of meaningful results.

3.1 Data Quality

For samples with compounds detected above the laboratory's Method Detection Limit (MDL) but below the laboratory's Reporting Limit (RL), the laboratories assign a "J" qualifier, indicating that the result is estimated since it was detected below the calibrated range. Note that for different laboratories and analyses, the MDL might alternatively be called Estimated Detection Limit (EDL), Estimated Maximum Possible Concentration (EMPC), or Limit of Detection (LOD). For different laboratories and analyses, the RL might alternatively be called Practical Quantitation Limit (PQL), Limit of Quantitation (LOQ) or Lower Quantification Limit (LQL). For this report, the terms MDL and RL will be used for all data.

Laboratories use a system of quality controls which include running duplicate samples, blanks, and matrix spikes at regular intervals and with every batch of samples. Results from these QC samples are compared with sample results to check for potential interference or laboratory contamination. If contaminants are detected in laboratory QC samples, the MDL or RL levels are generally raised. Any additional data qualifiers are reported with the data and explained near the end of the laboratory report, following quality control section.

Sample collection practices can be evaluated by analyzing trip blanks or duplicate samples collected in the field. Due to budget constraints, only two field blanks were collected for this project, on 03/05/21 at the WVV and NRT stormwater sampling locations. The field blanks were only analyzed for PFAS. All results were ND for the WVV field blank. The NRT field blank had one "J"-qualified detection of 0.68 ng/L of PFHxS indicating possible sample contamination for that parameter. The NRT Stormwater outfall sample on that date also had a "J"-qualified detection of 1.2 ng/L PFHxS (among other PFAS detections). Therefore it should be considered that the actual PFHxS concentration at NRT on 03/05/21 might have been lower by at least the concentration detected in the field blank.

3.2 Data Reduction

Since most analyses in this study were requested to report to the MDL versus the RL, a large portion of the data has been reported with a "J" qualifier. In the evaluation of the data, more weight has been given to parameter detections above the RL. In addition, less attention was given to parameters that were found in similar concentrations in both burned area and reference sample areas. Most final data sets were reduced to evaluate only those parameters which had at least one detection above the RL. Data reduction approaches are noted in each section below.

4.0 STORMWATER OUTFALL – WATER QUALITY RESULTS

4.1 Total Petroleum Hydrocarbons (TPH) as Gas-Range Organics (GRO), Diesel-Range Organics (DRO), or Oil-Range Organics (ORO), with and without Silica-Gel (SG) Cleanup

4.1.1 TPH AS GAS RANGE ORGANICS (GRO)

No TPH as GRO was detected in stormwater samples on 11/15/20, 12/30/20, or 03/05/21. As a result, TPH-GRO analyses were discontinued following the 03/05/21 sampling event.

4.1.2 TPH AS DIESEL RANGE ORGANICS/OIL RANGE ORGANICS (DRO/ORO)

Total Petroleum Hydrocarbons as DRO/ORO were detected on all sampling dates except 11/09/2021 in stormwater samples from the burned areas at WVV and NRT. Table 3 shows the range of TPH as DRO/ORO detections at WVV, NRT and the unburned, reference location CR. Samples were not collected at CR on 12/30/2020 and 03/05/21.

Table 3 - TPH as DRO/ORO in stormwater outfall samples 2020-2023

Dates	TPH (DRO/ORO) in Stormwater 2020-2023 (in ug/L)							
	12/30/2020	3/5/2021	11/9/2021	1/3/2022	3/15/2022	10/22/2022	3/13/2023	5/2/2023
WVV	1884	1100	ND	395	136.3	455	349	171
NRT	536	1262	ND	363.5	52.9	1530	527	718
CR	NA	NA	ND	ND	151.1	961	443	591

Bold = Above RL

Orange = Above MDL, below RL (J-flagged data)

NA = Not sampled

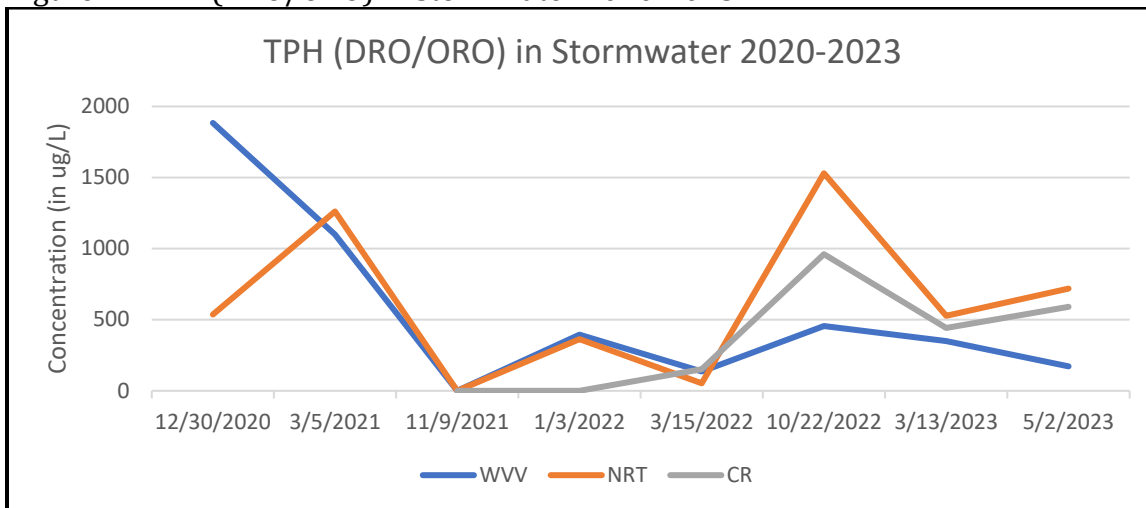
ND = Not detected above MDL

Although TPH (DRO/ORO) was reported as ND in all samples collected on 11/09/2021, the laboratory detection limit was higher on this date than on any other analysis date. Sample results of up to 300 ug/L may not have been considered as detected on that date.

A graph of TPH (DRO/ORO) at each location is provided in Figure 2. Without the potentially misleading dip to 0 ug/L (ND) at 11/09/2021, the TPH (DRO/ORO) concentrations at WVV and NRT would show a more gradual decline from the high just following the Almeda Fire to lower concentrations in early 2022.

Concentrations continue to decrease at WVV through 05/02/2023. Increased concentrations are observed on 10/22/2022 and 05/02/2023 at NRT and CR, however.

Figure 2 - TPH (DRO/ORO) in stormwater 2020-2023



Chromatograms of the stormwater samples are provided in Appendix D. The tall peak between 6 and 7 minutes on the chromatograms is the surrogate spike. The hydrocarbon peaks and/or hump of unresolved complex mixture to the left of the surrogate peak are generally in the diesel range and material to the right of the surrogate peak are generally in the oil range. The chromatograms for most samples show a slightly larger contribution from ORO than DRO. The ORO contribution is particularly noticeable for samples collected on 12/30/2020 and 01/03/2022 from WVV and NRT versus from CR. In general, the data show impact from a complex mix of hydrocarbons due to the presence of various petroleum products and some semi-polar/polar non-hydrocarbons related to biogenic materials.

4.1.3 SILICA GEL CLEANUP

Silica gel column cleanup (SGCC) was conducted on samples from 12/30/20 through 01/03/2022. SGCC removes polar compounds that are not typically abundant in petroleum products but are commonly present in many biogenic materials. Typical classes of biogenic compounds that are semi-polar/polar includes some tannins, lignins, resins, and fatty acids.

Comparison of samples analyzed before and after SGCC shows slight reductions in concentration following SGCC, indicating a minor contribution of polar organics in the results. Polar organics are generally related to natural plant material.

4.1.4 PERCEIVED IMPACT FROM ALMEDA FIRE

The TPH (DRO/ORO) data indicates a likely contribution to hydrocarbons in stormwater resulting from the Almeda fire, particularly in 2020 and early 2021. Later increases in TPH (DRO/ORO) at NRT, particularly on 10/22/22, are possibly related to cleanup and construction activities in the area at that

time or could be related to increased sediment in the sample related to heavy rainfall at the time of collection. The source of TPH (DRO/ORO) increases at CR in 2022 and 2023 are unknown.

4.1.5 AQUATIC HEALTH CONSIDERATIONS

Aquatic life water quality criteria were not available in the Oregon Department of Environmental Quality (DEQ) Administrative Rule OAR 340-041-8033 Table 30 and 31 Toxic Pollutants Lists for total petroleum hydrocarbons (TPH) in the diesel range and oil range (DRO/ORO). TPH includes a range of different chemical compounds, some of which were detected using SVOC analyses, the results of which are presented in section 4.3 below.

