

A Case Study of the Camp Fire –

Notification, Evacuation, Traffic, and Temporary Refuge Areas (NETTRA)

Module 3: Burnovers and Temporary Refuge Areas

NIST WUI DAYS 2023 – Session 2.1

November 8, 2023



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WUI Fire Days: Camp Fire NETTRA

- Module 1: Notification and Evacuation Pre-Fire Conditions and Planning
- Module 2: Notification Timeline, Evacuations, Traffic Flow and Road Closures
- Module 3: *Burnovers and TRAs*
- Module 4: Rescues
- Module 5: NETTRA Summary

Last week, Nov 1

Burnovers

Temporary Refuge
Areas (TRAs)

Relationships of
Burnovers and
TRAs

Exposures at
TRAs

Analysis of TRAs

Technical
Findings

Burnovers

summary

23 Identified Burnovers

19 events in NIST TN 2135 (Camp 3)
4 new events in NIST TN 2252 (Camp 4)

Reports describe identified:

burnovers, entrapments, and “near misses”

- Unexpectedly caught
- Life-threatening position
- Fire overtakes personnel or equipment
- Escape routes or safety zones are absent, inadequate, or compromised
- May or may not result in injury
- Possible damage to equipment



Summary of Burnovers

Burnovers

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Technical Findings

ID ^a	Location ^b	Community	Severity Category	Burnover Initiation	Burnover Duration (min)	Road Width (m)	Vegetation Setback (m)	Roadway Length Affected ^c (m)	Impacted Civilian Evacuation (Y if yes)	Traffic Gridlock/Obstruction ^d (Y if yes)	Fire Shelter(s) Deployed (Y if yes)	TRA Formed (Y if yes)	Fatalities
1	Hoffman Rd	Concow	1	07:50	40	3	0-2, more at creek	250	Y		Y	Y	
2	Concow Rd	Concow	2	07:50	70	7	0-1	1000	Y				
20	Camelot Ln	Concow	1	07:55 ^e	50	6	0 (in grass)	n/a	Y			Y	
3	Chapman Ln	Paradise	1	08:30	n/d ^f	3	0-3	250	Y				
4	Skyway (upper)	Paradise	1	08:30	360	8	0-10	2600	Y	Y		Y	
5	Windermere Ln	Concow	1	08:35 ^e	n/d	4	0-2	1100	Y				1
6	Pentz Rd	Paradise	1	08:45	150	8	0-1	1300	Y	Y		Y	
7	Pearson Rd	Paradise	1	09:15	60	11	1-3	800	Y	Y	Y	Y	1
8	Bille Rd	Paradise	1	09:25	140	8	0-2	500	Y	Y		Y	
21	Edgewood Ln	Paradise	1	09:30	n/d	3	0-3	250	Y				5
9	Wagstaff Rd	Paradise	2	09:30	60	8	0-3	500	Y				
10	Clark Rd / American Way	Paradise	2	10:00	120	11	1-3	700	Y				
11	Clark Rd / Airport Rd	Butte County	2	10:00	90	9	1	1500	Y				
12	Skyway (lower)	Paradise	2	10:15	90	7-20	1-3	1000	Y				
13	Jordan Hill Rd / Granite Hill Rd	Concow	1	11:30	n/d	5	0-4	800	Y				
22	Neal Rd	Paradise	1	11:30	90	6	1-3	800	Y	Y			
23	Clark Rd / Cypress Ln	Paradise	2	11:45	n/d	8	0-6	1300	Y				
14	Clark Rd / Black Bear Diner	Paradise	2	13:10 ^e	n/d	23	3 (structure)	150					
15	Rattlesnake Flats Rd	Butte County	1	15:15	15	3	0 (in grass)	300					
16	Coutolenc Rd	Magalia	2	00:00 ^g	120	7	0-2	3000				Y	
17	Chestnut Cir	Magalia	1	06:00 ^g	n/a ^h	9	0-1	150					
18	Ponderosa Way	Magalia	2	07:15 ^g	n/d	12	0-3	400	Y			Y	
19	Concow Fire Station 37	Concow	1	07:15 ^g	n/d	9	0-3	600				Y	

- Newly identified since TN 2135 (#20-23)

- Egress artery in **bold**

- Category 1 high severity events in **Red**

- Life safety impacts and attributes

- Many before 09:30

Burnover Locations

Burnovers

- 23 identified events
- Concow impacted first
- Paradise arteries impacted from E to W and S
- Progression from E to W
- Significant contributions from spot fires
- 12 on primary egress arteries

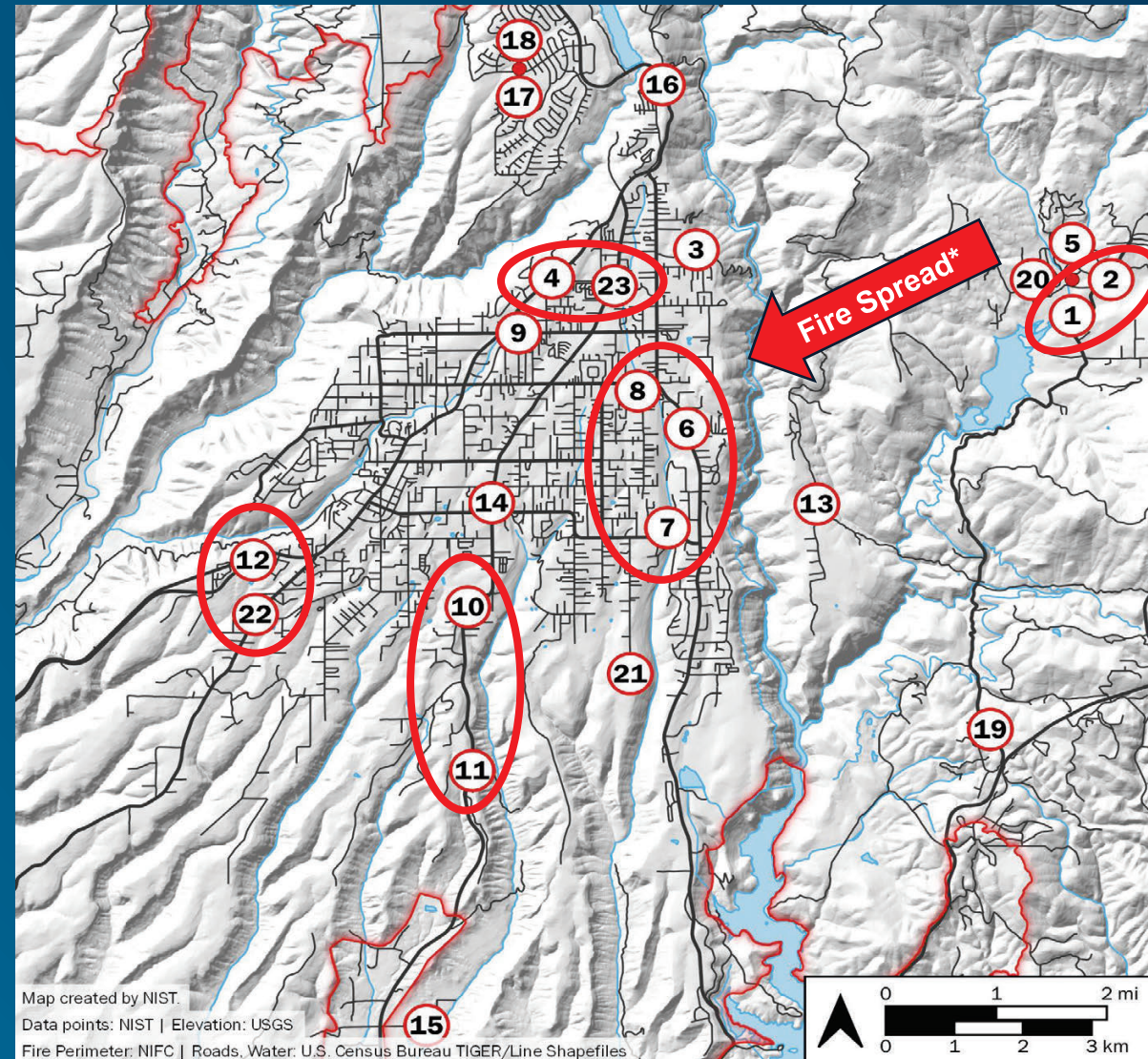
Temporary Refuge Areas (TRAs)

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* General initial fire spread direction

Burnovers

**Temporary Refuge
Areas (TRAs)**

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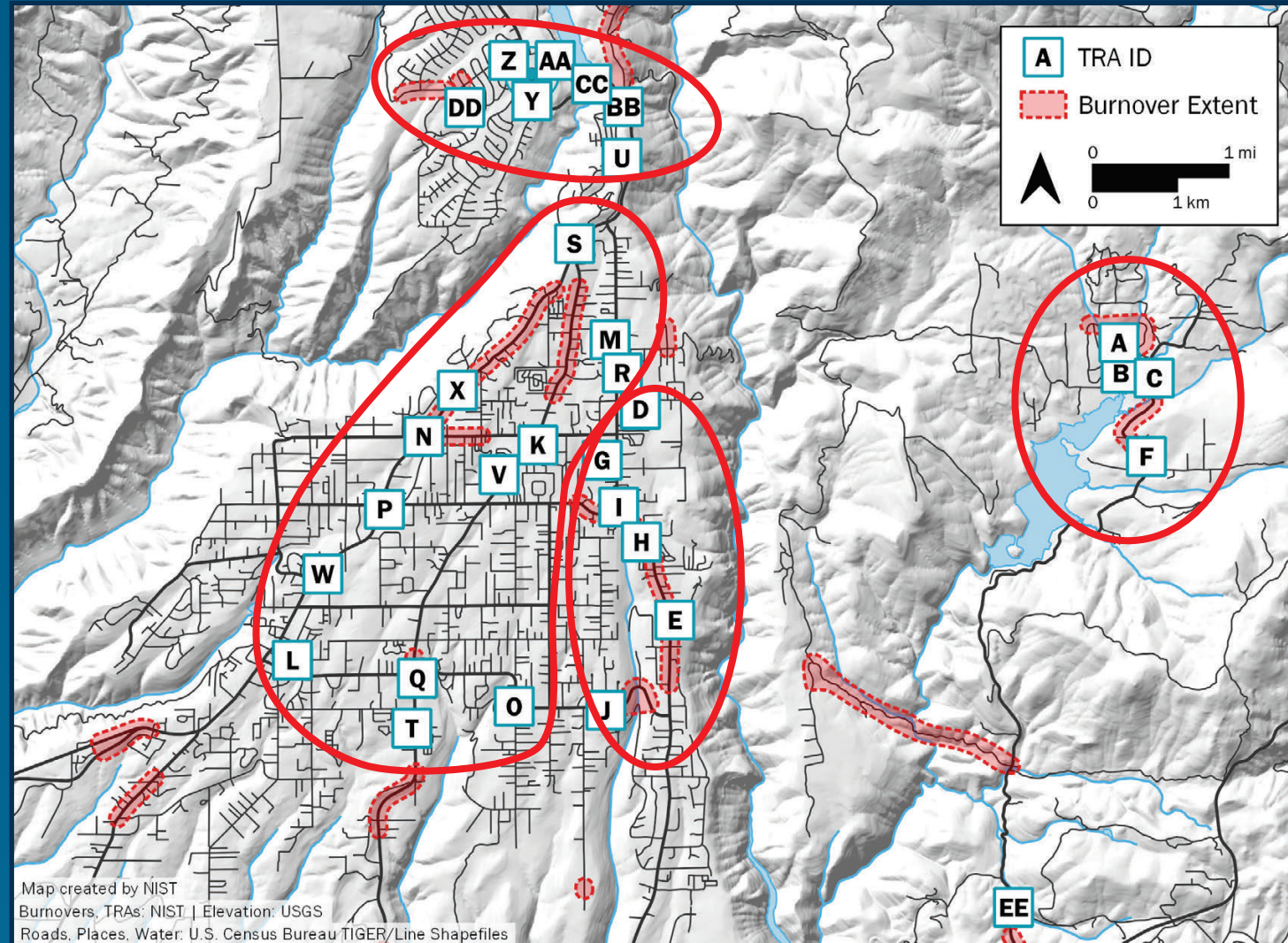
Technical
Findings

Temporary Refuge Areas (TRAs)

summary | overview | attributes

Temporary Refuge Areas (TRAs)

- 31 different TRAs
- 12 TRAs directly in response to burnovers
- Parking lots, roadways, structures, natural areas
- Used for immediate life safety and for management of evacuees



