Oregon Health Authority
Drinking Water Services

December 30, 2022

Oregon Wildfires: Impacts on Drinking Water Systems and Water Quality

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Acknowledgements

This report was supported by a Multipurpose Grant for States and Tribes funded by the U.S. Environmental Protection Agency. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. Environmental Protection Agency or Oregon Health Authority Drinking Water Services.

Oregon Health Authority Drinking Water Services thanks principal authors Kaden Flick, Nicole Alfafara, Russell Kazmierczak, and Casey Lyon.

Additionally, Oregon Health Authority Drinking Water Services thanks all individuals, water systems, agencies and organizations that contributed to and made possible the 2020 volatile organic compound monitoring efforts, the 2020 Oregon wildfire response, and information development related to the 2020 wildfires and drinking water systems. Oregon Health Authority Drinking Water Services extends special thanks to:

- Nielson Research Corporation
- Oregon Department of Environmental Quality Laboratory and Environmental Assessment Division
- Oregon Association of Water Utilities (OAWU)
- Oregon State University
- Rural Community Assistance Corporation (RCAC)
- U.S. Environmental Protection Agency

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Executive summary

Wildfires are disasters that pose complex challenges when protecting drinking water infrastructure and quality. The impacts of wildfires on drinking water quality and drinking water infrastructure are diverse and knowledge continues to evolve. The purpose of this report is to enhance understanding of wildfire impacts on drinking water systems. The first objective is to synthesize and summarize volatile organic compound (VOC) contamination analytical results from Oregon public drinking water systems impacted by the 2020 wildfires. The second objective is to evaluate perspectives and insights from impacted water system operators and emergency response staff to create a collection of information and lessons learned from 2020 wildfire response efforts. Information in this report can be utilized by drinking water system operators, emergency response mangers and coordinators, and other agencies faced with wildfire response in the future.

Oregon Health Authority Drinking Water Services (OHA-DWS) required water systems impacted by the 2020 wildfires that lost water pressure in the distribution system and sustained structure loss or physical damage to test all burned structures' service lines for VOC contamination prior to restarting service. This testing, which is ongoing, revealed VOC contamination in 20 of the 25 systems tested to date. In six systems, at least one VOC was detected at levels that exceeded the maximum contaminant level (MCL) or health advisory level (HAL), with benzene being the most common exceedance. (23) Through conversations with system operators and in an online survey distributed to emergency response staff, several key recommendations for improving public water system response to wildfire were determined, including developing and maintaining emergency response plans (ERPs), streamlining communication between operators and outside agencies and reducing hurdles to applying for and receiving financial assistance.

For wildfire response and water system resilience to improve, continued assessment of current patterns and trends in VOC contamination and system recovery challenges is necessary. Summaries of VOC data for each individual drinking water system participating in testing are included in the appendices of this report. Findings in this report are also summarized and can be viewed in the formats listed below.

- Esri ArcGIS StoryMap (11)
- Esri ArcGIS Web Mapping Application (12)
- Esri ArcGIS Web Experience (13)
- Key Findings Fact Sheet (14)

Introduction

Wildfires and drinking water

On Labor Day 2020 a combination of high temperatures, dry fuels and strong east winds led to an unprecedented number of wildfires burning simultaneously across Oregon. Wildfires have a devastating impact on infrastructure in the built environment, especially in wildland urban interface communities, and the 2020 wildfires were no different. (2,3,18) Over the course of Oregon's 2020 wildfire season, over one million acres — twice the ten-year average — were burned by 229 fires. (15) By the end of the 2020 fire season, 4,129 homes were destroyed, 40,000 people were evacuated, and 11 people lost their lives. (15) OHA-DWS identified 37 public water systems that sustained wildfire damage. The Oregon Office of Emergency Management (OEM) puts the conservative estimate for damages caused by the 2020 wildfires at over 380 million dollars. (15)

In addition to damaged infrastructure, wildfires also have numerous environmental health impacts like smoke exposure and potential drinking water source contamination. (1,5,7,19) Following the 2017 Tubbs and 2018 Camp fires in California, VOC contamination in levels that exceeded state and federal government exposure limits were found to be present in buried water distribution and service lines of impacted systems. (16) Several studies have since been conducted to understand the source of this VOC contamination in drinking water systems damaged by wildfire and have identified several vectors of contamination including loss of system pressure, burned and melted service lines and meter boxes, and loss of structures connected to water systems. (4,6,17,18) During a fire, residential plumbing and other water distribution components can be damaged and water lines can become depressurized, leading to back siphonage that can potentially spread contaminated water to other parts of the drinking water distribution system and suck in contaminated air, smoke and ash. (6,16) Plastic pipes can be thermally degraded when exposed to temperatures produced by wildfires and have been shown to generate and then leach VOCs into drinking water. (6)

As part of the response to the 2020 wildfires in Oregon, OHA-DWS immediately recognized the public health risk of contamination from VOCs, including the known carcinogen benzene, in drinking water systems. OHA-DWS notified water systems damaged by the 2020 wildfires of the risks associated with VOC contamination and began an organized effort to have impacted systems damaged by fire and that lost pressure collect and analyze samples to determine the extent of VOC contamination. OHA-DWS received emergency funding from the state legislature to develop a VOC testing program and collaborated with the Oregon Department of Environmental Quality (DEQ) laboratory and operators of impacted water systems to collect water samples at no cost to water systems with service populations of 3,300 people or fewer. Initially, water systems were asked to test for VOCs at locations throughout the distribution system including mainlines, burned service connections and unburned service connections. OHA-DWS later required all water systems that lost water pressure and sustained structure damage to test all burned service connections prior to restarting water service. If sample analysis

revealed VOC contamination exceeding the MCL for a given service connection, the water system was required to take corrective action.

OHA-DWS worked with DEQ and private laboratories to analyze samples collected by water system operators. The results from the laboratory analysis are published in OHA-DWS Data Online, a public data access site where visitors can find water system information like coliform and chemical monitoring results, system contact information, and basic water system information. (9) OHA-DWS also generated preliminary summaries of VOC sampling results that included a comparison of detected analyte levels to the MCL and HAL. These summaries and VOC analysis data were distributed to sampled water systems.

Study purpose and research objectives

The purpose of this report is to enhance understanding of wildfire's impacts on drinking water by summarizing drinking water system VOC contamination following the 2020 wildfires in the state of Oregon, synthesize insight from both public water operators and emergency management staff and provide a summary of the 2020 wildfire response to inform future disaster response and increase resiliency. The two objectives were to 1) aggregate data on and summarize VOC contamination experienced by Oregon drinking water systems after the 2020 wildfires and 2) to evaluate perspectives and insights from impacted water system operators and emergency response staff to create a collection of information and lessons learned from 2020 wildfire response efforts that can inform drinking water system operators, emergency response mangers and coordinators, and other agencies faced with wildfire response.

Objective 1: Impact of 2020 Oregon wildfires

The first objective of this report is to synthesize and summarize VOC contamination experienced by Oregon drinking water systems after the 2020 wildfires and VOC sample analysis data. To achieve this, spatial analysis was conducted to identify impacted systems, and water samples were taken from those systems and analyzed to determine the extent of VOC contamination.

