

How Wildfires Can Contaminate Your Drinking and Wastewater

Indiana Partners for Pollution Prevention Conference
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2024



PURDUE
UNIVERSITY

Support from:



Rotary 

Club of
Paradise,
California



THE
Water
Research
FOUNDATION





Lat: 39.825°, Lon: -70.386° FIRES: 2024-09-08 (24HRS)

September 8, 2024



500 km
500 mi

BASIC MODE

TODAY **24HRS** 7DAYS 24HRS From [Yesterday 00:00:00 UTC] to present

Fires / Hotspots

Simple Time Based

- Landsat [30m]
- VIIRS (S-NPP, NOAA-20 & NOAA-21) [375m]
- MODIS (Aqua & Terra) [1km]

Active Alerts

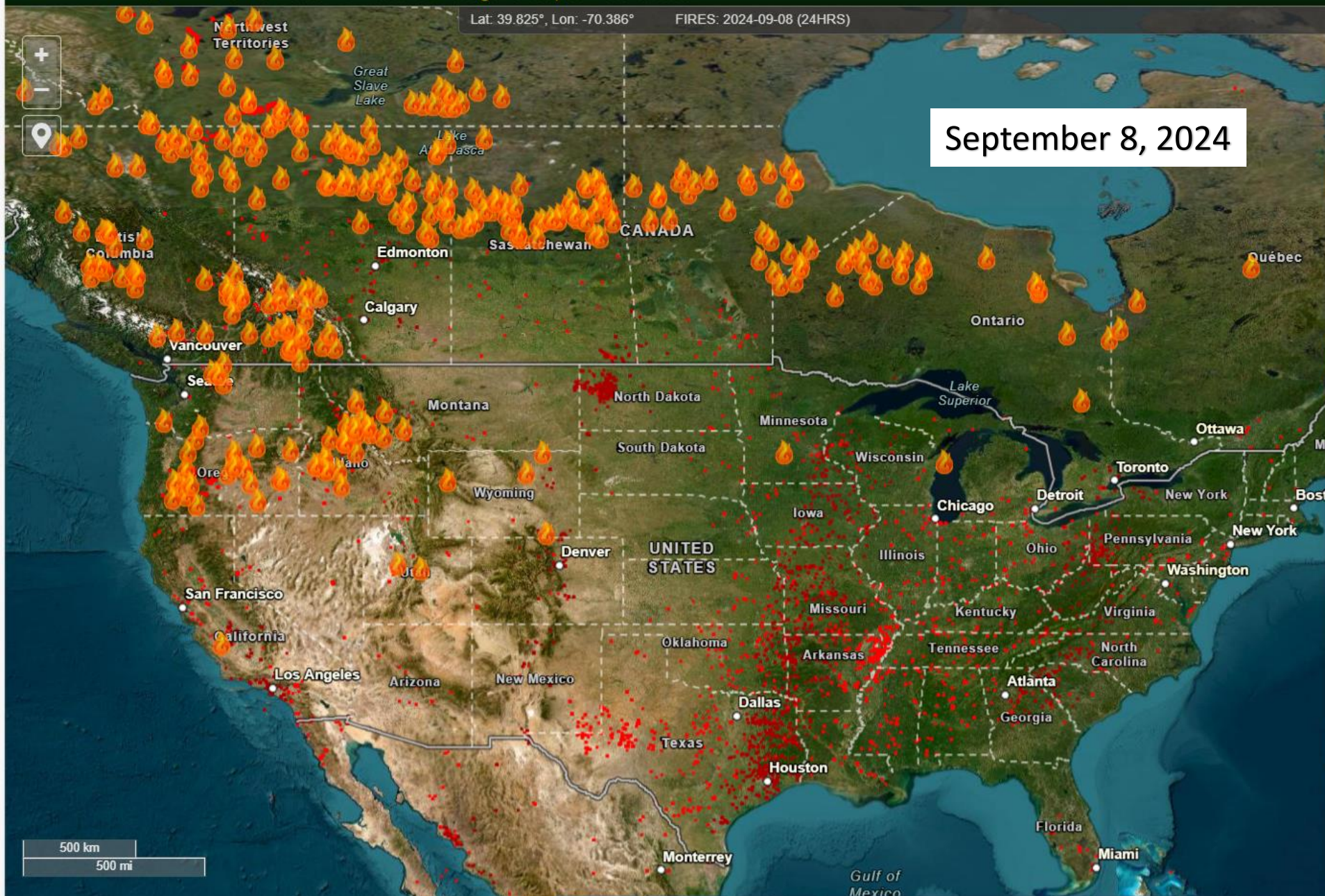
FIRES NOT DECLARED CONTAINED, CONTROLLED, NOR OUT.

- USA Active Fires - IMSR
- Canada Active Fires - DIP
- USA Fire Perimeter
- USA Fire Weather Watch
- USA Red Flag Warning

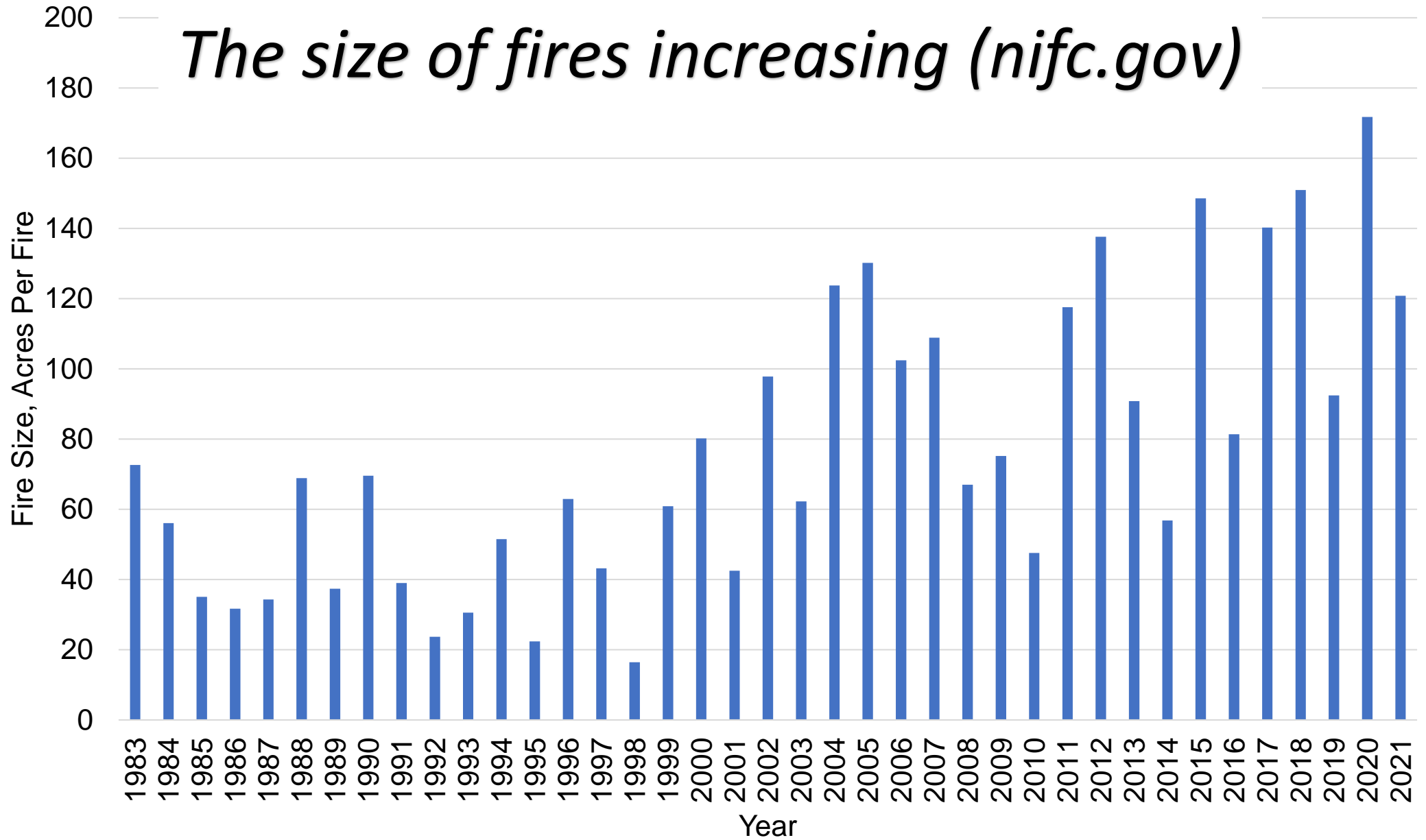
Overlays

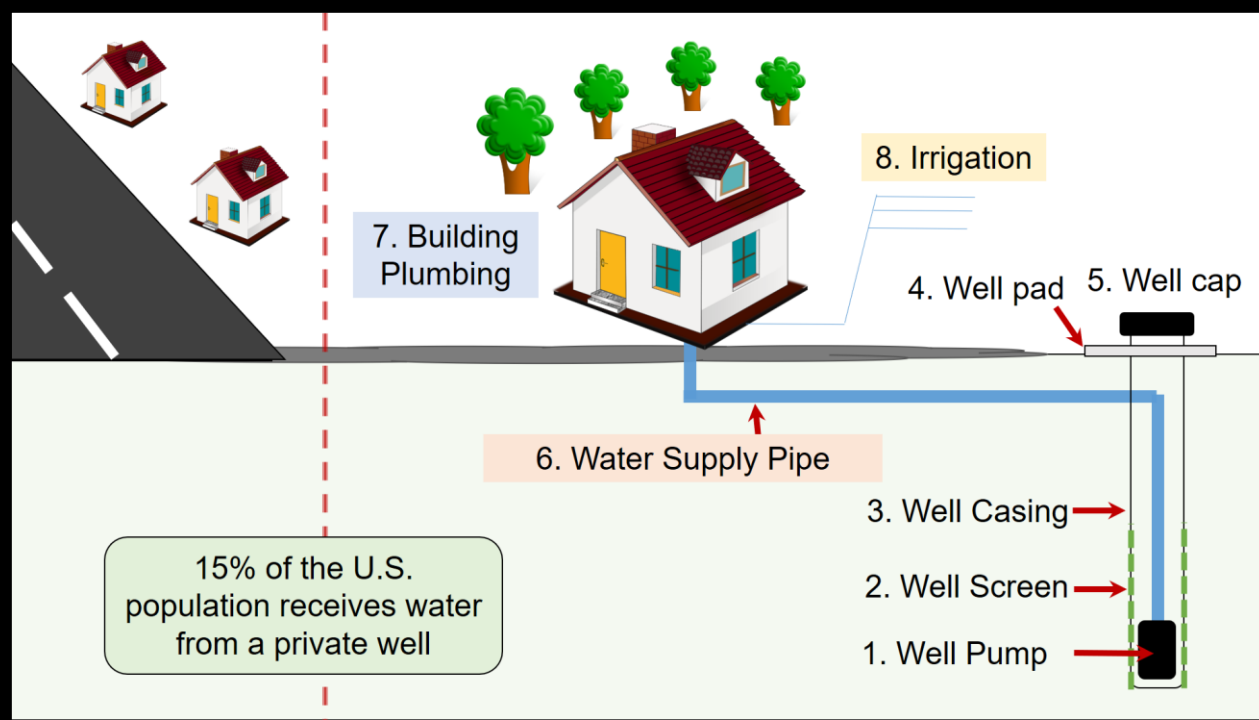
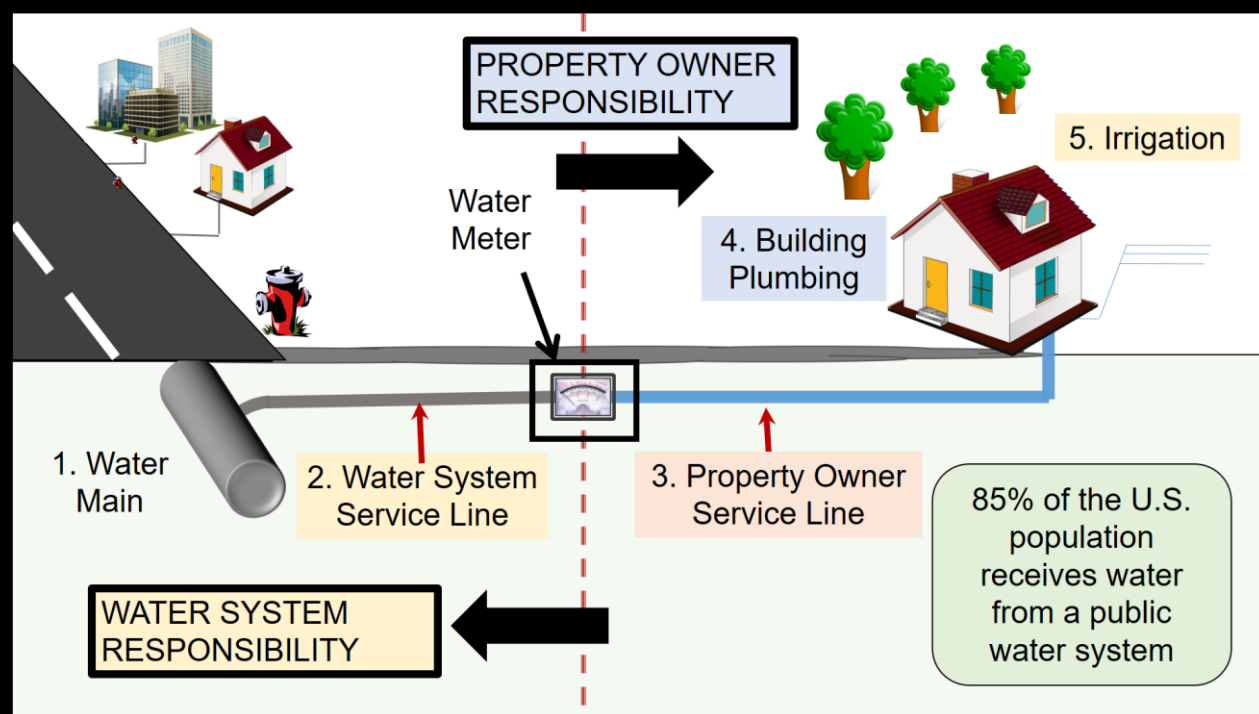
Dynamic Imagery

