THE Water Research FOUNDATION

PROJECT NO.
5106

Concept of Operations (CONOPS) Plan for Water Distribution System Testing and Recovery

Los Angeles Department of Water & Power
SAN JOSE WATER
EBMUD
CONTRA COSTA WATER DISTRICT

Concept of Operations (CONOPS) Plan for Water Distribution System Testing and Recovery

Prepared by:

Andrew J. Whelton, Kristofer P. Isaacson, Amisha D. Shah
Purdue University

Co-sponsored by:

East Bay Municipal Utility District
Contra Costa Water District
Los Angeles Department of Water & Power
San Jose Wate Company

2024

THE Water Research FOUNDATION

The Water Research Foundation (WRF) is the leading research organization advancing the science of all water to meet the evolving needs of its subscribers and the water sector. WRF is a 501(c)(3) nonprofit, educational organization that funds, manages, and publishes research on the technology, operation, and management of drinking water, wastewater, reuse, and stormwater systems—all in pursuit of ensuring water quality and improving water services to the public.

For more information, contact:
The Water Research Foundation

1199 North Fairfax Street, Suite 900
Alexandria, VA 22314-1445
P 571-384-2100

6666 West Quincy Avenue
Denver, Colorado 80235-3098
P 303-347-6100

www.waterrf.org
info@waterrf.org

WRF ISBN: 978-1-60573-696-9
WRF Project Number: 5106

Prepared by Purdue University

Acknowledgments

Research Team

Principal Investigators:
Andrew J. Whelton, PhD
Purdue University, Civil Engineering and Environmental and Ecological Engineering
Amisha D. Shah, PhD
Purdue University, Civil Engineering and Environmental and Ecological Engineering

Research Team:
Kristofer Isaacson, Graduate Student
Purdue University, Environmental and Ecological Engineering

WRF Project Subcommittee or Other Contributors

Project Advisory Committee:
Kevin Morley, PhD
American Water Works Association, Washington, D.C.
Benjamin Klayman, PhD
West Yost & Associates, Inc. (formerly with Medford Water Commission), Medford, Oregon

Sponsors:
Susan Teefy
East Bay Municipal District (EBMUD), California
David Briggs
East Bay Municipal District (EBMUD), California
Michael Hartlaub
East Bay Municipal District (EBMUD), California

Participating Professionals and Utilities:
Joe Schiavone
City of Santa Rosa, California
Mark Shipman
City of Santa Rosa, California
Emma Walton
City of Santa Rosa, California
Mickey Rich
Paradise Irrigation District, California
Sarah Richardson
San Jose Water Company, California
Francois Rodigari
San Jose Water Company, California

Suzanne DeLorenzo
San Jose Water Company, California
Marlyn Stasiak
Los Angeles Department of Water and Power, California
John Kuo
Los Angeles Department of Water and Power, California
Dave Huey
Central Contra Costa Water District, California
Andrea Flores
Central Contra Costa Water District, California
Joy Eldredge
City of Napa, California
Kimberly Gupta, PE
Portland Water Bureau
Kurt Kowar, PE
City of Louisville, Colorado
Cory Peterson, PE
City of Louisville, Colorado
Alex Arinello, PE
Town of Superior, Colorado

WRF Staff

Jian Zhang, PhD, PE
Research Principal

Corina Santos
Project Coordinator

Megan Karklins
Communications & Marketing Director

Angelina Dinsmore
Content Lead

Preface

Wildfires are increasingly damaging public drinking water systems, and this negatively impacts the safety, security, and economic health of communities. In recent years, numerous wildfires have damaged water distribution networks even when the drinking water source and water treatment facilities were not affected (Proctor et al. 2021; Whelton et al. 2023; Toth et al. 2024; Whelton et al. 2024). This damage has been significant as distribution systems store and transport water to customers, after the final stage of drinking water treatment.

Wildfire damaged water distribution systems can pose immediate risks to public safety and be difficult to assess and repair. Power loss and the destruction of backup supplies can prompt an inability to produce or supply water for firefighting purposes or move existing supply through the infrastructure to prevent depressurization. Damaged and destroyed assets as well as customer buildings can prompt water leaks. Loss of water pressure caused by numerous leaks can negatively affect water availability for residential, commercial, and industrial customers. Localized and widespread chemical drinking water contamination can also be caused. Chemical drinking water contamination can be extreme and pose both immediate and long-term risks to public safety. This contamination can originate from outside or within the wildfire damaged water distribution system. Assets themselves such as pipes, tanks, hydrants, valves, and meters can be secondary sources of contamination, making safe water placed into the distribution system unsafe. Assets above and below ground can be physically and chemically damaged. Depending on the magnitude of system damage, testing to simply find the contaminated infrastructure can take weeks to years. Repair and restoration of the affected infrastructure to deliver safe drinking water can take equally long or longer. Restricted water use conditions to protect the customers from the contaminated water can remain in effect for long periods.

The present document was created due to the lack of guidance for public water system staff facing wildfire attacks of their distribution systems. This document was part of a larger Water Research Foundation project entitled *Post-Wildfire Distribution System Water Quality Impacts and Potential Responses* (Isaacson et al. Forthcoming). The lack of prior guidance on wildfire response decisions and conflicting and incorrect information from various supporting agencies has caused numerous challenges. In the past, public water systems have sometimes (1) been encouraged to take actions that inhibited them from detecting the full extent of chemical contamination and contaminated assets, (2) not rapidly warned customers about potential health risks of contaminated drinking water exposure, (3) delayed action to restore pressure and remove contaminated water from the system, (4) been unable to explain the post-fire drinking water safety issues to their customers and supporting organizations, among other challenges. This evidence-based document is primarily designed to inform public water system staff who are making response decisions. Second, information contained in this document should be considered by organizations that assist public water system staff in their response.

This document contains rationale and protocols that can immediately inform developed public water system staff decision-making. It is expected that information in this document and its approach will be updated in the future as new information becomes available.

Contents

1. Introduction

Public water systems provide critical public health and safety services, are "essential to government and business functions," and are vulnerable to damage by wildfires (FEMA 2018, FEMA 2024). Today, operational guidance for water professionals on how best to respond to a wildfire impacting water distribution systems is basically nonexistent. Some general guidance issued by government agencies about post-fire water testing exists but much of it lacks specificity, recentness, and lacks context in the larger disaster response decision-making construct. To begin to address this gap a strategic concept of operations (CONOPS) plan that water systems can adopt, in whole or in part, was developed.

A CONOPS plan is a focused description of a system, its operational policies, customers, interactions between the system, other organizations, and its customers, and the system's contribution to the operational mission. A CONOPS plan can help water system staff anticipate the roles, responsibilities, and activities associated with preparing for, responding to, and recovering from wildfire-impacted drinking water distribution systems.

This guidance document is meant to inform all stakeholders about their expected roles and responsibilities related to wildfire incidents that affect public water systems. Primary users of this guidance are public water system staff. Second, this guidance should be considered by organizations that assist public water system staff in their response.

This document was developed through a series of interactions with water utilities that had experienced wildfire damage and service interruptions since 2017 as well as a review of related literature. Further, a July 2022 workshop was convened in Oakland, California where utility representatives shared their experiences, feedback, and reviewed draft CONOPS materials. Nine utilities from California, Colorado, and Oregon participated in the workshop with service populations ranging from 6,500 to 3,800,000. Water system response lessons from wildfires after this workshop were also obtained by contacting impacted utilities (i.e., Maui County after the 2023 wildfires).

2. Acronyms and Abbreviations

BTEX	Benzene, toluene, ethylbenzene, and xylenes
CDC	U.S. Centers for Disease Control and Prevention
CONOPS	Concept of operations
EPA	U.S. Environmental Protection Agency
FEMA	U.S. Federal Emergency Management Agency
HA	Health advisory
HDPE	High-density polyethylene
ICP-MS	Inductively coupled plasma – mass spectroscopy
ICS	Incident command system
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
GC-MS	Gas chromatograph y- mass spectroscopy
RSL	Regional screening level
ppb	Parts per billion
POD	Points of distribution
PPE	Personal protective equipment
PVC	Polyvinyl chloride
SDWA	*Safe Drinking Water Act*
SOP	Standard operating procedure
SVOC	Semi-volatile organic compound
TIC	Tentatively identified compound
TOC	Total organic carbon
UV_{254}	Ultraviolet light absorbance at 254 nanometers
VOC	Volatile organic compound
WARN	Water / Wastewater Agency Response Network
WHO	World Health Organization

3. Context of a Water System CONOPS Plan in Emergency and Disaster Management

Man-made and natural events can prompt emergencies and disasters for a public water system. Emergencies are defined as small-scale, localized incidents which are resolved quickly using local resources. However, small-scale emergencies can escalate into disasters that are large-scale and cross geographic, political, and academic boundaries. Disasters require a level of response and recovery greater than local communities can provide. Water systems may be able to handle small-scale emergencies, but the larger disaster response will involve coordination and support from a multitude of organizations.

Emergency and disaster management consists of four phases: Preparedness, Response, Recovery, and Mitigation. For this document, only three phases are considered. Mitigation is not considered here because the present study primarily focused on supporting decision-making before, during, and shortly after an incident to protect public health and infrastructure. For information purposes, the four phases of emergency and disaster management are described in more detail. For each phase, some examples of actions related to water systems threatened or attacked by wildfires are listed.

3.1 Preparedness

This includes planning, training, and educational activities for events that cannot be mitigated. Examples include: Develop disaster preparedness plans for what to do, where to go, or who to call for help in a disaster; Obtain wildfire specific personal protective equipment (PPE) and train utility staff on how to prevent injuries should a wildfire threaten or impact the facilities; Create a supply list of items that are useful in a disaster; Identifying asset vulnerabilities; Acquire or identify backup emergency generators so that a power loss lessens the chance pressure loss occurs, fire-fighting support is jeopardized, and distribution system contamination occurs; Establish mutual aid agreements for personnel to assist in system repair, water sampling, analysis, and equipment access enabled through the Water / Wastewater Agency Response Network (WARN); Conduct department, organization, and multi-organization exercises to practice addressing the operational, managerial, scientific, and communication challenges during and following a wildfire (Whelton et al. 2006; Deere et al. 2017); Top off all finished water storage tanks in anticipation of an approaching fire, a power loss, or distribution system damage that can prompt water leaks; Contact the water testing laboratory and commercial laboratories to determine who guarantees to provide 24- to 72-hour turnaround times for emergency post-fire sampling/analysis support; Identify the conditions where untreated or partially treated source water would be sent into the water distribution system to support fire-fighting activities; As part of employee training and organizational culture, share experiences about responding to and recovering from disasters that impact water distribution systems; Establish and maintain relationships with subject matter experts on water distribution system contamination response and recovery actions, technical support, and decision making.

3.2 Response

This phase is comprised of the coordination and management of resources (including personnel, equipment, and supplies) utilizing the Incident Command System (ICS) in an all-hazards approach; and measures taken for life/property/environmental safety. The response phase is a reaction to the occurrence of an emergency or disaster. The response phase occurs in the immediate aftermath of an incident. During the response phase, business and other operations do not function normally. Personal safety and well-being and the duration of the response phase depend on the level of preparedness. While pressure loss can sometimes be quickly addressed, finding, and removing microbial and chemical contamination from affected infrastructure can sometimes take weeks to years. The time needed to find and characterize contamination severity greatly lengthens the time the water system, or parts of it, are technically still in the response phase. At the same time, parts of the water distribution system that may be unaffected may be restored to safe use. This is an important distinction when communicating with officials and the public. Examples of response activities include: Implement disaster response plans; Utilize appropriate PPE and practices to lessen the chance of injury when staff could be exposed to smoke, electrical, flame, and physical hazards; Monitor storage tank water levels and system pressure; Shut valves to damaged or destroyed structures and areas; Issue water use advisories and orders; Open the emergency interconnection with the nearby water system to supply water and pressure; Flush and re-pressurize the affected water distribution system areas; Require water meter removal and the physical disconnection of damaged and destroyed properties from the water distribution system if no functional backflow prevention device exists.

3.3 Recovery

This phase includes restoration activities that occur concurrently with regular operations and activities. The recovery period from a disaster can be prolonged. Examples of recovery activities include: Support employees who have experienced trauma; Prevent or reduce stress-related illnesses and excessive financial burdens; Decontaminate, physically removing and replace damaged or chemically contaminated assets; Require chemical testing of the property service line, install a backflow prevention device, or replace infrastructure before damaged property services are reconnected to the distribution system; Rebuild damaged structures based on lessons learned from the preceding disaster; Reduce vulnerability to future disasters.

3.4 Mitigation

This phase is an effort to reduce loss of life and property by lessening the cause, impact, and consequences of disasters. Examples of hazard mitigation include: Acquire emergency generators for water treatment facilities and pump stations; Remove vegetation from near water system assets; Install physical interconnections with neighboring utility distribution systems to support emergency pressure and water needs; Tie down infrastructure with ground anchors to withstand wind damage; Install backflow devices at service lines to prevent contamination from entering distribution systems from damaged or destroyed buildings; Upgrade distribution system construction requirements, as pressure zone separations, service line backflow prevention devices, remote shutoff meters/valves, and selective plastic use can reduce the rate and magnitude of pressure loss, water loss, and impact of chemical contamination; Require metal piping, metal water meters, metal and concrete meter boxes where assets are shallow or not buried; Buy insurance policies; Inspect facilities periodically to confirm the wildfire risk conditions are reduced.

The information contained in this document defines and explains the following associated with wildfire incident response for water systems:

1. Roles and responsibilities for key organizations,
2. Conditions that prompt wildfire caused contamination,
3. Phases of water system wildfire response,
4. Determination if a water use warning is necessary,
5. Evaluation of the contaminant exposures and determination of which water use warning is necessary,
6. Customer property factors that influence whether chemical testing is needed, and
7. Water sampling, testing, outcomes, and decisions.

4. Roles And Responsibilities of Key Organizations

4.1 Several stakeholders are integral to a water system incident response

The information below is intended to inform the water system's overall response posture as it is related to wildfires. This information is provided because past ambiguity at local, county, state and federal levels has impeded water system (and community) response and recovery associated with wildfires. Water system response and recovery to emergencies and disasters can be expedited with clearly defined roles and responsibilities of pertinent organizations.

When wildfires impact water systems, there are often seven core stakeholder groups (Figure 1). Six of these groups are described in detail below, while a separate, but important group, includes the customers themselves. Customers should provide feedback to the water system about water leaks, pressure loss, and indicators of contamination, and submit questions. They may also provide information to county and state agencies to better understand drinking water safety, response, and recovery activities and requirements. Information provided by customers should be sought by the water system as it can help identify unknown or unresolved system integrity and service issues, as well as population needs (Whelton et al. 2007).

Group Type	**Group Name**		
Local	**Public Water System**	**Customers**	**County Public Health Department**
State	**State *SDWA* Primacy Agency**	**State Public Health Department**	
Federal	**U.S. Environmental Protection Agency**	**U.S. Centers for Disease Control and Prevention**	

Figure 1. There are several important groups that are directly impacted by wildfires or provide critical support to water systems during wildfire response and recovery.

Sometimes the State Safe Drinking Water Act (SDWA) primacy agency in a state is the state health department, whereas for other states a different non-Public Health agency is the SDWA primacy agency.

Other important organizations not listed in Figure 1 include the county and state emergency management agencies, executive leadership of counties and states, mutual aid organizations, private companies, nongovernmental organizations, and higher education institutions. To focus the CONOPS plan, the roles and responsibilities of the six groups described above are defined below. To correspond to the preparedness, response, and recovery explanations above, the information below is provided in several distinct groupings:

a) Preparedness
b) Response
   I. Immediate Objectives,
   II. Damage Containment and Reasserting Control Objectives,
   III. Chemical Contamination Hunting Objectives, and
c) Recovery
d) Mitigation is not described as part of the roles and responsibilities due to a primary focus of this document on the preparedness, response, and recovery phases.

4.2 Public water system roles and responsibilities

The water system is on the front line for managing water system preparedness, response, and recovery operations.

4.2.1 Preparedness

1. Train water system workers about hazards, acquire and train with appropriate PPE related to smoke, electrical, flame, physical, and other hazards.
2. Validate backup emergency power systems and equipment are operable and fuels are on-hand to avoid power loss. (*NOTE: Natural gas suppliers may shutoff natural gas treatment facility and emergency generator supplies during a wildfire*).
3. Check the operability of utility interconnections with neighboring water systems.
4. Check that the backflow prevention devices in the water distribution system are operable in that they can prevent contaminated water from moving between pressure zones.
5. Check that the backflow prevention devices at service connections are operable in that they can prevent contamination being sucked into depressurized water distribution systems where buildings may become fire damaged or destroyed.
6. Where applicable, stage water system workers and equipment to reduce the risk that all resources are impacted in a single location or inaccessible during and after the incident. For example, consider whether all vehicles, hydrants, pipes, tools, and other asset inventories be stored at a single location.
7. Contact firefighting and city/county emergency management teams to encourage notifications about low pressure and how water system staff can then take action to isolate the impacted areas.
8. Notify electricity and natural gas suppliers about the priority status of the water system as the system will be relied upon by emergency responders who will protect life and property, public safety, and community resilience. Make clear the providers understand that water systems have been legally designated as a "critical lifeline service". Confirm that the water systems are on their critical customer list. Inquire about the lead time the providers will notify the water system before cutting off service.
9. Notify communications providers about the priority status of the water system as the system will be relied upon by emergency responders who will protect life and property, public safety, and community resilience. Make clear the providers understand that water systems have been legally designated as a "critical lifeline service". Confirm that the water

systems are on their critical customer list. Inquire about the lead time the providers will notify the water system before cutting off service.

10. Consult the calibrated hydraulic water distribution system model to understand how structure destruction could impact maximum water flow demands in different parts of the distribution system as well as the duration by which portions of the distribution system would lose pressure.
11. Maintain plans to hydraulically isolate damaged properties or areas of the water distribution system, including shutoffs, valves, etc.
12. Check that all water distribution system assets (valves, hydrants, service lines, etc.) are properly identified and located on water distribution system asset maps,
13. Determine how water distribution system asset maps will be accessed by public water system personnel if power and telecommunications are out,
14. Subscribe to the Water and Wastewater Utility Action Network (WARN) for mutual aide, and request resources to help during and after an incident.
15. Check that the methods and volatile organic compound (VOC)/semi-volatile organic compound (SVOC) chemicals in drinking water to be targeted post-fire are the most up-to-date.
16. Maintain a list of emergency water testing laboratories that can screen water samples for the full list of fire-related chemicals.
17. Encourage the state primacy agency to facilitate expedited commercial laboratory resources. It is not unusual to have tens to hundreds of water samples needing VOC and SVOC analysis with less than 5 day turnaround times on short-notice.
18. Encourage the state primacy agency to request an explanation of potential support from the U.S. EPA Water Lab Alliance.
19. Consider contacting WARN about their capacity to find laboratory support for emergency conditions.
20. For water systems in wildfire vulnerable areas, educate customers about anticipated challenges associated with wildfires impacting water system service and quality, potential actions the water system could take to minimize impact, and methods by which the water system will communicate.
21. Engage subject matter experts in and outside the organization who specialize in challenges and solutions to wildfire caused drinking water contamination.

4.2.2 Response: Immediate objectives

1. Protect workers from health and safety risks.
2. In coordination with the state primacy agency or issued unilaterally by the state agency due to the public water system being overwhelmed by the disaster, issue a Do Not Use Order, Do Not Drink Order, and/or Boil Water Advisory to the community. (*See section 7 of this document for a detailed discussion of these warnings. Note that a hybrid Do Not Drink-Do Not Boil Order is not one of the three recognized water use warnings recommended by the CDC. Different water use warning terminology is used by different state SDWA primacy agencies*)
3. Monitor power supply in the system.
4. Keep power to critical assets.

5. Monitor water pressure in the system.
6. Keep pressure in the distribution system.
7. Isolate damaged distribution system components to prevent contamination from entering and transiting the network. Note that commercial and industrial properties often have larger service lines and may have destroyed sprinkler systems which can leak large amounts of water quicker than some residential buildings. Prioritize isolating properties that are causing the largest water loss to limit potential system physical and chemical damage.
8. Engage neighboring utility interconnections to support water pressure and distribution system demands.

4.2.3 Response: Damage containment and reasserting control objectives

1. Isolate areas where extensive damage and destruction exists from the main water distribution system to maintain pressure and prevent contamination entry and spread.
2. Flush out potentially contaminated water from the distribution system through hydrants, blowoffs, service lines, and other utility assets to restore disinfectant and bacterial control.
3. Physically remove water meters from properties with destroyed structures so that property owners do not turn back on water and their contamination could enter the water system. This is a cross-connection control public health hazard. Some customers have turned on their shutoff water meter without public water system consent or knowledge after past wildfires.
4. Conduct disinfectant residual and microbiological water sampling and analysis.
5. Notify customers about the preliminary system damage assessment and actions being taken by the public water system.

4.2.4 Response: Chemical contamination hunting objectives

1. Keep areas where extensive damage and destruction exists isolated from the main water distribution system.
2. Flush out potentially contaminated water from the distribution system through hydrants, blowoffs, service lines, and other utility assets to restore disinfectant residual and microbiological control.
3. Conduct VOC and SVOC chemical water sampling and analysis.
4. Receive customer feedback about water quality and send out water quality investigation teams when necessary to follow-up on potential indicators of a localized or system-wide water quality issue.
5. Notify customers about the actions being taken by the public water system.

4.2.5 Recovery

1. Prepare a Return to Service Plan for the state primacy agency (Appendix A)
2. Assess physical damage and test for contamination in each area where extensive damage and destruction exists that was isolated from the main water distribution system.
3. Conduct chemical water sampling and analysis of water system assets (i.e., water mains, hydrants, service lines).
4. Purchase and install backflow prevention device for each customer property. Integrate the periodic inspection and testing of these devices into the public water system cross-connection control program.

5. Notify customers about the actions being taken by the public water system.
6. Provide customers contact information to have water service restored and describe the conditions required needed for reconnection to the public water system (i.e., negative chemical test of their service line, backflow prevention device installation, etc.).
7. Require customers with destroyed properties to either (a) replace their property service line, or (2) conduct chemical testing to ensure systems are not contaminated. This can be supported by County of State building code requirements.
8. Notify customers of a pending construction or response activity in their area.
9. Notify customers of water testing results.
10. Receive customer feedback about water quality and send out water quality water system water quality investigation teams when necessary.
11. Defer private property plumbing integrity and in-building water treatment recommendations to the agency responsible for water and sanitation within buildings (i.e., Health Department).