1.1 Methods

Identifying impacted drinking water systems

In this report, a drinking water system impacted by the 2020 Oregon wildfire is defined as any public water system whose service area boundaries or approximate service area boundary centers intersect with 2020 Oregon historic wildfire burn perimeters and sustained damage or lost pressure in the distribution system. (8) OHA-DWS identified 29 water systems that sustained wildfire damage to the distribution system and experienced loss of pressure, three systems that sustained no damage but experienced loss of water pressure and five systems that experienced a complete system loss and are no longer serving customers, for a total of 37 impacted drinking water systems. Twenty water systems were required by OHA-DWS to conduct VOC sampling and five voluntarily conducted VOC sampling themselves.* Qualifying Transient Non-Community systems were not selected by OHA-DWS for VOC sampling. Sampling efforts were focused on Community and Oregon Very Small (OVS) water systems with service populations of year-round residents to account for potential chronic exposure to VOCs.

Water system service area boundaries for most Oregon public drinking water systems are not available; however, the state maintains a database of approximate service centers for most systems. Two sampled water systems were not present in the approximate-center database, so the centers of each were manually placed based on their associated sample locations. These approximate service centers were used to locate wildfire impacted systems.

Sample collection and VOC data management and analyses

Sample collection and laboratory analysis methods varied by drinking water system. DEQ and OHA-DWS developed sampling method guidance that was distributed to operators of 25 systems required by OHA-DWS to sample for VOCs or that conducted voluntary VOC sampling. However, time of collection, number of samples and repeat samples, sampling location within the water system (e.g., meter box, distribution site), and expertise of sampling staff varied. VOC analyses were performed by private labs and the state DEQ laboratory. Sample analysis methods included EPA Method 524.2, EPA Method 8260 and DEQ modified EPA Method 524.2. (21,22) DEQ modified the 524.2 method sample collection instructions to include an OHA-DWS recommended minimum 72-hour stagnation period to better target VOC contamination from distribution pipes over time. Results were reported via a standardized electronic data delivery file developed by OHS-DWS and public and private laboratories. Depending on the lab and analysis

* Medford Estates and Pacific Village Mobile Home Park are customers of larger water systems (Charlotte Ann Water District and Medford Water Commission, respectively) that sustained wildfire damage and were sampled separately from the larger water system. Medford Estates is reported under the water system ID 01547A and Pacific Village Mobile Home Park under 00513A in this report's appendices.

method, samples were analyzed for between four and 60 analytes. (21,22) Samples and monitoring results that were deemed *not valid* by the DEQ laboratory (qualifiers with suffixes C, D or E) were marked as such and not included in subsequent analyses. In addition, labs utilized different names for various analytes when reporting results. These differences were manually rectified, and a list of unique VOCs present in the data was created for use in subsequent data analyses.

Descriptive statistics, including MCL and HAL exceedances, were calculated for each unique sample. (23) Exceedances were calculated by comparing detection level to the regulated MCL, 1-day HAL, 10-day HAL, and lifetime HAL levels in mg/L. (23) A list of detected VOCs with their frequency of detection and minimum and maximum levels were reported for each sampled water system and for the entire state (see Appendices D and A, respectively).

Maps of sample locations were created by geocoding partial addresses associated with many of the samples. For cases where it was not possible to match the partial address or the partial address was not recognizable as an address, context was used to find a correct address. For example, addresses for samples taken from a mobile home park frequently contained only the space number, which could be used to generate a complete address.

1.2 Results

Water systems and individual samples

There are a total of 3,320 active drinking water systems within the state of Oregon in 2020, approximately 93 of which were impacted by wildfire in 2020. OHA-DWS identified 37 systems that sustained damage or lost pressure due to the fires. Those systems with damage are primarily located along rivers and in the passes of the Cascade Range, east of the Willamette Valley (see Appendix C). They are primarily Community, OVS, and Transient Non-Community system types, with service populations ranging from 12 to 91,000. Twenty-six systems are supplied primarily with groundwater and 11 with surface water. All but three of the 25 systems sampled for VOCs are Community and OVS system types. Twelve sampled systems use groundwater and 13 use surface water as their primary source.

Most impacted systems with OHA-DWS identified damage are clustered in counties containing the largest fires, with notable exceptions being Jackson and Lincoln counties, where the

Table 1. Impacted drinking water systems with confirmed identified damage by county (*n*=37)

County	Impacted Systems	Sampled Systems	Sampled Systems with Detections	Sampled Systems with Exceedances
Clackamas	1	2	2	0
Douglas	3	0	-	-
Jackson	9	9	6	3
Klamath	2	1	0	0
Lane	8	3	2	0
Lincoln	4	4	4	1
Linn	2	1	1	1
Marion	8	5	5	2

Table 2. Systems with volatile organic compounds exceeding an advisory or guidance level (*n*=7 unique water systems)

Maximum Contaminant Level	1-day Health Advisory Level	10-day Health Advisory Level	Lifetime Health Advisory Level
Detroit WS	Detroit WS	Detroit WS	Detroit WS
City of Gates			Lyons Mehama WD
Lyons Mehama WD			Hiland WC – Echo Mountain
Hiand WC – Echo Mountain			City of Phoenix
City of Talent			City of Talent
Whispering Pines MHV			Whispering Pines MHV

relatively small Almeda and Echo Mountain Complex fires burned structures in densely developed areas. The majority of sampled systems in all counties except Klamath had at least one detection, though a smaller portion had at least one detection that exceeded the MCL or HAL (see Table 1).

Twenty of the 25 systems sampled had at least one VOC detection. All VOC detections over the MCL or HAL were collected from burned service line locations. Mainline samples did not show contamination over the MCL or HAL. Samples collected from Charlotte Ann Water District, McKenzie Palisades Water Board, Pacific Village Mobile Home Park, and ODF/WL Klamath Fish Hatchery had no VOCs detected despite being classified as a system with identified damage. Of the 20 systems with at least one VOC detection, six systems had at least one MCL exceedance (Detroit WS, City of Gates, Lyons Mehama WD, Hiland WC – Echo Mountain, City of Talent, and Whispering Pines MHV), one system had at least one 1-day HAL exceedance (Detroit WS), one system had at least one 10-day HAL exceedance (Detroit WS), and six systems had at least one lifetime HAL exceedance (Detroit WS, Lyons Mehama WD, Hiland WC – Echo Mountain, City of Phoenix, City of Talent, Whispering Pines MHV [see Table 2]).

Of the systems that serve more than 300 people, five detected a VOC that exceeded the MCL or lifetime HAL. City of Gates detected vinyl chloride over the MCL. City of Phoenix detected 2-butanone (MEK) at levels greater than the lifetime HAL. Lyons Mehama, Hiland Water – Echo Mountain, and City of Talent each detected benzene over the MCL and lifetime HAL. Additional information about each sampled system's VOC results can be found in Appendix D alongside general system information. A more detailed and interactive map of impacted and sampled water systems, as well as unique sample locations, is presented as an Esri ArcGIS Web Mapping Application. (12)

Unique VOCs and individual samples

A total of 1,767 valid samples were collected from 25 impacted water systems and were collectively analyzed for 71 different VOCs. VOCs were detected in 866 of 1,767 (49%) samples collected. However, of the 71 unique VOCs, only 36 were detected in the 866 samples with a VOC detection (see Appendix A).

