Healthy Waters After Wildfires
Evaluating Post-Fire Water Quality

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FRIGIDAIRE
NONGSHIM
TRY THESE OTHER GREAT FLAVORS!
LARGE SIZE
CRUNCH
Follow the Cap'n on


GORILLA CARTS


CAUTION
MAX WEIGHT
sto


2022
USA


MARIA LANAKILA
MARIA LANAKILA
CATHOLIC CHURCH
Weekend Masses:

Temporary Site for King Kamehameha Elementary School


EQM
FEDERAL CONTRACTOR


Lahaina Non-Targeted Analysis (NTA) Project

Collaboration across Federal, State, and County Agencies; Academia

- US EPA – Office of Research and Development
- HDOH – Safe Drinking Water Branch
- California State Water Resources Control Board
- Maui County Department of Water
- University of California, Davis

Lahaina Non-Targeted Analysis (NTA) Project

Sample Locations: 4 service laterals selected – Isolated and left undisturbed

- All 4 sample locations had confirmed low-level VOC detections during the wildfire recovery sampling
- At the completion of EPA's Mission Assignment on Maui, contaminated service laterals were cut and removed from the distribution system
- The 4 service laterals used for the NTA Project were kept intact and isolated off the service clamps at the corporation stop. They were left undisturbed to serve as a "time capsule" of contamination within the isolated service laterals
- 4 short-term stagnation samples: 1-2 week stagnation period
- 2 long-term stagnation samples: 4-8 week stagnation period

Lahaina NTA Sample Locations

Lahaina NTA Sample Locations

E1 – Ka'uipo St.

Lahaina NTA Sample Locations

Lahaina NTA Sample Locations

E2 – Waine'e St.

Lahaina NTA Sample Locations

Lahaina NTA Sample Locations

L5 – Kuhua St.

Lahaina NTA Sample Locations

Lahaina NTA Sample Locations

E1 – Front St.

Lahaina NTA Project

Sample Collection Dates

- Short-term Stagnation samples collected on 11/25/24
- Long-term Stagnation samples collected on 1/21/25 and 2/3/25

Sample Collection

- Approximately 400 mL of water was purged prior to collecting sample
- Each sample consisted of:
  - Two 1L amber bottle filled with sample water (one sample plus one duplicate)
  - One 1L amber bottle filled with blank water (DI water provided by lab)
  - Field measurements: Chlorine, pH, and Temperature

Healthy Waters After Wildfires: Evaluating Post-Fire Water Quality Using Advanced Analytical Methods

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Hawai’i Water Works Association
Annual Conference
October 16, 2025

CALIFORNIA
Water Boards


Malibu, California
January 2025

Disclaimer

All views are those of the author, and do not necessarily represent those of the State Water Board, the California Environmental Protection Agency, or the State of California.

Presentation Overview

1. Contamination After Fires
2. Chemistry of Combustion
3. Water Quality Research
4. Best Practices for Water Systems
5. Emerging Research and Priorities

Mechanisms of Contamination

- Low or no pressure + open water lines = **pathway for contamination**
- Likely cause: thermal degradation & entry of smoke
- Contaminants stick to pipe walls, biofilms, and other surfaces
- Flushing helps remove contaminants
- Heavy or persistent contamination: replace
- Primarily volatile organic compounds (VOCs); some semi-VOCs (SVOCs)
- Benzene most prevalent contaminant ≥ maximum contaminant limit
- **Does not occur after every fire**