- VIIRS NOAA-20 Corrected Reflectance (true color)



The size of fires increasing (nifc.gov)





Fires attack drinking water system assets and property plumbing

This threatens the health, safety, and economic security of communities

2021 Marshall Fire: 90 to 102 mph wind gusts

December 30, 2021

11:06 am, Fire in Boulder Co.
12:10 pm, Fire in Superior
12:50 pm, Fire in Louisville
1:00pm, 1,000 acres

60,000+ evacuation ordered

The 3 largest communities

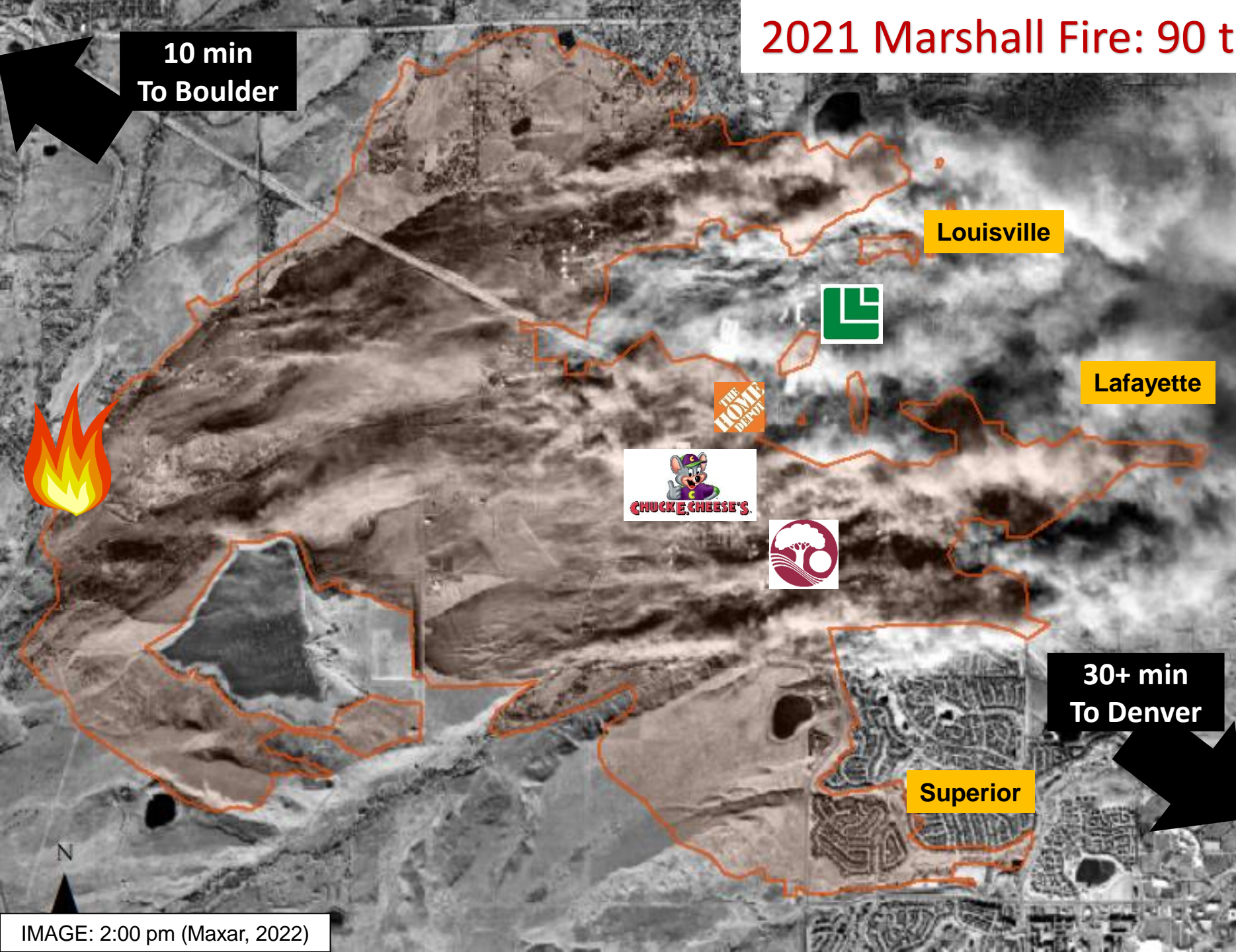
Louisville: 21,266

Superior: 13,094

Lafayette: 30,411

6 regulated water systems impacted

Image source: Fischer & Wham et al. GEER. The 2021 Marshall Fire, Boulder County, CO.