4.2 Volatile Organic Compounds (VOCs)

No volatile organic compounds were detected in stormwater samples on 11/15/20, 12/30/20, or 03/05/21. As a result, VOC and TPH-GRO analyses were discontinued following the 03/05/21 sampling event.

4.3 Semi-Volatile Organic Compounds (SVOCs) and SVOC Tentatively Identified Compounds (TICs)

Twenty-three SVOC parameters were detected above the MDL in stormwater samples collected between December 2020 and May 2023, including 17 at WVV, 20 at NRT and 18 at the reference site, CR. Fourteen SVOC parameters had at least one detection above RL. Tables with results for these 14 SVOCs at each sample location are presented in Appendix E. Nine of 17 detected parameters from WVV were above the RL at least one time and 9 of 20 detected parameters from NRT were above the RL at least once. Only 1 of 18 detected parameters from the reference site, CR was above the RL.

Of these parameters above the RL in the burned areas of WVV and NRT, bis(2-ethylhexyl)phthalate (also known as di(2-ethylhexyl)phthalate or DEHP), phenanthrene and pyrene were detected above the RL at both burn area locations, primarily on 12/30/2020 and 11/09/2021. The only parameter detected above the RL at the unburned, reference site CR, was phenanthrene, which was only detected once, on 03/15/2022.

DEHP was a prevalent contaminant at NRT. The highest concentration of DEHP was 3.03 ug/L. DEHP is a chemical used in plastics and is present in wall coverings, floor tiles, upholstery, shower curtains, garden hoses, shoes, sheathing for wires, etc. It is a common contaminant in stormwater, detected in 22% of samples in a 1978-83 EPA National Urban Runoff Study. (EPA, 1983).

Detections of polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene and pyridine were all recorded more than once. PAHs are formed from incomplete combustion of oil, gas, wood, garbage, and other organic substances. They are also found in asphalt and roofing materials. Pyrene, phenanthrene, chrysene and fluoranthene were detected in 15%, 12%, 10% and 10% of samples, respectively, in a 1978-83 EPA National Urban Runoff Study. (EPA, 1983).

Graphs of this data are provided in Appendix E. The graphs show that total SVOC concentrations of these 14 parameters were highest at WV and NRT on 12/30/2020 and declined in subsequent months. Concentrations of SVOCs at CR showed an increase from first measurements on 11/09/2021 through 10/22/22.

4.3.1 SVOC TICs

The only SVOC TIC detected at a significant concentration was hexadecenoic acid, at 44 ug/L. This compound is a saturated fatty acid related to plant material and is insignificant as relates to this study.

4.3.2 PERCEIVED IMPACT FROM ALAMEDA FIRE

The higher concentrations of SVOCs in stormwater from burned area locations at WV and NRT in 2020 and early 2021, which reduced over time, compared to lower concentrations at the reference location CR, indicates a likely contribution of some SVOCs in stormwater resulting from the Alameda fire.

A USGS report states that the most significant factor affecting SVOC concentrations in water is suspended solids (Lopes et al., 1998). PAHs in general do not dissolve well in water. They typically will stick to the surfaces of small particles. (ATSDR, 1995). As a result, the presence of sediment in the unfiltered stormwater samples may have impacted the number and concentration of PAHs detected on different dates of the study. The presence of sediment in samples is likely related to the intensity of precipitation at time of collection.

The USGS report also noted that PAHs, phenolic compounds, and phthalates in runoff from urban areas and roadways often exceed EPA drinking water and aquatic life standards and guidelines. This indicates that SVOC detections were likely influenced in part by normal roadway and urban contaminants.

Detections of SVOCs in pond water that were recorded following a fire at a construction and demolition debris pile included similar detected compounds such as 2-methylphenol and 3+4-methylphenol though at much higher concentrations (11.2 and 7.9 ug/L) (EPA. 2019) than detected in stormwater (0.27 and 0.47 ug/L) in this project. This indicates that these phenolic compounds have been detected in runoff as a presumed result of burned construction material.

4.3.3 AQUATIC HEALTH CONSIDERATIONS

Aquatic life water quality criteria for most detected SVOCs were not available in the OAR 340-041-8033 Table 30 or 31 Toxic Pollutants List or in a list of Water Quality Based Assessment Thresholds provided by the California Environmental Protection Agency (California EPA. 2016).

Fluoranthene: Aquatic life water quality guidance value for Fluoranthene in the OAR 340-041-8033 Table 31 Toxic Pollutants List is 3,980 ug/L – acute toxicity. The CA EPA acute toxicity threshold for fluoranthene is 398 ug/L. The highest concentration detected in stormwater (at WV) for fluoranthene was 0.136 ug/L.

PCP: The graphs in Appendix E indicate that the wood preservative pentachlorophenol (PCP) was a prevalent contaminant at WV and CR. PCP is a fairly common contaminant in stormwater, detected in 19% of samples in a 1978-83 EPA National Urban Runoff Study (EPA, 1983). The highest concentration of PCP detected in this study was 1.290 ug/L (at the unburned, reference location, CR).

Aquatic life water quality criteria for PCP per the OAR 340-041-8033 Table 30 are calculated based on measured pH of the samples, which ranged from 7.0 to 8.99 in this study. The highest detected PCP concentration of 1.290 ug/L was below the Acute/Criterion Maximum Concentration (CMC) calculated thresholds of 8.7 to 64.5 ug/L and below the Chronic/Criterion Continuous Concentration (CCC) calculated thresholds of 6.7 to 49.4 ug/L.

The highest detected concentration of PCP was also lower than the acute (5.3 ug/L) and chronic (4 ug/L) thresholds for PCP in water with a pH of 6.5 as listed in the California Toxics Rule Water Quality Based Assessment Thresholds (California EPA. 2016). Tables with these Aquatic Life Standards are presented at the end of Appendix E.

4.4 Per- and polyfluoroalkyl substances (PFAS)

Out of 32 individual PFAS compounds analyzed, 18 were detected in at least one of the stormwater collection sites. Of the 18 detections, 11 compounds had at least 1 detection above the laboratory reporting limit (RL) or Practical Quantitation Level (PQL). Six of the 11 compounds had more than one detection above the RL. These 6 compounds included PFDA, PFHpA, PFHxA, PFOA, PFOS and PFPeA. A table of the detections is included in Appendix F.

A graph of PFOA and PFOS concentrations at WV, NRT and at the reference site, CR, is provided in Figure 3. A graph of the other PFAS compounds detected above RL more than once (PFDA, PFHpA, PFHxA and PFPeA) is provided in Figure 4.

Figure 3 – PFOA and PFOS in stormwater 2021-2023

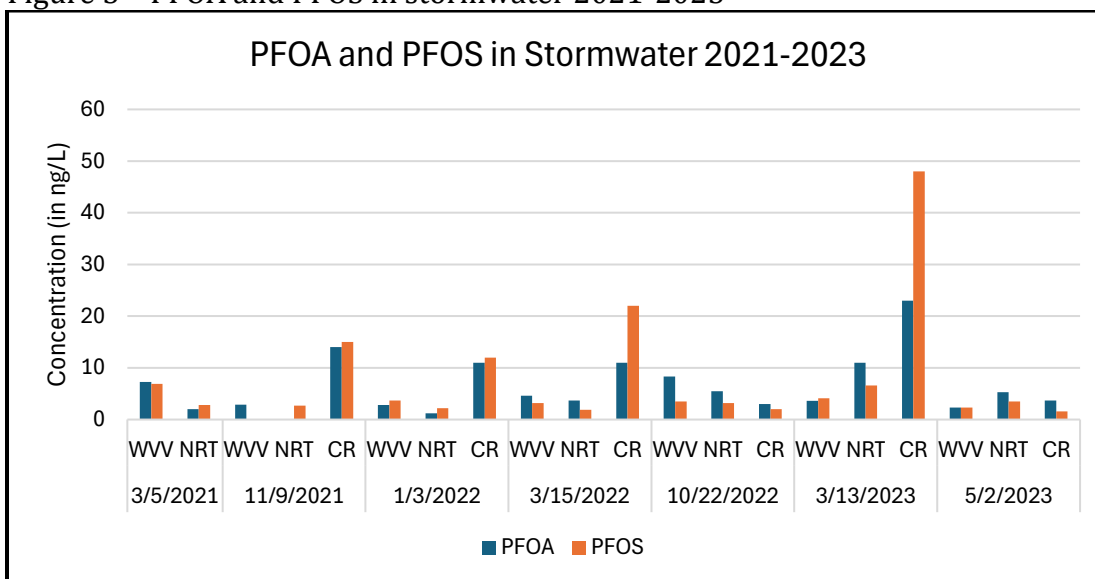


Figure 3 shows that PFOA and PFOS concentrations from 2021 through 2023 were higher at the reference site CR than in the burned area sites WV and NRT on most sample dates.

