**RICHARD T. BISSEN, JR.**
Mayor

**JOSIAH K. NISHITA**
Managing Director

**BRADFORD K. VENTURA**
Fire Chief

**GAVIN L.M. FUJIOKA**
Deputy Fire Chief

**DEPARTMENT OF FIRE & PUBLIC SAFETY**
COUNTY OF MAUI
200 DAIRY ROAD
KAHULUI, MAUI, HAWAIʻI 96732
www.mauicounty.gov

September 16, 2024

Honorable Richard T. Bissen, Jr.
Mayor, County of Maui
200 South High Street
Wailuku, HI 96793

APPROVED FOR TRANSMITTAL

SEP 16 2024

Acting Mayor — Date

For Transmittal to:

Honorable Tasha Kama, Committee Chair
Housing and Land Use Committee
Maui County Council
200 South High Street
Wailuku, HI 96793

Dear Chair Kama,

**SUBJECT: BILL 103 (2024), AMENDING CHAPTER 19.08, MAUI COUNTY CODE, RELATING TO DENSITY WITHIN RESIDENTIAL DISTRICTS** (HLU-32)

The Department of Fire & Public Safety is in receipt of your letter dated August 20, 2024. The information provided is based on the interpretation of the proposed Bill and where current Maui codes fall short on mitigating the potential risks and associated hazards. In addition to the statements below, the following attachments have been included for your review:

- IBHS Early Insights – Lahaina Fire 2023
- Lahaina: From Conflagration to Resilience

There is a definite need for more housing, an increasing in housing density is inevitable. However, it must be balanced with a parallel increase for the community's safety and fire protection.

This proposal brings a greater level of fire threat to the community. The most common cause for fires in the urban environment is the human factor whether that results in conflagration is a result of fuel loads and density.

More houses mean greater fuel loads, which leads to higher heat release rates which in turn causes fire to spread more rapidly and with greater intensity. Higher density means the involvement of exposures is much more likely due to their proximity to each other.

Lahaina disaster was in part a result of unchecked and unmanaged density increase coupled with a lack of infrastructure maintenance and improvements. Illegal or non-conforming development was a huge contributor to the problem. If we now make that the norm we invite same scenario to repeat itself.

It is a challenge to keep a structure fire contained to one property. Without additional safety measures at these proposed densities we will likely experience not just the loss of multiple structures on the same property but upon full development, we are unlikely to be able to protect neighboring properties.

From a fire protection standpoint, it would be highly recommended to carefully take into consideration the improvements that would be required to deal with such a density increase and implement those improvements prior to allowing further development.

Currently Maui county roads and water-supplies are struggling to meet and maintenance at minimum standards. Water-supply fire flows would need to be calculated and supplied to meet the increased need.

Building size restrictions would need to be implemented to stay within the water supply capabilities. Building separation by current building or fire code does not adequately address the fire hazard associated with multiple houses on one property therefore new ordinances would need to be adopted to mitigate the potential for conflagration. Even current setbacks to property lines are not restrictive enough to reduce fire spread.

Roadway improvements are needed to provide clear access for emergency response while allowing the emergency egress of the residents. Roadways may also need to be widened to serve as fuel breaks where density dictates. Parking would have to be taken into consideration and provided for to guarantee no interference with access.

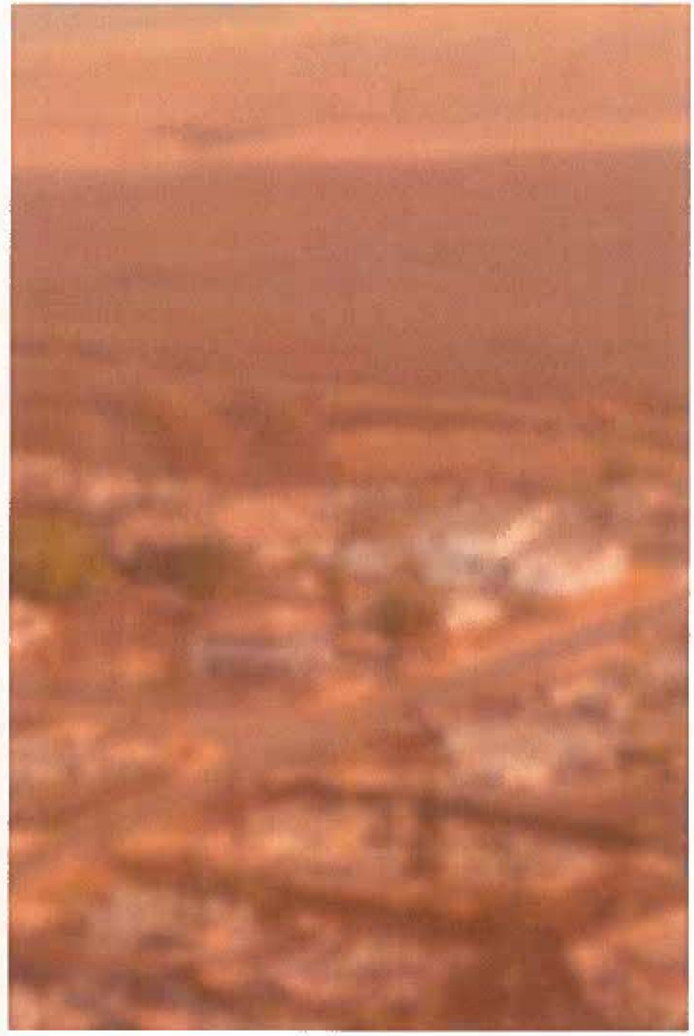
It would be very dangerous and highly irresponsible to approve the increase density for the unaware residents before the County improve our support structure and protection regulations. Maui County Fire Code amendments are currently being drafted and will be submitted shortly for approvals. Should this Bill be considered, the Fire Prevention Bureau will need to work on mitigation ordinances immediately to be able to enforce these requirements prior to implementation of HLU 32.

If you have any further questions or concerns, please feel free to contact the Office of the Fire Chief at (808) 270-7561.

Sincerely,

BRADFORD K. VENTURA
Fire Chief

# LAHAINA: FROM CONFLAGRATION TO RESILIENCE



IBHS RESEARCH CENTER WILDFIRE

Insurance Institute for Business & Home Safety
April 2024

# LAHAINA: FROM CONFLAGRATION TO RESILIENCE

On August 8, 2023, a devastating and tragic fire swept through the Lahaina community as three wildfires burned on the island of Maui. A ***grassfire turned into a conflagration***, causing more than one hundred deaths and destroying three quarters of the structures in Lahaina.

The ***specifics of connective fuels, community layout, unique geography, and weather in Lahaina*** affected how the conflagration unfolded within the community. As Lahaina rebuilds, a crucial set of mitigation actions–based in years of wildfire science, IBHS's Wildfire Prepared Home standard, and Lahaina's unique characteristics–can reduce the risk of future conflagrations.

