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

NIST WUI FIRE DAYS 2022

Enhancing Life Safety and Reducing WUI Fire Loses

NIST WUI Research Overview

July2022

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

2022 | NIST WUI DAYS 2022 | 2023 | 2024 | NIST WUI DAYS 2024

Case Studies

FALL 2022

CAMP #4 NETTRA – Notification/ Evacuation/ Traffic and Temporary Refuge Areas

CAMP #5 Emergency Response/ Defensive Actions and Damaged Structures

Hazard Mitigation Methodology (HMM)

NIST TN 2205

SPRING 2023

Graphical User Tool

Laboratory Research

SSE

SPRING & FALL 2022

Sheds

RVs, ADUs and Single Family

Fences, Wood Piles

Emberometer

Sealants and Gaskets

Fed: IWG (including FEMA, USFA, HUD)
States: CA, OR, WY, CO, SC
Codes and Standards/ Best Practices
CA Chapter 7A & Chapter 49
ICC IWUI
NFPA 1140 & Firewise

HMM | CAMP | SSE

engineering laboratory

Agenda

NIST WUI FIRE DAYS 2022

Research Presentations Agenda

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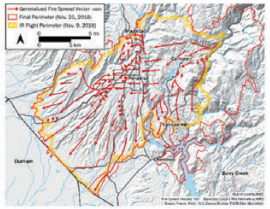
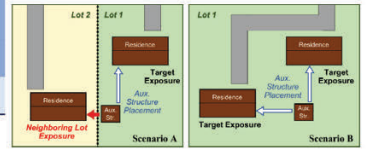
Day 1 — July 6, Starting at 1:00 pm Eastern

Session	Time (ET)	Title
1.0	1:00 – 1:15 (15 min)	Opening Remarks – NIST Engineering Laboratory (EL) Director
1.1	1:15 – 1:45 (30 min)	Camp Fire Case Study Overview
1.2	1:45 – 2:30 (45 min)	Camp Fire – Fire Progression Timeline
	2:30 – 2:40 (10 min)	Q&A
	2:40 – 2:45 (5 min)	Break
1.3	2:45 – 2:55 (10 min)	Update on Camp Fire – NETTRA (Notification, Evacuation, Traffic, Temporary Refuge Areas) Report
1.4	2:55 – 4:10 (75 min)	WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology (HMM)
	4:10 – 4:20 (10 min)	Q&A

Total Day 1: 3 h 20 min





Day 2 — July 13, Starting at 1:00 pm Eastern

Session	Time (ET)	Title
2.1	1:00 – 1:20 (20 min)	Structure Separation Experiments (SSE) Overview
2.2	1:20 – 2:05 (45 min)	SSE Phase 1 – NIST Indoor Experiments
2.3	2:05 – 2:15 (10 min)	Update on SSE Phase 1 – NIST Outdoor Experiments
	2:15 – 2:25 (10 min)	Q&A
	2:25 – 2:30 (5 min)	Break
2.4	2:30 – 2:50 (20 min)	SSE Phase 1 – IBHS Outdoor No Wind Experiments
2.5	2:50 – 3:00 (10 min)	Update on SSE Phase 1 – IBHS Cold-Flow Measurements
	3:00 – 3:10 (10 min)	Q&A
	3:10 – 3:15 (5 min)	Break
2.6	3:15 – 4:15 (60 min)	SSE Modeling
	4:15 – 4:25 (10 min)	Q&A
2.7	4:25 – 4:45 (20 min)	SSE Phase 1 – Summary

Total Day 2: 3 h 45 min

NIST WUI FIRE DAYS 2022

Research Presentations Agenda

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Day 3 — July 20, Starting at 1:00 pm Eastern

Session	Time (ET)	Title
3.0	1:00 – 1:15 (15 min)	Parcel-level Hazard Mitigation Introduction
3.1	1:15 – 2:00 (45 min)	NIST Fences Research and Findings
	2:00 – 2:10 (10 min)	Q&A
	2:10 – 2:15 (5 min)	Break
3.2	2:15 – 2:50 (35 min)	NIST Woodpiles and Landscape Timbers Research and Findings
3.3	2:50 – 3:25 (35 min)	NIST Emberometer Research
	3:25 – 3:35 (10 min)	Q&A
	3:35 – 3:40 (5 min)	Break
3.4	3:40 – 4:00 (20 min)	HMM WUI Structure/Parcel/Community Design Considerations
3.5	4:00 – 4:10 (10 min)	Closing Remarks – NIST EL Director