10 min
To Boulder

Louisville

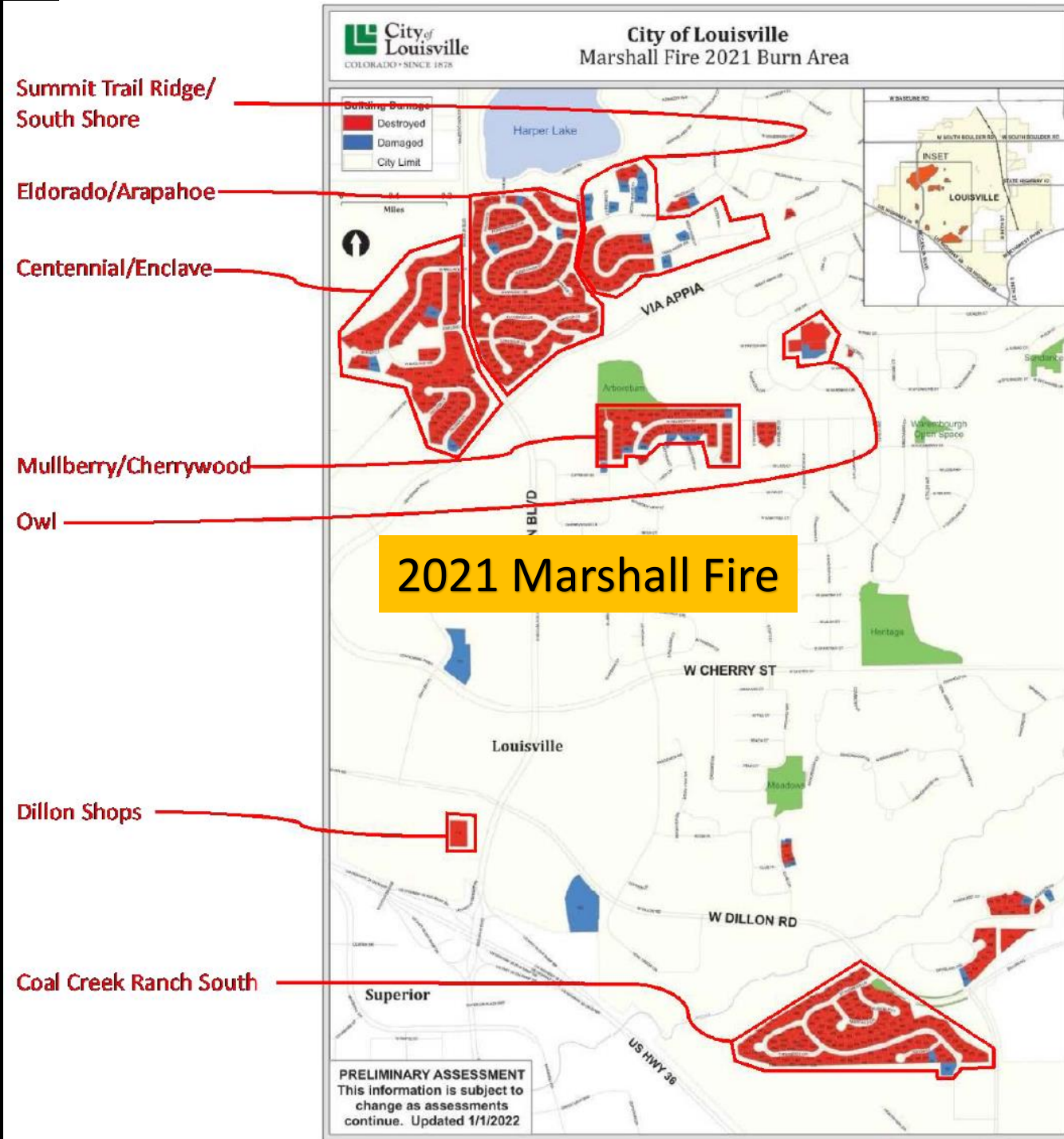
Lafayette

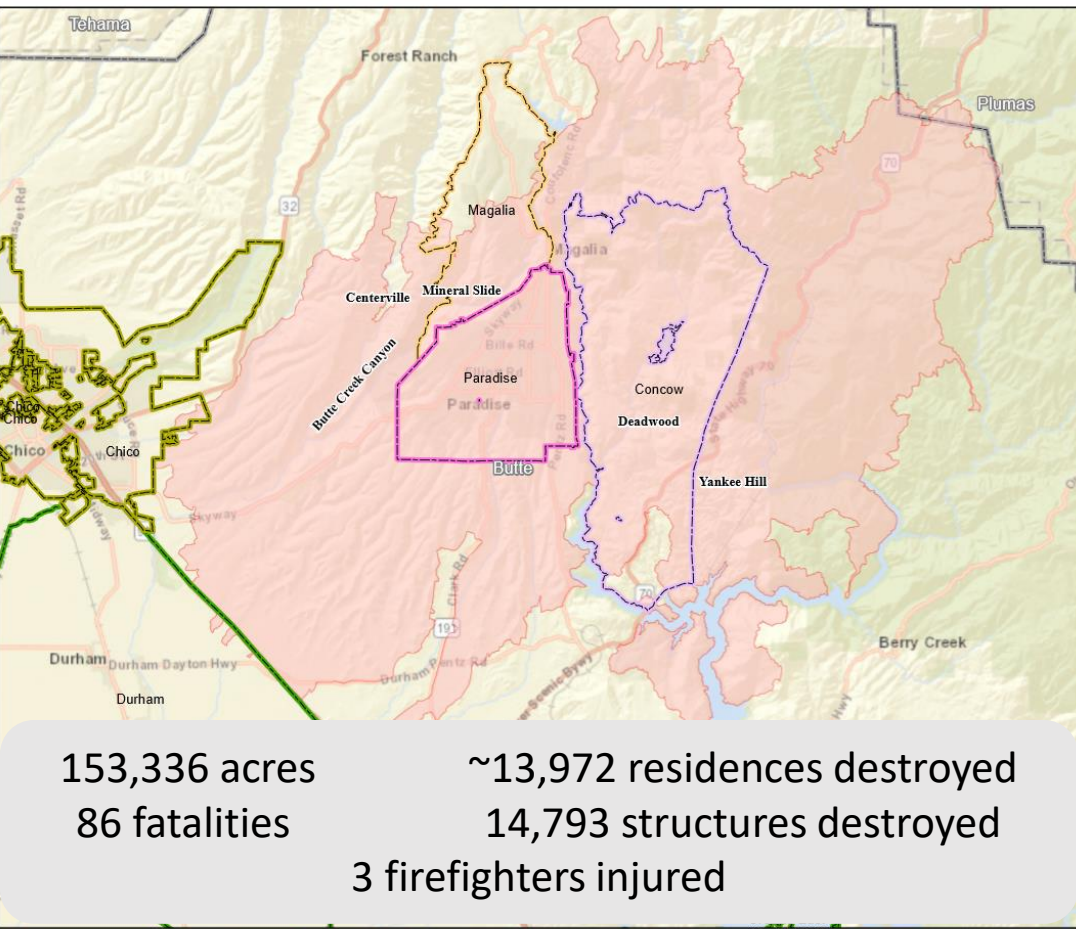
30+ min
To Denver

Superior

IMAGE: 2:00 pm (Maxar, 2022)

**Wildfires cause
widespread or partial
structure damage
across communities**





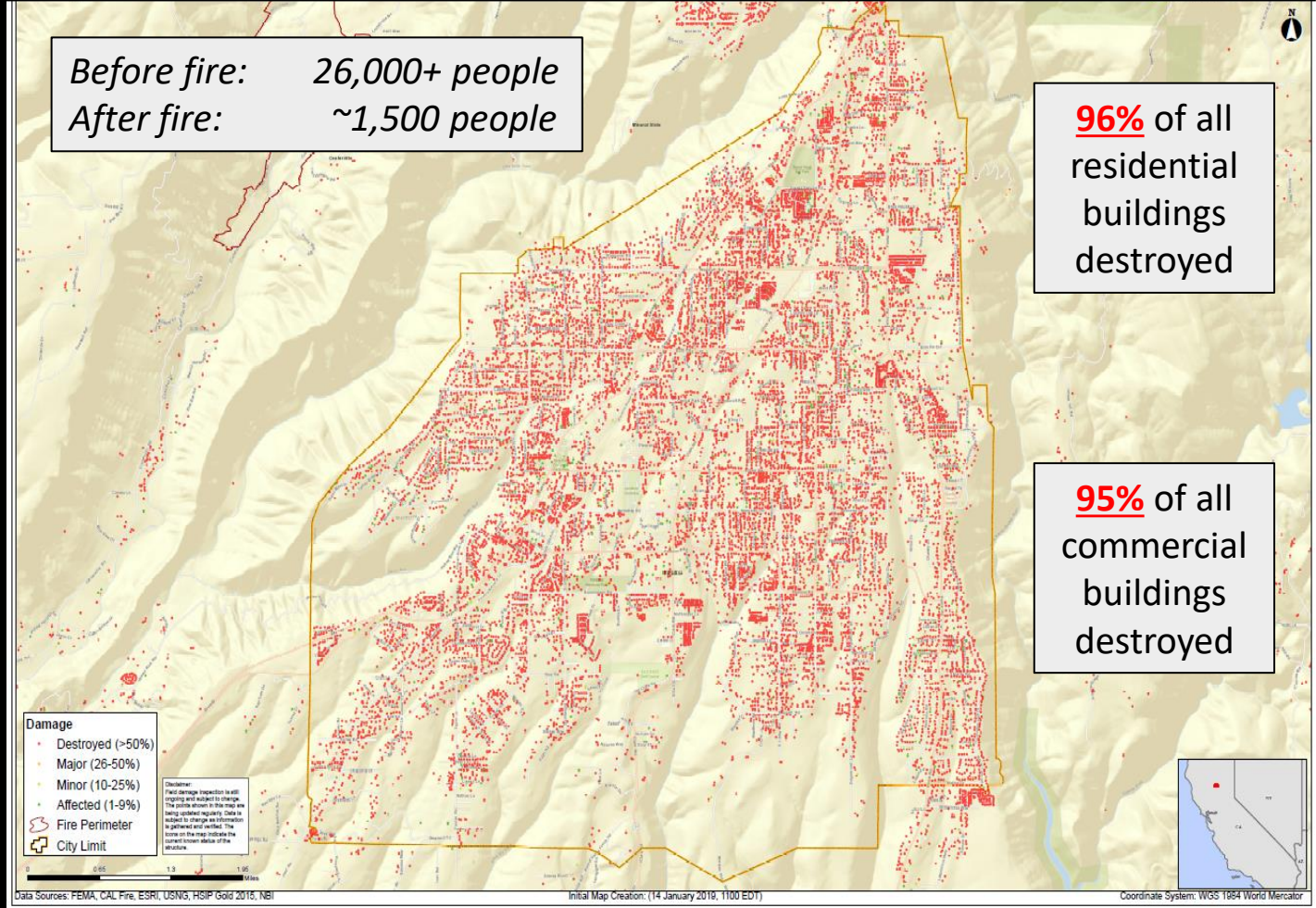
2018 Camp Fire

Town of Paradise Limits

Before fire: 26,000+ people
After fire: ~1,500 people

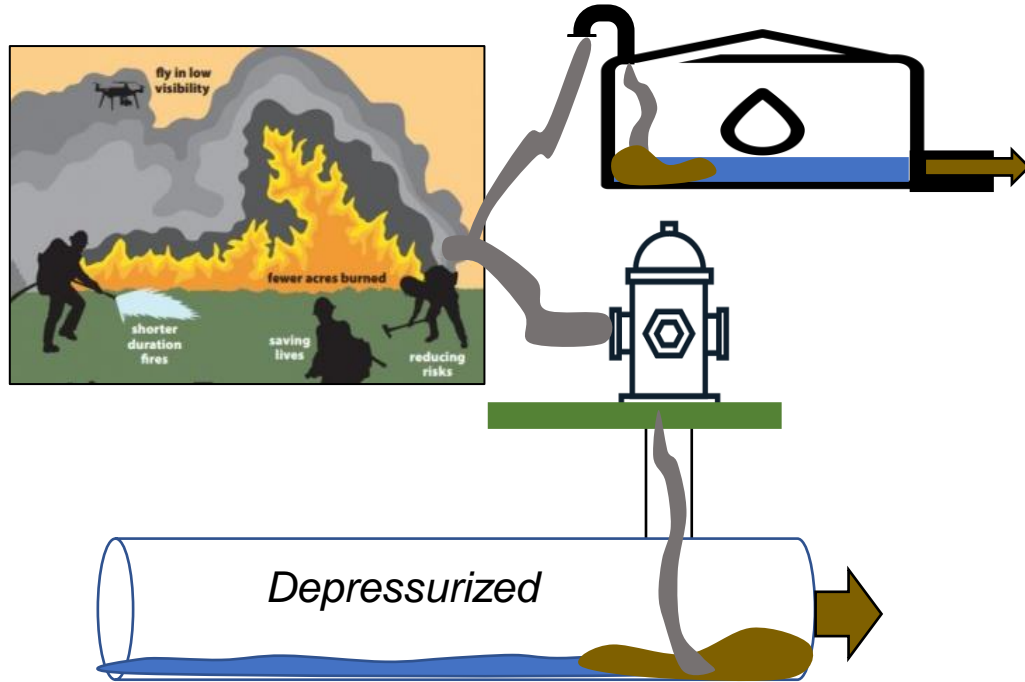
96% of all residential buildings destroyed

