IBHS RESEARCH

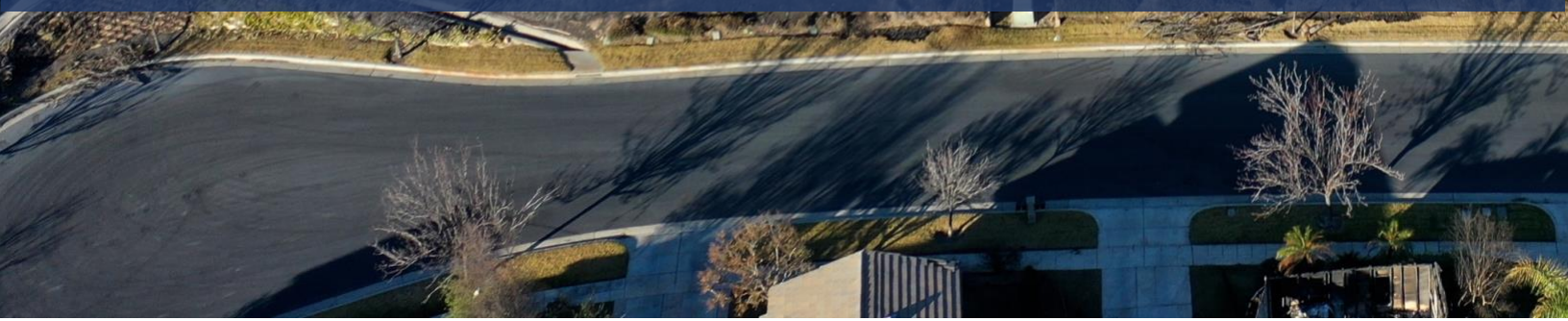


2025 LA County Wildfires:

Early Insights from Field Observations

Insurance Institute for Business & Home Safety

March 6, 2025



FROM WILDFIRE TO CONFLAGRATION

The Palisades and Eaton Fires raged through Los Angeles County neighborhoods creating catastrophic conflagration. More than 16,000 structures were destroyed in the fires which now rank as **two of California's three most destructive fires on record.** In the days following the conflagration, the Insurance Institute for Business & Home Safety (IBHS) deployed teams to study the damage and further advance the understanding of fire spread into and through communities.

Conflagrations follow humans, drought, and wind. Fire weather conditions in Los Angeles County reached their extreme just before the first fire reports: relative humidity dropped as the strong northerly Santa Ana winds kicked in. At these wind speeds, fixed-wing firefighting aircraft could not operate safely. With **the fire environment primed for rapid growth and aerial firefighting grounded, wind-driven fire dynamics took over**, accelerating both the spread and intensity of the flames in the early critical stages.

Since the early 20th century, urban conflagrations have resulted in significant financial losses across the United States. From historic fires like the Big Blowup Fire of 1910 in the Northwest to more recent devastating urban fires—the Tubbs Fire (2017) and the Camp Fire (2018) in California, the Marshall Fire (2021) in Colorado, the Lahaina Fire (2023) in Hawaii, and now the Palisades and Eaton Fires in Southern California—these events highlight the vulnerability of communities with dense housing, interconnected urban fuels (e.g., fences, vehicles, and sheds), and vulnerable building components that struggle to withstand even non-intense fire conditions.

Fire Behavior

Wildfires spread at different rates, influenced by factors like available fuel, topography, weather conditions, and suppression efforts. In California, these driving factors differ across the state's diverse wildland regions. In central and Northern California where conifer forests are more common, wildfires are primarily fuel driven. In contrast, **Southern California, characterized by chaparral shrubland, experiences fires where fuel is more limited, and wind plays a dominant role in fire spread**.

These Southern California wildfires generally fall into two categories:

- fall fires that are typically driven by strong offshore Santa Ana winds, and
- summer fires which typically occur under hot, dry conditions with comparatively weak onshore winds[1].

Most wildland ignitions in Southern California occur during the summer under the weaker onshore winds. However, the Santa Ana-driven fires receive the most attention and drive the majority of losses.

Santa Ana Winds

The Santa Ana downsloping wind events are often the driving factor for damaging wildfires that enter the built environment across Southern California, as was the case for the Palisades and Eaton Fires.

- Climatologically, Santa Ana wind events typically peak in November and December. Their seasonal occurrence typically spans October through April with the region averaging two events per month during this time.[2]

1 Jin, Yufang, et al. "Contrasting controls on wildland fires in Southern California during periods with and without Santa Ana winds." Journal of Geophysical Research: Biogeosciences 119.3 (2014): 432-450.

2 Guzman-Morales, J., A. Gershunov, J. Theiss, H. Li, and D. Cayan (2016) Santa Ana winds of Southern California: Their climatology, extremes, and behavior spanning six and a half decades, Geo Phys Res. Lett, 43 (6), 2827-2834. https://doi.org/10.1002/2016GL067887

- The intradecadal frequency of these wind events is generally tied to the El Niño/Southern Oscillation (ENSO) phases, with El Niño years typically seeing a reduced number of Santa Ana events compared to neutral or La Niña conditions, which was the case in January of 2025.[3]
- The most intense Santa Ana events both in magnitude and duration occur primarily in December and January. On average, events last 1.5 days, which is near the duration of peak downsloping winds that occurred during the Palisades and Eaton Fires.
- Santa Ana wind events exhibit a diurnal cycle which differs from typical convectively driven wind events that reach their peak in the mid-afternoon during peak daytime heating. Santa Ana wind events often peak in the early morning hours and decay during the daytime. During these fires, the winds reached their initial peak during the late afternoon and early evening hours on January 8, followed by a secondary wind maximum during the early morning hours of January 9.

This strong Santa Ana wind event, combined with dry conditions and low relative humidity, created extreme fire conditions on Tuesday, January 7. Once the Palisades and Eaton Fires ignited, they quickly became two of California's most destructive, together destroying more than 16,000 structures.

Drought

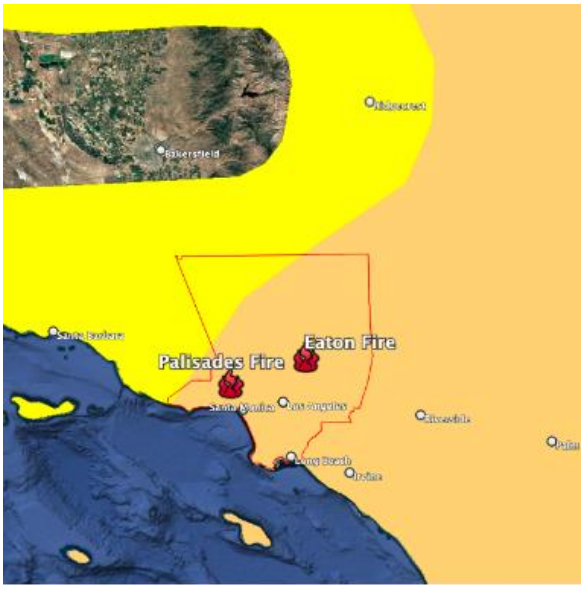
In early December 2024—just over a month before the fires, Los Angeles County was not experiencing any drought conditions (Figure 1a). However, by the end of the month, parts of the county fell under D0 (abnormally dry) and D1 (moderate drought) intensity levels (Figure 1b). Drought conditions persisted throughout January. On the day both fires started, the US Drought Monitor expanded the severe drought classification to cover most of Los Angeles County: 40% of the county was classified as moderate drought, while 60% of the county—including the areas where both fires ignited—was in severe drought. The overall intensity and extent of drought leading up to the fires and throughout January are summarized by the time history of the Drought Severity and Coverage Index shown in Figure 2, which indicates that Los Angeles County experienced drought conditions ranging from extreme (200–299) to exceptional (300–400) during January.