Total Day 3: 3 h 10 min

Day 4 — July 27, Starting at 1:00 pm Eastern

NIST Grantees Presentations

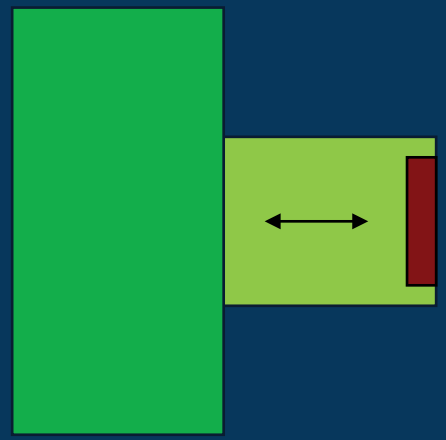
Session	Time (ET)		Title
4.0	1:00 – 1:10	(10 min)	WUI Fire-related NIST Grants Introduction
4.1	1:10 – 1:55	(45 min)	WUI-NITY 3: Multi-method traffic movement data collection for WUI fire evacuation modeling – *Prof. Steve Gwynne Ph.D., Lund University*
	1:55 – 2:05	(10 min)	Q&A
	2:05 – 2:10	(5 min)	Break
4.2	2:10 – 2:55	(45 min)	Developing AI-Based Wildfire Evacuation Behavior (AI-WEB) model – *Prof. Xilei Zhao Ph.D., University of Florida*
	2:55 – 3:05	(10 min)	Q&A
	3:05 – 3:10	(5 min)	Break
4.3	3:10 – 3:55	(45 min)	Measuring source terms of firebrand generation numbers for physics-based models – *Prof. David Blunck Ph.D., Oregon State University*
	3:55 – 4:05	(10 min)	Q&A
	4:05 – 4:10	(5 min)	Break
4.4	4:10 – 4:55	(45 min)	Quantification of firebrand production from WUI fuels for model development – *Prof. Michael Gollner Ph.D., the University of California, Berkeley*
	4:55 – 5:05	(10 min)	Q&A
4.5	5:05 – 5:15	(10 min)	Closing Remarks

Total Day 4: 4 h 15 min

Evolution of Structure/Parcel and Community Hardening

Early Experiments

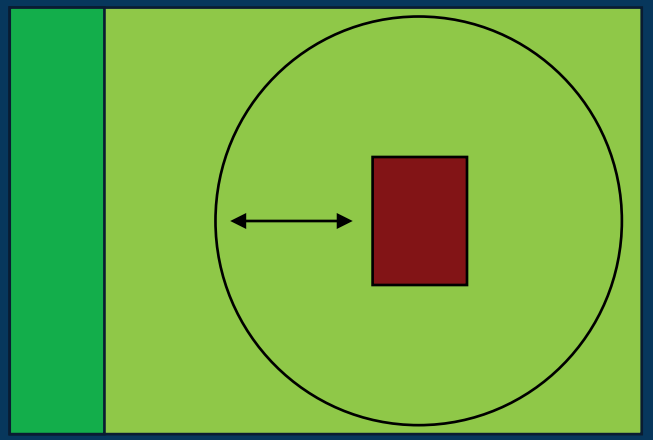
- Limited exposure to structure coupling
- Limited ambient wind
- No ember hardening



"House in the woods"

Early Building Codes (2008-2020)

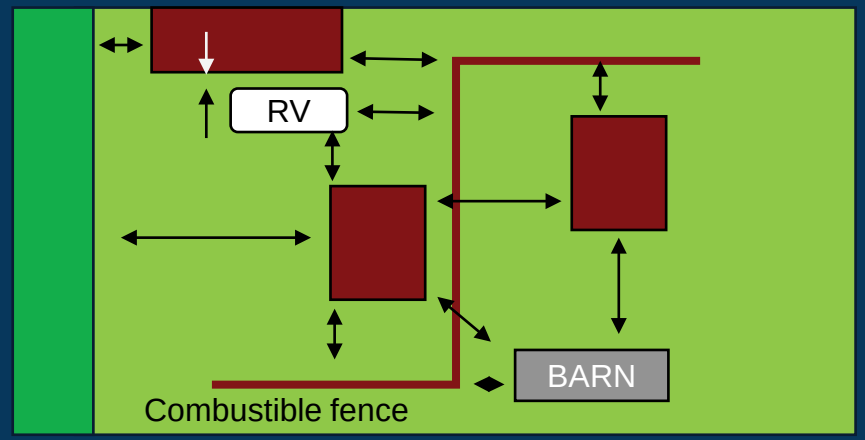
- *Defensible Space*
- Some exposure to structure coupling
- Some ember hardening



"Parcel and zones"

Structure/Parcel/Community HMM (2022)