Influencing Factors

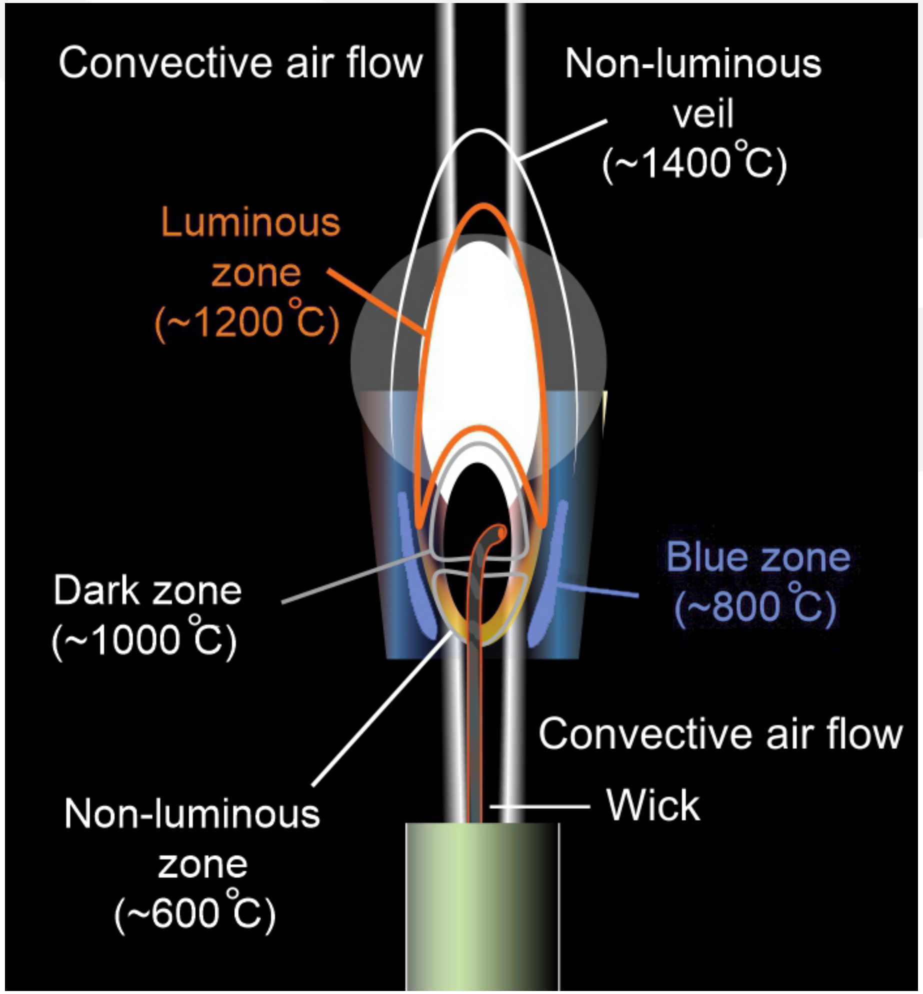
- Timing of pressure loss and re-pressurization
- Open water lines and damaged service connections
- System hydraulics and pressure zone design
- Piping configuration and material type
- Infrastructure age and condition
- Distance from contamination source
- Fire temperature and soil burn intensity
- Other site-specific conditions

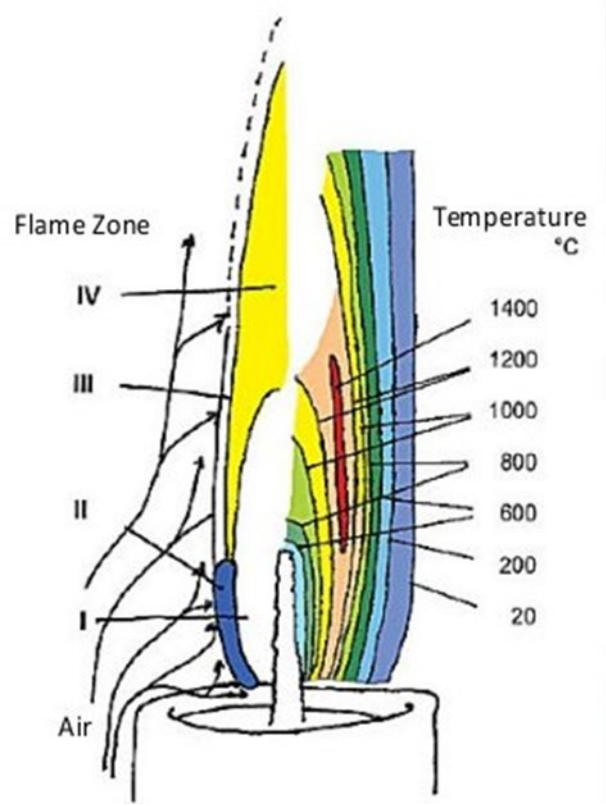
Combustion Chemistry

"The simplest hydrocarbon combustion – methane and oxygen – produces hundreds of different intermediates and byproducts through hundreds of different chemical reactions occurring at different rates."