Figure 4 – Additional PFAS compounds in stormwater 2021-2023

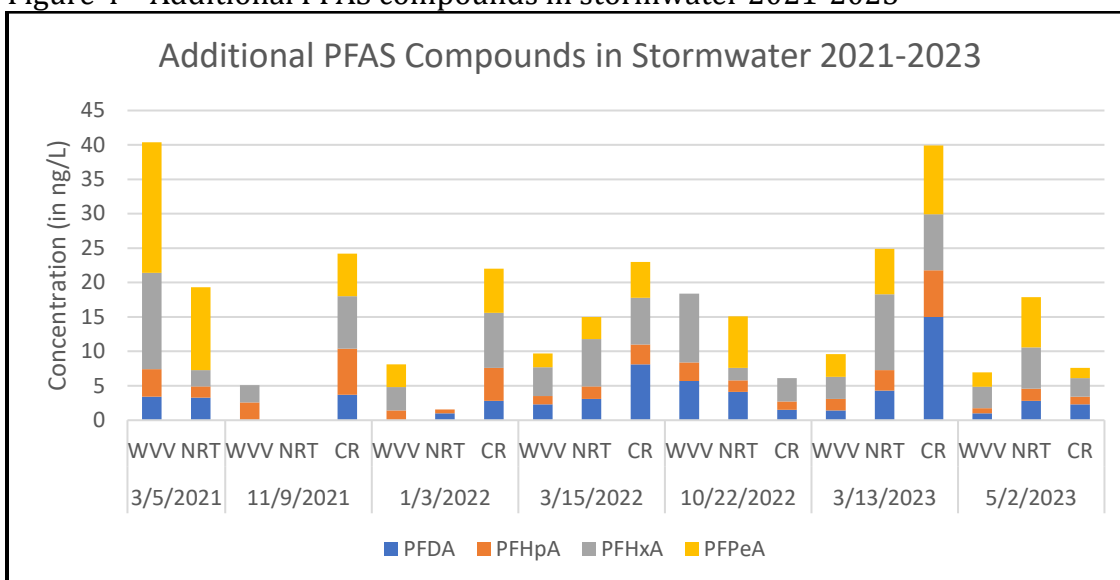


Figure 4 shows the concentrations over time of other PFAS compounds that had more than one detection above RL between 03/05/21 and 05/02/23. Figure 4 shows that the highest concentrations of PFHxA and PFPeA were detected at the WV site on the 03/05/2021 sample date. For 4 of the remaining 6 sample dates, the reference site CR generally had higher concentrations of PFAS compounds than the burned area sites WV and NRT.

4.4.1 PERCEIVED IMPACT FROM ALMEDA FIRE

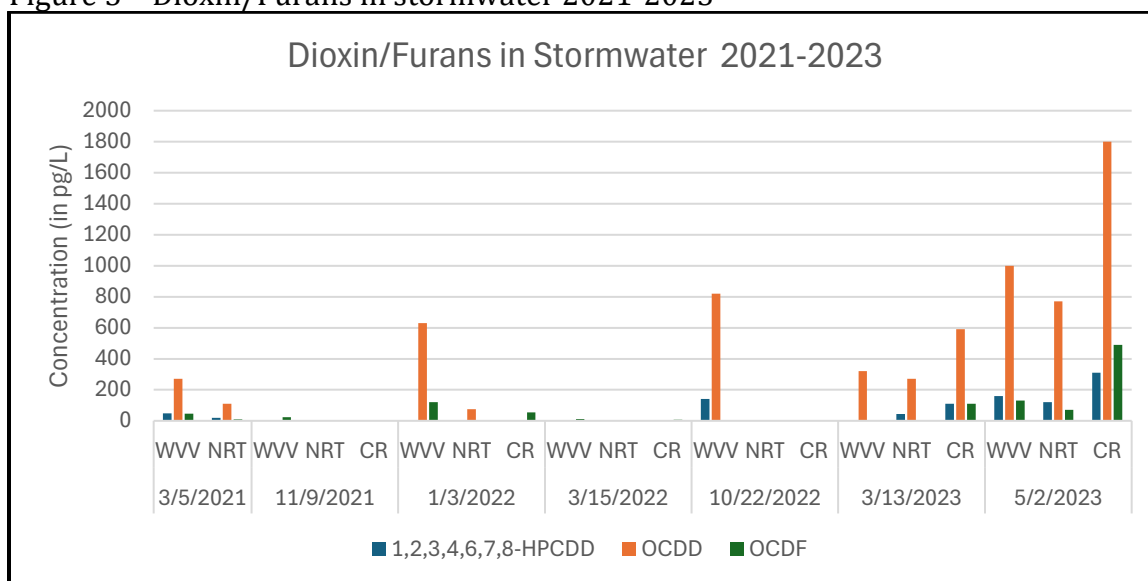
The elevated concentrations of PFAS at the reference location, CR, indicates that PFAS contaminants are generally present in stormwater at these sample sites and concentrations were not necessarily significantly impacted by the burned structures at WV and NRT.

4.5 Dioxin/Furans

Seventeen individual dioxin and furan compounds were analyzed for this study. Of these, 10 were detected in stormwater at WV, 7 at NRT, and 8 at the unburned, reference, site CR. A table with analytical results is provided in Appendix G.

The compounds most frequently detected were OCDD (octachlorinated dibenzo-*p*-dioxin), OCDF (octachlorinated dibenzofuran), and 1,2,3,4,6,7,8-HpCDD (heptachlorinated dibenzo-*p*-dioxin). OCDD was detected *above* the RL in 5 of 7 detections at WV, in 4 of 6 detections at NRT and in 2 of 6 detections at CR. OCDF was not detected *above* the RL at WV or NRT. OCDF was only detected *above* the RL in 1 sample at CR. OCDF was detected *below* the RL in 5 of 7 samples at WV, in 2 of 7 samples at NRT, and in 4 of 6 samples at CR. 1,2,3,4,6,7,8-HpCDD was detected *above* the RL in 3 of 4 detections at WV, and in 1 of 3 detections at CR. All 4 detections of this compound at NRT were *below* RL. A temporal graph of the most frequently detected compounds at WV, NRT and CR is provided in Figure 5.

Figure 5 – Dioxin/Furans in stormwater 2021-2023



Although the detections of dioxins and furans were more frequent and more frequently above the laboratory reporting level at WV through 10/22/22, the concentrations detected were higher at the reference location CV in 2023 than at WV or NRT. The maximum and average concentrations of dioxins in stormwater at the reference location, CV, were higher than those measured at WV or NRT for all

compounds except one, 2,3,4,7,8-PeCDF. In addition, the concentrations of dioxin/furans detected increased in many cases between 2021 and 2023.

4.5.1 PERCEIVED IMPACT FROM ALMEDA FIRE

These findings indicate that the presence of dioxins and furans in stormwater at the sample locations were not significantly impacted by the Almeda fire.

Dioxins and furans do not dissolve readily in water. In surface water, dioxins bind to organic and inorganic particles (Vartianinen, 1995). Therefore, it is likely that detections of these compounds in the water samples are related to sediment entrained in the sample. This possibility indicates that the variability in compound detection may be more related to the intensity of precipitation at the time of sample collection as well as the length of antecedent dry period than an actual variation in presence of dioxin/furan compounds in the area of sample collection.

