Reducing WUI Fire Losses with the Hazard Mitigation Methodology

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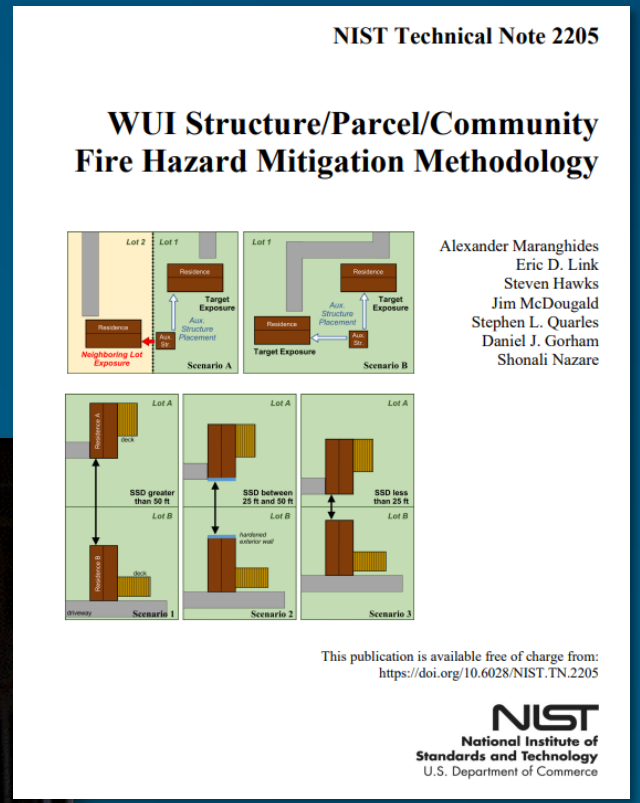
Fire does not care about <u>what</u> is regulated and <u>who</u> owns what; it is all about specific hardening for flame and ember exposures

BOARD OF FORESTRY
STATE OF CALIFORNIA
AND FIRE PROTECTION


NIST Technical Note 2205

WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology

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This publication is available free of charge from:
https://doi.org/10.6028/NIST.TN.2205

NIST National Institute of Standards and Technology U.S. Department of Commerce

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Overview

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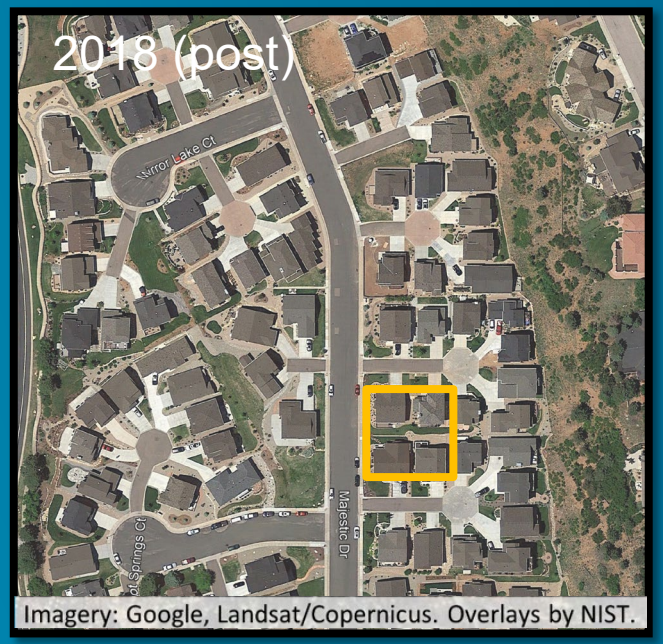
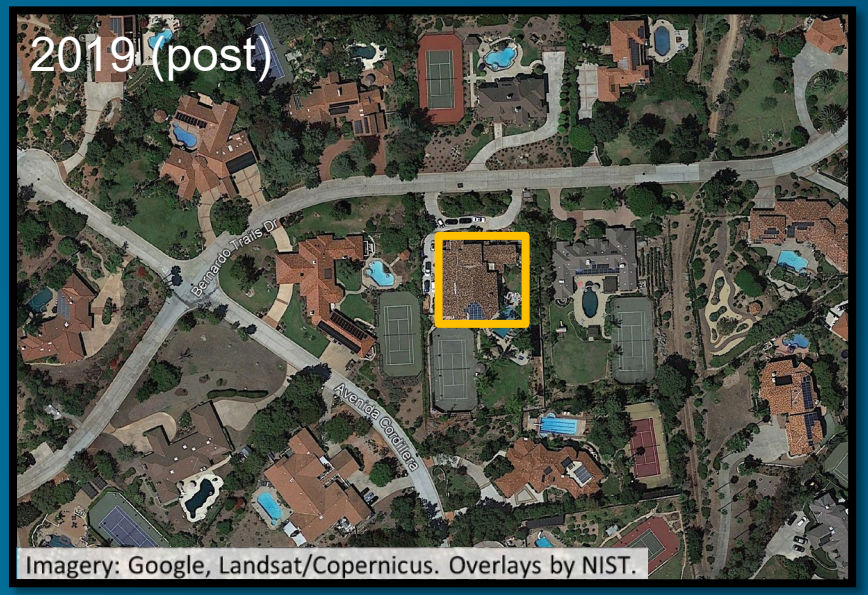
1. Not all WUI is the same – different problems require different solutions
2. Exposures in the WUI
3. There are fundamental differences in what can be understood from the field and what cannot
4. Where current codes and best practices stand and challenges with retrofit?
5. Hazard Mitigation Methodology (HMM) and paths forward