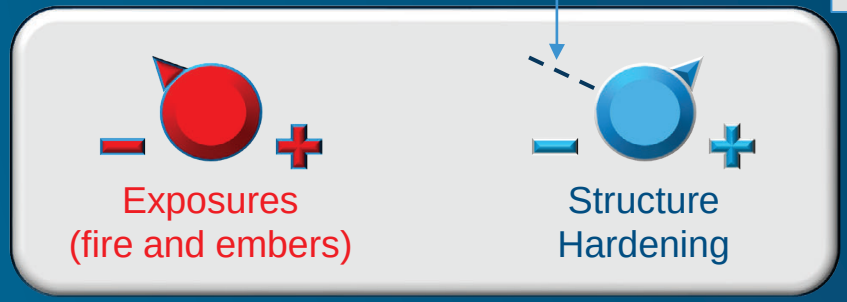
- *Goal: Stand alone structures*
- Comprehensive exposure to structure coupling for ***Fire and Embers***
- ***Multiparcel fuels***
  - *Housing density (H, M, L)*
- ***Community hardening***



"Multiparcel spatial analysis"

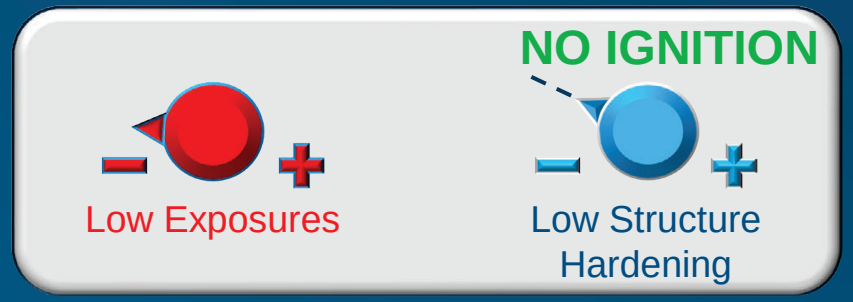
Exposures and Structure Hardening

Baseline - ember hardening



➢ UNDERHARDENED

✓ EFFECTIVE HARDENING



BCA TOOLS – utilize available exposure reduction options

✓ EFFECTIVE HARDENING

➢ OVERHARDENED

Structure Separation Experiments - Overview
NIST WUI FIRE DAYS 2022

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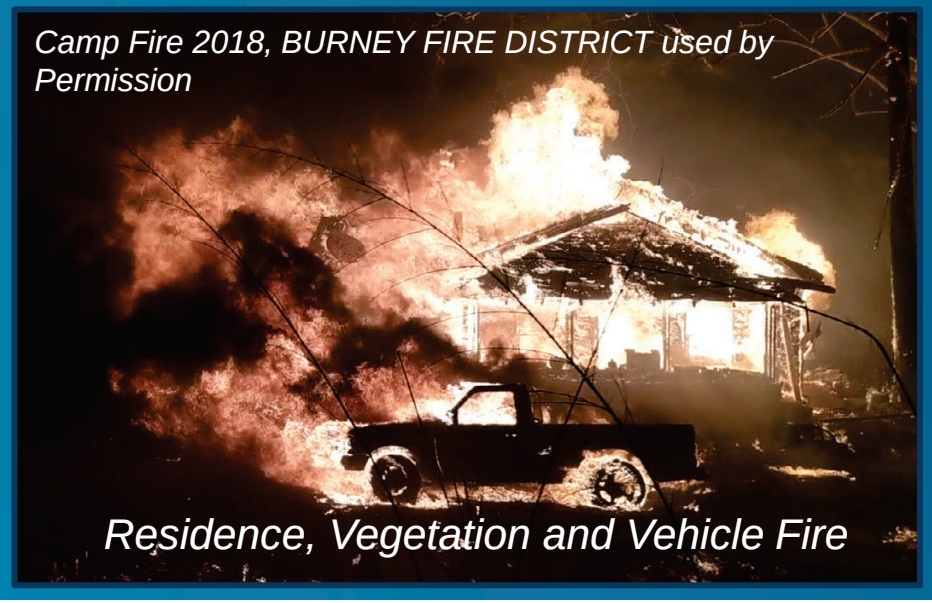
https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/structure-separation-0



No wind - 5 ft SSD

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Assembling the TEAM

Acknowledgments

- OSFM, USFS PNWS, FEMA, USFA

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ICC IWUI

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UMD

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Derek McNamara
GMSGIS

The SSE TEAM

- NIST: technical lead, test method development
- USFS: modeling (cold flow and fire)
- CALFIRE: codes
- CBIA: construction
- WFCA (non-CA perspective both for response and buildings/hazard)
- IBHS: testing facility (wind)
- USFA: tech transfer to fire services
- FEMA: RVs
- ICC IWUI: implementation of findings at national level

Three Phase Effort 2020 – 2024
Building Technical Expertise

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- Phase 1 –Sheds 15 (3x5) ft^2 to 288 (12x24) ft^2
  2 years (wrapping up in 2023)

- Phase 2 – Auxiliary Dwelling Units (ADUs) “in-laws suites”: 600 ft^2
  1.5 years (in development)