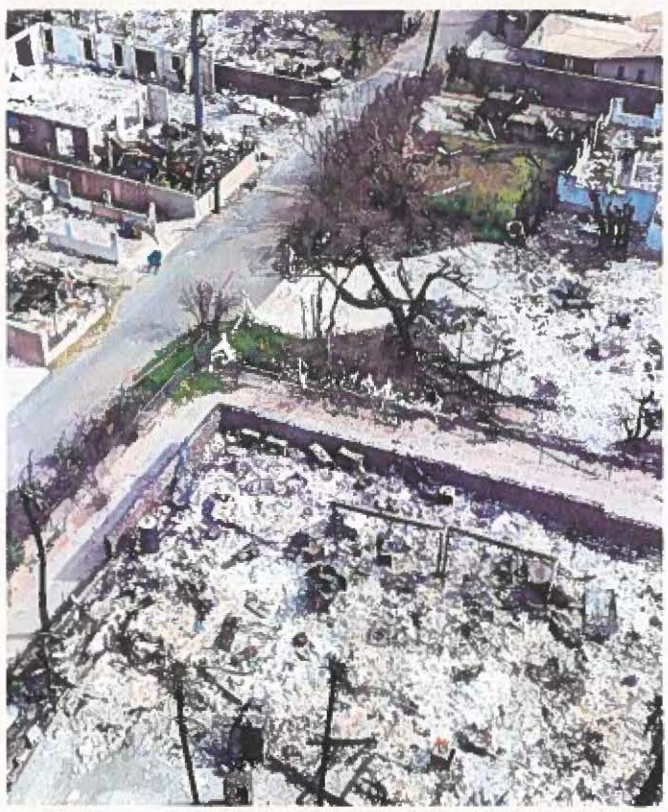
## Key Observations in Lahaina

**Disrupting Conflagration:** Where manmade and natural conditions reduced heat intensity, fire resistant building materials withstood the fire, creating pockets of unignited structures that disrupted the conflagration.

**Exterior Building Materials:** Fire resistant building materials are more durable than traditional materials, but their effectiveness was diminished in Lahaina due to intense heat from burning buildings with limited structure spacing.

**Structure Spacing:** *Flames from burning homes often extended over twenty feet*, rapidly igniting homes at closer distances downwind.

**Connective Fuels:** Connective fuels acted as pathways that brought wildfires to and enabled them to spread *within* the built environment.



**Conflagration:** A wildfire that spreads into the built environment leading to uncontrollable structure-to-structure fire spread. Factors associated with conflagration include: drought, wind, a fire start (often human-caused), dense construction with little to no exterior fire resistance, and dense combustible connective fuels surrounding and between structures.

**Connective Fuels:** Pathways of manmade materials (e.g., fences, outbuildings, sheds, or even automobiles) or vegetation by which fire can spread into or within a community.

**Structure Spacing:** The distance between buildings.

**Defensible Space:** The buffer area created and maintained between a structure and the grass, trees, shrubs, or any wildland surrounding it.

**Zone 0:** A horizontal 5-foot noncombustible buffer area surrounding a structure and outbuildings, including around and under attached decks and stairs. During a wildfire, embers can travel miles ahead of a fire front and accumulate at the base of a home's exterior walls and within the first 5 feet. Anything combustible in this critical zone acts as a fuel source for ignition, increasing the risk of flames spreading to the home.

## CRUCIAL ACTIONS TO REBUILD WITH RESILIENCE AT PARCEL-LEVEL AND COMMUNITY-SCALE

### Parcel-Level Actions

- **Rebuild homes to at least the Wildfire Prepared Home standard,** preferably to the Wildfire Prepared Home Plus standard in dense neighborhoods.
- **Apply modern building codes** to ensure structures can withstand hurricanes and wildfires.
- **Eliminate connective fuels between homes** by using native hardscapes such as lava rock or concrete fences to disrupt continuous pathways of fuel. Defensible space beyond Zone 0 is paramount for properties abutting grasslands.

### Community-Scale Actions

- **Expand or otherwise maximize structural separation** between buildings.
- **Establish and maintain fuel breaks along the periphery of the community,** especially in communities surrounded by grassland. Use noncombustible fencing on properties abutting the grasslands.

## Background

Nestled between the natural grassland and the Pacific Ocean, the community of Lahaina sits on the northwestern coast of the island of Maui. Prevailing winds flow down the topographic landscape, across the wild grasses, and into the suburban area.

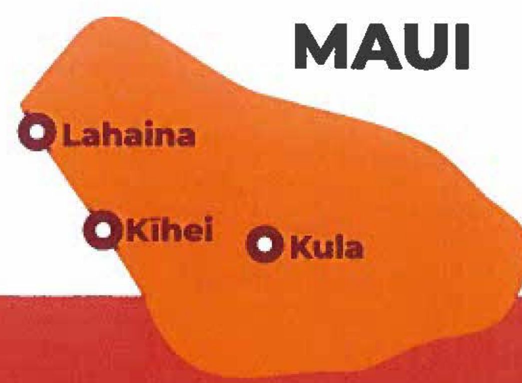
On August 8, 2023, one of three wildland fires burning on the island entered Lahaina. Exacerbated by strong winds, the fire resulted in a catastrophic conflagration within the community. Once fire entered the community from the grasslands, it quickly spread through the built environment, overwhelming firefighting resources. The rapid fire spread from the grasslands to the built environment draws parallels to other grass fires such as the Marshall Fire in Colorado and the Balch Springs neighborhood fire in Texas. In addition to tragic loss of life, the Lahaina Fire destroyed over 2,200 structures—accounting for three quarters of all structures in Lahaina—resulting in the seventh most damaging fire in the United States since 1990, based on structures destroyed.

***Figure 1.*** *Post-fire satellite image showing the boundary (in orange) of the Lahaina Fire and larger areas within the community that escaped the conflagration. Imagery courtesy of Maxar.*

In addition to the Lahaina Fire, the island of Maui experienced two other wildfires on August 8, 2023. One wildfire impacted the community of Kula, Upcountry Maui where the topography and vegetation coverage is similar to Northern California. The other wildfire sparked near Pūlehu Road, north of Kīhei where the vegetation coverage is combination of trees and grassland.

In November 2023, IBHS conducted a post-disaster investigation in Maui to deepen scientific understanding of suburban conflagration by studying how the fire progressed through the community and focusing on structures that were not destroyed by the fire. The IBHS team looked at structures across Lahaina; however, it was not able to collect data from the Kula community or on the Pūlehu Road fire.