WUI Community Types

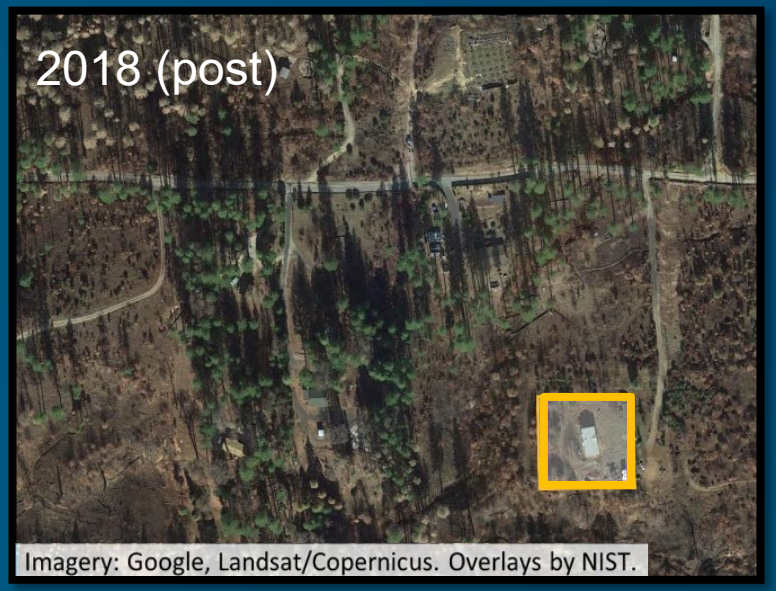
Interface/Intermix, housing density



Waldo Canyon Fire, Interface



Witch Fire, Interface



Camp Fire, Intermix

equal scale images – 0.85 acres

Hazard mitigation solutions for low density are insufficient for moderate and high density

"my community is my castle" ⟸ **"my home is my castle"**

Exposures in the WUI

Fire and Ember Exposures

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Two Different Problems with Different Spatial Scales

Intra or Inter ***Community***

n=1 to ~1,000,000
diameter: 0.1 to ~5+ inches
material: variable
other: accumulation, energy content ignition conditions: variable

WIND

Ember Exposures - up to ~2+ miles

Fire Exposures - up to ~100+ ft

Wildlands / Veg.

Neighboring structure

Aux. fuels

Small fuels including parcel veg.