4.6 Polybrominated diphenyl ethers (PBDEs)

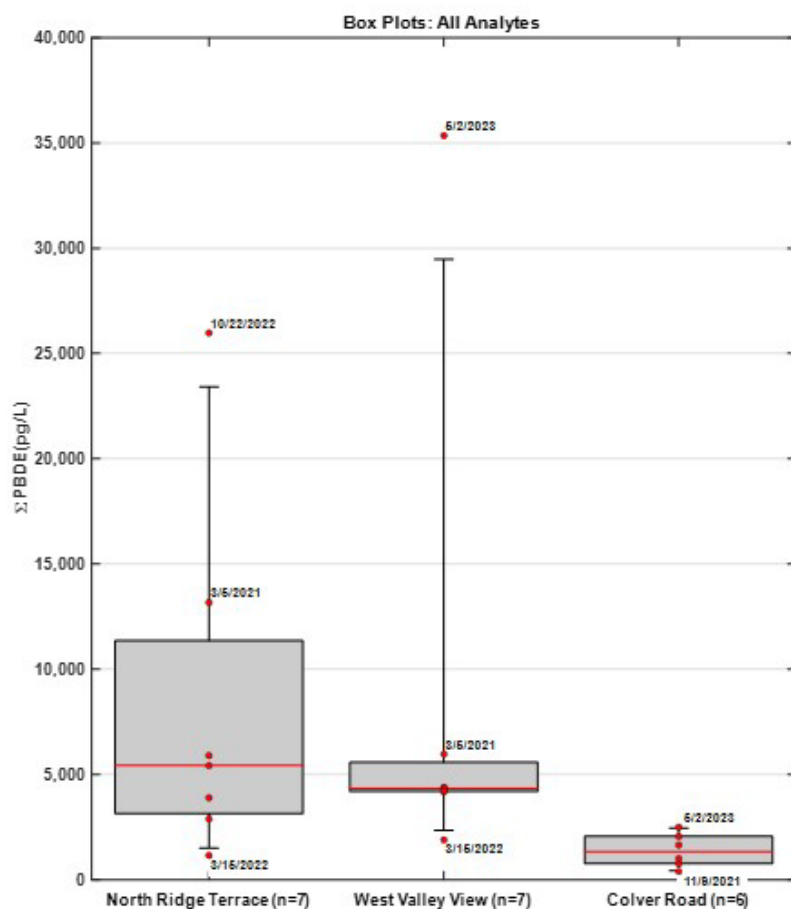
Forty-nine individual PBDE congeners were analyzed for this study. Of these, only one, BDE-10, was not detected in any sample at any location. 44 congeners were detected at WVV, 48 at NRT and 33 at CR. Of the congeners detected at WVV, 39 were detected at WVV at least twice, 42 were detected at NRT at least twice and 10 were detected on all 7 sample dates at both WVV and NRT. In comparison, at CR, only 25 congeners were detected at least twice, and 10 were detected on all 6 sampling dates at that location.

A reduced set of 20 PBDE congeners which had at least one detection above the RL for any location was used for further data evaluation. Tables of the reduced set of PBDEs for each sample location are provided in Appendix H.

Box plots created using the sum of these 20 congeners for each sample date at all three sample locations are provided in Figure 6. The horizontal red line on each plot is the median total concentration. The grey boxes demonstrate the range of summed concentrations from the 25th percentile to 75th percentile, and the whiskers from 10th and 90th percentiles. The highest and lowest concentration samples are labeled with the sample date.

The box plots show that summed PBDE concentrations and the spread of summed concentrations per sample date were highest in samples from the burned areas, NRT and WVV. While the maximum summed PBDE concentration was highest for WVV samples, the median concentration for WVV and NRT samples were similar, but higher at NRT. The spread of summed concentrations in samples from the reference location CR was much more confined and overall concentrations were lower at CR than WVV and NRT.

Figure 6 – Box plots of PBDE results per sample collection location

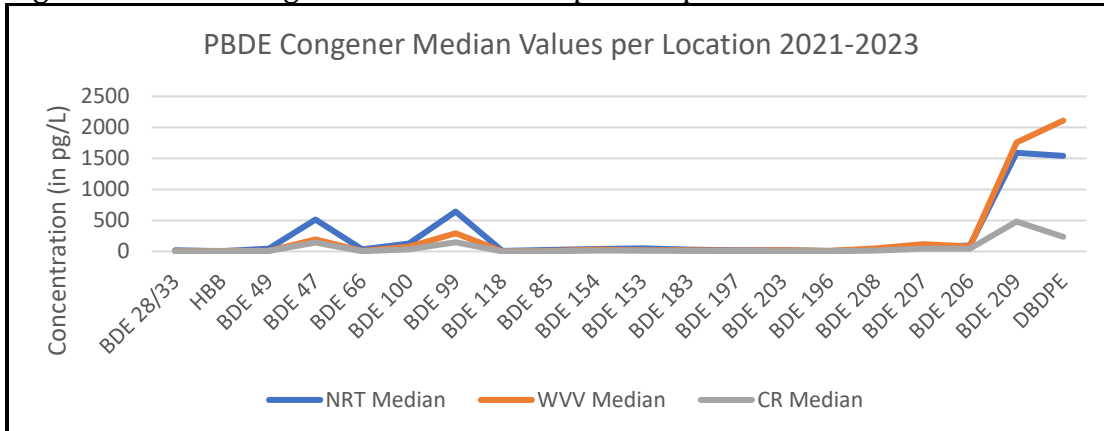


Box Plots were provided by Glenn W. Johnson of GeoChem Metrics, Inc.

A graph of median PBDE concentrations per congener for each site is provided in Figure 7. The graph shows that samples from burned area NRT had the highest median concentrations in most cases. Clear exceptions to this are for compounds with higher densities, BDE 207, BDE 208 and BDE 209 and DBDPE, at WVV.

Stacked bar graphs of PBDEs in stormwater at each sample location are provided in Appendix H. The graphs illustrate the considerably higher combined concentration of PBDEs at WVV on 05/02/2023 and the considerably higher combined concentration of PBDEs at NRT on 03/05/2021 and 10/22/2022. Concentrations at CR are considerably lower than either WVV or NRT on all dates, although there is an interesting, slight, upward trend in the PBDE concentrations over time at CR. Note that the graphs stack the lowest congeners (BDE 28/33 at the base and the highest congeners (BDE 209 and DBDE on the top).

Figure 7 – PBDE congener median values per sample collection location



Figures 8 and 9 (regular scale and zoomed in version) illustrate the proportions of each PBDE homolog group detected at each sample location between 03/05/2021 and 05/02/2023. The graphs illustrate that tetra-, penta- and deca-BDEs seem to be the most prevalent homologs present.

Figure 8 – PBDE homolog groups in stormwater per sample date 2021-2023

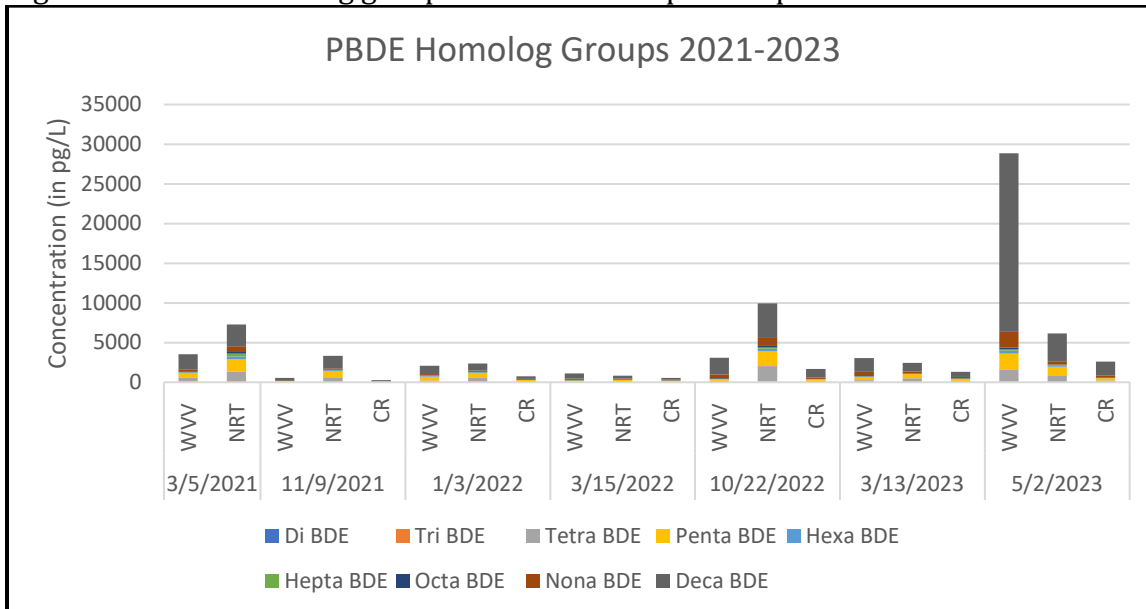
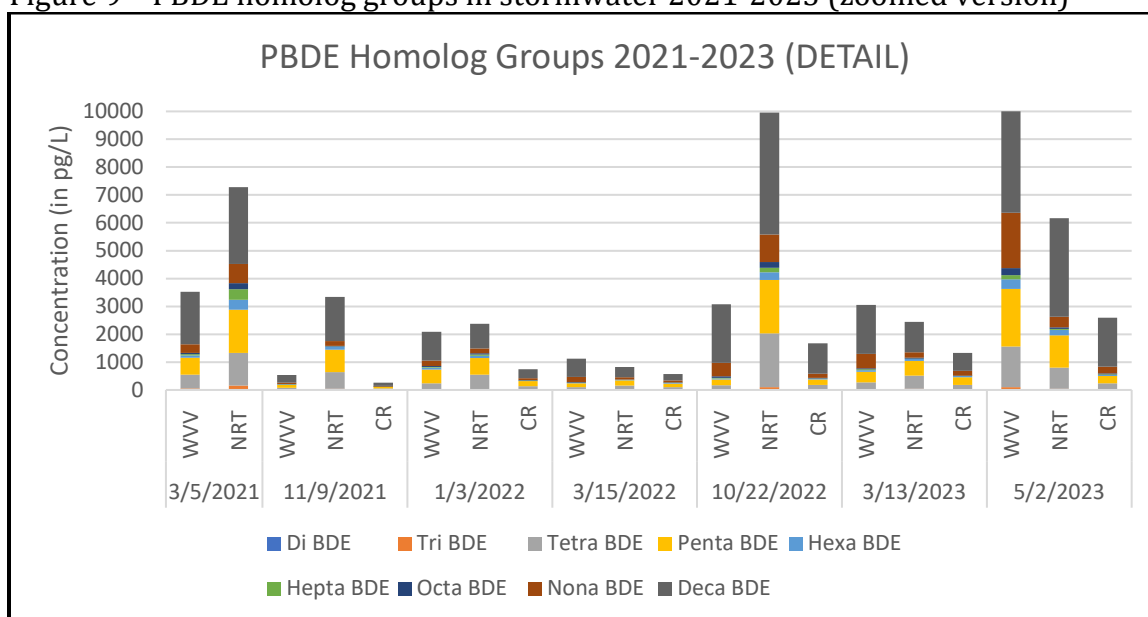