- Phase 3 – Single Family Residences: 1200 ft^2 and RVs and vehicles (in development)

Technical Challenges

- Large number of variables (continuum of exposure/ hardening coupling, wind, slope, geometries)
- Limitations of experimental facilities/capabilities
- Modeling - limited validation data sets

Determining SSD - Project Technical Overview

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Technical Issue/Measurement	NIST Indoors	NIST Outdoors	IBHS Outdoors	Univ. Of Corsica	Modeling
Heat Release Measurement	Y	N	N	N	Input Parameter
Mass Loss Rate (no wind)	Y	Y	Y	Y (limited)	
Mass Loss Rate (w/ wind)	N	N	N	Y (limited)	Must be inferred
Heat Flux Measurements	Y	Y	Y	Y	Predicted
Target Ignition	Y	Y	Y	Y	Predicted based on flux
Effects of Slope	Only very small scale	Only very small scale	Only small-medium scale	Y (fixed slope)	Limited validation data
Effects of Target Geometry	Y	Y	Y	Y (limited)	Predicted

SSE Project

- Leveraging skills and facilities from multiple agencies/organizations to address complex technical problem
- Addressing Code and *Code+* issues
- Developing implementable low impact solutions

The Hazard

Source to structure spread from radiation and convection (not fire brands) causes significant losses in WUI

- Source: *auxiliary structures*, *fences*, vehicles
- Moderate and High-density construction *additional* source: residences

NIST Case Studies - Field Observations

NIST Reconstructions

- Witch Fire (CA) – High density structure-to-structure, just east of The Trails
- Tanglewood Complex (TX) – Hazard from detached combustibles, including sheds
- Waldo Fire (CO) – Majestic community, high density structure
- Camp Fire (CA) – Hazard from auxiliary structures

NIST Recon

- Tubbs Fire (CA) – Coffey Park community, high density structure-to-structure

WUI Fires – Structure Ignition Hazard Mitigation

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Existing Buildings/Communities

- Limitations to exposure reduction - existing Structure Separation Distance (SSDs)
- Limited ignition resistance

- Transition from parcel to multiparcel hazard assessment and mitigation needed
- Lifestyle - paradigm shift needed
- Large building stock – cost effective hardening/funds needed

New Buildings/Communities

- Greater exposure reduction options:
  - Community design
  - Structure spacing
- Cost effective construction/hardening
- Lifestyle/paradigm shift easier to implement

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Range of Housing Density in Paradise

NIST Camp Fire Report #3, Figure 2.

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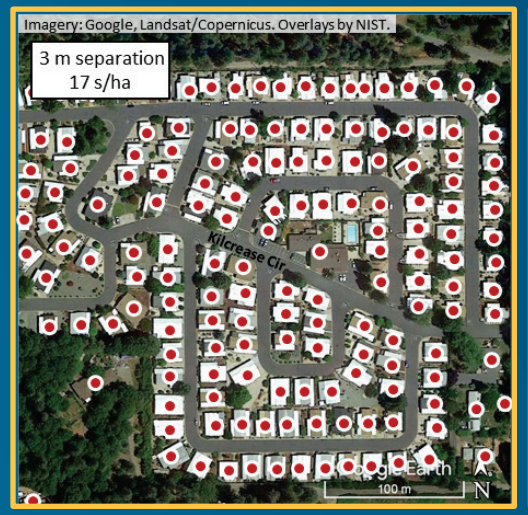
a) Apple Tree Village Mobile Home Park
- ≤ 3 m (10 ft) separation
- 7 structures / acre



b) Lancaster Dr (Bille Rd)
- 3 m (10 ft) separation
- 2.9 structures / acre

c) Valley Ridge Dr
- 8 m (26 ft) separation
- 1.4 structures / acre

d) Round Valley Ranch Rd
- 25 m (82 ft) separation
- 0.3 structures / acre

engineering laboratory

SSE Update *July2022*

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2022 | NIST WUI DAYS 2022 | 2023 | 2024 | NIST WUI DAYS 2024

SPRING & FALL 2022

Sheds

RVs, ADUs and Single Family

Fed: IWG (including FEMA, USFA, HUD)
States: CA, OR, WY, CO, SC
Codes and Standards/ Best Practices
CA Chapter 7A & Chapter 49
ICC IWUI
NFPA 1140 & Firewise

https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/structure-separation-0

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SSE Phases 2 & 3 Development

- Previous lab experiments = baseline for next phases
  - Early NIST research TN1600 – August 2008
- Field data = support for problem identification and experimental design

NIST Technical Note 1600

Residential Structure Separation Fire Experiments

Alexander Maranghides
Erik L. Johnsson

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SSE Phases 2 & 3 Development