Attached combustibles

Source

Intra or Inter ***Parcel***

Flux: up to ~100 kW/m²
*Duration: seconds to tens of minutes**
Ignition heat flux: variable, exposed combustibles: ~15 kW/m²
** Ignition is driven by the combination of duration and flux intensity*

Structure hardening for embers always needed

Protect your community from Wildfire

HMM

Hazard Mitigation Methodology

HMM is a comprehensive, science-based community wildfire protection approach

Fuels spacing and/or structure hardening is scenario specific

WUI Fire Hazard Mitigation Components

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Defensive Actions Reduce Exposures DURING the event

WUI fire hazard mitigation is a balance between two input dials — reducing exposure and increasing structure hardening

Why we cannot assess "successes" from the post fire environment

Defensive Actions Change the Event

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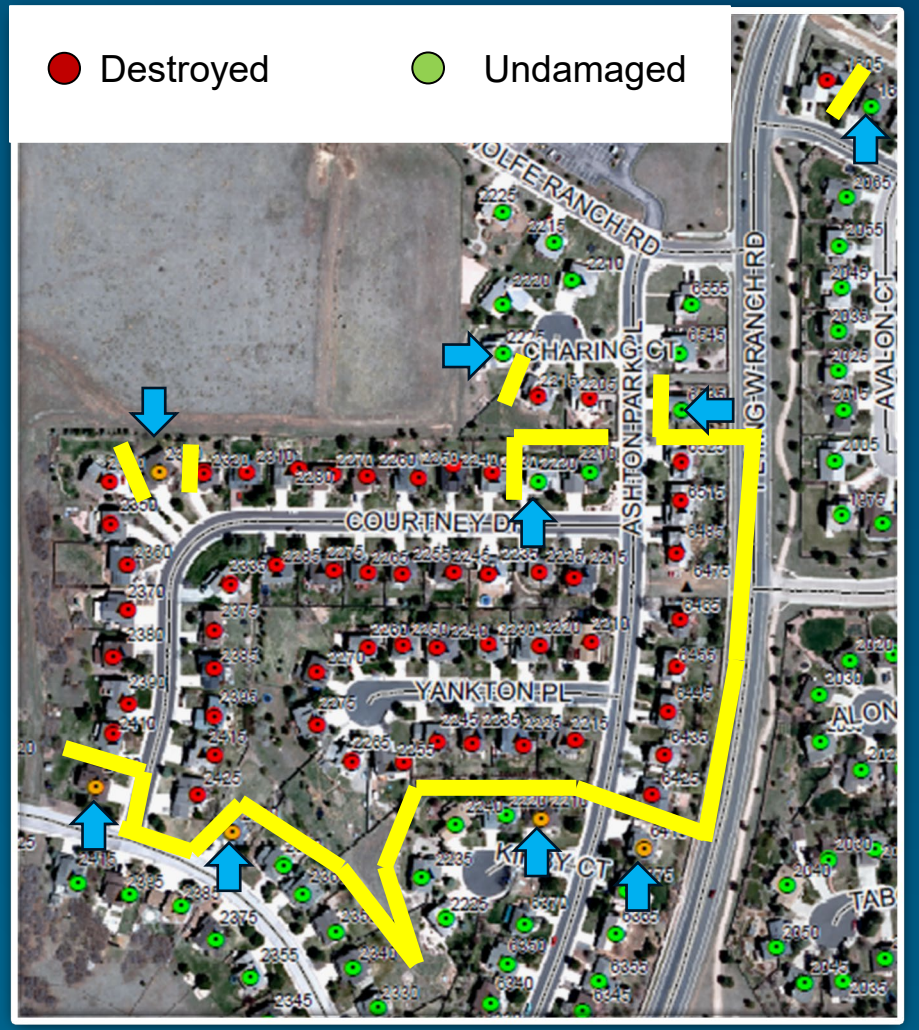
Waldo Fire, CO - NIST Technical Note 1910

- Fire boxed in very effectively
- Containment aided by wind decrease
- Damaged is ~ Defended

	Structures within fire perimeter	Destroyed	Damaged	Undamaged
Total	1455	344	101	1010
Defended (%)	324 (22%)	76 (22%)	94 (93%)	154 (15%)*

* Confirmed value of defended structures, number of parcels defended expected to be significantly larger – based on technical Discussions

WUI defensive actions reduce the extent of destruction, however actions cannot be guaranteed and should not be taken by civilians



[A Case Study of a Community Affected by the Waldo Fire - Event Timeline and Defensive Actions]

What Can be Learned from Post Fire Study?