The research conducted in Maui sought to better understand why some structures escaped destruction during the conflagration with a particular focus on the building vulnerabilities and features that distinguished these buildings. The IBHS team collected data in three key categories: fuel-related factors, building components, and separation distance between structures.



## Existing Wildfire Research

For more than a decade, IBHS has been conducting extensive research at its research facility into the ignition of structures due to wind-driven wildfires by examining building components and parcel features along with building-to-building fire spread. The findings from this research have been presented in numerous studies, most recently IBHS's "The Return of Conflagration in the Built Environment"[1] and "Wildland Fire Embers and Flames: Home Mitigations that Matter"[2]. IBHS also released early insights from the Lahaina Fire[3] in August 2023.

As described in "The Return of Conflagration in the Built Environment," IBHS has identified the set of most important factors contributing to suburban conflagration across the natural environment, the built environment, and human behavior (Table 1). Within the factors related to the natural environment, wildland fuel is the only factor that humans can meaningfully change. In comparison, the factors relating to the built environment and human behavior can be altered by humans over time at differing levels of effort and investment. For example, modifying infrastructures and adjusting structural density is possible but may present significant challenges, whereas reducing connective fuels and retrofitting structures with ignition-resistant building materials are both effective and achievable.

***Table 1.*** *Factors contributing to suburban conflagration as described in "The Return of Conflagration in the Built Environment".*

| *Natural Environment* | The Built Environment | Humans |
| --- | --- | --- |
| ***Topography*** | Structure density | Preparedness and mitigation |
| ***Climatology*** | Building materials | Ignition sources |
| ***Local Weather*** | Connective fuels | Fire service intervention |
| ***Wildland Fuels*** | Infrastructure | |

IBHS research also has investigated the ignition of structures due to wind-driven wildfires by examining building components and parcel features. The findings from this research are set forth in "Wildland Fire Embers and Flames: Home Mitigations that Matter" and inform IBHS's Wildfire Prepared Home[4] mitigation program. This body of work highlights the importance of undertaking a collective set of mitigation actions to drive down the risk of structural ignition from embers and the heightened criticality of removing combustible material from the five-foot zone surrounding structures, sometimes called Zone 0[5]. Although reducing the risk of ignition requires a systemic application of mitigation actions, some mitigation actions are more important than others depending on the type of wildfire threat (i.e., some components are more vulnerable against embers while others are to flames and radiant heat exposure).

*1 Ian M. Giammanco et al., "The Return of Conflagration in the Built Environment," Insurance Institute for Business & Home Safety (2023). https://ibhs.org/wildfire/returnconflagration/*
*2 Faraz Hedayati et al., "Wildland Fire Embers and Flames: Home Mitigations that Matter," Insurance Institute for Business & Home Safety (2023). https://ibhs.org/MitigationsthatMatter*
*3 "IBHS Early Insights: Lahaina Fire—2023," Insurance Institute for Business & Home Safety (2023). https://ibhs.org/EarlyInsights-Lahaina/*
*4 https://wildfireprepared.org*
*5 "Noncombustible Zone 0: Minimizing Pathways to Home Ignition," Insurance Institute for Business & Home Safety (2023). https://ibhs1.wpenginepowered.com/wp-content/uploads/IBHS_Noncombustible_Zone_0.pdf*

# What is Wildfire Prepared?

Wildfire Prepared is a mitigation program that guides homeowners through taking preventative measures for the home and yard to protect against wildfire. Available for **new construction and as retrofits** to existing homes, Wildfire Prepared Home features a set of mitigation actions that, together, meaningfully reduce the risk of home ignition. The **Wildfire Prepared Home level** protects against ignition from embers, and the **Wildfire Prepared Home Plus level** includes additional actions to protect against ignition from flame and heat exposure.

| Required Mitigation Actions | Wildfire Prepared Home | Wildfire Prepared Home Plus |
|---|---|---|
| Create a **5-foot noncombustible buffer**, often known as Zone 0 | X | X |
| **Replace combustible fencing within 5 feet** of the home | X | X |
| Ensure the **roof is Class A fire-rated** | X | X |
| Choose **noncombustible gutters** and downspouts | X | X |
| Routinely **clear tree debris from the roof and gutters** | X | X |
| Install **ember-resistant vents** or cover vents with 1/8-inch metal mesh | X | X |
| Ensure **6-inches of vertical noncombustible material** at the base of exterior walls and decks | X | X |
| Routinely **clear debris from decks, replace combustible furniture, maintain the underdeck area; enclose low-elevation decks** | X | X |
| Maintain **defensible space to 30 feet** | X | X |
| Keep **accessory structures compliant within 30 feet** | X | **No accessory structures within 30 feet** |
| **Cover gutters** | | X |
| **Enclose the underside of eaves** with noncombustible material | | X |
| Install a **metal dryer vent with a louvers or a flap** | | X |
| Install **noncombustible exterior siding** | | X |
| Ensure **shutters, if present, are noncombustible** | | X |
| Upgrade to **dual-pane tempered windows** | | X |
| Upgrade to **noncombustible exterior doors** | | X |
| Enclose the space **underneath bay windows** | | X |
| Upgrade to a **noncombustible deck** | | X |
| **Remove back-to-back fencing** within 30 feet | | X |

**More resilient construction practices are not prohibitively expensive.** In a 2022 study[6], IBHS and Headwaters Economics compared the additional costs of building a new home with greater wildfire resilience in Southern California than the requirements set forth in California's Building Code Chapter 7A (California's wildfire building code). As the requirements of California's Chapter 7A building code are substantially similar to the National Fire Protection Association (NFPA) 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire in use in Hawaii, the study provides a notional sense of the cost implications for enhancing Hawaii's existing requirements for new construction.

- Building to the Wildfire Prepared Home level is largely **cost neutral**. The study found additional costs arising from choices in landscaping Zone 0 and in enclosing decks, of approximately $3,000. This cost could be reduced through different material or landscaping choices.
- Building with additional wildfire resilience measures included in the Wildfire Prepared Home Plus level (e.g., dual-pane tempered glass windows, ignition-resistant siding, etc.) and a more resilient tile roof increased costs by approximately **4-13 percent**. These costs can be reduced through homeowner choices without jeopardizing wildfire resilience. For example, the absence of a deck eliminates the costs associated with mitigating wildfire risk associated with the deck.

For communities interested in incorporating the requirements of the Wildfire Prepared Home program into building codes and ordinances, IBHS has created a Model Ordinance for Construction in WUI Area[7].