With the highly flammable chaparral fuels primed for ignition by the flash drought, strong winds pushed the fire quickly into heavier vegetation, including shrubs and trees, leading to medium- and long-range spotting.

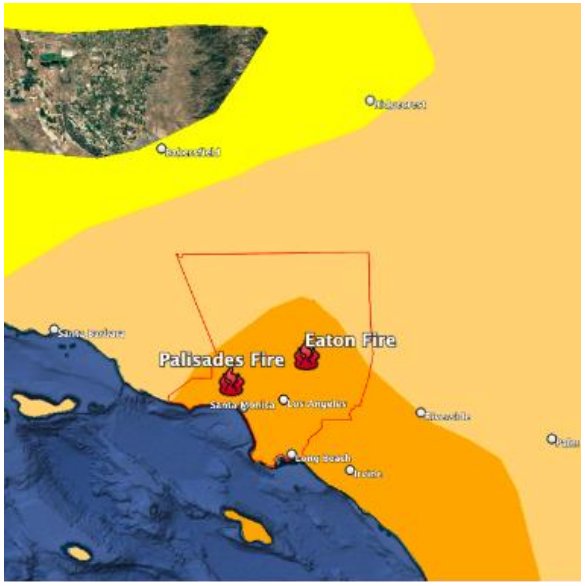
3 Rafael, M.N. (2003) The Santa Ana winds of California, Earth Interactions, 7(8), 1-13. https://doi.org/10.1175/1087-3562(2003)007%3C0001:TSAWOC%3E2.0.CO;2



(a) Valid 7 a.m. EST December 3, 2024.



(b) Valid 7 a.m. EST December 31, 2024.



(c) Valid 7 am EST January 7th, 2025.

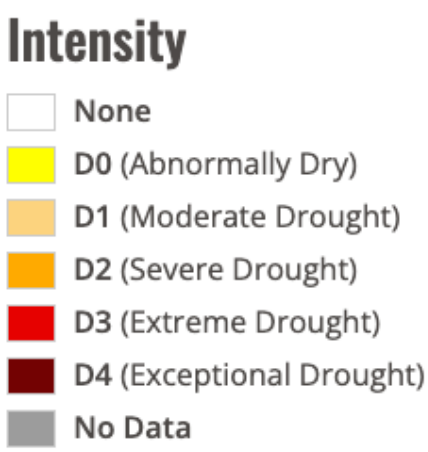


Figure 1. *US Drought Monitor showing changes in drought conditions in Los Angeles County (outlined in red) during the weeks leading up to the fires. Location of the fire ignition is indicated in the map.*

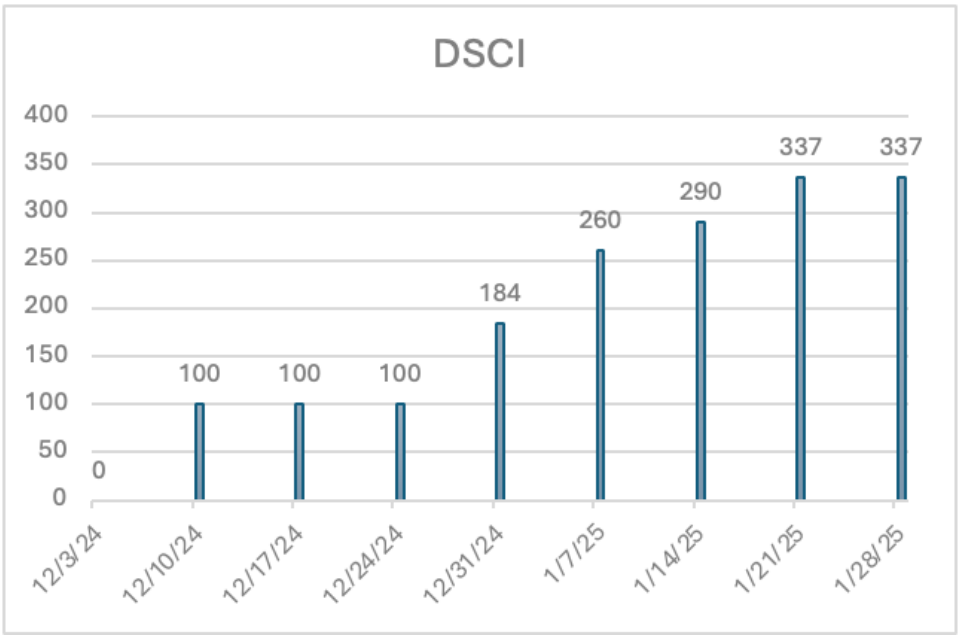


Figure 2. *Time history of the Drought Severity and Coverage Index (DSCI) in Los Angeles County during December 2024 and January 2025, highlighting the intensification of drought conditions.*

Palisades Fire

On January 7, 2025, just before 10:30 a.m. local time, a fire ignited near Skull Rock in the Summit neighborhood. As shown in Figure 3, data from the National Weather Service Automated Surface Observing Station (ASOS) at Van Nuys, located approximately 9 miles north of Pacific Palisades, indicates that at the time of ignition, the mean wind speed was around 30 mph, with gusts reaching up to 60 mph. These intense winds combined with a falling relative humidity created **a highly volatile environment** that contributed to the rapid spread of the fire and spotting across the Palisades neighborhood. Further, these winds created very unstable conditions for flight operations **hindering aerial firefighting containment efforts.**