4.3 Drinking water *SDWA* primacy agency roles and responsibilities

This organization has oversight of regulated public water systems under the *SDWA.*

4.3.1 Preparedness

1. Create evidence-based Public Notifications and procedures for what information is needed to lift post-fire drinking water use warnings. These should include health risk assessments associated with chemical inhalation, dermal, and ingestion exposure pathways, durations, various populations, etc.
2. Prepare explicit guidance on what actions are needed for property owners who desire to reconnect a destroyed property to the public water distribution system with respect to cross-connection control hazards and contamination.
3. Identify the formal documents that should be created and submitted to the agency by the water system in response to milestones of the testing and recovery plan (i.e., letters, notices, permit amendments to the water system). Prepare to provide written documentation about what documents the agency expects to receive to minimize confusion between the agency and public water system.
4. Oversee the commercial water testing laboratory certification program.
5. Provide the commercial water testing laboratories a list of the specific chemicals needed for fire-related drinking water testing, not omitting some due to general U.S. EPA analytical method use.
6. Notify all certified laboratories about the standard operating procedure for drinking water analysis where samples originate from water distribution systems and building plumbing. This should include the contaminants of health concern, applicable methods, and modifications, and need for stagnation before water sample collection. Update this guidance as new information becomes available.
7. Engage subject matter experts in and outside the organization who specialize in challenges and solutions to wildfire caused drinking water contamination.

4.3.2 Response: Immediate objectives

1. Advise the water system, coordinate issuing public notification, or issue unilaterally due to the public water system being overwhelmed by the disaster a Boil Water Advisory, Do Not Drink Order, Do Not Drink-Do Not Boil Order, Do Not Use Order based on chemicals and microbial contaminants potentially present to mitigate public exposure.
2. Provide technical input and regulatory oversight of water system response actions and assist the water system with complex operations/logistics that exceed the system's capacity.

4.3.3 Response: Damage containment and reasserting control objectives

1. Provide ongoing technical input on allowable water use conditions based on water testing results received by the water system.
2. Provide technical input on the disinfectant and bacteriological sampling locations and frequency needed to determine system control has been achieved.
3. Conduct agency led rapid water sampling and analysis for resource limited water systems.
4. Coordinate with the state and county public health department to share public water system data as it becomes available.
5. Notify all certified laboratories about the standard operating procedure for water system and building plumbing sampling and analysis, including the contaminants of concern, applicable methods, and modifications, and need for stagnation before water sample collection. Update this guidance as new information becomes available.

4.3.4 Response: Chemical contamination hunting objectives

1. Conduct agency led rapid water sampling and analysis for resource limited water systems.
2. Coordinate with the state and county public health department and share public water system data as it becomes available.
3. Notify all certified laboratories about the standard operating procedure for water system and building plumbing sampling and analysis, including the contaminants of health concern, applicable methods and modifications, and need for stagnation before water sample collection. Update this guidance as new information becomes available.
4. Lift the property or area water use advisory once appropriate and repeated testing data indicate no contamination.

4.3.5 Recovery

1. Provide a written explanation to the public water system about what documents the agency expects to receive in anticipation that a Return to Service Plan will be created and submitted. This will help minimize confusion between the agency and public water system.
2. Defer private property plumbing integrity and in-building water treatment recommendations to the agency responsible for water and sanitation within buildings (i.e., Health Department).
3. Review costs encountered during water system response and recovery if requested by the FEMA as part of reimbursements.
4. Prepare formal approval letter(s) to support the public water system actions taken and costs for response and recovery that can be provided to FEMA.

4.4 County and state public health department roles and responsibilities

These organizations have responsibility for understanding public health risks and issuing guidance to public and private property owners about building plumbing safety, unregulated onsite drinking water systems, and onsite wastewater treatment systems.

4.4.1 Preparedness

1. Support the state drinking water primacy agency's creation of evidence-based public notification and procedures for what information is needed to lift water use warnings.
2. Provide technical input on allowable water use conditions based on the chemicals detected, their concentrations, exposure pathways, durations, and populations at risk.
3. Support the state drinking water primacy agency's creation of explicit guidance on what actions are needed for reconnecting a destroyed property to the public water distribution system with respect to cross-connection control hazards and contamination.
4. Identify the formal documents that should be created and submitted to the local authority having jurisdiction about requirements for reconnecting destroyed properties to the water distribution system during property repair and rebuilding.
5. Prepare and issue building owner post-incident plumbing inspection and testing guidance.
6. Notify all certified laboratories about the standard operating procedure (SOP) for water system and building plumbing sampling and analysis, including the contaminants of health concern, applicable methods and modifications, and need for stagnation before water sample collection. Update this guidance as new information becomes available.
7. Prepare and issue building water system decontamination guidance based on contaminant classes (VOCs, SVOCs, etc.) and various exposure scenarios based on exposure estimate and risk assessments and necessary interventions (i.e., ventilation, shutoff water heaters, PPE, etc.).
8. Engage subject matter experts in and outside the organization who specialize in challenges and solutions to wildfire caused drinking water contamination.

4.4.2 Response: Immediate objectives

1. Publicly share post-incident property owner inspection and testing guidance for plumbing.
2. Provide the water system and state agencies technical input on allowable water use conditions based on chemical water testing results received by the water system and nature of the incident.
3. Coordinate with the water system and state agencies to share anonymized plumbing inspection and testing results as it becomes available.

4.4.3 Response: Repair and return to use

1. Consider conducting agency led rapid building water sampling and analysis for resource limited communities.
2. Publicly share anonymized plumbing inspection and testing results.
3. Coordinate with the water system and state agencies to share anonymized plumbing inspection and testing results as it becomes available.

4.4.4 Response: Repair and return to use

1. Provide guidance to building owners and inhabitants (i.e., renters) about private property plumbing integrity and in-building water treatment.

4.5 U.S. Environmental Protection Agency roles and responsibilities

This organization has oversight of regulated public water systems under the *SDWA.* For a national disaster, this is typically the lead federal partner for Emergency Support Function 3: Public Works and Engineering (FEMA 2020a).

4.5.1 Preparedness

1. Confirm that the state agencies delegated primacy under the *SDWA* recognize the most up to date list of specific fire-related chemicals for post-fire drinking water testing and sampling methods.
2. Create evidenced-based water use advisories and protocols for advisory issuance and lifting with the U.S. Centers for Disease Control and Prevention.
3. Identify the conditions and approval requirements where the U.S. EPA mobile water testing laboratory could be deployed.
4. Identify the conditions that would prompt the U.S. EPA Water Lab Alliance to provide direct support to the state and public water systems impacted. Specify the actions needed for engagement/approach, and speed of engagement that will be taken by this entity.
5. Support projects that investigate means to expedite water system testing, decontamination, and repair.
6. Engage subject matter experts in and outside the organization who specialize in challenges and solutions to wildfire caused drinking water contamination.

4.5.2 Response

1. Provide technical guidance to the state agencies delegated primacy under the *SDWA* as requested.
2. Provide the U.S. EPA onsite mobile water testing laboratory when conditions meet the predefined requirements.
3. For resource limited water systems and those that have had considerable staff and infrastructure impact due to the incident, consider deploying agency staff to directly assist in rapid water sample collection, transport, and analysis to expedite data collection for rapid decision making.
4. Where engaged, facilitate FEMA interactions with public water systems about questions for costs and reimbursement.
5. Coordinate technical assistance connections between the water system, state *SDWA* primacy agency, county health department with the CDC pertaining to health risks posed by chemical and microbiological contaminants in buildings.

4.5.3 Recovery

1. Support public water system response and recovery actions and costs supported by State agencies delegated primacy under the *SDWA*.

4.6 U.S. Centers for Disease Control and Prevention roles and responsibilities

This organization has responsibility for understanding public health risks and issuing guidance to public and private property owners about building water system safety, unregulated onsite drinking water systems, and onsite wastewater treatment systems. For a national disaster, this is the organization lead federal partner for Emergency Support Function #8 – Public Health and Medical Services (FEMA 2020b).

4.6.1 Preparedness

1. Provide technical assistance to the state and county public health agencies responsible for drinking water safety on properties, including those people who are delivered water from public water systems and private unregulated systems.
2. Recognize the most up to date list of specific fire-related chemicals for post-fire drinking water testing.
3. Create evidenced-based water use advisories and protocols for advisory issuance and lifting with the U.S. EPA. Make this evidence-based guidance available to the state and county public health agencies.
4. Create evidence-based personal safety guidance for property owners who return to their fire damaged properties. Make this evidence-based guidance available to the state and county public health agencies.
5. Create evidenced-based building water system decontamination protocols for with the U.S. EPA. Make this evidence-based guidance available to the state and county public health agencies.
6. Create evidence-based water system occupational safety guidance for situations where staff are operating in an active wildfire area with smoke, flames, high winds, airborne debris, electrical, and other hazards. Make this evidence-based guidance available to the state and county public health agencies and water systems.
7. Identify the conditions that would prompt deployment of staff to provide onsite support to the state and public health agencies.
8. Support projects that investigate ways to expedite exposure assessments, property water system testing, decontamination, and property remediation.
9. Engage subject matter experts in and outside the organization who specialize in public health threats and solutions to wildfire caused drinking water contamination.

4.6.2 Response

1. Provide technical guidance to the state and county public health agencies responsible for drinking water safety on properties, including those delivered water from public water systems and private unregulated systems.
2. For resource limited communities and those that have had considerable staff and infrastructure impacts due to the incident, consider deploying agency staff to directly assist in rapid water sample collection, transport, and analysis to expedite data collection for rapid decision making.
3. Where engaged, facilitate U.S. Federal Emergency Management Agency (FEMA) interactions for property owners about questions for costs and reimbursement.

4. Coordinate technical assistance connections between the water system, state, and county health department with the U.S. state agency responsible for the *SDWA* as well as U.S. Environmental Protection Agency pertaining to health risks posed by chemical and microbiological contaminants in buildings.

4.6.3 Recovery

1. Support county and state level public health response and recovery actions.

5. Conditions That Prompt Wildfire Caused Drinking Water Contamination

Wildfires can contaminate drinking water sources, water treatment plants, and distribution systems. Contaminants can include microorganisms such as pathogens, as well as VOCs, SVOCs, and metals (Figure 2). Directly contaminated source water (i.e., from falling ash, debris dissolved constituents) that passes through water treatment facilities can reach water distribution systems.

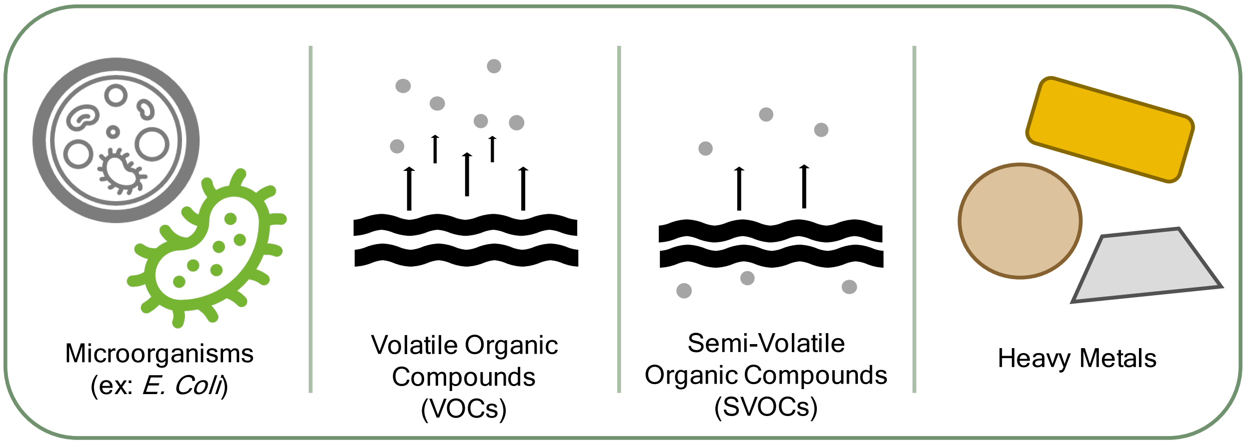


Figure 2. After wildfires, contamination can sometimes be found in distribution systems. Water use advisories should be based on protecting the population from harm when specific exposure pathways are likely.

Contamination can enter water distribution systems through multiple pathways as shown in Figure 3. Since 2017, VOCs and SVOCs have been found in fire damaged water distribution systems. VOCs and SVOCs can originate from heat damaged plastics (gaskets, pipes, coatings, linings, etc.) (Isaacson et al. 2021; Draper et al. 2022; Metz et al. 2023). A greater number of damaged or destroyed structures in an area increases the likelihood that contamination may be found in the water distribution system (Schulze and Fischer 2021). Structures that caught fire or were destroyed may also be sources of VOCs and SVOCs if contaminated water has backflowed through the service line (Horn et al. 2024). Contamination can also be caused within building plumbing and can enter water distribution systems. Metal contaminants, while present in debris and storm water runoff from damaged areas, may also be present in source water but testing to date has not evaluated whether these contaminants can enter water distribution systems directly. It is important to underscore that contamination of water distribution systems is a widely accepted consequence of wildfires (U.S. EPA 2021; NASEM 2022; NEHA 2023; Su and Whelton 2024). As such, conditions that prompt this consequence should be considered by decision-makers during the disaster response.

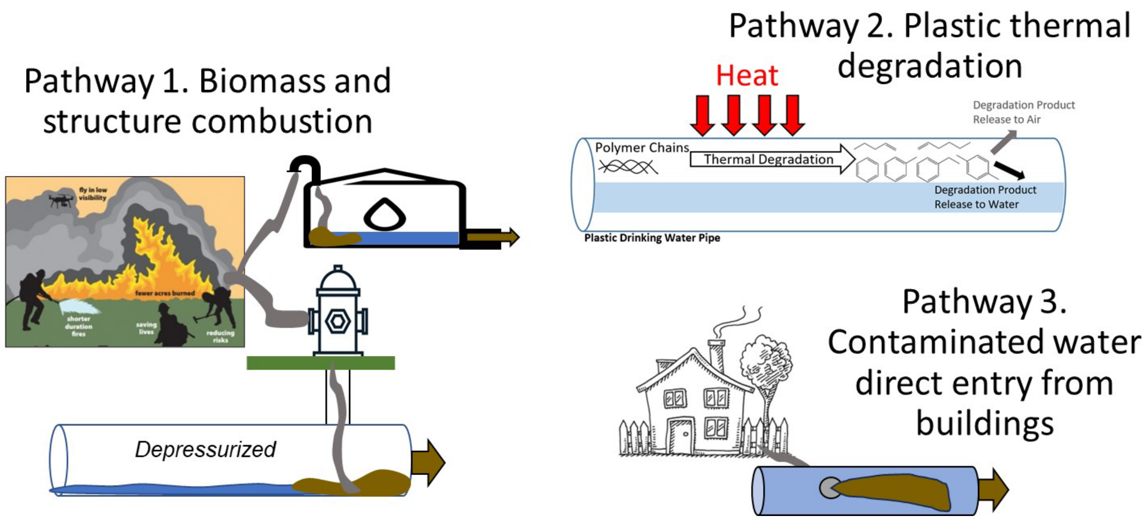


Figure 3. Sources of VOC and SVOC contamination in water distribution systems after fire have been hypothesized to be due to (1) forest biomass or structure combustion, (2) thermal degradation of water system plastics like pipes, gaskets, seals, linings, and other materials, and (3) contaminated water back siphonage into the water distribution system because there is no backflow prevention device separating the property from the water distribution system.

Microorganisms like bacteria are ubiquitous in the soil and water. These contaminants can enter distribution systems due to the failure of water treatment processes and the lack of residual disinfectant concentration. Microorganisms can also enter distribution systems through damaged infrastructure assets (i.e., pipes, tanks).

VOCs and SVOCs are sometimes present in contaminated soil and water, but during fires, their levels in air can increase due to thermally damaged or burned infrastructure materials. Wood and plastic are common sources of VOCs and SVOCs when subjected to heat. The treatment facilities can also be directly contaminated (i.e., falling ash, debris). VOCs and SVOCs can also directly enter water distribution system facilities through broken or open infrastructure assets. Unlike microorganism contaminants, VOCs and SVOCs can volatilize into the air, and this is how they can sometimes enter water distribution systems (e.g., open hydrants, vent pipes).

While SVOCs called polycyclic aromatic hydrocarbons have lower water solubility values than VOCs, they can be more likely to adhere to infrastructure (pipes, meters, tanks, etc.) and desorb slower from infrastructure than VOCs into drinking water. VOCs are more likely than SVOCs to diffuse into and out of certain plastics used for infrastructure and plumbing.

Metal contaminants are known to be associated with fire debris.

> *WARNING: Direct VOC and SVOC entry into a water distribution system can occur during localized depressurization where debris and smoke (i.e., particulates, gases, vapors) are sucked in through compromised assets (i.e., hydrants, tanks, valves, water meters, utility service lines, etc.) or through customer service lines because of damaged structures. Once the pollutants have entered the water distribution system, VOCs and SVOCs such as vapors and particulates can mix with drinking water and deposit or sorb into and out of infrastructure materials.*

Because of this, chemical contamination that enters the water distribution system can be difficult to find and remove. Sometimes chemically contaminated water can be drawn from one part of the system to another through service lines and water mains, spreading contamination elsewhere.

6. Response and Key Decisions

6.1 General

There are three general response phases for responding to wildfires that attack water system assets (Figure 4). During a wildfire, the water system is typically relied upon as a priority fire-fighting asset. In response to large incidents, localized or widespread depressurization and contamination can occur. For localized small incidents, water pressure can be maintained and system failures (i.e., breaks, leaks) can be avoided or minimized. By maintaining water pressure and limiting breaks and leaks the system can avoid the intrusion of microorganisms and chemical contamination. To explain simply, dirt cannot easily enter a garden hose when water is flowing out of it. When system pressure loss occurs (i.e., hydrants are left open, numerous structures are destroyed, storage tanks are low or empty) contamination can enter the distribution system through hydrants, pipe breaks, and storage tank vents, etc.

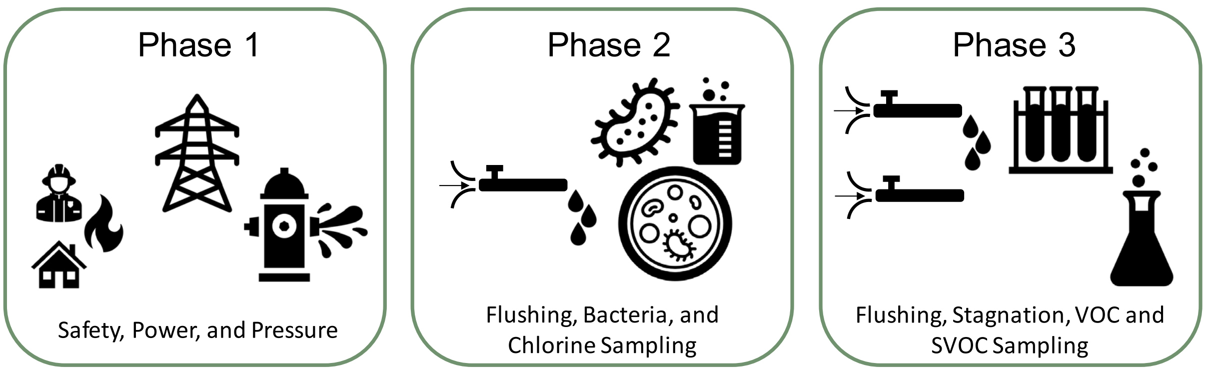


Figure 4. Phases of water system wildfire incident response.

6.2 Phase 1: Safety, power, and pressure

One of the most critical aspects of the response is that water system staff must be trained, equipped with proper PPE, and protected from injury. To keep the water system functional, staff can encounter numerous occupational hazards in the field. To maintain water system pressure, water storage and power are essential. Loss of power can hinder the water system's ability to produce and deliver water into a leaking distribution system. Power loss can occur due to electricity and natural gas shutoffs or damage to that infrastructure. The loss of water production capacity, coupled with high fire-fighting demand draws on the distribution system and structure destruction (i.e., leaks) can prompt depressurization.

6.3 Phase 2: Flushing, bacteria, and chlorine sampling

Once water leaks have been managed and water pressure control has been restored to distribution system facilities, rapidly surging fresh treated drinking water into the system is essential. This can be achieved by flushing hydrants, blowoffs, tank overflows, disconnecting service lines, etc. Once the water has been turned over, microorganism sampling and testing is typically conducted. If raw source water or less than optimally treated drinking water is delivered to the distribution system to support firefighting efforts (i.e., bypassed treatment facilities), this may lengthen the time needed to achieve pressure and microbiological control of the distribution system.

6.3 Phase 3: Flushing, stagnation, VOC and SVOC sampling

After or simultaneously alongside flushing and microorganism sampling efforts, VOC and SVOC testing can be conducted. Chemical sampling should be prioritized based on risk factors in the distribution system associated with the emergency and/or disaster. Risk factors can include localized or widespread depressurization coupled with open hydrants, blowoffs, tank vents in proximity to smoke and debris. Structures that were destroyed and damaged may also be a source of contamination. These structures can backflow into the water distribution system through service lines and water meters if there is no functional backflow prevention device on the service line. Additional risk factors for customer property damage are described below. The type of customer in or near the affected area may also prompt increased sampling (i.e., childcare centers, schools, medical facilities, etc.).

6.4 The complexity of the water system and damage will prompt different decisions during each phase

Water systems damaged by wildfires can have different designs as well as operational conditions. As such, some systems may be vulnerable to depressurization if a certain number of buildings may be destroyed (and leak) whereas other systems may be able to withstand that scale of damage and continue to operate relatively unimpacted. The varied designs and materials used are often based on local decisions. For example, water meters may be located belowground close to the street, inside basements, or even above ground, depending on local climate conditions (Figure 5). This design and construction variability can even be found at a single water system due to different construction and development policies.

