Focused Off-site Ignition Risk Assessment

Centennial

MARCH 2025

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
CAL FIRE	California Department of Forestry and Fire Protection
CBC	California Building Code
CEQA	California Environmental Quality Act
CFC	California Fire Code
CMG	Centennial Monitoring Group
EIR	environmental impact report
ERP	Emergency Response Plan
FHSZ	Fire Hazard Severity Zone
FMZ	fuel modification zone
FPP	fire protection plan
FRAP	Fire and Resource Assessment Program
GIS	geographic information system
HOA	Homeowners Association
I	Interstate
IRWIN	Integrated Reporting of Wildland Fire Information
LACoFD	Los Angeles County Fire Department
NFPA	National Fire Protection Association
OAG	Attorney General's Office
PRC	Public Resources Code
Project	Centennial Master-Planned Community Project
SDG&E	San Diego Gas and Electric
SR	State Route
SRA	state responsibility area
WSP	Wildfire Safety Plan
WUI	wildland–urban interface

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1 Executive Summary

The potential fire impacts of the Centennial Specific Plan project (Approved Project) were fully disclosed and analyzed in in the Centennial Specific Plan Draft Environmental Impact Report (DEIR) and Final Environmental Impact (FEIR) (collectively the "2019 EIR") in accordance with the California Environmental Quality Act (CEQA). The 2019 EIR was certified by the Los Angeles County Board of Supervisors on April 30, 2019, but it was subsequently challenged in two separate lawsuits, one of which was brought by Climate Resolve, a public interest environmental organization. Among other claims, the Climate Resolve lawsuit alleged that the 2019 EIR of the environmental impacts caused by Approved Project and related to fire risk failed to comply with CEQA.

On April 5, 2021, the Los Angeles County Superior Court issued an order (Court Order) upholding the 2019 EIR's assessment of fire impacts in most respects. However, it faulted the 2019 EIR for purportedly failing to adequately analyze the Approved Project's potential fire-related impacts on existing off-site resources. Following issuance of the Court Order, but prior to final judgement in the Climate Resolve action, the Approved Project proponent and Climate Resolve entered into a legally enforceable settlement agreement to resolve the Climate Resolve litigation (Settlement Agreement). The Settlement Agreement addresses the key fire-related issues identified in the Court Order by requiring the Approved Project to (i) implement a Fire Protection Plan (FPP) that is subject to ongoing update procedures to incorporate any new or modified state or county fire prevention, protection, and response requirements to ensure that each phase of the Approved Project's development is at all times in compliance with then-prevailing standards and fire codes, (ii) obligate funding of the ongoing implementation of the Settlement Agreement FPP, (iii) ensure the completion of ongoing FPP compliance monitoring by a qualified third-party compliance inspector approved by the Los Angeles County Fire Department, including annual fuel management zone inspection, and (iv) require the establishment of a Good Neighbor Firewise Fund, which will provide grants to needs-based applicants to aid communities with a population of less than 100,000 within 15 miles of the project site to reduce off-site fire risks, increase fire prevention, protection and response measures, and avoid adverse impacts of fire, to be funded in an amount equal to $500,000 per year. Following full execution of the Settlement Agreement, on November 30, 2021, Climate Resolve filed with the Court a dismissal with prejudice of the Climate Resolve litigation, which dismissal was ordered by the Court on December 3, 2021.

The purpose of this report is to assess the potential to cause fires that ignite on-site and subsequently spread off-site, thereby impacting existing land uses in the Project's proximity. It is intended that the determinations of this report will be used to inform the fire impact analysis prepared as a supplement to the 2019 EIR (SEIR) to analyze the environmental impacts of proposed minor revisions to the Approved Project. This assessment also takes into account proposed modifications to the Approved Project to add battery energy storage systems as a conditionally permitted use and local microgrid electrical distribution systems as a permitted use to serve the Specific Plan area with renewable energy generated on site (Proposed Modifications). The Proposed Modifications would also open a portion of the existing Cement Plant Road and the entirety of a new Cement Plant Road for public use to improve overall fire resiliency

To date, there is no recognized scientific method for analyzing off-site ignition risk impacts of a proposed master-planned community such as the Centennial Specific Plan. There are various data available that can be used to evaluate some aspects of the potential for a project's population to result in ignitions, but understanding how specific and targeted design features and mitigation measures reduce potential ignition risk, if not prevent it altogether, have not been formalized. In many cases, the Project's features and measures also provide a public benefit beyond lessening the potential for increased ignitions and off-site fire spread, as discussed herein. To

that end, this analysis provides a comprehensive approach to evaluating the potential for an on-site ignition to cause an off-site ignition and spread-related impacts for a new master-planned community in a Fire Hazard Severity Zone (FHSZ). This report also applies this method to the Project to better inform the SEIR's assessment of the Project's potential fire-related impacts.

A team of fire protection experts was assembled to develop this assessment method utilizing best practices, extensive research, publicly available and Project-specific fire environment data, and years of professional experience to quantify and weigh the various risk factors and fire protection mitigation measures. Resumes of the fire protection team members are provided in Appendix A. The process involved creation of an off-site wildfire[1] risk matrix that assesses risk based on provisions for fire safety and protection features (described in detail herein).

Technical Report – Scope of Study

The scope of study included the following:

1. Characterize the existing site and its surroundings (estimate up to 5 miles) in terms of fire environment.
2. Summarize the Project's fire protection and safety features (required codes, Project proposed [specific], litigation settlement [above and beyond]); Required codes: CBC, CFC, Fire Safe Regulations (Public Resources Code), local ordinances.
3. Research articles, studies, and other sources to support analysis.
4. Conduct advanced fire behavior/fire spread modeling.
5. Discuss/describe Project's multi-layered approach to fire safety and protection.
6. Utilizing the analysis results and findings, develop a systematic method that can be used for a project to determine its off-site ignition risk.

Summary

Following the comprehensive research, development and application of the off-site risk assessment method, it was concluded that the Centennial Specific Plan Project presented a Moderate Off-site Ignition Risk to the adjacent land uses and communities in the region.

[1] CFC 4902 Definitions. WILDFIRE. Any uncontrolled fire spreading through vegetative fuels that threatens to destroy life, property or resources as defined in PRC, Sec. 4103 and 4104.

2 Project Background

Description of the Project site and its surrounding areas within a 5-mile radius are provided to assess landscape characteristics and features that may influence the Project's impact on off-site wildfire ignitions. This includes an assessment of the local fire environment and adjacent land uses.

The proposed Project site consists of approximately 12,323 acres of natural and agricultural land and is located in the northwestern portion of the Antelope Valley in an unincorporated area of Los Angeles County (County) (Figure 1, Project Site). The site is located adjacent to Quail Lake and is contiguous to the southern boundary of Kern County (Figure 2, Regional Map). The western boundary of the Project site is approximately 1 mile east of Interstate 5 (I-5). State Route (SR) 138 traverses the southern portion of the Project site in an east-west direction and forms its southern boundary west of Quail Lake. Elevations range from approximately 3,000 feet above mean sea level on the floor of Antelope Valley in the northeastern portion of the site to approximately 4,250 feet above mean sea level in the southwestern portion of the property.

Appendix B includes images and photographs of the site and surrounding area that support the discussion and conclusions presented herein.

- The current site is vacant and includes agricultural and open space, much of which is part of Tejon Ranch's ongoing grazing operation.
- The site includes paved roads (Cement Plant Road, 300th Street, Oso Pumping Plant Road), dirt roads, fences, power poles, and agriculture, effectively compartmentalizing the landscape.
- Vegetation is primarily maintained/grazed non-native grass and weedy growth and grassland with scattered native shrubs and oak woodland.

2.1 Off-site Fire Environment[2]

2.1.1 Fire History

According to the Integrated Reporting of Wildland Fire Information (IRWIN) database[3], there have been 196 reported wildfire ignitions within five miles of the Project site since 2014 (see Figure 3, Fire History). As presented graphically in Figure 4, Historical Off-site Ignition Locations, regional wildfire ignition locations documented in the IRWIN database are **strongly associated with major roadways** including I-5, SR-138, and Pine Canyon Road, with the majority of ignitions occurring along I-5 to the southwest of the Project site.

As depicted in Figure 4, the majority of wildfires within five miles of the Project site occur along the I-5 corridor and other major roadways. This pattern has been observed in other areas of Southern California. In San Diego County, distance to roads contributed significantly to the location of ignition points, with more ignitions closer to roads (Syphard and Keeley, 2015). Wildfire ignitions along roads are generally caused by **vehicles** with broken catalytic converters, dragging tow chains, parking over dry fuels, or directly from car fires spreading into adjacent vegetation. The potential for roadside ignitions is highest when fuels are cured and receptive to ignition from sparking.

[2] See the Project's Wildfire Safety Plan for more details about the Local Fire Environment including history, fuels (vegetation), climate and fire behavior modeling.

[3] https://www.wildfire.gov/application/irwin-integrated-reporting-wildfire-information

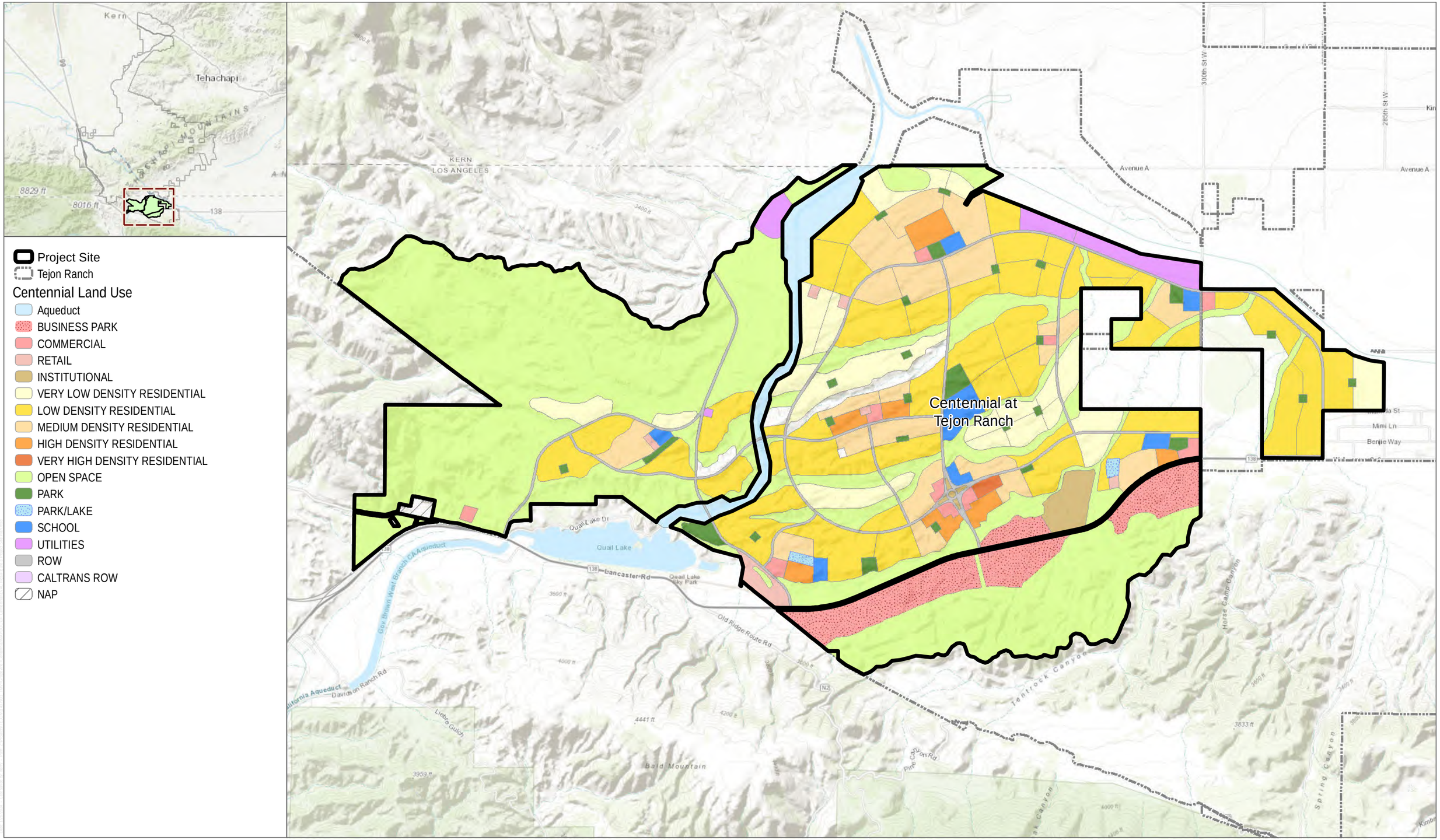
Maintenance or the removal of vegetation from roadsides has been a proven strategy for reducing the potential for roadside ignitions.

According to CAL FIRE's FRAP fire history database, other human-caused ignitions sources in the Project's vicinity include equipment use, arson, powerlines, and smoking. In other parts of the County, **equipment use** is the most common source of wildfire ignitions. Equipment commonly associated with wildfire ignitions includes power saws, mowers, or other equipment with gas or electric motors.

Compared to surrounding areas, the Project **site shows an obvious reduction in wildfire occurrence over time**. According to the FRAP database, 23 wildfires, have occurred on or within 1 mile of the Project site since 1800. The most recent fire burning in the vicinity of the Project site (within 1 mile) was the Gorman Fire, which occurred in May of 2007 and burned west of the property and I-5.

While not yet recorded in the public fire history database, other notable wildfires within the region have occurred in 2024. Most notably, the Post Fire ignited on June 15, 2024, near Gorman Post Road in Gorman, California located roughly 6 miles northwest of the Project site. Fueled by strong winds from the northeast and long-range spotting, the fire spread rapidly to the south, eventually growing to 15,563 acres. Firefighters suggested that fire spread was exacerbated by two back-to-back wet winters which resulted in dense vegetation growth. Two structures were destroyed in the Post Fire, resulting in one civilian injury. The fire was declared fully contained on June 26, 2024. While the Post Fire spread quickly south, it did not cross Interstate-5 or threaten the Project site.

The White Fire ignited on July 13, 2024, roughly 11 miles south of Tehachapi near Twin Lakes. The fire was caused by lightning and eventually spread to 5,646 acres roughly 16 miles northeast of the Project site. The fire was limited to the steeper terrain of the Tehachapi Mountains and did not spread to the Antelope Valley or the Project site. The lack of significant historical CAL FIRE activity on the majority of the Project site is likely **attributed to the removal of fine fuels by cattle grazing**. Limited wildfire history at the Project site is believed to be largely due to the site's terrain, managed fuels, barriers to wildfire spread, and quick wildfire detection and response. Wildfire occurrence off-site is more common, particularly south of the Project site in the Liebre Mountains. However, wildfires encroaching onto the Project site from the south rarely enter the interior of the site due to the position of Highway 138 and its utilization as a fire break. Wildfires that have previously burned within the Project site have been limited in size, with an average area of 284 acres. To date, fire has had a limited effect on the plant communities found on the Project site; grazing, which has been ongoing for over 150 years, has had the primary role in creating the current vegetation community.