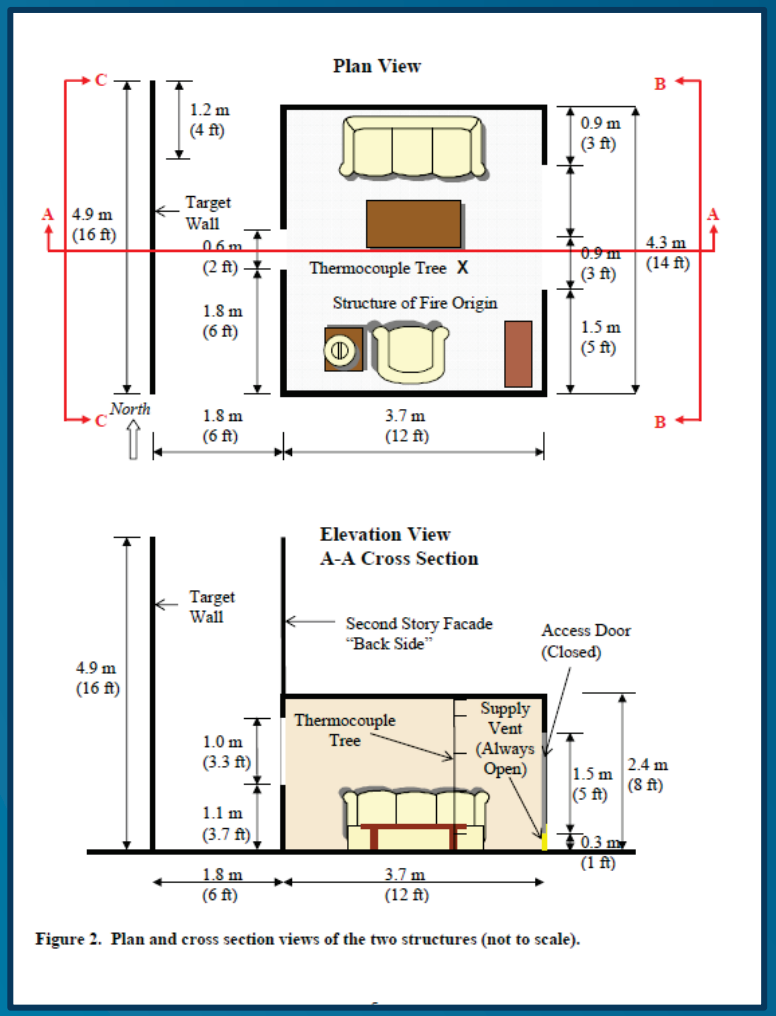


Figure 2. Plan and cross section views of the two structures (not to scale).

SSE Phases 2 & 3 Development

Not 'worst case":

- Limited exposure from *just* a room
- No eaves
- No wind
- No in line windows
- No fences or other combustibles