95% of all commercial buildings destroyed

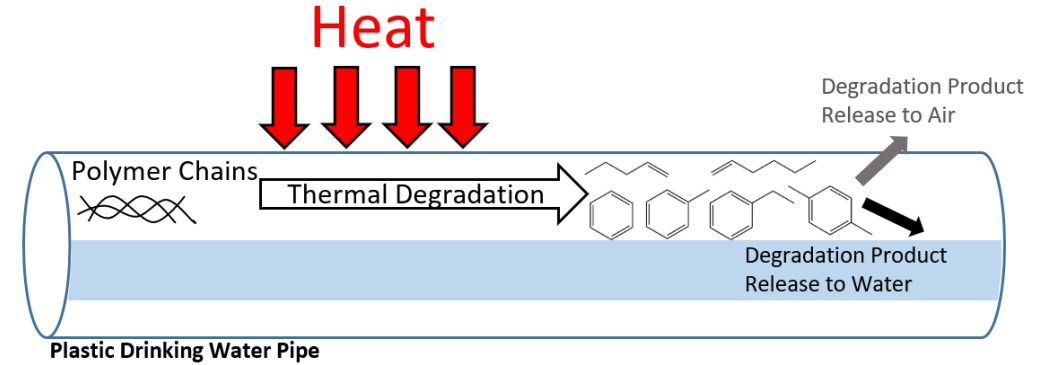


3 Ways water distribution systems become contaminated after a wildfire

Hypothesis 1. Biomass and structure combustion



Hypothesis 2. Plastic thermal degradation



Hypothesis 3. Contaminated water back siphonage

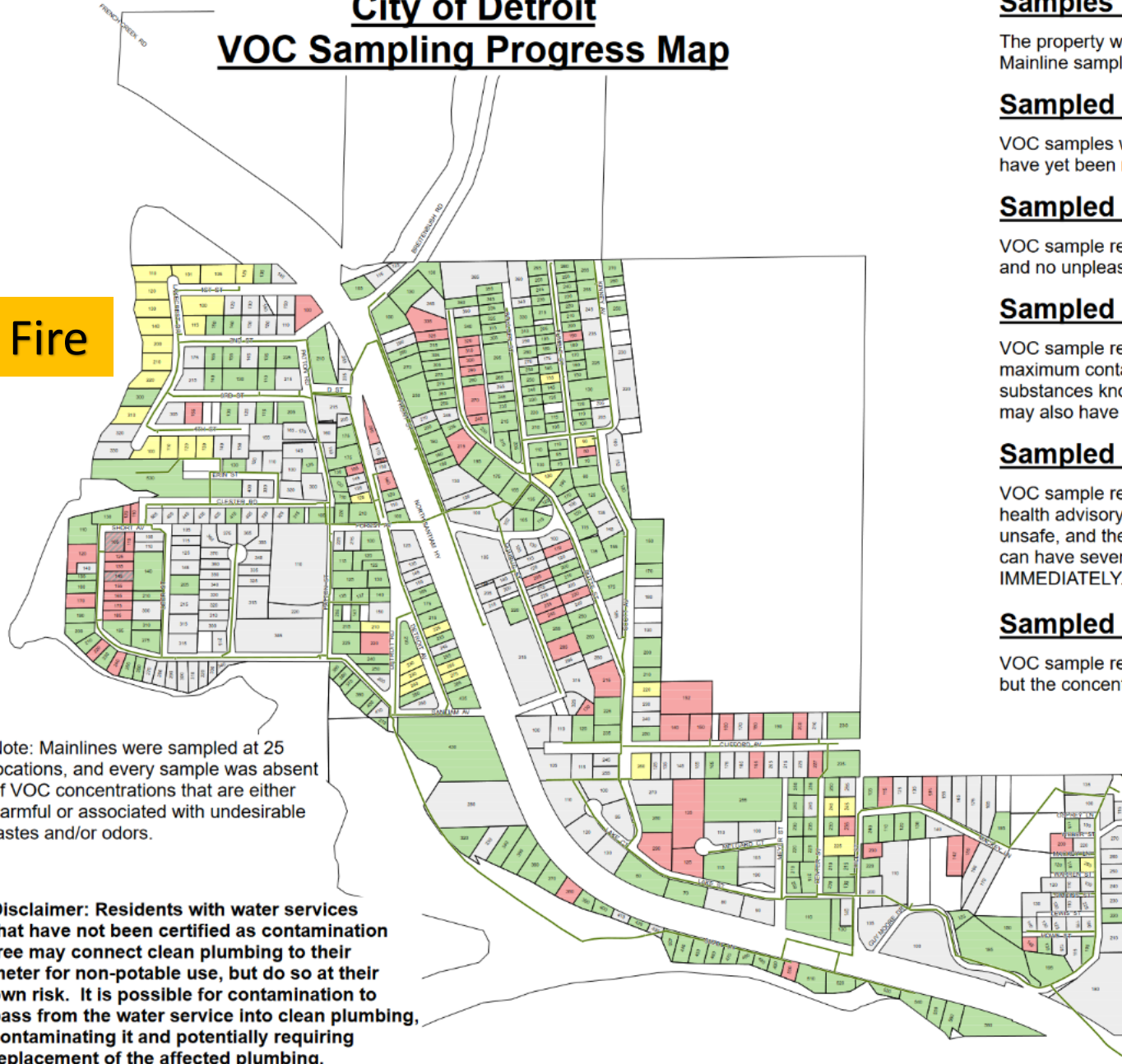


Secondary Sources: Infrastructure desorption

City of Detroit VOC Sampling Progress Map

2020 Santiam Fire

80%
structures
destroyed



Note: Mainlines were sampled at 25 locations, and every sample was absent of VOC concentrations that are either harmful or associated with undesirable tastes and/or odors.

Disclaimer: Residents with water services that have not been certified as contamination free may connect clean plumbing to their meter for non-potable use, but do so at their own risk. It is possible for contamination to pass from the water service into clean plumbing, contaminating it and potentially requiring replacement of the affected plumbing.

Samples Not Required

The property was not damaged in the fire, so no VOC samples were required. Mainline samples cleared the property as not contaminated with VOCs.

Sampled - Awaiting Results

VOC samples were required at this property and have been taken, but no results have yet been received.

Sampled - Not Contaminated

VOC sample results did not contain dangerous concentrations of any compounds, and no unpleasant taste or odor is anticipated.

Sampled - Unsafe Contamination

VOC sample results included concentrations of regulated substances above the maximum contamination level (MCL) and/or concentrations of unregulated substances known to be unsafe. This water is unsafe for contact/consumption, and may also have a foul taste or odor.








Sampled - Acute Health Risk

VOC sample results included concentrations of regulated substances above the health advisory level (HAL) for 1 and 10 day exposure. This water is extremely unsafe, and the City will disconnect your water for your safety. Short term use can have severe health effects. If your water service is on, CONTACT THE CITY IMMEDIATELY.

Sampled - Poor Taste and/or Odor

VOC sample results did not contain dangerous concentrations of any compounds, but the concentrations present will produce unpleasant odor and/or taste in the water.

Legend

-  Taxlots
- Sampling Status**
-  Samples Not Required
-  Sampled - Awaiting Results
-  Sampled - Not Contaminated
-  Sampled - Unsafe Contamination
-  Sampled - Acute Health Risk
-  Sampled - Poor Taste and/or Odor
-  Distribution System - Not Contaminated

Utilities experience power loss, asset damage and destruction, pressure loss, and safety hazards

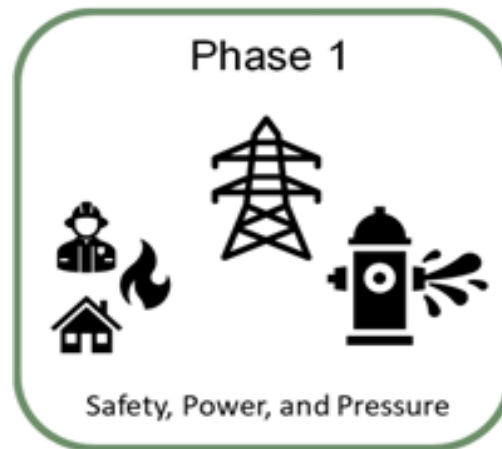
Pressure, utility network and building plumbing: Leaking, destruction

Power: Electric poles down, shutoff by provider, natural gas generators destroyed, lacking fuel

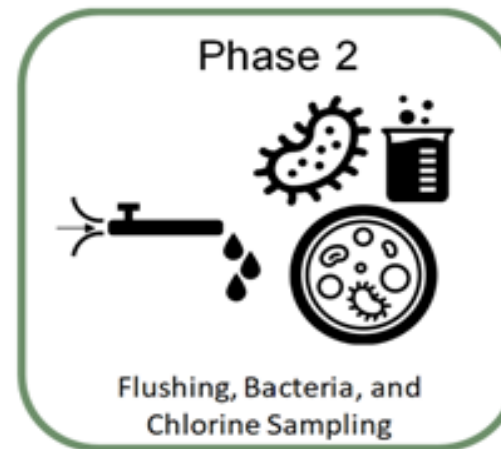
Telecommunications: Outages inhibit tank level, pressure, chemical feed, and pump status monitoring

Personnel: Hazard situations, unable to respond due to staff availability

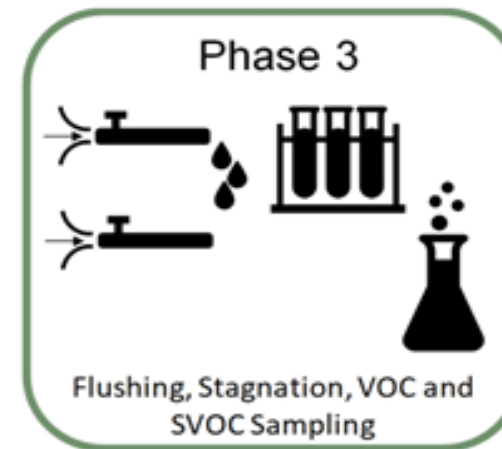
Contamination: Chemicals and microbiologicals drawn into the water system, immediate health risk



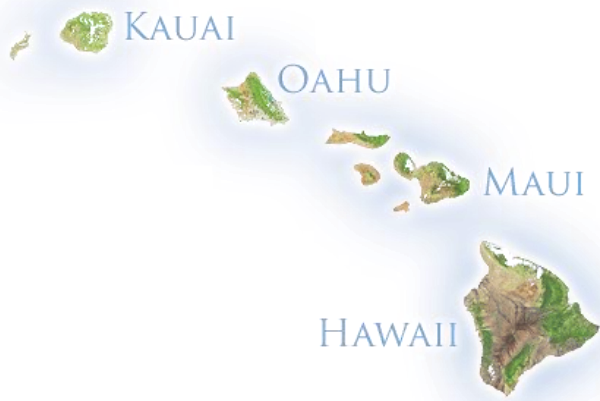
Support firefighting
Isolate damage
Maintain pressure
Water use warnings



Personnel surge
Restore control, pressure
Repeated sampling
Laboratories



Personnel surge
Repeated sampling
Laboratories
Decon, remove, replace



Hurricane Dora, 60-80 mph gusts onshore

Olinda Fire: 1,081 ac, 2 structures

Kula Fire: 202 ac, 544 structures

Lahaina Fire: 2,170 ac, 2,207 structures

Puelho Fire: 5,300 ac, 0 structures

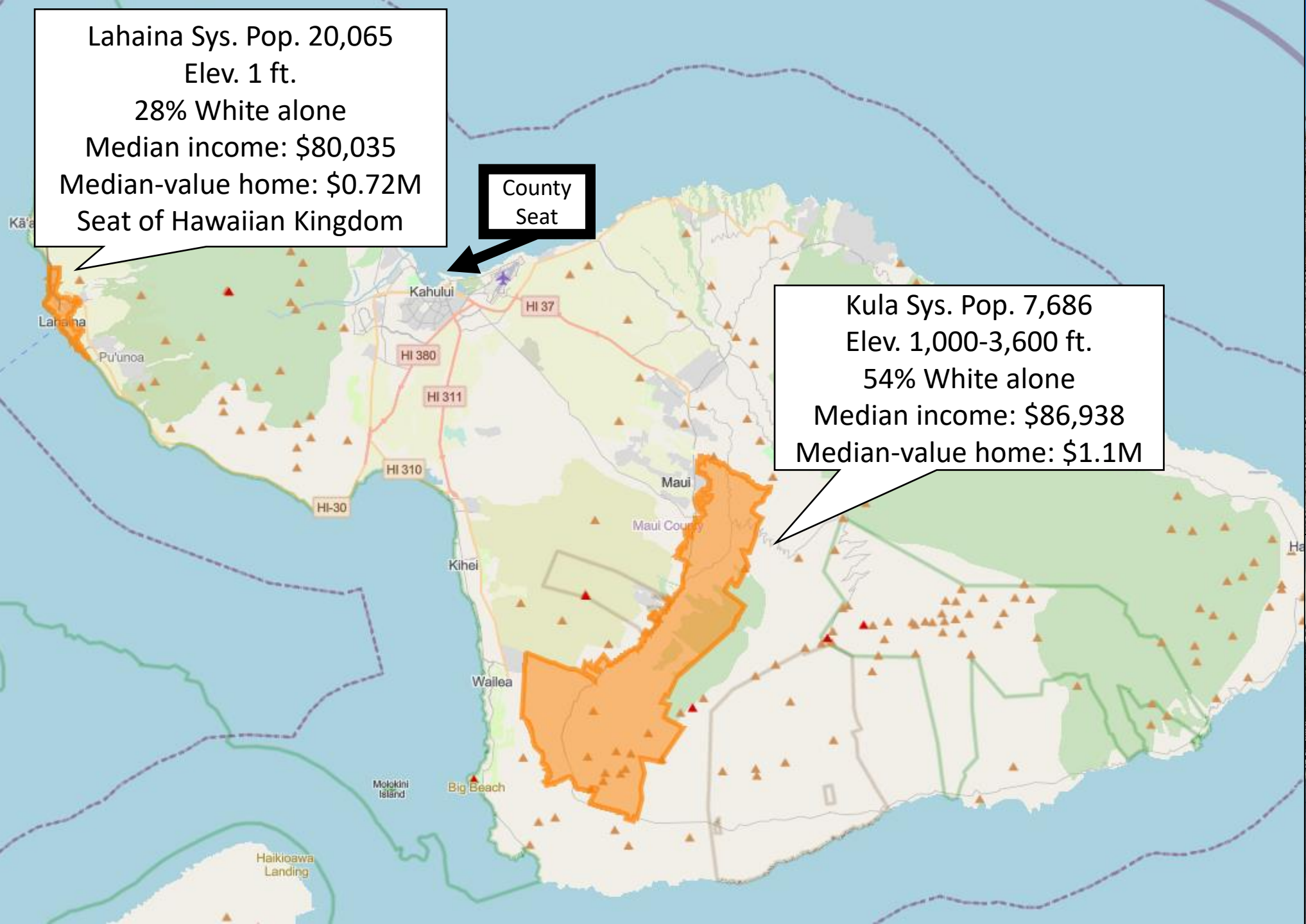
Deadliest wildfire incident in modern U.S. history