When working to minimize chemical contamination of the infrastructure, consider that plastic materials are especially vulnerable to being contaminated. The materials that wholly or partly comprise plastics include, but are not limited to:

- Service lines
- Valves, meters, hydrants
- Tank interior linings
- Pipe interior coatings
- Blowoffs
- Valves and other assets

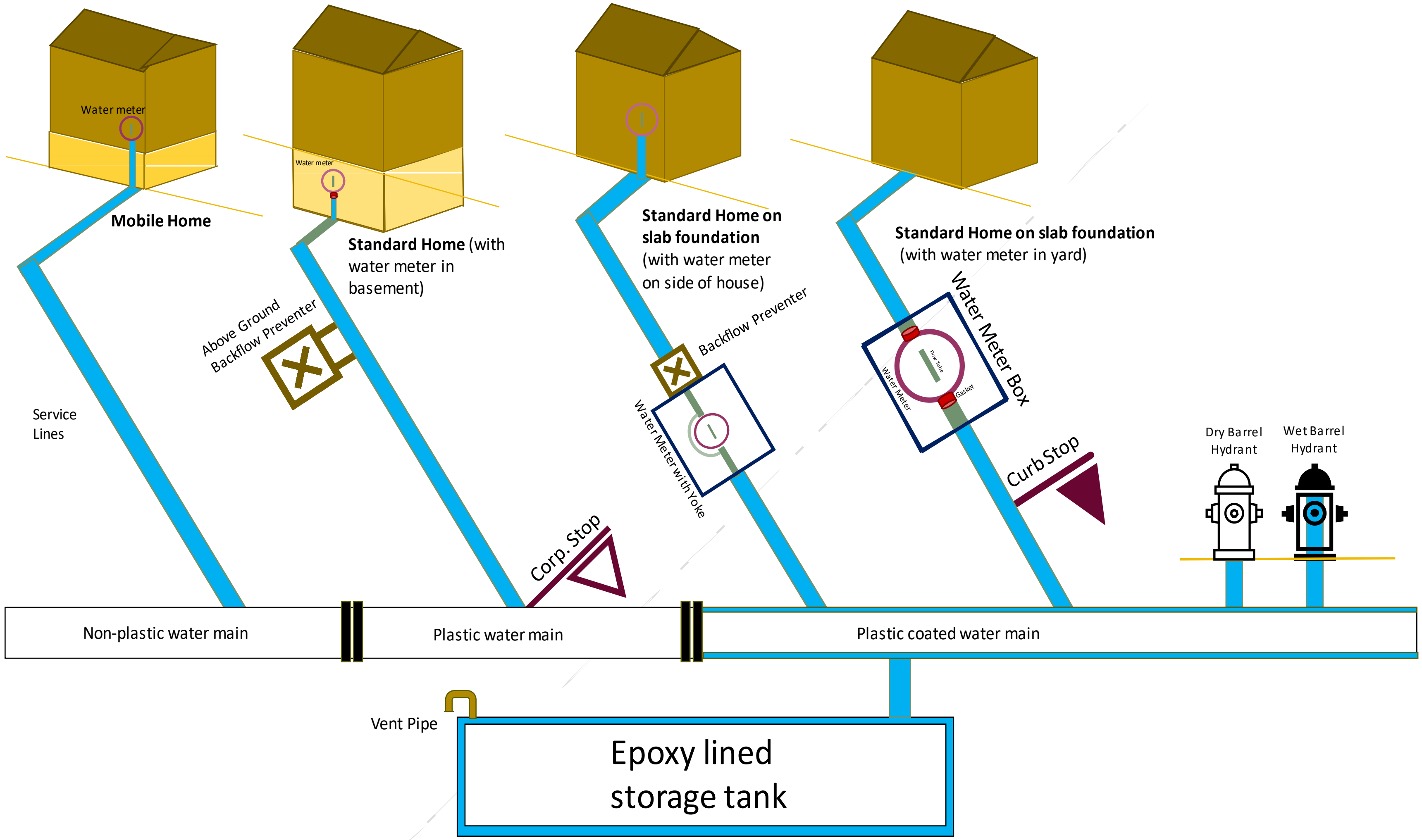


Figure 5. Schematic of water distribution system components that may be thermally or chemically damaged due to a fire. Water meters may be located at the street, on customer property, or inside buildings.

7. Evaluate Contaminant Exposures and Determine the Water Use Warning

7.1 General considerations

Water use warnings should be based on limiting contaminant exposure for the entire population impacted (i.e., infants, children, adults). Some contaminants found in wildfire contaminated drinking water can prompt immediate health impacts such as headaches, nausea, vertigo, or gastrointestinal distress. Immunocompromised populations (i.e., infants, children, adults with medical conditions, dialysis) could be more susceptible to exposures. Water is typically used for cooking, bathing, showering, washing utensils, washing clothes, baby formula, as well as pets, and for other outdoor purposes. Whether the water can be used for dialysis and other applications without adverse health impacts should be considered in the water use decision. Each application has different exposure potential (i.e., showering = inhalation exposure vs. drinking = ingestion) (Figure 6). Public health officials (i.e., toxicologists, risk assessors) should provide water system staff guidance on risks for exposures.

WARNING: Chemical levels in drinking water from damaged distribution systems, after some wildfires, have exceeded hazardous waste limits (i.e., 40,000 benzene, >2,217 ppb benzene) and levels that are acutely harmful (>200 ppb benzene, >75,000 ppb methyl ethyl ketone). For these reasons extreme care must be taken to protect the population from harm. In other cases, chemical levels in damaged water systems did not exceed levels that posed acute harm.

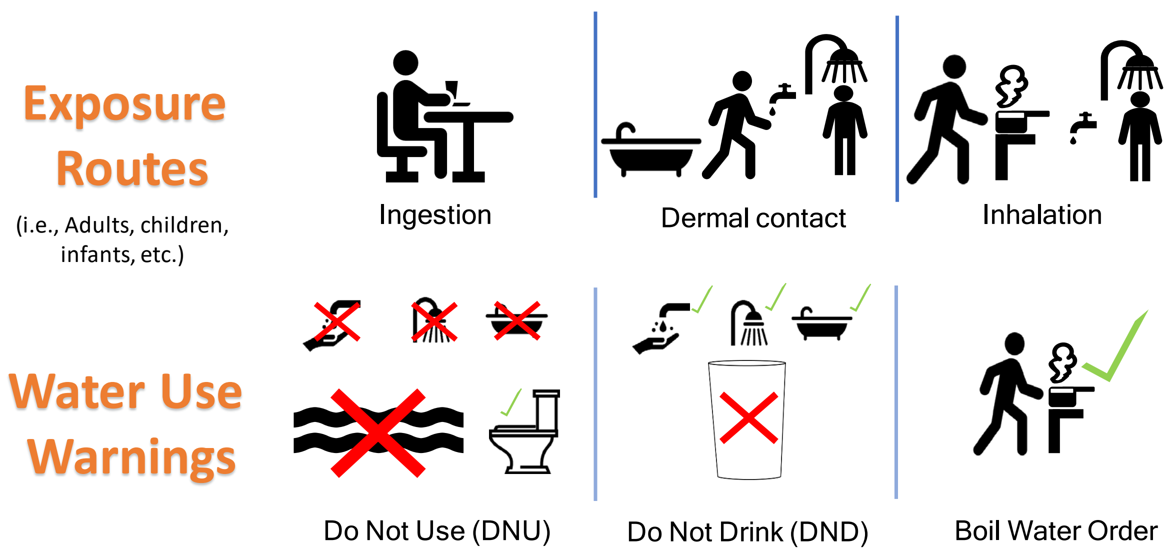


Figure 6. When VOCs and SVOCs reach customers, chemical exposure can occur by ingestion, inhalation, and dermal contact.

Boiling contaminated water can help inactivate pathogens but would increase chemical exposures to the water user. This is why boil water orders are not recommended when water distribution systems are damaged by fire or contaminated by VOCs and SVOCs.

7.2 Water advisory and order types

The conditions mentioned below should be considered regarding the issuance of a water use warning. Appendix B contains guidance from the U.S. Centers for Disease Control and Prevention about different types of water use warnings.

7.2.1 No advisory

No localized or widespread distribution system pressure loss, no isolated or widespread water distribution system damage, no customer properties damaged, no VOC or SVOC contamination present, no source water contamination, no water treatment plant contamination, no interruption of or failure of the water treatment system, no non-potable water entry into the distribution system.

7.2.2 Do not use order

Localized or widespread pressure loss occurred, water system infrastructure (meter boxes, meters, valves, backflow prevention devices, tanks, service lines, hydrants, etc.) are thermally damaged or burned, hydrants are found open (not closed), storage tanks are found open (not closed), customer properties are thermally damaged or burned, complaints of unidentified smoky, burnt, paint thinner, chemical drinking water tastes or odors, VOCs or SVOCs associated with fire damaged water systems are detected in drinking water samples.

> *NOTE: Many chemicals that pose health risks cannot be tasted or smelled before they are harmful. For example, benzene often cannot be detected by odor in water until it reaches a 2,000 ppb concentration. This level is orders of magnitude times higher than the level that poses a health risk in drinking water. No customers should be advised to use taste and odor instead of chemical testing to determine the safety of drinking water. <u>Taste and odor should never be used in place of chemical testing for post-fire water safety assessments</u>.*

7.2.3 Boil water advisory

Localized or widespread pressure loss occurred, BUT no isolated or widespread water distribution system damage, no customer properties damaged, no VOC or SVOC contamination present. NOTE: Boiling chemically contaminated water can prompt greater chemical exposures.

> *NOTE: While Do Not Drink-Do Not Boil Orders have been issued after recent wildfires, the U.S. CDC does not recognize these notifications in their federal guidance. The U.S. CDC recognizes boil water advisories, do not drink, and do not use orders. Different states have different policies for the types and preferred formats of water use orders. Regardless of the advisory or order name, the population should be warned about how to protect themselves from the hazard posed by the drinking water.*

7.3 Emergency drinking water, alternate sources

The type and duration of the drinking water use advisory, and order issued as well as the population characteristics and environment will impact the scale of emergency drinking water needed for the community. Depending on the water advisory or order, alternate water sources may be needed for the community for consumption, cooking, and hygiene. Other water use activities may also need emergency drinking water such as water for pets and laundry. After past wildfire disasters households sometimes used emergency drinking water for garden watering and cleaning. According to federal law, *42 U.S. Code § 300g–2*, when a public water system is impacted by "earthquakes, floods, hurricanes, and other natural disasters," each state is responsible for the emergency drinking water supply plan and its implementation (U.S. CFR 2024). States have sometimes supported the provision of emergency drinking water supply supported by mobilizing the state national guard and providing emergency drinking water assets to the public water system and local government to distribute.

Emergency drinking water can be bulk distributed using bottled water as well as temporary drinking water filling stations to be setup in the community. Temporary filing stations may involve water buffalo points. Points of distribution (POD) can be established throughout the community to provide convenient access points to emergency drinking water. More details about the setup of water filling stations and bulk water distribution considerations can be found elsewhere (U.S. EPA 2011, U.S. EPA 2023a).

There is some variability for the volume of water recommended for the same water use activities across organizations, but it seems U.S. EPA's current estimate is of 1 gallon per person per day greatly underestimates the need (U.S. EPA 2011). U.S. EPA claimed 1.5 gallons of water use person per day is recommended by FEMA, but a review of the cited FEMA document indicates the value was closer to 1.52 gallons per person per day (FEMA 2004). While the 0.02 gallon per person per day difference seems minimal, when considering 1000s or 10000s of people needing water, this water volume deficit becomes significant. Table 1 was compiled for decision makers to inform their initial water volume calculations. Table 2 provides decision makers perspective on how many bottles of water and tractor trailers are needed to support a community of 10,000 people when water use is either 1 or 3 gallons per day per person. However, as cautioned by FEMA, "people in hot environments, children, nursing mothers, and ill people will require even more water than typical estimates" (FEMA 2004). Longer-term emergency drinking water distribution scenarios may involve the setup of water tanks at each property with deliveries from water filling stations or other approved drinking water sources.

Table 1. Individual water needs estimated by various organizations reported as volume of water needed per person per day.

Parameter	Water Use, Gallon/Person/Day			
	WHO[a]	EPA[a]	Zdanowicz[a]	FEMA[b]
Drinking	0.7 to 0.8	-	1.2	0.5
Cooking	0.8 to 1.6	-	1.6	-
Personal hygiene	0.6 to 1.6	-	2.84	1
Other uses	-	-	1.1	-
Drinking, food preparation, and	2 to 4	1	5.8	-
Total volume needed	2 to 4	0.5 to 5	6.7	1.5

Values from: Wang et al. 2019, FEMA 2004

Table 2. The estimated number of water bottles and tractor trailers needed to provide emergency drinking water to 10,000 people per week.

Resource Needed		Water Use, Gallon/Person/Day	
		1	3
Bottle volume and number	8 oz	160,000	480,000
	12 oz	106,667	320,000
	16.9 oz	75,740	227,219
Tractor trailer, 53 ft	8 oz	2	6
	12 oz	2	6
	16.9 oz	2	5

Values calculated for 0.5 L of drinking water per water bottle. People in hot environments, children, nursing mothers, and ill people will require even more water than typical estimates above (FEMA 2004).

For conditions where water advisories or do not use orders greatly restrict water use activities, the population can be issued plastic bulk water collection containers (1 gallon to 5 gallon size). These containers can be used by people at filling stations to collect and transport their water. These containers can initially be distributed at the PODs, where populations can come and acquire the water. It should be recognized that households may not have these containers on-hand so the responding organizations should consider purchasing and issuing them to the population to enable easier water access.

When emergency drinking water is needed, a new waste stream will be generated that requires management as it pertains to bottled water. In addition to used plastic water bottles that will take up volume in solid waste at the household level, waste plastic wrapping and cardboard can also be generated. At water distribution sites, waste pallets and the shrink wrap for the pallets can also be generated. The amount of waste generated will be influenced by the degree bottled water vs. filling stations vs. both approaches are applied. The scale of waste generated can be significant. For example, in response to the Flint Michigan lead drinking water contamination incident tens of millions of used plastic water bottles were generated by the population of 97,000 each week (Wang et al. 2019). To limit solid waste management systems from being overwhelmed and posing a public nuisance and health risk, plastic water bottle recycling activities and more frequency household pickups may be recommended. The population should also be encouraged to drop off used plastic bottles at the PODs that have solid waste collection points for these waste materials.

In the immediate wake of a wildfire, point-of-use and point-of-entry building water system water filters should not be solely relied upon. At the present time, commercially available building drinking water treatment system devices are not “certified” or challenged against drinking water that is contaminated with extreme levels of post-wildfire chemicals, for example. As mentioned previously, benzene levels as high as 2,000 to 40,000 ppb have been found in water distribution systems after some prior fires and certified devices are tested against a small fraction of those concentrations. At the same time, a variety of other contaminants at high concentrations have been found present. Before building water system filters are contemplated, the range and magnitude of chemicals entering the customer’s building over time should be known. These levels can fluctuate greatly depending on nearby water infrastructure that is damaged or leaching chemicals into the drinking water. Should devices be installed, they should be installed properly, undergo immediate water testing to validate the effluent water does not pose a health risk, and undergo periodic water testing to validate they are effectively operating.

> *Specific considerations about finding and mitigating property plumbing contamination caused by the wildfire or delivered to the property through contaminated water distribution systems are not described in this document. Guidance can be found elsewhere, and new studies are increasingly being published (Purdue University, 2021a, 2021b).*

7.4 Categorize customer properties to help determine water distribution system testing is needed and where

To expedite the potential assessment of contamination to water distribution systems, customer properties should be characterized in one of three categories:

Standing	**Damaged**	**Destroyed**

7.5 Four risk levels are associated with damage caused to water distribution systems and contamination

There are four risk levels associated with damage caused to customer properties and potential for water distribution system contamination (**Figure 7**). These can be determined by a combination of field observations and customer complaints (of no, low, fluctuating pressure).

Backflows at individual customers can sometimes be detected by reviewing electronic water meter records. The four conditions are described below.

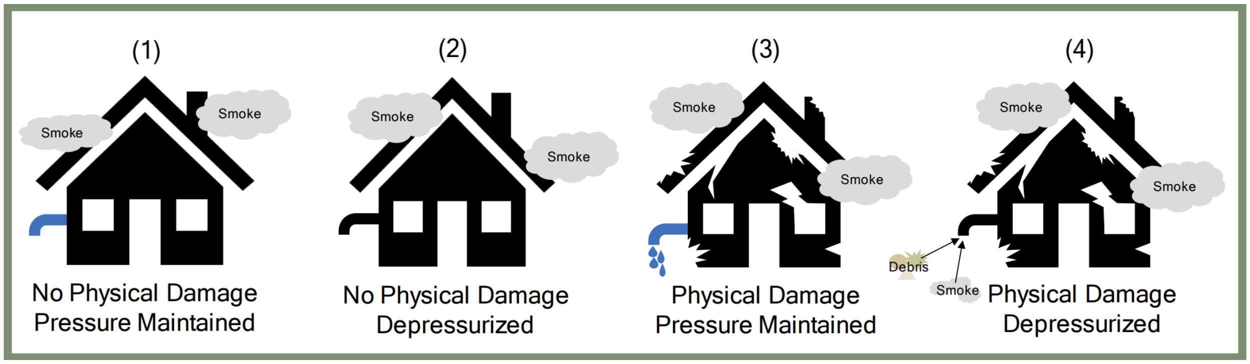


Figure 7. Evidence from the case study and prior wildfires indicates certain customer property damage and environmental conditions may increase the possibility chemical contamination may exist in the water distribution system.

Emergency managers and utilities can identify and prioritize areas near these properties locations for testing by using four risk levels.

Risk Level 1: No structure loss or physical damage with pressure maintained

If normal operations were maintained and no physical damage occurred, it is unlikely the water system was contaminated. If the water system was unattended for some period (e.g., under evacuation), it may be advisable to collect baseline water quality samples (coliform bacteria, disinfectant residual, physical parameters) – these samples could help to identify any unanticipated problems.

Risk Level 2: No structure loss or physical damage with depressurization (pressure loss)

Contaminants could have entered empty water lines through tanks, cross-connections, or unidentified leaks (i.e., smoke, ash, auxiliary water supplies, groundwater contaminants, etc.). The system should issue a boil water advisory and immediately unidirectional flush upon repressurization (multiple cycles preferred), assess the system, and perform necessary water quality sampling, including coliform bacteria, disinfectant residual, and physical parameters such as pH and temperature. Customers should be advised to flush their household plumbing once results show an absence of coliforms.

Risk Level 3: Structure loss or physical damage with pressure maintained

Damage to water system components could cause localized contamination. Physically damaged system components should be immediately isolated and replaced (when possible). This includes removing water meters and capping the service lines; unidirectionally flushed (multiple cycles preferred); and assessed on a case-by-case basis as to whether sampling should be performed.

Risk Level 4: Structure loss or physical damage with depressurization (pressure loss)

This unique situation requires extra caution. There is a risk of contamination. Immediate unidirectional flushing of the water system when repressurizing and refilling water lines (to limit potential contaminant migration) is needed. A Do Not Use notice should be issued until repeated sampling indicates that the system is free of contaminants. The system should be sampled for coliform bacteria, and disinfectant residual. In addition, chemical testing as explained below is highly recommended. Physically damaged system components should be immediately isolated and removed, such as water meters, when possible. Service lines should be capped when water meters are removed.

8. Post-Fire Chemicals, Concentrations, and Comparing Results to Drinking Water Exposure Limits

As of 2024, the complete array of chemicals and concentrations that are present in water distribution systems after fires have not been determined. Based on fires since 2017, a variety of specific VOCs and SVOCs have been identified and are included in **Appendix C**. These compounds have been determined using routine and conventional water analysis methods. The "fire package" list will be revised as new information becomes available from state and local water testing responses to wildfires. Information is and will be posted at www.PlumbingSafety.org under the wildfires tab.

The goal of testing should be to quickly identify the contaminants, concentrations, and then enable toxicologists to estimate health risks associated with using that water. Health risk assessments can be rapidly completed by state and federal officials. Few health risk assessments for acute exposure to chemically contaminated drinking water. Water systems rarely have toxicologists on staff so they must rely on responsive health risk assessments by government agencies assisting in the response.

There are two outcomes when sampling a drinking water system after a wildfire:

1. Results do not reveal the presence of compounds at levels that pose an acute or chronic health risk.
2. Results indicate the presence of contamination:
   A) Chemicals with explicit concentrations exceeded their known drinking water exposure thresholds:

      - U.S. EPA 1 day and 10-day Health Advisory Levels (HA) for drinking water: (U.S. EPA 2018a)
      - U.S. EPA Regional Screening Levels (RSL) for drinking water: (U.S. EPA 2023b)
      - U.S. EPA Maximum Contaminant Levels (MCL) for drinking water: (U.S. EPA 2024a)
      - Other state specific or pertinent government agency drinking water levels

        NOTE: When chemical concentrations exceed these thresholds, state and county public health toxicologists should provide the public water system explicit advice on how the water can and cannot be used by customers.

        NOTE: Water use orders should be lifted once adequate water testing data is available characterizing the hazard. Should chemicals and concentrations be found that exceed drinking water exposure limits indicating a previously unidentified acute risk to human health, a more stringent water use order should be rapidly issued.

   B) There are chemicals that do not have published drinking water exposure thresholds that can be harmful at certain concentrations. These can include tentatively identified compounds or TICs that require subsequent follow-up by analytical chemistry and toxicology experts. The water system should rely on state and federal public health toxicologists to provide the water system explicit advice on concentrations that pose a risk and how the water containing those chemicals and concentrations can and cannot be used. The toxicologists should also recommend what would prompt existing water use orders change or remain the same. Water use decisions should be based on formal health risk assessments considering ingestion, inhalation, and dermal exposures, at the minimum, for susceptible populations.

9. Post-fire Chemicals for Analysis

Acute contamination incidents prompt atypical chemicals to find their way into drinking water systems. Some of these chemicals are often found using conventional or routine drinking water analytical methods. Others however require screening the water for TICs, which may be unregulated. These compounds are present in the water sample but are not screened for (or reported) by routine U.S. EPA analytical methods. TICs can cause acute health risks to water users, in some cases (Whelton et al. 2017). At present, post-wildfire drinking water responses have primarily only looked for conventional contaminants with conventional methods.

Recent lessons learned from testing in response to wildfire-caused water system damage are shown in **Figure 8.** Some chemicals found using conventional drinking water analysis methods have exceeded short- and long-term drinking water exposure standards post-fire. It is important to require specific chemicals for water analysis, including those that have been found in contaminated water distribution and plumbing systems following a wildfire.

- Benzene is NOT a surrogate for the presence of other chemicals that may pose immediate or long-term health risks.
- Screening water for BTEX only (benzene, toluene, ethyl benzene, and xylenes) is NOT a surrogate for the presence of other chemicals that may pose immediate or long-term health risks.
- VOCs are NOT a surrogate for the presence of SVOCs that may pose immediate or long-term health risks.
- Total organic carbon (TOC) concentration is NOT a surrogate for the presence of other chemicals that may pose immediate or long-term health risks.
- The complexity of drinking water contamination after a wildfire requires a wide screening approach to narrow down and identify the specific chemicals of concern for the water system.
- For the same USEPA method, different laboratories use different lists of chemicals. Therefore, the laboratory should explicitly confirm what chemicals of concern post-fire are going to be screened. If one USEPA Method cannot achieve all analyses for the same type of chemicals (i.e., VOCs), multiple methods should be applied to the single water sample.
- The current methods applied for post-fire drinking water analyses may be updated as different chemicals are identified by water systems, government agencies, and researchers. Please keep up to date on the "fire package" screening list.
- Not all commercial laboratories have the ability to test for all chemicals of concern and

Figure 8. Recent lessons learned from testing after wildfires.