The ten most detected VOCs were 2-butanone (MEK), benzene, bromodichloromethane, bromoform, chloroform, chloromethane, dibromochloromethane, methyl-tert-butyl ether, styrene, and toluene (see Table 3). Chloroform was the most common VOC with 708 detections,

Table 3. Top ten volatile organic compounds (VOCs) detected across all samples
(*n*=1,767 total samples / *n*=866 samples with VOC detection)

Analyte	Detections	Min (mg/L)	Max (mg/L)	MCL, 1-day HAL, 10-day HAL, Lifetime HAL (mg/L)			
Chloroform	708	0.00051	0.364	0.08	4	4	0.07
Bromodichloromethane	707	0.0005	0.137	0.08	1	0.6	-
Dibromochloromethane	229	0.0005	0.071	0.08	1	0.6	-
Methyl-tert-butyl ether	160	0.000106	0.605	-	-	-	-
Bromoform	111	0.0005	0.0332	0.08	5	0.2	-
Benzene	103	0.00051	0.271	0.005	0.2	0.2	0.003
Chloromethane	75	0.0005	0.0568	-	9	0.4	-
Toluene	75	0.00052	0.14	1	20	2	-
Styrene	36	0.0005	0.14	0.1	20	2	0.1
2-Butanone (MEK)	34	0.00554	3.96	-	75	7.5	7.5

Note: Not all detected VOCs have a regulated maximum contaminant level (MCL) or health advisory level (HAL).

though it is important to note that chloroform, bromoform, bromodichloromethane, and dibromochloromethane have been identified by EPA as byproducts of drinking water disinfection and may not be associated with wildfire. (24) Bromoform, bromodichloromethane, and dibromochloromethane were also among the top ten detected VOCs in sampled water systems (Table 3).

VOC levels exceeded multiple EPA advisory or guidance levels (see Table 4). (23) Forty-eight samples exceeded an MCL (33 from Detroit Water System alone), 2 samples exceeded the 1-day HAL, 2 samples exceeded the 10-day HAL, and 64 exceeded the lifetime HAL. (23) The VOC with the greatest number of samples exceeding an advisory or guidance level was benzene with 31 MCL exceedances, two 1-day HAL exceedances, two 10-day HAL exceedances, and 45 lifetime HAL exceedances. (22) Additional information on individual VOC detections and analyses can be found in Appendix A.

Research has been conducted to identify VOCs that are associated with systems damaged by wildfire. (4,6,25) Of the 53 VOCs included in the “fire package” developed by Whelton, 39 were analyzed as part of the 2020 VOC sampling program and 26 were detected at least once across all water systems. (25) All ten most detected analytes (Table 3), except chloroform, are present in the fire package. Ten VOCs (chloroform, dichloromethane, p-dichlorobenzene, m-dichlorobenzene, o-chlorotoluene, chloroethane, trichloroethane, 1,3,5-trimethylbenzene,

Table 4: Volatile organic compounds detected at levels exceeding advisory/guidance level (*n*=8)

Maximum Contaminant Level	1-day Health Advisory Level	10-day Health Advisory Level	Lifetime Health Advisory Level
Benzene	Benzene	Benzene	2-Butanone (MEK)
Bromodichloromethane			Benzene
Chlorobenzene			Chlorobenzene
Chloroform			Chloroform
Dichloromethane			Styrene
Styrene			
Vinyl chloride			

bromomethane, and 4-isopropyltoluene) were detected but are not identified in the Whelton fire package. (25) Excluding all EPA-identified disinfectant by-products, the following VOCs were identified in both the Whelton fire package and in the top ten VOCs detected in sampled water systems: methyl-tert-butyl ether, benzene, toluene, styrene, and 2-butanone (MEK). (25) Furthermore, methyl-tert-butyl ether and benzene were also detected in tap samples from systems in California impacted by the 2018 Camp fire. (20) These specific VOCs may be indicators of wildfire damage and future research is needed to evaluate their roles in assessing wildfire impacts on drinking water.

Objective 2: Insights from operators and emergency response staff

The second objective of this study was to evaluate perspectives and insights from impacted system operators to develop information about resource needs and lessons learned from 2020 wildfire response efforts that complement guidance published by EPA and OHA-DWS and can be used by drinking water system operators, emergency response mangers and coordinators, and other agencies faced with future wildfire response. (10,24)

2.1 Methods

Operators of drinking water systems impacted by the 2020 Oregon wildfires who conducted VOC sampling were contacted by OHA-DWS staff in September and October of 2022 and invited to share their experiences via structured telephone discussions. OHA-DWS staff gathered information from operators about their systems and experiences during and after the 2020 wildfires. The discussion encouraged operators to critically review and reflect on what went well with fire response and fire recovery and to identify the challenges they faced and areas for improvement.

In addition, OHA-DWS staff identified key emergency response contacts in state government and at private consulting companies that assisted water systems in responding to the 2020 wildfires. All emergency response participants were contacted and invited to share their perspectives on water system wildfire response via an online survey. Specific questions used to facilitate discussions with operators can be found in Appendix E and the survey distributed to emergency response staff can be found in Appendix F. Responses were reviewed to identify common trends and patterns.

2.2 Results

Sampled Drinking Water System Operators

Eight drinking water operators participated in discussions and shared their experiences during and after the 2020 wildfires. Preparedness, funding, communication, teamwork and coordination were central themes expressed by surveyed drinking water operators. Future wildfire response by drinking water systems could benefit from incorporating these themes and their messages. Specific common messages under these themes are described in this section.

All drinking water operators stated the vital importance of system emergency preparation. Preparation referenced included trained and knowledgeable system staff, as well as resilient infrastructure that is protected from fire. Onsite fire suppression systems and vegetation management around drinking water infrastructure were identified as strategies that systems could employ to protect critical infrastructure. Multiple drinking water operators identified alternative or backup power (i.e., generators) as a key resource during an emergency response. In addition, respondents acknowledged that an updated emergency response plan (ERP) was or could be a valuable resource and would allow for a quick and effective initial response.

Financial aid assistance was a challenge for drinking water operators during the 2020 wildfires. Some operators struggled with identifying financial resources and understanding the application process or their system's eligibility for aid. Other operators expressed frustration with paperwork hurdles and delay in receiving aid as they juggled assessing wildfire damage to the system and conducting emergency repair work. Tracking labor, invoices and equipment purchases are easily overlooked in the moment, but detailed documentation and recordkeeping were deemed important later when seeking financial aid. The Federal Emergency Management Agency (FEMA), U.S. Department of Agriculture (USDA) and Business Oregon were a few partners operators found helpful.

Communication among those participating in wildfire response and with the public was a central theme in wildfire discussions with impacted drinking water operators. A few operators described a lack of communication among partnering or assisting agencies and felt as though organizations and agencies were working in silos. One operator stated that while technically skilled and knowledgeable emergency response staff are key, nontechnical skills such as coordination and communication are just as important. Consequently, most agreed that developing channels for communication among all staff, agencies and partners would be beneficial. In addition, some operators stated that emergency communication needs to acknowledge uncertainty, be accurate and be concise so that the message is not lost or obfuscated. More specifically, operators described the need for transparent, honest, and clear communication among emergency response teams about limitations and operational struggles so that realistic solutions or next steps can be identified and responses to specific problems prioritized.