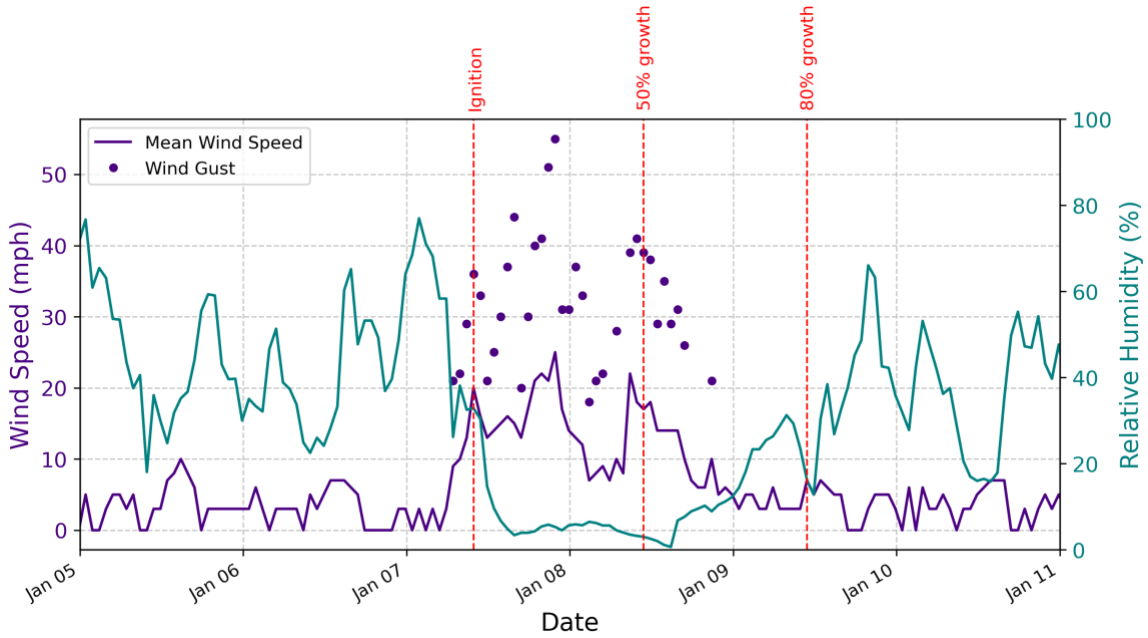


Figure 3. *Mean wind speed, wind gusts, and relative humidity recorded by the Van Nuys Automated Surface Observing Station (ASOS). The time of ignition of the Palisades Fire as well as its size relative to the final perimeter are indicated after 24 hours and 48 hours.*

After ignition, the fire quickly spread downhill toward the Riverview Country Estates while also advancing eastward. According to the CAL FIRE incident reports, within just an hour and a half—by 12:00 p.m.—the fire spotted across Palisades Drive. Shortly after 2:00 p.m., the fire had grown to 771 acres and reached the Castellammare neighborhood to the southwest near the coast. Within 8 hours, by 6:00 p.m., the fire spread along Temescal Canyon Road toward the Pacific Coast Highway in the south and crossing Topanga Canyon Boulevard on the west, consuming 2,920 acres on its path through neighborhoods to the Pacific Ocean.

Strong winds persisted throughout the night, and by 1:00 p.m. on January 8, the fire had reached 15,832 acres, extending from Eastern Malibu to Rustic Canyon in the east. While the fire continued to burn for 43 more days, this 48-hour period of rapid growth accounted for 80% of the fire's final size, highlighting the intensity and speed at which the fire spread under extreme winds and dry conditions. As winds subsided and aerial firefighting returned, targeted, strategic large drops of fire retardant aided containment efforts and kept fire from entering the next communities—the Monte Nido community in northwest Malibu and Crestwood Hills east of Mandeville Canyon (Figure 4). Additional fire growth was primarily backward, as forward growth had reached the Pacific Ocean fire break (Figure 5). **While wind drives forward fire progression, fuels drive lateral spread.**

The Palisades Fire was fully contained on February 20 after burning over 23,000 acres, destroying 6,833 structures, and claiming 12 lives. The final fire perimeter abuts the perimeters of two historical fires in the area in the past four years (Figure 6). The Franklin Fire, which started on December 9, 2024, burned over 4,000 acres and destroyed 20 structures in Malibu. The 2021 Palisades Fire began on May 4, 2021, in Topanga State Park and consumed 1,202 acres. These **previous fires created a fuel break for the 2025 Palisades Fire**, as the fire-prone vegetation was significantly depleted following these incidents, reducing available fuel for the active fire.

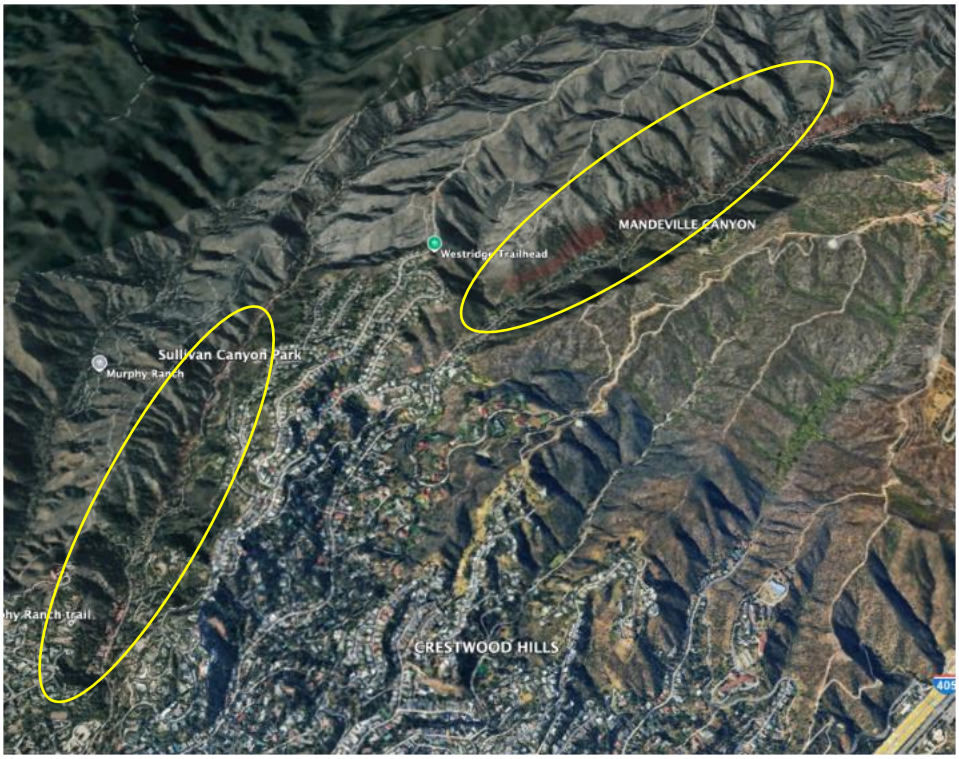


Figure 4. *Strategic areas where fire retardant was dropped as part of the containment operations to prevent the fire spreading into Crestwood Hills.*