SOURCE: BASEMAP-ESRI MAPPING SERVICE 2023; LAND USE-TEJON RANCH 2023

DUDEK

0 1,950 3,900 Feet

FIGURE 1

Centennial Project Site Plan

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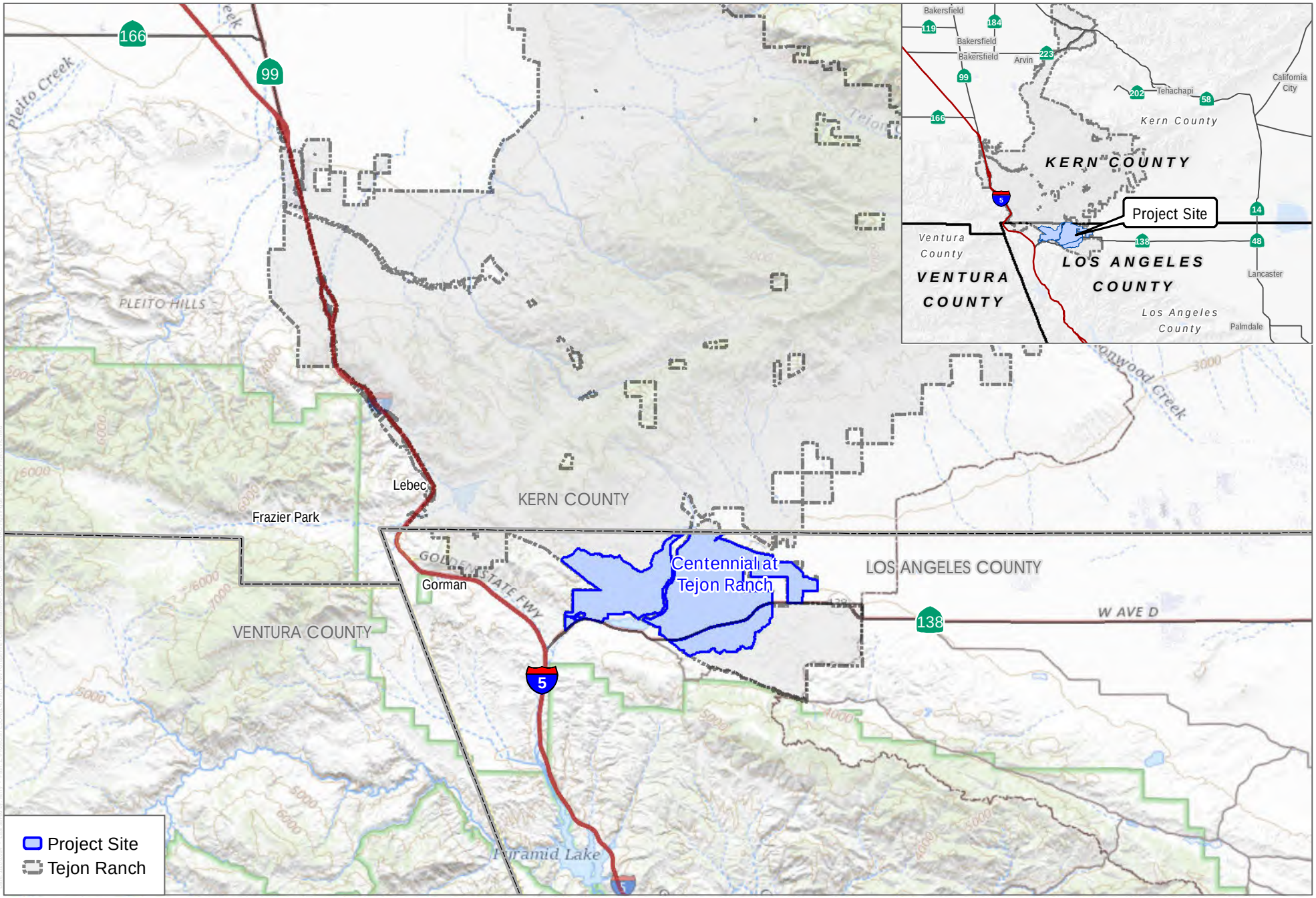

SOURCE: AERIAL-NAIP 2020

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FIGURE 2

Regional Project Vicinity

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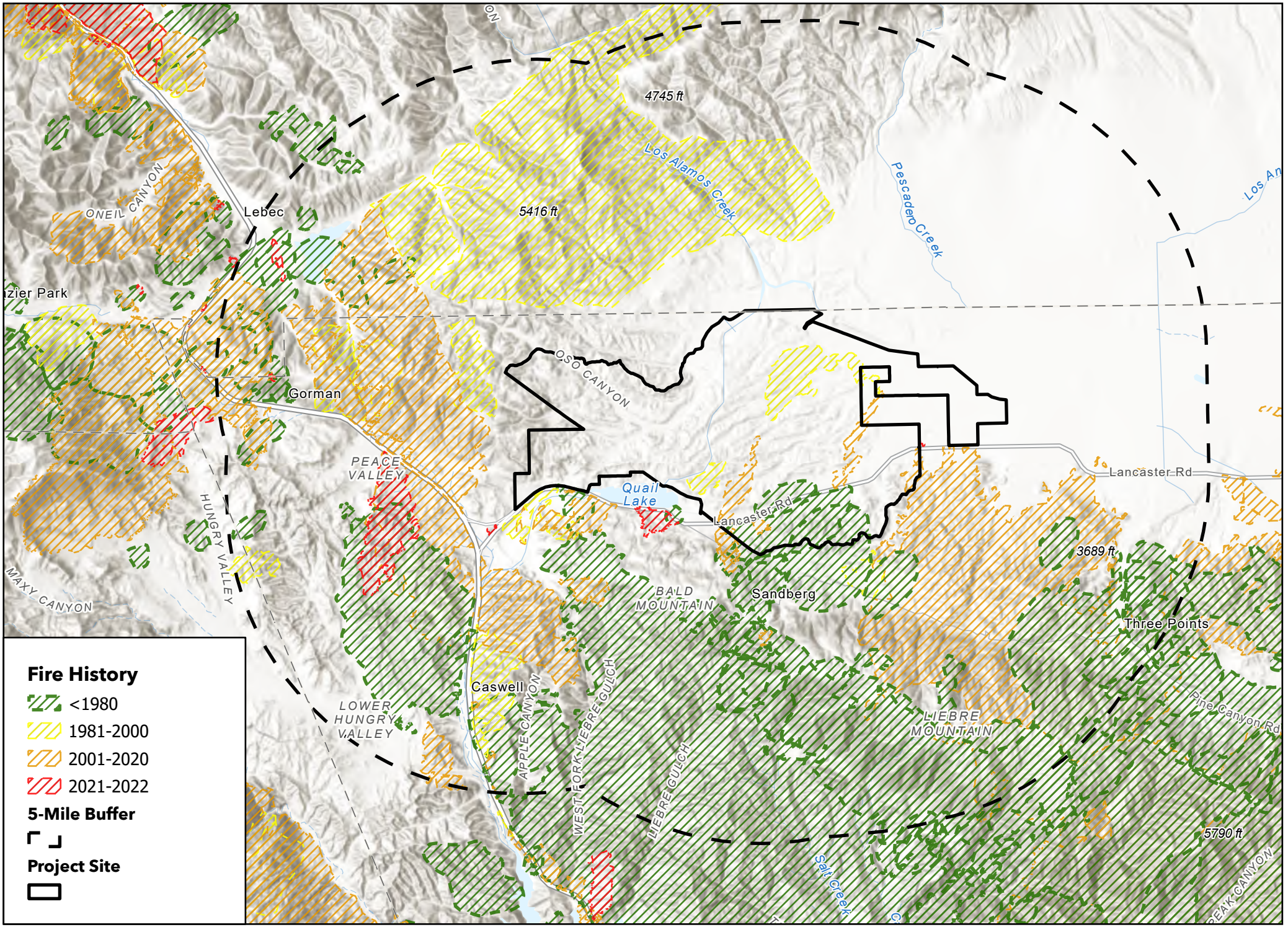

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Source: FRAP, 2023

FIGURE 3
Fire History

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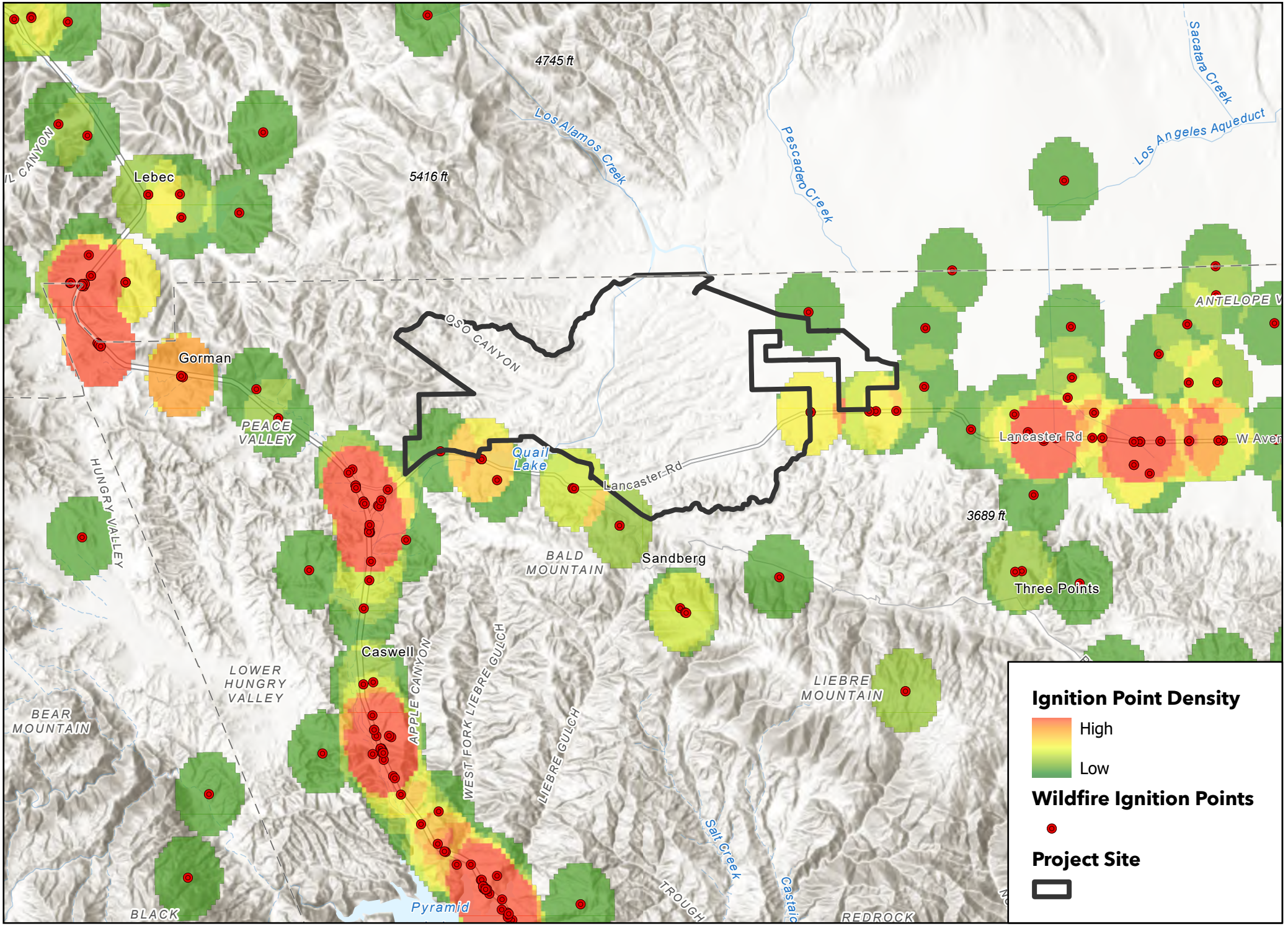

DUDEK

0 1 2 4 Miles

Source: WFGIS Ignition Data, 2023

FIGURE 4

Wildfire Ignition Locations

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2.1.2 Topography

In general, off-site terrain is heavily influenced by the southern edge of the Tehachapi Mountains to the north and Liebre mountains to the south (see Figure 5, Off-site Topography). Notable topographic features in the Project's vicinity include Liebre Mountain, Bald Mountain, Peace Valley, Pine Canyon, Apple Canyon, Liebre Gulch, and Tejon Pass. Terrain to the east of the Project site is generally flat, comprising the western edge of Antelope Valley. Wildfires burning in off-site areas are likely to be heavily influenced by variations in topography, among other factors. The Project site can be described as occurring in a wide valley absent of the topographical features that contribute to more aggressive fire behavior, as presented in Table 1.

Table 1. Effects of Topographic Features on Fire Behavior

Topographic Feature	Effect
Narrow Canyon	Surface winds follow canyon direction, which may differ from the prevailing wind. Wind eddies/strong upslope air movement expected, which may cause erratic fire behavior. Radiant heat transfer between slopes facilitates spotting/ignition on opposite canyon side.
Wide Canyon	Prevailing wind direction not significantly altered; aspect significant contributor to fire behavior. Wide canyons are not as susceptible to cross-canyon spotting except in high winds.
Box Canyon/ Chute	Air is drawn in from canyon bottom, with strong upslope drafts. No gaps or prominent saddles to let heated air escape. Fires starting at the canyon bottom can move upslope very rapidly due to a chimney-like preheating of the higher-level fuels and upslope winds.
Ridge	Fires may change direction when reaching ridge/canyon edge; strong air flows likely at ridge point; possibility for different wind directions on different sides of the ridge. Ridges experience more wind. Fires gain speed and intensity moving toward a ridge. Fires burning at a ridge can exhibit erratic fire behavior. Strong air flows can cause a whirling motion by the fire. As the wind crosses a ridge it usually has a leeward eddy in which the wind rolls around and comes up the leeward side.
Saddle	Potential for rapid rates of fire spread; fires are pushed through saddles faster during upslope runs. Winds can increase when blowing through saddles due to the funneling effect of the constricted pass. On the other side, winds will slow, but erratic winds potentially occur at the saddle due to eddies.

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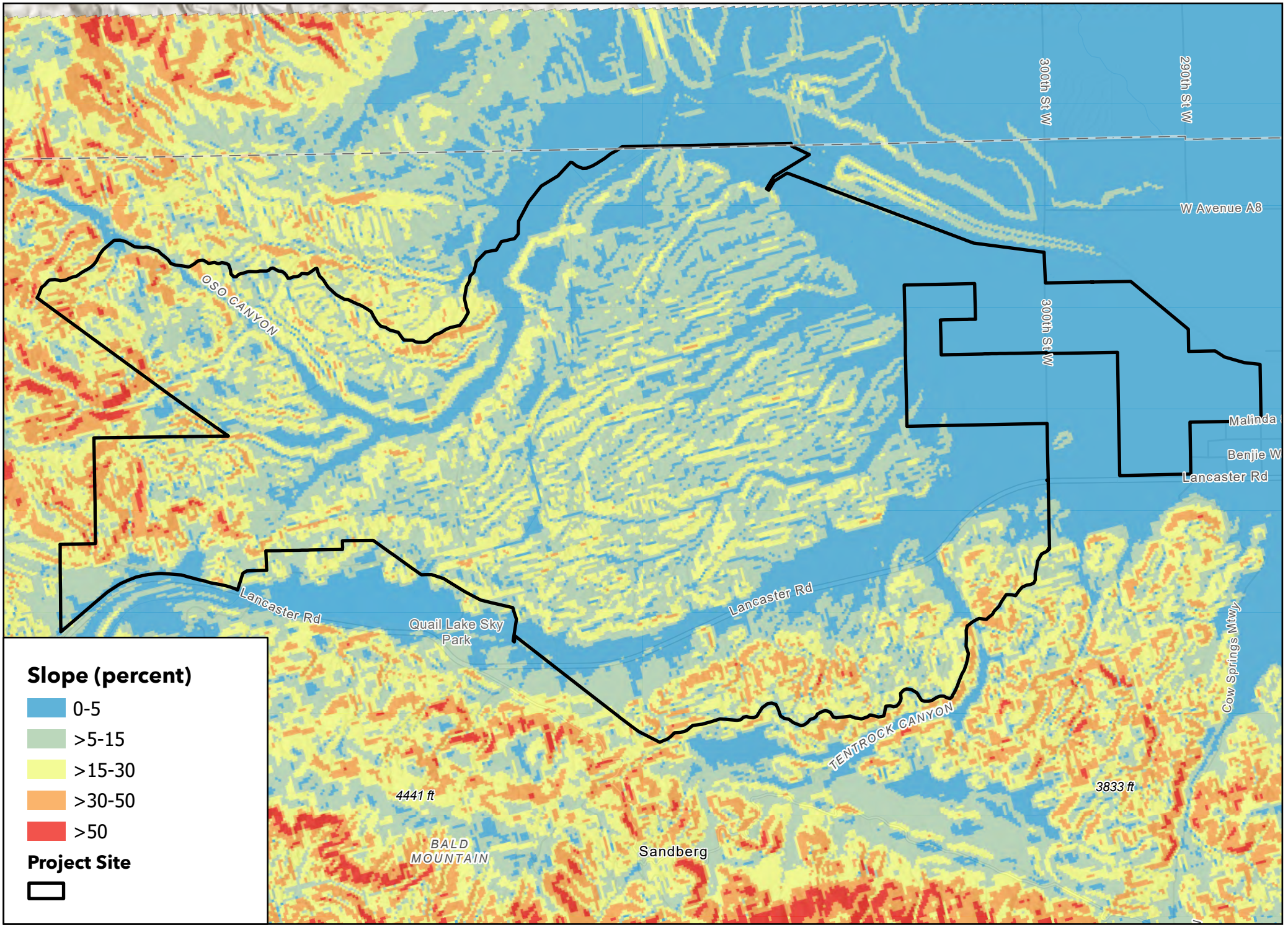

DUDEK

0 0.5 1 2 Miles

Source: LANDFIRE, 2024

FIGURE 5

Topography

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2.1.3 Vegetation and Fuels

Tejon Ranch remains unfragmented and has been carefully managed with livestock and cattle grazing for nearly 160 years, first by pre-statehood vaqueros, up until today by modern-day cowboys, and has committed to doing so in the future. Actively grazed landscapes, including those of portions of the ranch within the Antelope Valley in the County, assure sustainability and limit the severity of wildfire due to the reduction of grassland fuel loads. The sustainable grazing operation employed at Tejon Ranch effectively reduces the grass fuels on an ongoing basis, which reduces the potential for ignitions and for rapid fire spread.