TRAs – Temporal Analysis

- 07:50 to 09:35 (A through J)
Concow and eastern Paradise
- 09:35 to 12:00 (K through T)
central and western Paradise
- 12:00 to 19:15 (U through AA)
Paradise and Magalia
- 00:00 to 07:45 (BB through EE)
Magalia and Concow

One third (10/31) of the TRAs were formed between 07:55 and 09:35; four in Concow and six in Paradise

ID	Name	UoF	PHL	Location	
A	Camelot Meadow Wild Fire Safety Zone	!!!	▲▲▲	Camelot Ln	Concow
B	Hoffman Rd	!!!	▲▲▲	Hoffman Rd 350 m (0.2 mi) west of Concow Rd	Concow
C	Concow Rd "dozer zone"	!!!	▲▲▲	Concow Rd at Hoffman Rd	Concow
D	Chris Ct	!!	▲▲	Chris Ct, east of Pentz Rd north of Wagstaff Rd	Paradise
E	Feather River Hospital	!!!	▲▲	Pentz Rd between Bille Rd and Pearson Rd	Paradise
F	Concow Rd "gravel area"	!!	▲▲	Concow Rd near Ishi Tr	Concow
G	Ponderosa Elementary School	!!!	▲▲	Pentz Rd just south of Wagstaff Rd	Paradise
H	Chloe Ct	!!!	▲▲▲	Chloe Ct, off Pentz Rd 500 m (0.3 mi) south of Bille Rd	Paradise
I	Bille Rd	!!!	▲▲▲	Bille Rd and Pentz Rd	Paradise
J	Pearson Rd	!!!	▲▲▲	Pearson Rd near Cherry Ln, 1 km (0.6 mi) west of Pentz Rd	Paradise
K	Paradise Plaza	!	▲	Clark Rd at Wagstaff Rd	Paradise
L	PPD/Fire Station 81	!	▲	Birch St at Black Olive Dr	Paradise
M	Paradise Ridge Southern Baptist Church	!!	▲▲	Pentz Rd 1.1 km (0.7 mi) north of Wagstaff Rd	Paradise
N	Wagstaff Rd	!!	▲▲	Wagstaff Rd at Skyway	Paradise
O	Fire Station 82	!	▲▲	Pearson Rd between Clark Rd and Pentz Rd	Paradise
P	Walgreens	!!	▲▲	Skyway at Bille Rd	Paradise
Q	Ace Hardware	!	▲▲	Clark Rd at Pearson Rd	Paradise
R	Beyond Fitness	!!	▲▲	Pentz Rd 700 m (0.4 mi) north of Wagstaff Rd	Paradise
S	Optimo	!	▲▲	Skyway at Clark Rd	Paradise
T	Best Western	!!	▲▲	Clark Rd 700 m (0.4 mi) south of Pearson Rd	Paradise
U	Magalia Community Church	!!	▲▲	Old Skyway	Magalia
V	CMA Church	!	▲	Clark Rd between Wagstaff Rd and Clark Rd	Paradise
W	Paradise Shopping Center	!	▲▲	Skyway near Oliver Rd, 500 m (0.3 mi) north of Elliott Rd	Paradise
X	Firland Dr	!!	▲▲	Firland Dr at Skyway, 660 m (0.4 mi) north of Wagstaff Rd	Paradise
Y	Magalia Pines Baptist Church	!	▲▲	Lakeridge Cir	Magalia
Z	Magalia Sav-Mor	!	▲	Lakeridge Cir	Magalia
AA	Rite Aid	!	▲▲	Skyway at Ponderosa Way	Magalia
BB	Skyway and Coutolenc Rd	!!!	▲▲	Skyway at Coutolenc Rd	Magalia
CC	Magalia Dam	!!	▲	Skyway 600 m (0.4 mi) north of Coutolenc Rd	Magalia
DD	Pine Ridge School	!!!	▲▲	Compton Dr, off Ponderosa Way and W Park Dr	Magalia
EE	Concow Rd and Pinkston Canyon Rd	!!!	▲▲▲	Concow Rd at Pinkston Canyon Rd	Concow

Burnovers

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Analysis of TRAs

- A temporal summary and brief descriptions of each TRA
- A detailed summary of the sequence of burnovers and the utilization of multiple TRAs in Concow
- Estimates of the number of civilians taking refuge
- An analysis of TRA characteristics, such as urgency and exposure levels, location types, and defensive actions, and
- A summary of technical findings.

TRA Summaries – Appendix I

Burnovers

Temporary Refuge Areas (TRAs)

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NIST TN 2252 sup
July 2023

J. Pearson Road

Date/Time: November 8, 09:35-10:18

Location: Pearson Rd near Cherry Ln, 1 km (0.6 mi) west of Pentz Rd, Paradise [39.748394, -121.581266]

Formation Urgency: High 111

Hazard Level: High ▲▲▲

TRA Type: Natural

Approx. Area of TRA: 0.29 ha (0.71 ac)

Site Description: Primary area was a grassy undeveloped residential lot.

Occupants: Civilians and First Responders

Civilian Headcount: n/d

Civilian Vehicle Count: 30 to 70

Related Burnover(s): Pearson Rd [R07 #7] 0 m to 700 m (0 mi to 0.4 mi)

Related TRA/ Safety Zone: Feather River Hospital [FRH-1]

Synopsis: Evacuating traffic heading westbound on Pearson Rd was backed up east of Stearns Rd. Intense fire spread through the drainage at the east end of Pearson Rd, impacting and trapping dozens of vehicles. Firefighters directed vehicles off the roadway into a grassy undeveloped residential lot as a dozer cleared the area. When the fire subsided, the dozer cleared burned vehicles and debris from the roadway to escort the civilians to the parking lot at Feather River Hospital (FRH-1) where they waited for conditions to allow safe evacuation from the fire area.

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NIST TN 2252 sup
July 2023

Time	Observation	Source
08:56	Traffic is jammed both directions on Pearson Rd at Hilde Dr. Explosions are audible from structures burning on Pentz Rd.	TD-014 TD-017 TD-058
09:00	Traffic is stopped using both lanes westbound on Pearson Rd west of Stearns Rd. All side streets feeding Pearson Rd are backed up as well. Law enforcement is trying to move traffic.	TD-067 TD-068 TD-087 TD-087 TD-309 VTD-17
09:00-09:20	A spot fire is burning in the drainage south of Pearson Rd near Stearns Rd. It is spreading and flame lengths are 7 m to 9 m (20 ft to 30 ft). It is dark and smoky; visibility is reduced below 15 m (50 ft) at times.	TD-017 TD-068 TD-068 VTD-32 VTD-32 TD-067 TD-087
09:20-10:00	The drainage is fully involved in fire. Visibility is very poor, sometimes zero. Flames are impacting vehicles stuck in traffic and people are abandoning vehicles. There is significant ember shower.	TD-122 TD-123 TD-129 VTD-16 VTD-23 VTD-24 VTD-32 TD-067 TD-087
09:35-10:00	There are 2 fire engines present, and firefighters are trying to get traffic moving. Traffic is backed up all the way to Clark Rd (2.7 mi [1.7 mi]) preventing vehicles from moving. Firefighters identified an empty lot to use as a TRA. They are rationing water to protect for life safety.	TD-111 TD-122 VTD-23 VTD-34 TD-063 TD-079 VTD-16 VTD-25 VTD-32 PPD
09:50-09:55	Several people (4 to 5) on foot, including law enforcement officers, have abandoned their vehicles, and are rescued by a dozer and an engine. Everything around is burning, visibility is near zero, and there is heavy ember shower.	TD-067 TD-122 TD-129 VTD-16 VTD-23 VTD-32 PPD
09:55-10:24	The dozer continues westbound on Pearson Rd toward the traffic jam, pushing burning and abandoned vehicles from the roadway. The dozer clears an area of the empty residential lot near Cherry Ln.	TD-017 TD-087 TD-122 TD-123 TD-129 VTD-23 VTD-25
10:00-10:18	Vehicles are directed into the dozer-cleared lot as a make-shift safety zone.	TD-017 TD-087 TD-123 TD-129 VTD-23
10:18	The dozer and engine load the carcasses of 50 (+/-) 20 vehicles through the Pearson Rd drainage to Pentz Rd, pushing vehicles and power poles from the roadway. The convoy is then directed to Feather River Hospital.	TD-017 TD-087 TD-123 TD-129 VTD-23

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NIST TN 2252 sup
July 2023

Duration: 0 h, 42 min

Pre-planned TRA: No

Roadway width: 9 m (30 ft) Pearson Rd

Fuels around TRA: Trees along grass lot border (0 m), burned structure N (20 m), burned structure E (20 m), burned structure SW (20 m), burned structure W (25 m), burned structure S (45 m).

Suppression activity: None

Related TD: TD-034, TD-036, TD-037, TD-063, TD-068, TD-087, TD-100, TD-111, TD-122, TD-123, TD-129, TD-300, VTD-16, VTD-17, VTD-23, VTD-24, VTD-25, VTD-32, PPD

Related streets or keywords: Pearson Rd, Cherry Ln

Street-level view: View of Pearson Rd and the empty parcel used as the TRA. View is looking southeast.

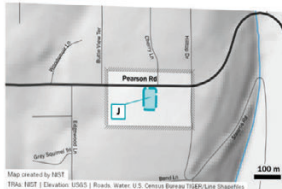
Pre-fire imagery links: [Google Maps Street View](#), [Bing Maps StreetView](#)

Post-fire imagery links: [Google Maps Street View](#)

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NIST TN 2252 sup
July 2023

Street map:



Map created by NIST
Title: 4227 | Elevation: 10565 | Roads, Water: U.S. Census Bureau TIGER/LINE Shapfiles

Satellite view:



Map created by NIST
Title: 4227 | Imagery: Public Domain 2018

1-40

TRA Appendix Details

Burnovers

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Occupants: Civilians and First Responders
Civilian Headcount: n/d
Civilian Vehicle Count: 30 to 70

Related Burnover(s): Pearson Rd [BO #7] 0 m to 700 m (0 mi to 0.4 mi)
Related TRA/ Safety Zone: Feather River Hospital [TRA-E]

Synopsis: Evacuating traffic heading westbound on Pearson Rd was backed up east of Stearns Rd. Intense fire spread through the drainage at the east end of Pearson Rd, impacting and trapping dozens of vehicles. Firefighters directed vehicles off the roadway into a grassy unbuilt residential lot as a dozer cleared the area. When the fire subsided, the dozer cleared burned vehicles and debris from the roadway to escort the civilians to the parking lot at Feather River Hospital (TRA-E) where they waited for conditions to allow safe evacuation from the fire area.

NIST TN 2252 sup
July 2023

Time	Observation	Source
08:56	Traffic is jammed both directions on Pearson Rd at Hilbe Dr. Explosions are audible from structures burning on Pentz Rd.	TD-034 TD-036
09:00	Traffic is stopped using both lanes westbound on Pearson Rd west of Stearns Rd. All side streets feeding Pearson Rd are backed up as well. Law enforcement is trying to move traffic.	TD-037 TD-068 TD-087 TD-300 VTD-17
09:00–09:20	A spot fire is burning in the drainage south of Pearson Rd near Stearns Rd. It is spreading and flame lengths are 7 m to 9 m (20 ft to 30 ft). It is dark and smokey; visibility is reduced below 15 m (50 ft) at times.	TD-037 TD-068 TD-100 VTD-32
09:20–10:00	The drainage is fully involved in fire. Visibility is very poor, sometimes zero. Flames are impacting vehicles stuck in traffic and people are abandoning vehicles. There is significant ember shower.	TD-037 TD-087 TD-122 TD-123 TD-129 VTD-16 VTD-23 VTD-24 VTD-32
09:35–10:00	There are 2 fire engines present, and firefighters are trying to get traffic moving. Traffic is backed up all the way to Clark Rd (2.7 km [1.7 mi]) preventing vehicles from moving. Firefighters identified an empty lot to use as a TRA. They are rationing water to protect for life safety.	TD-037 TD-087 TD-111 TD-122 VTD-23 VTD-24
09:50–09:55	Several people (4 to 5) on foot, including law enforcement officers, have abandoned their vehicles, and are rescued by a dozer and an engine. Everything around is burning, visibility is near zero, and there is heavy ember shower.	TD-063 TD-129 VTD-16 VTD-25 VTD-32 PPD
09:55–10:24	The dozer continues westbound on Pearson Rd toward the traffic jam, pushing burning and abandoned vehicles from the roadway. The dozer clears an area of the empty residential lot near Cherry Ln.	TD-037 TD-122 TD-129 VTD-23
10:00–10:18	Vehicles are directed into the dozer-cleared lot as a make-shift safety zone.	TD-037 TD-087 TD-122 TD-123 TD-129 VTD-23
10:18	The dozer and engines lead the caravan of 50 (+/- 20) vehicles through the Pearson Rd drainage to Pentz Rd, pushing vehicles and power poles from the roadway. The convoy is then directed to Feather River Hospital.	TD-037 TD-087 TD-123 TD-129 VTD-23