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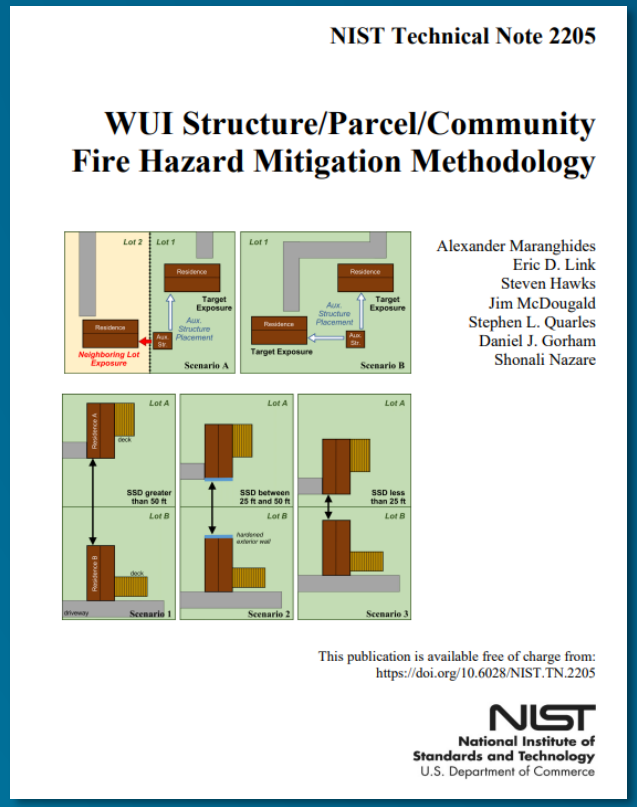
Exposures do not average out over the incident

You almost always *cannot* tell "what works" because *you do not have* ***local exposure*** *information and* ***defensive actions***.

Post fire allows to identify failures, but even then, typically without specific context about exposures intensity and duration.

Waldo Fire, Courtesy of Colorado Springs Fire Department, used by permission

Hazard Mitigation Methodology (HMM)



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Evolution of Structure/Parcel and Community Hardening

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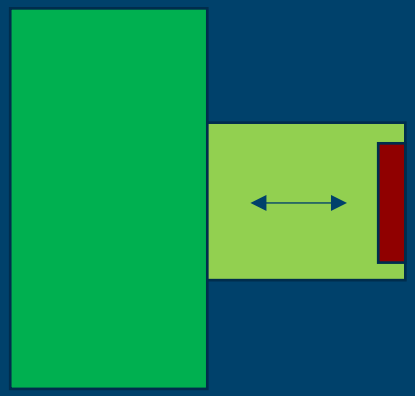
Early Experiments

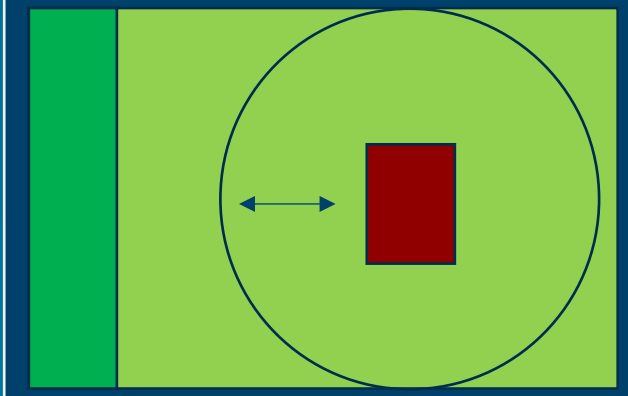
- Limited exposure to structure coupling
- Limited ambient wind
- No ember hardening