The analytical water testing methods used for screening for fire-related chemicals are described below. EPA Methods for specific compounds can be found on the EPA website here: https://www.epa.gov/dwanalyticalmethods/approved-drinking-water-analytical-methods (U.S. EPA 2024b).

VOCs
Prior wildfire drinking water contamination investigations have applied several VOC methods. These are EPA Method 524.2 (Alford-Stevens et al. 1995) and EPA Method 524.4 (Prakash et al. 2009) Measurement of purgeable organic compounds in water by gas chromatography/mass spectrometry using nitrogen purge gas. Specific VOCs in **Appendix C** should be considered for water distribution system testing.

SVOCs
Prior wildfires have involved the application of a few SVOC water testing methods. These include EPA Method 8270E (SW-846) (U.S. EPA 2018b), Semi-volatile organic compounds by gas chromatography/mass spectrometry (GC-MS), with screening for tentatively identified compounds; EPA Method 525.2, Determination of organic compounds in drinking water by liquid-solid extraction and capillary column gas chromatography/mass spectrometry, with screening for tentatively identified compounds.

Tentatively identified compounds (TICs) for Organic Compounds
Acute contamination incidents prompt atypical chemicals to find their way into drinking water systems. For VOC and SVOC methods, it is recommended that not only are confirmed chemicals listed in the methods screened for, but also TICs. Per the New Jersey Department of Environmental Protection: "a TIC is a compound that can be seen by the analytical testing method, but its identity and concentration cannot be confirmed without further analytical investigation. An analogy is when a photograph is taken of a subject. The picture also captures the information in the background, and often this information is fuzzy, but the focus of the picture is the subject. The subject (i.e., target item) is clear, but the background components (i.e., the tentatively identified items), while captured in the picture, are fuzzy."

Metals
While elevated metals concentrations can be found in wildfire disaster debris, in storm water runoff, and surface waters post-fire, to date, no metals have been found in water distribution systems associated with wildfire caused drinking water contamination. EPA Method 200.8 (Long et al. 1994) is often used for routine drinking water metals analysis.

10. Water Sampling Approach, Locations, and Flushing Times

10.1 Stagnation is critical to detecting contamination

Water samples are collected to identify if, where, and how much post-fire contamination is within a water system. Because chemicals can adsorb to infrastructure material surfaces and penetrate into biofilms and plastic materials, there is a time dimension to water sampling and interpreting water sampling results. The stagnation time, or time the water sits still within the asset (i.e., water main, service line, tank), will highly influence whether or not the data can be relied upon for decision making. Water sampling data, where the samples were collected with no stagnation time, may have little to no value depending on the scale of contamination present. **Figure 9** visually depicts that VOCs sorb into certain plastics and then desorb from those materials into clean drinking water when placed into service.

Figure 9. Stagnation before a water sample is collected helps chemicals leach from biofilms and infrastructure into the water, and this increases the chances contaminants present can be detectable by the laboratory method.

A video of the phenomenon can be found here.

Source: Purdue University.

When the stagnation time of a water sample cannot be determined, additional repeated water samples of that area are needed. The number of sampling locations may be reduced as recovery continues and no contamination is repeatedly found. A representative sampling approach for the area impacted is also needed taking into consideration that certain assets (i.e., gaskets for hydrants and blowoffs, storage tank epoxy liners, water meters, etc.) may be contaminated where the pipes connecting those assets to the rest of the water distribution system may not be. Regulatory agencies may recommend reducing the number of water sampling locations as parts of the system are repaired and replaced. Long-term sampling may continue for months to years. This duration depends on the scale of damage to the water distribution system and repairs, among other considerations. Of particular note, some water systems impacted by wildfires have conducted water sampling for two months before finding chemical contamination in their water distribution systems. Once chemical contamination is found, removing it by water distribution system flushing (with follow-up sampling) is a common first approach. Under certain conditions, removal and replacement of the contaminated material may be necessary (storage tank epoxy liners, pipes, blowoffs, water meters, etc.).

10.2 Water sampling results can help predict the time needed to flush assets

The time needed to remove VOCs that have penetrated plastic water system components will depend on the initial contaminated drinking water exposure concentration, duration of contaminated water contact before flushing, among other factors. In response to the 2018 Camp Fire in California, the time needed to remove benzene (one of many VOCs associated with the wildfire-caused drinking water contamination) was estimated for 1 inch diameter HDPE service lines (Whelton et al. 2019a). The approach involved flushing out the benzene contaminated water, inserting clean water, and then waiting 72 hours before taking a follow-up water sample. If, for example, the 72-hour stagnation water sample benzene concentration was found to be 10 ppb, 155 days of continuously flushing the pipe at about 2 gallons per minute would be needed make that asset safe to use again (**Table 3**). **Table 4** then shows that approximately 453,000 gallons of water would need to be flushed for that condition. This information can be used to predict whether it is reasonable to flush the HDPE pipes for recovery or if they should be physically removed and replaced.

Table 3. Time in days needed per service line to decontaminate pipe based on the concentration of benzene measured before flushing begins.

Initial measurement concentration (C_2)	**Goal A (never above 0.5 ppb)**		**Goal B (only exceed 0.5 ppb after 72 hours of stagnation)**	
	Continuous	**Intermittent (once/ 72 hrs)**	**Continuous**	**Intermittent (once/72 hrs)**
100 ppb	286	312	195	240
50 ppb	246	270	156	198
20 ppb	195	213	104	141
10 ppb	155	171	66	99
5 ppb	116	129	33	60
2 ppb	64	74	8	20

Flushing is with 2.04 gallons per minute with benzene-free (0.0 ppb) water. Table created with U.S. EPA input and considered discoveries by Haupert et al. (2019) and Haupert et al. (2023).

Table 4. Volume of water flushed in gallons per service line to decontaminate pipe based on the concentration of benzene measured before flushing begins.

Initial measurement concentration (C_2)	**Goal A (never above 0.5 ppb)**		**Goal B (only exceed 0.5 ppb after 72 hours of stagnation)**	
	Continuous	**Intermittent (once/ 72 hrs)**	**Continuous**	**Intermittent (once/72 hrs)**
100 ppb	836,264	206	570,180	158
50 ppb	719,304	178	456,144	131
20 ppb	570,180	141	304,096	93
10 ppb	453,220	113	192,984	65
5 ppb	339,184	85	96,492	40
2 ppb	187,136	49	23,392	13

Flushing is with 2.03 GPM of benzene-free (0.0 ppb) water. Table created with U.S. EPA input and considered discoveries by Haupert et al. (2019) and Haupert et al. (2023).

There are many reasons why chemical levels may differ in different parts of the water distribution system during the decontamination process. Chemical levels may differ even in water removed from similar same assets (i.e., pipes, tanks). Contamination can be sequestered in different plastics as parts of blowoffs, valves, water meters, and other assets. Because of this variability, repeated sampling and testing is recommended.

10.3 Addressing closed and open areas of the water distribution system

During the response, portions of the water system that were damaged or served damaged and destroyed structures may have been isolated (or closed) from other parts of the system. Isolation by shutting valves or physically disconnecting infrastructure can help prevent chemically contaminated water from spreading throughout the broader (open) water distribution system. Sometimes, however, damaged and destroyed structures can be interspersed throughout large portions of and undamaged distribution system.

10.3.1 Open area considerations

1. Activity. These areas have customers actively receiving water from the water system. Water is in motion within the distribution network based on customer demands and other activities. Water in this portion of the system has no easily defined stagnation time because it is in motion.
2. General Considerations. This type of monitoring requires repeated sampling of the same and numerous locations. This is because water is in motion within the system, so the ability to find contamination, if it exists, is greatly impacted by the rate of chemical release from the assets and how long that water has been in contact with the specific contaminated asset. Sampling may be best optimized during periods of lower system water use.
3. Priority and Frequency. Sampling should be prioritized for these areas as water is being actively drawn into customer buildings. Samples should be collected weekly or more frequently at locations throughout the distribution system. A sample should be collected immediately and then again after flushing. Sampling may be necessary over the course of several months.

4. Entry Point(s) to the Distribution System. Sample to confirm water quality entering the distribution system is not contaminated and is of consistent quality.
5. Sentinel Locations. Sample to detect changes in water quality in the broader utility pipe network that is actively being used by customers. Locations (i.e., hydrants, blowoffs, storage tank, pump stations, sample taps used for regulatory monitoring) should be representative of the water quality in the water distribution system. Monitoring water quality at locations adjacent to damaged or destroyed structures/properties is another important action of system level monitoring.
6. Service Lines. Disconnect water meters to damaged and destroyed properties to sample service lines to detect changes in water quality for buildings. Locations should be buildings adjacent to and near damaged or destroyed structures/properties.

10.3.2 Closed area considerations

1. Activity. In these areas no water use is permitted because the system has been hydraulically isolated from the active distribution system. Water use orders are also in place. Because water is not being used, water is not in motion within this distribution network. This water is effectively “stagnated”.
2. General Considerations. This type of monitoring is the most controlled in that the water collected should have a defined “age”, and thus the chemical analysis data can be interpreted more easily. The ability to find contamination, if it exists, is greatly impacted by the rate of chemical release from the assets and how long that water has been in contact with the specific contaminated asset.
3. Priority and Frequency. Sampling is generally less of a priority for these areas as water is not being actively drawn into customer buildings. Samples should be collected before flushing, after flushing, and then the asset should be placed under stagnation. At the end of the stagnation period, a sample should be immediately collected and then again after flushing. This should be done weekly or more frequently at locations throughout the distribution system. Sampling may be necessary over the course of several months.
4. Locations. This type of monitoring requires a very methodical procedure. A stepwise process should be followed whereby water quality entering the area is tested first to determine that there is no contamination and then assets are tested as clean water is provided to the area. For example, hydrant water samples would be first tested to determine that water mains are free of contamination. Then, and only, then curb stops would be reopened to buildings and service lines for those buildings would be tested.

10.4 Priority customers regardless of closed or open area location

Certain customers and properties may be priority for investigating water safety and returning pressure. This may include schools, hospitals, medical centers, evacuation centers, public assistance centers, government facilities, critical businesses, and other organizations.

10.5 Additional considerations for location selection and data interpretation

1. The selected water quality monitoring locations should consider proximity to schools, childcare centers, medical facilities, and other buildings that support sensitive populations.
2. It is expected that a single water sample will not confirm contamination does not exist in specific locations, as such repeated sampling is necessary. Sampling sometimes has shown contamination varying from non-detect to exceeding MCLs over several months.
3. The frequency of water sampling may be biweekly, or more or less frequent. Initial sampling activities will likely be concentrated and voluminous as the extent of contamination is explored.
4. The more damage and repairs that are needed the longer the repeated water sampling will likely be conducted.

10.6 Maps, photos, and videos can help explain the damage

Maps should be created to assist in identifying areas, infrastructure, and customers impacted by the fire, and outlining how to create a response and recovery plan. Additionally, public water systems are highly encouraged to document with photographs and videos the damage that was sustained to the system. This information will be highly important for internal communications, communication with regulatory agencies, and ultimately with the customers. Examples of maps created by several public water systems after wildfires are shown below.

1. Figure 10, City of Louisville, Colorado Building Damage Map, January 2022
2. Figure 11, Detroit, Oregon, Sample Progress Map, June 2021
3. Figure 12, Water Quality Assurance Monitoring Program Map from the Paradise Irrigation District (PID), Paradise, California, April 2023
4. Figure 13, Maui County, Hawaii Online Water Advisory Locator Map, September 2023

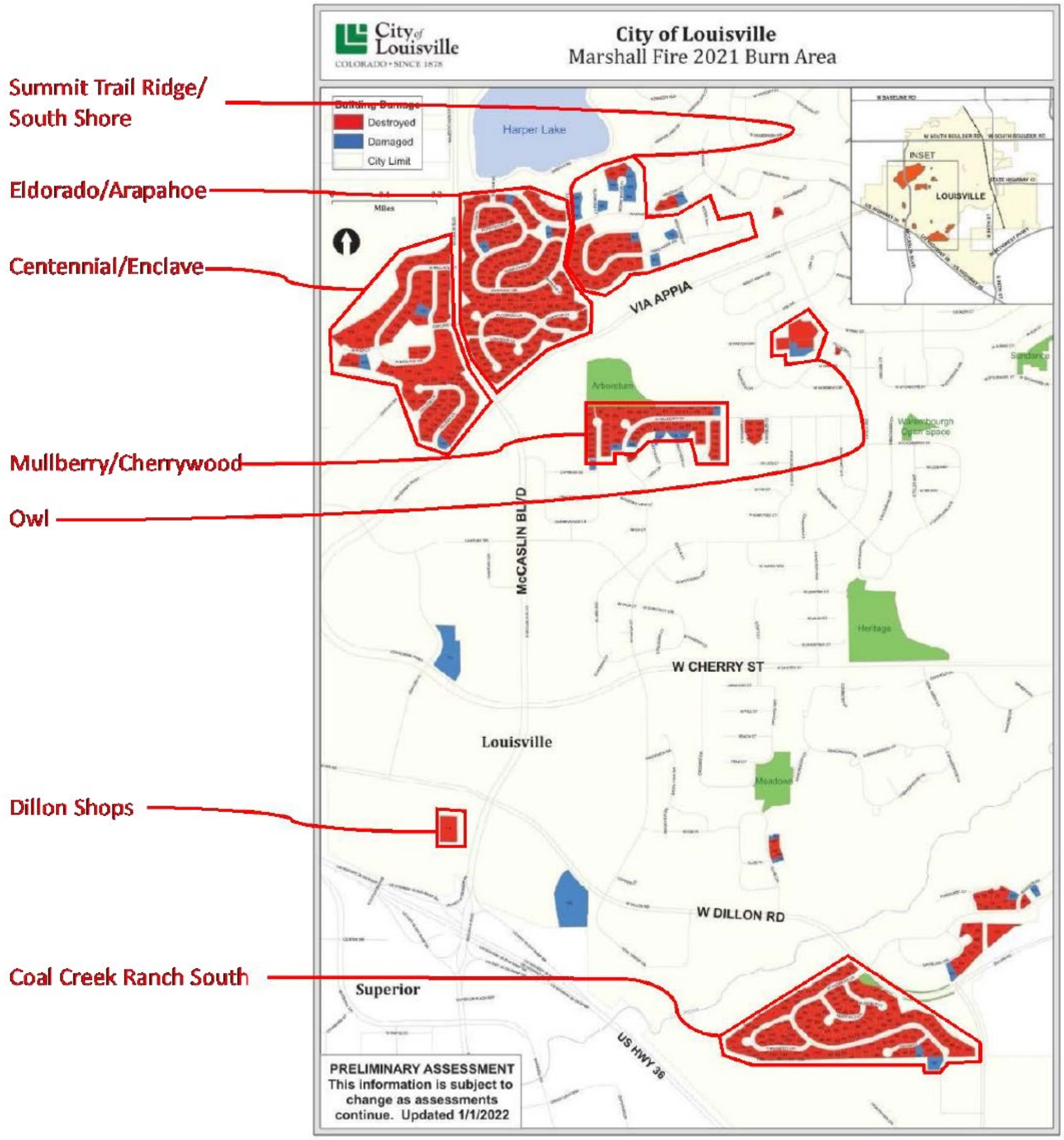


Figure 10. City of Louisville, Colorado building damage map, January 2022.

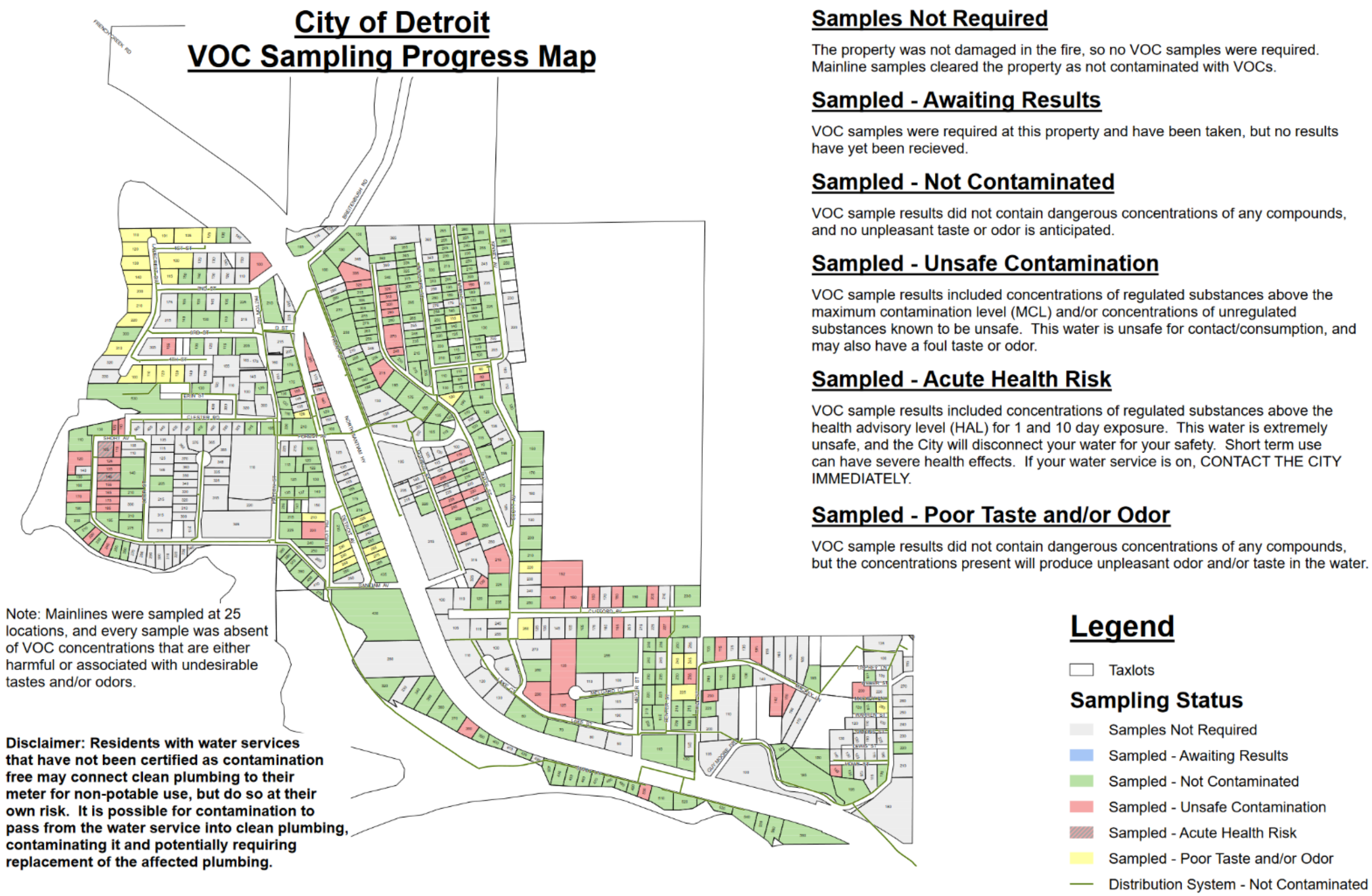


Figure 11. Detroit Oregon, sample progress map, June 2021

Source: City of Detroit 2021.

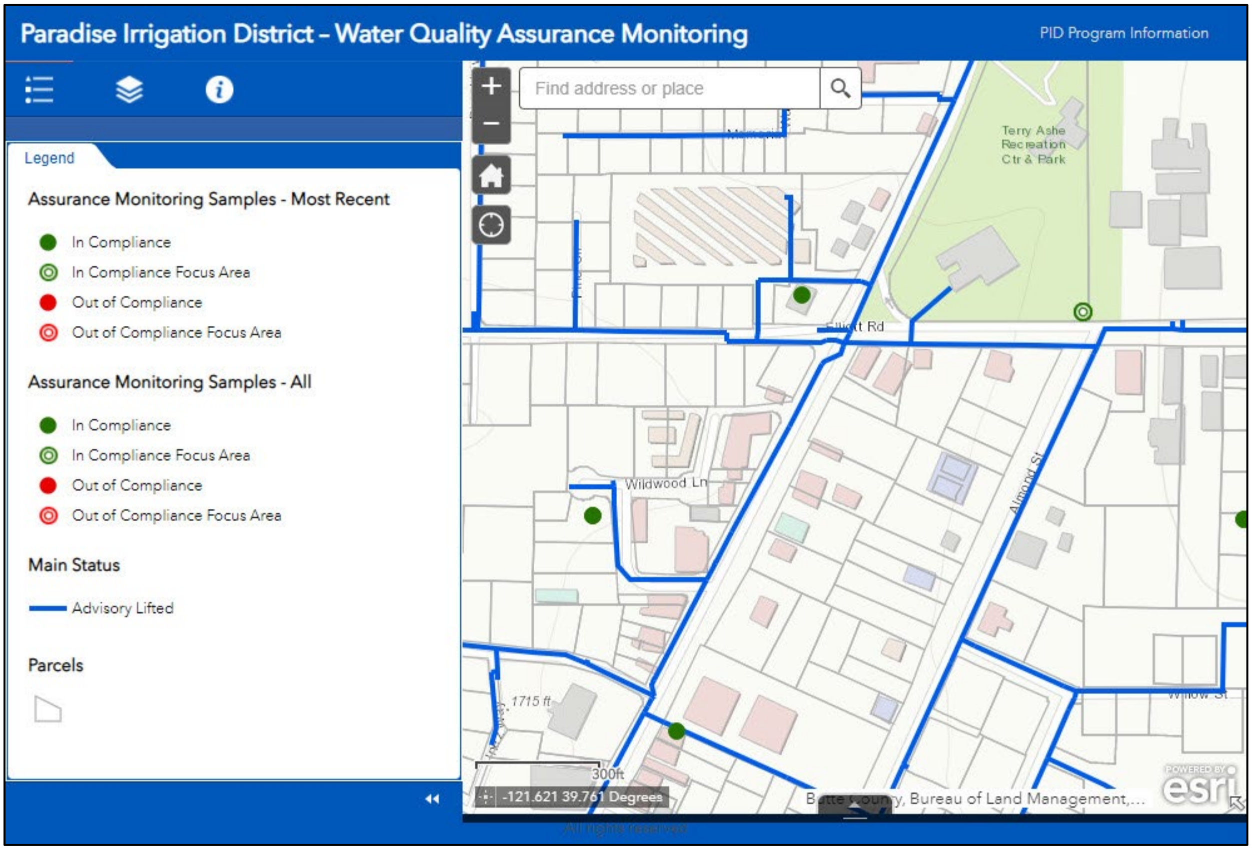


Figure 12. Paradise Irrigation District – Water Quality Assurance Monitoring Program Map.
Source: Esri 2023a.