As presented in Table 2, off-site fuels include grazed grasslands, oak woodlands, scrub vegetation, chaparral, coniferous forests, and extensive agricultural areas to the east. Variations in vegetative cover type and species composition have a direct effect on fire behavior. Some plant communities and their associated plant species have increased flammability based on plant physiology (resin content), biological function (flowering, retention of dead plant material), physical structure (bark thickness, leaf size, branching patterns), and overall fuel loading. For example, non-native grass-dominated plant communities become seasonally prone to ignition and produce lower-intensity, higher-spread rate fires. In comparison, sage scrub can produce higher heat intensity and higher flame lengths under strong, dry wind patterns, but does not typically promote ignition or spread as quickly as light, flashy grass fuels.

Table 2. Vegetation Communities within 5 Miles of the Project Site

Vegetation Type (WHR13NAME)	Acres	Percent of Area
Shrub	48,798	42%
Herbaceous	36,404	32%
Hardwood Forest	8,961	8%
Hardwood Woodland	6,366	6%
Agriculture	3,631	3%
Urban	2,907	3%
Desert Shrub	2,542	2%
Conifer Woodland	1,725	1%
Water	1,213	1%
Barren	1,035	1%
Desert Woodland	1,009	1%
Conifer Forest	590	1%
Wetland	265	<1%
Total:	**115,452**	**100%**

Source: FVEG, 2024

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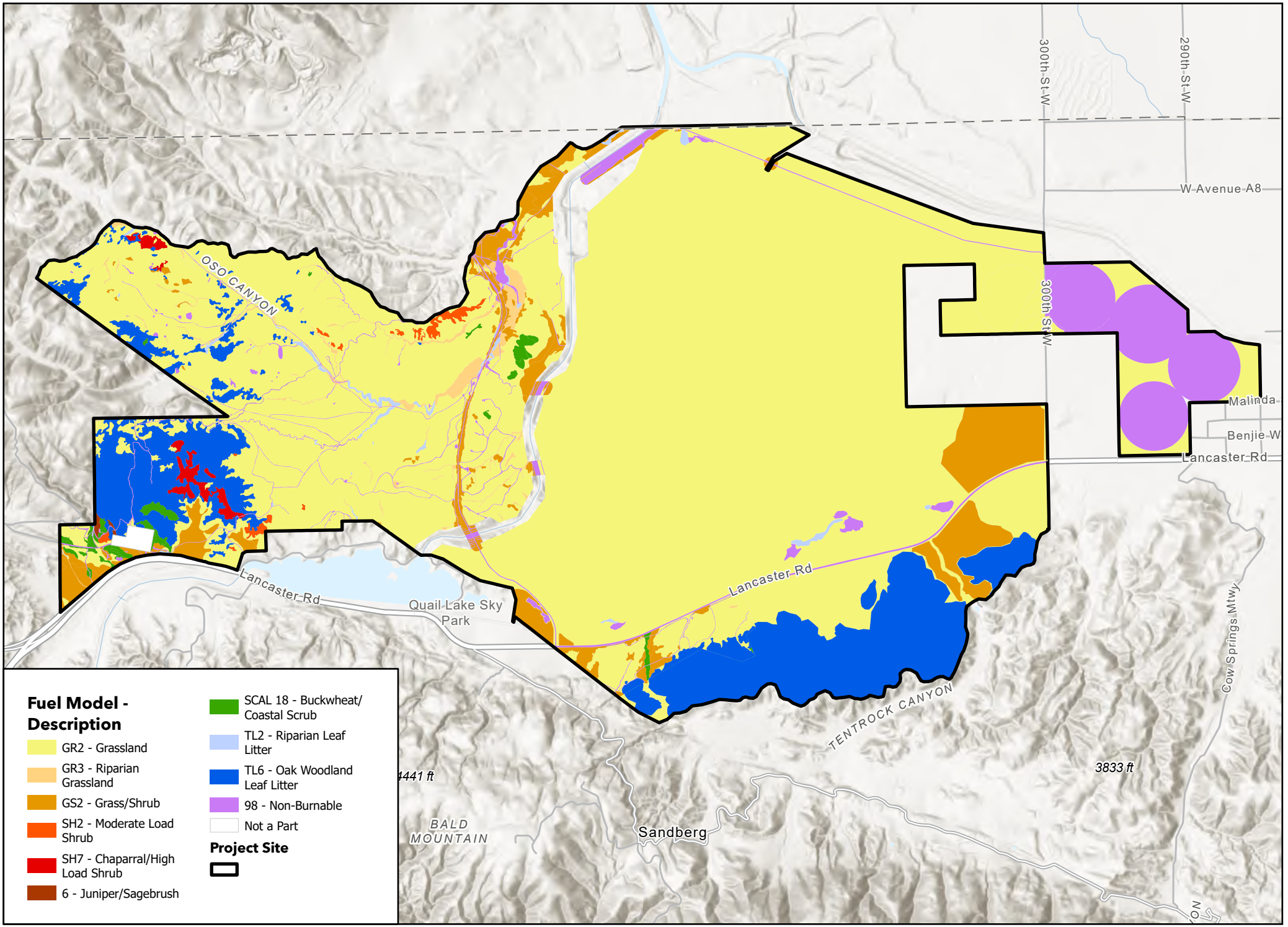

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0 0.5 1 2 Miles

Source: Bonterra, 2009, Edited 2024

FIGURE 6

Vegetation - Fuel Models

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2.1.4 Climate

Table 3 provides typical (50th Percentile) and extreme (97th Percentile) weather conditions at the Project site that were used for site-specific fire behavior modeling.

Table 3. 50th and 97th Percentile Weather Conditions at the Project Site

Climate Variable	50th Percentile Weather	97th Percentile Weather (w/ Max. Wind)
1 hour fuel moisture	5%	2%
10 hour fuel moisture	6%	3%
100 hour fuel moisture	12%	6%
Live herbaceous moisture	60%	30%
Live woody moisture	70%	60%
20 foot wind speed (mph)	7 mph	47 mph (maximum observed Fall wind speed)
Wind direction	240 degrees	60 degrees
Slope steepness	Variable by location, range: 0% to 95%	Variable by location, range: 0% to 95%

2.1.5 Project Vicinity and Land Uses

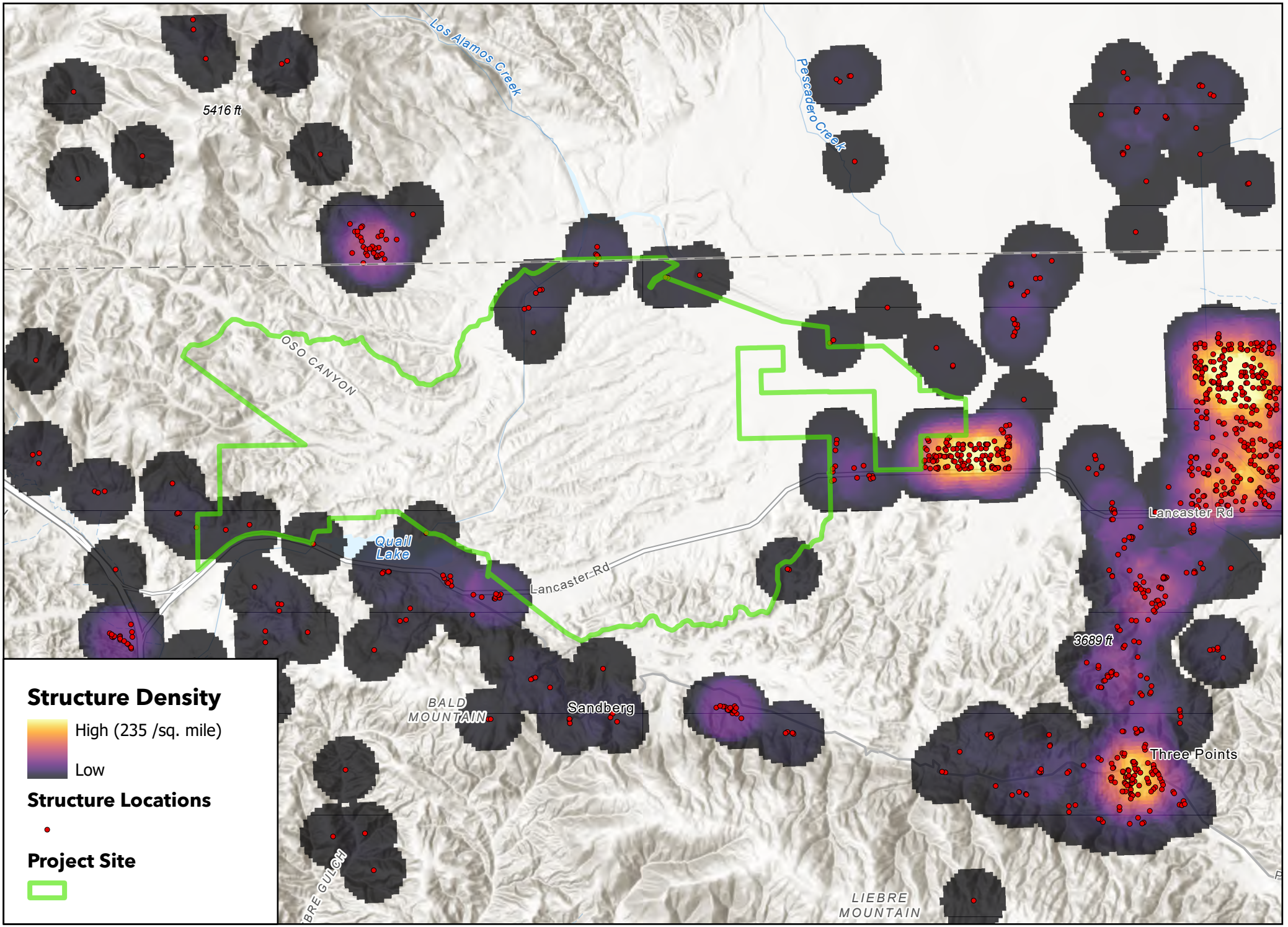
Existing land uses within 10 miles of the Project site were analyzed to identify off-site assets at risk from potential wildfires originating from the Project site. The immediate vicinity of the Project site is generally bound by the Tehachapi Mountains to the north, the Antelope Valley is to the east, the northern edges of the Liebre and San Gabriel Mountains (Angeles National Forest) are approximately one mile to the south, privately owned vacant land is immediately adjacent to the site to the west, and the Los Padres National Forest is approximately seven miles to the west. The Project site is approximately 35 miles north of the City of Santa Clarita in Los Angeles County, approximately 50 miles south of the City of Bakersfield in Kern County via SR-99 and I-5, and approximately 36 and 43 miles west of the cities of Lancaster and Palmdale, respectively, in Los Angeles County via SR-138. The community of Gorman in Los Angeles County is adjacent to the I-5 approximately four miles north of the I-5/SR-138 junction.

The majority of adjacent lands can be categorized as undeveloped or agricultural. Vast open spaces in the Project's vicinity include the Angeles National Forest, Bureau of Land Management lands, Tejon Ranch, Hungry Valley State Vehicular Recreation Area, Los Padres National Forest, and various private landowners. Proximal human development is generally limited to small enclaves along major roadways. Existing communities are rural large-lot residential and lower-density residential and are generally confined to the areas of Lebec, Gorman, Caswell, Sandberg, Three Points, and Neenach. According to the Microsoft Building Footprints database, 1,064 structures currently exist within 10 miles of the Project site, the majority of which are located to the east near Three Points and Neenach, in the opposite direction that wildfire under extreme conditions would spread from a wildfire originating from the Project site. Structure locations and density in the Project's vicinity are presented graphically in Figure 7, Off-site Existing Structures. Other adjacent land uses include but are not limited to the following:

- California Department of Water Resources – the California Aqueduct and Quail Lake

- Pacific Gas and Electric, Southern California Gas Company, and Southern California Edison – major transmission facilities that traverse Tejon Ranch and are constantly monitored and upgraded
- Multiple telecommunications carriers – communications facilities and fiber optic easements traversing Tejon Ranch adjacent to or through future developments
- National Cement – major mining operations
- Agricultural and farming operations

The aerial image in Figure 2 illustrates the Project's immediate surroundings, which are a mix of agriculture, grassland-dominated open space, Quail Lake and aqueduct, rural large-lot residential, lower-density residential, school, I-5 freeway and SR-138, and various disturbed landscapes.



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0 0.75 1.5 3 Miles

Source: Microsoft Building Data, 2023

FIGURE 7

Offsite Existing Structures

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2.1.6 Fire Hazard Severity Zones

CAL FIRE is statutorily required to determine and map FHSZs throughout California. These zones were established based on fire environments and the likelihood of wildfire ignition and spread. The initial mapping process was completed and adopted in 2007. The 2007 fire hazard severity mapping at the Project site included mostly High FHSZs (north, west, and south), an area of Very High FHSZ in the central/north-central portion of the site, and a Moderate FHSZ in the eastern portion of the site.

> Fire Hazard Severity Zone maps evaluate "hazard," not "risk". They are like flood zone maps, where lands are described in terms of the probability level of a particular area being inundated by floodwaters, and not specifically prescriptive of impacts.[4]

CAL FIRE is also statutorily required to update the FHSZ maps on a periodic basis. The first map update in state responsibility areas (SRAs), like that found on the Project site, has recently been updated. The first and second drafts of the updated maps resulted in most of the site being elevated to a Very High FHSZ with small portions of the eastern and northeastern portions mapped as High or Moderate FHSZs. Dudek's analysis of the updated CAL FIRE modeling approach revealed that the inputs, including fuel models/fire behavior and burn probabilities, were not well aligned to the actual conditions on site. After providing details to CAL FIRE, the Project site was remapped by CAL FIRE to include primarily High FHSZs, as depicted in Figure 8. (See Figure 6 for Fuel Models.)

2.2 Project Description

The proposed Project involves the development of a new community with residential, commercial, business park, and cultural and civic/institutional uses. Additionally, the proposed Project includes open space, parks, and infrastructure to support the proposed land uses and future residents.

The Project site encompasses approximately 12,323 acres and would allow up to 19,333 dwelling units on approximately 4,987 acres, approximately 7,363,818 square feet of employment-generating uses (office, research and development, and warehousing or light manufacturing uses) on approximately 597 acres, and approximately 1,034,550 square feet of commercial uses on approximately 102 acres. Proposed sites for civic and institutional land uses (such as schools for higher education, fire and police stations, transit centers, and a library) encompass approximately 110 acres. The Approved Project includes approximately 130,680 sf of Recreation/Entertainment uses (clubhouse, farmers market, childcare facilities, health clubs) on approximately 75 acres. Approximately 5,624 acres (approximately 45.6 percent) of the 12,323-acre Approved Project site are proposed for Open Space for natural resource protection and greenways, and parks for active and passive recreational use. The Project site also includes a vehicular and a non-vehicular circulation system.