TRA Appendix Details

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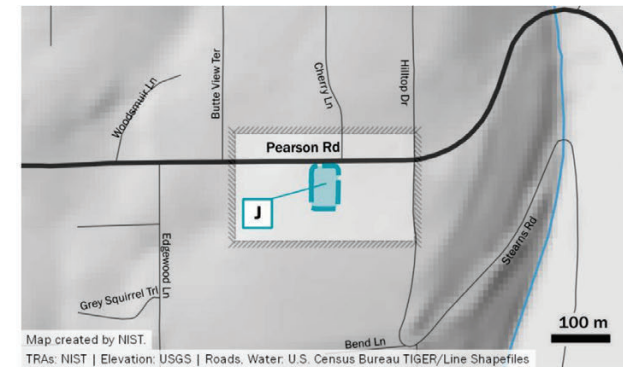
Analysis of TRAs

Technical Findings

		NIST TN 2252 sup July 2023
Duration:	0 h 43 min	
Pre-planned TRA:	No	
Roadway width:	9 m (30 ft) Pearson Rd	
Fuels around TRA:	Trees along grass lot border (0 m), burned structure N (20 m), burned structure E (20 m), burned structure SW (20 m), burned structure W (23 m), burned structure S (45 m).	
Suppression activity:	None	
Related TD:	TD-034, TD-036, TD-037, TD-063, TD-068, TD-087, TD-100, TD-111, TD-122, TD-123, TD-129, TD-300, VTD-16, VTD-17, VTD-23, VTD-24, VTD-25, VTD-32, PPD	
Related streets or keywords:	Pearson Rd, Cherry Ln	
Street-level view:	View of Pearson Rd and the empty parcel used as the TRA. View is looking southeast.	
Pre-fire imagery links:	Google Maps Street View , Bing Maps Streetside	
Post-fire imagery links:	Google Maps Street View	

NIST TN 2252 sup
July 2023

Street map:



Satellite view:



TRA Urgency of Formation (UoF)

Relative comparison into three levels (low, moderate, high) regarding the need to rapidly establish a TRA to address immediate life safety issues.

- **High Urgency of Formation** implies an urgent need to establish a TRA such as when people are trapped within a burnover.
- **Low Urgency of Formation** TRAs represent events where the formation of the TRA occurred to address civilian evacuation concerns that were not immediately life threatening. In many cases, Low UoF TRAs were utilized to organize and coordinate the evacuation of civilians.

TRA Peak Hazard Level (PHL)

Relative comparison into three levels (low, moderate, high) regarding the fire exposure when in the TRA.

- **High PHL** the exposures threatened the integrity of the TRA and immediately impacted the life safety of the occupants.
- **Low PHL** had low *fire* exposures as a result of
 - limited fire presence in the area (embers may still have been present)
 - limited surrounding fuels
 - large buffer areas (e.g., large parking lots)
 - availability of firefighting personnel and equipment

TRAs

- Listing by temporal occurrence – Concow / Paradise / Magalia
- All High PHL TRAs involving civilians started by 09:15

Civilians in 6 TRAs experienced High Peak Hazard Levels that impacted life safety

ID	Name	UoF	PHL	Location	
A	Camelot Meadow Wild Fire Safety Zone	!!!	▲▲▲	Camelot Ln	Concow
B	Hoffman Rd	!!!	▲▲▲	Hoffman Rd 350 m (0.2 mi) west of Concow Rd	Concow
C	Concow Rd “dozer zone”	!!!	▲▲▲	Concow Rd at Hoffman Rd	Concow
D	Chris Ct	!!	▲▲	Chris Ct, east of Pentz Rd north of Wagstaff Rd	Paradise
E	Feather River Hospital	!!!	▲▲	Pentz Rd between Bille Rd and Pearson Rd	Paradise
F	Concow Rd “gravel area”	!!	▲▲	Concow Rd near Ishi Tr	Concow
G	Ponderosa Elementary School	!!!	▲▲	Pentz Rd just south of Wagstaff Rd	Paradise
H	Chloe Ct	!!!	▲▲▲	Chloe Ct, off Pentz Rd 500 m (0.3 mi) south of Bille Rd	Paradise
I	Bille Rd	!!!	▲▲▲	Bille Rd and Pentz Rd	Paradise
J	Pearson Rd	!!!	▲▲▲	Pearson Rd near Cherry Ln, 1 km (0.6 mi) west of Pentz Rd	Paradise
K	Paradise Plaza	!	▲	Clark Rd at Wagstaff Rd	Paradise
L	PPD/Fire Station 81	!	▲	Birch St at Black Olive Dr	Paradise
M	Paradise Ridge Southern Baptist Church	!!	▲▲	Pentz Rd 1.1 km (0.7 mi) north of Wagstaff Rd	Paradise
N	Wagstaff Rd	!!	▲▲	Wagstaff Rd at Skyway	Paradise
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Q	Ace Hardware	!	▲▲	Clark Rd at Pearson Rd	Paradise
R	Beyond Fitness	!!	▲▲	Pentz Rd 700 m (0.4 mi) north of Wagstaff Rd	Paradise
S	Optimo	!	▲▲	Skyway at Clark Rd	Paradise
T	Best Western	!!	▲▲	Clark Rd 700 m (0.4 mi) south of Pearson Rd	Paradise
U	Magalia Community Church	!!	▲▲	Old Skyway	Magalia
V	CMA Church	!	▲	Clark Rd between Wagstaff Rd and Clark Rd	Paradise
W	Paradise Shopping Center	!	▲▲	Skyway near Oliver Rd, 500 m (0.3 mi) north of Elliott Rd	Paradise
X	Firland Dr	!!	▲▲	Firland Dr at Skyway, 660 m (0.4 mi) north of Wagstaff Rd	Paradise
Y	Magalia Pines Baptist Church	!	▲▲	Lakeridge Cir	Magalia
Z	Magalia Sav-Mor	!	▲	Lakeridge Cir	Magalia
AA	Rite Aid	!	▲▲	Skyway at Ponderosa Way	Magalia
BB	Skyway and Coutolenc Rd	!!!	▲▲	Skyway at Coutolenc Rd	Magalia
CC	Magalia Dam	!!	▲	Skyway 600 m (0.4 mi) north of Coutolenc Rd	Magalia
DD	Pine Ridge School	!!!	▲▲	Compton Dr, off Ponderosa Way and W Park Dr	Magalia
EE	Concow Rd and Pinkston Canyon Rd	!!!	▲▲▲	Concow Rd at Pinkston Canyon Rd	Concow

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Burnovers and TRAs

relationships | timeline

Relationships of Burnovers to TRAs

More than half of the TRAs had connection to specific burnover events. Connections were classified into two levels:

- **Burnover caused formation of the TRA** —
The conditions presented by a burnover (fire exposure) presented a critical need for those involved to take immediate life-saving refuge at their location.
- **Burnover related to the TRA** —
Fire conditions from an identified burnover prevented egress, contributing to the need to establish/utilize a TRA to coordinate and organize civilians for evacuation when conditions improved.

Burnovers and TRAs before 9:30

Burnovers

Temporary Refuge Areas (TRAs)

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Analysis of TRAs

Technical Findings

- 11 BOs started before 09:30
- 11 BOs related to 15 TRAs

BO ID	BO Name	BO Relation to TRA	TRA ID	TRA Name	TRA in BO
1	Hoffman Rd	Cause	B	Hoffman Rd	→ Yes
2	Concow Rd	Cause	C	Concow Rd “dozer zone”	→ Yes
20	Camelot Ln	Cause	A	Camelot Meadow Wild Fire Safety Zone	→ Yes
3	Chapman Ln	None			
4	Skyway (upper)	Related	K	Paradise Plaza	
		Cause/Related	N	Wagstaff Rd	
		Related	P	Walgreens	
		Related	S	Optimo	
		Cause	X	Firland Dr	Yes ^a
5	Windermere Ln	Related	A	Camelot Meadow Wild Fire Safety Zone	
6	Pentz Rd	Cause/Related	E	Feather River Hospital	Yes ^a
		Cause	H	Chloe Ct	→ Yes
		Related	I	Bille Rd	
7	Pearson Rd	Cause	J	Pearson Rd	→ Yes
8	Bille Rd	Cause	I	Bille Rd	→ Yes
21	Edgewood Ln	None			
9	Wagstaff Rd	Related	K	Paradise Plaza	

6 TRAs within Burnovers — High Peak Hazard Levels

Burnovers and TRAs

TRA	07:00	07:15	07:30	07:45	08:00	08:15	08:30	08:45	09:00	09:15	09:30	09:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00	13:15	13:30	13:45	14:00	14:15	14:30	14:45
Total Active TRA	0	0	0	1	2	2	2	2	5	4	5	7	6	6	7	7	9	11	12	12	10	11	10	9	8	7	9	9	8	8	7	6
TRA Impacted by BO	0	0	0	1	2	2	2	1	1	2	4	4	4	3	4	4	4	5	5	3	2	2	2	2	1	1	2	2	1	1	0	0
Fraction Impacted by BO (%)	0	0	0	100	100	100	100	50	20	50	80	57	67	50	57	57	44	45	42	25	20	18	20	22	13	14	22	22	13	13	0	0

Burnovers and TRAs

Burnovers

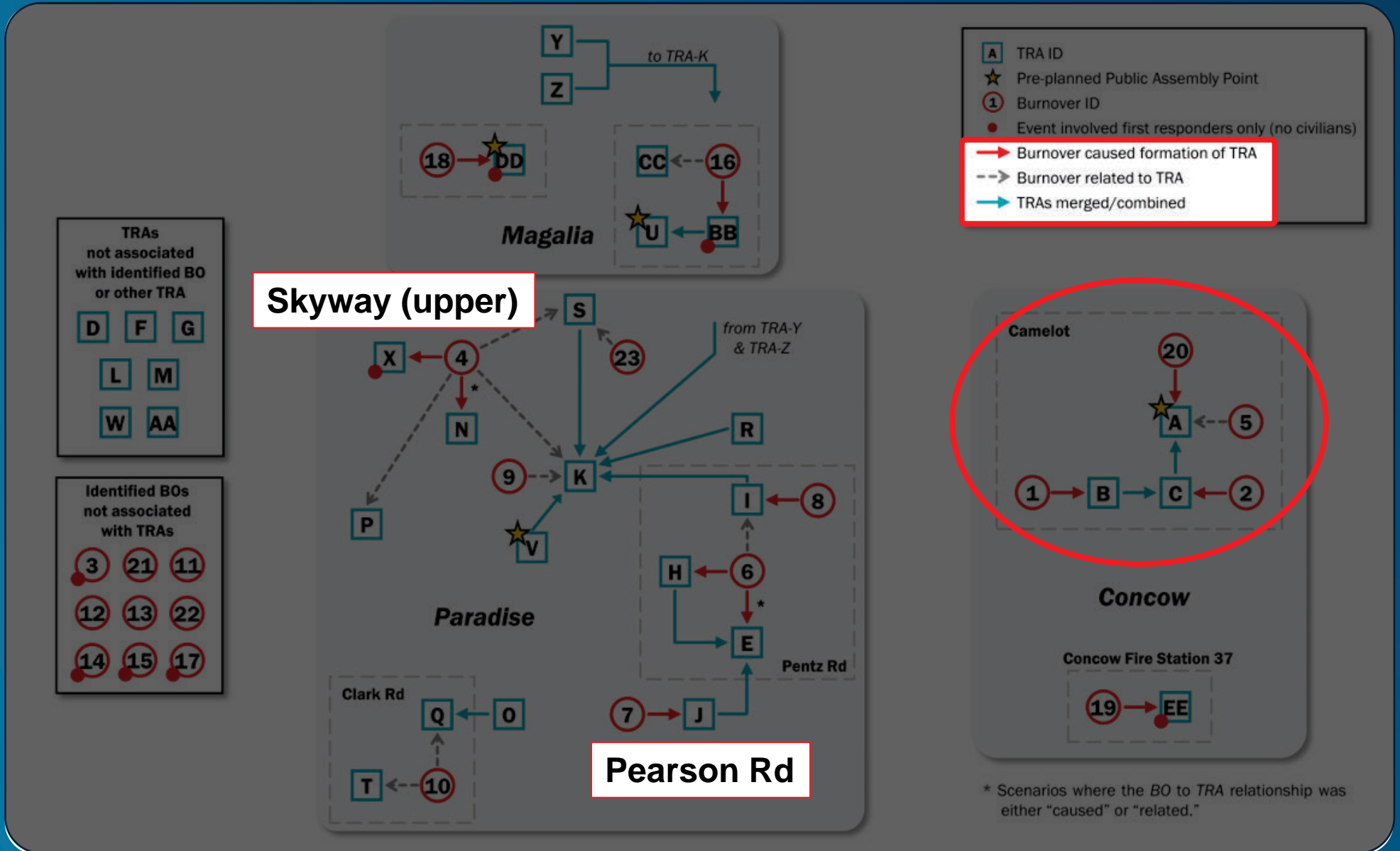
Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