PID's Assurance Monitoring Program Overview (from their website April 2023)

1. The Assurance Monitoring Program is a new long-term water quality monitoring program that follows PID's recovery sampling efforts. Its purpose is to verify that water distributed through the mains remains free of fire related volatile organic compounds (VOCs).
2. The first phase of this program will be conducted over the course of 24 months.
3. Each of the approximate 1,300 sample sites will be tested during this period, covering the whole distribution system. The majority of these sample sites are considered routine sample sites. Some areas have been identified as focus areas and will be sampled more frequently.
4. Focus areas are sections of mains that had previously tested out of compliance during initial recovery sampling efforts. These sections of main have since tested in compliance and been cleared for potable service, but PID will continue to monitor them closely to ensure they remain in compliance.
5. In the first 6 months of the program, focus areas will be sampled once every 2 months, followed by a frequency of once per quarter for the following 6 months. Focus Areas will then be sampled semi-annually in the second year of the program.
6. The total number of samples collected per week for the program will gradually decrease until PID falls back into routine sampling.

7. If a sample tests out of compliance, site specific information can be accessed through the "More info" link in the Water Quality Assurance Monitoring GIS map when viewing the sample data.

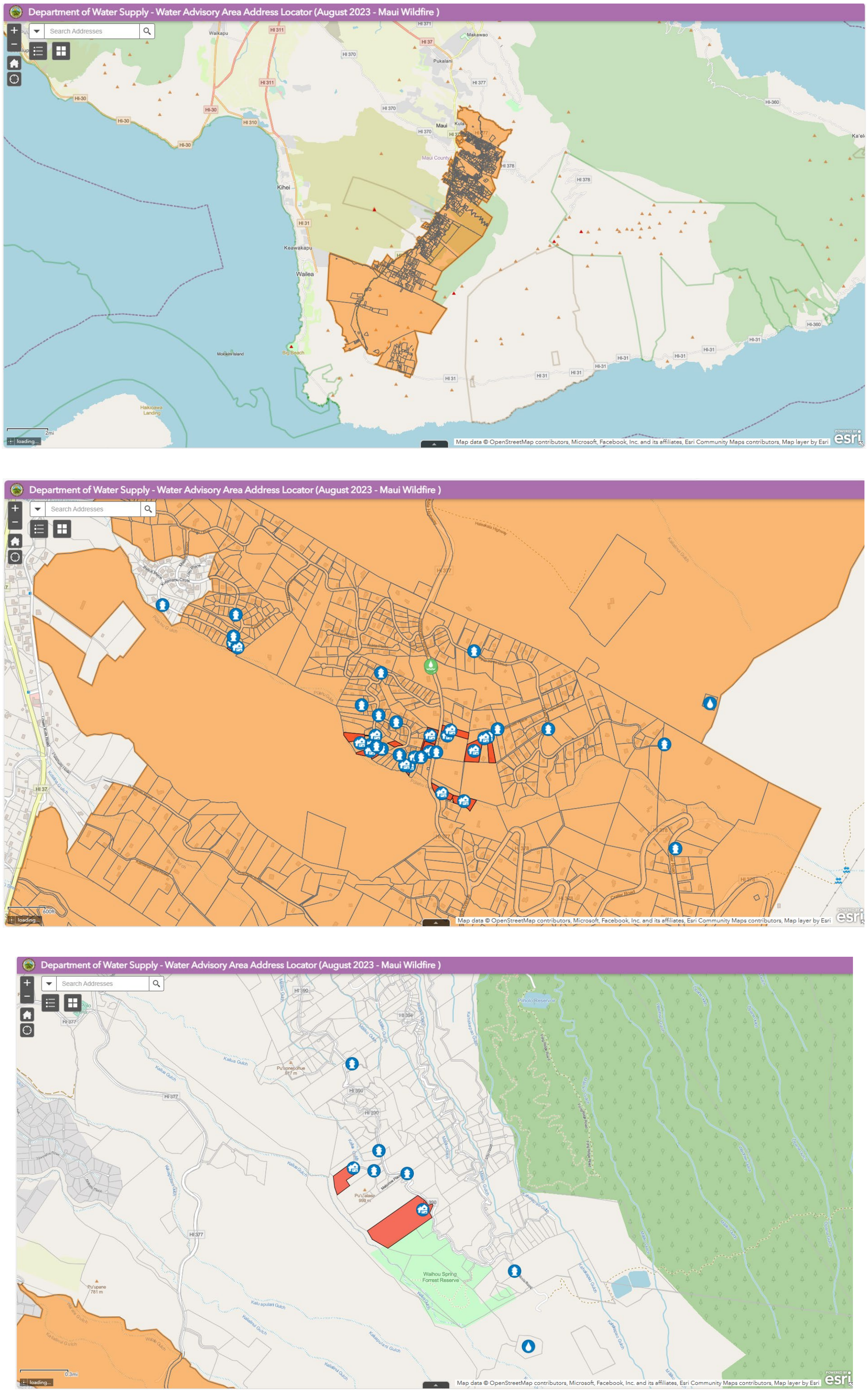


Figure 13. Maui County, Hawaii Online Water Advisory Locator Map.
Online address locator denoting the water advisory area (orange), locations of damaged properties (red), emergency drinking water buffalo dispensing stations (green), and water sampling locations (blue) from their website September 2023.
Source: Esri 2023b.

11. Water Sample Collection and Decision-Making Considerations Using these Results

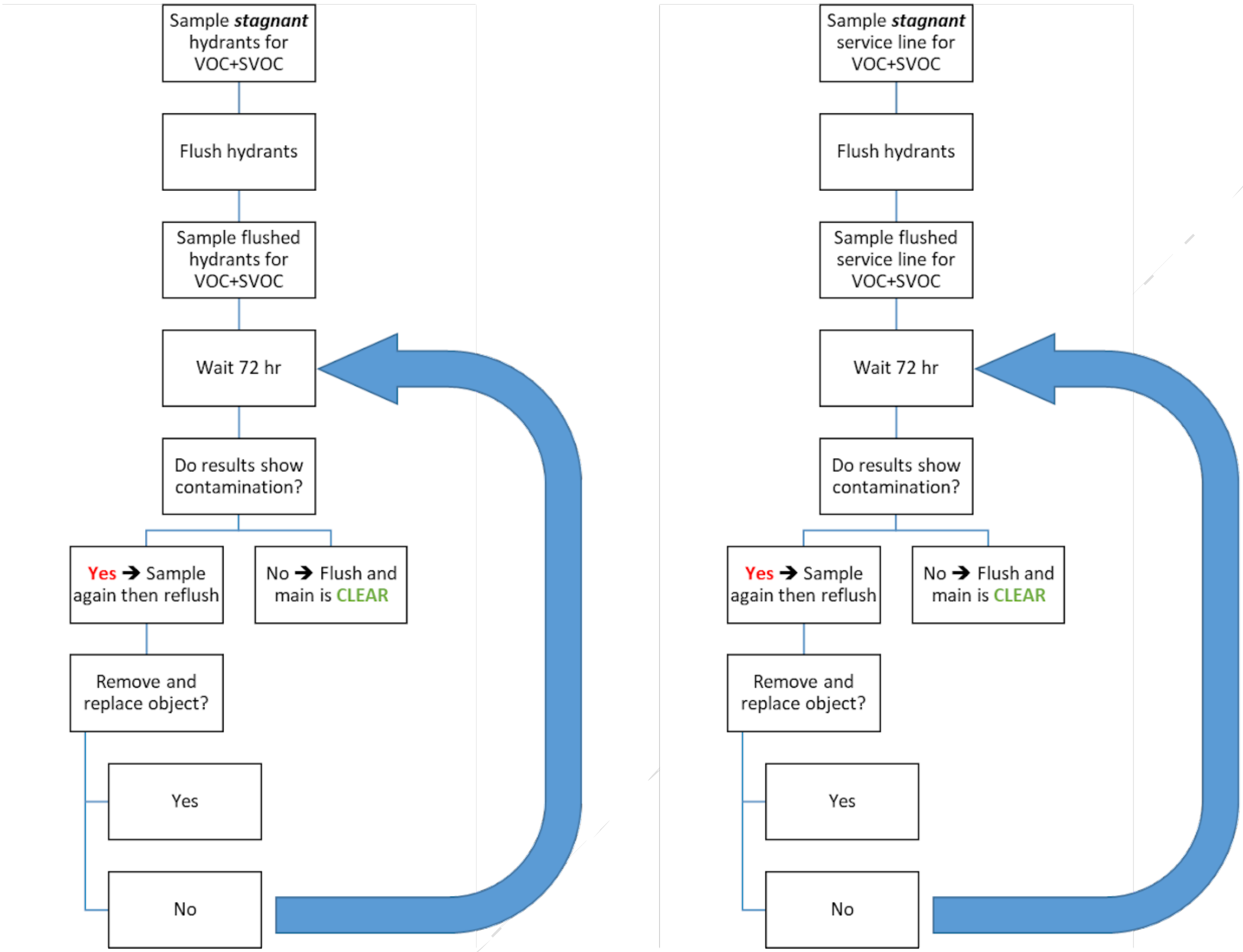
Water sampling must follow explicit sample site preparation and sample collection protocols otherwise, while numerical laboratory data may be received, it could have no value. Preparing the site for water sample collection is equally important as collecting a water sample and chemically analyzing that sample at a laboratory. Post-wildfire water sampling site preparation and collection procedures are listed in the standard operating procedures (SOPs) below. Additional information about SOP considerations can be found in Appendix D.

Because contaminants indicative of wildfire caused drinking water contamination sorb to the surface of infrastructure, biofilms, scales, and sometimes permeate plastics, it takes time for them to desorb and dissolve back into water. As a result, a period of stagnation (no movement or flow of water) is needed to determine if contamination exists in affected components. To date, experimental data shows that 72 hours is the optimal stagnation time; however, 24 or 48 hours may be used as an *initial* indicator. Shorter "soak times" of infrastructure before taking a sample may result in failure to find contamination, even if it is present. Contamination can also be sorbed into plastics used as gaskets and liners for hydrants, blowoffs, air release vales, water meters, backflow preventers, and other devices. Figures 14, 15, and 16 describe approaches applied in response to prior wildfires.

Water testing should be conducted until the asset is determined to be free of contamination or is replaced. The following additional considerations are provided:

1. If water is chlorinated, discuss with the laboratory about using a dechlorinating agent (ascorbic acid preferred) to prevent sample degradation during storage, shipping, and transport.
2. Ideally samples should be collected before flushing, and then after flushing. Due to urgency and local conditions, unidirectional flushing may be conducted prior to collecting samples. Multiple rounds of sampling are needed when contamination risk factors are present.
3. Stagnate water for an appropriate amount of time.
4. When collecting a screening sample to determine if contamination has entered the distribution system (just as the system is initially repressurized), flush the sample point for a few minutes until the water becomes cold or reaches a steady temperature prior to collecting the sample so that it represents water from the distribution system piping.
5. When collecting a sample to determine if an individual service line (PWS side) is contaminated with VOCs, collect a sample at the curb stop (end of the utility ownership). Flush enough water to avoid sampling fittings, gaskets, etc.
6. If the water meter is in the building but the building owner is responsible for some or all of the service line, the utility must explicitly determine about where the sample will be collected.
7. When collecting a sample to determine if an individual service line (customer side) is contaminated, flush enough water to avoid sampling fittings, gaskets, etc. then discard at

least 1 cup of water prior to collecting the sample. Take care to fill the vial using a low flow of water, and do not overfill the sample vial, so chemicals inside the vial do not spill out.



This only applies to components where the system has remained stagnant [no water movement] since the fire (5+ days).

Figure 14. Decision process for testing water mains via hydrants and service lines in the closed areas as they are being prepared for reopening.
A drinking water use order should be put in place in the area when there are no chemical water testing results that can attest to the safety of the drinking water and remain in place until samples are collected, analyzed, and reported with results indicating no concern.

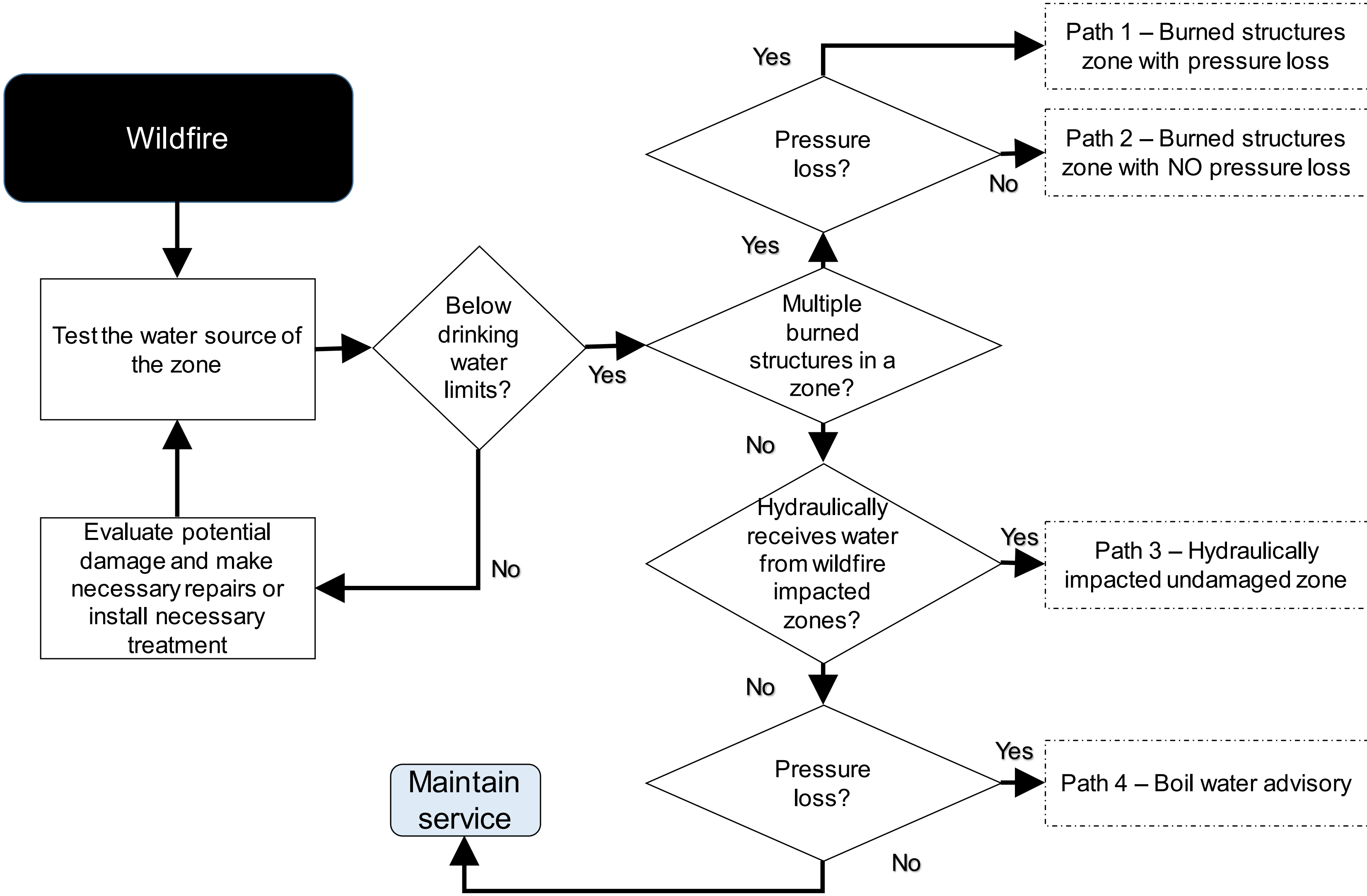
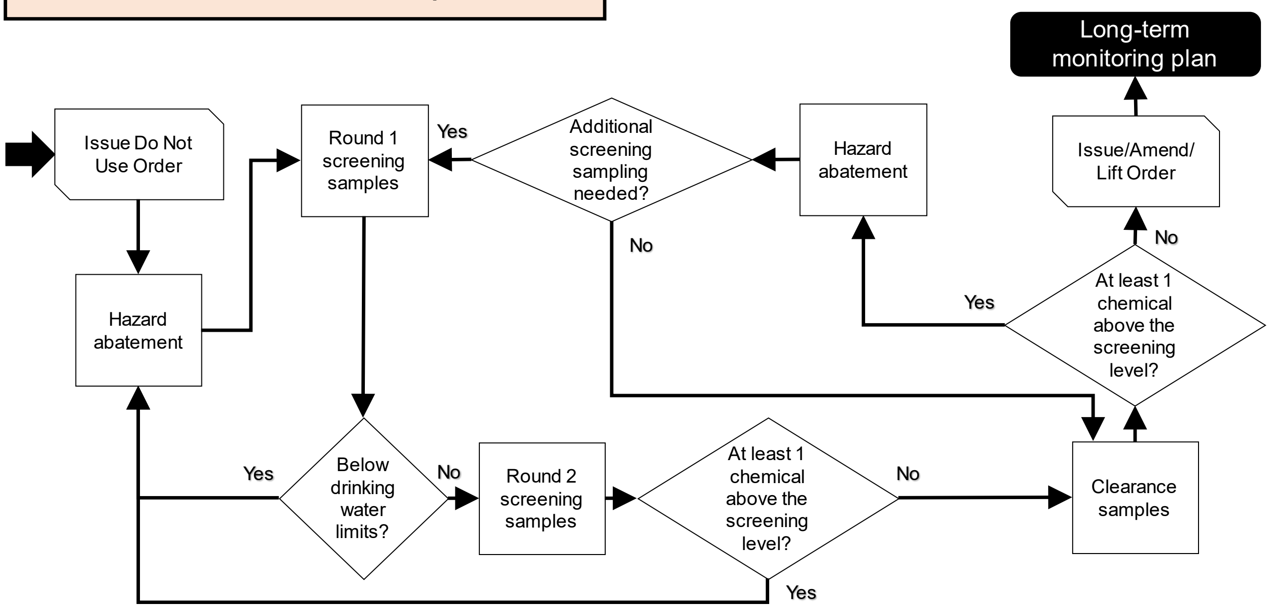


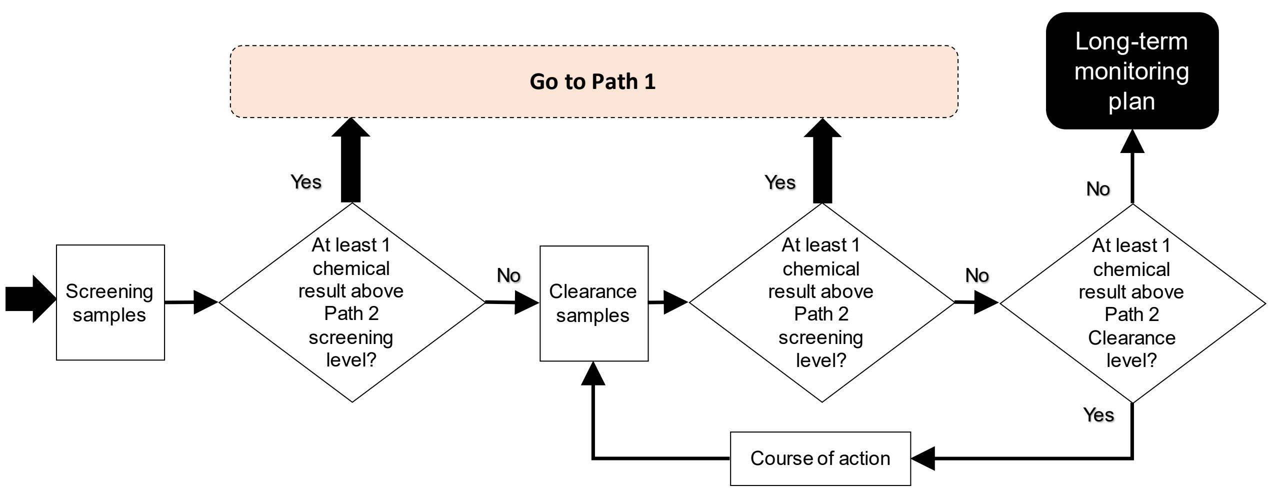
Figure 15. Overall response and recovery decision flow chart for investigating potential chemical or microbiological water distribution contamination systems.

Source: Adapted from Stufflebean 2023.