The proposed Project would include the implementation of off-site Project features consisting of roadway improvements, connections to existing off-site utility systems, and off-site public facilities. [See Wildfire Safety Plan for more details about the project.]

[4] CalFire OSFM: https://osfm.fire.ca.gov/what-we-do/community-wildfire-preparedness-and-mitigation/fire-hazard-severity-zones

2.3 Multilayered Approach to Fire Safety and Protection

2.3.1 Preventing Fire Ignitions

2.3.1.1 Emergency Response Plan

The Project's EIR requires the Project to prepare an Emergency Response Plan (ERP), which shall be updated as needed for each Tentative Map and shall be submitted to the County (California Department of Forestry and Fire Protection and County Fire Department and/or County Sheriff's Department) for review and approval. The Project Applicant/Developer shall be responsible for distributing the current ERP to each purchaser or tenant of each property within the Project site and shall distribute the ERP to all landowners through the Transportation Management Association (Mitigation Measure 3-7).

The plan will utilize existing information from the Los Angeles County Office of Emergency Management, coordinate with County emergency planners, and provide site-specific procedures for various emergency situations including wildfire. As required, the ERP will be available to all homeowners and commercial and resort tenants. There will be ongoing updates, which will be distributed to the community through the community website. As required by the Project's Development Agreement, the property owners shall require future residential and commercial property owners' associations to develop and implement an emergency preparation and response plan, which includes shelter-in-place and evacuation plans and also addresses first aid and emergency electric power supplies. At the initial point of property sale and annually thereafter in Property Owner Association website notices, the property owners shall provide educational information about the health and safety benefits of emergency preparation and response supplies for earthquakes and other potential disasters, such as a 7-day supply of potable water and food as well as solar-powered batteries for communication and refrigeration. The property owners and Property Owner Association website notices may also identify emergency response supply and battery vendors providing discounts or other preferential terms to Project site occupants (Development Agreement, Exhibit G, Section 12.3).

With regard to wildfire emergencies, the following components should be incorporated into the ERP:

- Building and facility protection (as defined in the Project's Wildfire Safety Plan (Dudek, 2024))
- Grounds protection (fuel modification zone [FMZ] purpose)
- Fire prevention during Red Flag conditions
- Emergency supplies
- Telephones/communications
- Fire Safe Council information
- Incident command list
- Emergency response notebook
- Annual review and update
- Emergency notification procedures
- Advisement of potential fire danger
- Emergency relocation/evacuation plan
- Animal relocation/evacuation plan

In addition to the ERP, the Project shall provide one or more of the following communication formats for dispersing wildfire (and other) hazard educational information in a timely manner:

- Establish a reverse 9-1-1 system capable of contacting every listed telephone number in the community by computer at a rate of at least 250 calls per minute.
- Establish a community website that can be used for providing wildfire education materials on an ongoing basis and that can be used to provide wildfire alert information on short notice.

2.3.1.2 Homeowner Association Wildfire Education Program

Project residents and occupants would be provided ongoing education regarding wildfire and the Settlement Agreement FPP and Wildfire Safety Plan (Dudek, 2024) requirements. This educational information must include maintaining the landscape and structural components according to the appropriate standards designed for this community. Informational handouts, a community website page, mailers, Fire Safe Council participation, inspections, and seasonal reminders are some methods that would be used to disseminate wildfire and relocation awareness information. The Los Angeles County Fire Department (LACoFD) would review and approve all wildfire educational material/programs before printing and distribution.

2.3.1.3 Fuel Modification Zones

The anticipated fire behavior for each area of the Project's phases was used to determine appropriate structure setbacks and fuel modification zone widths. FMZs are designed to provide vegetation buffers that gradually reduce fire intensity and flame lengths from advancing fire by strategically placing thinning zones, restricted vegetation zones, and irrigated zones adjacent to each other on the perimeter of the wildland–urban interface (WUI)-exposed structures. FMZs were originally developed by CAL FIRE to protect natural resources from urban area fires and over the years have become essential to setting urban areas back from wildland areas, with a dual role of protecting structures and people while buffering natural areas from urban ignitions and reducing the potential for urban fires to spread into wildland areas.

Each FMZ will incorporate three zones: a setback zone, an irrigated zone, and a thinning zone. The total width of the FMZ will be either 100, 150, or 200 feet, depending on the anticipated fire behavior. Landscaping on private lots directly adjacent to the WUI will include standard County fuel modification requirements. Flammable plant species will be restricted, spacing standards implemented, and basic low-fuel requirements will be applicable. A community landscape committee will be implemented to review and approve proposed landscaping in these areas.

Fuel modification will also occur along roadways to mitigate roadside wildfire ignition risk. A 20-foot FMZ along sides of roads adjacent to open spaces will be implemented. Roadways are a particularly common source for wildfire ignitions due to high usage and vehicle-caused fires (catalytic converter failure, overheated brakes, dragging chains, tossed cigarette, etc.) (Romero-Calcerrada et al. 2008). Reducing natural fuels along roadways and replacing them with irrigated and ignition-resistant landscaping substantially reduces the potential for wildfire ignition and spread. It is also likely that roadside maintenance activities by the state and County would continue and/or be enhanced in the Project's vicinity and would remove the flashy fuels most prone to ignitions on an annual basis.

The impacts of perimeter FMZs on slowing the off-site spread of wildfires originating on site was modelled using the FlamMap Minimum Travel Time tool and embedded FARSITE fire growth modeling in order to evaluate fire progression. FlamMap and the embedded FARSITE software requires a minimum of five separate input files that represent field conditions in the analysis area, including elevation, slope, aspect, fuel model, and canopy cover.

Each of these data files was obtained from the LANDFIRE (Landscape Fire and Resource Management Planning Tools) data distribution site. LANDFIRE is a shared program between the wildland fire management programs of the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior and provides landscape-scale GIS data layers, including those representing elevation, slope, aspect, fuel model, and canopy cover.

Fuel models in perimeter FMZ areas were edited to reflect vegetation conditions corresponding to the various FMZ standards. Off-site wildfire spread is modelled to slow substantially when accounting for the effects of perimeter FMZs during both average and extreme weather conditions. Graphical presentations of these results are provided in Figure 9, Off-site Fire Progression (50th Percentile Weather) and Figure 10, Off-site Fire Progression (97th Percentile Weather).

2.3.1.4 Structures

Ignition-resistant construction will be used for all of the buildings, including homes, in compliance with the LACoFD requirements for Very High Fire Hazard areas, per the 2022 California Fire Code (CFC) adopted by LACoFD, and also Chapter 7A of the 2022 California Building Code (CBC) (the most restrictive requirement shall apply). All buildings will include the construction features listed therein for WUI Fire Protection. All structures must comply with CBC requirements based on type of occupancy, size, and number of stories.

All habitable and combustible structures over 200 square feet will have approved interior fire sprinkler systems. The construction requirements apply to the main structure and to ancillary buildings and structures. The applicable codes at time of construction will govern design and construction of the structures on the Project site as determined by the architect, LACoFD, and the County Building Official.

2.3.1.5 Construction Period Ignition Risk Reduction

Construction activities are often associated with vegetation ignitions because activities that can create sparks, heat, and/or flame may occur in the process of clearing site vegetation, grading, trenching, and various hot-work associated with constructing the infrastructure and buildings found within a typical development. The Project's risk would include both on-site and off-site (roads and utilities) construction activities. The risks associated with construction-related vegetation ignitions are mitigated through application of relevant portions of the LACoFD Fire Code and construction best practices (Lordson 2020; National Safety Council 2016). These best practices would be implemented for all phases of construction, in addition to protections and restrictions during the periods when the risk of wildfire is at its highest. Construction contractors working in WUI areas would be expected to implement fire prevention and safety best practices at all times during construction, and they would routinely conduct daily safety meetings as reminders to site personnel about the highest-priority safety measures. According to the Project Wildfire Safety Plan (Dudek, 2024), the types of precautions that would be in place include:

- Clear brush and other combustible materials from immediate work area and pre-wet areas where there are known potential ignition sources.
- Have water tenders on site during initial vegetation grubbing.
- Ensure quick access to appropriate fire suppression hand tools and fire suppression equipment, including fire extinguishers, water trucks, and water tank trailers
- Perform equipment checks to reduce potential for a malfunction that could create an ignition source. Lock out faulty equipment for repair prior to use on site.

- Reduce run time of common ignition sources such as trucks, heavy equipment, generators, and welders, using them only as much as needed to complete the job.
- Keep construction equipment and materials on site as little as possible in fire-prone areas. This will reduce loss if the construction storage area is affected by nearby fire. This includes removing equipment during weekends or off-work hours.
- Restrictions during Red Flag Warning weather.
- Hot works restrictions and fire watch during and following hot work activities.
- Designation of a site safety supervisor responsible for education and enforcement of fire safety rules.
- Coordination with LACoFD for presence during highest-risk activities.
- Notify local fire authorities of potential higher-risk work.
- Develop and use "Stop Work" guidelines that include weather monitoring, work type, and work locations. These should be easily communicated to work crews, clients, and owners' groups.

The results of these and other fire prevention, fire safety, and fire protection requirements during construction have been found to minimize the potential for vegetation ignitions and have been used extensively on large construction sites similar to the Project's on- and off-site construction areas in wildfire-prone environments throughout California (Dudek 2022).

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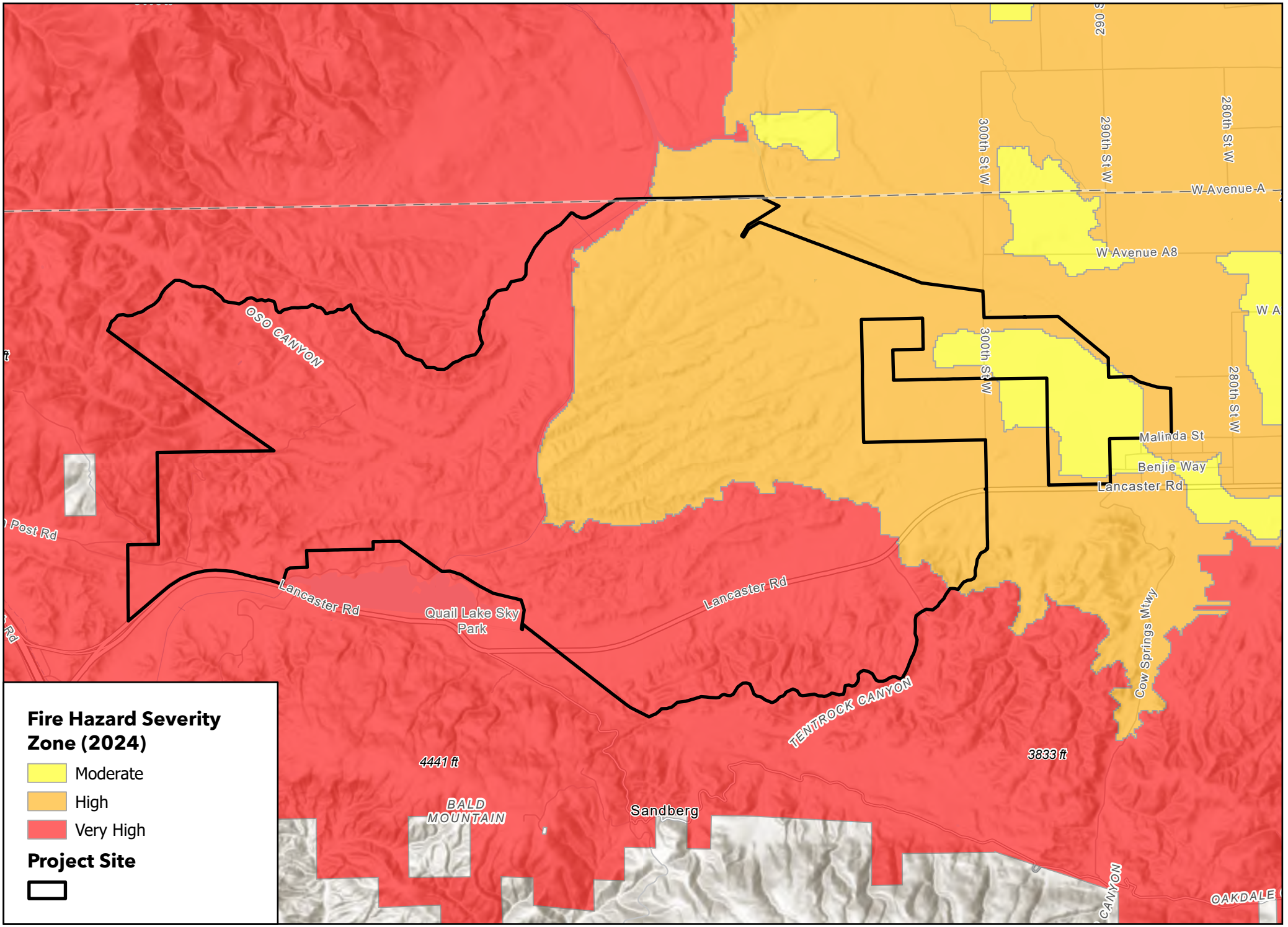

DUDEK

0 0.5 1 2 Miles

Source: OSFM, 2024

FIGURE 8
Fire Hazard Severity Zones

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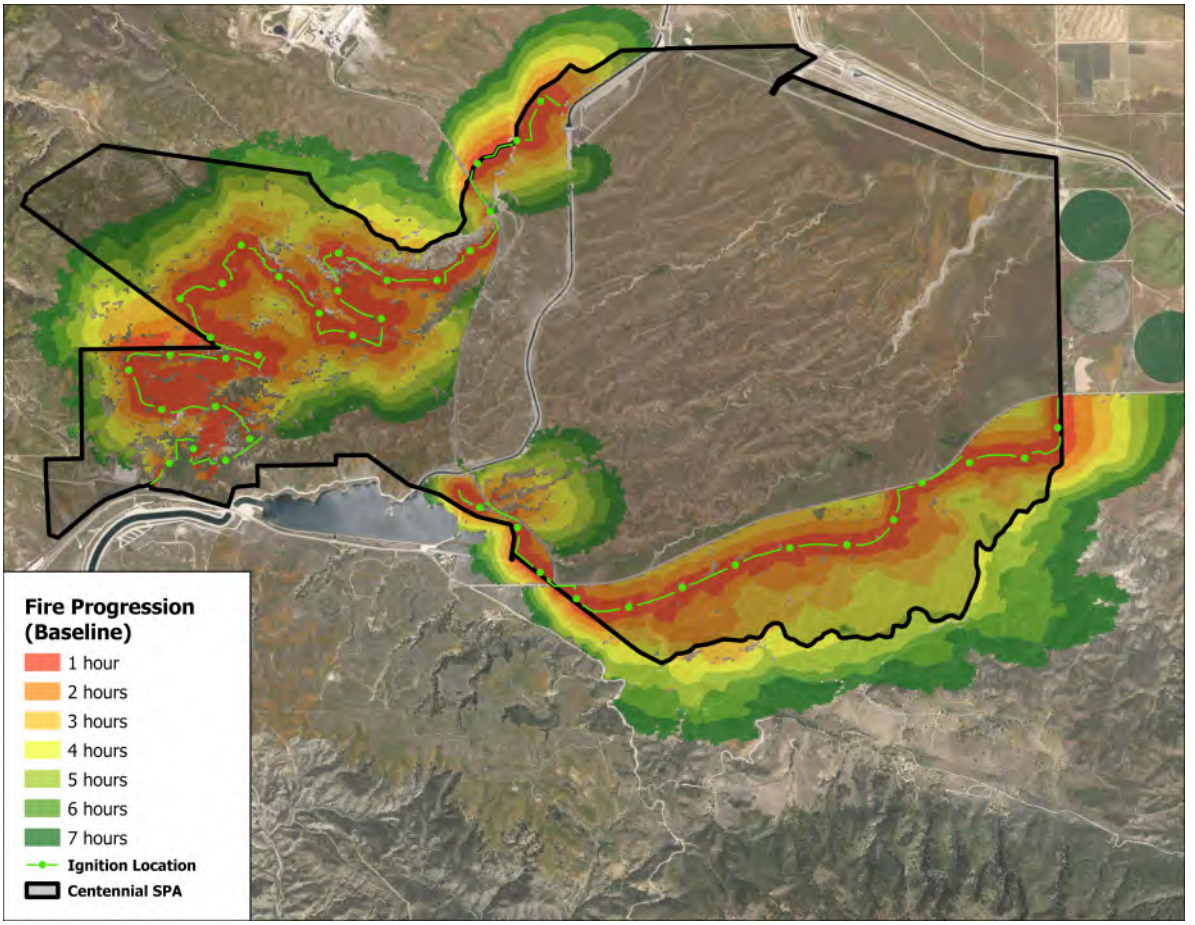