Maui Wildfires August 8, 2023

Lahaina Sys. Pop. 20,065
Elev. 1 ft.
28% White alone
Median income: \$80,035
Median-value home: \$0.72M
Seat of Hawaiian Kingdom

County
Seat

Kula Sys. Pop. 7,686
Elev. 1,000-3,600 ft.
54% White alone
Median income: \$86,938
Median-value home: \$1.1M



KEEP OUT!
Drinking Water Supply
No Trespassing
No Tampering
VIOLATORS SUBJECT TO PROSECUTION

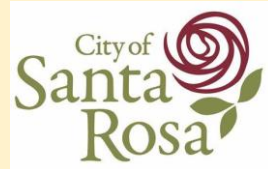
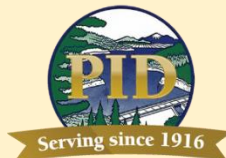




1. Conduct free in-home drinking water testing for Lahaina, Kula, and Olinda households and survey needs



2. Advise Maui County Utilities on how to respond to and recover their damaged water systems



3. Assist the State of Hawai'i Veterinarian investigate damage and contamination of ranch water systems



Power was lost, lift stations stopped, structure destruction prompted debris entry into collection systems

- Minimal to no drinking water use permitted for standing buildings because sewer service lacking
- Inspection, flushing, and vac truck of collection system to remove debris
- USEPA took responsibility for managing sewer inspection and repair



4 months after the fire, drinking water had been found to be contaminated in both Lahaina and Upper Kula public drinking water systems

Most common chemicals	Lāhainā PWS	Upper Kula PWS
Benzene	40 (exceeded MCL)	3.8
Dichloromethane	3	3.8
Ethyl benzene	2.5	Not most common
Total xylenes	2.4	Not most common
Bis(2-ethylhexyl) phthalate	1.4	Not most common
Styrene	Not most common	1.8
Toluene	Not most common	1.6

During the initial response, Maui County and Hawai'i DOH screened for 21 VOCs (some fire-related), not the 51 fire-related VOCs. After we got involved and learned best practice, they adjusted their approach.

University of Hawai'i private property drinking water results were more expansive and indicated more MCLs were sometimes exceeded

Chemicals exceeded a drinking water exposure limit for at least 1 sample, maximum concentration in ppb	Percentage of water samples where a chemical was detected greater than 50% of the time, maximum concentration in ppb	The top 5 chemicals detected at the highest concentrations found, in ppb	
Trichloromethane* (MCL 80 ppb TTHMs) 195	Acetone* 84% 178	Methyl ethyl ketone (MEK)* 293	
1,2,3-Trichloropropane (MCL 0.6 ppb) 11.2	Trichloromethane* 80% 195	Tetrahydrofuran* 217	
1,2-Dibromoethane (MCL 0.04 ppb) 10.3	Bromodichloromethane* 71% 19.3	Trichloromethane* 195	
Carbon tetrachloride* (MCL 5 ppb) 10.0	Dibromochloromethane* 68% 23.0	Acetone* 178	
1,2-Dichloropropane* (MCL 5 ppb) 10.0	Bromoform* 68% 33.9	Bromoform* 33.9	
Vinyl chloride* (MCL 2 ppb) 9.80	1,2-Dichlorobenzene* 67% 10	Other notable chemicals detected for at least 1 sample, maximum concentration in ppb	
Methylene chloride* (MCL 5 ppb) 9.72	Methylene chloride* 63% 9.72		
1,1-Dichloroethane* (MCL 5 ppb) 9.73	Bromomethane 57% 10.4		
1,2-Dibromo-3-chloropropane (MCL 0.04 ppb) 9.62	1,3-Dichlorobenzene 56% 9.79		
1,2-Dichloroethane* (MCL 5 ppb) 9.50	Iodomethane* 56% 8.50		
Benzene* (MCL 5 ppb) 8.56	Toluene* 56% 7.99		
	1,2,4-Trichlorobenzene* 55% 8.73		
	m-/p-Xylene* 54% 9.30		
			Bromoform* (MCL 80 ppb TTHMs) 33.9
			Dibromochloromethane* (MCL 100 ppb) 23.0
		cis-1,2-Dichloroethene* (MCL 70 ppb) 18.0	
		Bromomethane (MCL 80 ppb TTHMs) 10.4	
		1,1,2,2-Tetrachloroethane (HA 2,500 ppb) 10.3	
		1,1,2-Trichloroethane* (MCL 200 ppb) 9.48	
		trans-1,3-Dichloropropene (1,3-D) (RSL, 60 ppb) 9.39	

Data as of December 2023

Asterix (*) indicates the chemical was found in wildfire damaged drinking water systems outside Hawai'i prior to the 2023 wildfires in Maui.

Some households sought out their own water test kits, but....

VOC	Chemical Screened for by the Organization		Home Test Kit Name, Cost, and Minimum Detection Limit for Chemical in ppb		
	State of Hawai'i	University of Hawai'i	Safe Home ULTIMATE Drinking Water Test Kit, \$379	City Check Deluxe, \$329	Extended City Water Test, \$675
XAcetone		Yes	50	10	
X,*^ΔBenzene	Yes	Yes	1		1
Bromochloromethane		Yes	1		0.5
Bromodichloromethane		Yes	1	2	1
Bromoform		Yes	1	4	1
n-Butylbenzene		Yes			0.5
sec-Butylbenzene		Yes			0.5
tert-Butylbenzene		Yes			0.5
Carbon disulfide		Yes	5		
*Carbon tetrachloride	Yes	Yes	1	1	0.5
*Chlorobenzene	Yes	Yes	1	1	0.5
Chloromethane		Yes	1	2	0.5
4-Chlorotoluene		Yes		1	0.5
Dibromochloromethane		Yes	1	4	0.5
*1,2-Dichlorobenzene	Yes	Yes		1	
*1,4-Dichlorobenzene	Yes	Yes		1	0.5
1,1-Dichloroethane	Yes		1		0.5
*1,2-Dichloroethane	Yes	Yes	1	1	0.5
1,1-Dichloroethene	Yes	Yes			0.5
1,2-Dichloroethylene		Yes		Not Screened By Any Kit	
*1,2-Dichloropropane	Yes	Yes	1	2	0.5
XEthanol					
X,*Ethylbenzene	Yes	Yes	1	1	0.5

Two Weeks After the 2023 Maui Wildfires



- 1) After the evacuation order was lifted, above/below ground smoldering continued
- 2) Interviewed households had received no government communication; All used drinking water before hearing it was unsafe to use.
- 3) Home drinking water tests revealed contamination utility tests did not; Consumers use pool test kits and bought at-home kits, but could not find all fire-related chemicals.
- 4) Agricultural water system damage was like residential systems. 50,000 ft of HDPE animal watering pipe destroyed at 1 property.
- 5) Public health recommendations provided.



**What do we know about where,
and the degree, chemical
contamination is impacting
drinking water?**

For decades, VOCs and SVOCs have been well-known products of plastic thermal degradation

History and Theory

For decades the plastic waste management sector has known VOCs and SVOCs are created due to HDPE, PP, PVC, and CPVC thermal degradation: BTEX, chlorobenzene, naphthalene, among others.

PE vs. PVC (no HCL vs. yes HCL)

Literature VOC/SVOC generation theories

- Polymer chain scission
- Aromatization

On the Topic of Fire

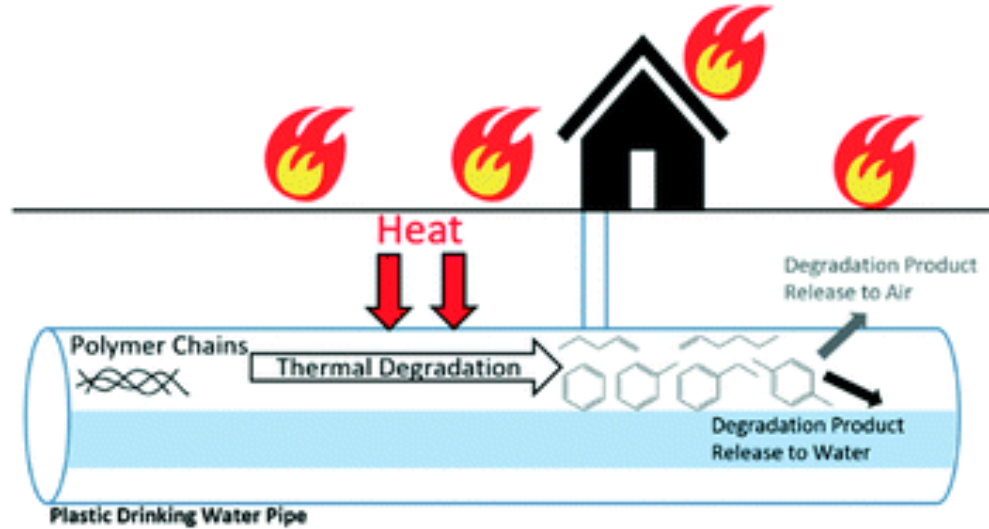
- ✓ Wildfire ground level and structure fire temperatures 200 °C to > 800°C
- ✓ Temperatures function of fuel and environmental conditions

Key Terms

- “Combustion”: Oxygen present
- Pyrolysis: Little to no oxygen
- Flaming combustion: Flame, oxygen present
- Smoldering combustion: No flame, oxygen present, surface oxidation

(Santoso et al. 2016; Richter et al 2020)

Thermally damaged plastic drinking water pipes can be a source of drinking water contamination



Heating at 200-400°C for new HDPE, PEX, PVC, CPVC, & PP pipes generated VOCs & SVOCs

Benzene generated by heating all pipes except PP

Once plastic cooled, chemicals leached into water

Material	Confirmation of BTEX Components in Water				Number of TICs in extract ^a	
	B	T	E	X	Water	<i>n</i> -Hexane
Cold water pipes						
PVC	✓	✓	-	-	4	41
HDPE	✓	✓	✓	✓	14	100
Hot and cold water pipes						
CPVC	✓	-	-	-	3	32
PEX-a1-a	✓	✓	✓	✓	19	123
PEX-a1-b	✓	✓	✓	✓	16	122
PEX-a2	✓	✓	✓	✓	22	117
PEX-b	✓	✓	✓	✓	18	127
PEX-c1-a	✓	✓	✓	✓	19	133
PEX-c1-b	✓	✓	✓	✓	17	134
PEX-c1-EVOH	✓	✓	✓	✓	20	109
PP	-	✓	-	-	6	95

Kris Isaacson et al. 2020. *Env. Sci. Wat. Res. & Technol.*
<https://doi.org/10.1039/D0EW00836B>



Wildfires can contaminate drinking water systems both by thermal damage to plastic pipes and intrusion of smoke

Characterized target and nontarget VOCs and SVOCs in water from 1 contaminated service line after the Camp Fire.