6 *Kimiko Barrett et al "Construction Costs for a Wildfire-Resistant Home: California Edition," Headwaters Economics and IBHS (2023). https://headwaterseconomics.org/natural-hazards/wildfire-resistant-costs-california/*

7 *https://ibhs1.wpenginepowered.com/wp-content/uploads/Wildfire_model_ordinances-in-WUI.pdf*

In addition, IBHS continues to conduct research to better understand building-to-building fire spread through flames, heat, and embers. This research indicates that structure spacing of less than twenty feet significantly increases the likelihood of conflagration once a wildfire has entered a community. As demonstrated in Figure 2, the severity of damage declines at distances greater than twenty feet. Under this condition in a Wildland-Urban Interface (WUI) fire, the intensity of the fire exposure surpasses the tolerance of nearly all fire-resistant materials and designs.

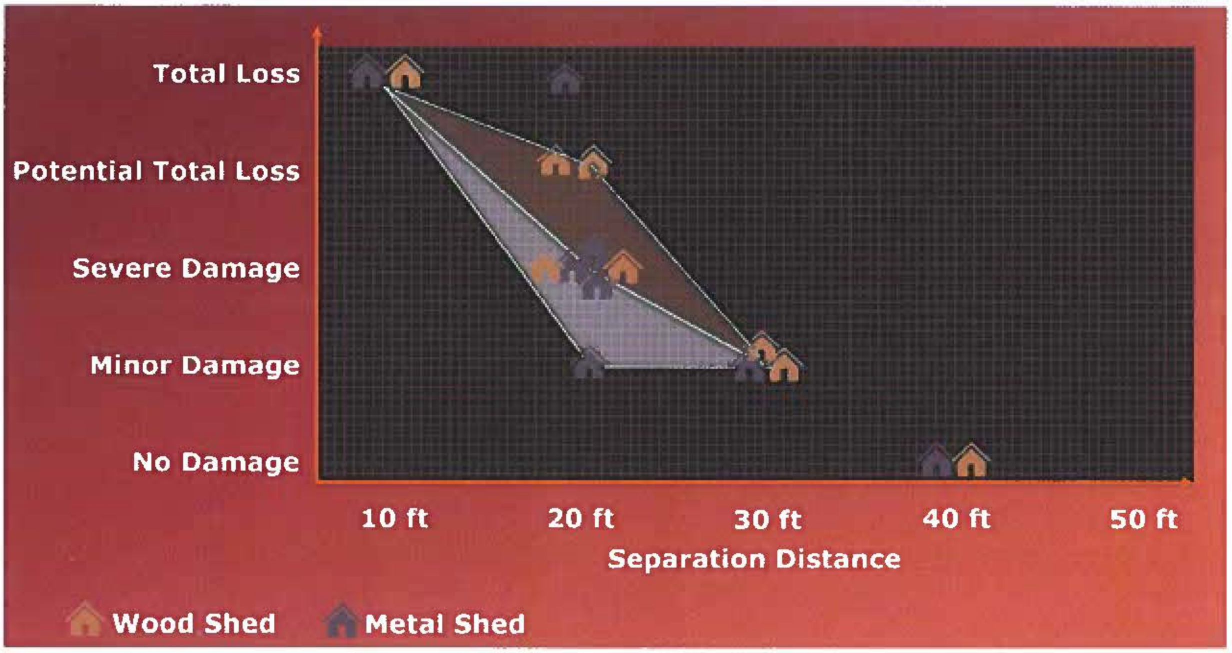



***Figure 2.*** *Different damage severities as a function of distance resulting from a set of IBHS's wind-driven building-to-building fire spread experiments.*

Put together, IBHS's existing body of research demonstrates that a single resilience action is insufficient to reduce the risk of home ignitions and community-level conflagration. Rather, wildfire risk can only be meaningfully reduced through a **multi-layer approach**:

1. At the **parcel level**,
   a. A foundational layer of mitigation actions to protect against ignition through embers;
   b. A secondary layer of mitigation actions to guard against flame and heat exposure; and
2. At the **community scale**,
   a. Community-wide mitigation actions to reduce the likelihood of conflagration once a single structure is ignited.

The mitigation actions that collectively make up the foundational and secondary layers of protection at the parcel level are known. The community-level mitigation actions necessary to reduce conflagration risk are currently under investigation, but this set of actions will certainly include the reduction of connective fuels (vegetation and structural) and a certain threshold of parcel-level mitigated homes in the community.

# Maui Deployment: Observations and Findings

While the unique geography and topography surrounding Lahaina contribute its vulnerability, the data IBHS collected in Maui demonstrates the acute reality of wildfire in a suburban community. This also aligns with IBHS's scientific research and field observations over the past decade. Observations in Lahaina advance scientific knowledge by demonstrating the factors that are most important for understanding how wildfires ***enter*** communities from grasslands and how wildfires ***spread within*** communities once the initial structural ignitions occur.

**When a wildfire threatens a community** in or near the Wildland-Urban Interface, reducing structural ignitions is of paramount importance. Once fire enters a community, a variety of factors—including structural spacing, connective fuels, and lofted structural embers—vastly increase fire spread.

**For wildland areas featuring grassland,** as is the case in Lahaina, the structures abutting the wildland are the first line of defense against community conflagration. Because these wildland fires typically ignite structures through direct flame contact rather than embers, the risk of conflagration is reduced if the exposed structures do not ignite.

**For wildland areas featuring forests,** as is the case in Kula, vegetative embers lofted by the wind play an important role in bringing the wildfire into the community by igniting sporadic spot fires and causing structural ignitions. In these cases, all structures in the community are equally vulnerable to ignition from embers—and mitigating all structures is equally important to preventing the initial structural ignitions that lead to conflagration.

## Wildland fire entering Lahaina

Wildland fire entered Lahaina through connective fuels that bridged the grasslands with the community. These connective fuels are present in many forms, ranging from natural elements like vegetation (e.g., wildland grasslands, shrubs, and trees) to manmade objects such as vehicles and building components like fences. These connective fuels created a pathway for fire to reach and ignite structures–setting off a conflagration.

In areas like Lahaina, characterized by predominantly grassland and shrub vegetation, the primary mechanism of fire spread to the built environment was direct flame contact. The community lacked fuel breaks that would have disrupted the continuous connection between buildings at the edge of the community and the wildland, minimizing the risk. Evidence suggests that structures that did not burn created a discontinuity–i.e., a fuel break–in the fire's pathway which resulted in lower thermal exposure for nearby structures, lowering the risk of ignition.


*Figure 3. Homes in northern Lahaina that did not burn because of disconnected fuel as the fire propagated from the wildland on the right side of the image.*

This phenomenon can be seen twice in Figure 3. In Case 1, the connective fuel path is interrupted by a noncombustible fence. In Case 2, the disruption occurs in two stages, involving irrigated grass and a concrete driveway.

## Fire spread within Lahaina

Once the wildfire entered Lahaina, it spread throughout the community. From observations on the ground, IBHS identified ten community and building features with the greatest impact on how the fire spread within Lahaina–which drives which structures escaped destruction and which ones did not.