- *Ludovico Cademartiri, University of Parma, Italy*

Thermal Gradients





What’s Happening Chemically With Wildfires?

Things Break Down
(Pyrolysis) 200℃ - 500℃

Gases Catch Fire
(Combustion) 1000℃ - 1500℃

Soot and Smoke
Contain Chemicals

Water and Air Keep
Chemistry Going 20℃ - 100℃

Distribution System Vulnerabilities

Low/No Pressure Conditions

- Enables intrusion of air, gases, liquids and debris
- Flow reversals can pull in contaminants
- Entry points:
  - Leaks, cracks, melted fittings
  - Relief valves, unsealed tanks

Water System Risks

- Infrastructure: sources, pumps, tanks, mains, treatment
- Above-ground or shallow-buried lines, plastic and synthetic materials
- Water quality risks:
  - VOC/SVOC contamination
  - DBPs from chlorine + organics

Analytical Innovations

Targeted analysis: Tests for a specific list of known compounds

Non-targeted analysis (NTA): Screens for a broad range of known and unknown compounds

- Pros: Fast, cost-effective, easy to interpret results
- Cons: Limited scope, misses other compounds

- Pros: Wide range of compound detection, enables chemical fingerprinting
- Cons: Resource intensive, time consuming, requires advanced data analysis