In addition to communication struggles among individuals included in wildfire response, some operators stated that they found delivering public emergency messages challenging. All operators surveyed expressed confidence in issuing public drinking water advisories under normal operating conditions but referenced the complexity of messaging during emergencies. Emergency scenarios introduce numerous sources of complexity, like the need to adapt message delivery methods, continually changing conditions, battles with misinformation and concern about the effectiveness of communication to those who had no power or had evacuated. One operator mentioned loss of communications infrastructure and inadequate backup equipment during an emergency were barriers to communication and has explored alternative communication methods like a portable cell tower. In addition, the specific need to assist rural and small communities with delivering emergency messages was also emphasized.

Many impacted drinking water operators highlighted the role of teamwork and coordinated response when asked about the 2020 wildfires. Operators credited a diverse group of individuals from various agencies and organizations in many roles. Local firefighters were repeatedly called "heroes," the National Guard's assistance was described as "quick" and "helpful," FEMA was acknowledged for cleanup aid, and the efforts of multiple county health departments and technical guidance provided by the state during and after the wildfires was described as "beneficial" and "appreciated." Many operators valued the free VOC testing by the DEQ laboratory, and one operator mentioned how test results increased confidence in the decision to lift advisories by confirming that the water being served was safe.

Lastly, while the efforts of many agencies and organizations were lauded by water system operators, the efforts of the local community and staff of impacted individual systems were key to a successful wildfire response. Many stories, from a water system staff member working 36 straight hours to a private contractor offering immediate assistance with a service-first attitude, demonstrated how dedicated system staff and community camaraderie are valuable tools in emergencies like wildfire. One operator expressed how a smaller scale, regional emergency response approach that involves the community may have value. Benefits of a regional- or community-scale approach may include easy sharing of resources, broader communication, and efficient leveraging of available funding. There was general agreement that developing and maintaining partnerships that include the community is an important activity for successful wildfire response and recovery.

Emergency Response Staff

Two members of agencies that assisted with 2020 wildfire response completed the survey sent to the emergency response staff. The input from emergency response staff tracked closely with the survey responses provided by water system operators and followed similar themes. Their feedback is summarized in this section.

Emergency response staff emphasized the need for an updated ERP that was concrete, affordable, and realistic and included rules and guidance for wildfire response. Training and education for operators around disaster response and recovery methods, recognizing assets and resources that are available for disaster response and recovery, and possible investment into additional emergency assets like portable generators were also identified as ways that water systems can become more resilient to wildfire. One respondent to the survey noted that general strategies are relatively straightforward to identify, but that the details of those strategies are often water system specific. An increase in funding was identified as a resource that would improve resiliency and response across the board, however.

Communication was a common theme in responses from emergency response staff and water system operators. The challenges inherent in disaster messaging to impacted populations noted by water system operators were reflected in emergency response staff survey responses. Additionally, response staff identified technical limitations with reporting tracking efforts, as well as file and contact sharing between the various responding agencies and water system operators. Emergency response staff identified the lack of an official, formal system of communication between relevant agencies and water system operators as something that could be improved for future responses. They stressed the importance of developing channels of communication and building relationships with groups like Oregon Association of Water Utilities (OAWU) and Oregon Water/Wastewater Agency Response Network (ORWARN) to increase the speed of initial communication between disaster response agencies and water system operators when disaster does strike. Building community connections were also mentioned as beneficial.

Coordination with and technical assistance from engineers and organizations like OAWU and guidance around VOC contamination were also identified as beneficial to a successful disaster response. Real, hands-on assistance by those with knowledge of drinking water system structure

and operation by outside organizations was identified as an additional resource that could improve water system response and reduce the workload for operators of water systems with limited staff. Emergency response staff also stated that coordination with Oregon Department of Transportation and the U.S. Forest Service to help clear roads and provide access to water treatment plants or source water intakes could be helpful. Doing so would allow water system operators to more quickly assess any potential damage to water system infrastructure and begin emergency repairs and recovery efforts.

Discussion

Key takeaways and recommendations

Research findings enhance our understanding of the impacts wildfires have on both drinking water system infrastructure and drinking water quality. Sample analyses revealed VOC contamination across wildfire-damaged systems and confirmed the presence of VOCs, like benzene, above the MCL and HAL in many systems. Sampling results for public water systems damaged by Oregon's 2020 wildfires also confirmed VOC contamination similar to studies done on wildfire-damaged water systems in other states and reinforce the need for additional research to better understand the impacts of wildfire damage on public drinking water systems.

Evaluating past emergency response efforts is an important management tool. Reflecting and identifying gaps and lessons learned from past responses can be beneficial when preparing for future emergencies. Furthermore, evaluating experiences from multiple perspectives is beneficial when performing a holistic evaluation of disaster response. Drinking water operators and emergency staff identified the importance of preparedness and disaster planning; quick access to emergency funding; messaging to inform the public of ever-shifting conditions; and communication, coordination, and teamwork among the many entities working on disaster response when battling the 2020 Oregon wildfires. It is important to note that even with a well-written, rehearsed, and updated ERP, some water systems — especially small water systems with few operators and limited time and sampling expertise — need additional support when responding to events like wildfire.

Multiple guidance documents developed by EPA and OHA-DWS are available to assist drinking water operators in their preparedness, response and resiliency to wildfire. Two examples are:

- Build Wildfire Resilience – U.S. EPA (24)
- Emergency Preparedness – Oregon Health Authority (10)

In addition to the recommendations synthesized from operator and emergency response staff surveys, OHA-DWS staff identified several ways to improve OHA-DWS's response to wildfire when addressing potential VOC contamination in public drinking water systems. There are several overarching themes. The first is the need for an established ERP that clearly defines how to respond to an emergency event. Ad hoc responses can lead to shifting messages that cause confusion and frustration. An ERP needs to include increased training, sample collection method standardization (like specific sampling plans), and standardized sample analysis methods to ensure data quality and reporting accuracy. An electronic method of collecting and storing information about specific samples is also necessary to better track sample locations and store context for each sample, such as a sample's location in a water distribution system and the assessed damage level of the structure from which the sample was taken. This information will improve after action reports and analysis and will increase data quality and availability for further academic research.

Limitations

The data used in this report have several limitations that are important to understand. With respect to the spatial data, most water systems are represented with an approximate service area center alone, rather than with a complete service area boundary. Representing a large area with a single point can lead to errors. For example, the approximate centers for several of the systems sampled as part of this project lie outside of 2020 wildfire burn perimeters, even though some of those systems were damaged or lost pressure. Thus, maps of systems impacted by wildfires are potentially incomplete. Because systems vary significantly in geographic size, it is difficult to verify potentially impacted systems that lack more robust boundaries.