Path 1- Burned structures zone with pressure loss



Path 2- Burned structures zone with NO pressure loss



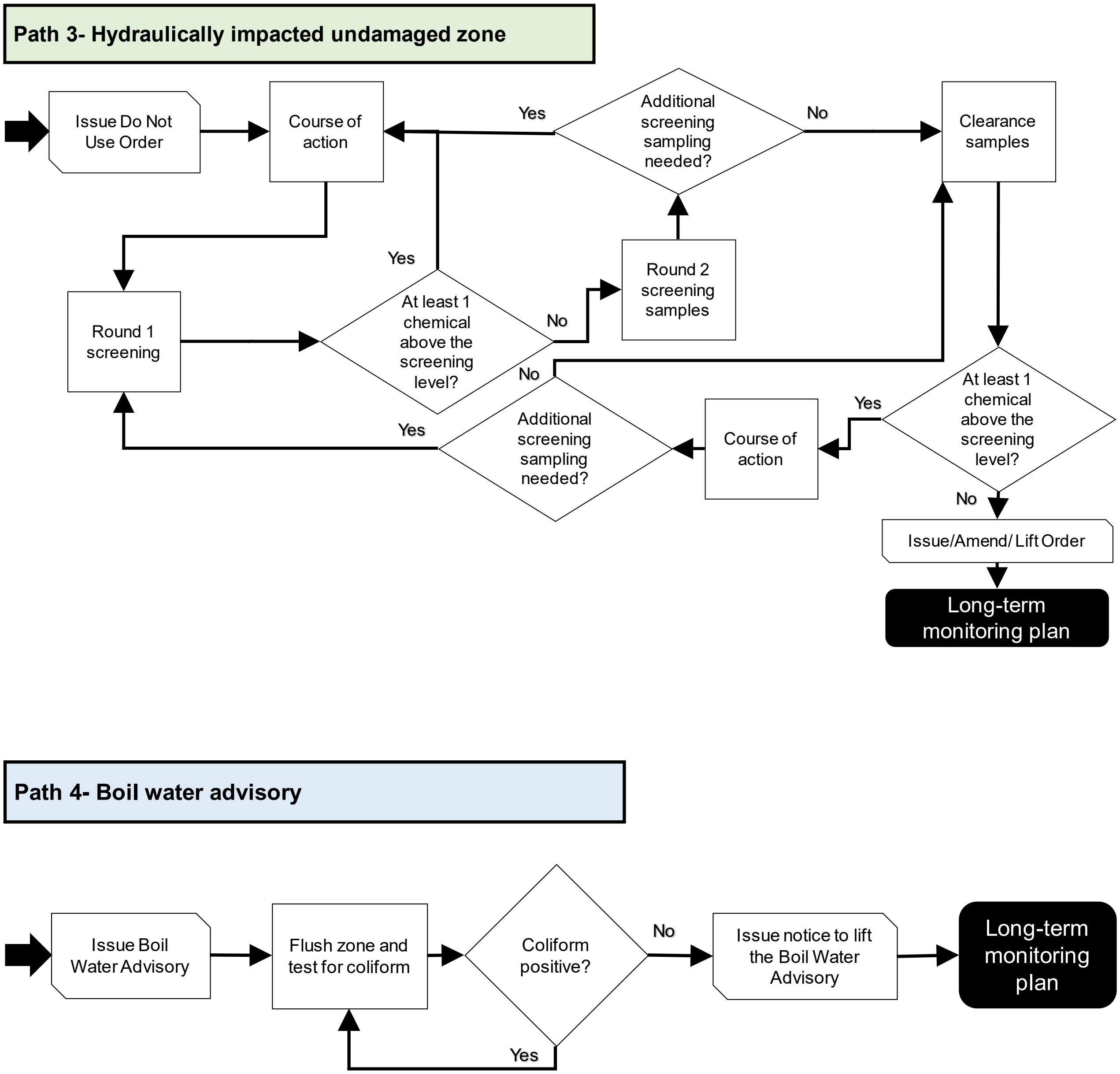


Figure 16. There are four distinct decision paths that can be followed as water systems look to determine when to collect water samples to clear assets that may be contaminated.

For Maui County after the 2023 Wildfires, screening levels were considered individual health-based VOC concentration that had been determined to be unacceptable for customer exposure. Water samples were first screened against "screening levels" and then once the chemical concentrations do not exceed screening levels "clearance samples" were collected for evaluation. Clearance samples were those where individual health-based VOCs and SVOCs concentrations were that had been determined to be unacceptable for customer exposure were evaluated. Long-term monitoring plan is a plan to conduct periodic water quality monitoring post-fire to confirm the distribution system is operating as expected and does not pose a health risk due to the fire impacts.

Source: Adapted from Stufflebean 2023.

12. Communication and General and Technical Questions

12.1 General guidance

Communicating with water system customers is important to protect them and their property from potential harm and enable them to understand the path forward. It is important that after the advisory or order is issued that the water system set forth the actions to be initiated for investigating water system impacts and potential contamination.

1. Establish a website or webpage specific to the disaster to describe status and updates.
2. Explain that you will inspect infrastructure like sources, treatment facilities, pipes, tanks, valves, and other assets.
3. Isolate damaged assets from the main water distribution system.
4. Request emergency drinking water assistance for those populations under the water advisory or order.
5. Request state laboratory assistance for rapid drinking water sampling and chemical analysis.

    [NOTE: water sampling results can often be returned within 72 hours or less. While some commercial laboratories may have a 14 day turnaround time for a single water sample, other laboratories are available].

6. Make public the list of chemicals the water system is requesting testing for (see Appendix C). This will allow homeowners to test their own plumbing for contamination.
7. When chemical drinking water contamination is possible, warn households not to try to treat their drinking water at home until the levels of contamination, if present, are defined. Certified in-home water treatment devices have not been proven to remove all types and magnitudes of wildfire drinking water contamination.
8. Create an online map denoting locations of damaged properties, emergency drinking water filling stations, and water testing results.
9. For households that do not have internet access, engage local community organizations, and ask for assistance disseminating the information through their networks.
10. Document the system damage and actions being taken to restore the water system to safe use. Public instructional videos can also be created to share how damage is being assessed, testing is being conducted, and reasons for the actions being undertaken.

12.2 Technical questions

The following technical questions have been asked by water system staff and regulators following previous wildfires that affect drinking water systems. These questions pertain to drinking water quality parameters, chemicals to be tested for, drinking water aesthetics, and contaminated water discharge. The list of questions and answers below can be used as an initial guide by water system staff in preparing their own response actions and public communications.

Is total organic carbon (TOC) concentration or ultraviolet 254 nm absorbance (UV_{254}) a good surrogate indicator of VOC and SVOC contamination?
No. These parameters should not be relied upon in isolation for contamination decision-making. Chemical specific water analyses are needed. TOC levels can sometimes indicate gross levels of chemical and microbial water contamination, but levels can also be attributed to background conditions. Historical background drinking water quality data, for the sample location and similar water use conditions, is typically needed for such determinations. TOC levels found in plumbing however, have sometimes exceeded 40 mg/L when no chemical contamination was present.

Can analyzing water for benzene only act as a surrogate indicator VOC contamination?
No. Non-BTEX compounds exceeded their short- and long-term exposure limits when BTEX compounds were below their health-based limits (Proctor et al. 2020; Oregon Health Authority, 2022a). For example, methyl ethyl ketone (138 mg/L) exceeded its U.S. Environmental Protection Agency (U.S. EPA) 1-day health advisory (75 mg/L), vinyl chloride (8.2 µg/L) and dichloromethane (41 µg/L) exceeded their federal maximum contaminant levels (MCL) of 2 and 5 µg/L, and methyl-tert-butyl ether (317 µg/L) in California exceeded its state MCL of 13 µg/L.

Can analyzing water for benzene, toluene, ethyl benzene, and xylenes (BTEX) only act as a surrogate indicator VOC contamination?
No. Non-BTEX compounds exceeded their short- and long-term exposure limits when BTEX compounds were below their health-based limits (Proctor et al. 2020; Oregon Health Authority, 2022a). For example, methyl ethyl ketone (138 mg/L) exceeded its U.S. Environmental Protection Agency (U.S. EPA) 1-day health advisory (75 mg/L), vinyl chloride (8.2 µg/L) and dichloromethane (41 µg/L) exceeded their federal maximum contaminant levels (MCL) of 2 and 5 µg/L, and methyl-tert-butyl ether (317 µg/L) in California exceeded its state MCL of 13 µg/L.

Can analyzing water for VOC be a surrogate indicator of SVOC contamination?
No. VOCs may be removed from drinking water systems faster than SVOC and SVOCs have been found when VOCs were not detected.

Is a NPDES discharge permit required before flushing contaminated water onto the ground or storm drains?
One of the most important activities after a disaster is to restore fire-fighting capability to the system and water pressure to customers for basic hygiene and sanitation purposes. Flushing helps remove contamination from the infrastructure so that chemical damage does not occur. The longer contamination remains in the system, the more time it has to penetrate materials (i.e., biofilms, plastics) and longer it will require to decontaminate. Some infrastructure may require replacement if it has sorbed contaminant. The water system should consult with the state primacy agency about time-sensitive actions needed to restore pressure.

Does the absence of taste or odor indicate safe drinking water?
No. Some chemicals can be acutely toxic in water at levels where no taste or odor characteristic is detectable. Taste and odor should not be substituted for confirming the presence and concentrations of chemicals by chemical specific testing.

Does the present of taste or odor indicate unsafe drinking water?
No. Some chemicals can pose no harm in water at levels when a taste or odor characteristic is detectable. Taste and odor should not be a substitute for confirming the presence and concentrations of chemicals.

Does discolored water indicate unsafe drinking water?
Maybe or maybe not. This should be investigated. During system repair, water flows in pipes in different directions, sometimes dislodging scale from pipes into drinking water. Other times sediment in tank is suspected in the water. Ash and debris can enter water systems during and after the fire causing discoloration. Discolored water should be reported to the utility.

12.3 General questions

The following 14 questions have been asked by customers following wildfires that threaten or damage water systems. Additional frequently asked questions can be found in **Appendix E**. These questions pertain to nuances with customer water use activities, actions customers can take themselves to make water safe, how the drinking water may have become chemically contaminated, among other questions. The list of questions and answers below can be used as an initial guide by the water system in preparing their own response actions and public communications.

My home never lost pressure, is my water safe?
Even if the pipes in your home were continually pressurized, portions of the water systems affected by the advisories lost pressure which introduces the possibility that contamination from other properties could have entered the system thereby introducing contamination into the main lines that feed your house. Therefore, it is still important to heed the Do-Not-Use advisories if you are located within the advisory area.

Is water within the advisory area safe for watering plants?
[NOTE: This question should be answered by agricultural experts].

Is the water in affected areas safe for pets and livestock?
[NOTE: This question should be answered by veterinarian experts].

Why does the advisory say filters will not work to remove wildfire related contamination?
Every water filter is engineered to certain specifications. These specifications include things like normal operating flow rate and the expected concentrations of contaminants entering the filter. If the concentration of contaminants entering the filter exceeds the specifications, the filter may be overwhelmed and may let water through which still has harmful levels of contaminants. Because the presence or amount of contamination in the water system is currently unknown, it is not recommended to attempt to purify the water through filtering.

How long will the advisory last?
[NOTE: This question should be answered by with an understanding of the extent of system depressurization, damage, and structures destroyed. Sometimes it can be a few weeks to restore water service while other times it can take months to highly damaged parts of the water distribution system].

What are the main contaminants to worry about, and can I test them myself?
The most reliable data we have comes from research carried out on similar major urban-wildfire incidents, like those in California, Oregon, Colorado, and Hawai'i. In previous studies of wildfires, the harmful substances detected in water systems typically belong to two groups: Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs). There are very specific fire-related chemicals that must screened for. Water quality laboratories using EPA approved analysis methods do not necessarily look for all the chemicals. You must ask them to review the fire related chemical list. At the present time, standard home test kits do not work to detect all of the fire-related contaminants.

What are ways water can become contaminated from wildfires?
Wildfires have the potential to harm drinking water systems, building plumbing, catchment systems, rendering them unsafe. Chemical contamination can happen both from smoke, ash, and foreign matter directly entering the water system at breaks, as well as the heating or burning of the materials within the water system, including plastics.

What is the difference between micrograms (μg/L) and milligrams (mg/L)?
Microgram per liter (μg/L) is a unit of concentration that measures the amount of a substance dissolved in a given volume of water (1 liter). A microgram is equivalent to one millionth of a gram. 1000 micrograms is equivalent to 1 milligram (mg), so 1 mg/L is equal to 1000 μg/L.

What is the difference between micrograms (μg) and ppb (parts per billion)?
They are basically the same. Micrograms per liter (μg/L) are sometimes referred to as ppb (parts per billion) in aqueous solutions because there are 1 billion micrograms in 1 liter.

What does MCLG and MCL mean?
The maximum contaminant level goal (MCLG) is the level of a contaminant in drinking water below any known or expected risk to health. MCLGs allow for a margin of safety and are not enforceable standards. Maximum contaminant level (MCL) is the highest level of a contaminant that is allowed in drinking water. MCLs are enforceable standards.

Are there private labs where I can get my own VOC and SVOC water tests?
Yes there are. These laboratories are private, generally for-profit companies and likely have variable costs, sample processing times, and lists of services. Typical costs range from $100-$200 for a VOC test and ~$250 to add SVOCs.

Does EPA regulate volatile organic compounds (VOCs) in household products?
Yes

Are VOCs dangerous?
It is difficult to generalize the dangers of waterborne VOCs because there are so many different variations of them. Furthermore, there has not been extensive testing done to determine the health risks posed by many of the household products that release VOCs. But, there is evidence that VOC exposure can have negative health impacts. According to the EPA, volatile organic compounds are associated with irritation of the eyes, nose, and throat, headaches, loss of

coordination, and nausea. Prolonged exposure can cause damage to the liver, kidneys, and central nervous system.

What are VOCs?

Volatile organic compounds are chemicals that both vaporize into air and dissolve in water, having a high vapor pressure and low water solubility. Many VOCs are human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants. VOCs typically are industrial solvents, such as trichloroethyene, fuel oxygenates, such as methyl *tert*-butyl ether (MTBE); or by-products produced by chlorination in water treatment, such as chloroform. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry-cleaning agents.

VOCs are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (u to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

Organic chemicals are widely used as ingredients in household products. Paints, varnishes, and wax all contain organic solvents as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.

12.4 Guidance to the public on water testing

Customers with standing buildings and damaged will be interested in understanding the public water system response and findings. A major part of this interest pertains to water testing results. For many people, this incident may be the first-time they have paid close attention to the terminology and practices of drinking water testing. Appendix F explains key terms and concepts to customers about water sampling for chemical drinking water contamination for a man-made disaster. That information was prepared by the Columbiana County Health Department in 2023 after a chemical incident but can be used as a guide for water systems and regulators for preparing similar public communications.

Another reason for issuing public education about drinking water sampling and analysis is that concerns about wildfire caused drinking water contamination can prompt customers to make their own decisions about drinking water sampling and analysis. It is important that the water system and regulators help educate customers so they do not needlessly spend their own funds and generate uninterpretable information that causes confusion or leads them to a false sense of security (Odimayomi et al. 2021; Whelton et al. 2024). Additionally, after past wildfires commercial laboratories sometimes approached homeowners to offer testing services in which they provide homeowners bottles to use for sampling. In some cases, customers filled the bottles half full for VOC samples, which the laboratory the proceeded to analyze the sample and bill the customer. However, because VOCs are volatile, the water being analyzed by the laboratory was not representative of the water delivered to the tap of the customer or exiting a faucet. Here, the chemical analysis report provided to the customer had no value. Proper sampling, handling, and chemical analysis methods are needed for drinking water result validity and interpretation.

APPENDIX A

Post-Fire Return to Service Plan for the City of Louisville, Colorado Submitted to their *SDWA* Primacy Agency

Please Note: The list of fire-related chemicals has been updated since the following return to service plan was created. Please use the most up-to-date list of fire related chemicals for testing drinking water distribution systems after wildfire.

City of Louisville | Department of Public Works & Utilities
COLORADO ▪ SINCE 1878

Mr. Tyson Ingels
Water Quality Control Division, Colorado Department of Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Date: January 27, 2022

RE: City of Louisville – Return to Service Plan for Water Service Closure Areas After the Marshall Fire

Dear Mr. Ingels:

Included is the City of Louisville's (City) proposed return to service plan for closed water mains and services after the historic Marshall Fire Event that occurred in Boulder County. During and immediately following the firefighting activities, City staff isolated water mains and services to prevent water/pressure loss and as a cross connection control measure in fire damaged areas within the distribution system.

Following the Fire Event and in coordination with CDPHE, the City conducted extensive flushing of the entire distribution system and collected water samples to test for multiple contaminants, including bacteria and volatile organic compounds (VOCs). Test results confirmed the City's water treatment systems are working properly and the water reaching customers meets all state and federal water quality standard. On January 6, CDPHE lifted the boil water order for the City excluding the closure areas. With this action the majority of the City's distribution system was returned to normal service.

Water Service Closure Areas
The fire-damaged areas in the distribution system that remain isolated and without water service have been categorized in the list below. Each area is outlined in red and shown in Figure 1.

- Summit Trail Ridge/South Shore
- Eldorado/Arapahoe
- Centennial/Enclave
- Mulberry/Cherrywood
- Owl
- Dillion Shops
- Coal Creek Ranch South

Source: City of Louisville 2022.

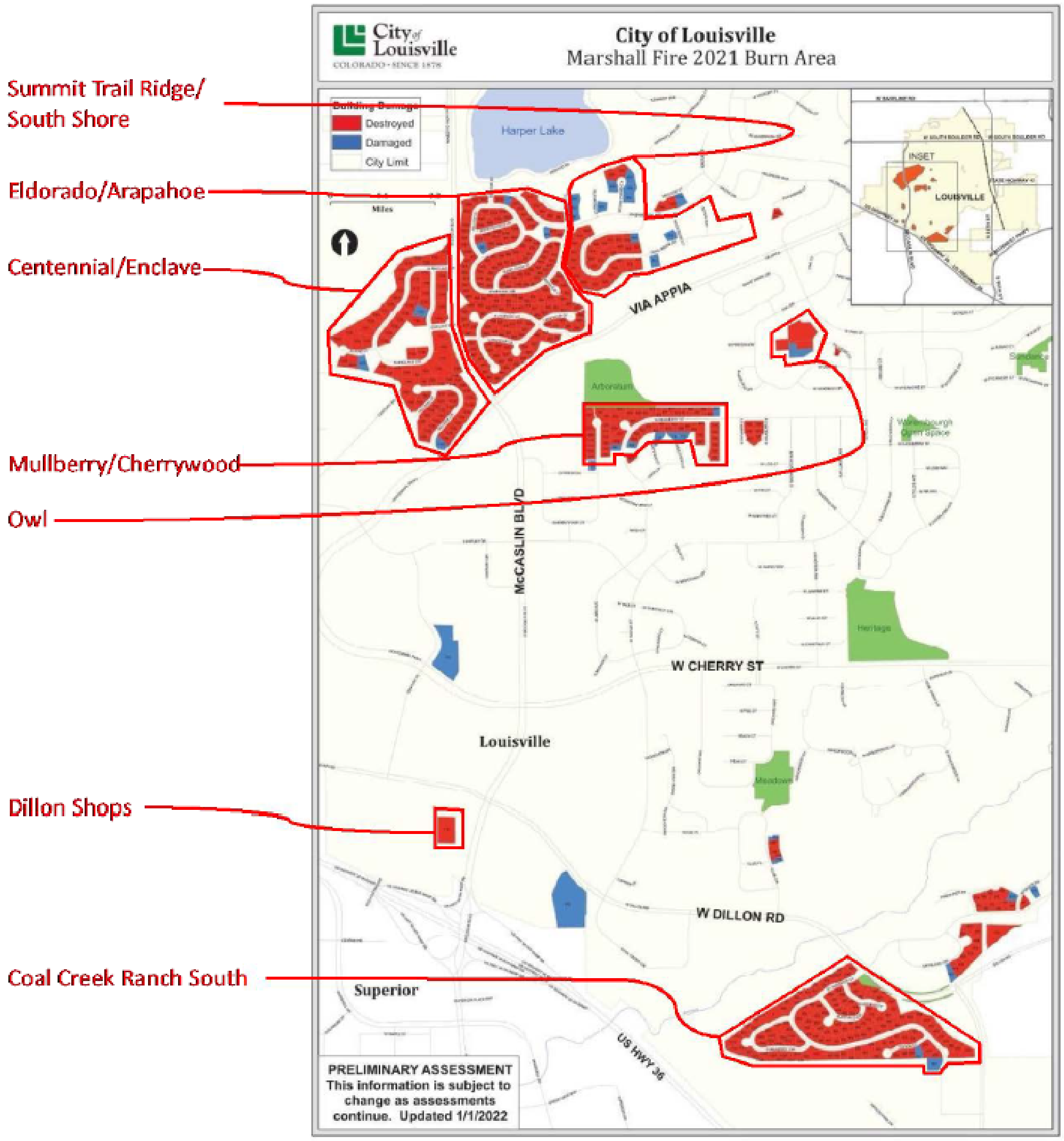


Figure 1. Complete and Partial Water Service Closure Areas (January 12, 2022)

Chemicals of Possible Concern

Historically, VOCs have been the primary focus of post-wildfire drinking water contamination investigations though semi-volatile organic compounds (SVOC) could potentially also be present. US Environmental Protection Agency Method 524.2 (Measurement of purgeable organic compounds in water by capillary column gas chromatography / mass spectrometry) is often applied for drinking water VOC analysis after wildfires. US Environmental Protection Agency

749 Main Street, Louisville, Colorado 80027 • P - (303) 335-4608 • F - (303) 335-4550 • www.louisvilleco.gov

Source: City of Louisville 2022.

Methods 8260C (SW-846) (Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) can also be used to provide analysis for parameters after wildfires. Table 1 lists chemicals that have been detected in other water distribution systems after experiencing impacts from wildfire. Wildfires can have exceeded short- and long-term drinking water exposure standards as indicated in the right hand column. The parameters shown below in Table 1 will be targeted for water distribution system testing and laboratory analysis.

Table 1. List of Parameters Detected in Drinking Water Distribution System Water Samples after Previous Wildfires

Parameter	**CAS #**	***Exceeded a short- or long-term drinking water exposure level**
Acetonitrile	75-05-8	
Acetone	67-64-1	
Acrolein	107-02-8	
Acrylonitrile	107-13-1	
Benzene	71-43-2	Yes
Bromochloromethane	74-97-5	
Bromodichloromethane	75-27-4	
Bromoform	75-25-2	
n-Butylbenzene	104-51-8	
sec-Butylbenzene	135-98-8	
tert-Butylbenzene	98-06-6	
Carbon disulfide	75-15-0	
Carbon tetrachloride	56-23-5	
Chlorobenzene	108-90-7	Yes
Chlorodibromomethane	124-48-1	
Chloromethane	74-87-3	
4-Chlorotoluene	106-43-4	
Dibromochloromethane	124-48-1	
1,2-Dichlorobenzene	95-50-1	
1,4-Dichlorobenzene	106-46-7	
1,1-Dichloroethane	75-34-3	
1,2-Dichloroethane	107-06-2	
1,1-Dichloroethene	75-35-4	
cis-1,2-Dichloroethene	156-59-2	
trans-1,2-Dichloroethylene	156-60-5	

749 Main Street, Louisville, Colorado 80027 ● P - (303) 335-4608 ● F - (303) 335-4550 ● www.louisvilleco.gov

Source: City of Louisville 2022.

Parameter	CAS #	*Exceeded a short- or long-term drinking water exposure level
1,2-Dichloropropane	78-87-5	
Ethanol	64-17-5	
Ethylbenzene	100-41-4	
Ethyl-*tert*-butyl ether (ETBE)	637-92-3	
Iodomethane	74-88-4	
Isopropylbenzene	98-82-8	
Methylene chloride	75-09-2	Yes
Methyl ethyl ketone (MEK)	78-93-3	Yes
Methyl isobutyl ketone (MIBK)	108-10-1	
Methyl-*tert*-butyl ether (MTBE)	1634-04-4	
Naphthalene	91-20-3	Yes
Styrene	100-42-5	Yes
tert-Butyl alcohol (TBA)	75-65-0	Yes
Tetrachloroethylene	127-18-4	
Tetrahydrofuran (THF)	109-99-9	Yes
Toluene	108-88-3	Yes
1,2,3-Trichlorobenzene	87-61-6	
1,2,4-Trichlorobenzene	120-82-1	
1,1,1-Trichloroethane	71-55-6	
1,1,2-Trichloroethane	79-00-5	
Trichloroethylene	79-01-6	
Trichloromethane	67-66-3	
1,2,4-Trimethylbenzene	95-63-6	
1,3,5-Trimethylbenzene	108-67-8	
Vinyl chloride (VCM)	75-01-4	Yes
ortho-Xylene	95-47-6	
meta-Xylene	108-38-3	
para-Xylene	106-42-3	

(*) A "Yes" value indicates the parameter exceeded a short- or long-term drinking water exposure level in other post-wildfire distribution system sampling. At present, there is limited understanding of the most common chemicals associated with post-wildfire water contamination.