"House in the woods"

Early Building Codes (2008-2020)

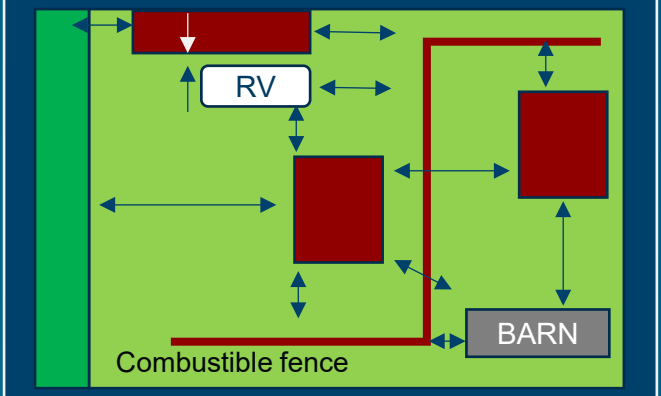
- Defensible Space
- Some exposure to structure coupling
- Some ember hardening



"Parcel and zones"

Structure / Parcel / Community HMM (2022)

- **Goal: Stand alone structures**
- Comprehensive exposure to structure coupling for fire and embers
- Multiparcel fuels
- Housing density (H, M, L)
- Community hardening



"Multiparcel spatial analysis"

Paradigm Shifts

- From defensible to **structure must stand alone**
- From single parcel zones to **multi-parcel spatial analysis and mitigation**
- From voluntary to **comprehensive addressing all the vulnerabilities**

WUI Structure / Parcel / Community Fire Hazard Mitigation Methodology (HMM)

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- A **performance-based approach** to structure/parcel and community spatial hazard mitigation
- **Comprehensive** coupling of fire and ember exposures to structure/parcel and community hardening
- Designed specifically to address hazard **mitigation of existing communities – retrofit ready methodology**
- HMM can also be used for new construction
- Graphical User Interface tool online: https://www.nist.gov/el/hmm

HMM Requires:

1. Hardening for embers by addressing *all* structure vulnerabilities to embers (~40) *and*

2. Addressing all flame exposures vulnerabilities by:
   a. Removing, reducing or relocating fuels *and/or*
   b. Directionally hardening the structure for flames

Fire does not care about parcel boundaries or legislative mandates

Codes: Value Added and Limitations

Comparison of HMM to WUI Codes

Hazard Reduction Continuum

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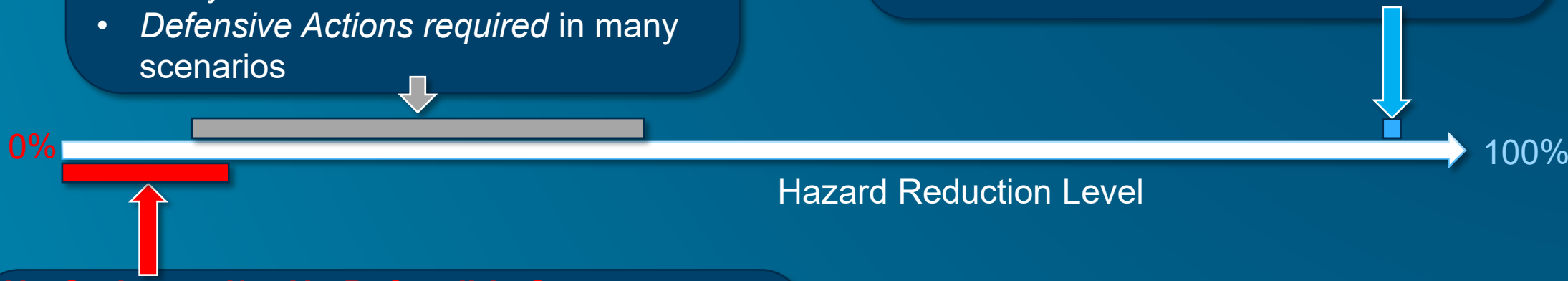
Current Codes and Defensible Space