- Unrestricted and Partly-Hardened Construction

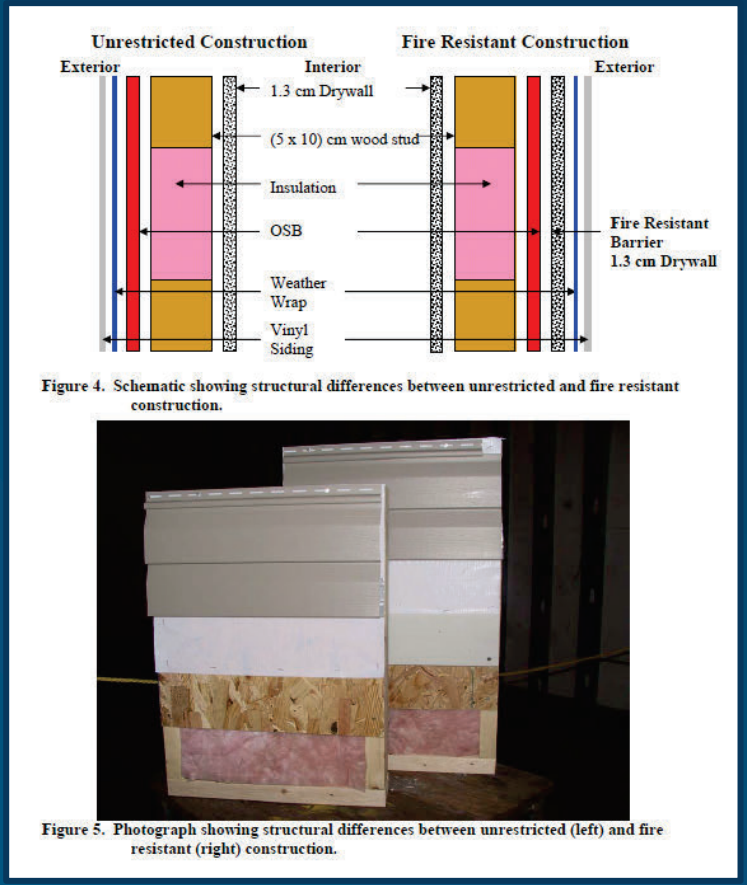
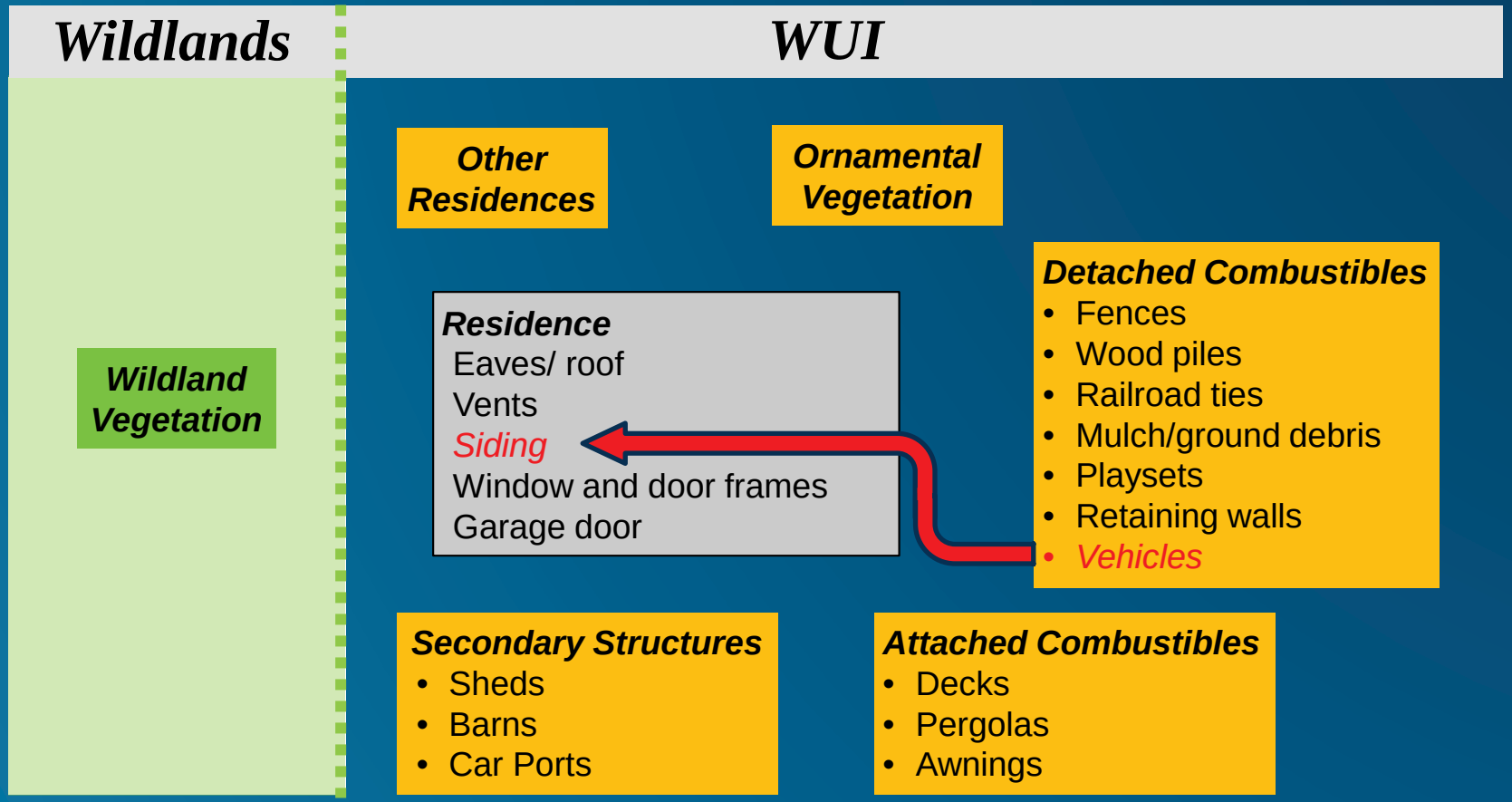


Figure 4. Schematic showing structural differences between unrestricted and fire resistant construction.

Figure 5. Photograph showing structural differences between unrestricted (left) and fire resistant (right) construction.