749 Main Street, Louisville, Colorado 80027 ● P - (303) 335-4608 ● F - (303) 335-4550 ● www.louisvilleco.gov

Return to Service Procedure

The sampling procedure overview is to (1) sample the mains that have been closed for potential contamination by chemicals of concern, total coliforms and chlorine residuals. Once the mains have been demonstrated to be free of contamination proceed to (2) sample service connections at kitchen sinks for potential contamination by chemicals of concern. The schedule for completing the procedure depends on conducting sampling, laboratory analysis turnaround times, and other factors.

1. **Mains**
    a. **Sample** the selected mains for water that has stagnated since shutdown after the fire. Collect samples from hydrant locations representative of the isolated main by introducing clean water supply and drawing it to the hydrant and collecting samples during the time represented by the stagnated water. After sample collection, flush the main until all stagnant water is displaced and then isolate the main until sample results are analyzed and reviewed.
    b. **Analyze** the collected samples for the Table 1 listed parameters using EPA Method 524.2 and/or 8260C and total coliforms. **Review** the laboratory reported results for the listed parameters to determine if there is any contamination.
        i. **If no contamination is found,** the selected main can be returned to service with supplied service connections remaining isolated until service connection testing is completed.
        ii. **If contamination is found,** repeat the procedure starting at 1.a. Experimental data shows that 72 hours is the optimal stagnation time; however, 24 or 48 hours may be used as an indicator.
2. **Service connections**
    a. Once the supply main has been demonstrated to be free of contamination using EPA Method 524.2, and/or 8260C and total coliforms, supplied service connections will be temporarily restored to allow for testing and then suspending pending results.
    b. **Sample** the selected service connections at the kitchen sink for water that has stagnated since shutdown after the fire.
    c. **Analyze** the collected samples for the Table 1 listed parameters using EPA Method 524.2, and/or 8260C. **Review** the laboratory reported results for the listed parameters to determine if there is any contamination.
        i. **If no contamination is found,** the selected service connection will be restored with and returned to normal service.
        ii. **If contamination is found,** repeat the procedure starting at 2.a.

Communications

The City has provided customers with updated information on the return to service plan on its website with an interactive map that shows previous and ongoing water sample testing activity. Further enhancements are being added to identify the status of each water service.

Source: City of Louisville 2022.

APPENDIX B

Guidance About Boil Water, Do Not Use, and Do Not Drink Advisories and Examples From The U.S. Centers For Disease Control and Prevention (CDC)

B.1 Boil Water Advisory

If your local health officials issue a **boil water advisory**, you should use bottled water or boil tap water. This is because a boil water advisory means your community's water has, or could have, germs that can make you sick.

https://www.cdc.gov/healthywater/emergency/drinking/drinking-water-advisories/boil-water-advisory.html

Advisories may include information about preparing food, drinks, or ice; dishwashing; and hygiene, such as brushing teeth and bathing. Boil water advisories usually include this advice:

1. Use bottled or boiled water for drinking, and to prepare and cook food.
2. If bottled water is not available, bring **water to a full rolling boil for 1 minute** (at elevations above 6,500 feet, boil for 3 minutes). After boiling, allow the water to cool before use.
3. Boil tap water even if it is filtered (for example, by a home water filter or a pitcher that filters water).
4. Do not use water from any appliance connected to your water line, such as ice and water from a refrigerator.
5. Breastfeeding is the best infant feeding option. If you formula feed your child, provide ready-to-use formula, if possible.

Handwashing

1. In many cases, you can use tap water and soap to wash hands during a boil water advisory. Follow the guidance from your local public health officials.
2. Be sure to scrub your hands with soap and water for at least 20 seconds. Then, rinse them well under running water.
3. If soap and water are not available, use an alcohol-based hand sanitizer that contains at least 60% alcohol.

Bathing and showering

1. Be careful not to swallow any water when bathing or showering.
2. Use caution when bathing babies and young children. Consider giving them a sponge bath to reduce the chance of them swallowing water.

Brushing teeth

1. Brush teeth with boiled or bottled water. Do not use tap water that you have not boiled first.

Washing dishes

1. If possible, use disposable plates, cups, and utensils during a boil water advisory.
2. Household dishwashers generally are safe to use if:
   a. The water reaches a final rinse temperature of at least 150 degrees Fahrenheit (66°Celsius), or
   b. The dishwater has a sanitizing cycle.
3. Sanitize all baby bottles.
4. To wash dishes by hand:
   a. Wash and rinse the dishes as you normally would using hot water.

   b. In a separate basin, add 1 teaspoon of unscented household liquid bleach for each gallon of warm water.
   c. Soak the rinsed dishes in the water for at least one minute.
   d. Let the dishes air dry completely before using again.

Laundry

5. It is safe to wash clothes as usual.

Cleaning

6. Clean washable toys and surfaces with:
   a. Bottled water,
   b. Boiled water, or
   c. Water that has been disinfected with bleach [PDF – 1 page].

Caring for pets

7. Pets can get sick from some of the same germs as people or spread germs to people. Give pets bottled water or boiled water that has cooled.
8. If bottled water is not available, bring **water to a full rolling boil for 1 minute** (at elevations above 6,500 feet, boil for 3 minutes). After boiling, allow the water to cool before use.
9. Boil tap water even if it is filtered (for example, by a home water filter or a pitcher that filters water).
10. Do not use water from any appliance connected to your water line, such as ice and water from a refrigerator.

Caring for your garden and houseplants

11. You can use tap water for household plants and gardens.

B.2 Do Not Use Water Advisory

Local health authorities issue a **do not use** water advisory when your community's water is, or could be, contaminated with germs, harmful chemicals, toxins, or radioactive materials. Under this advisory any contact, even with the skin, lungs, or eyes, can be dangerous. Do not drink or use tap water from the impacted system for any purpose as long as the advisory is in effect, including for bathing. These types of advisories are rare.

B.3 Do Not Drink Water Advisory

Local health authorities issue a **do not drink** water advisory when your community's water is, or could be, contaminated with harmful chemicals and toxins, and <u>when boiling water will not make it safe.</u>

Do Not Drink Water Advisory | Water, Sanitation, & Hygiene-related Emergencies & and Outbreaks | Healthy Water | CDC

Authorities may recommend limited use of tap water for some tasks, depending on the harmful chemical or toxin contaminating the water. Follow health officials' advice carefully to protect your health and your family's health.

During a do not drink water advisory, use bottled water for:

- Drinking and cooking
- Brushing teeth
- Washing fruits and vegetables
- Preparing food
- Mixing baby formula
- Making ice
- Giving water to pets

In some instances, it will be safe to wash hands, flush toilets and shower; in other instances, it will not. You should be cautious when bathing a baby and young children; they might swallow water.

Do not drink or use water from any appliance connected to your water supply lines. This includes the water and ice dispensers in your refrigerator, freezer and dishwasher.

B.4 Example Advisories

EXAMPLE BOIL WATER ADVISORY

_______'s __________ Tested Positive for Fecal Indicator

(System Name) (Source Name- i.e. Well #1) BOIL YOUR WATER BEFORE USING

Our water system recently detected a fecal indicator (insert organism) * in our source. As our customers, you have a right to know what happened and what we are doing to correct this situation. On [give date] _____________, we collected a sample from our source water. The sample tested positive for E. coli.

What should I do? What does this mean? DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST. Bring all water to a boil, let it boil for three minutes, and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation until further notice. Boiling kills bacteria and other organisms in the water.

**Fecal indicators are microbes whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes can cause shortterm health effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems. **

The symptoms above are not caused only by organisms in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice from their health care providers about drinking this water.

What is being done? (Describe corrective action) ____. We will inform you when tests show no E. coli and you no longer need to boil your water. We anticipate resolving the problem within (estimated time frame) ___________. For more information, please contact (name of system's contact) ________________at (number) _________________ or (mailing address) ____________________________.

General guidelines on ways to lessen the risk of infection by microbes are available from the EPA Safe Drinking Water Hotline at 1-800-426-4791.

**Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail. **

This notice is being sent to you by (system name) ______________________________

Public Water System ID#: ___________. Date distributed: ______.

ADDITIONAL DETAILS FOR THE WATER SYSTEM FROM THE EXAMPLE

Since detection of a fecal indicator (*E. coli, enterococci* or coliphage) is a situation requiring Tier 1 notice, you must provide public notice to persons served as soon as practical but no more than 24 hours from learning of the violation [40 CFR 141.202(b)].

During this time, you must also contact your primacy agency. You should also coordinate with your local health department. You must use one or more of the following methods to deliver the notice to consumers [40 CFR 141.202(c)]: • Radio • Television • Hand or direct delivery • Posting in conspicuous locations

You may need to use additional methods [e.g., newspaper, delivery of multiple copies to hospitals, clinics, or apartment buildings] since notice must be provided in a manner reasonably calculated to reach all persons served. If you post or hand deliver, print your notice on your system's letterhead, if you have it.

The notice on the reverse is appropriate for hand delivery or for publication in a newspaper. However, you may wish to modify it before using it for a radio or TV broadcast. If you do modify the notice on the reverse, you must still include all required PN elements from 40 CFR 141.205(a) and leave the mandatory language unchanged (see below).

Mandatory Language: Mandatory language on health effects (from Appendix B to Subpart Q) must be included as written (with blanks filled in) and is presented in this notice in italics and with an asterisk on either end.

You must also include standard language to encourage the distribution of the public notice to all persons served, where applicable [40 CFR 141.205(d)]. This language is also presented in this notice in italics and with an asterisk on either end.

Alternative Sources of Water: If you are selling or providing bottled water, your notice should say where it can be obtained. Remember that bottled water can also be contaminated. If you are providing bottled water, make sure it meets US Food and Drug Administration (FDA) and/or state bottled water safety standards.

Corrective Action: In your notice, describe corrective actions you are taking. Listed below are some steps commonly taken by water systems that have detected a fecal indicator in their ground water source. Depending on the corrective action you are taking, you can use one or more of the following statements, if appropriate, or develop your own text: • We are increasing sampling at our sources to determine the source of the contamination. • We are working with state officials to implement corrective actions to ensure water supplies are protected against contamination. • We are providing water from an alternative source until the problem is resolved. • We have discontinued use of the contaminated well and will rely on our other sources to meet demand.

After Issuing the Notice: Please mail the statement of certification below and a copy of the printed notice and the date(s) the notice was either posted or mailed. Send this copy and certification to EPA Region ___ within ten days from the time you issue the notice (141.31(d)). Send the copy of your notice and dates to: _____, US EPA Region ____, Drinking Water Program), [address]. It is recommended that you notify health professionals in the area of the violation. People may call their doctors with questions about how the violation may affect their health, and the doctors should have the information they need to respond appropriately.

EXAMPLE DO NOT USE ADVISORY

_______’s __________ May be Chemically Contaminated

(System Name) (Source Name- i.e. Well #1) DO NOT USE YOUR WATER

Our water system is possibly chemically contaminated with an unknown substance. We will inform you when tests show that the water is safe again. As our customers, you have a right to know what happened and what we are doing to correct this situation. On [give date] _____________, (explain info) __________. (explain any test results or customer complaints).

What should I do? What does this mean? DO NOT USE THE WATER. (explain what uses are allowed such as toilet flushing. Is skin contact okay or not?). Try not to draw in water from the source until testing results indicate it is safe. Boiling the water will not make it safe. Do not attempt to treat the water yourself.

**(explain chemicals that have been identified and list the short- and long-term health effects) They may pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems. **

The symptoms above are not caused only by chemicals in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice from their health care providers about drinking this water.

What is being done? (Describe corrective action) _______________________________________. We will inform you when tests show no chemical contaminants and you no longer need to follow the water use requirements. We anticipate resolving the problem within (estimated time frame) ___________. For more information, please contact (name of system’s contact) ________________at (number) _________________ or (mailing address) ___________________________.

General guidelines on ways to lessen the risk of infection by microbes are available from the EPA Safe Drinking Water Hotline at 1-800-426-4791.

**Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail. **

This notice is being sent to you by (system name) ______________________________

Public Water System ID#: ___________. Date distributed: ______.

EXAMPLE DO NOT DRINK-DO NOT BOIL ADVISORY

_______'s __________ May be Chemically and Microbiologically Contaminated

(System Name) (Source Name) DO NOT USE YOUR WATER

Our water system is possibly chemically contaminated with an unknown substance. We will inform you when tests show that the water is safe again. As our customers, you have a right to know what happened and what we are doing to correct this situation. On [give date] _____________, (explain info) __________. (explain any test results or customer complaints).

What should I do? What does this mean? DO NOT USE THE WATER. (explain what uses are allowed such as toilet flushing. Is skin contact okay or not?). DO NOT TRY AND TREAT THE WATER YOURSELF. Boiling, freezing, filtering, adding chlorine or other disinfectants, or letting water stand will not make the water safe. Bottled water should be used for all drinking (including baby formula and juice), brushing teeth, washing dishes, making ice and food preparation until further notice.

Try not to draw in water from the source until testing results indicate it is safe. Boiling the water will not make it safe. Do not attempt to treat the water yourself.

(explain chemicals that have been identified and list the short- and long-term health effects) They may pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems

The symptoms above are not caused only by chemicals in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice from their health care providers about drinking this water.

What is being done? (Describe corrective action) _______________________________________. We will inform you when tests show no chemical contaminants and you no longer need to follow the water use requirements. We anticipate resolving the problem within (estimated time frame) ___________. For more information, please contact (name of system's contact) ________________at (number) _________________ or (mailing address) ___________________________.

General guidelines on ways to lessen the risk of infection by microbes are available from the EPA Safe Drinking Water Hotline at 1-800-426-4791.

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

This notice is being sent to you by (system name) ______________________________

Public Water System ID#: ___________. Date distributed: ______.

APPENDIX C

Target Chemicals for Post-Fire Drinking Water Sampling

C.1 List of VOCs detected in previous drinking water distribution system water samples after wildfires (as of July 2024)

Acetonitrile	Chlorodibromomethane	Ethyl benzene	**ΔToluene** *
ΔAcetone	Chloromethane	**Ethylene dibromide (EDB)** *	1,2,3-Trichlorobenzene
Acrolein	4-Chlorotoluene	Ethyl-*tert*-butyl ether (ETBE)	1,2,4-Trichlorobenzene
Acrylonitrile	Dibromochloromethane	Iodomethane	1,1,1-Trichloroethane
ΔBenzene *	**1,2-Dibromo-3-chloropropane (DBCP)** *	Isopropylbenzene	1,1,2-Trichloroethane
Bromochloromethane	1,2-Dichlorobenzene	**Methylene chloride** *	Trichloroethylene
Bromodichloromethane	1,4-Dichlorobenzene	**ΔMethyl ethyl ketone (MEK)** *	**Trichloromethane** *
Bromoform	1,1-Dichloroethane	Methyl iso butyl ketone (MIBK)	**1,2,3-Trichloropropane (TCP)** *
n-Butylbenzene	**1,2-Dichloroethane** *	**Methyl-*tert*-butyl ether (MTBE)** *	1,2,4-Trimethylbenzene
sec-Butylbenzene	1,1-Dichloroethene	**ΔNaphthalene** *	1,3,5-Trimethylbenzene
tert-Butylbenzene	*cis*-1,2-Dichloroethene	**ΔStyrene** *	**Vinyl chloride** *
Carbon disulfide	*trans*-1,2-Dichloroethylene	***tert*-Butyl alcohol (TBA)** *	Δ*ortho*-Xylene
Carbon tetrachloride *	**1,2-Dichloropropane** *	Tetrachloroethylene	Δ*meta*-Xylene
Chlorobenzene	ΔEthanol	**Tetrahydrofuran (THF)** *	Δ*para*-Xylene

Asterix and (*) bolded chemical name indicates the contaminant exceeded a short- or long-term drinking water exposure level; Triangle (Δ) symbol indicates the chemical has been found sucked into stainless steel tubing from the air during a structure fire. At present, there is limited understanding of the most common chemicals associated with post-wildfire water contamination. Chemicals reported above have been those most looked for, not necessarily the ones of most frequency or concern. Different laboratories sometimes choose to look for different, not all the same, chemicals on EPA Method 524.2; Please note that the total number of chemicals that are reported to the water system by the laboratory is not necessarily a number to tout. This is because some of the EPA Method 524.2 chemicals laboratories commonly report would not necessarily be detected post-wildfire, but are chemicals that the laboratory automatically includes anyways, so they are reported. Updated: July 26, 2024.

C.2 List of SVOCs detected in previous drinking water distribution system water samples after wildfires (as of July 2024)

1-Methylnaphthalene	2-Nitroaniline	Anthracene	Fluoranthene
1,1`-Biphenyl	2,2`-Oxybis(1-chloropropane)	Azobenzene	Fluorene
1,2-Dichlorobenzene	2,4-Dinitrophenol	Benzaldehyde	Hexachloroethane
1,2-Dinitrobenzene	2,4-Dinitrotoluene	Benzo(a)anthracene	Isophorone
1,2-Diphenylhydrazine	2,4,6-Tribromophenol	Benzo(b)fluoranthene	*N*-Nitroso-di-*n*-propylamine
1,2,4-Trichlorobenzene	2,6-Dinitrotoluene	Benzoic acid	*N* -Nitrosodimethylamine
1,3-Dinitrobenzene	3-Nitroaniline	Benzyl alcohol	*N*-Nitrosodiphenylamine
1,4-Dichlorobenzene	4-Chloro-3-Methylphenol	Bis(2-chloroethyl)ether	Naphthalene
1,4-Dinitrobenzene	4-Chloroaniline	Bis(2-ethylhexyl)phthalate	Nitrobenzene
1,4-Dioxane	4-Nitrophenol	Butyl benzyl phthalate	Pentachlorophenol
2-Chloronaphthalene	Acenaphthene	Caprolactam	Phenanthrene
2-Fluorobiphenyl	Acenaphthylene	Di-*n*-butyl phthalate	Phenol
2-Fluorophenol	Acetophenone	Di-*n*-octyl phthalate	Pyrene
2-Methylnaphthalene	Aniline	Diethyl phthalate	

(*) At present, there is limited understanding of the most common chemicals associated with post-wildfire water contamination. Chemicals reported above have been those most commonly looked for, not necessarily the ones of most frequency or concern. Different laboratories sometimes choose to look for different, not all the same, chemicals; Please note that the total number of chemicals that are reported to the water system by the laboratory is not necessarily a number to tout. This is because some of the EPA Methods, etc. chemicals laboratories commonly report would not necessarily be detected post-wildfire, but are chemicals that the laboratory automatically includes anyways, so they are reported. Sometimes no VOCs were detected, but SVOCs were found indicating contamination was present. Updated: August 13, 2023.

APPENDIX D

Post-Fire Chemical Water Sampling Standard Operating Procedures (Sops)

Overview. There are three levels of questions to be answered post-fire:

1. Is there contamination entering from the water treatment plant into the distribution system,
2. Is there contamination in the water mains and tanks?
3. Is there contamination in the service lines (and water meters)?

Depending on the area impacted, some of the assets (i.e., hydrants, mains, service lines) may be in a portion of the water distribution system that's actively being used. This differs from closed areas of the water distribution system where water use is not possible or prohibited. Below are notes collected from public water systems impacted by fires about how they proceeded through the water sampling and decision-making process.

QUESTION TO BE ANSWERED: Is there contamination in the water mains?

OVERALL

1. These areas are using water without restriction. There is no stagnation time in these sampling locations. These are typically areas outside of the closure areas.
2. Locations to be tested should be adjacent to damaged or destroyed properties as well as sensitive populations (schools, disabled, elderly, health care facilities, etc.)
3. Methods for chemical analysis
   - Method 524.2 and tentatively identified compounds
4. Sample hydrant or building nearby monitoring site

Purpose: To determine if chemical contamination exists in the water main by sampling immediately and after a 72 hour stagnation time.

LOGISTICS

Identify locations to sample from the routine monitoring program

ACTIONS

Collect sample after 15 minute flush

DECISIONS BY WATER SYSTEM

If chemical contamination is not found, move on and return to this location again. If chemical contamination is found, return to resample.

Closed Area Water Sampling: Water sampling in regions that are within the closure area or burned area

QUESTION TO BE ANSWERED: Is there contamination in the water mains or service lines?

OVERALL

1. There should be a Do Not Use notice.
2. Select water mains to test

3. Methods for chemical analysis

- EPA Method 524.2 and tentatively identified compounds
- EPA Method SW-846 8270E and tentatively identified compounds

Water main sampling

Purpose: To determine if chemical contamination exists in the water main by sampling immediately and after a 72 hour stagnation time.

LOGISTICS

Prepare to look for leaks in damaged properties when you turn on the water for sampling hydrants. Notify residents of water testing within the area XXXX days before start. Notify residents that the water is not being turned on for use, the properties will still not have water available.

ACTIONS

1. Turn off all curb stops to standing structures
2. Turn on water valve to area a little to get a little pressure
3. Sample hydrants
4. Flush hydrants to bring new water
5. Turn off water valve to area to let stagnate
6. Stagnate for 72 hours
7. Turn on water valve to area a little to get a little pressure
8. Sample hydrants
9. Is the water acceptable? If not, flush and repeat.
10. If the water is acceptable, leave the water valve open to the area. Now move to testing service lines in the area

DECISIONS

Each location should undergo two sampling regimes even if the first regime shows no contamination. Once two sample regimes have been completed (and no contamination has been found), move on to the next sampling location. If chemical contamination is found at all, flush and then resample following steps a - j above.

Service line sampling

Purpose: To determine if chemical contamination exists in the service line by sampling immediately and after a 72 hour stagnation time

ACTIONS

1. Flush main
2. Turn on curb stop to building to get a little pressure

3. Sample
4. Flush curb stop to bring new water
5. Sample after running a faucet (if a house, kitchen faucet is okay) for 1 minute
6. Now run faucet for 15 minutes
7. Turn off curb stop to building to let stagnate
8. Wait 72 hours
9. Turn on curb stop to building to get a little pressure
10. Sample after flushing faucet 1 minute
11. Now run faucet for 15 minutes
12. Turn off curb stop to building to let stagnate
13. Is the water acceptable? If not, flush and repeat.
14. If the water IS acceptable, move to the next service line.