By a wide margin, structure spacing—the distance between one structure and another—was the most critical factor to fire spread within Lahaina. The potential intensity of a structure fire is so high that, for other structures within twenty feet, it surpasses the tolerance of even fire-resistant building materials and designs. At separation distances larger than twenty feet, building components can make a difference in the ability of a structure to withstand a neighboring structural fire—if building components allow a sufficient number of structures to be able to do so, the conflagration can be stopped.

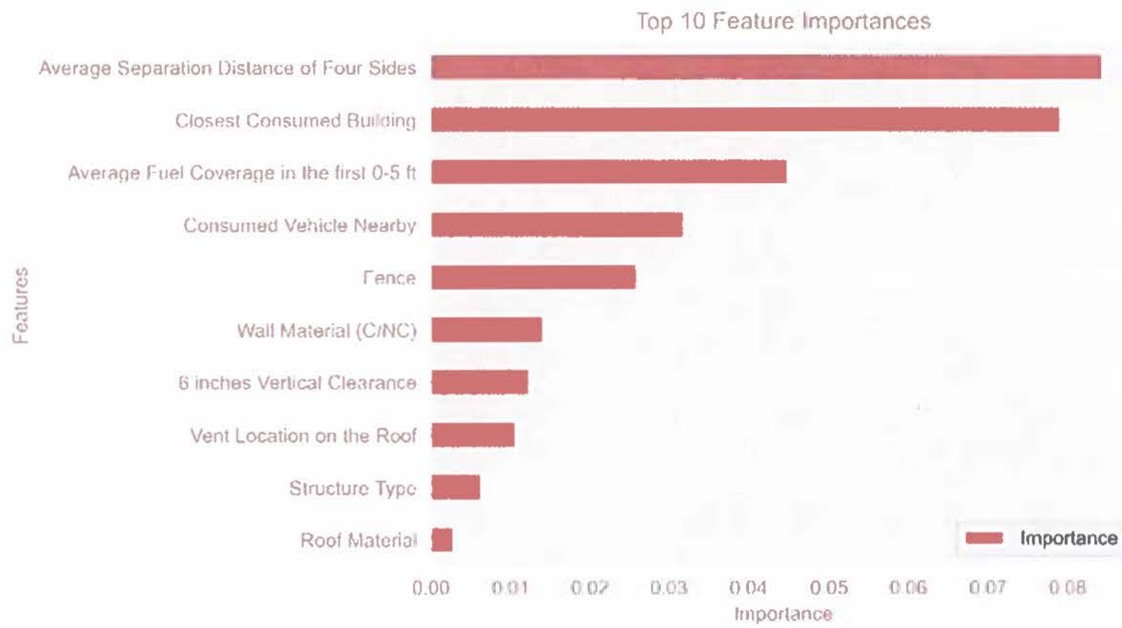



***Figure 4.*** *The community and building features influencing damage state.*

Other influential factors highlight the significance of available connective fuels in communities. Particularly in densely packed communities like Lahaina, connective fuels—which can encompass both stationary items like sheds and fences, as well as more dynamic elements such as vehicles—must be monitored and mitigated to disrupt the potential continuous pathway between buildings. IBHS researchers observed cases where the abundance, scarcity, or discontinuity of connective fuels changed the degree to which nearby buildings were damaged. As demonstrated in the buildings featured in Figure 5—both of which experienced only minor damage from the fire—the absence of connective fuels can reduce exposure and protect structures.


***Figure 5.*** *Examples of reduced exposure with non-connective fuel (A) The building on the left of image experienced minor damage due to radiation only (no connective fuel). (B) Embers ignited the combustible fence and vegetation on the leeward side of this building, leading to minor damage. The attached combustible fence was likely disconnected during the event.*

IBHS researchers observed specific instances in Lahaina where this reduced thermal exposure—either through structure spacings exceeding twenty feet or by disrupting the connective fuel path—allowed fire-resistant materials to withstand the fire, thereby preventing ignition and resulting in areas of unburned structures within Lahaina. These observations are consistent with past field observations and laboratory experiments.

In addition, structures in Lahaina that escaped being a total loss underscored the importance of the same parcel-level mitigation actions highlighted in "Wildland Fire Embers and Flames: Home Mitigations that Matter" and included in IBHS's Wildfire Prepared Home program. Features like a noncombustible Zone 0, protected openings, a Class A fire-rated roof, and a 6-inch noncombustible vertical clearance around the base of structures mitigated the risk of structural embers igniting additional homes as conflagration unfolded. By preventing these ignitions, pockets of Lahaina escaped conflagration.

## MULTI-HAZARD CONSIDERATIONS

Community leaders must help residents grapple with risks to multiple hazards faced by the community and not just the most recent disaster. Preparing and mitigating for each hazard may require careful consideration of overlapping vulnerabilities in the built environment. Ensuring buildings are rebuilt to modern building codes is paramount for resilience to the high wind experienced during hurricanes. While wildfire mitigation centers on connective fuels, building spacings, and material choices, wind resilience centers on how all the building materials are connected together.

## Recommendations for Resilient Recovery

A resilience-centric recovery approach that ensures the community rebuilds in a stronger and safer way is possible for Maui following the Lahaina Fire and the wildfires in Kula and Kīhei. Coupling years of research with the recent observations from the IBHS deployment, the following considerations can help Maui recover with resilience.

*Although grounded in IBHS's observations in Maui, these considerations incorporate years of wildfire research and are broadly applicable to other communities, whether similar to Lahaina (experiencing exposure to grassland) or Kula (experiencing exposure to forests).*

# IBHS: TURNING SCIENCE INTO SOLUTIONS

IBHS's groundbreaking research is closing gaps in building science to **strengthen the nation's resilience** against the growing threat of severe weather and wildfire, bringing science to life, educating audiences, and driving change.

The Institute's unique capabilities to **test full-scale structures** against high-wind, wind-driven rain, hail, and wildfire allow researchers to identify vulnerabilities – the points of failure – during these events. That research then flows into **achievable, affordable, and effective solutions** to guide building practices, retrofits, and mitigation programs for residential and commercial properties.

IBHS has been at the **forefront of building science research** since the opening of its Research Center in 2010. IBHS has **fundamentally shaped the state of scientific knowledge and the resilience solutions** available across our core perils of wind, wind-driven rain, hail, and wildfire. This includes:

- Synthesizing existing wildfire research into the Wildfire Prepared Home program to **provide homeowners with a clear pathway to meaningfully reduce wildfire ignition risk**.
- Unraveling the details of **building-to-building fire spread**.
- Exposing the **true vulnerability of asphalt shingles to wind** and expected lifespan in high wind environments.
- Bringing the **sealed roof deck** into the International Residential Code.
- Reaching **60,000 FORTIFIED designations** and launching the FORTIFIED Multifamily standard.
- **Driving market changing actions** by shingle manufacturers through impact resistant shingle product testing and performance rating, resulting in **improved products**.