- *Hazard Reduction* achieved for (fire and ember) certain scenarios – losses are scenario specific
- *Structures will not stand alone* in many scenarios
- *Defensive Actions required* in many scenarios

Hazard Reduction Methodology (HMM)

- *Hazard Reduction* achieved for *all* identified scenarios
- *Defensive Actions not required*



No Codes and/or No Defensible Space

- *Very Limited Hazard Reduction in most cases* – large losses expected
- *Defensive Actions* necessary in most scenarios
- *Potentially Hazardous* for first responders
- *Potentially Hazardous* for residents

HMM addresses both fire and ember exposures at the structure, parcel, and community levels

Comparison of HMM to WUI Codes

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Table 6. HMM items completely included in selected existing WUI building codes.

WUI Code	Number of ember items from **Table A** (out of 57)	% of ember items	Number of fire items from **Table D** (out of 10)	% of fire items
7A/1140/IWUIC	5 to 13	9 to 23	0 to 5	0 to 50
All 3 codes	3	5	0	0
None	42	74	5	50

Codes add value but they are, currently, not sufficient – we need Code +

What Codes buy us for *Fire (Flames)*?

Fuel Density – *up to a point*

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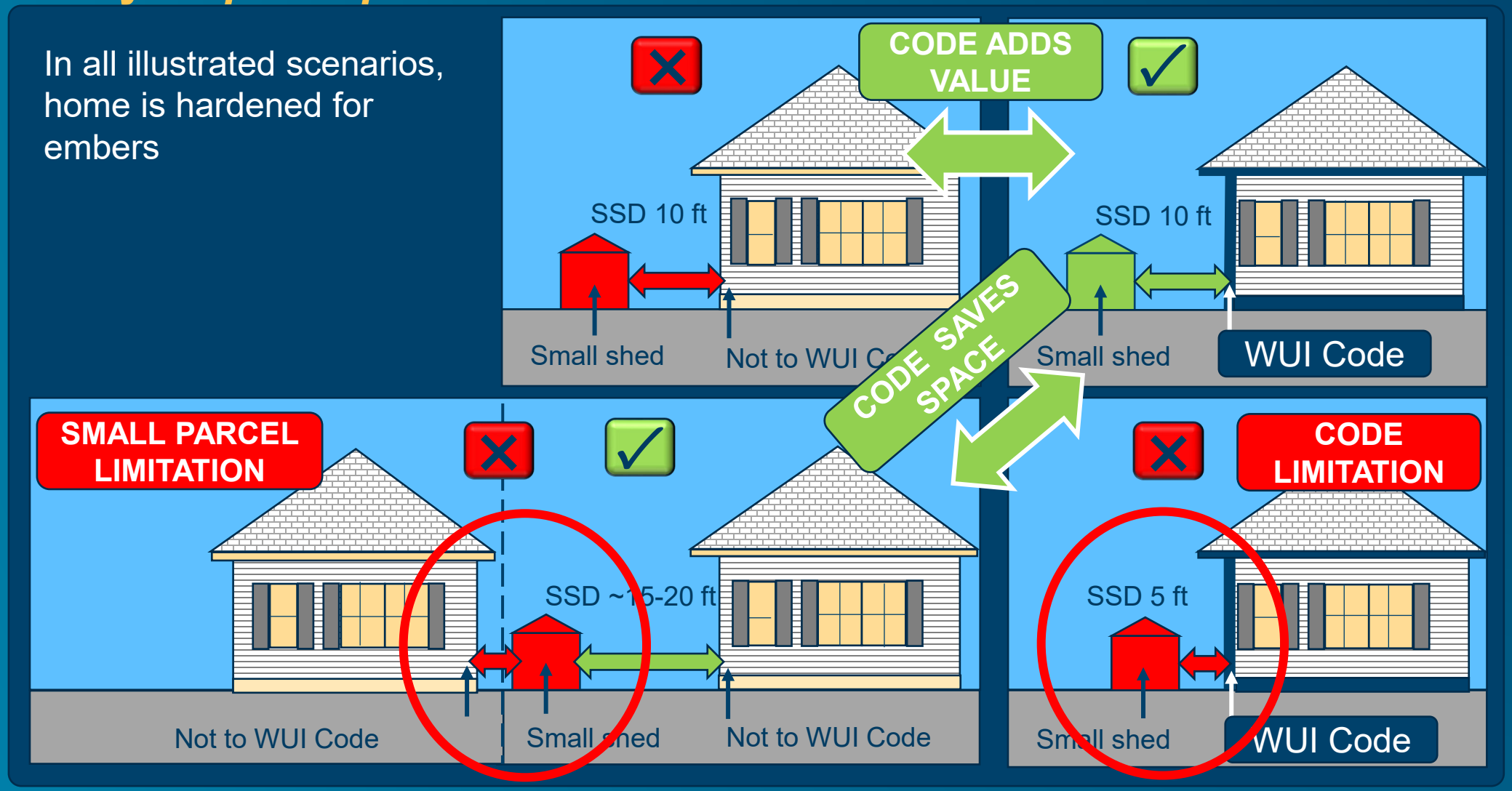
In all illustrated scenarios, home is hardened for embers