Structure Ignition, SSE Phase 3 Vehicle

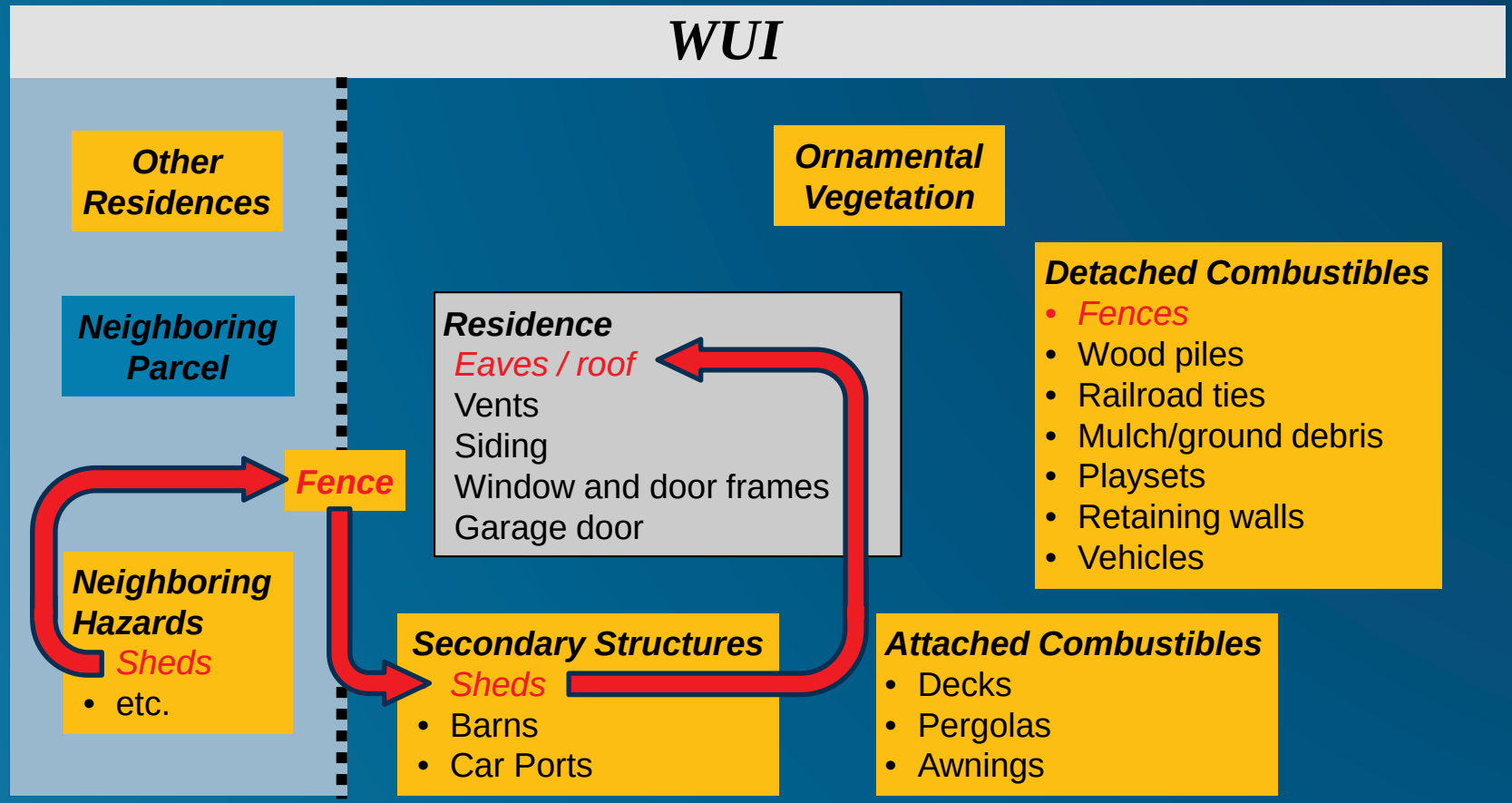


Structure Ignition, SSE Phase 3: Vehicle

a) A dozer displaced the vehicle to stop fire spread

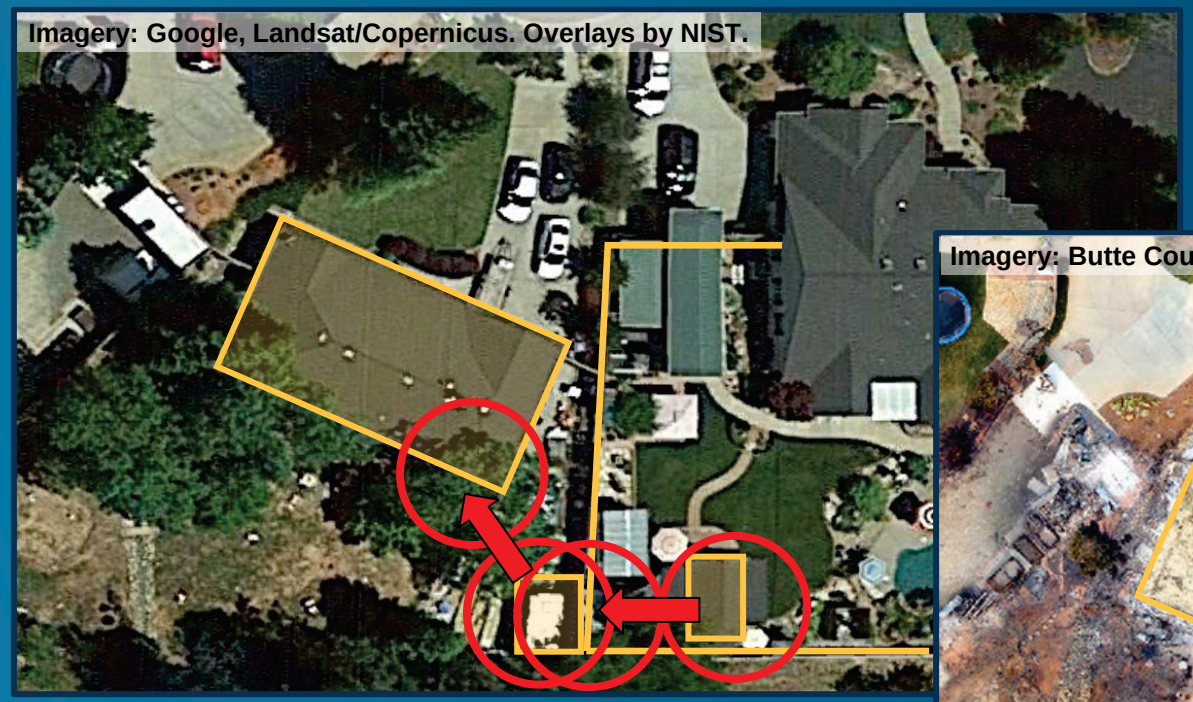
b) Associated evidence of the fire ignition and defensive actions encountered during NIST damage assessments.