Insurance Institute for Business & Home Safety®

# LAHAINA: PATHWAY TO RESILIENCE

| | Key Observations | Resilient Recommendations |
|---|---|---|
| Community-Scale | The type and intensity of **potential exposures** from the wildland vary depending on the location of communities, influenced by factors such as topography, surrounding fuels, and weather. | Recovery efforts should put emphasis on **different mitigation strategies** in areas of the community that abut the natural environment and areas of the community that are surrounded by the built environment. |
| Community-Scale | The most effective strategy for preventing suburban conflagration is to **reduce the likelihood of initial structural ignitions**. For homes that border the grassland, the main threat of ignition is from direct flame contact through connective fuels, as grassland embers have a short flying range and burn out quickly. Maintaining wildland vegetation in forested areas such as Kula can reduce the rate of fire spread, but these fuels still have the potential to generate long-range embers. | **Establish and maintain fuel breaks** along the periphery of the community, especially in communities surrounded by grassland. |
| Community-Scale | **Structural spacing** is of paramount importance in reducing conflagration risk for structures within a community. | **Expand or otherwise maximize the separation distance** between buildings to at least 20 feet where possible. In cases where increasing the separation distance is not possible, it is crucial to prioritize safety by avoiding the construction of larger buildings on the parcel that would reduce the space between structures. |
| Parcel-Level | Homes abutting wildland are vulnerable to embers and flames. **Maintaining a defensible space** can significantly reduce the risk of flame contact to these homes, especially for homes surrounded by grassland. Noncombustible fencing can mitigate this vulnerability while also, in the event of a home ignition, compartmentalizing the fire, reducing thermal exposure on surrounding homes. | **Defensible space** beyond Zone 0 is vital for properties abutting grasslands. These parcels should feature concrete or noncombustible fencing on all sides, without vegetation in close proximity to the fence. |
| Parcel-Level | The density of buildings directly correlates with the **presence of connective fuels**–such as vehicles and ornamental vegetation–which are also a source of embers once conflagration starts. | **Eliminate connective fuels** between homes. Maintain defensible space and a noncombustible Zone 0. Use native hardscapes such as lava rock and concrete or noncombustible fencing to break the connective fuel path and compartmentalize potential fires. Avoid outbuildings in yards within dense communities. The requirements in the Wildfire Prepared Home program can guide decision-making. |
| Parcel-Level | **Fire-resistant building materials** can stall fire progression when the thermal exposure is not extreme. The level of thermal exposure varies spatially and temporally throughout an event and, even under reduced exposure, ignition-resistant building materials can ignite. | When possible, rebuild homes to the Wildfire Prepared Home Plus standard. **At minimum, rebuild homes to the requirements of Wildfire Prepared Home.** |

IBHS RESEARCH

# IBHS Early Insights

*Lahaina Fire—2023*

Insurance Institute for Business & Home Safety (IBHS)

August 2023

**Why It Matters:** The August 9th Lahaina Fire on the island of Maui is the most recent example of a wildfire that transitioned to a nearby community with catastrophic and deadly results.

**Dig Deeper:** Like the 2021 Marshall Fire, high winds drove the fire, which entered the community of Lahaina though adjoining grasslands. It spread quickly once the built environment was ignited, and the resulting conflagration overwhelmed first response resources. Limited evacuation routes contributed to more than 100 known fatalities, making this fire more deadly than the 2018 Camp Fire, and potentially the largest loss of life from a wildfire in over 100 years.

**It's Not Just One Thing:** A notable exception to the widespread destruction is the survival of a development built in 2019-2020 with a mix of single family homes and a cluster of multifamily units in its interior. Within this development, no single-family structures were lost. Although several multifamily structures in the interior ignited (probably from embers), there was no structure-to-structure conflagration in this area. Despite close spacing, this area was spared in part because of:

- Class A roof covers, specifically asphalt shingles and metal.
- Non-combustible exterior wall materials.
- High-wind rated off-ridge attic vents, which have been shown by IBHS to also be effective at reducing ember entry.
- Due to the newness of the developed area, landscape vegetation did not cover as much area, providing less connective fuel between structures.

**Real-World Impact:** Modern building codes and community plans that consider wildfire along with programs like IBHS's Wildfire Prepared Home™ designation can reduce the losses and displacement caused by conflagration-level events such as the Lahaina Fire. Hawaii's modern building code has high-wind requirements that introduced elements that helped newer construction resist wildfire conditions.

# OVERVIEW

The August 9, 2023, Lahaina Fire on the island of Maui, is the most recent example of a catastrophic wildland-urban interface (WUI) fire that transitions to a built environment conflagration. Fire entered the community though grasslands and spread quickly once the built environment conflagration took shape, overwhelming response resources. The rapid spread through both grasslands and the built environment coupled with limited evacuation routes contributed to over 100 fatalities so far, making this fire more deadly than the 2018 Camp Fire.

With over 2,200 structures destroyed, the Lahaina Fire is the seventh most damaging fire in the United States, based on structures destroyed, since 1990. The number of destroyed structures represents nearly three-quarters of all buildings in the community. Figure 1 provides a post-fire satellite view along with the estimated fire boundary and areas within Lahaina that survived.


*Figure 1: Post-fire satellite image showing the boundary of the Lahaina Fire and larger areas within the community that survived (orange lines). Imagery courtesy of Maxar.*

# WEATHER CONDITIONS

- Parts of the island of Maui were under moderate drought conditions.
- Strong easterly trade winds were intensified by a strong ridge of high pressure to the north of the Hawaiian Islands and Hurricane Dora (low pressure center) passing approximately 700 miles south of the Hawaiian Islands.
- Easterly trade winds flowed down the sloping terrain toward Lahaina, helping to dry the airmass further. Relative humidities were between 20 and 30 percent.

  Although not as extreme as those observed during the 2017-2018 western US wildfires, the humidity levels were low enough to reduce the moisture content of fuels, such as grasses, to single-digit percentages[1], contributing to rapid fire spread.

- Typical wind gusts during the event were likely between 50 and 60 mph, with peak gusts near 70 mph. This estimate is supported by available video during the fire and the limited surface weather observations available.

  The closest observing station to Lahaina was a RAWS automated observing station at Kealia Pond National Wildlife Refuge, approximately 15 miles southeast of Lahaina. It measured a peak gust of 53 mph. Winds in Lahaina were likely stronger given the mean north-east wind direction, as this station was not affected as much by the downsloping terrain as in Lahaina. The peak wind gust measured on Maui during the event was 67 mph near Kula.