Figure 9 – PBDE homolog groups in stormwater 2021-2023 (zoomed version)



4.6.1 PERCEIVED IMPACT FROM ALMEDA FIRE

The higher concentrations of detected PBDEs at WV and NRT versus CR indicates a likely contribution to PBDEs in stormwater resulting from the Almeda fire.

PBDEs are expected to primarily adsorb to sediments and particulate matter so variations in detections in stormwater may be related to sediments entrained in the stormwater samples.

4.6.2 AQUATIC HEALTH CONSIDERATIONS

Aquatic life water quality criteria for PBDEs were not available in the OAR 340-041-8033 Table 30 or 31 Toxic Pollutants List or in a list of Water Quality Based Assessment Thresholds provided by the California Environmental Protection Agency (California EPA. 2016).

A small number of PBDE congeners are found most frequently and in the greatest concentrations in human and environmental samples. In samples from fish and humans, BDE-47 tends to be found most frequently, followed by BDEs 99, 100, 153 and 154. BDE 209 (a decaBDE) is often found in environmental media such as sediment and household dust (EPA 2009).

Lower brominated congeners of PBDE (like tetra-, penta- and hexa-BDEs) tend to bioaccumulate more than higher brominated congeners and are more persistent in the environment (De Wit 2002 and ATSDR, 2017). However, more highly brominated congeners such as BDE 206 through BDE 209 can breakdown to form lesser brominated PBDEs in the environment or metabolically within fish and other

animals. (EPA 2009). Deca and octa-brominated congeners are also known to degrade to brominated bibenzofurans and dioxins under high temperatures caused by fires. (Siddiqi et al. 2003). In addition, a 2013 study of the impact of BDE-209 on the growth of microalgae concluded that the presence of BDE-209 showed acute toxic effects on both species of microalgae tested (Zhang, 2013). PBDEs are also reported to act as endocrine system disruptors. (EPA, 2012).

5.0 BEAR CREEK WATER QUALITY RESULTS

5.1 Total Petroleum Hydrocarbons (TPH) as Gas-Range Organics (GRO), Diesel-Range Organics (DRO), or Oil-Range Organics (ORO)

5.1.1 TOTAL PETROLEUM HYDROCARBONS – GAS RANGE ORGANICS

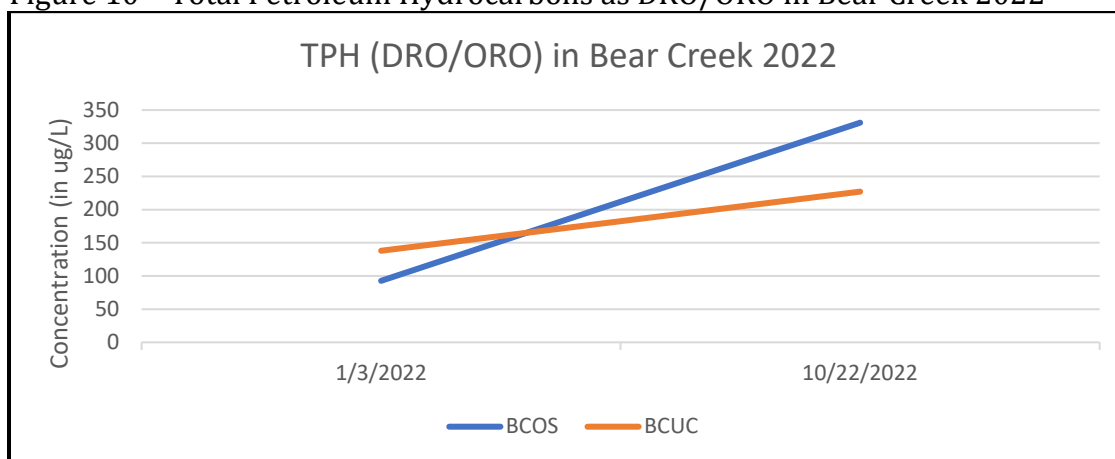
Samples from Bear Creek at BCUC and BCOS were not analyzed for TPH-GRO.

5.1.2 TOTAL PETROLEUM HYDROCARBONS – DIESEL AND OIL RANGE ORGANICS

Samples from BCUC and BCOS were collected and analyzed for TPH-DRO/ORO on 01/03/22 and 10/22/22. Samples from 01/03/22 were also analyzed for TPH-Dx with silica gel (column) cleanup.

A graph of TPH (DRO/ORO) results is provided in Figure 10. Detections were slightly higher at BCUC, downstream of the burned area, than at the reference location, BCOS, on 01/03/2022 and had the opposite relationship by 10/22/22.

Figure 10 – Total Petroleum Hydrocarbons as DRO/ORO in Bear Creek 2022



Slight reductions in TPH (DRO/ORO) concentrations following silica gel cleanup indicate that part of the TPH detected is due to polar organics, likely from natural sources.

5.1.3 PERCEIVED IMPACT FROM ALMEDA FIRE

This data set is insufficient to indicate a contribution to hydrocarbons in Bear Creek resulting from the Alameda fire.

5.2 Volatile Organic Compounds

No volatile organic compounds were detected in samples from Bear Creek at BCUC on 11/04/20, 11/15/20 and 12/17/20. Samples were not collected at BCOS on those dates. VOC analysis was discontinued for creek samples after 12/17/20.

5.3 Semi-Volatile Organic Compounds (SVOCs) and Tentatively Identified Compounds (TICs)

The only SVOC with detections above the RL in Bear Creek was benzo(a)pyrene at a concentration of 0.54 ug/L at BCUC on 12/17/20. The 2020 NRC laboratory SVOC results were only reported to the RL (not the MDL) so SVOC detections, if below 0.50 ug/L, were not reported. Apex Laboratories used a much lower detection limit for SVOCs which resulted in more detections in samples from BCOS and BCUC in 2022. Benzo(a)pyrene was detected at BCUC again on 10/22/22, though at much lower concentrations (0.0171 ug/L) and below the RL. Benzo(b)fluoranthene was also detected at BCUC below the RL (at 0.0155 ug/L). Both detections were unique to BCUC. A table of all detections of SVOCs for each sample location is provided in Appendix E.

Pyrene was also detected at BCUC only, on 10/22/22, at a very low concentration. Other SVOC parameters detected below the RL were naphthalene, benzyl alcohol and pentachlorophenol (PCP), all detected on 01/02/22 at both BCUC and BCOS. The naphthalene and PCP concentrations were greater at the upstream reference site, BCOS, than downstream of the burned area at BCUC.