3 Case Studies Using NTA

Camp Fire

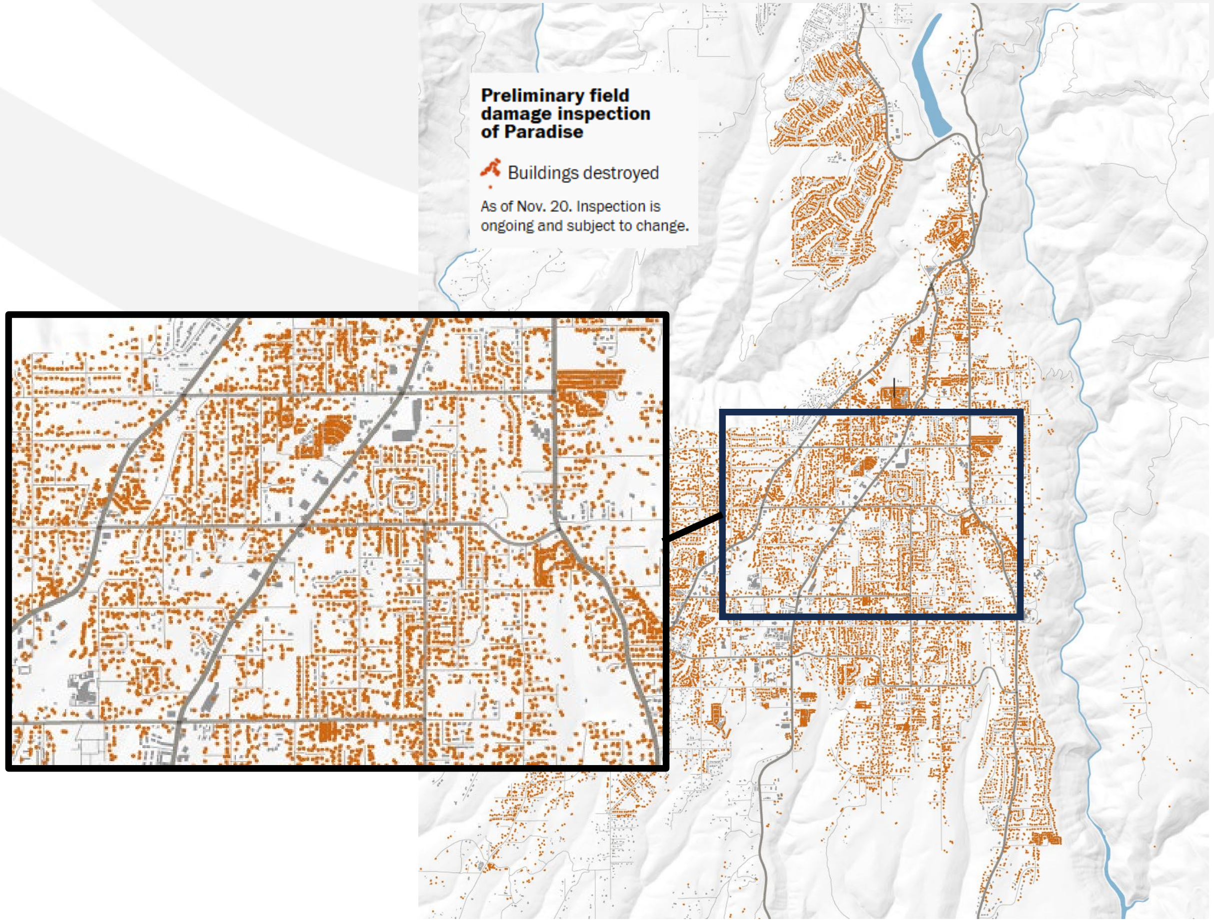
Lahaina Fire

Los Angeles Fires

Case Study 1: 2018 Camp Fire

Background

- Four water systems heavily impacted
  - ~19,000 structures damaged/destroyed
  - ~1,800 structures remained standing
- Widespread drinking water contamination
  - Primarily linked to plastic service lines
  - Especially High-Density Polyethylene (HDPE) lines



Source: *Washington Post*, using data from Cal Fire/Digital Globe

Case Study 1: Paradise, CA

Study Design

- Single service line sampled
- Heavily contaminated HDPE line
- Located on a flat street, mid-system
- Concrete meter box with intact brass meter
- House believed to have copper interior plumbing

Case Study 1: Key Findings

95 organic compounds identified, including VOCs and SVOCs

Benzene detected at concentrations exceeding 2,200 parts per billion

Thermal Degradation of Plastic Pipes

- PVC pyrolysis: 32 compounds linked to breakdown products
- HDPE/PEX pyrolysis: 28 compounds identified
- Heat-damaged pipes can release a range of volatile and semi-volatile organics

Intrusion of Combustion Products

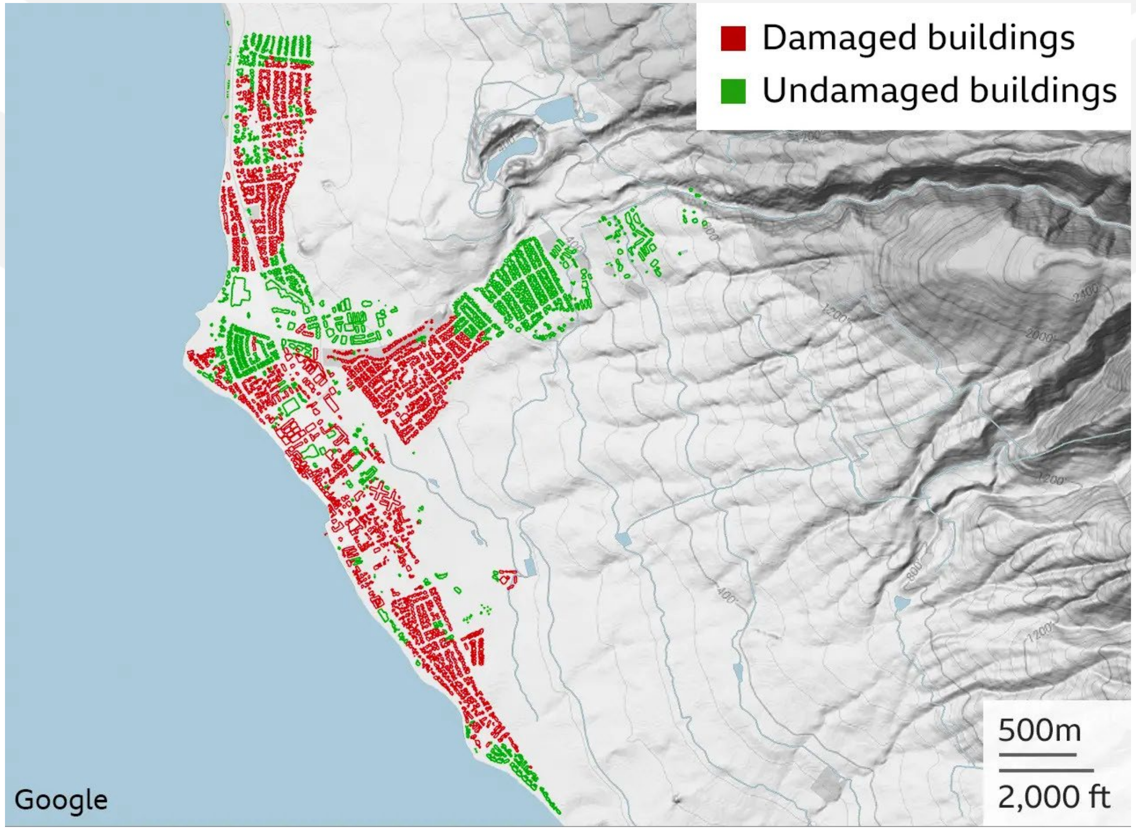
- 55 compounds associated with burning biomass, building materials, and waste
- Likely entered the system during depressurization and smoke intrusion while the fire was active