Exposures at TRAs

Analysis of TRAs

Technical Findings



Concow TRA Sequence Summary

Burnovers

Temporary Refuge Areas (TRAs)

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Time	Concow Events, 07:15 to 8:17, Nov 8
7:15	911 calls, fire in yards
7:22	IC requests evacuation of Concow, fire fighters on Hoffman
7:45	Several responding engines, crews, and dozers encountered heavy fire conditions on Concow Road and had to wait to gain access beyond Tweedy Lane.
7:50	Firefighters scout out the fire and announce evacuations on Hoffman Road and observe multiple spot fires along the road. Concow Road burnover starts (BO #2) .
7:55	Law enforcement officers in Camelot informed the ECC via radio that they may not be able to escape Camelot due to fire conditions. The pre-designated Camelot Meadow Wild Fire Safety Zone was the only option and was on fire (BO #20). Officers planned to park all vehicles in the field after the grass burned.
8:00	Firefighters returning eastward on Hoffman Road encountered 4 civilians running westbound from Concow Road toward the low water crossing. Their clothing was burned, and their hair was on fire. The road ahead was blocked by fire, and they could not make it out to Concow Road. Visibility was less than 3 m (10 ft).
8:10	A dozer was able to progress further on Concow Road
8:00 to 8:17	10 to 15 civilian vehicles were blocked by fire on Hoffman Road along with the firefighters. Two firefighters extracted all the civilians (n=24) from their vehicles and took shelter in the creek. Fire shelters were deployed to protect against radiation as the fire burned through dense vegetation. Several homes and vehicles were also burning, and propane tanks were exploding.

Time	Concow Events, 08:17 to 10:00, Nov 8
8:17	Civilians and firefighters were trapped at the Hoffman Road TRA, there were approximately 15 civilian vehicles and additional law enforcement vehicles in Camelot. Visibility there was less than 100 m.
8:15 to 8:23	Dozer accesses and was able to clear Hoffman Road from Concow Road to the creek to find the trapped group. Civilians packed into 8 unburned civilian vehicles and the firefighter's pick-up truck and were led to the Concow Road intersection.
8:23	On Concow Road, the burnover (BO #2) which started at 07:50 was continuing and there were downed powerlines just north of the intersection. The Hoffman Road convoy was trapped again, along with additional civilian vehicles and fire engines attempting to get to the Camelot Meadow Fire Safety Zone. To provide additional space for the Hoffman Road convoy and the other vehicles at the intersection, the dozer operator pushed out an area on the east side of Concow Road, the "dozer zone" (TRA-C). The dozed area was approximately 0.15 ha (0.37 ac) [nominally 50 m x 30 m].
8:31	A fire engine managed to drive from the intersection to Camelot but reported that it was not yet safe to escort the civilian convoy through.
8:47 to 8:55	Civilians are escorted to Camelot Meadow Fire Safety Zone (TRA-A). Civilians that sheltered in the creek were involved in two high peak hazard level exposure TRAs for over one hour before they were escorted to safety.
~10:00	Civilians were escorted out of the Camelot Meadow TRA.
until 12:00	A number of search and rescue activities extended through the morning in Camelot. Severe exposures significantly impacted some of these operations (BO #5).

Concow Burnover/TRA Sequence

Burnovers

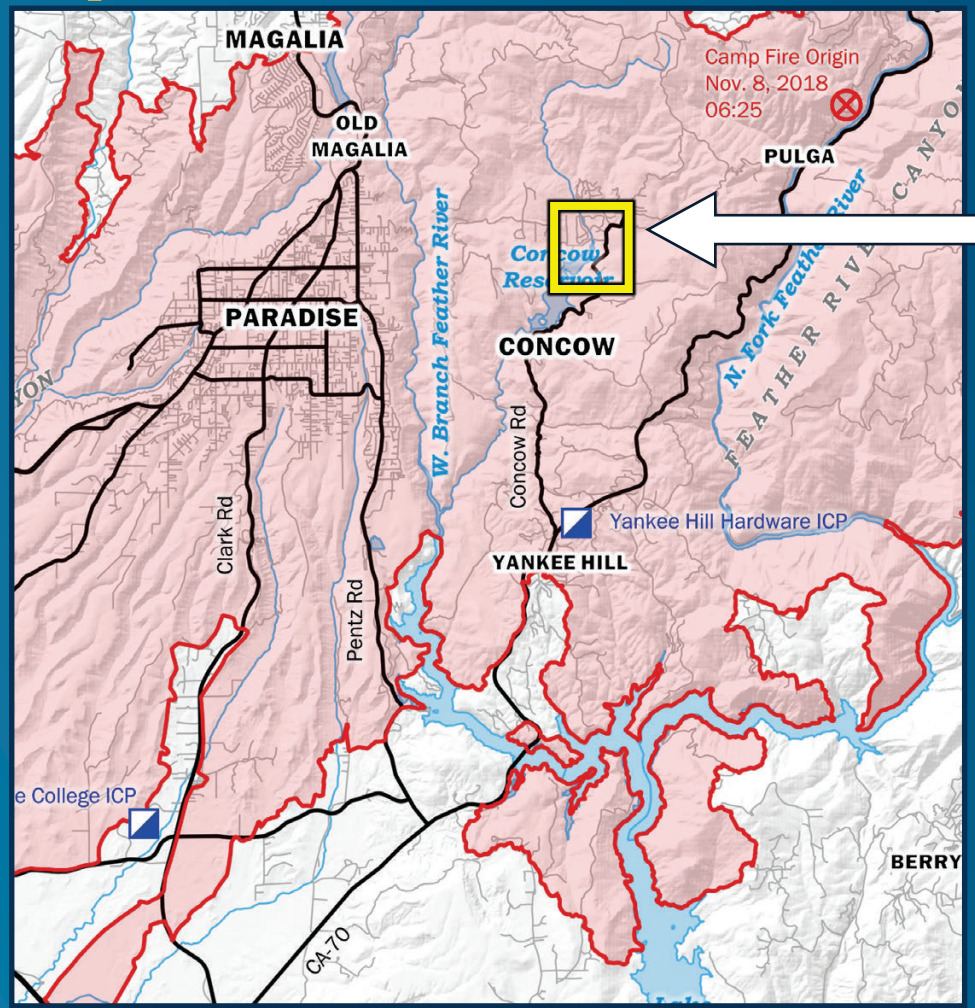
Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

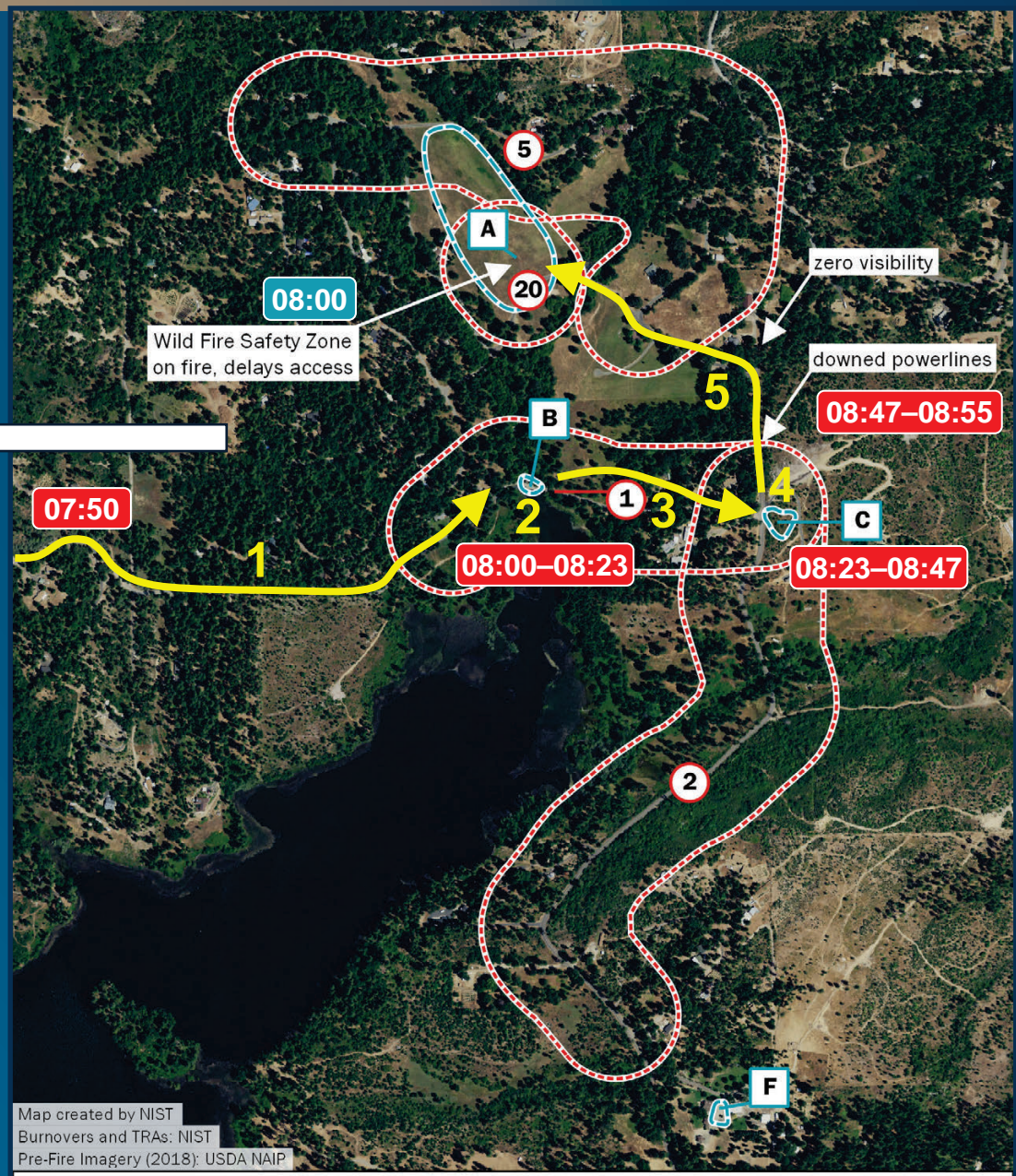
Exposures at TRAs

Analysis of TRAs

Technical Findings



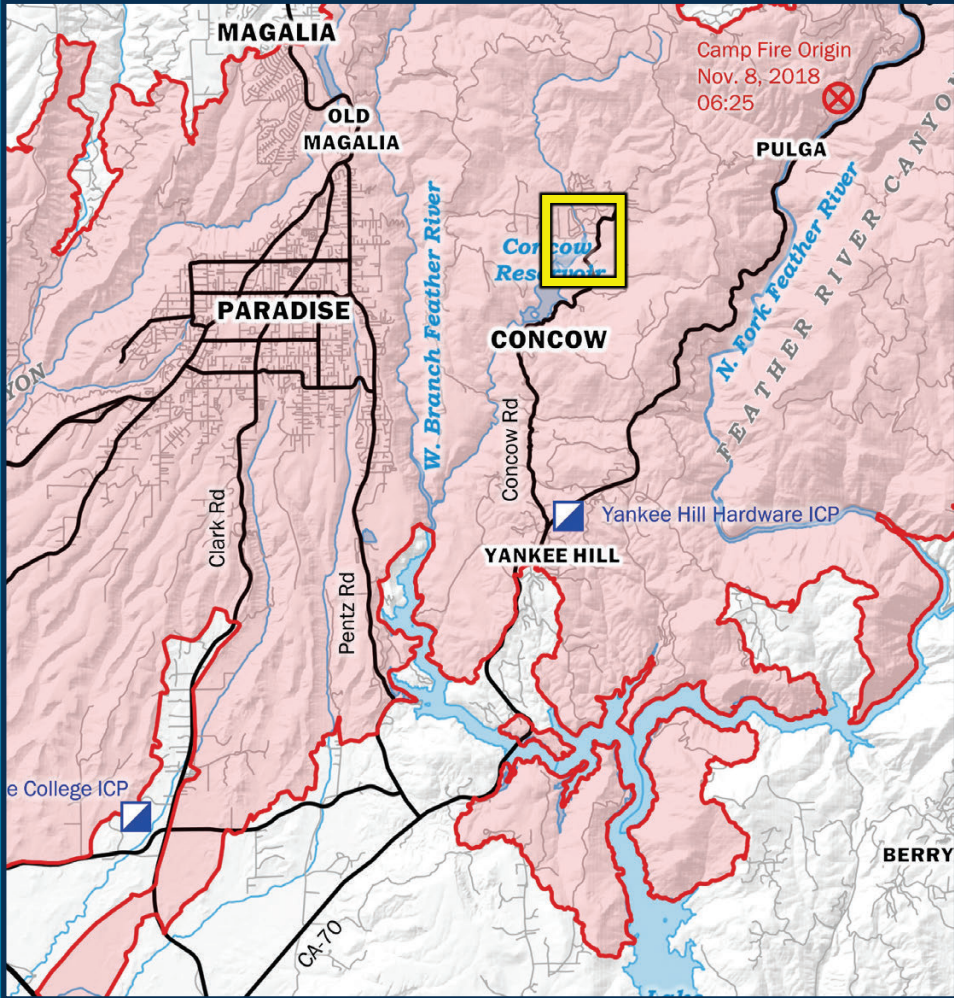
“multiple spot fires” to “impassable” in 10 minutes