Sample data collection methods also led to some problems in the data. Because operators recorded information about samples on paper forms, the precise locations of some samples could not be determined. Most samples could be geocoded and placed on a map, but a few were recorded without a recognizable address. For some small systems, especially those located at a single address, samples were taken from various buildings connected to the system, rendering it difficult to record precise locations. Most of these points are stacked atop each other, usually located at a single street address or in the center of a city, and the true spatial distribution of the samples cannot be determined. A digital field survey tool that includes GPS location for each sample could be used to solve this issue in the future.

Differences in sample analysis methods used by the labs that contributed to this project meant that not all samples were tested for the same analytes. For this reason, a complete picture of all VOCs present in impacted water systems is not available. A lack of standardization in data collection methods — especially sampling location in the water system, stagnation time and collection method — potentially introduced errors into the data.

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Appendices

Appendix A: All detected volatile organic compounds (VOCs) in the 2020 wildfires

Analyte	Chemical Abstract Service (CAS) number	Maximum detection (mg\L)	Valid samples	Detections	Maximum contaminant level (MCL) exceedances
1,1,1,2-Tetrachloroethane	630-20-6	-	917	0	0
1,1,1-Trichloroethane	71-55-6	-	917	0	0
1,1,2,2-Tetrachloroethane	79-34-5	-	917	0	0
1,1,2-Trichloroethane	79-00-5	0.0005	917	2	0
1,1-Dichloroethane	75-34-3	-	917	0	0
1,1-Dichloroethylene	75-35-4	-	917	0	0
1,1-Dichloropropene	563-58-6	-	916	0	0
1,2,3-Trichlorobenzene	87-61-6	0.000510	436	1	0
1,2,3-Trichloropropane (TCP)	96-18-4	-	917	0	0
1,2,4-Trichlorobenzene	120-82-1	0.00106	906	4	0
1,2,4-Trimethylbenzene	95-63-6	-	479	0	0
1,2-Dichlorobenzene	95-50-1	0.011	917	7	0
1,2-Dichloroethane	107-06-2	0.0025	917	6	0
1,2-Dichloropropane	78-87-5	0.0042	917	1	0
1,2-Dimethylbenzene	95-47-6	0.0159	858	9	0
1,3,5-Trimethylbenzene	108-67-8	0.00094	481	2	0
1,3-Dichloropropane	142-28-9	-	917	0	0
1,3-Dichloropropene	542-75-6	-	49	0	0
1-Propene, 2-methyl-	115-11-7	-	0	0	0
2,2-Dichloropropane	594-20-7	-	916	0	0
2-Butanone (MEK)	78-93-3	3.96	36	34	0
4-Chlorotoluene	106-43-4	0.00198	906	3	0
4-Isopropyltoluene	99-87-6	0.000720	453	1	0
Acetone	67-64-1	2.17	1	1	0
Acrolein	107-02-8	0.00895	11	11	0
Benzene	71-43-2	0.271	1763	103	31

Bromobenzene	108-86-1	-	917	0	0
Bromochloromethane	74-97-5	-	453	0	0
Bromodichloromethane	75-27-4	0.137	917	707	1
Bromoform	75-25-2	0.0332	917	111	0
Bromomethane	74-83-9	0.00147	918	1	0
Carbon disulfide	75-15-0	-	0	0	0
Carbon tetrachloride	56-23-5	-	917	0	0
Chlorobenzene	108-90-7	0.127	917	27	1
Chloroethane	75-00-3	0.0011	918	2	0
Chloroform	67-66-3	0.364	917	708	15
Chloromethane	74-87-3	0.0568	943	75	0
cis-1,2-dichloroethylene	156-59-2	-	917	0	0
cis-1,3-dichloropropene	10061-01-5	-	868	0	0
Cyclohexanone	108-94-1	-	0	0	0
Dibromochloromethane	75-27-4	0.0710	917	229	0
Dibromomethane	74-95-3	-	917	0	0
Dichlorodifluoromethane (Freon 12)	75-71-8	-	453	0	0
Dichloromethane	75-09-2	0.015	917	17	3
Ethylbenzene	100-41-4	0.0572	1756	21	0
Hexachloro-1,3-butadiene	87-68-3	-	453	0	0
Isopropylbenzene (Cumene)	98-82-8	-	483	0	0
m-dichlorobenzene	541-73-1	0.0094	916	11	0
Methyl-tert-butyl ether	1634-04-4	0.605	910	160	0
m-xylene/p-xylene	No Data	0.0099	854	9	0
Naphthalene	91-20-3	0.0146	474	9	0
n-butylbenzene	104-51-8	-	449	0	0
n-propylbenzene	103-65-1	-	446	0	0
o-chlorotoluene	95-49-8	0.00254	917	3	0
p-dichlorobenzene	106-46-7	0.0108	905	15	0
Propylene	115-07-1	-	0	0	0
Propyne	74-99-7	-	0	0	0
Sec-butylbenzene	135-98-8	-	451	0	0
Styrene	100-42-5	0.14	919	36	1

Tentatively identified compounds	-	-	409	0	0
Tert-butyl alcohol (TBA)	75-65-0	-	0	0	0
Tert-butylbenzene	98-06-6	-	453	0	0
Tetrachloroethene (PCE)	127-18-4	0.0016	917	1	0
Tetrahydrofuran	109-99-9	-	0	0	0
Toluene	108-88-3	0.14	1761	75	0
Trans-1,2-dichloroethylene	156-60-5	-	917	0	0
Trans-1,3-dichloropropene	10061-02-6	-	868	0	0
Trichloroethene (TCE)	79-01-6	0.0028	917	2	0
Trichlorofluoromethane (Freon 11)	75-69-4	-	453	0	0
Vinyl chloride	75-01-4	0.00822	916	18	1
Xylenes, total	1330-20-7	0.0309	1756	14	0