- Wind flow conditions were likely ideal for tilting and stretching the large flames. Given the elevated wind speeds, the chance of long-range spotting embers from grass and shrubs was minimal. These embers would likely burn out completely during their airborne journey. However, in the case of embers originating from structures, these wind speeds could facilitate ember transport over longer distances.

# BUILDING CODE ENVIRONMENT

- Hawaii has currently adopted the 2018 International Residential Code and the 2018 International Building Code; however, the state has several amendments to the model code, and enforcement is at the county level.
- Hawaii has adopted NFPA 1 as the statewide fire code. Within the state fire code, WUI provisions are provided (Chapter 17). The WUI provisions are based on the NFPA 1144 standard and are contingent on WUI areas being defined. However, it is unclear where or when these are required for new construction and what areas of the state are defined WUI areas. Life safety elements related to ingress/egress requirements, interior fire spread, and interior sprinkler systems (commercial only), are required in all instances.
- Maui County has a County Wildfire Preparedness Plan, originally developed in 2014. The county also has a Hazard Mitigation Plan, most recently published in 2018.

---

[1] Overholt, K. & Cabrera, Jan-Michael & Kurzawski, A. & Koopersmith, M. & Ezekoye, Ofodike. (2014). Characterization of Fuel Properties and Fire Spread Rates for Little Bluestem Grass. Fire Technology. 50. 10.1007/s10694-012-0266-9.

# BUILDING STOCK

As in all wildland-urban interface built-environment conflagrations, to slow or stop fire progression structures must function as fuel breaks rather than fuel sources. Many homes in Lahaina had some individual components of wildfire-resistant construction (for example, Class A roof covers or noncombustible wall material) but when all three ignition mechanisms (ember attack, direct flame contact, and radiant heat) are acting simultaneously in a built-environment conflagration, any major weak point in the system of protection is often exploited. Older construction, built prior to the common use of central air conditioning systems, is designed for cooling and ventilation by natural means which makes it more susceptible to ember entry. It does not appear likely that any structures were built with wildfire as a primary risk. Newer construction had the high-wind protection elements required by Hawaii's building codes.

- The building stock in Lahaina was approximately 80% single-family residential construction. The dominant era of construction was the 1960s to the 1980s. However, there are newer homes built under modern building codes.
- Commercial buildings ranged from historic structures along Front Street to typical light commercial seen in most communities. Multi-family construction was a mix of duplex, low-rise condominiums, and multi-structure apartment complexes.
- Roof cover was dominated by asphalt shingle roofs, with a small number of tile, metal, and wood shake roofs.
- Open eave roof construction is common, given the need for ventilation in a consistently warm climate.
- Wall cover materials are highly variable ranging from concrete masonry unit (CMU) block walls, wood panel siding (dominant on homes built in the 1960s and 1970s), concrete fiber board, stucco, and a small number with vinyl or aluminum siding.
- Structure separation distances are varied but on average were between 15 and 25 feet apart in most residential areas.

# FIRE EVOLUTION

The evolution of the Lahaina Fire followed a classic wildland-urban interface progression, as outlined by Cohen (2008)[2], and quickly became a built-environment conflagration. In general, the sequence of events was like those observed during the 2021 Marshall Fire.

- Fire spread quickly through dry grasslands, down the gently sloping terrain toward Lahaina following the general mean wind direction. In this event, complex terrain was not present. The terrain is a nearly constant downward slope from approximately 160 ft of elevation east of Lahaina to the ocean. At this time, the exact cause of the fire is unknown. However, analysis of the fire boundary, distribution of destroyed structures and wind flow characteristics supports the potential for multiple points of ignition within or near the grasslands.
- Like the Marshall Fire, this fire likely entered the built environment through a combination of direct flame and radiant heat ignitions on the initial structures, likely in multiple locations. Once the initial structure ignitions occurred, all three ignition mechanisms took hold in these

[2] Cohen, J., (2008). The wildland urban interface fire problem: A consequence of the fire exclusion paradigm. *Forest Hist. Today*, 20-26.

areas. Structure separation distances of less than 20 feet were present and the area contained sufficient fuels connecting homes, both vegetative, and other elements such as vehicles and sheds.

- As with most WUI fires, a major weak link was the presence of tall dense vegetation and other connective fuels near homes, specifically in the 0 to 5-foot home ignition zone (also referred to as Zone 0). With combustible materials inside the home ignition zone, the open eave roof configuration was likely easily exploited by flames and radiant heat build-up. Also, general architectural design for cooling and ventilation may have contributed to a greater ember entry threat.

Post-fire satellite imagery courtesy of Maxar and Umbra Space synthetic aperture radar data does suggest varying degrees of fire exposure and severity within the community. An example of this is shown in the northern residential areas of Lahaina, north of Malanai Street (Figure 2 - left).

*Figure 2: Satellite imagery of two areas where some of the most intense fire exposure possibly occurred, (left) south of Fleming Rd. to Kapunakea St. and (right) the area south of Shaw Street and bounded on the east side by the Honoapiilani Highway, including along Front Street. Satellite imagery courtesy of Maxar.*

In this area of mostly single-family homes, the fire intensity was not enough to consume all vegetation and the presence of some sporadic homes that survived suggests that ember-driven ignitions (from both vegetative and structural fuels) may have been the dominant spread mechanism. This area also had structure spacing ranging from approximately 11 ft to greater than 25 ft for a few parcels.

South of Fleming Road, in a slightly denser area of older single-family homes, imagery indicates a more intense fire, with little materials remaining. In this area, all three ignition mechanisms (ember attack from structural fuels, direct flame contact, and radiant heat) were likely present and each were substantial contributors to the intense fire. It is likely fire spread from this area into the historic structures along Front Street. Pier and beam construction was common in this section of Lahaina. Wood lattice often surrounded the elevated structures along with a larger number of elevated decks. Vegetation coverage was near or greater than 50% on many parcels.

The area of mixed commercial construction between Kapunakea Street and the Kahoma stream channel survived and appeared to function as a partial fuel and ember break between this area and a new residential development immediately downwind to the south-southwest. However, fire spreading through the grassland east of Lahaina appeared to enter the community through residential areas on the eastern side and either continued or started a new chain of structure-to-structure spread.

Fire ultimately spread through nearly the entire community, with another area of intense fire noted in the residential areas at the southern extent of Lahaina (Figure 2-right). The area south of Shaw Street and bounded on the east side by the Honoapiilani Highway, including along Front Street, appeared to also experience some of the most extreme fire conditions.

Efforts to decrease the fire's intensity in proximity to buildings, whether through the establishment of fuel breaks or protecting structures, did not yield the desired results. Several factors, including power outages, the failure of operational hydrants, and a scarcity of fire engines on the island, compounded these difficulties.