5.3.1 PERCEIVED IMPACT FROM ALMEDA FIRE

The presence of benzo(a)pyrene and benzo(b)fluoranthene at BCUC and none at BCOS indicates a possible impact of on creek waters due to materials burned during the Alameda fire. Higher laboratory detection limits in 2020 than in 2022 may have influenced the lack of SVOC detections in Bear Creek on 11/04/2020 and 11/15/2020 and makes comparison of data from these dates difficult.

Because benzo(a)pyrene, benzo(b)fluoranthene and pyrene were all recorded more than once in burned area stormwater samples at WVV and NRT and only once at the reference site CR, there is a possible connection between the detections of these parameters in stormwater and in the creek at BCUC.

Aquatic life water quality criteria for most detected SVOCs were not available in the OAR 340-041-8033 Table 30 or 31 Toxic Pollutants List or in a list of Water Quality

Based Assessment Thresholds provided by the California Environmental Protection Agency (California EPA. 2016).

5.4 Per- and polyfluoroalkyl substances (PFAS)

Out of 32 PFAS compounds analyzed between 11/4/20 and 10/22/22, 15 were detected in either the BCUC or BCOS site. In Table 4, concentrations above the RL are shown in bolded black. Concentrations below the RL but above the MDL are shown in orange.

Of the 15 compounds detected, only 5 compounds were detected above the laboratory reporting limit (RL) (or Practical Quantitation Level [PQL]). These compounds included PFBS, PFHxA, PFOA, PFOS and PFPeA. Four of the compounds were detected above RL at both sites. PFPEA was only detected above RL at the downstream, BCUC site, but not at the upstream, BCOS location.

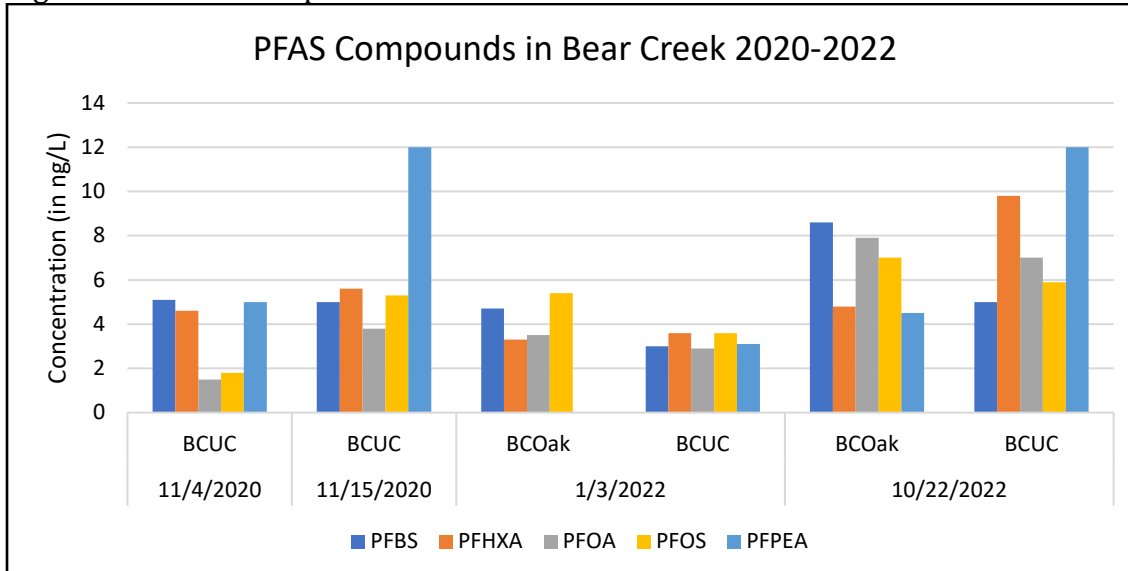
Table 4 – PFAS compounds in Bear Creek 2020-2022

Location	BCUC (downstream of fire)					BCOS (upstream)	
Date	11/4/2020	11/15/2020	12/17/2020	1/3/2022	10/22/2022	1/3/2022	10/22/2022
Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
PFBA	1.4	ND	2.4	1.6	3.2	3.2	7.4
PFBS	5.1	5	3.5	3	5	4.7	8.6
PFDA	ND	0.88	0.44	0.81	0.92	1.2	2
PFDOA	ND	ND	ND	ND	ND	0.52	ND
PFHpA	0.64	1.3	1.3	1.4	2.5	2.1	4
PFHxA	4.6	5.6	3.1	3.6	9.8	3.3	4.8
PFHxS	1.3	ND	0.59	1.1	0.92	1.1	1.5
PFNA	ND	ND	0.49	1.2	2	1.1	1.9
PFOA	1.5	3.8	2.6	2.9	7	3.5	7.9
PFOS	1.8	5.3	3.2	3.6	5.9	5.4	7
PFOSA	ND	ND	ND	1.8	0.69	3.4	ND
PFPeA	5	12	2.9	3.1	12	ND	4.5
N-MeFOSAA	ND	ND	ND	ND	0.69	ND	1
NMeFOSE	ND	ND	ND	ND	4.1	ND	ND
6:2 FTS	ND	ND	0.5	ND	ND	ND	ND

Concentrations of these compounds were detected at similar levels at both sites and occasionally were higher at the upstream, reference site BCOS than at the BCUC location downstream from the burned area.

The exception is for PFPeA, which was detected twice at BCUC at 12 ng/L and at considerably lower levels at BCOS. Figure 11 shows concentrations of PFOA and PFOS concentrations over time.

Figure 11 – PFAS compounds in Bear Creek 2020-2022



The lack of data from the upstream location, BCOS, in 2020 makes comparison with downstream data impossible prior to 2022. Elevated concentrations of PFPeA at BCUC but not at BCOS may merit further consideration.

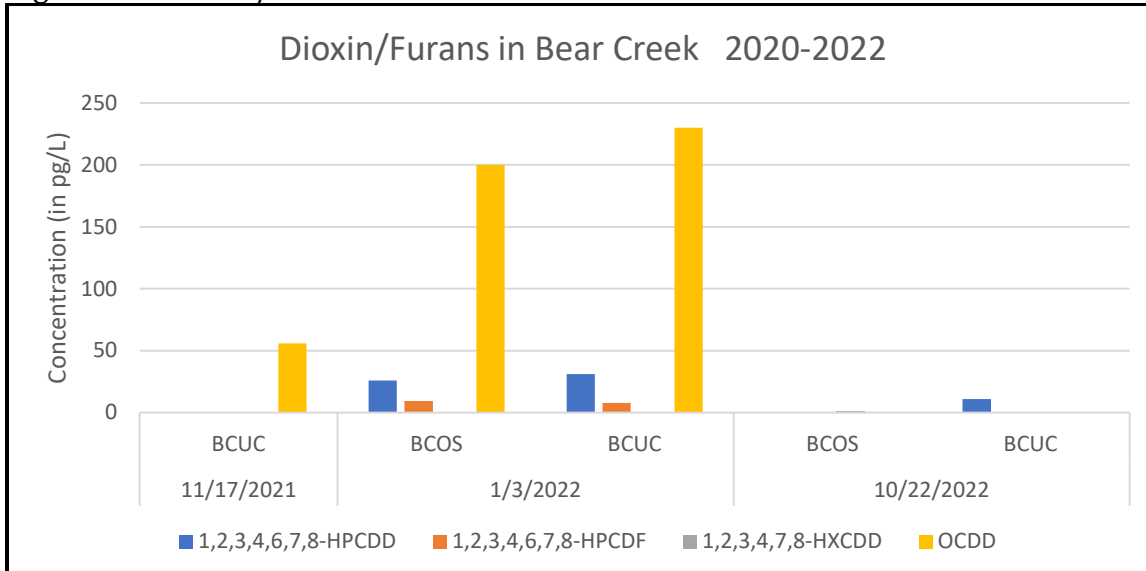
5.4.1 PERCEIVED IMPACT FROM ALMEDA FIRE

The elevated concentrations of PFAS at the upstream location, BCOS, on 01/03/2022 and 10/22/2022 in comparison to concentrations at the downstream location BCUC indicates that PFAS contaminants are generally present in Bear Creek at these sample sites and concentrations were not necessarily significantly impacted by the structures burned during the Almeda Fire. Elevated concentrations of PFPeA at BCUC but not at BCOS may merit further consideration.