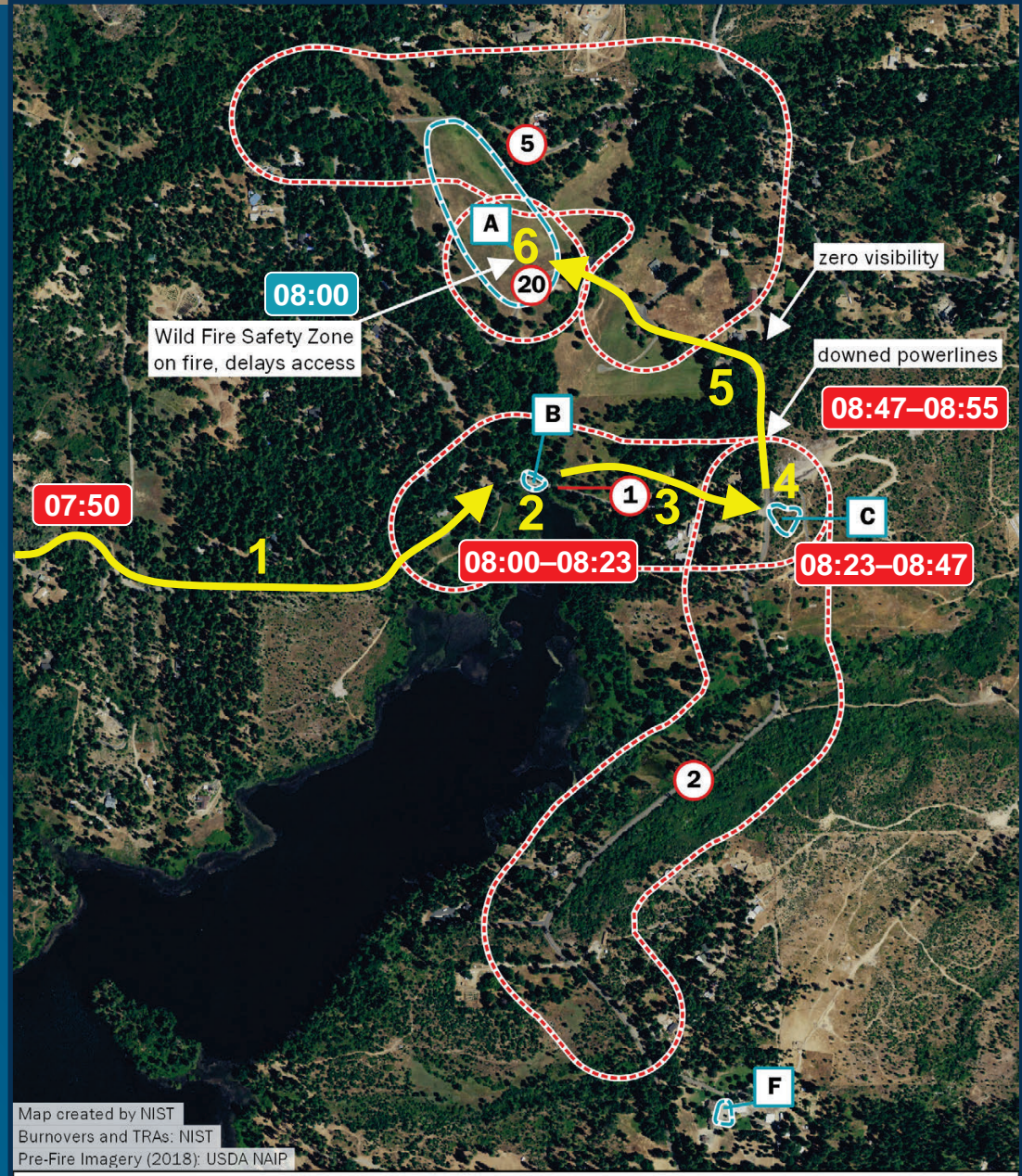
Map created by NIST
 Burnovers and TRAs: NIST
 Pre-Fire Imagery (2018): USDA NAIP



Concow Burnover/TRA Sequence



Multiple TRAs used en route to safety zone



Map created by NIST
Burnovers and TRAs: NIST
Pre-Fire Imagery (2018): USDA NAIP

0 0.25 mi
0 200 400 m

A TRA ID	1 Burnover ID
TRA Extent	Burnover Extent

Burnovers

Temporary Refuge Areas (TRAs)

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Burnovers

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Areas (TRAs)

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Burnovers and
TRAs

**Exposures at
TRAs**

Analysis of TRAs

Technical
Findings

Exposures at TRAs

types / locations / fuels

TRA Types and Sizes (area)

TRA Types

- 14 parking lots
- 7 roadways
- 6 structures
- 3 natural areas (e.g., roadside creek), and
- 1 maintained natural area (e.g., ballfield, maintained meadow)

TRA Area

Differences between preplanned Wild Fire Safety Zones and TRAs created under High Urgency of Formation were driven by local options

Areas range from 0.1 acre to 8.3 acre

ID	Name	Type	Area	
			ha	ac
A	Camelot Meadow Wild Fire Safety Zone	Natural (Maintained)	3.37	8.33
B	Hoffman Rd	Natural	0.06	0.16
C	Concow Rd "dozer zone"	Natural	0.15	0.37
D	Chris Ct	Roadway	0.30	0.74
E	Feather River Hospital	Parking Lot	1.38	3.40
F	Concow Rd "gravel area"	Parking Lot	0.08	0.20
G	Ponderosa Elementary School	Parking Lot	0.28	0.70
H	Chloe Ct	Structure	0.31	0.77
I	Bille Rd	Roadway	0.31	0.77
J	Pearson Rd	Natural	0.29	0.71
K	Paradise Plaza	Parking Lot	2.32	5.74
L	PPD/Fire Station 81	Structure	0.37	0.92
M	Paradise Ridge Southern Baptist Church	Parking Lot	0.21	0.52
N	Wagstaff Rd	Roadway	0.49	1.22
O	Fire Station 82	Structure	0.11	0.26
P	Walgreens	Structure	0.55	1.37
Q	Ace Hardware	Parking Lot	0.53	1.30
R	Beyond Fitness	Parking Lot	0.34	0.83
S	Optimo	Structure ^a	0.34	0.83
T	Best Western	Parking Lot	0.70	1.74
U	Magalia Community Church	Parking Lot	0.57	1.41
V	CMA Church	Parking Lot	2.56	6.34
W	Paradise Shopping Center	Parking Lot	0.75	1.86
X	Firland Dr	Roadway	0.11	0.28
Y	Magalia Pines Baptist Church	Parking Lot	0.93	2.31
Z	Magalia Sav-Mor	Parking Lot	0.39	0.95
AA	Rite Aid	Structure	0.55	1.37
BB	Skyway and Coutolenc Rd	Roadway	0.32	0.78
CC	Magalia Dam	Roadway	0.17	0.43
DD	Pine Ridge School	Parking Lot	1.25	3.09
EE	Concow Rd and Pinkston Canyon Rd	Roadway	0.06	0.16

^a The parking lot was used initially, but civilians were moved into structures for increased protection.

Fuels around TRAs and Exposure Considerations

- *Fire* exposures are local from fuels surrounding the TRAs
 - Local: in the vicinity of the TRA up to ~150–200 ft
- Smoke and ember exposures can be from local or remote sources
 - Remote: hundreds of feet to several miles

Local Conditions Drive Fire Exposures and Peak Hazard Levels at TRAs

Managing Hazard Levels

Peak Hazard Levels at Wild Fire Safety Zones
can be reduced by:

1. Local fuels reduction and/or
2. Increasing distance (for radiation attenuation),
i.e., increasing the area of the Wild Fire Safety
Zone

Burnovers

Temporary Refuge
Areas (TRAs)