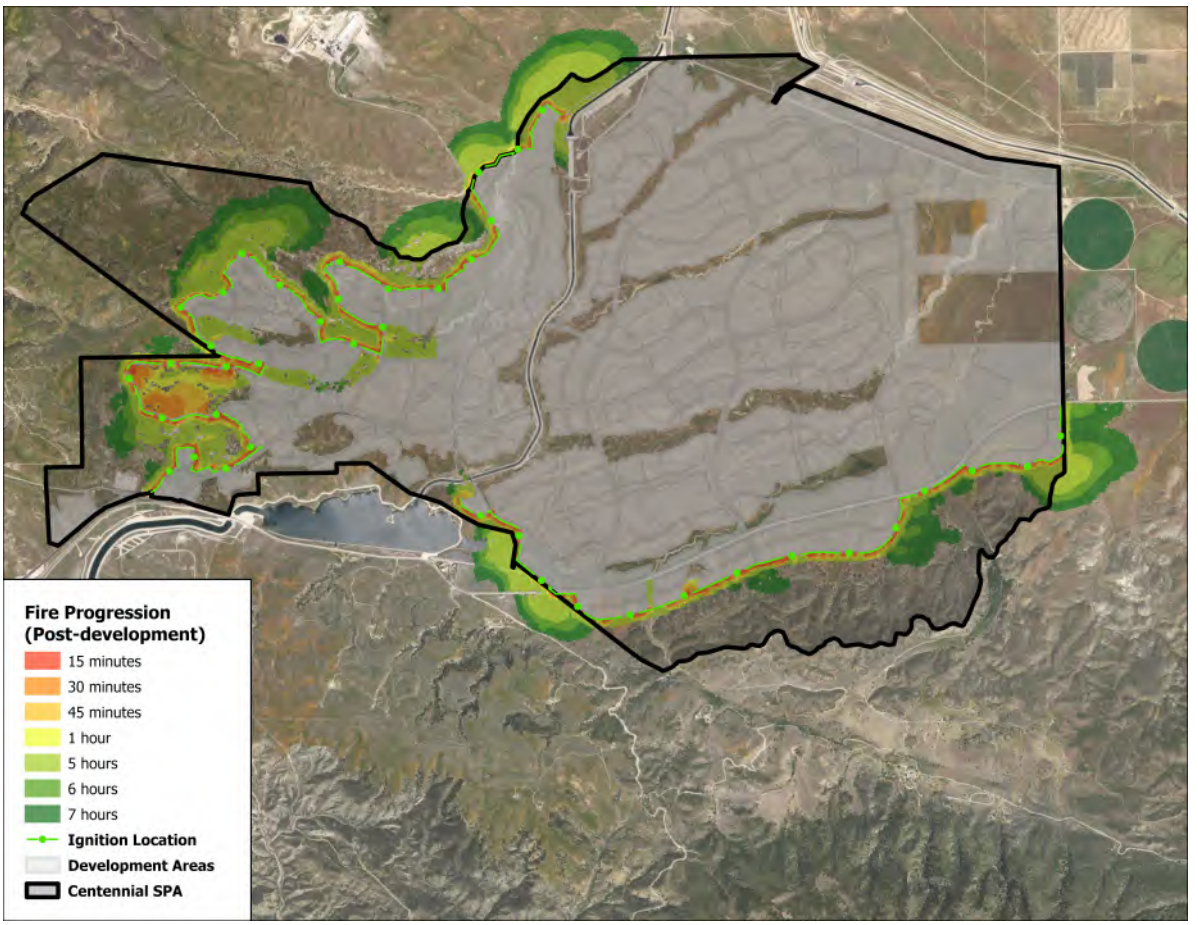

SOURCE: BASE MAP- ESRI MAPPING SERVICE

DUDEK

0 .75 1.5 Miles

FIGURE 9

Off-site Fire Progression

50th Percentile Weather

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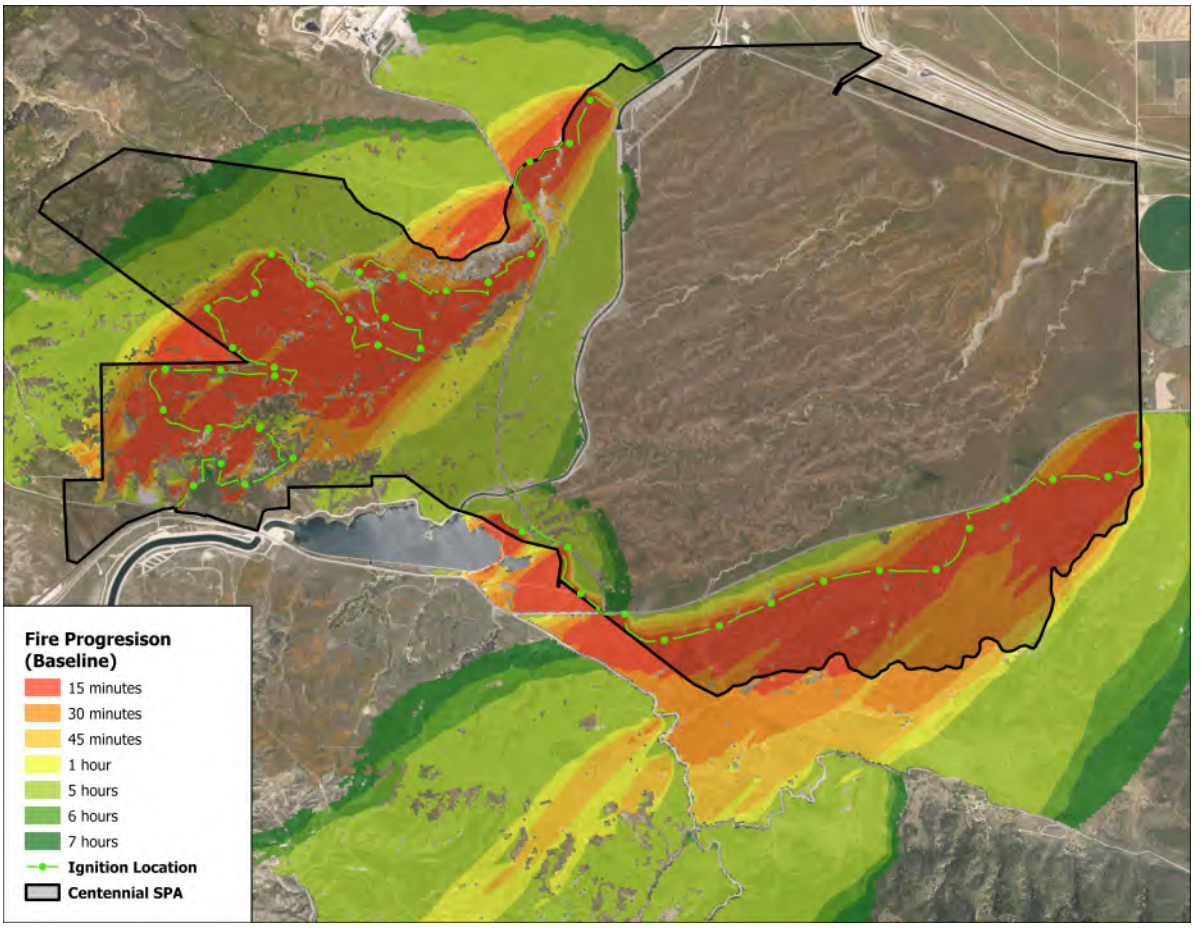

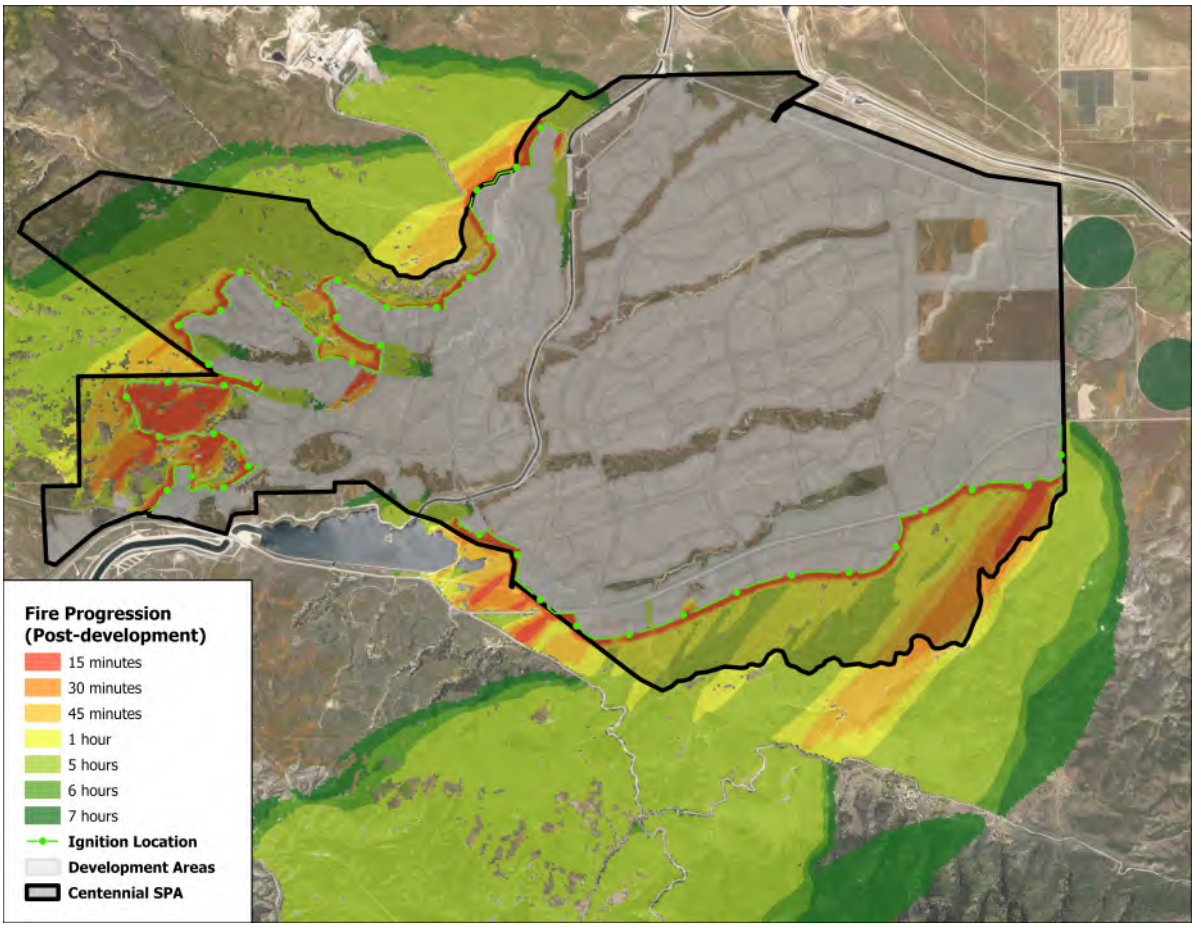

SOURCE: BASE MAP- ESRI MAPPING SERVICE

DUDEK

0 .75 1.5 Miles

FIGURE 10

Off-site Fire Progression

97th Percentile Weather

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2.3.2 Emergency Response to Ignitions

2.3.2.1 On-site Fire Stations

The **Project will provide at least three, and up to four, on-site fire stations** and will thus provide a robust response capability to the Project site and the region, in which there are currently long emergency response delays due to the rural nature of the area. This response capability includes fast response throughout the Project site and surrounding open space areas and a heavy response (number of engine companies) that can respond within a short timeframe. Attacking fires in their incipient stages is critical to fire suppression and controlling fire spread, especially for wildfires moving into off-site open spaces. Thus, the Project's provision of significant firefighting resources will greatly improve the ability to control and suppress all fires in the Project area, both on-site and off-site, compared to existing conditions.

2.3.2.2 Water

Water will be provided via a fire-code-consistent delivery system including hydrants placed at County spacing requirements and fire flow meeting pressure and duration standards. The water supply for fire protection will be a looped public water system provided by the local water district and shall be designed and installed to their standards. The water delivery system will be designed to minimize damage and service interruptions as a result of seismic activity. A "Can and Will Serve" letter will be obtained from the water purveyor. If a private water system is utilized, it must comply with National Fire Protection Association (NFPA) Standard 24.

The water supply to the fire sprinkler systems shall be designed to water purveyor, LACoFD, and NFPA 13 standards. Design, coverage, and plans will be subject to LACoFD approval. Sprinkler systems in designated houses should have approved systems with a four head calc, or as otherwise required by the Fire Marshal. The final design criteria and sprinkler standard used (13-D, 13-R or 13) shall be subject to County fire marshal approval.

Large water bodies on site, including Quail Lake and the California Aqueduct, may also be utilized as water sources for aerial fire suppression efforts, facilitating a rapid and effective initial attack.

2.3.3 Wildfire Safety Plan and Settlement Agreement

The following provides a summary of the Settlement Agreement as it pertains to enhanced fire mitigation measures for the Project.

- Fire Mitigation
  - Requires establishment and funding of two fire mitigation funds:
    - On-site fire risk mitigation. FPP: $500,000/yr funding to provide for implementation of the EIR-required FPP, which identifies community fire hazard reduction measures including building, design, and fuel management requirements.
  1. Off-site fire risk mitigation. Centennial shall establish a Good Neighbor Firewise Fund, which will provide grants to needs-based applicants to be awarded by the CMG to aid communities with a population of less than 100,000 within 15 miles of the boundaries of Tejon Ranch to reduce off-site fire risks, increase fire prevention, protection and response measures, and avoid adverse impacts of fire, for the

Project's residents and neighboring communities. The 100,000-population limit will be adjusted commensurately with population changes in Los Angeles, Kern and Ventura Counties as documented by each Census. Centennial shall fund the Good Neighbor Firewise Fund in the inflation-adjusted amount of $500,000 annually. CMG will review applications and award the grants to applicants based on a majority vote of the CMG Board. The grants shall be in support of the following actions:

a. Updating planning documents and zoning ordinances, including general plans, community plans, specific plans, local hazard mitigation plans, community wildfire protection plans, climate adaptation plans, and local coastal programs to protect against the impacts of wildfires;
b. Developing and adopting a comprehensive retrofit strategy;
c. Funding fire-hardening retrofits of residential units and other buildings;
d. Reviewing and updating the local designation of lands within the jurisdiction as very high fire hazard severity zones;
e. Implementing wildfire risk reduction standards, including development and adoption of any appropriate local ordinances, rules, or regulations;
f. Establishing and initial funding of an enforcement program for fuel and vegetation management;
g. Performing infrastructure planning, including for access roads, water supplies providing fire protection, or other public facilities necessary to support the wildfire risk reduction standards;
h. Partnering with other local entities to implement wildfire risk reduction;
i. Updating local planning processes to otherwise support wildfire risk reduction;
j. Completing any environmental review associated with the listed activities;
k. Covering the costs of temporary staffing or consulting needs associated with the listed activities;
l. Implementing community-scale risk reduction programs to become Firewise USA sites;
m. Implementing resiliency plans such as resiliency centers with stable electricity supplies (e.g., microgrid, solar, and battery equipment) available to residents during times of power shutdowns or other emergencies; and
n. Other fire-related risk-reduction activities that may be approved by the CMG Board.