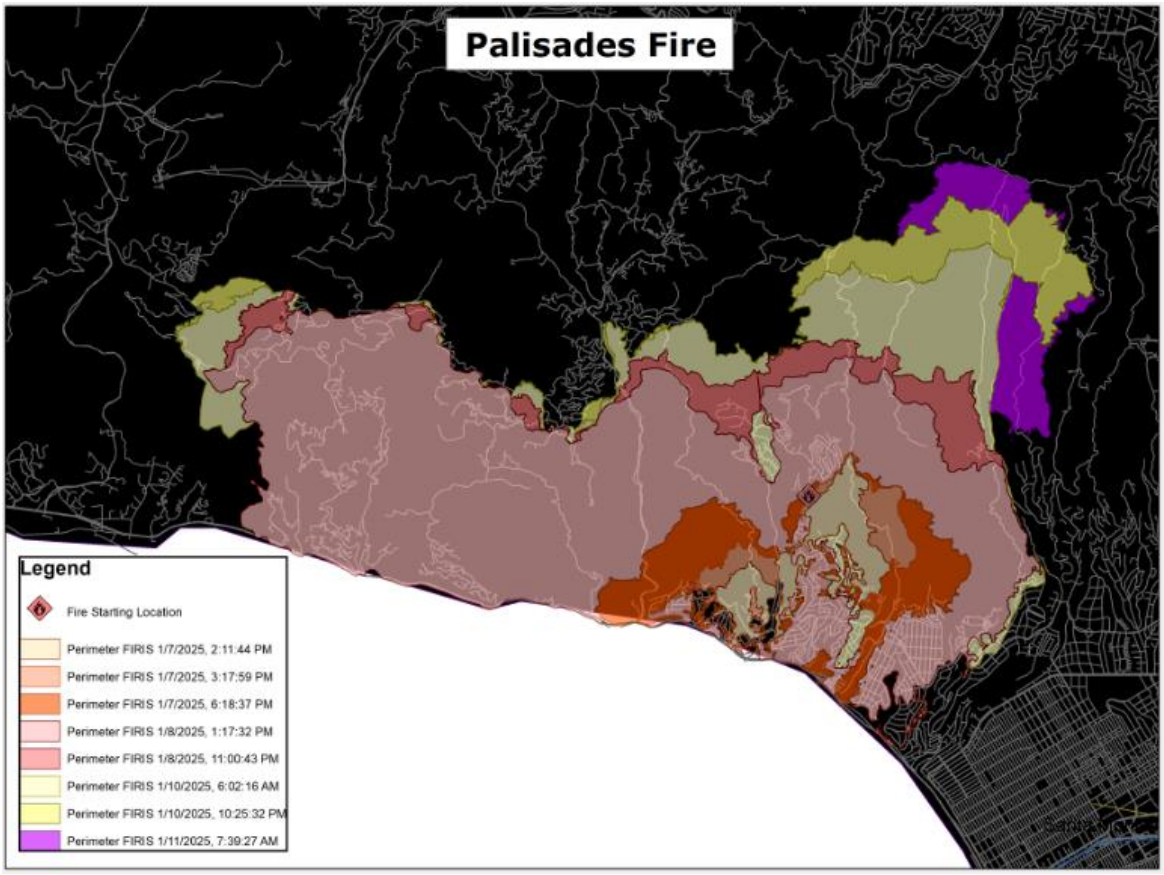


Figure 5. *Progression of the Palisades Fire reflected in the fire perimeters from January 7 to January 11.*



Figure 6. *Final Palisades Fire perimeter, shaded in red, with historical fire perimeters in the area outlined in green, including the 2024 Franklin Fire to the west and 2021 Palisades Fire to the north.*

Eaton Fire

The Eaton Fire ignited on January 7 at approximately 6:20 p.m. local time in the Eaton Canyon area of the San Gabriel Mountains, according to CAL FIRE status reports—eight hours into the Palisades Fire. At the time of ignition, relative humidity had dropped to around 10%, sustained winds exceeded 40 mph, and peak gusts surpassed 60 mph, as recorded by the ASOS at Burbank, located approximately 16 miles from the ignition site (Figure 7), creating extreme fire weather conditions.

As with the Palisades Fire, the combination of low humidity, dry fuels, and shifting winds created **ideal conditions for rapid fire spread and spot fire development.** The fire posed a significant threat to nearby communities and made containment efforts challenging. In less than an hour, the wind-driven fire had already spread to 200 acres. By 10:00 a.m. on January 8—just 16 hours after ignition—it had surged past 10,000 acres. Within 24 hours, by 6:10 p.m. on January 8, the fire had grown to over 13,600 acres, reaching 76% of its final size and devastating entire neighborhoods in Altadena. Maxar Satellite imagery shows the widespread destruction and active burning in Altadena on January 8 (see Figure 8). While the Eaton Fire continued to burn for 42 more days, **the extreme fire conditions during this initial 24-hour period led to conflagration.**

In the early hours of January 9, winds dropped below 10 mph, which allowed firefighting aircraft to operate along the northeast perimeter near Chantry Flats to suppress multiple hotspots. Despite ongoing containment challenges, minimal fire growth was observed after January 10. The fire became fully contained on February 20, 2025, after burning over 14,000 acres, destroying 9,418 structures, and claiming 17 lives.

As observed, the fire spread into Altadena for nearly two miles toward Historic Highlands in the southwest, completely burning neighborhoods between Lincoln Avenue (west of the fire footprint) and Sinaloa Avenue (east of the fire footprint). In the southeast, several structures in the wildland-urban interface (WUI) were destroyed. However, unlike in Altadena, the fire did not spread deep into these communities.

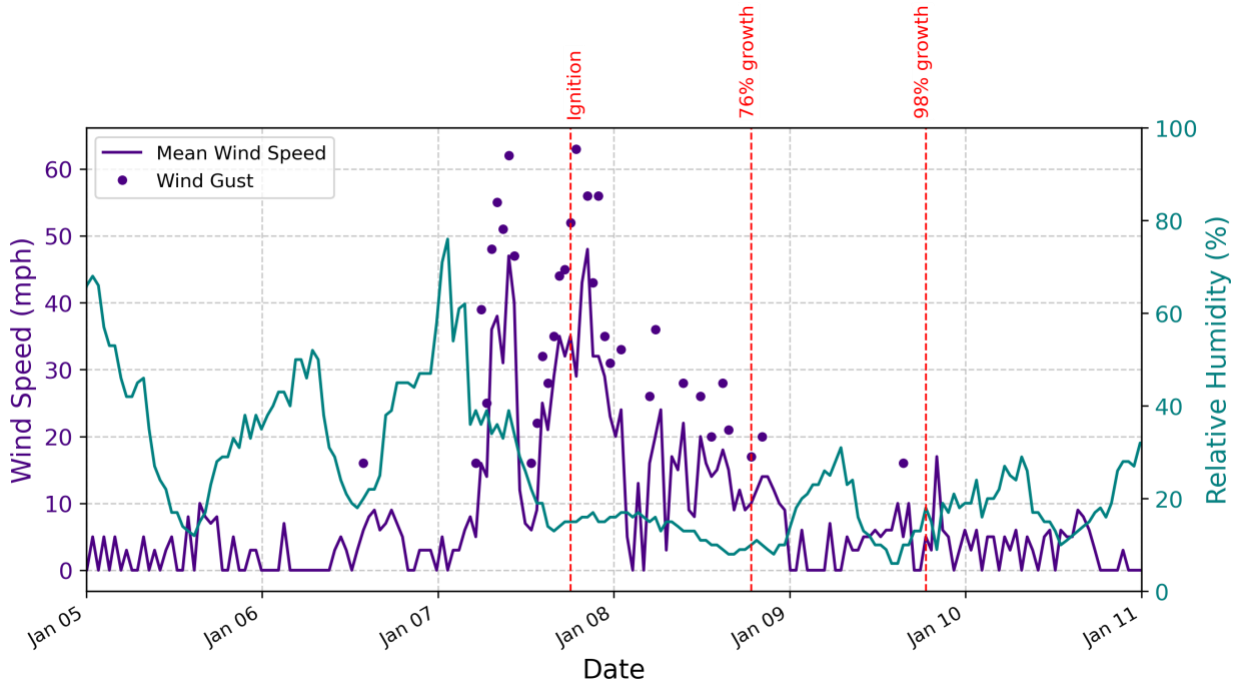


Figure 7. *Mean wind speed, wind gust, and relative humidity recorded by the Burbank Automated Surface Observing Station (ASOS) and the time of ignition of the Eaton Fire. The fire's size relative to the final perimeter are indicated after 24 hours and 48 hours*