5.5 Dioxin/Furans

Seventeen individual dioxin and furan compounds were analyzed for this study. Of these, only 4 were detected in Bear Creek at BCOS. Three of the same compounds and one other were detected at BCUC. A table with analytical results is provided in Appendix G. Figure 12 illustrates the similarity on 01/03/22 in concentrations of dioxin/furan compounds downgradient of the burned area at BCUC and upgradient of the burn, at BCOS. No dioxins were detected in BCUC on 11/04/2020 and only OCDD was detected on 11/17/2020. BCOS was not sampled in November of 2020. Dioxin detections were considerably reduced on the 10/22/2022 sampling date.

Figure 12 – Dioxin/Furans in Bear Creek 2020-2022



NOTE: The only data above the RL is the 11/17/2020 result from BCUSCellular

The compounds most frequently detected in Bear Creek were OCDD (octachlorinated dibenzo-*p*-dioxin), 1,2,3,4,6,7,8-HpCDD (heptachlorinated dibenzo-*p*-dioxin) and 1,2,3,4,6,7,8-HpCDF (heptachlorinated dibenzofuran). Only one compound (OCDD) was detected above the RL - at BCUC on 11/17/2020.

Although the detections of dioxin/furans were slightly more frequent at the burned site BCUC, the concentrations detected and the toxic equivalency quantity (TEQ) of the compound mixture were similar at both the burned and unburned sample collection sites.

5.5.1 PERCEIVED IMPACT FROM ALMEDA FIRE

These findings indicate that the presence of dioxins and furans in stormwater at the sample locations were not significantly impacted by the Almeda fire.

Dioxins and furans do not dissolve readily in water and therefore it is likely that detections of these compounds in the water samples were related to sediment entrained in the sample. This possibility indicates that the variability in compound detection may be more related to the intensity of precipitation at the time of sample collection than an actual variation in presence of dioxin/furan compounds in the area of sample collection.

5.6 Polybrominated diphenyl ethers (PBDEs)

Forty-nine individual PBDE congeners were analyzed for this study. Of these, 43 congeners were detected at BCUC and 36 at BCOS. Of the congeners detected at

BCUC, 35 were detected at least twice and 12 were detected on all 5 sample dates. At BCOS, 23 were detected on the 2 sampling dates for that location. A reduced set of 15 PBDE congeners which had at least one detection above the RL for either location was used for further data evaluation. Tables of the reduced set of 15 PBDEs for each sample location are provided in Appendix H. Note that the sample location used by Grants Pass Water (GP) in 2020 (called Bear Creek Greenway) is in the same location as the BCUC location used in the RVCOG study for later sample collection.

Stacked bar graphs of the reduced set of PBDEs in Bear Creek at each sample location are provided in Figures 13 and 14. The graphs illustrate varying concentrations of PBDEs at BCUC in the early months following the September 2020 fire and into 2022. Note that the graphs stack the lowest congeners (BDE 28/33 at the base and the highest congeners (BDE 209 and DBDE on the top). No samples were collected for PBDE analysis from the upstream location, BCOS, until 01/03/22 so comparison of 2020 data is not possible.

Of interest is 1) the increase in total PBDE concentrations at BCUC from 11/04/20 to 12/17/20, 2) the elevated total PBDE concentration at BCOS versus BCUC on 10/22/22 and 3) a spike in concentration, particularly of BDE 47 and BDE 99 on 10/22/22 and a relatively reduced concentration of BDE 209 and DBDPE on that date compared to 12/17/2020 and 01/03/2022 (see Table in Appendix H).

Figure 13 – PBDEs in Bear Creek at BCUC 2020-2022

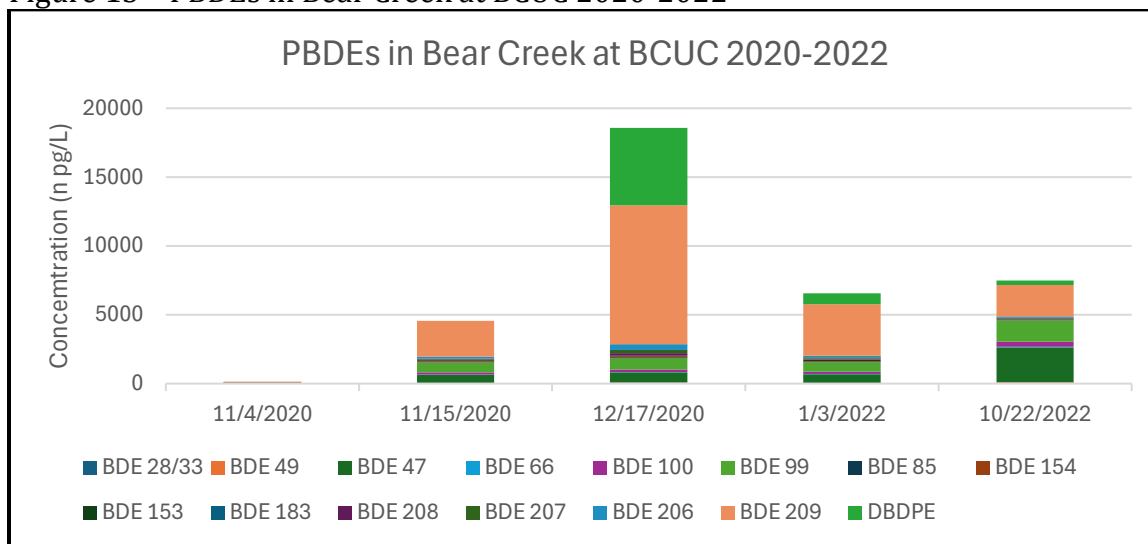
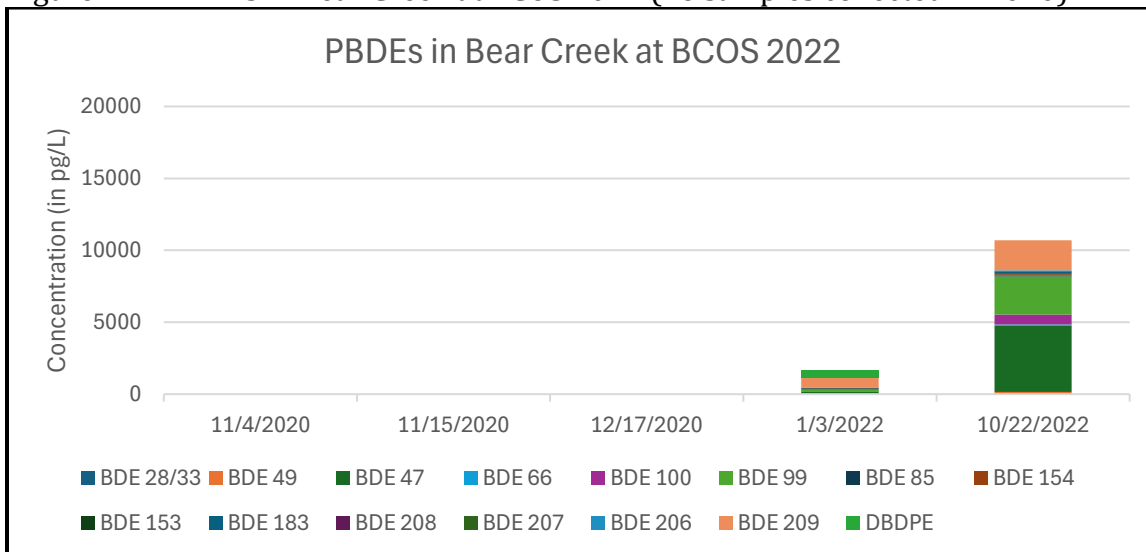
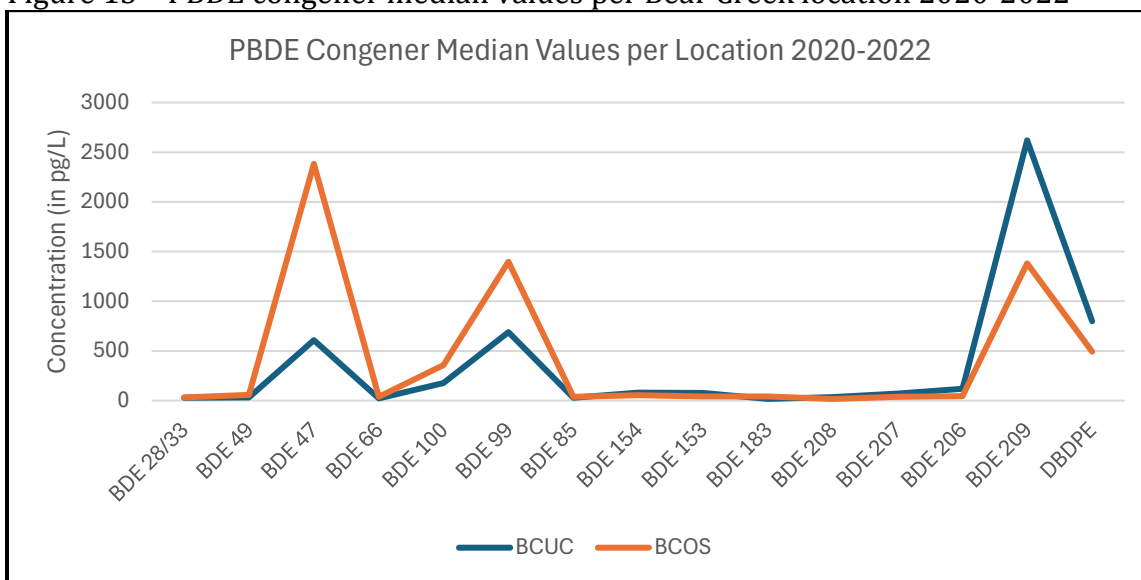