- Centennial Monitoring Group (CMG)
  - Independent nonprofit entity established to monitor compliance with agreement and implementation of terms
  - The Project to fund CMG operations annually, starting at $300,000/yr and adjusting as CMG implementation workload varies
  - Will receive and disburse Good Neighbor Firewise Fund grants

In addition, the Project shall implement the Wildfire Safety Plan (WSP), which shall be updated any time the Project files a tract map to include any new or modified state or County fire prevention, protection, and response requirements, and will, through covenants, conditions, and restrictions, ensure that each phase of the Project's development is at all times in compliance with then-prevailing standards and fire codes.

a) Prior to the filing of the first application for a building permit for dwelling units at the Project, Centennial shall cause the creation of a master Homeowners Association ("HOA") for all dwelling units at Centennial to fund the ongoing implementation, including education, inspections, enforcement, and corrective action, of

the FPP. Such HOA shall be authorized to assess each dwelling unit at the Project an ongoing, permanent fee, tax, or assessment in the total cumulative amount for the Project of no more than $500,000 per year, inflation adjusted, with a presumptive pro-rata allocation of $26.00 per dwelling unit ("On-site WSP Assessment"). The HOA shall disperse funds consistent with, and to further the implementation of, the WSP.

b) Centennial shall ensure, pursuant to the WSP, that the master Homeowners Association for Centennial will hire a qualified third-party compliance inspector, approved by the Los Angeles County Fire Department, to conduct a fuel management zone inspection and submit a Fuel Management Report to the County before June 1 of each year certifying that vegetation management activities throughout the Project site have been timely and properly performed.

c) Every 2 years after the first dwelling units are occupied, Centennial and County will meet with the purpose of reviewing evacuation policies and Centennial will demonstrate that they are clearly understood and communicated with residents. Centennial will also work with the HOA to promote creation of Firewise USA communities within the Project.

The detailed and specific actions and responsibilities outlined in the WSP and the Settlement Agreement result in a package of on- and off-site fire safety that is unprecedented. The fire protection, prevention, and suppression measures combine to present a robust fire hazard reduction strategy that contributes significantly to minimizing the Project's off-site ignition risk ratings.

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3 Review of Related Research

3.1 Purpose of Section

This section explores and summarizes scientific research that supports the Wildfire Off-Site Ignition Risk Matrix and the conclusions of this analysis.

People vary in their preference for where they choose to live, and there will continue to be a demand for homes in the WUI or within wildland areas. To safely meet this demand, decision makers should encourage design, mitigation, and construction standards that improve the protection of the life and safety of residents and reduce the potential for structural loss from wildfires (Moritz and Butsic 2020). In addition, development standards, mitigation standards, and project design features in wildfire-prone areas should also aim to reduce the potential for on-site ignitions and wildfire spread into off-site areas.

While components of land use planning including project design, and wildfire risk mitigation measures have been effectively proven to reduce risks to structures and their inhabitants from wildfire, these design and mitigation features also have an inverse impact of reducing the likelihood of on-site wildfire ignitions and their spread into off-site areas. This section provides a description of relevant research related to wildfire risk mitigation and creates a nexus describing how these mitigations also impact the likelihood of off-site wildfire ignitions.

The vast majority of structural damages and destruction in the state due to wildfires occur in the WUI, which is where human development is located within or adjacent to wildland vegetation. Various attributes of the WUI, particularly housing density, vegetative cover, and proximity to large patches of wildland vegetation, have proved extremely predictive of the potential for building loss in the United States (Caggiano et al. 2020). Thus, development in fire-prone areas should implement design and mitigation measures or actions to further reduce that risk and the risk of off-site ignitions and wildfire spread.

Reducing potential for loss requires a holistic approach that involves a diversity of stakeholder groups and disciplines (Calkin et al. 2013) and must be considered at multiple scales (Mell et al. 2010). Land use planners should aim to minimize exposure of development to wildfire based on the physical and sociopolitical factors at a given site (Gonzales-Mathiesen and March 2014; March and Rijal 2015). As discussed throughout this section, the implementation of measures intended to reduce a development's exposure to encroaching wildfires also reduces the potential for ignitions originating in development areas and spreading off site.

It should be noted that most predictive models of wildfire behavior are based on vegetative fuels, but the buildings in a WUI with sparse to no wildland fuels can also be significantly impacted (Maranghides and Mell 2012; Skowronski et al. 2016). Thus, risk reduction approaches, both on-site and off-site, and including the framework presented in this report, should account for multiple risk reduction factors at multiple spatial scales, recognizing that a "one-size-fits-all" approach may not meet the needs of each individual development (Syphard et al. 2021).

3.2 Risk Assessment Framework

Risk assessment is critical to identifying the likelihood of wildfire, predicting exposure of communities to radiant heat and embers, and guiding mitigation efforts to overcome said exposure (Calkin et al. 2013). Different fire hazard

and risk assessments are utilized in various locales at various scales, including at the national scale (Radelhoff et al. 2005), regional scale (Oregon Wildfire Risk Explorer 2018, CAL FIRE 2023, Southern Group of State Foresters 2023) and local scale (Maranghides and Mell 2012). While it is conventional to assess a development's risk from encroaching off-site wildfires, the risk assessment framework presented in this report seeks to understand a development's contribution to new wildfire ignitions and their potential to spread off-site.

This report utilizes the following formula to quantify a development's potential to contribute to off-site wildfire ignition risk:

Fire Hazard + Ignition Risk – Mitigation = Risk

This methodology has precedence in a previous study (Dicus et al. 2014, Leyshon 2015). As here, the previous study utilized California Fire Hazard Severity Zones (FHSZs) as the basis for fire hazard and explored mitigation actions to reduce the potential for structural loss (risk) in various communities of San Diego County that varied in housing density, age, and demographics.

3.3 Hazard Analysis

> "Hazard" is based on the physical conditions that create a likelihood and expected fire behavior without considering mitigation measures such as home hardening, recent wildfire, or fuel reduction efforts. "Risk" is the potential damage a fire can do to the area under existing conditions, accounting for any modifications such as fuel reduction projects, defensible space, and ignition resistant building construction.[5]

Note that fire "hazard" is not the same as fire "risk." **Risk is the likelihood that a fire in a given area will cause damage to human life, structures, or infrastructure**. Thus, even if there is a potentially low fire hazard in a given area (expected low flame lengths), a home might still be at high risk of ignition if the physical characteristics of the property would facilitate structural ignition (e.g., flammable vegetation next to a home with wood siding).

Fire hazard was selected as the methodology starting point as it reflects the "default" existing condition of the landscape and site. To convey relative fire hazard across California, CAL FIRE categorizes all lands in which the State has primary fire protection responsibilities into one of three specific FHSZs: Moderate, High, or Very High. These categories are based upon the probability of a wildfire occurring (a product of historic fire occurrence) and the likely behavior of the fire following ignition (a product of the expected mature vegetation at the site, extreme fire weather, and slope steepness).

By design, the state does not consider any planned actions that reduce the potential fire hazard in a given area when designating a specific hazard rating. Instead, FHSZs are based on worst-case conditions, including extreme fire weather in mature (and untreated) vegetation. FHSZs are not designated with the intention to prohibit development but are instead meant to be used as a tool to illustrate the relative fire potential if no steps are taken to reduce the threat in a given area and to trigger the more restrictive construction requirements for buildings, roads, water, and other fire protection and safety features.

[5] CalFire OSFM: https://osfm.fire.ca.gov/what-we-do/community-wildfire-preparedness-and-mitigation/fire-hazard-severity-zones

3.4 Ignition Risk Analysis

This off-site **ignition risk** analysis evaluates how development could impact potential fire ignitions. Even though ignition probability is inherently built into FHSZs via past fire history, changes to the landscape through development could change the probability of ignition via human activities.

While the proportion changes regionally across California, the vast majority of wildfires in California are started by human activities and are near developed areas (Syphard et al. 2007; Balch et al. 2017), or near human infrastructure (Syphard and Keeley 2016). Historically, the WUI expansion has been linked with increasing ignition probability (Faivre et al. 2014, Radeloff et al. 2018, Syphard et al. 2019), but wildfires in those studies occurred almost exclusively in older, existing communities that had little mitigation to lower the risk of loss to property. Since 2008, when the California Building Code was expanded to include Chapter 7A, Materials and Construction Methods for Exterior Wildfire Exposure, all new construction in WUI areas have included the "hardening" features outlined in that new code section.

3.4.1 Project Density, Population, and Roads

Ignition frequency in California has been tied to population density, with intermediate levels of population density and intermediate distances to WUI areas being observed as having the highest frequencies (Syphard et al. 2007, 2009). In intermediate-density development, homes are often located on larger parcels (See Exhibit 2, Intermediate-Density Development) and include varying levels of ignition resistance and landscape/fuel modification provision and maintenance. Therefore, this type of development results in a higher wildland exposure level for all homes and does not provide the same buffers from wildfire encroaching onto the site or starting at a structure and moving into the wildlands as a higher density, clustered master-planned community (Syphard et.al. 2019) (UCANR 2020). In general, as wildland areas are developed, ignitions increase until continued development reduces wildland fuels to the point where subsequent wildfires are largely excluded (Keeley and Syphard 2018). **Higher-density, interface, master-planned communities** are considered highly ignition resistant, often exclude readily ignitable vegetative fuels throughout, and provide a perimeter FMZ. This type of new development requires fewer fire resources to defend and can therefore minimize the likelihood of on-site fires spreading off site (APA Multihazard Planning Framework for Communities in the WUI, 2018; UCANR 2020.

The **extent of road networks**, which is commonly associated with housing density, has been associated with human-caused ignitions in numerous studies (Syphard et al. 2008; Naryanaraj and Wimberly 2012; Faivre et al. 2014; Li and Banjerjee 2021; Chen and Jin 2022). In California, the importance of road networks on human-caused ignitions seems to vary regionally, with the North Coast, Central Coast, and much of the Southern California regions showing the greatest potential for ignitions along roadways (Chen and Jin 2022). However, it should be noted that vehicle-caused fires have decreased in recent years, which may be a result of improved roadside fuel treatments or by improved warning lights indicating overheating of a car (Keeley and Syphard 2018), which possibly reduced expulsion of catalytic converter debris, which was considered to be a significant roadside ignition source (Bertagna 1999). **Roadside vegetation management** strongly reduces the likelihood of wildfires originating along existing and newly constructed roadways (Monlina et. Al. 2019).

Of interest, Naryanaraj and Wimberly (2012) found that the forest roads in areas of lower population densities seem to actually reduce predicted fire size. Road networks in these areas were deemed to increase suppression access and subsequent initial attack success, the effect of which was greater than the impact of increased fire ignitions. Roads throughout large land areas increase suppression capability by facilitating access by responding firefighters. It would

follow that land areas that are closely managed and prohibit unauthorized access, resulting in very infrequent use compared to public lands, would have much lower potential road-related ignitions than public access forest areas. Therefore, the benefits from the access roads in terms of fire suppression would be higher on managed lands because the number of fire ignitions per mile of road would be significantly lower than the roads evaluated in the study.

3.4.2 Fire Department Access

If on-site ignitions were to occur, rapid emergency response limits the time available for wildfires to spread into off-site areas. Because the response time needed to arrive to a fire ignition location significantly impacts initial attack success, the **proximity and access of firefighting resources** to a local community should appreciably impact the potential for loss to the built environment. Indeed, CAL FIRE aspires to keep 95% of wildfire ignitions to less than 10 acres. In general, the sooner fire resources can engage in suppression activities, the more likely a fire will be contained before it threatens developed areas. The same is true for wildfires originating along the edges of development areas, as rapid response limits the potential for off-site ignition and damages. Response time to arrival at the fire site, therefore, is dependent on multiple factors including **rapid fire detection, sound roadways (i.e., wide and relatively flat), and placement of fire department resources** that are strategically located to developed areas. Thus, land use planning should incorporate the availability, capacity, location, and travel times of emergency services (Gonzales-Mathiesen and March 2014; March and Rijal 2015).

That said, fire prevention is a shared responsibility between first responders and residents, and thus adequate fire suppression capabilities are not a substitute for sufficient mitigation efforts (Collins 2004). Also, it must be understood that initial attack is sometimes hindered even if response is almost immediate, especially under wind-driven events such as Santa Ana winds due to increased safety hazards and the inability to conduct aerial fire suppression. Therefore, pre-event mitigations are critically important to buy time in the event initial attack is delayed and to provide a passive protection that will function without outside intervention.

3.4.3 Overhead Powerlines

As noted, ignitions per capita have significantly declined in recent decades with the exception of powerline ignitions, which are becoming increasingly problematic in California and in other similar parts of the world (Collins et al. 2016; Keeley and Syphard 2018). Indeed, since 2015, six of the most destructive and deadly wildfires in California have been ignited via electrical power lines (Tilden 2022), which are occurring largely during high wind events (Syphard and Keeley 2015). Thus, **improving power line safety** would likely decrease both the number and consequences of wildfires in the WUI (Collins et al. 2016).

In addition to overhead powerlines increasing the potential for ignition, they also serve as a threat to both first responders and residents during a wildfire when wooden poles catch fire and subsequently fall onto roadways or other critical areas. Further, power loss due to burned distribution lines can cause water utility systems to lose pressure (Whelton et al. 2023), significantly impacting water availability for firefighting efforts (EPA 2019).

3.4.4 Site Location

The physical attributes of a development's location will impact the potential for human-caused wildfire ignitions. For example, **slope steepness** has been correlated with wildfire ignitions and spread in numerous studies (Syphard et al. 2008; Faivre et al. 2014; Li and Banerjee 2021; Li and Banerjee 2021; Chen and Jin 2022). Further, **vegetation type** (Syphard et al. 2008) and **precipitation levels** (Chen and Jin 2022), which influence moisture in

vegetation, have also been shown to influence potential for human-caused ignitions in the WUI. For example, certain vegetation types have higher likelihoods of ignitability due to their fuel characteristics. Flashy fuels, such as annual grasslands, have a higher surface-to-volume ratio than other vegetation types such as chapparal and therefore may dry out quickly and spread wildfire at faster rates. In the Santa Monica Mountains specifically, Syphard et al. (2008) found that wildfire ignitions were more likely to occur in non-native grasslands compared to other vegetation types such as northern mixed chaparral and coastal sage scrub.

3.4.5 Power Supply Reliability

Power supply for fighting wildfires is primarily related to the **potential impact on water supply** in areas without adequate gravity flow to sustain the minimum water pressure needed. As noted above, reliable water availability improves initial attack success and, therefore, helps to reduce the potential for structural loss in a given community. Power loss can cause water utility systems to lose pressure (Whelton et al. 2023), significantly limiting water availability for firefighting efforts (EPA 2019). Thus, **reliable power supply** in a development should be considered an initial component to reduce potential for a large, destructive wildfire.

3.5 Ignition Risk Mitigation Analysis

Certainly, even with diligent efforts to prevent wildfire, not all ignitions can be averted. Thus, mitigation and preparatory efforts will reduce the risk of life/safety impacts to residents and loss of structures, both on- and off-site, even if fire suppression is precluded in a given area. If fighting wildfire is considered to be a battle to protect lives, buildings, and infrastructure, then preemptive **mitigation measures** must be incorporated so as to shape the proverbial battlefield to best enable success. Hence, the next step of the risk assessment methodology is to analyze the proposed protection features and design elements and their effectiveness in mitigating the risk.

3.5.1 Housing Density and Development Design

Location and pattern of development significantly influence where wildfires are most likely to cause structural loss (Keeley et al. 2013) and, thus, it is critical that sound land use planning in the WUI incorporate these factors into the design of a given development (Gonzales-Mathiesen and March 2014; March and Rijal 2015). In addition to being less susceptible to impacts from encroaching wildfires, it can be concluded that higher-density, interface developments are also less likely to cause off-site wildfires. Reductions in vegetative fuels interspersed between development areas and continuous FMZs limit the capacity for wildfire spread within communities and from developed to undeveloped areas.