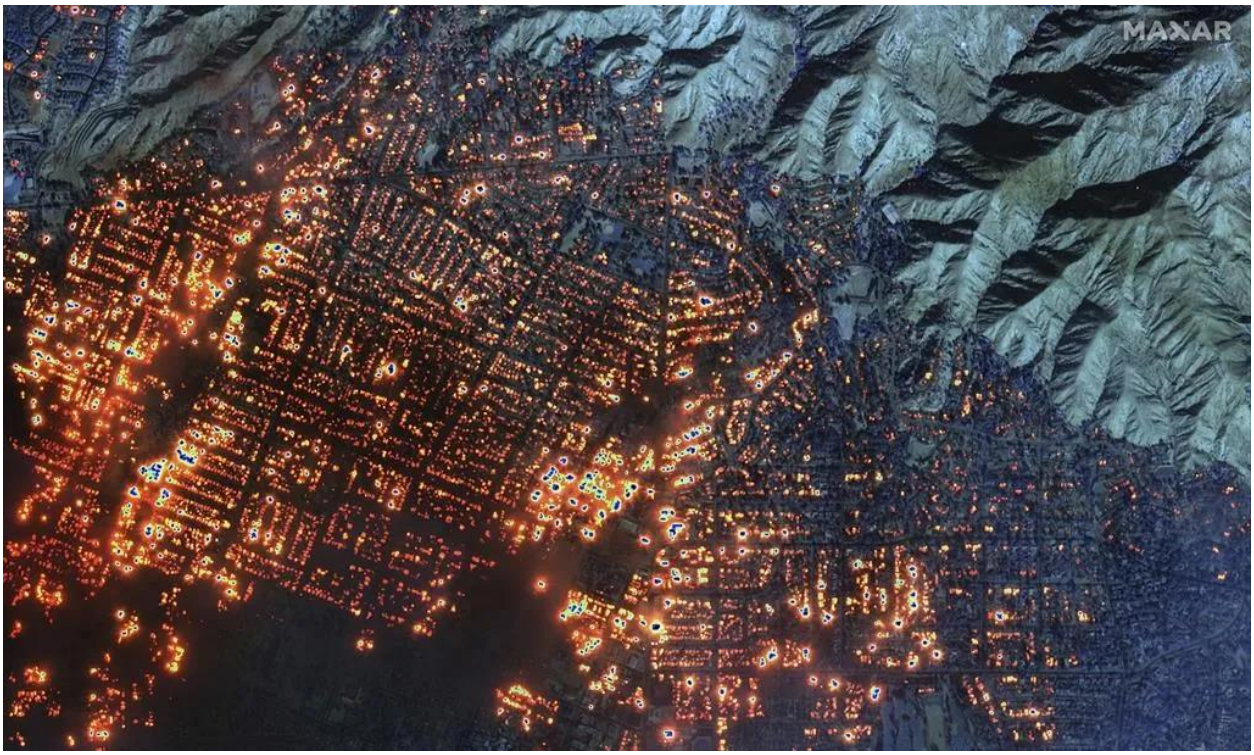


Figure 8. *Infrared Maxar Satellite image showing active burning in Altadena on January 8, 2025.*[4]

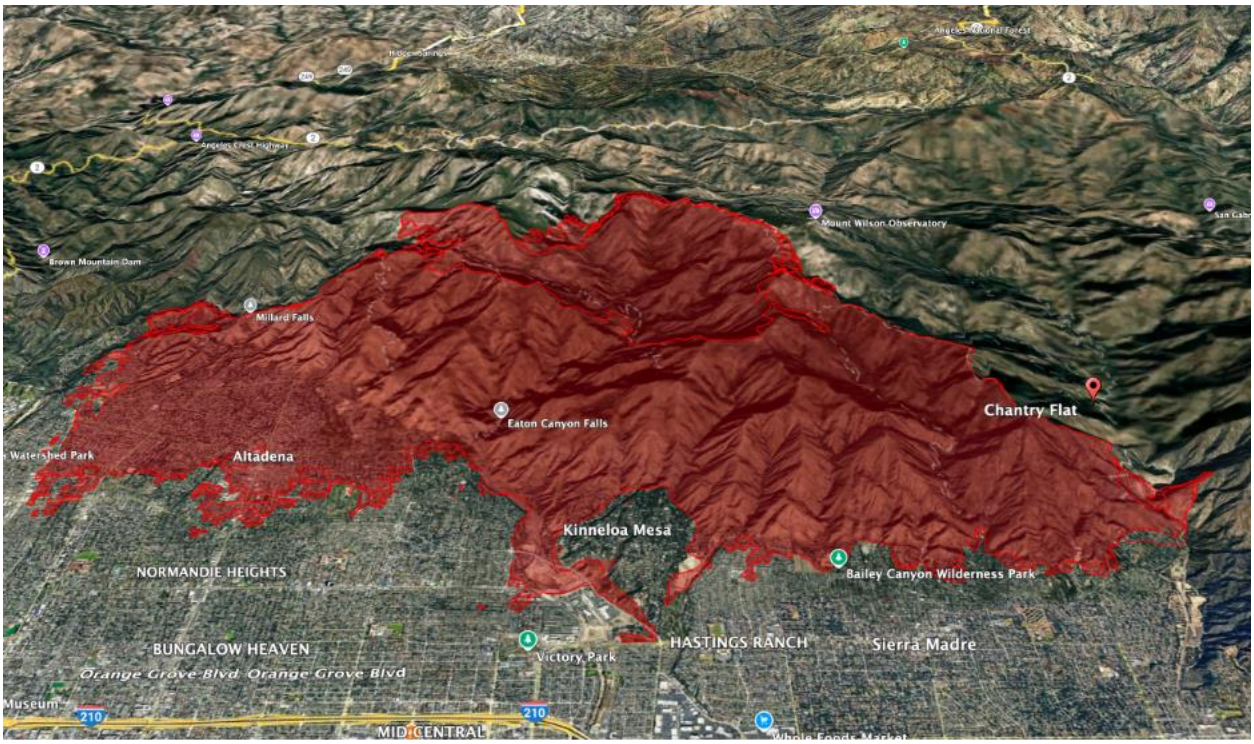


Figure 9. *Final Eaton Fire perimeter shaded in red.*

4 https://globalnews.ca/news/10950343/los-angeles-wildfires-photos-satellite-imagery/

Overview of the Deployment

From January 13 through 19, IBHS conducted a post-disaster investigation in Los Angeles County, California, with a team of nine staff who **evaluated 247 structures** affected by the fires. The deployment aimed to gain a better understanding of:

- the **exposure** to fire from both the wildland and the built environment,
- the **potential pathways** for fire spread into communities, and
- **building materials and mitigation strategies** that increase the likelihood of structural survivability.