Post-Fire Chemical Reactions

- Chlorine in the water forms disinfection byproducts

Case Study 2: 2023 Lahaina Fire

- Many Major Fires:
  - Lahaina
  - Pulehu-Kihei
  - Olinda
  - Kula Fire
- Lahaina Fire:
  - ~2,200 structures damaged/destroyed
  - ~1,500 structures remained



Source: *BBC News*, using data from FEMA/ESRI

Case Study 2: Lahaina, HI

Background

(Re-summarized)

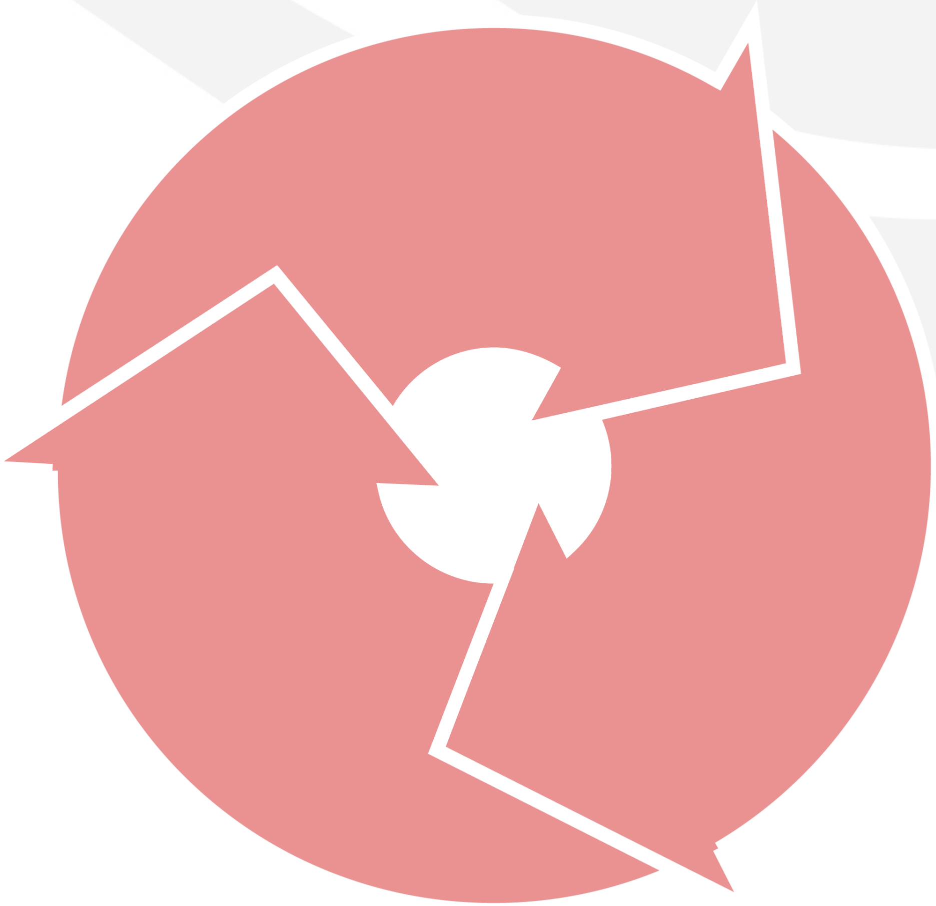
- Samples were collected from service lines scheduled for replacement to characterize pre-remediation conditions
- In all cases, the sampled pipes were subsequently removed and replaced prior to restoration of water service to customers
- Six samples collected from four sites:
  - Four sites with short-term stagnation
  - Two sites with long-term stagnation