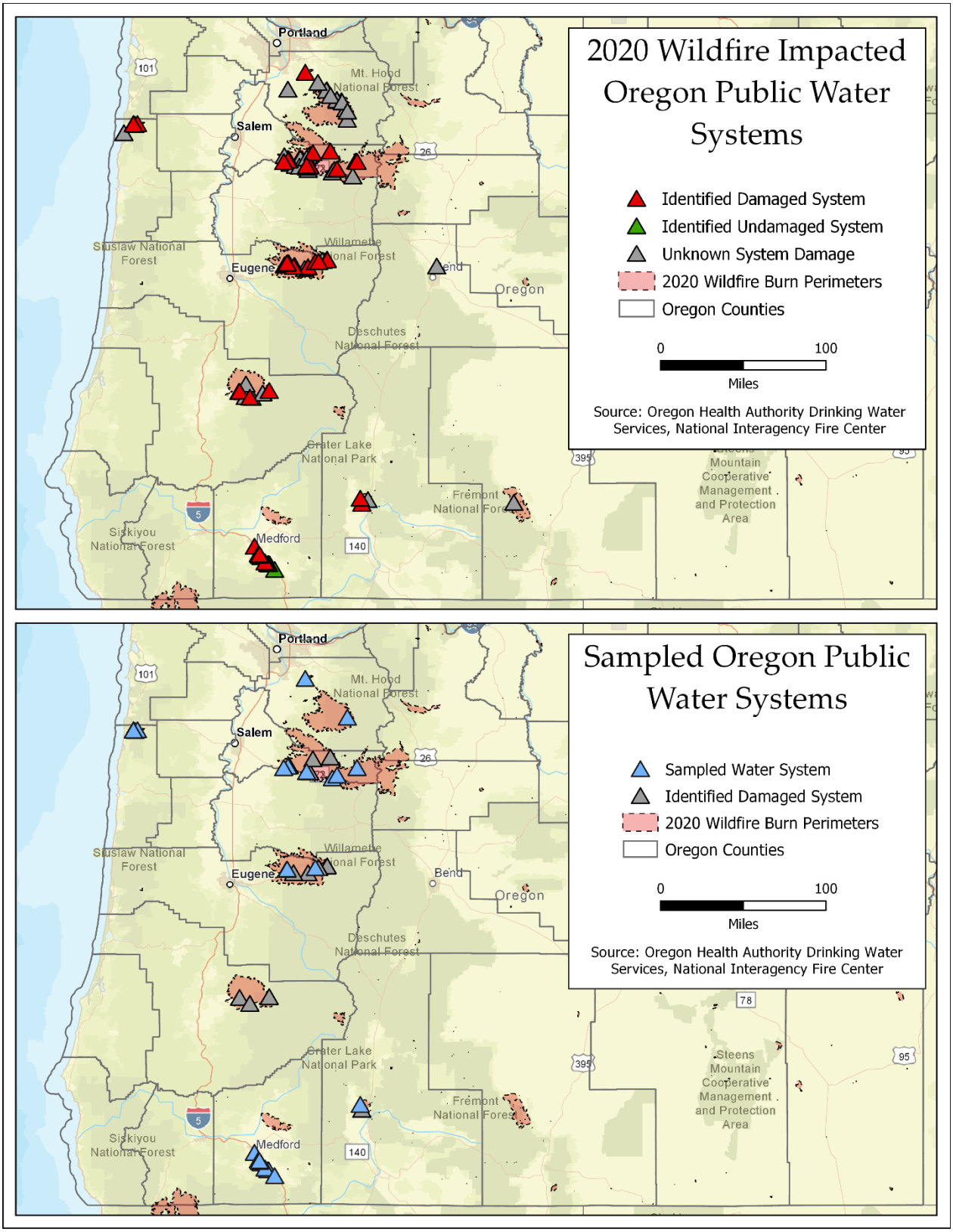
Appendix B: Oregon public water systems with evaluated 2020 wildfire damage

System name	System ID	Damage level	Sampled
Ashland Water Department	00047	No structure loss (or physical damage) with pressure maintained	Yes
Bear Creek Mobile Home Park	00050	Complete system loss, no longer serving customers	Yes
Blue River Water District	00125	Structure loss (or physical damage) with depressurization	Yes
Breitenbush Hot Springs	93461	Structure loss (or physical damage) with depressurization	Yes
Cedarhurst Improvement Club	00280	Structure loss (or physical damage) with depressurization	Yes
Charlotte Ann Water District	01547	Structure loss (or physical damage) with depressurization	Yes
Detroit Water System	00257	Structure loss (or physical damage) with depressurization	Yes
Evans Creek Camp Retreat	94085	Complete system loss, no longer serving customers	No
Finn Ranch Water District	01409	Structure loss (or physical damage) with depressurization	Yes
Gates, City of	00317	Structure loss (or physical damage) with depressurization	Yes
Heavens Gate Cottages	05186	Structure loss (or physical damage) with depressurization	No
Hiland Water Commission - Echo Mountain	00605	Structure loss (or physical damage) with depressurization	Yes
Hiland Water Commission - Riverbend	00601	No structure loss (or physical damage) with depressurization	Yes
Holiday Farm Resort	91819	Structure loss (or physical damage) with depressurization	No
Johnsons Park & Water Company	05865	Structure loss (or physical damage) with depressurization	No
Lazy Days Mobile Home Park	00990	Complete system loss, no longer serving customers	No
Lyons Mehama Water District	00493	No structure loss (or physical damage) with depressurization	Yes

Mckenzie Palisades Water Board	00923	Structure loss (or physical damage) with depressurization	Yes
Mckenzie River Trailer Park	05236	Complete system loss, no longer serving customers	No
Medford Estates Mobile Home Park	01547A	Structure loss (or physical damage) with depressurization	Yes
Medford Water Commission	00513	Structure loss (or physical damage) with depressurization	Yes
New Sammys Bistro	01199	Complete system loss, no longer serving customers	No
Oak Park Motel	05712	Structure loss (or physical damage) with depressurization	No
ODF/WL Klamath Fish Hatchery	94925	Structure loss (or physical damage) with depressurization	Yes
ODF/WL Rock Creek Hatchery	05025	Structure loss (or physical damage) with depressurization	No
Opal Creek Ancient Forest Center	06169	Structure loss (or physical damage) with depressurization	No
Pacific Village Mobile Home Park	00513A	Structure loss (or physical damage) with depressurization	Yes
Panther Creek Water District	00603	No structure loss (or physical damage) with depressurization	Yes
Phoenix, City of	00625	Structure loss (or physical damage) with depressurization	Yes
Sage Community School	94860	Structure loss (or physical damage) with depressurization	No
Salmon River Mobile Village	00606	Structure loss (or physical damage) with depressurization	Yes
Steamboat Inn	92135	Structure loss (or physical damage) with depressurization	No
Susan Creek Mobile Home Park	94508	Structure loss (or physical damage) with depressurization	No
Talent, City of	00857	Structure loss (or physical damage) with depressurization	Yes
Taylor Park	94257	Structure loss (or physical damage) with depressurization	No
Taylors Grove Water Works	05782	Structure loss (or physical damage) with depressurization	Yes
Vida Flats Water System	05266	No structure loss (or physical damage) with pressure maintained	No

Wayfarer Resort	91882	Structure loss (or physical damage) with depressurization	No
Whispering Pines Mobile Home Village	01468	Structure loss (or physical damage) with depressurization	Yes

Appendix C: Locations of impacted and sampled public water systems



Appendix D: Sampled water system summary tables

Water system name:	Ashland Water Department
Water system number:	00047

System type:	Community	Population served:	20,700
County served:	Jackson	Connections:	9,043
Regulating agency:	Region 2	Primary source:	Surface water

Associated wildfire:	Almeda Drive
OHA identified damage:	No structure loss (or physical damage) with pressure maintained

Total number of valid samples:	82		
Total number of positive samples:	1	% Total detects:	1.22%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [1]; Bromodichloromethane [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Bear Creek Mobile Home Park		
Water system number:	00050		
System type:	Oregon Very Small	Population served:	10
County served:	Jackson	Connections:	9
Regulating agency:	Jackson County	Primary source:	Groundwater

Associated wildfire:	Almeda Drive
OHA identified damage:	Complete system loss, no longer serving customers

Total number of valid samples:	5		
Total number of positive samples:	5	% Total detects:	100.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [5]; Bromoform [5]; Bromodichloromethane [5]; Dibromochloromethane [5]; Chlorobenzene [1]; Benzene [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Blue River Water District
Water system number:	00125

System type:	Community	Population served:	300
County served:	Lane	Connections:	95
Regulating agency:	Lane County	Primary source:	Groundwater