New PVC, PEX, and HDPE pipe **heating experiments** conducted

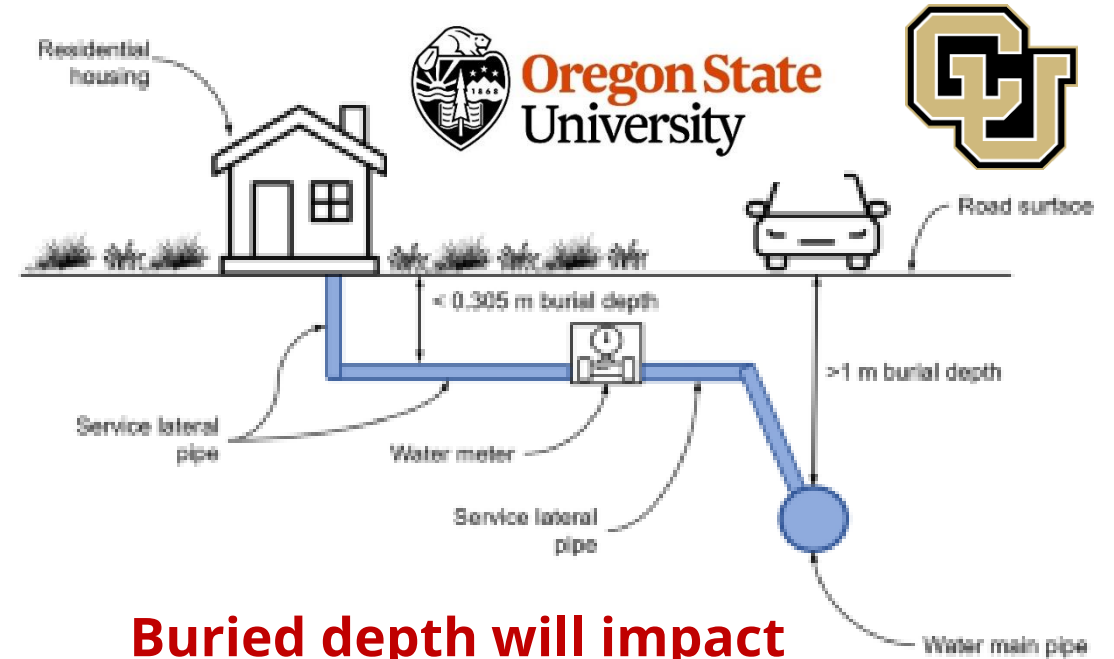
Results

PVC pipe heating: 32 compounds

HDPE/PEX pipes heating: 28 compounds

Service line: 55 compounds for uncontrolled burning of biomass and waste materials.

Draper et al. 2022. ACS EST Water.



Buried depth will impact thermal vulnerability

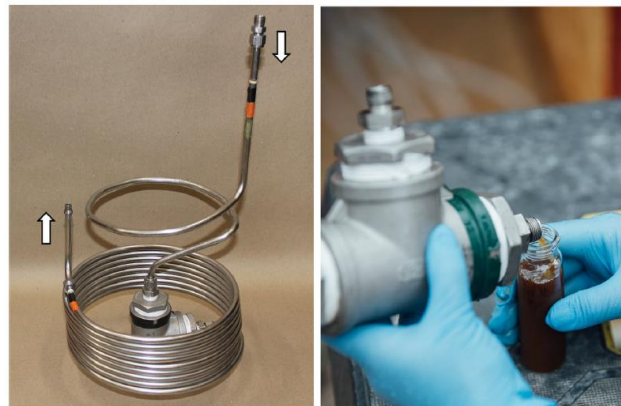
Mathematical Thermal Modeling Results

- Upper limit temperature for pressure service of the pipelines was exceeded at depths up to 0.45 m (1.5 ft).
- Upper limit temperature will be exceeded at least 50% of the time at depths up to 0.19 m (0.6 ft).

Metz et al. 2022. Fire Technology.



Pilot Study on Fire Effluent Condensate from Full Scale Residential Fires

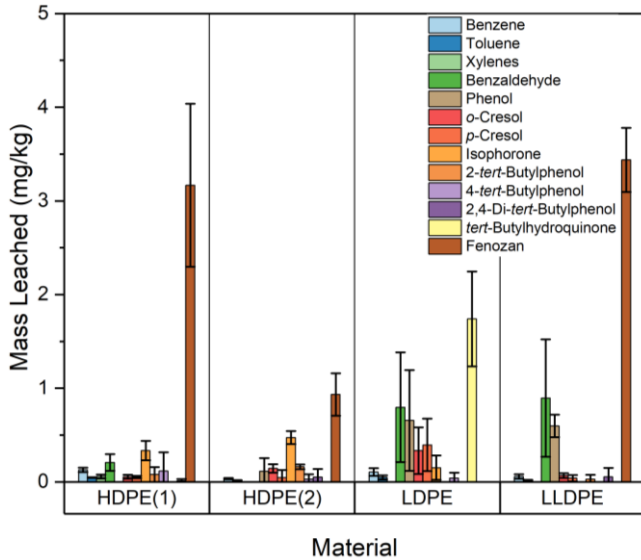


	Room 1		Room 2		
Exp. #	1	2	3	4	5
pH	2.56	1.10	1.93	1.96	1.59
Bromide	<3.0	5.5	6.6	9.8	13
Chloride	270	39,000	3,000	2,400	4,700
Nitrate	13	2.4	5.7	<1.0	6.4
Sulfate	330	9,200	2,700	2,100	2,300

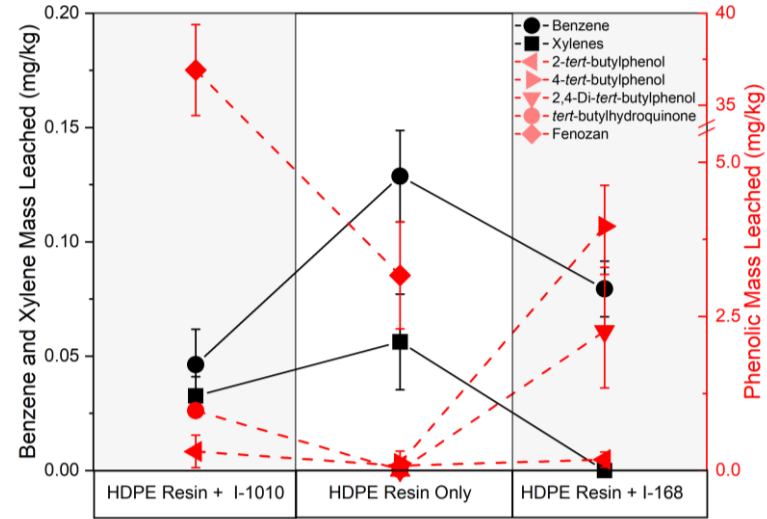
	Room 1		Room 2		
Exp. #	1	2	3	4	5
Benzene	1,100	6,400	2,600	3,600	33,000
Styrene	<400	1,200	470*	1,400	1,800
Toluene	180*	1,000	<340	660	3,900
Xylenes	<290	110*	<740	153	910*
Naphthalene	2,700*	8,100	7,400*	8,100	10,000
2-Butanone	2,100*	3,600*	7,300*	13,000	31,000
Acetone	57,000	31,000	74,000	110,000	250,000
Ethanol	<40,000	<40,000	67,000*	49,000	61,000*

***They looked for a limited list of chemicals in the condensate

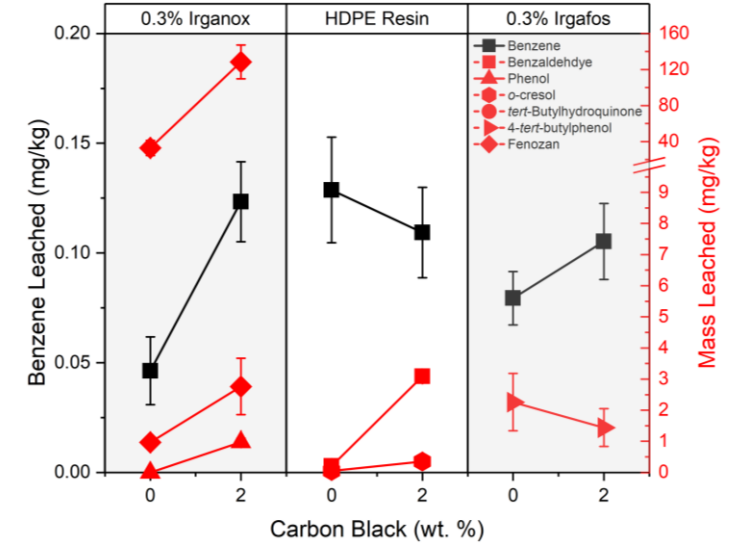
PE resin type, antioxidant loading, and carbon black influenced VOCs found in water



The type of virgin PE resin used impacts VOCs found in water



The presence of AOX decreased VOCs released but increased levels of AOX degradation products detected



CB had complex impacts on VOCs found in water

When CB ↑, benzene ↓
 When AOX1 ↑, benzene ↓
 When AOX2 ↑, benzene ↓
 When CB + AOX, benzene =

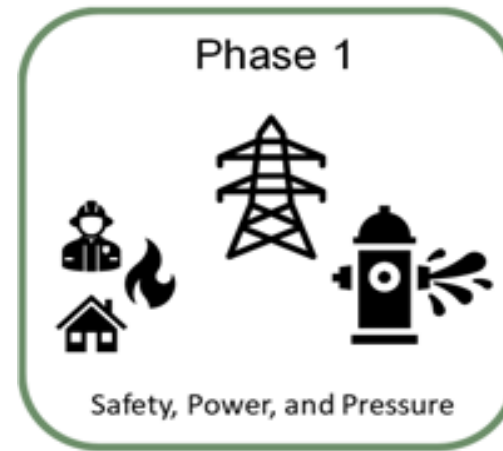


Science to Practice

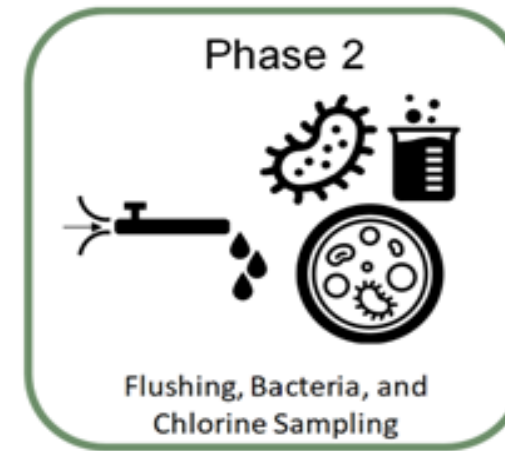
The drinking water contamination risk requires system managers and operators to investigate, warn customers, then find, and remove the health risks

There are 3 main phases of water utility response decisions

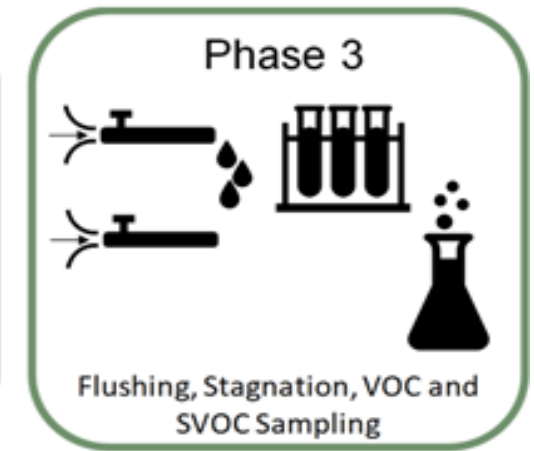
Concept of Operations Plan (CONOPS) for Water Distribution Response and Recovery