For example, a high-density, interface development would have minimal vegetation to ignite within the development itself since the structures are so close together (see Exhibit 1, High-Density Development). Conversely a low-density development (estate lots, or areas of intermixed open space) would have much more vegetation within the development that could be ignited (see Exhibit 3, Low-Density Development). A wildfire starting in the on-site vegetation could then communicate to adjacent off-site vegetation, that ultimately could threaten a nearby community.

Exhibit 1. High-Density, Interface Development. Example of master-planned community that is ignition resistant, excludes readily ignitable vegetative fuels throughout, and provides a perimeter FMZ. This type of new development requires fewer fire resources to defend and can minimize the likelihood of on-site fires spreading off site.

Exhibit 2. Intermediate-Density Development. Example of semi-rural, intermediate-density development. Homes are located on larger properties and include varying levels of ignition resistance and landscape/fuel modification provision and maintenance. Compared to a master-planned community, this type of development results in a higher wildland exposure level for all homes and does not provide the same buffers from wildfire encroaching onto the site or starting at a structure and moving into the wildlands.

Exhibit 3. Low-Density Development. Example of rural/large-parcel development where homes are interspersed amongst wildland fuels, are of varying ages, and include varying levels of FMZ setbacks. Homes are exposed on most or all sides to flammable vegetation, properties rely solely on owners for maintenance, are often far distances from the nearest fire station, and have minimal buffer from on-site fire spreading to wildlands.

3.5.2 Building Construction

Buildings themselves can be a contributory fuel; house-to-house spread may occur in WUI fires, particularly in older, non-ignition-resistant buildings (Maranghides and Mell 2012; Syphard et al. 2014; Kramer et al. 2019; Knapp et al. 2021; Maranghides 2022; Pludow and Murray 2023). Indeed, wildfire can cause extensive damage, even in areas with relatively little wildland vegetation (Kramer et al. 2019). While the studies cited above consider structure losses from wildfires encroaching upon communities, code-compliant building construction can be determined to also reduce the likelihood of fires igniting on-site from spreading structure-to-structure and then into off-site areas.

Because of the high fire intensity of burning buildings and their extended burning time compared to vegetative fuels (hours vs. minutes), higher-density development would seem at first glance to be at odds with mitigating fire losses. However, **structures built to meet new wildfire building codes** (i.e., Chapter 7A of the California Building Code and section R337 of the California Residential Code) are significantly less ignition prone than older buildings, especially when located next to other ignition-resistant buildings (Knapp et al. 2021).

Buildings constructed to meet exterior wildfire exposure standards (Chapter 7A of the California Building Code and Section R337 of the California Residential Code) can help to reduce the potential of a fire originating within the

structure escaping its confines and transmitting fire into off-site areas. In addition, if a structure were to ignite, these construction methods could reduce the potential of a fire communicating to adjacent structures or becoming a conflagration with multiple structures involved. **Additional structural hardening measures** (e.g., dual-pane, dual-tempered windows) can further reduce the potential for structure fires to spread into off-site areas.

Thus, expansion of code-compliant human development into the WUI does not necessarily increase risk of home loss during a wildfire but instead may actually serve to buffer older fire-prone developments (Dicus et al. 2014; Leyshon 2015), acting as a fuel break, potentially enabling firefighters to slow spread or control the fire's progression. Code compliant clustered developments convert readily ignitable vegetative fuels into hardened landscapes that act to buffer higher risk communities from high hazard vegetation.

3.5.3 Eliminating Structure-Adjacent Vegetation and Maintaining Defensible Space

3.5.3.1 Near-Structure (close proximity)

Near-structure vegetation exposes structures to radiant heat, flame impingement, and ember accumulation, which poses a substantial threat to structures (Dicus et al. 2009; Maranghides and Mell 2009; Syphard et al. 2012; Caton et al. 2017; Westhaver 2016; Maranghides et al. 2022; Manzello and Suzuki 2023). Thus, to reduce fire exposure to buildings, **near-structure vegetation should be eliminated** (Cohen 1999; Quarles et al. 2010; Mathiesen and March 2014; March and Rijal 2015; Hakes et al. 2017; Thomas et al. 2017).

Via modeling, experiments, and case studies, Cohen (1999) demonstrated that there should be from **10 to 40 meters of fuel modification** between wildland vegetation and buildings to minimize the impacts from radiant heat or direct flame impingement. Syphard et al. (2014, 2017) recommended **reducing near-structure vegetation to 40% woody cover** and also completely **eliminating vegetation that touches a structure** (due to likely flame impingement). Similarly, Leyshon (2015) and Uribe (2021) found that the most important area to **reduce combustible materials on a given property was the immediate 1.5 meters surrounding a building**. Because of the increasing evidence that wildland and non-wildland combustible materials (including ornamental vegetation, mulches, or storage) may readily cause structure ignition, California has recently updated its defensible space regulations in SRAs to completely eliminate combustible materials and minimize direct flame impingement in the so-called "Zone-0" (in addition to the existing 30-foot and 100-foot fuel management zones, CFC 4906.3.1), which is the immediate 5 feet surrounding a structure.

Trees or large shrubs (even if largely ignition-resistant due to distance from ground to foliage or high in moisture), **should also be eliminated** because deposition of leaves, needles, or twigs can accumulate next to or on top of a house, which would then serve as a ready receptor for airborne embers.

Fire threat on a given property increases through time without continued maintenance because vegetation regularly grows and deposits dead debris onto or next to structures (Moritz and Butsic 2020). Further, plants tend to dry out with age if not adequately irrigated and will thus burn with greater intensity. Many residents, particularly renters, commonly lack the means or motivation to mitigate elevated fire hazard (Collins 2004). Thus, focus should be placed on **diverse mechanisms to incentivize residents to ameliorate property elements** that may lead to home loss; the specific approach should vary based upon the demographics specific to a given community (Leyshon 2015).

Enacting **measures that minimize vegetation adjacent to buildings** would have the beneficial effect of reducing the potential for structure fires to ignite vegetation and facilitate spread to off-site areas.

3.5.3.2 Defensible Space

An important component of wildfire risk mitigation is the **provision of fire-resistant landscapes and modified vegetation buffers**. FMZs are designed to provide vegetation buffers that gradually reduce fire intensity and flame lengths from advancing fire, whether it originates on-site or off-site, by strategically placing thinning zones and irrigated zones adjacent to each other on the perimeter of the WUI-exposed structures. FMZs not only help protect new communities and structures from external wildfire risks, but FMZs also reduce the risk of fire originating from such new communities or structures and spreading to surrounding natural resources/habitat areas (Braziunas et al. 2021; Cochrane et al. 2012; Price et al. 2021).[6] FMZs thereby provide a dual benefit of **buffering communities and structures from encroaching wildfires** while separating the new community and structures (and potential introduction of new ignition sources associated with the new community) from surrounding open space, fuel sources, or habitat areas (Bhandary and Muller 2009; Braziunas et al. 2021; Cochrane et al. 2012; Fox et al. 2018). Research has also indicated that the likelihood of ignitions occurring in a given location is significantly influenced by the existing vegetation/fuel available (Elia et al. 2019). In addition to protecting structures, fuel treatments and defensible space, when utilized in conjunction with place-based fire-hardened design, also **act as a buffer for natural areas and surrounding communities** (Safford et al. 2009; Scott et al. 2016).

3.5.4 Structure Placement in the Landscape

As described in the following sections, the position of structures on the landscape (and relative to each other) influences the risk of structure loss from wildfires and off-site ignition risks (Alexandre et al. 2015; Knapp et al. 2021), and thus project locations should consider the overall context and landscape impacts on exposure in the design of a given development (Gonzales-Mathiesen and March 2014; March and Rijal 2015). How the position and placement of structures influences their risk is discussed in more detail in the following sections.

3.5.4.1 Avoiding Ridges and Steep Slopes

For example, locating buildings on highly variable topography or at the **top of ridges should be avoided** because wildfire intensity increases if moving uphill (Syphard et al. 2012; Syphard et al. 2019; Syphard and Keeley 2020). Further, **steep slopes and rugged terrain will negatively impact fire department access and response time** and can imperil residents during evacuation.

If a wildfire were to originate from a community, its spread rate into off-site areas may be increased if steep slopes are nearby. Steep terrain typically results in faster upslope fire spread due to the pre-heating of uphill vegetation. Flat areas typically result in slower fire spread in the absence of windy conditions. Topographic features such as saddles, canyons, and chimneys (land formations that collect and funnel heated air upward along a slope) may form unique circulation conditions that concentrate winds and funnel or accelerate fire spread. For example, fire generally moves slower downslope than upslope. Terrain may also buffer, shelter, or redirect winds away from some areas based on canyons or formations on the landscape. Saddles occurring at the top of drainages or ridgelines

[6] Historically, the California Department of Forestry and Fire Protection originated as a conservation agency and implemented brush management, like fuel modification and fire breaks to protect natural resource areas from fires originating in developed areas, such as the Ponderosa Way, an 800-mile fire break in the Sierra Nevada Mountain Range.

may facilitate the migration of wildfire from one canyon to the next. Various terrain features can also influence fire behavior, as summarized in Table 1.

3.5.4.2 Avoiding Wind Corridors

Similarly, **development should not be located in known wind corridors** (Syphard et al. 2012), the avoidance of which could be one of the most effective long-term strategies to prevent wildfire losses and off-site ignitions and wildfire spread (Syphard et al. 2022). When located in wind corridors or in terrain that facilitates fire movement, mitigations must be as proportionally extreme as the potential for wildfire.

3.5.5 Powerlines

Multiple strategies can be employed to mitigate ignitions via electrical powerlines. The California Public Utilities Code 8386 requires that electrical corporations "construct, maintain, and operate its electrical lines and equipment in a manner that will minimize the risk of catastrophic wildfire posed by those electrical lines and equipment." Certainly, one of the most prevalent mitigation activities is the clearing of vegetation around and under powerlines and poles, which occurs continuously throughout the state. Further, new technologies have been developed recently that immediately detect power surges in a specific electrical distribution line and then immediately deenergize it so as to avoid sparks that could ignite vegetation or debris beneath it. It should be noted that all public and private power companies are required to develop and annually update a Wildfire Mitigation Plan, which describes requirements for mitigating wildfire ignition risks associated with electrical power infrastructure.

Recently, major electrical utility companies, including Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E) have enacted Public Safety Power Shutoffs, where electrical lines are deenergized in specific areas that are deemed to present a significant risk of causing a wildfire ignition. Power outages from these Public Safety Power Shutoffs have proved to be negatively impactful, costly, and widespread in some areas. Indeed, one study on Public Safety Power Shutoffs in California identified approximately 12 million person-days of outages in 2019 (Abatzoglou et al. 2020), the costs of which were estimated to be $10 billion (Wara 2019).

Electrical utilities are recognizing the potential threat that overhead distribution lines cause to public safety, power disruption, and cost of replacement, and are thus mitigating potential for ignition to power poles in fire-prone areas. One such effort includes converting wood poles to steel poles, which significantly reduces the risk of pole ignition and subsequent failure. However, even when overhead poles are steel, wildfire ignitions can still be facilitated by powerlines if lines come in contact with other lines, vegetation, or floating debris during a high-wind event.

Arguably, the most effective mitigation to minimize ignitions from powerlines would be to place them underground. While these efforts certainly cause additional installation and short-term costs and may result in some environmental disturbance during their installation, they effectively eliminate the potential for ignitions from electrical utilities. New developments that choose to underground powerlines significantly reduce the likelihood of off-site ignitions caused by electrical infrastructure.

Thus, the most effective mitigation measure would be to place electrical utilities underground. While undergrounding powerlines may cause additional costs and provide some environmental disturbance, they largely eliminate damage to electrical utilities. Further, they also eliminate potential entrapment of residents during evacuation from burned poles falling onto roadways.

3.5.6 Development with Adequate Ingress/Egress

Safe ingress and egress includes time for fire detection, alarm, emergency response, pre-movement, and evacuation (Ronchi et al. 2017, 2019; Mitchell et al. 2023). Thus, planners should **facilitate efficient access and ingress of emergency services** as well as egress of evacuating residents (Gonzales-Mathiesen and March 2014; March and Rijal 2015). Longer distance to traffic flow and safe areas can cause gridlock, imperil evacuees, and increase emergency response times. Thus, **close proximity of developed areas to code-compliant major roadways** provides more options and contingencies to both residents and first responders and may reduce overall congestion by reducing travel distances and simplifying routes to the nearest safety zone (Conn et al. 2016).

Similarly, **additional points of ingress/egress into/out of a development** provide for multiple alternatives to leave a fire-threatened community and could reduce traffic congestion. Per Public Resources Code 4290, maximum dead-end lengths only depend on parcel size and do not take into account other factors such as land use, demographics, road system adequacy for proposed development, fire hazard level, and location of exits that may not be safe in the event of fire. Therefore, ingress/egress points should consider ultimate land uses, vegetation, expected wind speeds, topography, and subsequent evacuation time in a given locale (Conn et al. 2016).

Ensuring that **ingress and egress roadways are code compliant** allows for safe evacuation and efficient emergency response. If wildfires near development areas were to occur, rapid emergency response provides the best opportunity for an effective initial attack and quick wildfire suppression. Early wildfire suppression lowers the chances of wildfires growing out of control and damaging adjacent developments.

Rapid emergency response is a critical component in an effective initial attack. The potential for wildfires originating in development areas to spread off-site is greatly reduced when emergency responders have quick and efficient means of ingress.

3.5.7 Proximity to Emergency Services

As previously noted, sound land use planning should incorporate the availability, capacity, location, and travel times of emergency services (Gonzales-Mathiesen and March 2014; March and Rijal 2015). Again, **close proximity to fire department resources** better enables initial attack success, which subsequently reduces exposure of people and buildings to wildfire and improves ease of escape to off-site areas. Time to fire arrival is dependent on multiple factors including rapid fire detection, sound roadways (i.e., wide and relatively flat), and placement of fire department resources that are located strategically to developed areas.

3.5.8 Limiting Parking in WUI Developments

Limitations on roadside parking can better facilitate ingress/egress during a wildfire because they effectively guarantee a given road's unobstructed width. Limitations on parking can be enforced in local zoning ordinances or in subdivision design (Mowery et al. 2022).

Parking restrictions can be **permanent** in nature or enacted **during time periods in which fire ignition potential is heightened**. For example, the County enacted parking restrictions during a predicted Santa Ana wind event in October 2023 to proactively clear roads and better facilitate evacuation and emergency response should a wildfire occur (Mays 2023). Rapid emergency response improves the likelihood of quick wildfire extinguishment and may prevent a wildfire's off-site spread.

3.5.9 On-site Water Supply/Storage

As earlier noted, developments should provide for reliable water supply (Moritz and Butsic 2020), which can improve firefighting effectiveness. Proper water supply should include appropriate location, supply, connectivity, and signage (Gonzales-Mathiesen and March 2014; March and Rijal 2015).

Guaranteeing adequate water supply improves the potential success of wildfire suppression efforts. In addition to **ensuring code-compliant water supply and fire flow**, **additional on-site aerial fire-suppression water supplies** (dip sites) or **other aboveground water access points** can act as added mitigation and increase opportunities for rapid wildfire extinguishment.