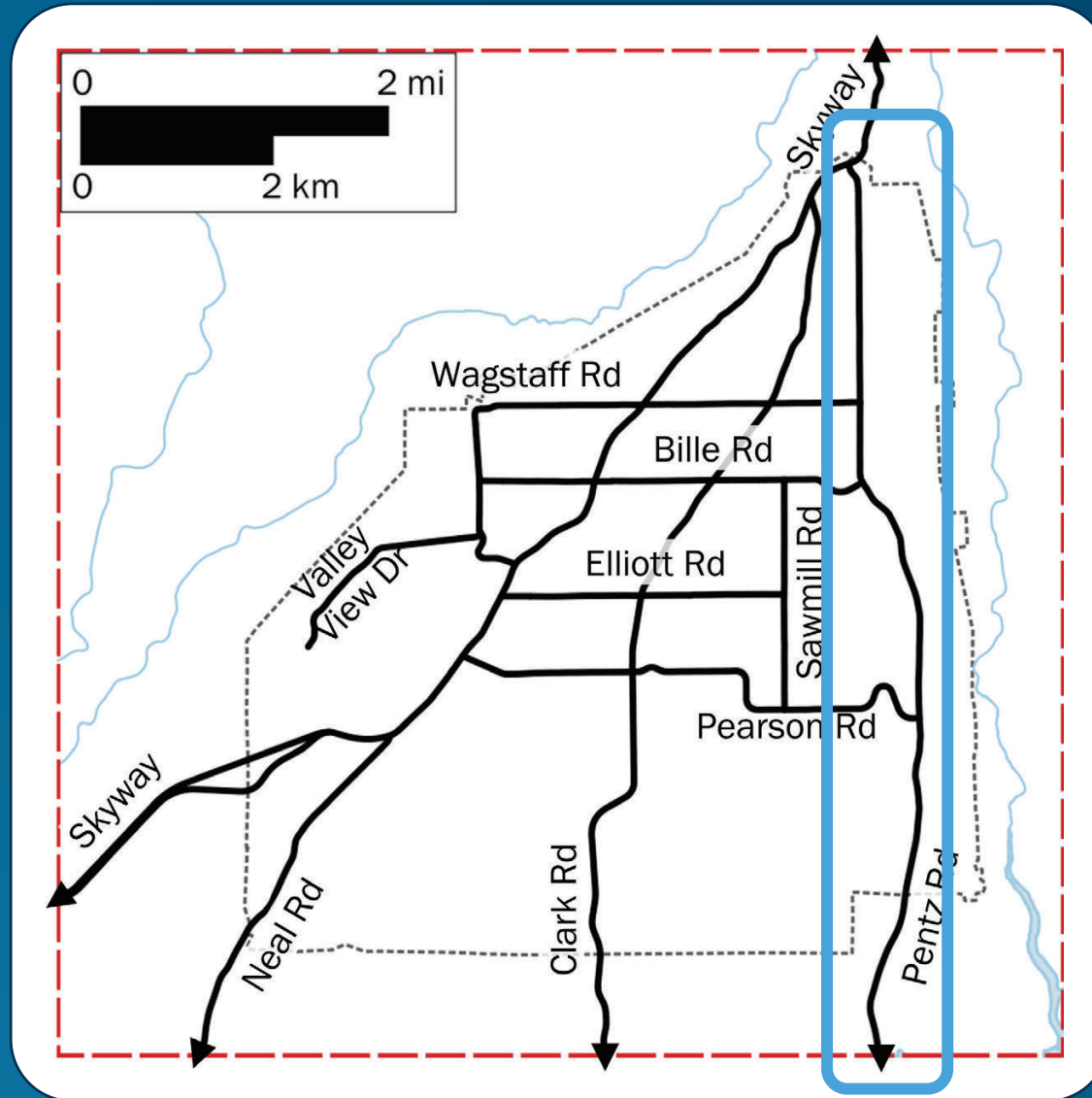
Relationships of
Burnovers and
TRAs

Exposures at
TRAs

Analysis of TRAs

Technical
Findings

Pentz Road TRAs



Burnovers

Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

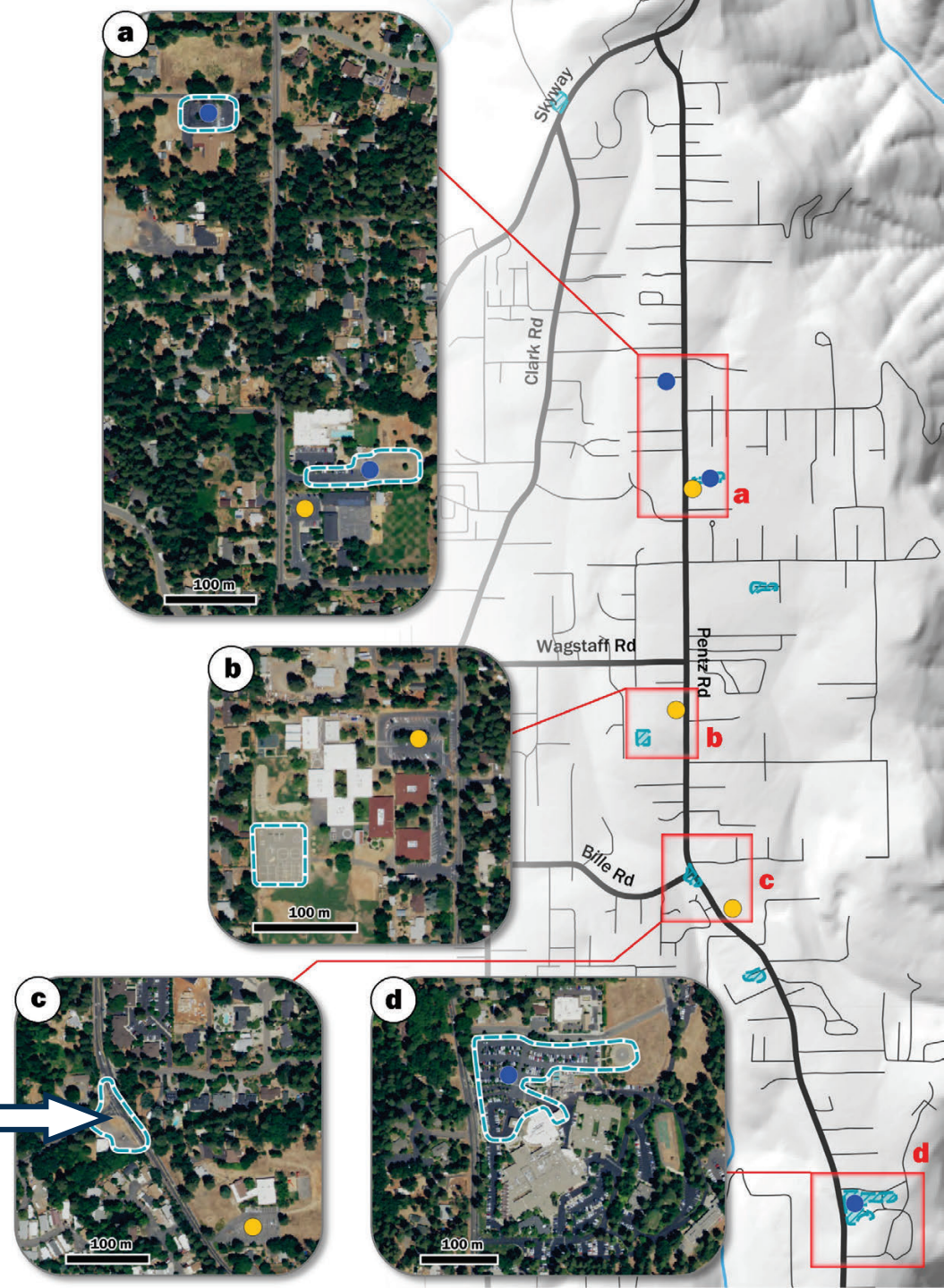
Exposures at TRAs

Analysis of TRAs

Technical Findings

Pentz Road TRAs

- TRAs along Pentz Rd utilized many of the readily visible and accessible parking lots, highlighted by blue dots.
- Additional parking areas are indicated by yellow dots.



Bille Road TRA

Burnovers

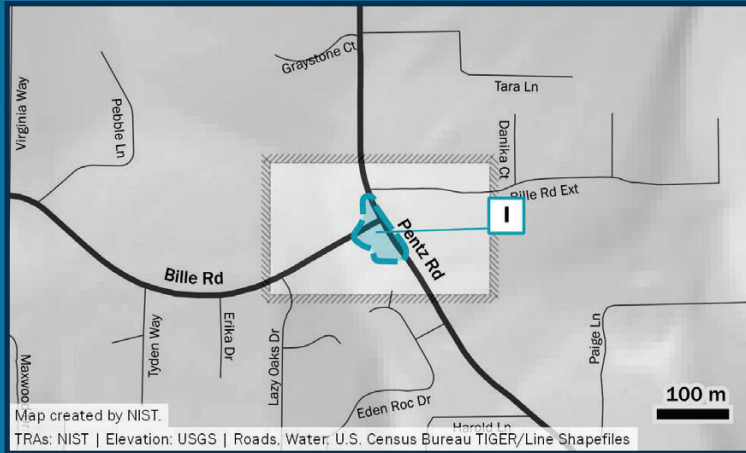
Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

Exposures at TRAs

Analysis of TRAs

Technical Findings



← view indicated above

Different Fuel Loadings

Burnovers

Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

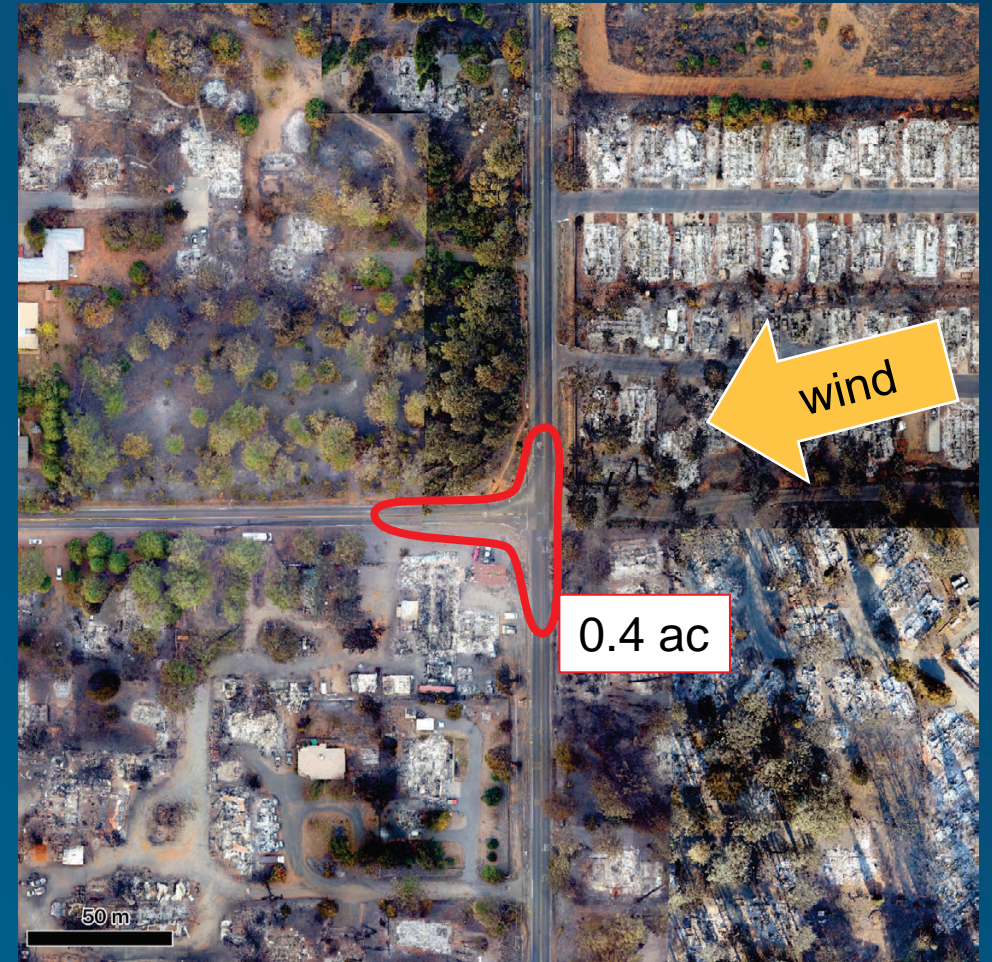
Exposures at TRAs

Analysis of TRAs

Technical Findings



Wagstaff Road and Clark Road
Paradise Plaza TRAs



Wagstaff Road and Pentz Road

images to scale

Camelot Wild Fire Safety Zone

Burnovers

Temporary Refuge
Areas (TRAs)

Relationships of
Burnovers and
TRAs

Exposures at
TRAs

Analysis of TRAs

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NIST photos of the Camelot meadow looking north from Camelot Ln, October 29, 2019. (~1 year post-fire)

Burnovers

Temporary Refuge
Areas (TRAs)

Relationships of
Burnovers and
TRAs

Exposures at
TRAs

Analysis of TRAs

Technical
Findings

Analysis of TRAs

*number of civilians | duration | evacuation
defensive actions*

Civilians in TRAs

Burnovers

Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

Exposures at TRAs

Analysis of TRAs

Technical Findings

ID	Name	Civilians		Vehicles ^a		Total Civilians ^b		Includes
		Min	Max	Min	Max	Min	Max	
A	Camelot Meadow Wild Fire Safety Zone	70	85	(24)	(30)	70	85	B + C
B	Hoffman Rd	24	24	(10)	(15)	24	24	
C	Concow Rd "dozer zone"	30	45	—	—	30	45	B
D	Chris Ct	—	—	6	6	6	6	
E	Feather River Hospital	65	115	50	110	115	225	H + J
F	Concow Rd "gravel area"	15	25	—	—	15	25	
G	Ponderosa Elementary School	—	—	6	6	6	6	
H	Chloe Ct	7	14	(2)	(2)	7	14	
I	Bille Rd	—	—	70	100	70	100	
J	Pearson Rd	—	—	30	70	30	70	
K	Paradise Plaza	—	—	350	550	350	550	I + R
L	PPD/Fire Station 81	30	60	(0)	(0)	30	60	
M	Paradise Ridge Southern Baptist Church	—	—	4	6	4	6	
N	Wagstaff Rd	—	—	100	200	100	200	
O	Fire Station 82	10	20	20	30	30	50	
P	Walgreens	100	140	—	—	100	140	
Q	Ace Hardware	—	—	—	—	—	—	
R	Beyond Fitness	—	—	3	3	3	3	
S	Optimo	180	220	—	—	180	220	
T	Best Western	—	—	15	20	15	20	
U	Magalia Community Church	—	—	—	—	—	—	
V	CMA Church	—	—	50	250	50	250	
W	Paradise Shopping Center	20	40	—	—	20	40	
X	Firland Dr	0	0	0	0	0	0	
Y	Magalia Pines Baptist Church	80	130	—	—	80	130	
Z	Magalia Sav-Mor	10	40	—	—	10	40	
AA	Rite Aid	40	60	—	—	40	60	
BB	Skyway and Coutolenc Rd	0	0	0	0	0	0	
CC	Magalia Dam	—	—	1	1	1	1	
DD	Pine Ridge School	0	0	0	0	0	0	
EE	Concow Rd and Pinkston Canyon Rd	0	0	0	0	0	0	

Note: The min and max values reflect uncertainty in the number of pedestrians and vehicles.
^a () indicate non-additive values; the indicated civilians were within those allotted vehicles.
^b Total head count assumes only 1 person per vehicle.