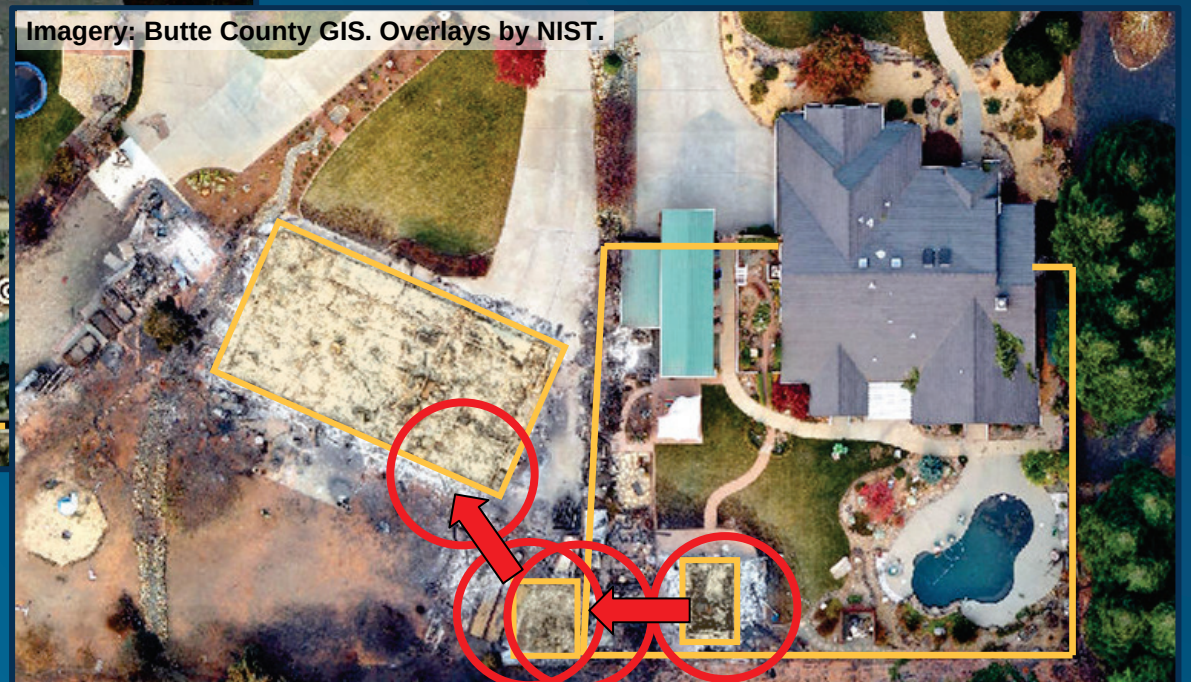
Structure Ignition, SSE Phase 1 Shed



Structure Ignition, SSE Phase 1

Shed ignition leading to residence destruction





Fire Spread Pathway:
Shed **to** ***Fence*** **to** ***Shed*** **to** ***House***