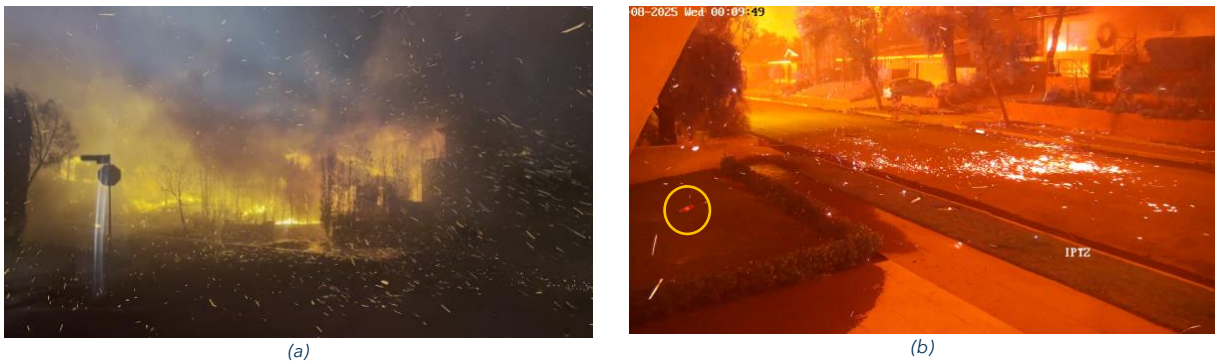
The team collected specific data across three key categories: building components, separation distance, and fuel factors, with a particular emphasis on connective fuels around the main structure on a parcel. In some cases, aerial drone imagery provided a broader perspective of the surrounding environment, including property boundaries and nearby connective fuels.

Key Data Collected:

- **Building Type:** 97% of the evaluated structures were single-family residential homes.
- **Roofing Material:** The most common roof materials of the evaluated structures were asphalt shingles and clay or concrete tiles. 46% of the evaluated structures had an asphalt shingle roof. 18.6% had clay or concrete barrel tile, 11.8% clay or concrete flat tile.
- **Vents:** Among structures with vents, only 7.8% had a 1/8-inch or finer metal mesh.
- **Wall Material:** 80% of structures had stucco as the primary exterior wall material.
- **Windows:** Window frames were most commonly metal (38%) and vinyl (34%).
- **Decks:** 63% of the structures had decks, most commonly with a wood walking surface.
- **Fencing:** Over 95% of the surveyed parcels had a fence, and in 61% of cases, the fence was either directly attached to the structure or located within Zone 0 (the 0–5 foot noncombustible zone). Additionally, 65% of fences were made of wood, increasing fire risk and serving as a dominant connective fuel.

Transition to Urban Fire

Post-event investigations consistently indicate that most initial structure ignitions in conflagrations result from the accumulation of airborne embers and wind-driven, ground-traveling burning debris near urban connective fuels or the buildings themselves, rather than direct contact with the main fire front. Under fire-conducive conditions, these small spot fires can grow vertically and lead to sporadic large fires within a community. **In extreme fire weather, these scattered fires can spread, merge, generate significant embers, and evolve into full-scale conflagrations** depending on the community's characteristics.



(a) (b)

Figure 10. *Examples of airborne and ground-traveling structural embers observed during the LA County fires shared by local residents with IBHS staff during the post-disaster investigation. Note that in (b), the fire on the connective fuel vegetation was successfully suppressed.*

Studies of past conflagrations and the observations by the IBHS team in the Eaton and Palisades fires reveal two distinct patterns in the destruction[5]:

1. sporadic losses where smaller clusters of homes are burned.
2. large-scale urban conflagration driven by structure-to-structure fire spread resulting in widespread devastation.

On a microscale, direct flame contact and radiation become the main fire spread mechanisms in conflagrations. On the macroscale, especially in high-wind events where ember generation markedly increases, embers remain a crucial factor in fire spread.

While even typical building materials that comply with modern building codes are likely to fail under the extreme heating rate of direct flame contact, fire intensity remains highly localized—even in strong wind conditions. This occurs because shifts in wind direction and natural breaks in fuel continuity—such as roads, parking lots, and parks—can disrupt fast and uniform fire spread.

When windflow characteristics—influenced by upstream buildings, terrain, vegetation, etc.—create pockets of reduced fire intensity, homes constructed with vulnerable materials or those with connective fuels that create paths to burning structures do not benefit from this variation in intensity. Slow-moving, low-intensity fires can still consume available connective fuels, reach structures, and eventually ignite vulnerable materials. However, **homes built with resilient components—such as those required in the IBHS Wildfire Prepared Home™ standard—can withstand prolonged exposure and help break the chain of conflagration.** In the Eaton and Palisades fires, the three pillars of conflagration, as identified by IBHS after the Lahaina Fire (2023), remained highly relevant: structure separation, connective fuels, and building materials.

Structure Separation

Structure density is a key factor in determining wildfire risk in WUI communities. **Once the first few homes ignite in densely built neighborhoods, downwind structures are more likely to experience extreme heating by direct flame contact.** Additionally, higher-density communities tend to have more connective fuels—such as fences, landscaping, and debris—which can allow low-intensity fires to build strength and potentially exceed the tolerance of building materials.

Dense neighborhoods pose challenges for evacuation where roads are one of the few fire breaks. Abandoned vehicles and congestion obstruct roads which reduces their effectiveness as natural fuel breaks, adds to the fuel load, and complicates firefighting efforts. These combined factors make **high-density, unmitigated communities particularly vulnerable to rapid fire spread** and complicate emergency response.

In wind-driven fires, flames are forced to tilt downward and extend forward, intensifying radiative heat transfer to downwind ground fuels and urban connective fuels. Stretched flames help fire spread rapidly from one building to another along the local wind vector. Meanwhile, homes positioned crosswind, or perpendicular to the wind vector, experience a level of convective cooling, as the surrounding air temperature remains lower than the temperature of the flames and the wind-driven plume. For these buildings, radiative heat transfer and intermittent flame contact act as the primary heating mechanisms. **Understanding these dynamics is critical to understanding how to effectively and wholistically mitigate communities against fire exposure.[5]**

In the densely built areas of Pacific Palisades and Altadena, the typical structure separation ranged from 8 to 20 feet. Differing exposures unique to the wind patterns of this event explain damage patterns in these communities.

Downwind

Research from IBHS shows that with about 10 feet of separation between a fully engulfed structure and a downwind structure no building material on the downwind structure is likely to survive. However, **when the separation distance increases to approximately 20 feet, the benefits of fire-resistant building components become evident**.

A home's overall fire resilience is only as strong as its weakest link. A combination of noncombustible building materials and double-pane tempered windows in a resilient frame—such as fiberglass or metal—significantly reduces

[5] *F. Hedayati, X. Monroy, E. Sluder, H. Fallahian, M. Shabanian, The 2023 Lahaina Conflagration, IBHS Research Report, September 2024.*

the likelihood of total loss. In contrast, vulnerable materials can fail even at greater separation distances due to intense downwind heat exposure, as illustrated in Figure 11 from the Palisades Fire. In this instance, a road with sidewalks provided a separation distance of approximately 60 feet from a burning upwind structure. The downwind home's window—a wood frame, single-pane annealed glass window—failed under moderate heat exposure. This highlights the critical role of both separation distance and material choice in determining a building's ability to withstand wildfire exposure.