Associated wildfire:	Holiday Farm
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	19		
Total number of positive samples:	1	% Total detects:	5.26%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Benzene [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Breitenbush Hot Springs
Water system number:	93461

System type:	Community	Population served:	150
County served:	Marion	Connections:	52
Regulating agency:	Region 1	Primary source:	Surface water

Associated wildfire:	Lionshead
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	4		
Total number of positive samples:	4	% Total detects:	100.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [4]; Bromodichloromethane [4]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Cedarhurst Improvement Club
Water system number:	00280

System type:	Community	Population served:	150
County served:	Marion	Connections:	52
Regulating agency:	Region 1	Primary source:	Surface water

Associated wildfire:	Lionshead
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	4		
Total number of positive samples:	4	% Total detects:	100.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [4]; Bromodichloromethane [4]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Charlotte Ann Water District
Water system number:	01547

System type:	Community	Population served:	1,540
County served:	Jackson	Connections:	192
Regulating agency:	Jackson County	Primary source:	Surface Water Purchased

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	90		
Total number of positive samples:	0	% Total detects:	0.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	None
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Detroit Water System		
Water system number:	00257		
System type:	Community	Population served:	80
County served:	Marion	Connections:	250
Regulating agency:	Region 1	Primary source:	Surface water

Associated wildfire:	Lionshead
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	453		
Total number of positive samples:	415	% Total detects:	91.61%
Total MCL exceedances:	35	% Total MCL exceedances:	7.73%
Total 1-day HAL exceedances:	2	% Total 1-day HAL exceedances:	0.44%
Total 10-day HAL exceedances:	2	% Total 10-day HAL exceedances:	0.44%
Total lifetime HAL exceedances:	45	% Total lifetime HAL exceedances:	9.93%

Detected analytes:	Chloromethane [37]; Chloroethane [1]; Methyl-tert-butyl ether [151]; Chloroform [404]; Bromodichloromethane [383]; Dibromochloromethane [10]; Xylenes, Total [7]; m-Xylene/p-Xylene [9]; Dichloromethane [11]; o-Chlorotoluene [1]; 4-Chlorotoluene [1]; m-Dichlorobenzene [3]; 1,2-Dichlorobenzene [3]; p-Dichlorobenzene [3]; Vinyl chloride [13]; 1,2-Dichloroethane [2]; 1,2-Dichloropropane [1]; Trichloroethene (TCE) [1]; 1,1,2-Trichloroethane [2]; Tetrachloroethene (PCE) [1]; Chlorobenzene [11]; Benzene [52]; Toluene [40]; Ethylbenzene [13]; Styrene [17]; o-Xylene [8]
MCL exceedances:	Chloroform [15]; Dichloromethane [3]; Chlorobenzene [1]; Benzene [20]; Styrene [1]
1-day HAL exceedances:	Benzene [2]
10-day HAL exceedances:	Benzene [2]
Lifetime HAL exceedances:	Chloroform [18]; Chlorobenzene [1]; Benzene [27]; Styrene [1]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Finn Ranch Water District
Water system number:	01409

System type:	Oregon Very Small	Population served:	15
County served:	Lane	Connections:	7
Regulating agency:	Lane County	Primary source:	Groundwater

Associated wildfire:	Holiday Farm
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	4		
Total number of positive samples:	2	% Total detects:	50.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Methyl-tert-butyl ether [1]; Chloroform [1]; Bromodichloromethane [1]; Dibromochloromethane [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Gates, City of
Water system number:	00317

System type:	Community	Population served:	500
County served:	Marion	Connections:	245
Regulating agency:	Region 1	Primary source:	Surface water

Associated wildfire:	Beachie Creek
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	102		
Total number of positive samples:	102	% Total detects:	100.00%
Total MCL exceedances:	1	% Total MCL exceedances:	0.98%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloromethane [1]; Naphthalene [1]; Methyl-tert-butyl ether [1]; Chloroform [102]; Bromodichloromethane [99]; Dichloromethane [4]; Vinyl chloride [5]
MCL exceedances:	Vinyl chloride [1]
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Hiland WC – Echo Mountain
Water system number:	00605

System type:	Community	Population served:	362
County served:	Lincoln	Connections:	142
Regulating agency:	Lincoln County	Primary source:	Groundwater

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	97		
Total number of positive samples:	59	% Total detects:	60.82%
Total MCL exceedances:	5	% Total MCL exceedances:	5.15%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	7	% Total lifetime HAL exceedances:	7.22%

Detected analytes:	Chloromethane [3]; Naphthalene [2]; Methyl-tert-butyl ether [3]; 1,2,4-Trichlorobenzene [1]; 1,2,3-Trichlorobenzene [1]; Chloroform [14]; Bromoform [29]; Bromodichloromethane [33]; Dibromochloromethane [49]; Xylenes, Total [1]; m-Dichlorobenzene [4]; 1,2-Dichlorobenzene [2]; p-Dichlorobenzene [4]; 1,2-Dichloroethane [2]; Trichloroethene (TCE) [1]; Chlorobenzene [4]; Benzene [16]; Toluene [17]; Ethylbenzene [3]; Styrene [12]; o-Xylene [1]
MCL exceedances:	Benzene [5]
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	Benzene [7]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Hiland WC - Riverbend
Water system number:	00601

System type:	Community	Population served:	172
County served:	Lincoln	Connections:	78
Regulating agency:	Region 2	Primary source:	Groundwater under direct influence of surface water

Associated wildfire:	Echo Mountain Complex
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	6		
Total number of positive samples:	5	% Total detects:	83.33%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [5]; Bromoform [3]; Bromodichloromethane [5]; Dibromochloromethane [5]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Lyons Mehama Water District
Water system number:	00493

System type:	Community	Population served:	1,300
County served:	Linn	Connections:	890
Regulating agency:	Region 2	Primary source:	Surface water

Associated wildfire:	Beachie Creek
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	17		
Total number of positive samples:	17	% Total detects:	100.00%
Total MCL exceedances:	1	% Total MCL exceedances:	5.88%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	1	% Total lifetime HAL exceedances:	5.88%

Detected analytes:	Acetone [1]; 2-Butanone (MEK) [1]; Chloroform [17]; Bromodichloromethane [16]; Dibromochloromethane [1]; Benzene [1]; Toluene [1]; Ethylbenzene [1]; Styrene [1]
MCL exceedances:	Benzene [1]
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	Benzene [1]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	McKenzie Palisades Water Board
Water system number:	00923

System type:	Community	Population served:	50
County served:	Lane	Connections:	35
Regulating agency:	Lane County	Primary source:	Groundwater

Associated wildfire:	Holiday Farm
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	6		
Total number of positive samples:	0	% Total detects:	0.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	None
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Medford Estates, (A connection within the Charlotte Ann Water District)
Water system number:	01547A

System type:	Part of larger system	Population served:	-
County served:	Jackson	Connections:	-
Regulating agency:	-	Primary source:	Surface water

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	43		
Total number of positive samples:	16	% Total detects:	37.21%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	2-Butanone (MEK) [16]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Medford Water Commission
Water system number:	00513

System type:	Community	Population served:	91,025
County served:	Jackson	Connections:	31,201
Regulating agency:	Region 2	Primary source:	Surface water