We have to uncouple all fire spread pathways, and we do not want to solve one problem and create another

Structure Separation Experiments

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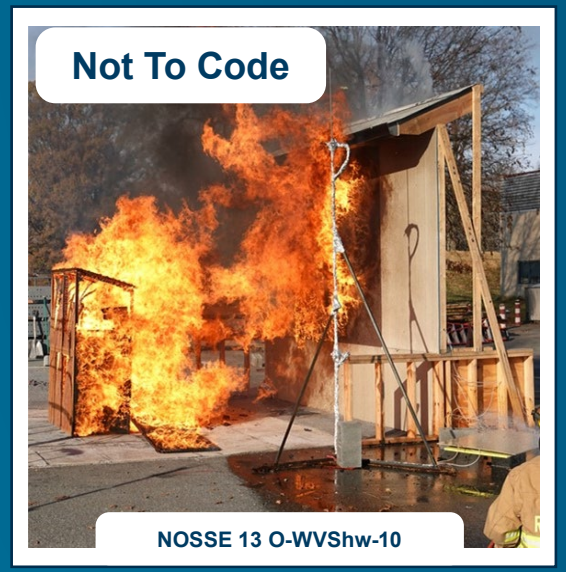
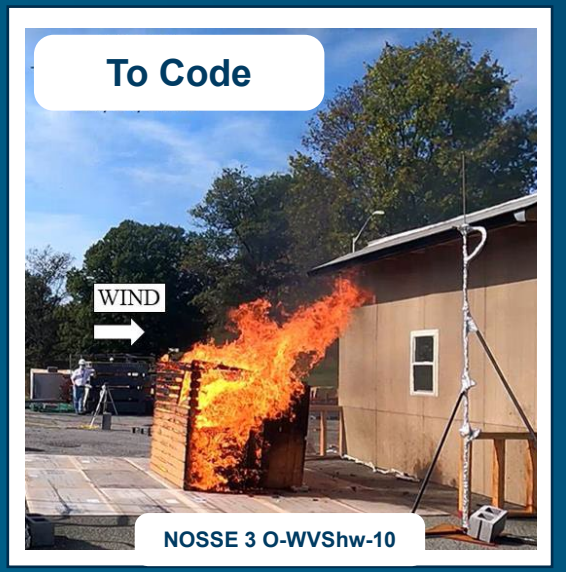
It is easy to conduct a burn
It is much harder technically to execute the “right experiment”





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NIST Technical Notes 2161, 2235 Sheds - no wind