(a) *(b)*

Figure 11. *Example of damage to less resilient building materials from a downwind exposure at approximately 60 feet.*

Crosswind

Exposure in crosswind conditions is significantly lower than in downwind scenarios, as radiation becomes the primary heating mechanism with some convective cooling and possible intermittent flame contact. **In these crosswind conditions, buildings with resilient materials can provide effective protection, even at a separation distance of just 10 feet**, as illustrated in Figure 12 in the Eaton Fire. In this crosswind scenario, the highlighted building experienced moderate to high heat exposure from a neighboring structure. However, because the highlighted building featured noncombustible siding and double-pane windows, the damage was limited and not a total loss. Notably, this home had a larger setback from the street than the neighboring destroyed structure, which helped reduce lateral radiation exposure to only a small portion of the side of the home. Field observations further revealed that only the overlapping sections of the highlighted structure sustained window damage, while others remained unaffected. This highlights the potential of strategically varying setbacks in high-density neighborhoods to help mitigate fire spread and reduce structural losses.



(a) *(b)*

Figure 12. *Example of a home with a crosswind exposure from the Eaton Fire.*

Connective Fuels

The connectivity of fuels between the wildland and the built environment, as well as between homes within a community, plays **a critical role in both the initial entry of fire and its spread** in a community.

Figure 13 highlights a case in the Eaton Fire where ignition was likely caused by embers traveling across a golf course and landing on flammable materials around a home or entering through openings. These embers ignited the corner home exposing the neighboring structure to crosswind heat. A tall concrete masonry unit block fence between the two buildings significantly reduced heat exposure, but the presence of connective fuels—in this case, an awning—between properties allowed the fire to spread closer to the neighboring home. It appears that first responders were able to suppress the fire on the awning before it could cause major structural damage. As a result, damage to the neighboring home was limited to broken window glass. The **survival of this house effectively disrupted the chain of conflagration**, creating an island of undamaged homes within a heavily impacted community.

Figure 13d further highlights the importance of fuel management in Zone 0. The leeward side of a tree in Zone 0 was completely consumed by fire, while the windward side remained green. This suggests that strong winds removed heat at a rate that prevented fire from spreading in the opposite direction toward the house. Without the persistent wind pushing the fire away from the home, the damage to the adjacent building could have been significantly worse. By maintaining Zone 0, homeowners become more in control of potential exposure to their homes rather than relying on stochastic fire behavior.



(a)



(b)



(c)



(d)

Figure 13. *Example of connective fuel exposure in the Eaton Fire. (b) shows the noncombustible wall bordering the property, which acted to reduce exposure. (c) shows the damaged window. (d) shows the tree in Zone 0 which burned similarly to the tree in the foreground.*

Figure 14 depicts another example of connective fuel in Zone 0 where rows of woody shrubs created a direct connective fuel pathway between the home and its neighbor. With a crosswind exposure, the fire used this vegetation to spread closer to the structure and heat the eave area, which showed signs of light charring suggesting that suppression efforts likely prevented further damage. The damage and the need for first responder intervention could have been prevented by removing the connecting fuel. This emphasizes that even under extreme fire conditions—where heat intensity along the wind can surpass the resistance of any building material—fire intensity in the crosswind direction varies locally. **By implementing the requirements of Wildfire Prepared Home, homeowners can use all available opportunities to reduce damage and improve survivability, even in extreme fire events.**



(a)



(b)



(c)

Figure 14. *Impact of connective fuel on damage spread in the crosswind direction from the closest destroyed neighbor on the side. This home is the same home shown in Figure 11 where the home's downwind structure separation was considered.*

In addition to permanent connective fuels such as trees and shrubs, portable connective fuels—such as trash cans, hot tubs, and small storage sheds—further impact a building's risk of ignition. The potential hazard these items pose depends on their contents, as certain materials can significantly increase fuel load and fire intensity.

- **Trash Cans:** IBHS researchers observed instances where ignited trash cans caused damage to the adjacent buildings (Figure 15a, 15b, 15c). In these instances, the fire was suppressed by first responders, limiting the damage to the building's cladding.
- **Hot Tubs:** Figure 15d depicts damage caused by a burning hot tub, likely ignited by embers. Fortunately, in this case, the wind direction helped limit fire spread to the building itself. However, the intense heat from the burning hot tub led to the failure of a nearby window and door, causing the frame and panes to collapse and creating an opening in the structure. Since this opening was on the leeward side, the likelihood of ember entry into the building was minimal, preventing a total loss. Nonetheless, the building still sustained severe damage.

These examples demonstrate how even seemingly minor external fuel sources can significantly impact fire behavior and the subsequent damage level to a home.



(a)



(b)



(c)

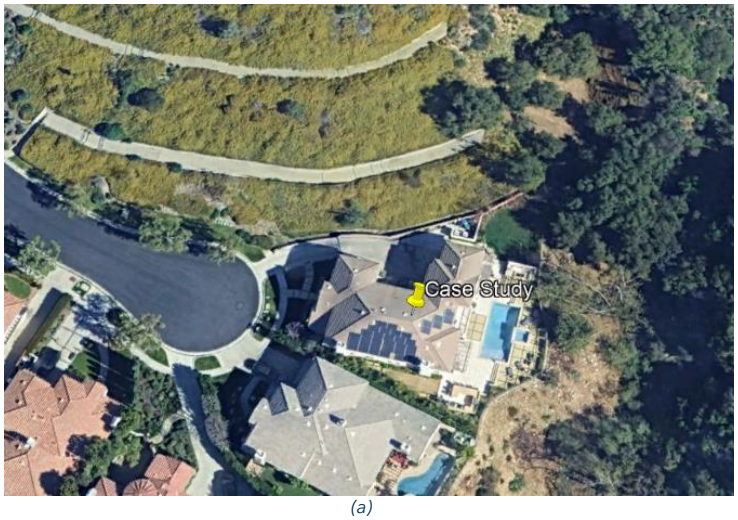


(d)

Figure 15. *Examples of portable connective fuels observed in the Palisades and Eaton Fires. (a), (b), and (c) show examples of trash cans while (d) shows a hot tub.*

Building Materials

Building materials play a decisive role in fire resistance when fire intensity is not extreme. Fire intensity in urban fires can vary significantly due to changes in available fuel, wind speed, and wind direction. **While wind patterns are beyond human control, reducing fuel connectivity and availability—by removing or spacing out combustible materials—creates an opportunity for fire-resistant building materials to mitigate damage.** This, in turn, can help slow fire spread and potentially break the chain of conflagration.



(a)



(b)



(c)



(d)

Figure 16. *Example of building material impacts in non-extreme fire conditions. (b) shows lack of connective fuels. (c) shows the two windows—one annealed glass and one tempered—on the side of the home that experienced similar fire exposure, but only the annealed glass window failed. (d) shows the tempered window etching.*

IBHS researchers identified **numerous cases where a combination of fire-resistant building materials and lower fire intensity—either due to shifts in wind patterns or fuel discontinuity—helped contain fire damage** (Figure 16). Figure 16 shows a home exposed to radiant heat from burning wildland shrubs along a nearby hiking trail. A break in the fuel continuity caused by the driveway reduced overall thermal exposure and limited damage to the home to the failure of annealed windowpanes, while the structure itself remained largely intact. Notably, two windows faced the fire and experienced similar levels of heat exposure—an annealed glass window and a tempered glass window. Only the annealed glass failed; the tempered glazing remained in place, sustaining only frame damage.