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	7		
Total number of positive samples:	0	% Total detects:	0.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	None
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	ODFWL Klamath Fish Hatchery		
Water system number:	94925		
System type:	Oregon Very Small	Population served:	12
County served:	Klamath	Connections:	6
Regulating agency:	Klamath County	Primary source:	Groundwater

Associated wildfire:	242
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	3		
Total number of positive samples:	0	% Total detects:	0.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	None
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	OPRD Detroit Lake State Park
Water system number:	91059

System type:	Transient Non-Community	Population served:	2,600
County served:	Marion	Connections:	1
Regulating agency:	Region 1	Primary source:	Surface water

Associated wildfire:	Beachie Creek
OHA identified damage:	Not identified

Total number of valid samples:	1		
Total number of positive samples:	1	% Total detects:	100.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [1]; Bromodichloromethane [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Pacific Village Motor Home Park
Water system number:	00513A

System type:	Part of larger system	Population served:	-
County served:	Jackson	Connections:	-
Regulating agency:	-	Primary source:	Surface water

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	4		
Total number of positive samples:	0	% Total detects:	0.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	None
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Panther Creek Water District
Water system number:	00603

System type:	Community	Population served:	620
County served:	Lincoln	Connections:	218
Regulating agency:	Region 2	Primary source:	Surface water

Associated wildfire:	Echo Mountain Complex
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	119		
Total number of positive samples:	115	% Total detects:	96.64%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [115]; Bromoform [36]; Bromodichloromethane [115]; Dibromochloromethane [115]; Dichloromethane [1]; Benzene [9]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Phoenix, City of
Water system number:	00625

System type:	Community	Population served:	4,800
County served:	Jackson	Connections:	1,122
Regulating agency:	Region 2	Primary source:	Surface water purchased

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	187		
Total number of positive samples:	31	% Total detects:	16.58%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	1	% Total lifetime HAL exceedances:	0.53%

Detected analytes:	4-Isopropyltoluene [1]; Chloromethane [20]; Bromomethane [1]; 2-Butanone (MEK) [4]; Methyl-tert-butyl ether [3]; Chloroform [4]; Bromodichloromethane [4]; Dibromochloromethane [3]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	2-Butanone (MEK) [1]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Salmon River Mobile Village
Water system number:	00606

System type:	Community	Population served:	75
County served:	Lincoln	Connections:	38
Regulating agency:	Lincoln County	Primary source:	Groundwater

Associated wildfire:	Echo Mountain Complex
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	3		
Total number of positive samples:	1	% Total detects:	33.33%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [1]; Bromodichloromethane [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Talent, City of
Water system number:	00857

System type:	Community	Population served:	6,293
County served:	Jackson	Connections:	5,737
Regulating agency:	Region 2	Primary source:	Surface water purchased

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	447		
Total number of positive samples:	43	% Total detects:	9.62%
Total MCL exceedances:	3	% Total MCL exceedances:	0.67%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	7	% Total lifetime HAL exceedances:	1.57%

Detected analytes:	Chloromethane [5]; Chloroethane [1]; Acrolein [11]; 2-Butanone (MEK) [12]; Naphthalene [5]; Methyl-tert-butyl ether [1]; 1,3,5-Trimethylbenzene [2]; Chloroform [1]; Xylenes, Total [6]; Benzene [17]; Toluene [13]; Ethylbenzene [4]; Styrene [6]
MCL exceedances:	Benzene [3]
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	Benzene [7]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Taylors Grove Water Works
Water system number:	05782

System type:	Community	Population served:	28
County served:	Marion	Connections:	15
Regulating agency:	Marion County	Primary source:	Groundwater

Associated wildfire:	Beachie Creek
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	8		
Total number of positive samples:	2	% Total detects:	25.00%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloroform [2]; Bromodichloromethane [1]; Dibromochloromethane [1]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	USFS Timber Lake JCC
Water system number:	01093

System type:	Non-transient Non-community	Population served:	300
County served:	Clackamas	Connections:	1
Regulating agency:	Clackamas County	Primary source:	Groundwater

Associated wildfire:	Riverside
OHA identified damage:	Structure loss (or physical damage) with pressure maintained

Total number of valid samples:	7		
Total number of positive samples:	5	% Total detects:	71.43%
Total MCL exceedances:	0	% Total MCL exceedances:	0.00%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	0	% Total lifetime HAL exceedances:	0.00%

Detected analytes:	Chloromethane [2]; Naphthalene [1]; 1,2,4-Trichlorobenzene [1]; Chloroform [2]; Bromodichloromethane [1]; Dibromochloromethane [2]
MCL exceedances:	None
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	None

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Water system name:	Whispering Pines Motor Home Village
Water system number:	01468

System type:	Community	Population served:	120
County served:	Jackson	Connections:	63
Regulating agency:	Jackson County	Primary source:	Groundwater

Associated wildfire:	Almeda Drive
OHA identified damage:	Structure loss (or physical damage) with depressurization

Total number of valid samples:	43		
Total number of positive samples:	38	% Total detects:	88.37%
Total MCL exceedances:	3	% Total MCL exceedances:	6.98%
Total 1-day HAL exceedances:	0	% Total 1-day HAL exceedances:	0.00%
Total 10-day HAL exceedances:	0	% Total 10-day HAL exceedances:	0.00%
Total lifetime HAL exceedances:	3	% Total lifetime HAL exceedances:	6.98%

Detected analytes:	Chloromethane [7]; 2-Butanone (MEK) [1]; 1,2,4-Trichlorobenzene [2]; Chloroform [26]; Bromoform [38]; Bromodichloromethane [37]; Dibromochloromethane [37]; Dichloromethane [1]; o-Chlorotoluene [2]; 4-Chlorotoluene [2]; m-Dichlorobenzene [4]; 1,2-Dichlorobenzene [2]; p-Dichlorobenzene [8]; 1,2-Dichloroethane [2]; Chlorobenzene [11]; Benzene [6]; Toluene [4]
MCL exceedances:	Bromodichloromethane [1]; Benzene [2]
1-day HAL exceedances:	None
10-day HAL exceedances:	None
Lifetime HAL exceedances:	Benzene [3]

OHA – Oregon Health Authority
MCL – Maximum Contaminant Level
HAL – Health Advisory Level
[#] – Number of unique detections of associated analyte across all samples in the water system for the current metric.

Appendix E: Operator survey

1. What resources were helpful during the fire?
2. What resources were helpful for recovery?
3. What resources were needed during the fire?
4. What were some lessons your water system learned, or challenges or water system faced during and after the fire?
5. What do water systems need to be more resilient to future wildfires?
6. How do you communicate important information to your customers (email, social media, website, etc.)?

Appendix F: Emergency response staff survey

1. What role, if any, did you have responding to the 2020 Oregon Wildfires?
2. What resources were helpful to water systems during the fire?
3. What resources were beneficial to water system recovery?
4. What resources were needed or not present during the fire that would have improved water system response?
5. What do water systems need to be more resilient to future wildfires?
6. What were some lessons your organization learned, or challenges your organization faced during and after the fire when assisting water systems?
7. Do you have any additional information that you would like to provide regarding wildfire response and recovery of drinking water systems?