NIST Technical Notes 2199, 2253 Sheds - with wind

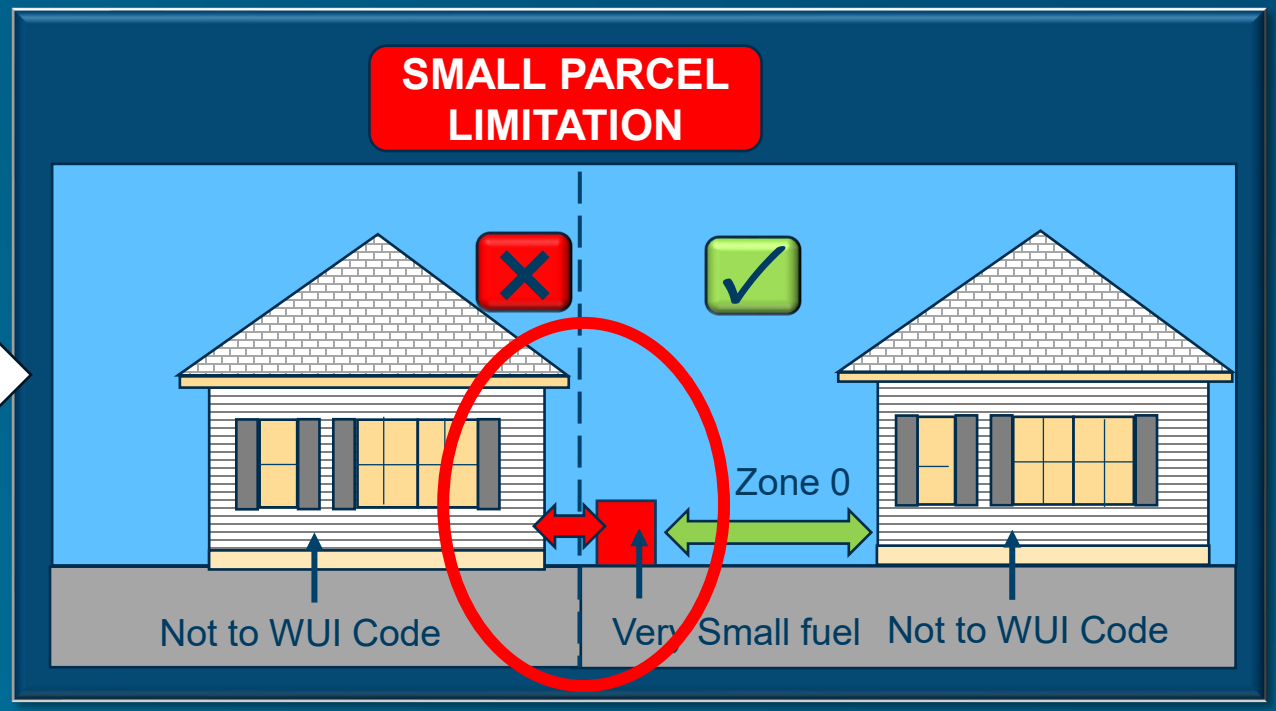
NIST Technical Note 2288 EaVE Phase A – no wind

This structure built to WUI Code ignited even with no fuels in the 5 ft Zone 0

Paths Forward to Reduce WUI Fire Losses Using HMM

- There is no “easy out”
- Generate a long term HMM implementation pathway for existing communities. *All HMM identified vulnerabilities must be addressed* but you can use a staged approach

- Zone 0 adds value but is not sufficient by itself
- Zone 0, if implemented without setback requirements, can ***“solve one problem and create another”***
- Fuels removal *not* displacement may be necessary in high density construction



Thank You

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https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/hazard-mitigation-methodology

https://www.nist.gov/el/hmm

New Educational Tool for Homeowners and City Officials

To be released early 2026!

What Can Be Learned from Post-fire Study?

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Fire Progression Timeline	Life Safety (Evacuation/Notification/ Rescues)	Defensive Actions (Response)	Building Vulnerabilities
Technical anchor for understanding WUI fire event	Need fire progression to understand context for evacuations and rescues	Captures defensive actions in the context of fire behavior and other event activities and conditions	Can *identify structure ignition vulnerabilities* (from damaged buildings) and develop exposure hardening hypotheses for laboratory testing

Cannot Quantify Successes