Figure 17 shows reduced exposure due to crosswind conditions and a lack of connective fuels. The building's noncombustible siding received enough heat to spall; had it been combustible, it likely would have ignited in a manner similar to the wood window frame, which did ignite before being suppressed. The annealed single-pane windows broke; however, because this window was not on the windward side, it received minimal ember exposure, and embers did not enter the house.

Figure 18 highlights an example of avoidable damage. While connective fuel in the form of a fence carried the fire close to the building, the stucco siding was able to withstand more heat than the burning fence could generate. This case demonstrates the effectiveness of fire-resistant materials when exposed to moderate heat and their ability to contain damage. However, it is important to note that if a window had been located near the fence, or if the local wind pattern had directed the flames from the fence toward the open eaves, the resulting heat could have caused window failure or eave ignition– potentially leading to the total loss of the building. This potential reinforces the need to **avoid connective fuels between homes, even when structures comply with modern WUI building codes**.

Decks are also vulnerable to ember ignition. Embers can accumulate on joists between deck boards, igniting debris trapped in those gaps (Figure 19). Once ignited, the fire can spread along the joists in a smoldering phase. When the smoldering fire reaches the board gaps, it can rekindle into open flames, creating a burn pattern where large sections are consumed at the interface of boards and joists. In this case, the deck ignition was successfully suppressed, preventing further fire spread.



(a) (b)

Figure 17. *Scorch marks and damaged windows show the exposure this home received and resisted because of the noncombustible stucco cladding.*



(a) (b)

Figure 18. *Two examples where fences served as connective fuels carrying fire towards structures. In both instances, the noncombustible cladding resisted ignition.*



Figure 19. *Decks pose a vulnerability to ember ignitions as seen at this home, where a hose was used to extinguish the ignitions.*

Building Materials and Extreme Fire Conditions

Most of the construction in the neighborhoods impacted by the Eaton and Palisades Fires occurred in the 1950s, **prior to the development of California's Chapter 7A** building code for wildfire-prone areas. While not required by building code at the time, typical construction in these neighborhoods favored the use of noncombustible siding—such as stucco—and Class A roofs. Many homes also featured double-pane windows for energy efficiency purposes, but few had tempered windows.

Fire intensity increases disproportionately under extreme wind conditions, underscoring the need for resilient building systems. **Research by IBHS on wind-driven fires indicates that the energy accumulation rate from a burning shed 20-feet away increases sixfold at a wind speed of 25 mph compared to no-wind conditions and rises twentyfold when exposed to 60 mph winds.**

During conflagration conditions, this intense energy is forced onto downwind structures, often overwhelming nearly all construction materials and leading to uncontrollable structure to structure fire spread. Only as these densely built structures experience the local variation in fire intensity can connective fuels and building materials compliant with modern WUI codes impact the chain of conflagration. **Noncombustible building materials alone cannot stop conflagration.**

Firefighter Interventions

IBHS surveyed numerous buildings that **demonstrated the effectiveness of on-the-ground firefighter interventions**. These interventions typically occurred at the initial point of fire development on or near buildings. Security camera footage shared by homeowners also revealed that some residents who did not evacuate suppressed ignitions in fuels near their homes. In one case, footage showed an individual applying fire retardant gel to a home a few hours before the arrival of the fire front. However, the timestamped footage indicated that about three hours later, the gel had dried out due to dry and windy conditions, minimizing its effectiveness. This observation aligns with previous IBHS research on fire retardant gels, which, while initially effective, undergo weathering and lose their protective properties within a few hours under extreme fire conditions.[6] In these conditions, the effectiveness of the gels largely depends on the time gap between their application and the fire front's arrival. IBHS advises homeowners against using valuable evacuation time to apply gels to their property.

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[6] *Kadel, J., Hedayati, F., Quarles, S.L. et al. Effect of Environmental Conditions on the Dehydration and Performance of Fire-Protective Gels. Fire Technol* ***57****, 1241–1257 (2021). https://doi.org/10.1007/s10694-020-01045-2*

SUMMARY

The Palisades and Eaton Fires collectively scorched approximately 60 square miles, resulting in the tragic loss of at least 29 lives and the destruction of over 16,000 structures.

- **From Wildfire to Conflagration:** Strong Santa Ana winds fueled an extreme fire weather setup and, once an ignition occurred, led to rapid, wind-driven, building-to-building fire spread through densely populated communities. The same weather conditions that fuel rapid fire spread grounded the air resources equipped to battle the blazes.
- **Structure Density:** Under such strong winds, flames from burning buildings bent down and stretched along the wind. For tightly spaced structures, this allowed flames to directly reach from one building to the next. Each home ignition generated high flux of short-range embers and ground-traveling embers, further amplifying the fire. In downtown Altadena and Pacific Palisades, the exposure was so extreme that even homes with some fire-resistant features had little chance of survival because the fire exploited the unmitigated weakest links.
- **Connective Fuels & Building Materials:** Where structure separation distances were closer to 20 feet, or when exposure was not directly downwind of the fire, fire-resistant building materials played a crucial role in reducing damage severity. These instances interrupted the chain of conflagration, leaving islands of undamaged homes within the scorched community. These homes typically did not have any connective fuels to their surrounding destroyed neighborhoods.

Exposure & Resilience: Among the three pillars of conflagration—structure density, connective fuel, and building materials—structure density and connective fuels couple with environmental conditions to determine thermal exposure intensity. Meanwhile, building materials determine a structure's resilience to this exposure. When exposure intensity surpasses resilience, structures are not expected to survive. With tight structure density, significant connective fuel, and Santa Ana winds, the exposure level becomes so intense that nearly all building materials are overwhelmed.

- In existing communities where structure separation cannot be changed, removing connective fuels becomes the meaningful lever to reduce exposure levels. Where connective fuels have been addressed, resilient building materials have a better chance of reducing damage.
- Noncombustible fences, such as brick and concrete masonry, can effectively minimize radiation and intermittent flame contact from burning neighbors and compartmentalize fire.

Work towards Wildfire Prepared Home: Typical construction in these communities featured some resilient elements compliant with the Wildfire Prepared Home requirements—such as stucco cladding, Class A roofs, double-paned tempered windows—but lacked the full system of mitigations. While individually these components provide an acceptable degree of fire resistance, the overall resilience of a structure is determined by its weakest component. Until all components are addressed, the property cannot reap the benefits of the individual component's fire resistance. Because the remaining weak component varied structure to structure from relatively inexpensive features like vents to more costly features like windows, the cost to mitigate homes in this area varies. But the investment required to enhance resilience in these communities is not as substantial as commonly estimated. Strengthening strategic vulnerable components within an already robust system can significantly improve a home's resistance to fire.

May 2025: Originally published on March 6, 2025, this version corrects Figure 3 and Figure 7.