DECISIONS

If chemical contamination is not found in the service line for this one sampling regime, this effort is done. If chemical contamination is found, determine (1) will you resample like above, or (2) remove and replace?

APPENDIX E

Example Frequently Asked Questions for Public Engagement to be Finalized in Collaboration with the State Primacy Agency and Health Department

Q: How do I know if my home or business is affected by the Advisory?

The Advisory has a map of affected areas, see [insert website link]. In addition to the areas shown on the map, the Advisory is in effect for [explain locations]. If you still cannot tell if you are in the affected areas, please contact [provide water system telephone number].

Q: *I'm located outside the affected areas. Can I use the tap water?*

Yes, you can use the tap water outside of the affected areas.

Q: Is the tap water contaminated in the affected areas?

Unfortunately, it is unknown at this time if the tap water is contaminated in the affected areas. The water is still being tested.

Q: If contamination is unknown, why is there an Advisory?

The Advisory is a precaution to protect health and safety while the water is being tested. Some areas of the water system (the affected areas) lost water pressure during the wildfire. Depressurization can lead to contamination. Possible contaminants that have been linked to wildfire depressurization events include bacteria, volatile organic compounds (VOC), and semi-volatile organic compounds (SVOC).

Q: When will it be known if the tap water is contaminated?

(Unfortunately a date cannot be provided. Explain ongoing activities, when are lab results expected)

Q: When will the Advisory be lifted?

Unfortunately, it is unknown when the Advisory will be lifted. The Advisory may be lifted or modified for different areas at different times. It depends on when water sampling shows the absence of contamination for the particular area.

Q: Can I take a shower using tap water in the affected areas?

[Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water. Insert specific recommendations from the public health officials who conduct the health risk assessment. If showering, bathing, laundry, dishwashing activities are permitted, the person exposed (i.e., adult, infant), their health status, water temperature, exposure time and ventilation should also be considered in the response. Also important to consider is adsorption of contaminants to the materials the contaminants contact with and whether they will then diffuse out after contact].

Q: Can I take a bath using tap water in the affected areas?

[NOTE TO UTILITY: Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water (i.e., 40,000 ppb benzene + thousands of ppb of other contaminants). Insert specific recommendations from the public health officials who conduct the health risk assessment. If showering, bathing, laundry, dishwashing activities are permitted, the person exposed (i.e., adult, infant), their health status, water temperature, exposure time and ventilation should also be considered in the response. Also important to consider is adsorption of contaminants to the materials the contaminants contact with and whether they will then diffuse out after contact].

Q: Can I flush toilets in the affected areas?

[NOTE TO UTILITY: Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water (i.e., 40,000 ppb benzene + thousands of ppb of other contaminants). Insert specific recommendations from the public health officials who conduct the health risk assessment. If showering, bathing, laundry, dishwashing activities are permitted, the person exposed (i.e., adult, infant), their health status, water temperature, exposure time and ventilation should also be considered in the response. Also important to consider is adsorption of contaminants to the materials the contaminants contact with and whether they will then diffuse out after contact].

Q: Can I fill up my hot tub or swimming pool with tap water in the affected area?

At this time, it is not recommended to fill up hot tubs or swimming pools with tap water in the affected areas. If hot tubs and/or swimming pools have been filled with tap water in the affected areas during or after the wildfire, the [local public health dept] recommends not to use the hot tubs and/or swimming pools at this time. If the water is contaminated, reducing the potential for it to be drawn into plumbing is recommended.

Q: Can I use a dishwasher to wash dishes in the affected areas?

[NOTE TO UTILITY: Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water (i.e., 40,000 ppb benzene + thousands of ppb of other contaminants). Insert specific recommendations from the public health officials who conduct the health risk assessment. If showering, bathing, laundry, dishwashing activities are permitted, the person exposed (i.e., adult, infant), their health status, water temperature, exposure time and ventilation should also be considered in the response. Also important to consider is adsorption of contaminants to the materials the contaminants contact with and whether they will then diffuse out after contact].

Q: Can I use the water to irrigate my outdoor plants in the affected areas, and vegetable garden?

[NOTE TO UTILITY: Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water (i.e., 40,000 ppb benzene + thousands of ppb of other contaminants). Insert specific recommendations from the environmental quality officials who conduct a risk assessment. Specific considerations include inhalation exposures of persons due to volatilization of contaminants during irrigation, sorption and release of contaminants to the vegetation and soil and the irrigation hoses and equipment. Many times household hoses are elastomers, flexible polyvinylchloride, and polyethylene plastics, which are all vulnerable to VOC and SVOC sorption.].

Q: Can I use tap water to do laundry in the affected areas?

[NOTE TO UTILITY: Do not make decisions on your own. This should be decided with toxicologist input. At present, no agency has conducted a health risk assessment about the safety of this practice with wildfire contaminated drinking water (i.e., 40,000 ppb benzene + thousands of ppb of other contaminants). Insert specific recommendations from the public health officials who conduct the health risk assessment. If showering, bathing, laundry, dishwashing activities are permitted, the person exposed (i.e., adult, infant), their health status, water temperature, exposure time and ventilation should also be considered in the response. Also important to consider is adsorption of contaminants to the materials the contaminants contact with and whether they will then diffuse out after contact].

Q: Can I treat the water myself? Would a home water treatment system make the water safe?

Do not try to make the water chemically safe yourself. Home water treatment systems are not “certified” to make wildfire contaminated drinking water safe for use. These devices are challenged against low chemical concentrations, not high levels that can be present after a fire. Testing is underway to determine the types and range of chemicals present. Once this is determined, these ranges can be compare against home water treatment device capabilities.

During past wildfires households sometimes were sold in-home water treatment devices and installed water treatment systems that could not make the water safe. Vendors were unaware of the scale of contamination present. Homeowners were unaware vendors were unaware. Insurance companies that provided the household money for this purchase were unaware. All water distribution system water testing data is available at [insert website]. Contact your local health department if you have questions about building plumbing and water safety questions.

APPENDIX F

Guidance About How to Read Drinking Water Testing Reports Prepared for the General Public Following a Disaster

APRIL 2023

Water Sample Reports

A guide to interpreting laboratory data.

SECTIONS OF THE REPORT

The full lab reports for samples taken by our office from private water wells in East Palestine are located on our website at: www.columbiana-health.org/resources/

You may have received a portion of that report which is specific to your property. Typically, the full report encompasses all of the samples taken that day and includes quality control (QC) samples. To protect privacy each sample is indicated by a specific sample ID rather than an address or owner name. The lab report is made up of several different sections, we have highlighted a few for you below.

Case Narrative- explains any problems encountered in the test which may or may not have affected the results.

Analytical Report- provides the method used, the lowest level the test can accurately detect listed under "PQL", the test result, the and data qualifiers listed under "Qual" which are notes that indicate any problem encountered.

QC Summary Report- shows additional tests run by the lab to help determine the accuracy of the test results. Detections reported in this section are not reflective of samples taken in the field.

Columbiana County Health District

7360 State Route 45
Lisbon, Ohio 44432
330-424-0272
cchd@columbiana-health.org

Science Speak

Laboratory reporting uses a language all its own, and that can be confusing for those who do not regularly review laboratory data. This guide is intended to help our residents translate the information contained in lab reports into real-life meaningful information for them. If you still have questions about something in your report, please do not hesitate to contact our office.

APRIL 2023

COMMON TERMS

Analyte- The specific chemical that is being tested for.

Duplicate- A duplicate is a second sample, as identical as possible to the first one. The sampler will not usually tell the lab about a duplicate sample in order to check on how well the lab reproduces an analytical result.

Field Blank (FB)- This is a sample container that is filled at the sample location with distilled water. This is done to confirm that there was no contamination from the site affecting the sample results.

Matrix Spike (MS)- Occasionally something in the sample itself interferes with the test for the analyte. To check for that interference, a lab may conduct a "matrix spike" (and a matrix spike duplicate). A known amount of the same chemical being tested for is added to two extra samples before the test is run. If your report shows a high percentage reported in the "matrix spike" data then no interference has occurred.

Method Detection Limit (MDL)- The calculated minimum concentration that the analyte can be measured.

Reporting Limit (RL)- The smallest concentration of an analyte that can be confidently reported by the laboratory. Also called PQL or Practical Quantitation Limit.

DATA QUALIFIERS

J- The reported value is greater than the Method Detection Limit but less than the Reporting Limit.
MB- The analyte was detected in the Method Blank at a concentration greater than the MDL.
QC- The continuing calibration check did not meet the method parameters.
QL- The laboratory control sample or control sample duplicate did not meet the method parameters.
S- The spike result was outside of the method parameters.
U- The analyte was not detected at a concentration greater than the detection limit.

Surrogate- A lab will monitor its analytical system by "spiking" a sample with another chemical similar to the analyte being tested for. If a good percentage of the surrogate chemical is recovered, it shows that the lab's test can accurately measure the analyte sought. If you see "surrogate" results on your lab report, it does not mean that particular chemical that was really in your sample.

Trip Blank (TB)- This is a sample container, often filled with distilled water. The trip blank travels unopened to the site with the empty sample containers and returns unopened to the laboratory with the samples. This is done to confirm that no contamination has been picked up during the "trip".

Figure F-1. How to interpret a laboratory report.
Source: Columbiana County Health Department 2023.

References

Alford-Stevens, A., J. W. Eichelberger, W. L. Budde, R. W. Slater, J. W. Munch, and T. A. Bellar. 1995. *Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 4.1.* Cincinatti, OH: US EPA Office of Research and Development. https://www.epa.gov/sites/default/files/2015-06/documents/epa-524.2.pdf

City of Louisville. 2022. Post Fire Return to Service Plan. January 2022. City of Louisville, Colorado.

City of Detroit. 2021. Water Sampling Progress Map. Detroit, Oregon. 2021. https://detroitoregon.us/wp-content/uploads/2021/07/2021-06-24-Final-Sample-Progress-Map.pdf

Columbiana County Health Department. 2023. Water Sample Reports: A Guide to Interpreting Data. April 2023. Lisbon, Ohio. https://www.columbiana-health.org/wp-content/uploads/CCHD-Water-sample-report-interp-42023.pdf

Deere, D., Leusch, F.D.L., Huimpage, A., Cunliffe, D., Khan, S.J. 2017. Hypothetical scenario exercises to improve planning and readiness for drinking water quality management during extreme weather events. *Water Research.* DOI https://doi.org/10.1016/j.watres.2016.12.028.

Draper, W.M., Li, N., Solomon, G.A., Heaney, Y.C., Crenshaw, R.B., Hinrichs, R.L., Chandrasena, R.E.P. 2022. Organic Chemical Contaminants in Water System Infrastructure Following Wildfire. *ACS ES&T Water.* 2022, 2 (2), 357–366. DOI: https://doi.org/10.1021/acsestwater.1c00401

Esri. 2023a. "Paradise Irrigation District – Water Quality Assurance Monitoring" [World Street Map]. Scale Not Given. "ArcGis Web Application." April 2023. https://arcgis.mobile-mms.com/arcgis/apps/webappviewer/index.html?id=4a4844462644497ca83dbb25b7d9d629 October 23, 2024.

Esri. 2023b. "Department of Water Supply – Water Advisory Area Address Locator." [Open Street Map]. Scale Not Given. "ArcGis Experience Builder." September 2023. https://experience.arcgis.com/experience/414545b8dd0b4117a1ec2727007a38df/page/Page/ October 23, 2024.

Federal Emergency Management Agency (FEMA). 2004. *Food and Water in an Emergency.* [Pamphlet.] Federal Emergency Management Agency and American Red Cross. FEMA 477 A5055. http://www.fema.gov/pdf/library/f&web.pdf

FEMA. 2020a. *Emergency Support Function #3- Public Works and Engineering Annex.* Washington, D.C: FEMA. *https://www.fema.gov/sites/default/files/2020-07/fema_ESF_3_Public-Works-Engineering.pdf*

FEMA. 2020b. *Emergency Support Function #8 – Public Health and Medical Services Annex.* Washington, D.C: FEMA. *https://www.fema.gov/sites/default/files/2020-07/fema_ESF_8_Public-Health-Medical.pdf*

FEMA. 2024. *Community Lifelines.* Washington, D.C: FEMA. https://www.fema.gov/emergency-managers/practitioners/lifelines

Haupert, L.M., Magnuson, M.L. 2019. "Numerical Model for Decontamination of Organic Contaminants in Polyethylene Drinking Water Pipes in Premise Plumbing by Flushing." *Journal of Environmental Engineering.* 145 (7). DOI: https://doi.org/10.1061/(ASCE)EE.1943-7870.0001542

Haupert, L.M., Garcia-Bakarich, L.M., Sojda, N., Schupp, D.A., Magnuson, M.L. 2023. "Benzene diffusion and partitioning in contaminated drinking water pipes under stagnant" conditions. *Environmental Science and Technology Water.* DOI: https://doi.org/10.1021/acsestwater.3c00040

Horn, G.P., Dow, N.W., Neumann, D.L. 2024. Pilot Study on Fire Effluent Condensate from Full Scale Residential Fires. *Fire Technology.* 60, 1-18. DOI: https://doi.org/10.1007/s10694-023-01487-4

Isaacson, K.P., Proctor, C.R., Wang, Q.E., Edwards, E.Y., Noh, Y., Shah, A.D., Whelton, A.J. 2021. Drinking water contamination from the thermal degradation of plastics: implications for wildfire and structure fire response. *Environmental Science: Water Research and Technology.* 7, 274-284. DOI: https://doi.org/10.1039/D0EW00836B

Isaacson, K., Whelton, A.J., Shah, A.D. Forthcoming. *Post-Wildfire Distribution System Water Quality Impacts and Potential Responses.* Project 5106. Denver, CO: The Water Research Foundation. https://www.waterrf.org/research/projects/post-wildfire-distribution-system-water-quality-impacts-and-potential-responses

Long, S. E., T. D. Martin, E. R. Martin, J. T. Creed, and C. A. Brockhoff. 1994. *Method 200.8: Determination Of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, Revision 5.4.* Cincinnati, OH: US EPA Office of Research and Development. https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.8.pdf

Maui County. 2023. Decision Making Flowchart for the Water Sampling Plan. Kahalui, Hawaii.

Metz, A.J., Fischer, E.C., Wham, B.P. 2023. Behavior of Service Lateral Pipes during Wildfires: Testing Methodologies and Impact on Drinking Water Contamination. *Environmental Science and Technology Water. 3* (2), 275-286. https://doi.org/10.1021/acsestwater.2c00248

National Academies of Sciences, Engineering, and Medicine (NASEM). 2022. *The Chemistry of Fires at the Wildland-Urban Interface.* Washington, D.C. USA. The National Academies Press. https://doi.org/10.17226/26460

National Environmental Health Association (NEHA). 2023. *Wildfire Response Guide for Environmental Public Health Professionals.* Denver, Colorado USA. https://www.neha.org/Images/resources/2023-Wildfire-Guide_Digital.pdf

Odimayomi, T.O., Proctor, C.R., Wang, Q.E., Sabbaghi, A., Peterson, K.S., Yu, D.J., Lee, J., Shah, A.D., Ley, C.J., Noh, Y., Smith, C.D., Webster, J.P., Milinkevich, K., Lodewyk, M.W., Jenks, J.A., Smith, J.F., Whelton, A.J. 2021. Water safety attitudes, risk perception, experiences, and education for households impacted by the 2018 Camp Fire, California. *Natural Hazards.* 108, 947–975. DOI: https://doi.org/10.1007/s11069-021-04714-9

Oregon Health Authority. 2022b. Drinking water data online—post wildfire VOCs. Salem, OR. https://yourwater.oregon.gov/wildfirevocs.php?ra=all&cs=all&st=all&year=0&det=all&mcl=n.

Prakash, B., A. D. Zaffiro, M. Zimmerman, D. J. Munch, and B. V. Pepich. 2009. Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Version 1.0. USEPA. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100J75C.PDF?Dockey=P100J75C.PDF

Proctor, C.R., Lee, J., Yu, D., Shah, A.D., Whelton, A.J. 2020. Wildfire caused widespread drinking water distribution network contamination. *AWWA Water Science*. 2(4), e1183. DOI: https://doi.org/10.1002/aws2.1183

Purdue University, Center for Plumbing Safety. 2021a. *After a Wildfire: Water Safety in Buildings.* Prepared by: A. J. Whelton and C. R. Proctor, West Lafayette, Indiana USA. April 2021. West Lafayette, IA: Center for Plumbing Safety at Purdue University . https://engineering.purdue.edu/PlumbingSafety/resources/After-a-Wildfire-water-Safety-in-Buildings-2021-05-16.pdf

Purdue University, Center for Plumbing Safety. 2021b. *After a Wildfire: Water Safety Considerations for Private Wells.* Prepared by: A. J. Whelton and C. R. Proctor, West Lafayette, Indiana USA. April 2021. West Lafayette, IA: Center for Plumbing Safety at Purdue University. https://engineering.purdue.edu/PlumbingSafety/resources/After-a-Wildfire-Private-Drinking-Water-Wells-2021-05-16.pdf

Schulze and Fischer. 2021. Prediction of Water Distribution System Contamination Based on Wildfire Burn Severity in Wildland Urban Interface Communities. *ACS ES&T Water*. 1 (2). DOI:https://doi.org/10.1021/acsestwater.0c00073

Stufflebean, J. 2023. *Drinking Water Sampling and Analysis Plan to Restore Drinking Water to Areas with Standing Structures.* City of Maui. https://drive.google.com/file/d/1noDBQzdvXfJAlL7AppPaNUn27VbELEey/view

Su, J., Whelton, A.J. 2024. *Post-wildfire Drinking Water Crisis: Implications and Opportunities for the Insurance Industry.* Society of Actuaries Research Institute. Schaumburg, Illinois USA. https://www.soa.org/4957d8/globalassets/assets/files/resources/research-report/2024/wildfire-drinking-water-crisis.pdf

Toth, N., Harper, C., Del Moro, M., Henry, R.M., Fischer, E.C., Jane Davis, E. 2024. Oregon's Unprecedented Labor Day 2020 Fires: Impacts and Response. *Journal of the American Water Works Association.* DOI: https://doi.org/10.1002/awwa.2277

U.S. Code of Federal Regulations (CFR). *42 U.S. Code § 300g–2 - State primary enforcement responsibility.* Accessed August 1, 2024. https://www.law.cornell.edu/uscode/text/42/300g-2

U.S. EPA. 2011. *Planning for an Emergency Drinking Water Supply.* Washington, D.C: US EPA National Homeland Security Research Center. *https://www.epa.gov/sites/default/files/2015-03/documents/planning_for_an_emergency_drinking_water_supply.pdf*

U.S. EPA. 2018a. *2018 Edition of the Drinking Water Standards and Health Advisories, EPA 822-F-18-001*. Washington, D.C.: EPA Office of Water. https://www.epa.gov/system/files/documents/2022-01/dwtable2018.pdf

U.S. EPA. 2018b. Method 8260D (SW-846): *Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 4.* Washington, D.C.: USEPA. https://www.epa.gov/sites/default/files/2018-06/documents/method_8260d_update_vi_final_06-11-2018.pdf

U.S. EPA. 2021. *Addressing Contamination of Drinking Water Distribution Systems from Volatile Organic Compounds (VOCs) After Wildfires, EPA 817-F-21-011*. Washington, DC.: EPA Office of Water. https://engineering.purdue.edu/PlumbingSafety/resources/EPA-Wildfire-VOC-Drinking-Water-Contamination-Guidance-Sep-2021.pdf

U.S. EPA. 2023a. *State Emergency Drinking Water Supply Guidance.* Washington, D.C.: EPA Office of Water. *https://www.epa.gov/system/files/documents/2023-04/StateEDWS_Guidance_508c.pdf*

U.S. EPA. 2023b. Risk Assessment: Regional Screening Levels (RSLs). Accessed July 31, 2024. Washington, D.C. USA. https://www.epa.gov/risk/regional-screening-levels-rsls

U.S. EPA. 2024a. *National Primary Drinking Water Regulations.* Accessed July 31, 2024. Washington, D.C. USA. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

U.S. EPA. 2024b. Analytical Methods for Drinking Water: Approved Drinking Water Analytical Methods. Accessed July 31, 2024. Washington, D.C. USA. https://www.epa.gov/dwanalyticalmethods/approved-drinking-water-analytical-methods

Wang, T., Kim, J., Whelton, A.J. 2019. Management of plastic bottle and filter waste during the large-scale Flint Michigan lead contaminated drinking water incident. *Resources, and Recycling 140,* 115-124. https://doi.org/10.1016/j.resconrec.2018.08.021

Whelton, A.J. Wisniewski, P.K., States, S., Birkmire, S.E., Brown, M.K. 2006. Lessons learned from drinking water disaster and terrorism exercises. *Journal of the American Water Works Association.* 98 (8), 63-73. DOI: https://doi.org/10.1002/j.1551-8833.2006.tb07734.x

Whelton, A.J., Dietrich, A.M., Gallagher, D.L., Roberson, J.A. 2007. Using customer feedback for improved water quality and infrastructure monitoring. *Journal of the American Water Works Association.* 99, (11), 62-76. DOI: https://doi.org/10.1002/j.1551-8833.2007.tb08081.x

Whelton, A.J., McMillan, L., Novy, C.L, White, K.D., Huang, X. 2017. Case Study: the crude MCHM chemical spill investigation and recovery in West Virginia, USA. *Environmental Science Water Research and Technology*, 3, 312-332. DOI: https://doi.org/10.1039/C5EW00294J

Whelton, A.J., Proctor, C.R., Lee, J. 2019a. *Considerations for decontaminating HDPE service lines by flushing.* March 18, 2019. Center for Plumbing Safety, Purdue University. West Lafayette, Indiana USA. https://engineering.purdue.edu/PlumbingSafety/opinions/Final-HDPE-Service-Line-Decontamination-2019-03-18.pdf

Whelton, A.J., Coelho, P.D., Shuler, C., Kagawa-Vivani, A., Cole, K.D.P., Surdyka, S., Heffner, S. 2024. Two Weeks After the 2023 Maui Wildfires: Drinking Water Experiences and Needs. *Environmental Science: Water Research and Technology.* DOI: https://doi.org/10.1039/D4EW00216D

THE
Water
Research
FOUNDATION

advancing the science of water®

1199 North Fairfax Street, Suite 900
Alexandria, VA 22314-1445

6666 West Quincy Avenue
Denver, CO 80235-3098

www.waterrf.org | info@waterrf.org