# SUCCESSES

The most notable success story was a new development, built in 2019-2020. This neighborhood had single-family home construction with multi-family units in its interior. The development is located immediately south of the Kahoma stream channel and bordered by Front Street on the west, the Honoapiilani Highway to the east, and Kenui Street on the south side (see Figure 3). Within this development, no single-family structures were lost, but four multi-family structures in its interior ignited (initially likely from embers), but a structure-to-structure conflagration was avoided in this area.

*Figure 3: Post-fire satellite image of a new development, built in 2019-2020, that survived the Lahaina Fire. Note the four multifamily structures within the development that were destroyed. The initial ignition here was likely ember-driven, but a structure-to-structure conflagration scenario did not unfold here. Imagery courtesy of Maxar.*

Favorable elements may have included:

- Upwind fire and ember break from commercial construction and the Kahoma Stream channel.
- Class A roof covers, specifically asphalt shingles and metal.
- Non-combustible wall cover materials

- High wind-rated off-ridge attic vents (for wind and wind-driven rain mitigation). IBHS tests have shown that these vents are effective at reducing ember entry[3].
- Less dense connective fuels between structures, including vegetation.
- Vegetation, due to the new construction, was less mature, with lower areal coverage compared to other residential areas in the community.

Elsewhere, in the areas where fire exposure was not extreme, some individual structures survived amidst those that were destroyed, indicative of the sometimes-random nature of ember attack as a dominant ignition mechanism. In these cases, fuel density in the 0 to 5-foot zone was often less than neighboring structures, the presence of non-combustible wall materials, or structure separation distances greater than 40 feet. An example of a home that survived within an area of intense fire is shown in Figure 4.

*Figure 4: An example of a home that survive, with low density fuel coverage, especially in the 0-5-foot home ignition zone, an asphalt shingle roof, and non- combustible concrete masonry unit wall material. Post-fire imagery courtesy of Maxar and pre-fire condition image courtesy of Google-Street View.*

Homes that were built under modern codes have wind mitigation elements along with other requirements that can foster construction styles and materials that provide some level of mitigation against fire. An example is the potential use of ridge and/or off-ridge attic vents that have both high wind and wind-driven rain protection. These vents have also been found to reduce ember entry[3]. Also, the use of concrete foundations extending above 6-inches on-grade for termite protection is also an element that would meet the IBHS Wildfire Prepared Home™–Base level of protection.

---

[3] Quarles, S. 2017: Vulnerability of vents to wind-blown embers. *Insurance Institute for Business & Home Safety*. Technical Report. 24 pp. https://ibhs.org/wildfire/ember-entry-vents/

# WILDFIRE PREPARED HOME™

Wildfire Prepared Home™ is a program that defines specific actions homeowners in a WUI area can take to reduce the possibility that their home is ignited by wildfire.

## Wildfire Prepared Home – Base

The Wildfire Prepared Home™–Base level focuses on ember defense. It is not clear if this system would have been sufficient to stop the initial structure ignitions, which likely occurred due to direct flame and/or radiant heat from the grassland fire.

In areas with less extreme fire conditions and structure separation distances greater than 20 feet, and especially those greater than 30 feet, the Wildfire Prepared Home–Base level could have been effective in slowing or even potentially preventing structural ignitions.

If the mitigations are applied comprehensively in residential areas, at a minimum they would have been effective at reducing fire spread rates with some potential to stop the rapid chain of building-to-building fire spread.

## Wildfire Prepared Home Plus

The Wildfire Prepared Home™ Plus system would have likely been effective at stopping the initial structure ignitions.

In areas of intense fire in neighborhoods with typical spacing distances of 10 to 30 feet, all three ignition mechanisms were probably acting simultaneously. In this situation, a full system of protection against all three types of ignition, such as the Wildfire Prepared Home Plus standard, is necessary for any success in slowing or stopping fire spread in the absence of large-scale fire service intervention.

In a dense community (less than 10 feet between structures) it is likely that the system of protection offered by Wildfire Prepared Home Plus would have needed to be coupled with other required defensible space measures outside the home ignition zone, effectively reducing the areal coverage of connective fuels, including vegetation. Ongoing research by IBHS and our academic partners suggests this may be as low as 20 to 30 percent areal coverage of any combustible fuel on the parcel.

# SUMMARY

The Lahaina Fire is the most recent example of a wildfire acting as a catalyst for a built-environment conflagration. The pre-fire weather conditions readily supported the potential for a conflagration and the common vulnerabilities of the built environment, such as dense construction with little fire resistance, were present. The chain of events conceptually followed Cohen's (2008)[2] original wildland-urban interface fire concept and were very similar to that of the Marshall Fire.

The rapid fire spread into the built environment overwhelmed limited suppression resources and the limited number of evacuation routes unfortunately led to significant casualties. The Lahaina Fire is now the deadliest United States wildfire in 100 years. With over 2,200 structures destroyed, the Lahaina Fire is the seventh most damaging wildfire in the United States since 1990, based on structures destroyed.

With the absence of effective suppression efforts and the relatively homogenous, downsloping coastal topography, this fire presents an intriguing opportunity to examine how different buildings materials and designs responded to varying heat intensities depending on their surroundings. IBHS is currently considering deploying a ground team to conduct assessments of building performance in support of ongoing research objectives and the Wildfire Prepared Community initiative.

# ACKNOWLEDGEMENTS

IBHS would like to acknowledge Maxar Technologies for their rapid and public dissemination of post-fire satellite imagery.

Special thanks to Umbra Space for providing access to post-fire synthetic aperture radar data.

Data from the Microsoft building footprint database was used to develop the initial insights presented here.

## HLU Committee

**From:** Michelle Santos <Michelle.Santos@co.maui.hi.us>
**Sent:** Monday, September 16, 2024 3:54 PM
**To:** HLU Committee
**Cc:** Bradford Ventura; Chasserae Kaawa; Cynthia Sasada; Gavin Fujioka; Josiah Nishita; Pili Nahooikaika; Ryan Otsubo
**Subject:** MT#10756 Bill 103
**Attachments:** MT#10756-HLU Committee.pdf

**NOTE: PLEASE DO NOT FORWARD MY EMAIL TO ANYONE OUTSIDE OF THE COUNTY OF MAUI. YOU MAY CLICK ON THE ATTACHMENT ITSELF AND CREATE YOUR OWN EMAIL TO FORWARD THE DOCUMENT TO ANOTHER PERSON OUTSIDE OF THE COUNTY.**

*Michelle L. Santos*
Office Operations Assistant
Office of the Mayor
County of Maui
200 S. High Street 9th Floor
Wailuku, HI 96793
phone: (808) 270-7855
fax: (808) 270-7870