Estimated head count of civilians in each TRA

- Number of pedestrians
- Number of vehicles
- Accounts for combined TRAs

Estimated number of individual civilians depending on vehicle occupancy

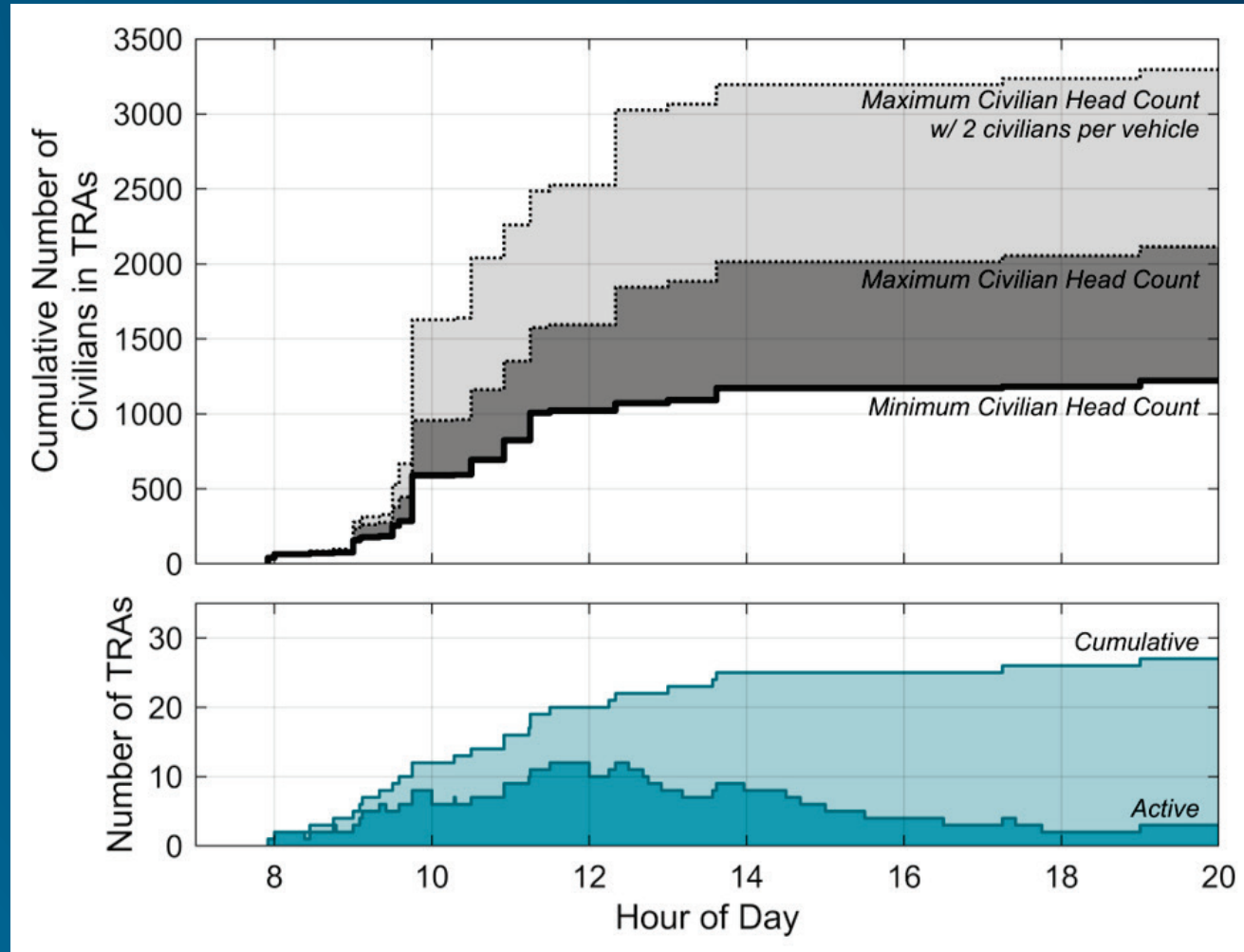
	Low Count	High Count
Pedestrians	622	934
Vehicles	600	1182
Total		
1.0 person/vehicle	1222	2116
1.5 persons/vehicle	1522	2707
2.0 persons/vehicle	1822	3298
2.5 persons/vehicle	2122	3889

Civilians in TRAs

Cumulative head count of civilians and TRAs over time.

Maximum civilian head count values show:

- the uncertainty in the number of people or vehicles, and
- the uncertainty in vehicle occupancy.



Between 1,200 and 3,000 Civilians in TRAs

High Urgency TRAs (07:55 to 09:35)

	ID	TRA Name	PHL	Civilian Head Count	
				Min	Max
Concow					
	A	Camelot Meadow Wild Fire Safety Zone	▲▲▲	70	85
	B	Hoffman Rd	▲▲▲	24 ^a	24 ^a
	C	Concow Rd “dozer zone”	▲▲▲	30 ^a	45 ^a
Paradise					
	E	Feather River Hospital	▲▲	115	225
	G	Ponderosa Elementary School	▲▲	6	6
	H	Chloe Ct	▲▲▲	7 ^b	14 ^b
	I	Bille Rd	▲▲▲	70	100
	J	Pearson Rd	▲▲▲	30 ^b	70 ^b
Total				352	569
				(261 individuals)	(416 individuals)

Note: The tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle. Total is the (person × exposure) count. Some individuals were located in multiple locations, as follows:

^a Consolidated into *TRA-A*.

^b Consolidated into *TRA-E*.

Listed headcount assumes one person per vehicle.

Evacuation of TRAs

Primary Evacuation Outcome of each TRA

- Drove out
- Transported out
- Escorted out
- Escorted/transported to another TRA
- (no data)
- (no civilians)

ID	Name	Primary Outcome
A	Camelot Meadow Wild Fire Safety Zone	Escorted out
B	Hoffman Rd	Escorted to TRA-C
C	Concow Rd "dozer zone"	Escorted to TRA-A
D	Chris Ct	Drove out
E	Feather River Hospital	Drove out / escorted out
F	Concow Rd "gravel area"	n/d
G	Ponderosa Elementary School	n/d
H	Chloe Ct	Transported to TRA-E
I	Bille Rd	Escorted to TRA-K
J	Pearson Rd	Escorted to TRA-E
K	Paradise Plaza	Escorted out
L	PPD/Fire Station 81	Transported out
M	Paradise Baptist Church	n/d
N	Wagstaff Rd	n/d
O	Fire Station 82	Escorted to TRA-Q
P	Walgreens	Transported out
Q	Ace Hardware	Escorted out
R	Beyond Fitness	Escorted to TRA-K
S	Optimo	Escorted to TRA-K
T	Best Western	Escorted out
U	Magalia Community Church	n/d
V	CMA Church	Escorted to TRA-K
W	Paradise Shopping Center	Escorted/transported out
X	Firland Dr	n/a
Y	Magalia Pines Baptist Church	Transported to TRA-K
Z	Magalia Sav-Mor	Transported to TRA-K
AA	Rite Aid	Escorted out
BB	Skyway and Coutolenc Rd	n/a
CC	Magalia Dam	n/d
DD	Pine Ridge School	n/a
EE	Concow Rd and Pinkston Canyon Rd	n/a

Note: n/d represents no data, n/a indicates that only first responders, not civilians, used the TRA

Evacuation of TRAs

Primary Evacuation Outcome of each TRA

- Drove out
- Transported out
- Escorted out
- Escorted/transported to another TRA
- (no data)
- (no civilians)

ID	Name	Primary Outcome
A	Camelot Meadow Wild Fire Safety Zone	Escorted out
B	Hoffman Rd	Escorted to TRA-C
C	Concow Rd "dozer zone"	Escorted to TRA-A
D	Chris Ct	Drove out
E	Feather River Hospital	Drove out / escorted out
F	Concow Rd "gravel area"	n/d
G	Ponderosa Elementary School	n/d
H	Chloe Ct	Transported to TRA-E
I	Bille Rd	Escorted to TRA-K
J	Pearson Rd	Escorted to TRA-E
K	Paradise Plaza	Escorted out
L	PPD/Fire Station 81	Transported out
M	Paradise Baptist Church	n/d
N	Wagstaff Rd	n/d
O	Fire Station 82	Escorted to TRA-Q
P	Walgreens	Transported out
Q	Ace Hardware	Escorted out
R	Beyond Fitness	Escorted to TRA-K
S	Optimo	Escorted to TRA-K
T	Best Western	Escorted out
U	Magalia Community Church	n/d
V	CMA Church	Escorted to TRA-K
W	Paradise Shopping Center	Escorted/transported out
X	Firland Dr	n/a
Y	Magalia Pines Baptist Church	Transported to TRA-K
Z	Magalia Sav-Mor	Transported to TRA-K
AA	Rite Aid	Escorted out
BB	Skyway and Coutolenc Rd	n/a
CC	Magalia Dam	n/d
DD	Pine Ridge School	n/a
EE	Concow Rd and Pinkston Canyon Rd	n/a

Note: n/d represents no data, n/a indicates that only first responders, not civilians, used the TRA

Unsuccessful TRA Evacuation Attempts

INBOUND

INBOUND

OUTBOUND

INBOUND

Time Range	Convoy Description	Intended Destination	Reason for Abort
before 10:00	Transit buses convoy from Butte College staging up Clark Road	Unknown	Fire conditions
10:00 10:30	A regional ambulance response team arrives to Butte County and attempts to enter Paradise via Skyway	Feather River Hospital (TRA-E)	Fire conditions
11:00 16:00	Various groups of civilians and civilians led by first responders attempt to evacuate from the hospital (TRA-E) multiple times	Out of the fire area	Fire and roadway conditions
14:00	Two transit buses were escorted toward the hospital but were turned around	Feather River Hospital (TRA-E)	Fire conditions

Evacuation With Transit Buses

Approx. Time Range	Description
08:00	Bus on Route 41 in Paradise, with passengers
08:00 11:00	Paratransit bus in service in Paradise; driver parks bus, evacuates passenger in personal vehicle
09:00 12:00	Bus on Route 41 is stuck in traffic; deviates from fixed route to evacuate with passengers
09:00 09:30	Attempt to send a Paratransit bus on an evacuation mission with law enforcement ^a
09:30 10:00	Buses dispatched to staging area at Butte College
10:00 12:30	Two transit buses with Paratransit bus go on rescue mission to Buschmann Rd area ^a
14:00	Attempt to send buses to FRH via Clark Rd ^a
15:30	Convoy departs staging area for Paradise TRA evacuations ^a
17:15	Convoy arrives at Paradise Plaza TRA
17:15 20:30	Buses load passengers; Paratransit buses ferry people from TRAs in Magalia
19:30	First group of buses depart Paradise Plaza with >100 evacuees; additional vehicles join convoy
23:00	Final buses depart Paradise Plaza
01:00	All buses have returned to the depot.
—	B-Line provided additional support to operations over the following days.