Case Study 2: Preliminary Findings

Preliminary identification includes VOCs and SVOCs

Applying Lessons Learned

Collaboration expands our scientific understanding of post-fire system behavior



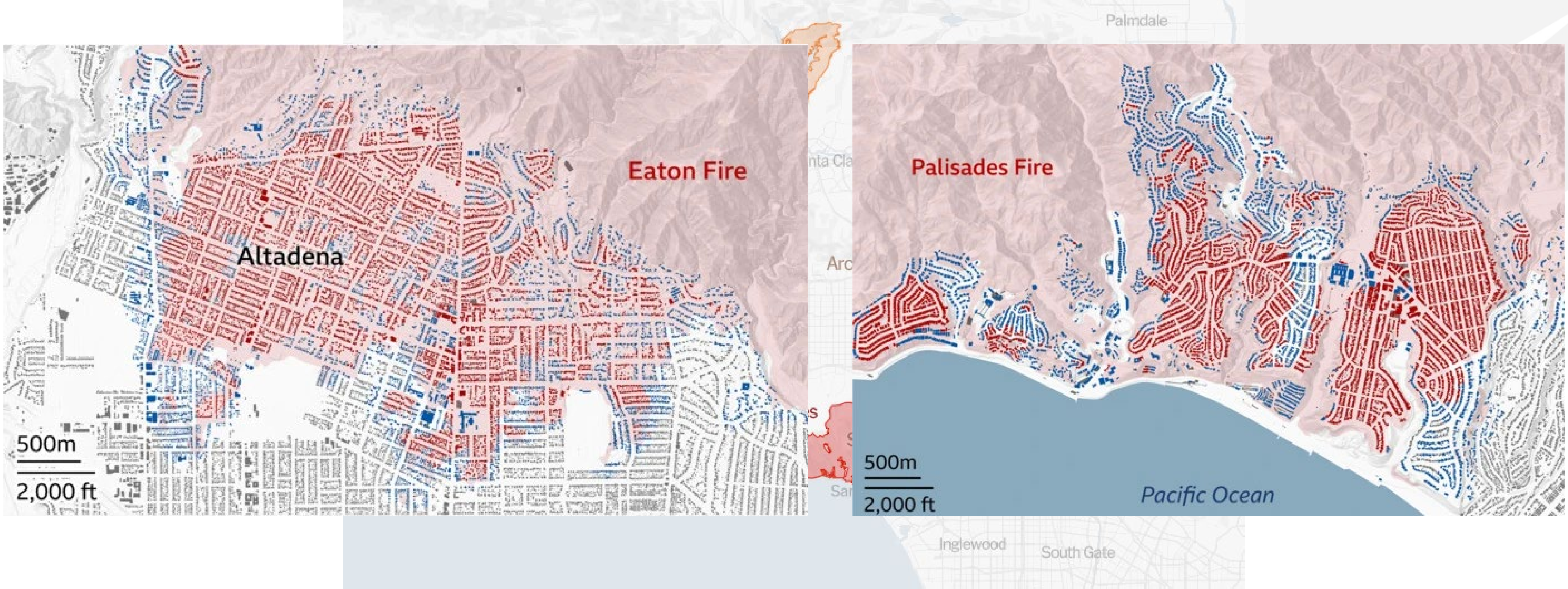
Expanding Scientific Contributions

Lahaina lessons informed approach used in Los Angeles

Builds on Previous Responses

Camp Fire NTA methods expanded in Lahaina

Case Study 3: Los Angeles, CA Fires



Source: *The Wall Street Journal*, using data from Cal Fire and OpenStreetMap. Jan. 31 at 2:29am Pacific Time.