Support firefighting
Isolate damage
Maintain pressure
Water use warnings



Personnel surge
Restore control, pressure
Repeated sampling
Laboratories



Personnel surge
Repeated sampling
Laboratories
Decon, remove, replace

Pressure, utility network and building plumbing: Leaking, destruction

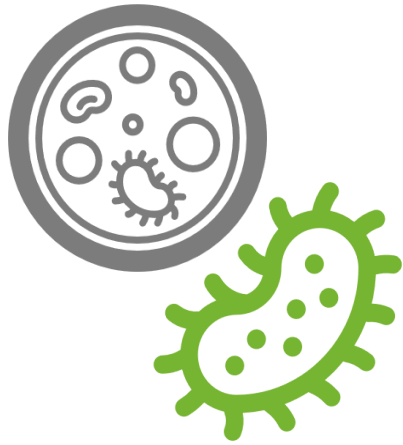
Power: Electric poles down, shutoff by provider, natural gas generators destroyed, lacking fuel

Telecommunications: Outages inhibit tank level, pressure, chemical feed, and pump status monitoring

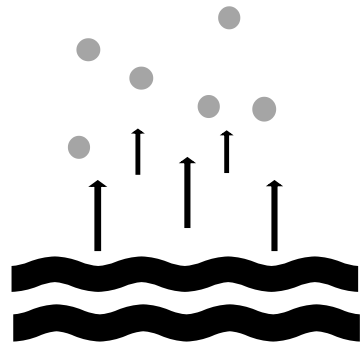
Personnel: Hazard situations, unable to respond due to staff availability

Contamination: Chemicals and microbiologicals drawn into the water system, immediate health risk

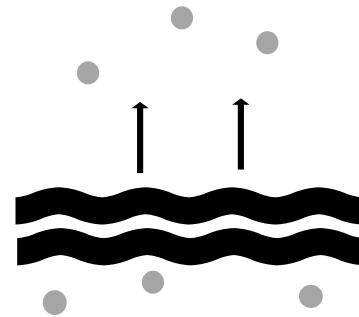
Drinking Water System Assets can Experience **EXTREME** Contamination



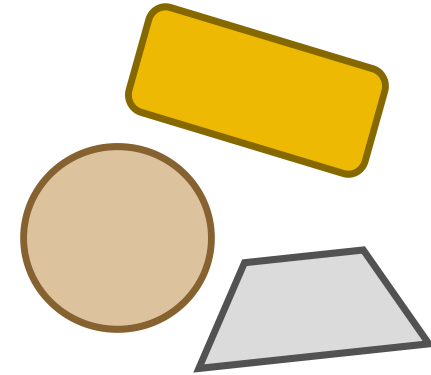
Microorganisms
(ex: *E. Coli*)



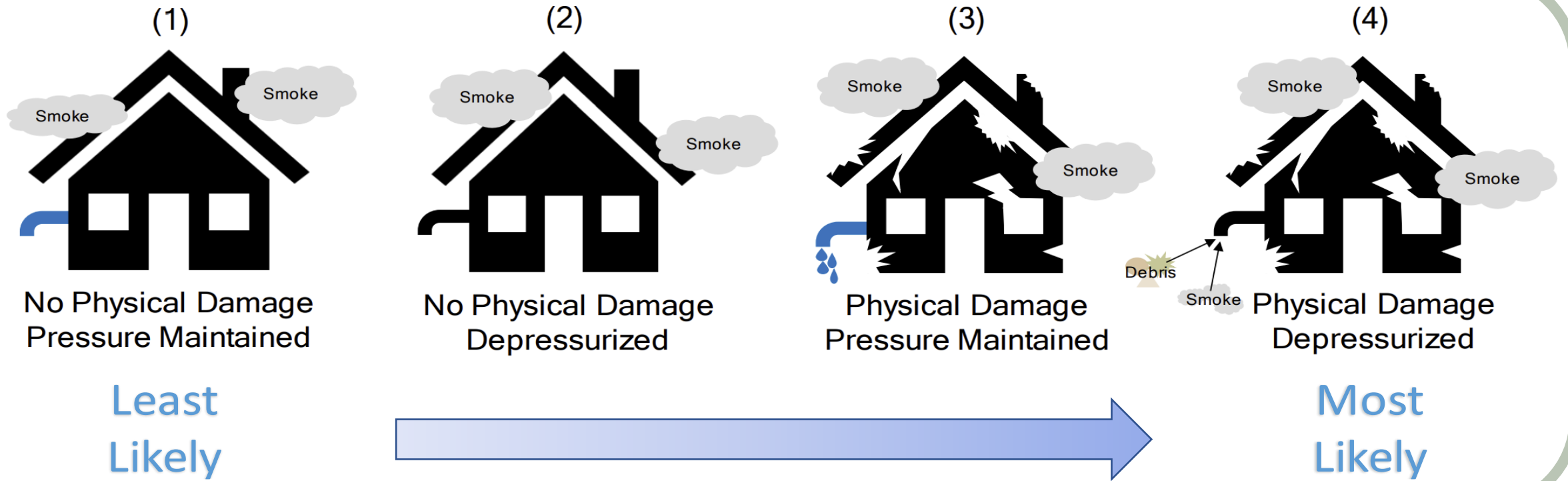
Volatile Organic
Compounds
(VOCs)



Semi-Volatile
Organic Compounds
(SVOCs)



Heavy Metals



Different scales of wildfire property damage will relate to the potential for contaminated drinking water. Water utilities should rate customer buildings to assess their potential for being a SOURCE of the contamination.

Exposure Routes

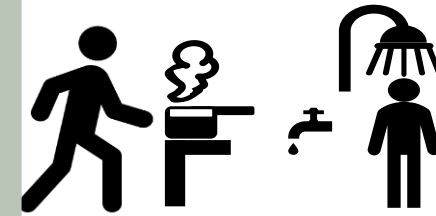
(i.e., Adults, children, infants, etc.)



Ingestion

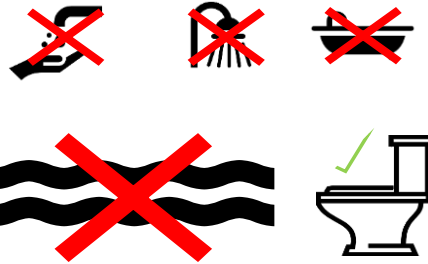


Dermal contact



Inhalation

Water Use Warnings



Do Not Use (DNU)



Do Not Drink (DND)



Boil Water Order

Water utilities should issue a drinking warning to customers ASAP, if necessary, (i.e., Boil Water Advisory, Do Not Use Order). It must be protective of the specific health threats.

Overall Decision Flow Chart

No advisory v. Boil Advisory v. Do Not Use Advisory?

Wildfire

Test the water source of the zone

Below drinking water limits?

Evaluate potential damage and make necessary repairs or install necessary treatment

Yes

No

Maintain service

Yes

Pressure loss?

Path 1 – Burned structures zone with pressure loss

No

Path 2 – Burned structures zone with NO pressure loss

Yes

Multiple burned structures in a zone?

No

Hydraulically receives water from wildfire impacted zones?

Yes

Path 3 – Hydraulically impacted undamaged zone

No

Pressure loss?

Yes

Path 4 – Boil water advisory

No

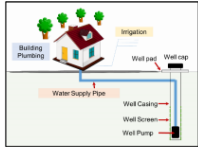
“Fire package” list of chemicals to screen –
***BOLD and RED* exceeded health limit (list as of March 2024)**

Acetonitrile	Chlorodibromomethane	Ethyl benzene	‡ Toluene **
‡Acetone	Chloromethane	Ethylene dibromide (EDB) **	1,2,3-Trichlorobenzene
Acrolein	4-Chlorotoluene	Ethyl- <i>tert</i> -butyl ether (ETBE)	1,2,4-Trichlorobenzene
Acrylonitrile	Dibromochloromethane	Iodomethane	1,1,1-Trichloroethane
‡ Benzene **	1,2-Dibromo-3-chloropropane (DBCP) **	Isopropylbenzene	1,1,2-Trichloroethane
Bromochloromethane	1,2-Dichlorobenzene	Methylene chloride **	Trichloroethylene
Bromodichloromethane	1,4-Dichlorobenzene	‡ Methyl ethyl ketone (MEK) **	Trichloromethane **
Bromoform	1,1-Dichloroethane	Methyl iso butyl ketone (MIBK)	1,2,3-Trichloropropane (TCP) **
<i>n</i> -Butylbenzene	1,2-Dichloroethane **	Methyl-<i>tert</i>-butyl ether (MTBE) **	1,2,4-Trimethylbenzene
<i>sec</i> -Butylbenzene	1,1-Dichloroethene	‡ Naphthalene **	1,3,5-Trimethylbenzene
<i>tert</i> -Butylbenzene	<i>cis</i> -1,2-Dichloroethene	‡ Styrene **	Vinyl chloride **
Carbon disulfide	<i>trans</i> -1,2-Dichloroethylene	<i>tert</i>-Butyl alcohol (TBA) **	‡ <i>ortho</i> -Xylene
Carbon tetrachloride **	1,2-Dichloropropane **	Tetrachloroethylene	‡ <i>meta</i> -Xylene
Chlorobenzene	‡Ethanol	Tetrahydrofuran (THF) **	‡ <i>para</i> -Xylene

Private wells...

PURDUE UNIVERSITY

After a Wildfire: Water Safety Considerations for Private Wells



Damage and Contamination Caused by Wildfires

Wildfires can directly damage private wells and springs causing an immediate health and safety risk to their users. Water testing after wildfires has revealed contaminated drinking water, sometimes exceeding hazardous waste limits. A thorough inspection of the well and water systems is needed before trying to use the water. If the building or property has been burned, make sure the fire debris is cleared before inspecting the water system.

Signs of contamination may include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings, broken and leaking pipes, valves, tanks, irrigation systems, and yard hydrants. Chemical contamination can occur due to the water system and the heating or burning of the water system materials themselves, including plastics. If the water system lost pressure, microorganisms and chemicals may have entered the system.

Persons impacted by wildfire should seek specific advice from their local health department.

A Water System Damage Inspection Should be Conducted and Include:

- The wellhead or well house.
- The well casing, cap or seal.
- Above ground piping or structures.
- Spring box.
- Pressure tanks.
- Filters or water treatment system.
- Wiring or electrical components
- Condition of the storage tanks, vents, or overflow pipes?
- Is there standing water in the tanks?
- Is there any evidence of melted plastic components?
- Is there any evidence of pressure loss in the system? One way to check this is to turn on an exterior faucet to see if there is water flowing or you hear air escaping from the system.
- Is there any ash or wildfire debris near the water system?
- Does it seem like any ash, soot, or debris has entered any part of the water system?
- Do you notice any other damage related to the fire?

Repairs should be completed by a licensed and bonded well contractor or pump installer. The contractor should follow appropriate protocols for repressurizing the system, avoiding backflow or cross-connections, disinfecting the service lines, and confirming the quality of water by certified testing before putting the system back online.

Using Water

Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated.

If the source of the contamination can be determined, isolate it. If the water system needs to be flushed, be careful to contain the runoff if possible or direct it to a channel to avoid erosion and minimize spreading the contamination. Before you use the water, it is important to verify that there is no microbiological or chemical contamination.


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Visit www.PlumbingSafety.org, PlumbingSafety@purdue.edu, Date Released: May 16, 2021

2021

Inside Buildings...