^a Convoys departed from Butte College staging area

Effective coordination and use of mass transportation facilitated evacuation

TRAs and Merging of TRAs

Burnovers

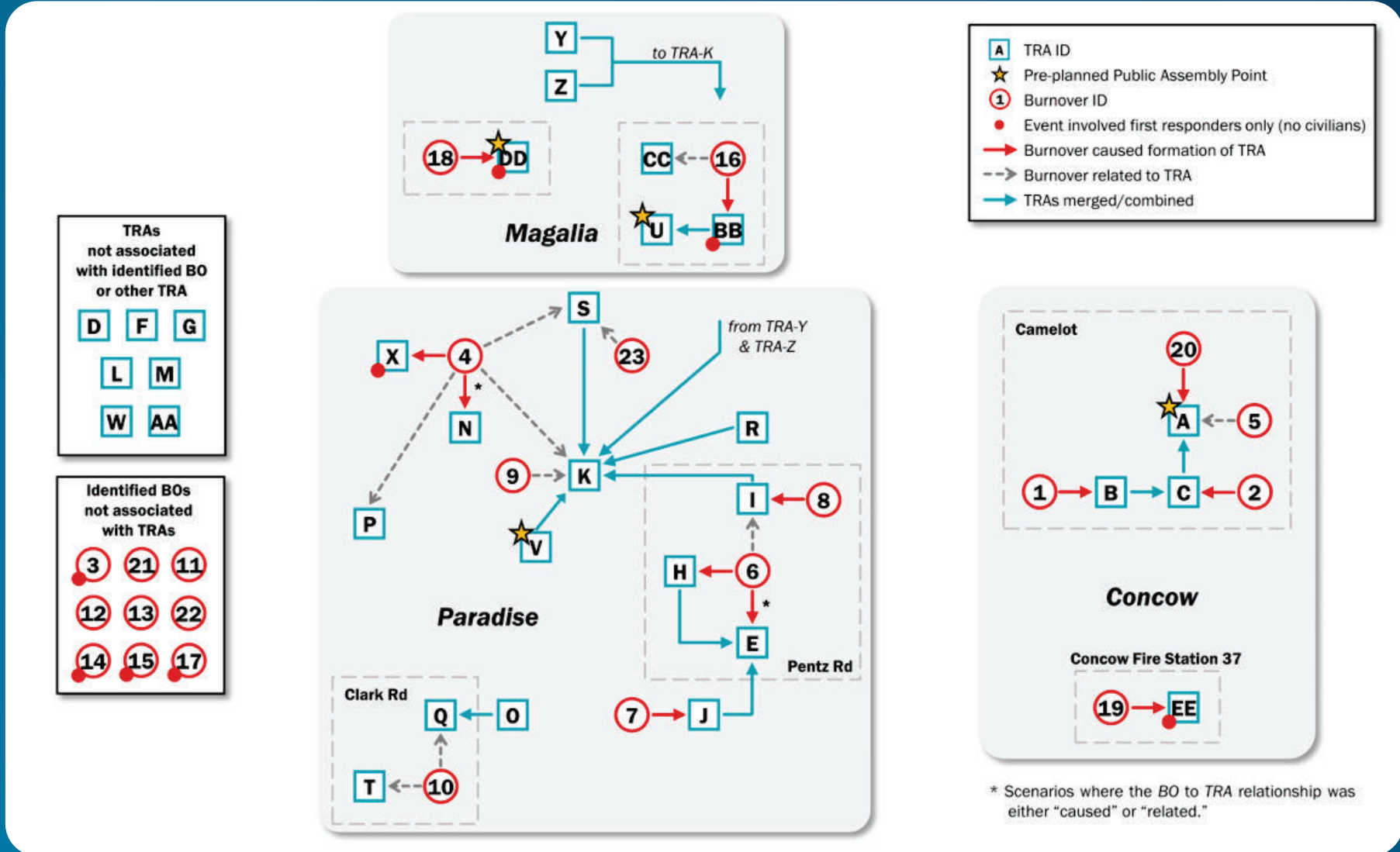
Temporary Refuge Areas (TRAs)

Relationships of Burnovers and TRAs

Exposures at TRAs

Analysis of TRAs

Technical Findings



Duration of TRAs

Active duration of each TRA was influenced by two primary factors:

1. Local conditions

- TRA use was kept to an absolute minimum in the cases when TRAs were within burnover areas and high exposures were present (*e.g., Hoffman Road, TRA-B, 23 minutes*)

2. Fire and traffic conditions between the TRA and

- another TRA (if used)
- a complete evacuation from the fire area

Duration of TRAs

- 9 TRAs active >3 hours
- None of these long-duration TRAs experienced high peak hazard levels
- 78 % of civilians, (minimum count between 955 and 1675) took refuge in one of nine TRAs for 3 to 9 hours
- FRH only long-duration TRA formed with high urgency due to:
 - early onset of severe fire conditions,
 - its location on Pentz Road, and
 - the vulnerable population at the hospital

Table 41. TRA duration and minimum civilian head count, t ≥ 3 hours.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count ^a	
					Min	Max
Y	Magalia Pines Baptist Church	!	▲▲▲	9:23	80	130
AA	Rite Aid	!	▲▲▲	9:00	40	60
K	Paradise Plaza	!	▲	8:00	350	550
E	Feather River Hospital	!!!	▲▲	6:00	115	225
S	Optimo	!	▲▲▲	5:15	180	220
V	CMA Church	!	▲	5:05	50	250
L	PPD/Fire Station 81	!	▲	4:56	30	60
Z	Magalia Sav-Mor	!	▲	4:45	10	40
P	Walgreens	!!	▲▲	3:35	100	140
Total (person × TRA)					955	1675

^a Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

Duration of TRAs

- 12 moderate duration TRA events (1–3 hr).
 - 3 TRAs were both high urgency and high peak hazard level.
 - 9 experienced moderate peak hazard level.
- Minimum estimated head count of 1222 civilians who were in at least one TRA
 - 319 (26 %) were in TRAs active between 1 and 3 hours.
 - Out of the 319, 147 (46%) were in high urgency of formation and high peak hazard level TRAs

Table 42. TRA duration and minimum civilian head count, $1 \geq t > 3$ hours.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count ^a	
					Min	Max
I	Bille Rd	!!!	▲▲▲	2:30	70	100
W	Paradise Shopping Center	!	▲▲	2:30	20	40
M	Paradise Baptist Church	!!	▲▲	2:28	4	6
N	Wagstaff Rd	!!	▲▲	2:25	100	200
A	Camelot Meadow	!!!	▲▲▲	2:05	70	85
H	Chloe Ct	!!!	▲▲▲	1:55	7	14
Q	Ace Hardware	!	▲▲	1:46	n/d	n/d
T	Best Western	!!	▲▲	1:41	15	20
DD	Pine Ridge School	!!!	▲▲	1:20	0	0
R	Beyond Fitness	!!	▲▲	1:15	3	3
O	Fire Station 82	!	▲▲	1:05	30	50
BB	Skyway and Coutolenc Rd	!!!	▲▲	1:00	0	0
Total (person × TRA)					319	518

^a Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

Duration of TRAs

- 10 TRAs (32 %) were active for less than one hour
- Account for ~10 % of the total number of civilians in TRAs.
- Most of these people were exposed to High PHL in Urgent TRAs
 - Between 90 and 145 people (80%) were in high urgency TRAs
 - 84 to 139 (75 %) were in TRAs with high peak hazard levels

Table 43. TRA duration and minimum civilian head count, $t < 1$ hour.

ID	TRA	Urgency	Peak Hazard	Active Duration (h:mm)	Civilian Head Count ^a	
					Min	Max
G	Ponderosa ES	!!!	▲▲	0:53	6	6
J	Pearson Rd	!!!	▲▲▲	0:43	30	70
D	Chris Ct	!!	▲▲	0:40	6	6
U	Magalia Community Church ^b	!!	▲▲	0:26	n/d	n/d
C	Concow Rd “gravel area”	!!	▲▲	0:25	15	25
X	Firland Dr	!!	▲▲	0:24	0	0
B	Hoffman Rd	!!!	▲▲▲	0:23	24	24
C	Concow Rd “dozer zone”	!!!	▲▲▲	0:20	30	45
EE	Concow Rd and Pinkston Canyon Rd	!!!	▲▲▲	0:18	0	0
CC	Magalia Dam	!!	▲	0:09	1	1
Total (person × TRA)					112	177

^a Tabulated civilian head count assumes only 1 person per vehicle. The min and max values reflect uncertainty in the number of pedestrians and vehicles. The true maximum is likely higher than 1 person per vehicle.

^b TRA was also used a second time by first responders only, not included in this table.

Defensive Actions at TRAs

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1. Life safety
2. Protect infrastructure
3. Reduce exposures



Photo courtesy of TD-112, 15:10. Used with permission.

Category 2



Photo courtesy of TD-127, 03:09 (Nov 9). Used with permission.

Category 1



Photo courtesy of TD-041, 14:12. Used with permission.

Category 3

Defensive actions by first responders took place at half of the TRAs

Civilian Decision Making and Evacuation Intent

Civilian intentions during evacuation in the context of TRAs can be divided into the following categories:

1. Civilians sought shelter in a Wild Fire Safety Zone or TRA by themselves.
2. Civilians trying to leave an area became trapped by fire in a burnover. In many cases civilians in burnovers were redirected to TRAs.
3. Civilians trying to leave the area (either for evacuation purposes or other reasons) and fire forced their redirection to a TRA.
4. Civilians were placed in a TRA because of traffic flow and fire exposures but were not in any immediate danger from fire exposures.

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**Technical
Findings**

Temporary Refuge Areas

technical findings & recommendations


Technical Findings

Temporary Refuge Areas

- TF-TRA 1.** Thirty-one different TRAs were formed during the first 25 hours, 27 of which involved civilians.
- TF-TRA 2.** Of the 18 pre-designated public assembly areas and Wild Fire Safety Zones, only four were used as TRAs during the Camp Fire. Another four were used for incident response staging.
- TF-TRA 3.** TRAs were selected to leverage natural and/or manmade features. TRAs types included 14 parking lots, 7 roadways, 6 structures, 3 maintained natural areas, and 1 unmaintained natural area.
- TF-TRA 4.** Roadways and natural area TRAs were frequently the only local options [35 % (11/31) of TRAs during the Camp Fire].
- TF-TRA 5.** At least 1200 to 2100 civilians were involved with TRAs. If average vehicle occupancy is assumed to be two, the estimated number of civilians increases to 3300.
- TF-TRA 6.** Individual TRA occupancy ranged from 1 to 550 civilians including people in vehicles and on foot.

Technical Findings

Temporary Refuge Areas

- TF-TRA 7.** High hazard conditions impacted at least 261 civilians in eight TRAs between 07:55 and 09:35 (100 minutes). Seven of the eight TRAs were formed in direct response to burnover events.
- TF-TRA 8.** Rapid event evolution prevented residents in Concow from reaching their local Safety Zone. It took one hour and two TRAs to get from Hoffman Road to the Camelot Meadow Wild Fire Safety Zone, a travel distance of 1 km (0.6 mi) [300 m (0.2 mi) straight-line distance].
- TF-TRA 9.** The Camelot Wild Fire Safety Zone burned before it was usable as a TRA. This event highlights the need to design and maintain TRAs for ready access. Irrigated and maintained Safety Zones like Crain Memorial Park or gravel areas may provide additional safety in quickly developing events.
-  **TF-TRA 10.** The extensive use of TRAs points to the critical need of developing an evacuation plan that includes scenarios where immediate evacuation out of the fire may not be possible.
- TF-TRA 11.** TRAs along major evacuation arteries enhanced civilian life safety because in many cases civilians did not have to go out of their way (off the evacuation route) to get to the TRA.
- TF-TRA 12.** Consolidation of TRAs and groups of civilians facilitated management and evacuation of TRAs by first responders.

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- Ideally, civilians will have time and ability to safely evacuate before the fire impacts their community.
- In events where this is not possible, a system of pre-planned Wildfire Safety Zones can be used to enhance life safety to *limit* civilian exposure to fire during evacuation, *especially in intermix communities*.
- The recommendations focus on the development and implementation of a Wildfire Safety Zone System; however, they also apply to the identification of TRAs.
- The use of ad hoc TRAs is, by default, a last resort and does not provide the full benefit of a pre-planned Wildfire Safety Zone System.



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- R-TRA 1. There is a need for a distributed pre-planned Wildfire Safety Zone System in communities to reduce the travel time needed to access these areas so they can be quickly accessed in case a rapidly moving and widespread fire near the community prevents a timely evacuation of the community.
- R-TRA 2. The number, size, and spatial distribution of safety zones need to be factored into the design of a community-wide Wildfire Safety Zone System and based on fire exposure consideration, population density in the surroundings, and number and size of other safety zones.
- R-TRA 3. Placement of and access to safety zones should consider civilian access pathways and address potential burnover locations, informed by fire history, fuel loading, and dangerous topographical features.

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- R-TRA 4. Identify high fuel-load areas such as heavily wooded areas, areas of flashy fuels (e.g., unburned tall dry grass), combustible structures, high density residential areas, and topographical features like chimneys and ravines. Assess civilian egress/transit to safety zones that may traverse these areas.
- R-TRA 5. Use Wildfire Safety Zones on major evacuation arteries to enhance civilian life safety.
- R-TRA 6. Consider spatial density (and minimum size) of safety zones, as well as their maintenance. The difficulty of getting to Camelot Wild Fire Safety Zone highlights the need to carefully place and maintain safety zones.
- R-TRA 7. Beyond the pre-planned safety zones, first responders should be aware of nearby natural and manmade areas conducive to TRAs, such as large parking lots, gravel areas, irrigated natural spaces (e.g., parks, cemeteries), roadways/intersections, and other open spaces.

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Thank You

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Camp Fire



[https://www.nist.gov/el/fire-research-division-73300/
wildland-urban-interface-fire-73305/nist-investigation-california](https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california)

Direct links to NETTRA reports:

<https://doi.org/10.6028/NIST.TN.2252>

<https://doi.org/10.6028/NIST.TN.2252sup>