Source: *BBC News*, using data from Cal Fire and OpenStreetMap. Jan. 9 at 7:00am Pacific Time.

Case Study 3: Los Angeles, CA

In Progress

Background

- Nine impacted water systems
  - ~16,000 structures damaged/destroyed
- Many are wholesale customers
- Very few plastic pipelines
- Damages varied by location
- Fires impacted both smaller and larger utilities

Source: *Mario Tama / Getty Images*

Case Study 3: Los Angeles, CA

In Progress

Study Design

- Sampling began after the fires
- Samples include:
  - Varying material types
  - Short- and long-term stagnation
  - Various contaminant profiles
  - Control samples collected for comparison
- **Over 100 samples collected**

Source: *Image by Water System Staff*

What To Do


LOST
CONFUSED
UNSURE
UNCLEAR
PERPLEXED
DISORIENTED
BEWILDERED

Best Practices

Before

- **Plan:** Create wildfire-specific emergency plans
- **Prepare:** Identify risks, coordinate, stockpile supplies
- **Practice:** Run drills, test systems, refine protocols

During & After

- **Respond:** Act quickly, issue advisories, isolate areas
- **Remediate:** Flush, test, repair, remove contamination
- **Recover:** Rebuild, monitor long-term, update plans

System Impacts

Impacts to Plastics

Recovery Technique: Sample Risers

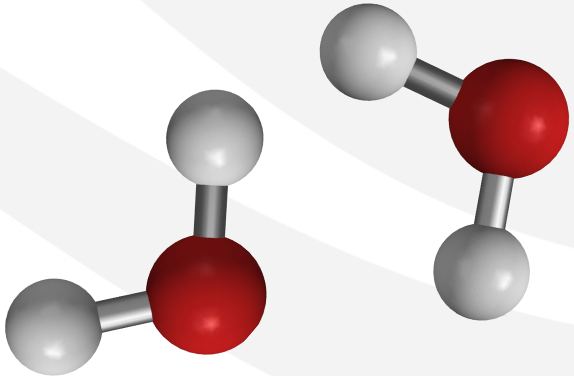
Recovery Technique: Hose Overs

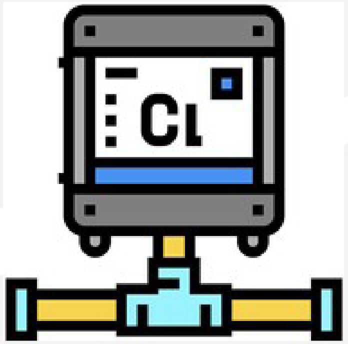
Recovery Technique: Temporary Storage

Source: *Circle of Blue*, With Alternate Water Sources, Paradise Businesses Reopen (2019)

Recovery Techniques: Emergency Power and Pumps

Emerging Research & Priorities





Contaminants & Pathways

- Identify regulated & unregulated compounds
- Understand formation and reaction mechanisms
- Model contamination risk and system behavior

Chemical & Biological Processes

- Study DBP formation, smoke deposition, and biofilms
- Investigate microbial interactions
- Co-contaminant behavior

Monitoring & System Response

- Use of real-time sensors and field-ready tools
- Material performance, flushing, and prevention strategies
- Premise plumbing risks

Key Takeaways

- Wildfires will likely continue to impact drinking water systems
- Contamination events are time consuming, challenging and costly
- Best practices are emerging
- Resilience starts with planning
- Collaboration is essential
- Analytical tools improve situational awareness

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Mahalo! Q&A

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