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After a Wildfire: Water Safety Considerations Inside Buildings



Damage and Chemical Water Contamination Caused by Wildfires

Wildfires can directly contaminate water systems that deliver water to buildings as well as the building's own plumbing. This can pose an immediate health and safety risk to water users. Drinking water can become chemically contaminated, sometimes exceeding hazardous waste limits. Boiling the water will **NOT** protect users from the chemical contamination and may increase chemical exposure. An inspection of property and building water system components is needed before trying to use the water. If a water utility delivers water to the property, the utility system may also be damaged including the service line and water meter. Water utilities should initiate rapid inspections, testing, and inform you of the results. Private wells should also be inspected and tested.

Signs of contamination can include the loss of water pressure, discolored water, heat damage to water systems inside and outside buildings; broken, melted, and leaking pipes, valves, tanks, water meters, irrigation system components, and yard hydrants. Heat damage to the building structure may indicate plumbing damage. Chemical contamination can occur due to the water system and the heating or burning of the water system materials themselves, including plastics. If the water system lost pressure, microorganisms and chemicals can enter the system.

Persons impacted by wildfire should seek specific advice from their local health department.

A Water System Damage Inspection Should Be Conducted and Include:

- The water meter box.
- The irrigation system.
- Above ground piping or structures, including outdoor spigots.
- The point of entry, where the water supply line enters the building.
- The whole building water treatment system, if one exists.
- The plumbing pipes inside the building.
- The water heater.
- The tubing that connects the fixtures to the plumbing.
- The fixtures like faucets, showerheads, toilets, etc.
- Point of use water treatment systems on faucets, showerheads, and under sinks
- Appliances such as dishwasher, washing machine, dryer, humidifier, HVAC furnace, etc.
- Wiring and electrical components.
- Evidence of melted plastic components.
- Briefly turning on an exterior faucet to see if water is not flowing or you hear air escaping from the system. This may indicate pressure loss.
- Fire sprinkler system. Also, pay attention to any ash, soot, or wildfire debris near the water system, whether this has entered any part of the water system, and any other damage related to the fire.

Repairs should be completed by a licensed and bonded contractor with plumbing expertise. The contractor should follow appropriate protocols for repressurizing the system, avoiding backflow or cross-connections, disinfecting the water lines, and confirming the quality of water by certified testing before putting the system back online.

Using Water

Use a different water source, such as bottled water, until water testing proves the water is safe for all uses. The installation of external water tanks with periodic deliveries is sometimes preferred, but this requires confirming that the indoor plumbing is not contaminated. If the source of the contamination can be determined, isolate it. If the

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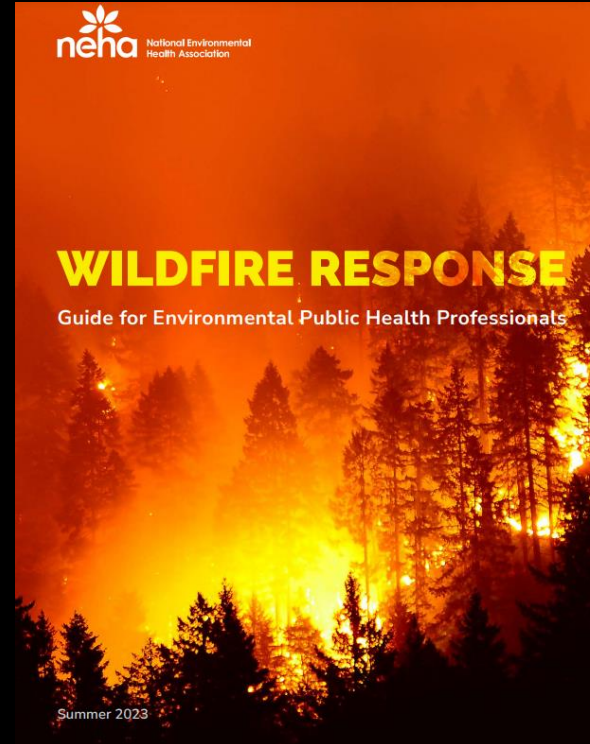
2021

Environmental health basics...

neha National Environmental Health Association

WILDFIRE RESPONSE

Guide for Environmental Public Health Professionals



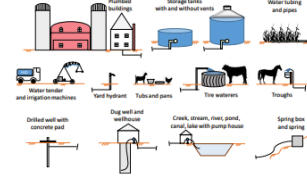
Summer 2023

2023

Agricultural water systems...

PURDUE UNIVERSITY

After a Wildfire: Water Safety Considerations for Agriculture Water Systems



Damage and Chemical Water Contamination Caused by Wildfires

Wildfires can directly damage agricultural water systems causing a health and safety risk. Water tested after wildfires has revealed chemically contaminated drinking water. A thorough inspection of impacted water systems is needed before system use.

Signs of potential contamination include a power outage, loss of water pressure, discolored water, heat damage to components inside and outside buildings, broken and leaking pipes, valves, tanks, irrigation systems, etc. The main sources of chemicals in piped water after fires are plastic heat damage, debris entry, and smoke entry into water systems. Chemicals can enter water systems through water tank vents, physically damaged assets like pipes and tanks. Chemicals can leach from heat damaged plastics into clean water and make it unsafe. Chemicals can also deposit into open containers (troughs, waterers, etc.).

Advice should be sought from local department of agriculture and extension agencies.

A Water System Damage Inspection Should be Conducted and Include:

Things to Look For...

- The wellhead, well house, spring box, intake.
- The well/spring casing, caps, and seals.
- Wiring and electrical components.
- Above ground piping or structures
- Water treatment system.
- Pressure tanks, storage tanks, vents, overflow pipes, troughs, tubs, waterers.
- Standing water in tanks.
- Melted plastic components.

Questions to Consider

- Is there evidence of pressure loss? One way to check this is to turn on an exterior faucet to see if there is water flowing or you hear air escaping from the system.
- Is there ash or wildfire debris in or near the water system?
- Does it seem like any ash, soot, or debris has entered any part of the water system?
- Do you notice other damage related to the fire?

Complex repairs should be completed by licensed and bonded water system contractors. Contractors should avoid backflow and cross-connections. Contractors should follow appropriate protocols for repressurizing the system. When needed, water system assets should be chlorine disinfected (i.e., minimum of 300 mg/L for 3 hours) before return to service. Care is needed to safely handle and dispose of this superchlorinated water. This water can cause chemical burns and damage plants if not handled properly.

What Should the Water Be Tested For and Where?

Chemical water testing is NOT necessary at every water system location. Testing is recommended at representative locations where contamination is possible and a concern. Water should be screened for chemicals listed on www.PlumbingSafety.org.


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Visit www.PlumbingSafety.org, PlumbingSafety@purdue.edu, Date Released: March 8, 2024

2023



2023, Infrastructure Investment and Jobs Act

September 2023

 *Enhancing Mitigation and Building
Effective Resilience Act* introduced June
20 by Sen. Kelly (AZ) and Sen. Romney
(UT) and includes water issues!

37. Expedite funding to water utilities in both immediate and long-term wildland fire recovery to maintain water delivery to consumers.

38. Authorize and incentivize flood mitigation, water quality, and source water protection projects in existing wildfire mitigation and wildfire recovery programs to protect community water supplies

39. Increase funding and technical assistance to state, local, Tribal and territorial public health agencies and water provider partners to increase local capacity for wildfire preparedness and resilience planning

40. Equip state, local, Tribal and territorial public health agencies and water provider partners to provide resources and support to residents to ensure access to safe drinking water after wildfire

41. Support identification of public health risks associated with exposure to wildfire-contaminated water and development of evidence-based water use recommendations

What needs to be done?

1. For water utilities...
 - Defense: Setbacks, BFPDs, zoning, storage, interconnects, automatic shutoffs, backup power, training
 - Respond: Damage isolation, mutual aid, correct water testing support practices
2. For households and businesses, seek and ask for help
3. For elected officials, listen, support and fund action
4. For research, conduct studies to better understand...
 - Contaminant fate in water systems and plumbing
 - Exposure at fixtures and health risks
 - Relationship between water system impacts and household health and economic resilience
 - Agricultural water system and animal/crop impacts



Raw water line
2020 CZU Lightning
Complex Fire



Wildfires Are Here: Learn What Utilities Should Expect and Do to Respond and Recover



AWWA'S 2024 Annual Conference & Exposition
Anaheim, California
1:30 pm PDT, Wednesday June 12, 2024, Room 204AB



The most destructive, costly, and deadliest wildfires have been recorded in recent U.S. history and these require an equally unprecedented response by water utilities. This session will share real-world lessons direct from impacted frontline utilities, offer a concept of operations plan (CONOPS) that all utilities can adopt, worker safety advice from California Department of Public Health, and researcher discoveries.



Resources

- Plumbing 101
- Flushing Plans
- Plumbing Demonstrations - Camp Fire
- Video / Audio
- Presentations / Reports
- Peer-Reviewed Publications
- Water Quality Risk Tools
- Hawaii Response
- Wildfire Response
- Survey - Camp Fire
- FAQs - General Plumbing
- FAQs - Camp Fire Response

Response and Recovery to Wildfire Caused Drinking Water Contamination

Wildfires can damage buried drinking water systems as well as private drinking water wells and building plumbing, making them unsafe to use. Since 2017, a growing number of wildfires have prompted chemical drinking water contamination in the United States. Levels found in some water systems have exceeded hazardous waste limits and posed an immediate health risk. To help households and building owners understand key wildfire drinking water contamination public safety issues, resources were compiled below. These resources will also be of interest to public health officials, water providers, municipalities, emergency management, insurance companies, nonprofit agencies, elected officials, and consultants.

- Questions can be directed to Dr. Andrew Whelton at awhelton@purdue.edu.

Marshall Fire Homeowner Support

[Letter to Homeowners Affected by the Marshall Fire in Unincorporated Boulder County](#) (January 2022)

Resources for Households, Private Well Owners, and Public Health Officials

Here is a list of chemicals to test for (as of May 2022) to find chemical contamination in wildfire impacted drinking water systems:

- [List of Chemicals in Wildfire Impacted Water Distribution Systems](#) [May 2022]

These 1 page information sheets provide households and public health officials considerations for water system, inspection, testing, and potential safe drinking water options when the plumbing is unsafe. These documents were developed based on firsthand experience investigating contamination after wildfire, building plumbing, sampling, decontamination, and advising local, county state, and federal agencies. Information in these documents is partly based on practices from several health departments who have responded to wildfire caused drinking water contamination disasters and also influenced by our firsthand experiences and testing.

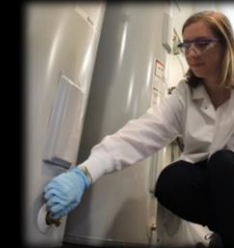
- [After a Wildfire: Water Safety Considerations for Private Wells](#) [May 16, 2021, Prepared by the Center for Plumbing Safety]
- [After a Wildfire: Water Safety Considerations Inside Buildings](#) [May 16, 2021, Prepared by the Center for Plumbing Safety]
- **Attention: Persons impacted by wildfire should seek specific advice from their local health department.**

Resources for Emergency Management, Water Utility, Public Health, and Elected Officials

This video helps prepare officials for water system damage scenarios. Wildfires can damage water distribution system infrastructure both physically –and– chemically. Some damage may not be visible. Hazardous waste scale drinking water chemical contamination can be caused. This presentation does not cover all situations, but instead provides an introduction for the viewer. More information and help can be obtained by contacting the Center for Plumbing Safety.

www.PlumbingSafety.org

www.CIPPSafety.org



- ✓ Post-fire chemicals to test for
- ✓ Brief videos for emergency managers and health officials
- ✓ Guidance for private well owners
- ✓ Guidance for building owners
- ✓ Government agency resources
- ✓ FEMA mitigation guidance
- ✓ Other training resources

Thank you

Andrew Whelton
awhelton@purdue.edu

A Special Thanks To...



and more...

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Paradise, CA