Figure 14 – PBDEs in Bear Creek at BCOS 2022 (no samples collected in 2020)



A graph of median PBDE concentrations per congener for each site is provided in Figure 15. The graph shows that samples from upstream of the burned area, at BCOS, had the highest median concentrations of lower brominated congeners (i.e. BDE 47 and BDE 99). For congeners with higher densities, particularly BDE 209 and DBDPE, samples from downstream of the burned area, at BCUC, had higher median concentrations.

Figure 15 – PBDE congener median values per Bear Creek location 2020-2022

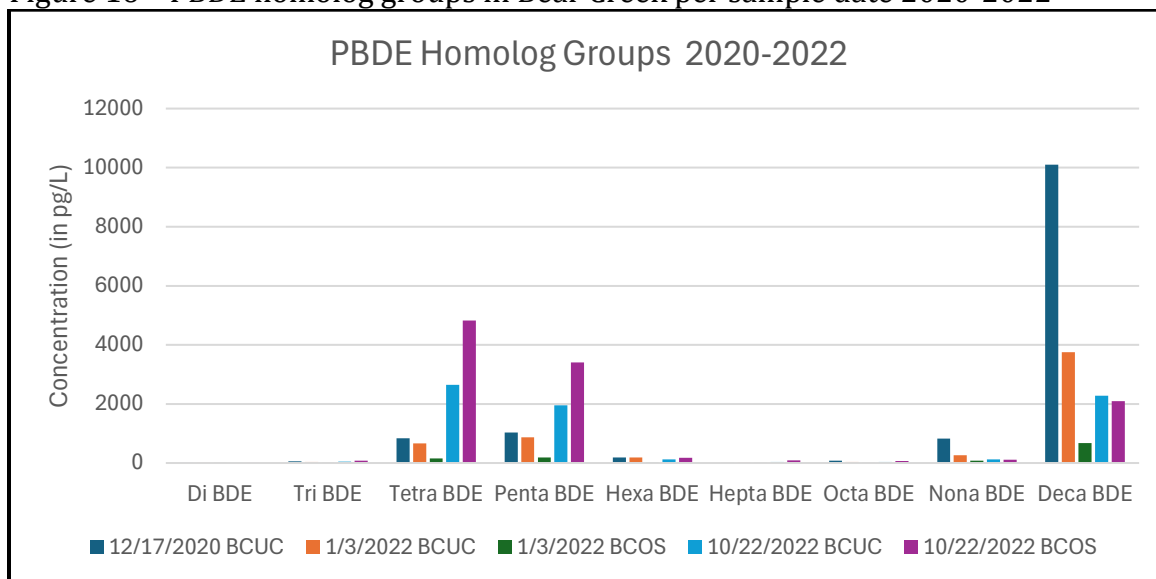


In Appendix H, a second graph of median PDBE concentrations is provided which compares only data from 01/03/22 and 10/22/22. The 2022-only graph shows a

smaller difference in median concentrations between locations for BDE 47 and BDE 99 (the high concentrations for these congeners on 10/22/22 skew high the 2022-only results for BCUC). Similarly, the 2022-only results are skewed higher for the BDE-209 results, increasing the difference between the BCOS and BCUC median for that congener.

Figure 16 illustrates the proportions of each PBDE homolog group detected at each sample location between 12/17/2020 and 10/22/2022. The graph illustrates that tetra-, penta- and deca-BDEs are the most prevalent homologs present.

Figure 16 – PBDE homolog groups in Bear Creek per sample date 2020-2022



Higher brominated congeners like BDE-209 are considered to be less toxic than lower brominated congeners such as BDE-47 since they are less likely to bioconcentrate in humans and aquatic organisms (ATSDR, 2017). However, a 2013 study of the impact of BDE-209 on the growth of microalgae concluded that the presence of BDE-209 showed acute toxic effects on both species of microalgae tested (Zhang, 2013).

5.6.1 PERCEIVED IMPACT FROM ALMEDA FIRE

Although the stormwater data presented in Section 4.7 indicates a contribution of PBDE contaminated stormwater to Bear Creek from both WV and NRT outfalls, the PBDE concentrations in Bear Creek measured in 2022 do not conclusively indicate an impact on Bear Creek contamination due to the Almeda Fire.

6.0 DISCUSSION OF WATER QUALITY RESULTS

Stormwater and Creek water quality results can be impacted by a variety of factors, among them the intensity and longevity of the rain events and activity in the area at the time of rainfall. While the RVCOG-OWEB project sampling plan attempted to control for rainfall intensity by targeting rainfall events of greater than 0.25 inches with antecedent dry weather periods of no less than 72 hours, the actual rainfall and intensity during the time of sample collection varied depending on time and specific location of sampling. The rainfall intensity and cleanup and construction activity in the stormwater catchment basins during the rain events can impact sediment load in stormwater outfalls and likely impact contaminant load.

During the course of this study, ash, burned cars, structures, oil tanks and soils were removed from the burned sites, primarily in 2021 and 2022. New homes were constructed, primarily during 2022, although construction activity was ongoing in some areas throughout 2023. It is important to note that soil and materials disturbance during these activities likely impacted the concentrations of contaminants available to be entrained in stormwater. Maps of the stormwater conveyance layouts and satellite imagery showing partial reconstruction in the burned areas are provided in Appendix I.

Several of the contaminants studied tend to adhere to sediments and do not dissolve well in water. Because of this, if a sample of stormwater or creek water contained a larger sediment load than other samples, it could impact contaminant concentrations. Concentrations of concerns for parameters measured in this study are small to miniscule, ranging from ug/L to pg/L (a pg/L is equivalent to 1 part per quadrillion, or, 1 minute in 1 billion years). Therefore, even miniscule variations in conditions can influence detected levels of some contaminants.

It is recommended that any future similar study separate any entrained sediment from the stormwater samples prior to sampling and to measure concentrations in both the sediment alone and in the separated water sample. Since several of the parameters tested tend to adhere to soil, testing of soils in drainage areas and possibly from river beds following an urban fire is also recommended.

7.0 RECOMMENDATIONS

Based on experiences in this study, the following recommendations are suggested for future evaluation of environmental impacts from a similar large urban burn site:

1. Have a funding source and sampling plan ready so that environmental sampling can begin immediately following the fire.
2. More sampling locations and more frequent sampling of stormwater and creek water would benefit the study.

3. Soil sampling from the creek bed or from sediment deposited from overland flow could provide better data for parameters which don't dissolve well in water such as PBDEs and dioxin/furans. Alternatively, separating sediment from the stormwater or creek water collected and analyzing both the separated sediment and the water sample could improve evaluation of the presence of those parameters.
4. Options for similar stormwater sample sites may be few and decisions need to be made quickly following a fire event which is by nature unexpected. However, identifying upwind, unimpacted, reference sites which are similar in size and area/type of land use as the impacted, burned sites is important. Samples from reference locations should be collected along with impacted samples, from the start of the project.
5. If possible, measurements of stormwater flow should be collected at the time of sampling to benefit evaluation of sample results.
6. Laboratory selection is important. Laboratories should be selected for high level of quality control and for the ability to detect low level concentrations.
7. For each sampling date, it would be beneficial to have notes and/or photographs of conditions in the area contributing stormwater to the sampled outfall. If this cannot be done on the sampling date due to darkness or other factors, collecting the data soon afterward would be an option.

8.0 USE OF THIS REPORT

This report was prepared for the use of the Rogue Valley Council of Governments and relates specifically to the stormwater and creek samples collected and analyzed for the 2020-2023 Alameda Post-Fire Water Quality Investigation. It is warranted that within the limitation of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions as this project. We make no other warranty, either express or implied.

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