3.5.10 Firebrand Hazard Discussion

Airborne embers, commonly referred to as firebrands, are burning materials which become airborne and carried for some distance in an airstream (Babrauskas 2020). Firebrands can serve as ignition sources through a phenomenon defined as spotting. Spotting occurs when firebrands are lofted into the air and ignite small fires called spot fires ahead of the main fire front when landing on a receptive fuel bed. Wildfire spotting is multi-faceted and occurs at varying levels of severity. Main drivers of wildfire spotting include (NWCG, 2021):

- Firebrand Source, Size, and Amount
- Firebrand travel distance
- Probability of ignition where firebrands land

Firebrands pose significant risk to communities. In extreme cases, California chapparal has been found to cause ignitions up to four miles away from the main fire front. However, these risks can be mitigated through the implementation of fire-resistant construction methods, properly maintained landscaping, Fuel Modification Zones, and ignition resistant landscaping (NIST, 2022, Tacaliti, 2023). While the majority of home losses in the WUI are due to firebrands (NIST, 2021), a review of structural loss data highlights that modern master-planned communities are extremely unlikely to be destroyed by wildfires (CBIA, 2022). Of all wildfires in California since 2017, less than 1% of structures lost were structures built after 2010 (CBIA, 2022). Structural hardening requirements mandated through Chapter 7A of the California Building Code and implementation of adequate defensible space at the community and parcel scale are designed to effectively mitigate structural ignition risks from firebrands.

The following section discusses wildfire hazards caused by firebrands. Factors influencing firebrand production, transport, and ignition are highlighted, emphasizing the importance of fire-resistant construction methods and defensible space.

3.5.10.1 Firebrand Generation

In extreme cases, fire spread by firebrands can become the dominant form of fire spread and overwhelm fire suppression efforts. In order for firebrands to pose a hazard, they must have had sufficient initial size to sustain enough heat during transport to ignite a receptive fuel bed (Babrauskas 2020). Firebrand size is influenced by an array of factors including fuel type, fire intensity, and wind speed (Adusumilli and Blunck, 2023, Suzuki and Manzello, 2022). However, the complex nature of firebrand production and spread remains relatively unstudied. Limited research exists regarding processes of firebrand generation and its relation to the source materials which

produce firebrands (Manzello and Suzuki, 2023). The vast majority of available firebrand research is focused on transport of firebrands, with little research focused on the burnout process of firebrands following generation and transport (CBC, 2022).

Currently, no computed models exist for predicting firebrand generation. Instead, research into the topic relies on experimental studies. In general, greater fire intensity is found to generate more firebrands (Thomas et al. 2021). Fuel load, or the total amount of combustible fuels, has been found to related to the severity of firebrand production. The total number of burning firebrands has been observed to increase alongside an increase in the height of trees or shrubs (Adusumilli et al., 2021).

3.5.10.2 Firebrand Transport

Firebrand transport is the most commonly studied component of firebrands. This is likely because the processes behind firebrand transport are the simplest to model. In addition, understanding maximum firebrand transport provides important information for firefighters and emergency managers during wildfires. Models predicting maximum firebrand transport or spotting distance account for factors such as fuel type, tree height and crown width, wind speed, spotting location (ex. Ridgetop, valley) (Albini 1979, Chase 1981, Rothermel 1983, Albini 1983, Chase 1984, Morris 1987). Before firebrands can travel downwind in the atmospheric air current, they first must be lofted into the air. Ember lofting leads to firebrands and is influenced by fire intensity, fuel loading, and terrain features (NWCG, 2021). Once airborne, firebrand transport distance is mainly driven by wind speed and firebrand size (Manzello and Suzuki, 2023).

3.5.10.3 Firebrand Ignition

Several properties influence a firebrand's ignition potential upon landing. Firebrand characteristics such as mass and size, thermal degradation or burnout, and environmental conditions (i.e. weather) greatly influence the potential for new ignition caused by firebrands (Bearinger et al., 2020). For example, firebrands may burnout completely in the atmosphere, or, after landing, undergo glowing combustion and die out, smolder, or transition into flaming and grow into a larger fire (Manzello et al, 2021). While the relationship between firebrand characteristics and ignition potential is understudied, several factors are known to mitigate structure losses from firebrands in the WUI. It is known from general understanding of thermodynamics that the condition of the receptive fuels, both urban and natural, is a significant predictor of new ignitions from firebrands.

Ensuring code compliant defensible space surrounding structures has been found to mitigate structure losses from firebrands in the WUI. Defensible space is often created in the form of Fuel Modification Zones, which create buffers between natural vegetation and structures. In many jurisdictions, Fuel Modification Zones within 30 feet of structures are required to be irrigated, further limiting the potential for firebrand ignitions. New research has shown that vegetation, decorations, and additional flammable material attached to the house are of the most important factors contributing to structure ignition from firebrands (IBHS, 2023). Research has shown that firebrands more easily collect around the edges of structures and can significantly contribute to structure ignitions if fuels are readily ignitable (IBHS, 2023). In response to these findings, CAL FIRE has created a new defensible space zone, Zone 0, which requires the first 5 feet from structures to be void of combustible materials.

The condition of building materials themselves greatly determines structure losses from firebrands (NIST, 2022). Studies suggest that building construction is as if not more important than defensible space in determining structure losses in the WUI (Syphard et al. 2017). As mentioned previously, firebrands are responsible for the majority of structure losses in the WUI. Chapter 7A of the California Building Code has been developed through

partnership with experimental research into structure losses. Incorporating the building construction and design requirements outlined in Chapter 7A (ex. Roof type and assembling, exterior decking, siding materials, etc.) have been proven to mitigate structure losses from firebrand ignitions (NIST, 2022).

3.6 Firebrand Production From Urban Fuels

The following sections discuss the potential for firebrand production from structure fires in modern master-planned communities, noting the effectiveness of building design features and fire safety measures in reducing the risk producing firebrands from onsite wildfires. Historical data on wildfires caused by structure fires are also presented, identifying common characteristics associated with wildfire incidents caused by structure fires.

3.6.1 Historical Wildfires Caused by Structure Fires

CAL FIRE maintains fire history data throughout the state and includes ignition causes when available (CAL FRAP, 2023). According to the historical fire record, wildfires caused by structure fires account for only <1% percent of all wildfires where the cause is known. Wildfires by cause in California is summarized below in Table 4.

Table 4. Wildfire Occurrences in California by Cause

Fire Cause	Frequency	Percent of All Causes
1 - Lightning	3483	22%
9 - Miscellaneous	3458	22%
2 - Equipment Use	1325	8%
7 - Arson	945	6%
5 - Debris	757	5%
10 - Vehicle	534	3%
11 - Powerline	444	3%
4 - Campfire	391	3%
3 - Smoking	337	2%
8 - Playing with fire	192	1%
18 - Escaped Prescribed Burn	103	1%
6 - Railroad	78	<1%
15 - Structure	**27**	**<1%**
19 - Illegal Alien Campfire	17	<1%
16 - Aircraft	15	<1%
13 - Non-Firefighter Training	11	<1%
12 - Firefighter Training	5	<1%

Note: Does not include wildfires with Unknown cause
Source: CAL FIRE FRAP, 2023

Through a detailed assessment of these fires, clear patterns and characteristics related to community design and the surrounding landscape are identified. These include:

- Wildland Urban Intermix style development with substantial vegetation surrounding structures.
- Limited setback from wildland vegetation with structures located in close proximity to unmaintained natural vegetation.
- Adjacent wildland vegetation often resembles heavy fuels. Vegetation surrounding structures is rarely herbaceous.
- Surrounding terrain is often steep with structures located on steep slopes.
- Structures are often positioned atop slopes.
- Development can be described as rural, with structures located far from existing communities or fire stations.
- Structure age is considered old.

Appendix C provides a graphical depiction of historical wildfires caused by structure fires. These occurrences exemplify many or all of the characteristics identified above. It is important to note that the Centennial Project is set apart from these characteristics and features a clustered master plan design with code compliant design features that minimize the potential for onsite structure fires to result in offsite ignitions. Centennial's development footprint does not include unmaintained vegetation near structures. Structures will be constructed in accordance with the latest building code requirements for fire safety and each structure will be equipped with automatic interior fire sprinklers. Development edges feature one, continuous interface between development and offsite grassland fuels buffered by annually maintained Fuel Modification Zones. Planned development pads are not located on steep terrain or on ridgelines. Further, Centennial will include three onsite fire stations with an optional fourth as determined necessary by LACoFD to ensure rapid response to potential onsite structure fires. **As described, Centennial does not include factors that increase the potential for offsite ignitions caused by onsite structure fires.**

3.6.2 Mitigation Summary

Studies have shown that land use decision making, defensible space, homeowner preparation, and ignition prevention can complement traditional management practices in reducing wildfire ignitions (Schwartz and Syphard 2021; Syphard et al. 2017). Because most fires are caused by humans, ignition reduction is a powerful management strategy (Syphard and Keeley 2015). **Examples of effective ignition risk mitigation measures** include:

Development location, design, and density

- The inherent nature of a project's site may have characteristics that affect wildland fire behavior and off-site ignition risk. Assessing and mitigating these factors can help to reduce potential ignitions and wildland fire behavior. For example, developments should be placed away from steep slopes, ridgelines, and known wind corridors.
- Lower-density developments, such as WUI development, should be avoided. Instead, high-density developments with one continuous interface between the built environment and vegetative fuels are preferred. This style of development reduces vegetative fuels between developments, thus limiting the potential for ignition within development areas.

Vegetation Management and Defensible Space

- Research has also indicated that the likelihood of ignitions occurring in a given location is significantly influenced by the existing vegetation/fuel available (Elia et al. 2019). Therefore, manipulating existing vegetation is a critical component of off-site ignition risk mitigation. Defensible space, often referred to as an FMZ, not only helps protect new communities and structures from external wildfire risks but also reduces the risk of fire originating from such new communities or structures and spreading to surrounding natural resources/habitat areas.
- In addition to FMZs surrounding structures, roadside FMZs have also proven effective in reducing ignition risks along roadways, a common ignition source in southern California.

Underground Powerlines

- Common ignition sources in southern California are related to powerlines, and many destructive fires across the state have been caused by powerlines (Keeley and Syphard 2018). However, this risk can be mitigated by placing powerlines underground.

3.7 Supporting Research Summary

The research cited in this section supports the Wildfire Off-Site Ignition Risk Assessment Matrix and the conclusions of this analysis.

- Development standards, mitigation standards, and project design features in wildfire-prone areas aim to reduce the potential for on-site ignitions and wildfire spread into off-site areas.
- While components of land use planning including project design and wildfire risk mitigation measures have been effectively proven to reduce risks to structures and their inhabitants from wildfire, these design and mitigation features also have an inverse impact of reducing the likelihood of on-site wildfire ignitions and their spread into off-site areas.
- The reports cited provide a description of relevant research related to wildfire risk mitigation and creates a nexus describing how these mitigations also impact the likelihood of off-site wildfire ignitions.
- Reducing potential for loss requires a holistic approach that involves a diversity of stakeholder groups and disciplines (Calkin et al. 2013) and must be considered at multiple scales (Mell et al. 2010).
- Land use planners should aim to minimize exposure of development to wildfire based on the physical and sociopolitical factors at a given site (Gonzales-Mathiesen and March 2014; March and Rijal 2015).
- The implementation of measures intended to reduce a development's exposure to encroaching wildfires also reduces the potential for ignitions originating in development areas and spreading off-site.
- Risk reduction approaches, both on-site and off-site, and including the framework presented in this report, should account for multiple risk reduction factors at multiple spatial scales, recognizing that a "one-size-fits-all" approach may not meet the needs of each individual development (Syphard et al. 2021).

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4 Wildfire Off-site Ignition Risk Assessment Matrix

4.1 Introduction

At the request of the Tejon Ranch, Dudek assembled a team to research and develop **an approach to evaluate the potential of a new master-planned community to cause off-site wildfire ignitions and ember cast**. This effort is in response to the Project's litigation that specifically included rulings on potential off-site ignitions and is also influenced by a variety of factors including the October 2022 California Attorney General Guidance on Wildfire and Evacuation Planning (California OAG 2022), the lack of California Environmental Quality Act (CEQA) thresholds targeting off-site ignitions, and Office of the State Fire Marshal revisions of FHSZ Maps (typically increasing the footprint of Very High FHSZs).

Concern about project wildfire risks is often focused on a project's introduction or increase of people to an area; by attracting more people, the presumption is that proposed development would result in a higher likelihood of wildfire ignitions. While wildfire impacts to older, established communities have been notably documented, the authors of this study could not find research directly linking ignition-resistant master-planned communities developed in accordance with modern fire code standards with increased fire ignitions or frequency. Chapter 3 of this report provides published documentation that **high density master-planned communities constructed using modern ignition resistant development techniques actually minimize the likelihood of an on-site fire transitioning to off-site areas**.

This report describes a risk assessment matrix that can be utilized for development projects located in fire hazard severity zones, including the Project, as part of an EIR document to address the potential for off-site ignitions and impacts. However, **the present focus of the methodology centers on the proposed Project** and the characteristics therein. Essentially, modeling or other tools are used to analyze ignition risk[7] and reveal the potential impacts that proposed development projects may have on adjacent lands or communities.

- Challenge: Determining potential wildfire ignition increases from new communities, including the Project, and potential impact on existing residents, structures, and communities
- Goal: Develop defensible method for evaluating off-site ignition potential from the Project (or any project), addressing the significance question
- Objectives:
  - Utilize new method to inform the Project's EIR Wildfire Section
  - Create an off-site wildfire risk matrix that assesses risk based on:
    - Fire hazard
    - Ignition risk
    - Fire protection/mitigation measures
  - Address California Attorney General Guidance on CEQA Wildfire Risk Mitigation

[7] "Risk" is the potential damage a fire can do to the area under existing conditions, accounting for any modifications such as fuel reduction projects, defensible space, and ignition-resistant building construction (CAL FIRE 2023).

4.2 Risk Assessment Equation

The overall risk assessment is **based on a model developed in 2015** (Leyshon) that starts with the hazard of a site based on the FHSZ rating and then subtracts the mitigation for the site to arrive at a risk score for the site.

Hazard - Mitigation = Risk

For purposes of determining the potential off-site risk for a development, the Leyshon equation was modified to add an Ignition Risk factor to represent the potential for on-site ignitions; the sum is reduced by the risk mitigation measures a proposed project is providing. The result then represents the potential Off-site Risk.

Hazard + Ignition Risk – Mitigation = Off-site Risk

1. The first term in the equation is **Hazard**. A given site's overall wildfire hazard may be analyzed using a variety of models and approaches. Because California relies on CAL FIRE's FHSZ modeling as the best available science, it is prudent to incorporate that model into this assessment of off-site ignition risk. Therefore, the FHSZ ratings are incorporated as the potential wildfire **Hazard** and simplified using the following ranking:

Hazard: CAL FIRE FHSZ; Very High (3); High (2); Moderate (1)

2. The second term in the equation is **Ignition Risk**. Ignition Risk is associated with a variety of site and project factors that either increase or decrease the potential for a vegetation ignition. The various factors are incorporated as the potential **Ignition Risk** and simplified using the following ranking:

Ignition Risk: High risk factor (3); Moderate risk factor (2); Low risk factor (1)

3. The third term in the equation is **Mitigation**, which, based on natural or project-provided features can reduce the overall risk, which the mitigation measures are designed to do whether they are code-based, above and beyond the code, or naturally occurring.

- Structural Mitigation Variables: hardening features, period of urban development, house size
- Non-structural Mitigation Variables: defensible space, housing density, distance from wildland vegetation
- Natural: bodies of water, non-burnable landscape

The measures are incorporated as **Mitigation** and simplified using the following ranking:

Mitigation: High reduction of ignition risk (3); Moderate reduction of ignition risk (2); Low reduction of ignition risk (1)

After establishing the risk assessment equation as the applicable **Formula**, then the terms of the equation are identified (hazard, risk, and mitigation **Factors**) which leads to populating the risk assessment **Matrix,** and subsequently a **Ranking** system in order to apply the **Matix** to a development and assess its potential off-site ignition risk.

Formula —> Hazard/Risk/Mitigation Factors —> Matrix —> Ranking —> Application

4.3 Off-site Ignition Risk Assessment Method

4.3.1 Wildfire Hazard Assessment

For purposes of this analysis, the CAL FIRE FHSZ classification system will be relied upon for the de facto hazard[8] designation for a project or area. The CAL FIRE hazard rating reflects the inherent natural physical conditions of the site that create a likelihood of fire ignition and expected fire behavior and burn probability for a potential wildfire that may be ignited within the project vicinity. **Listed below are the CAL FIRE FHSZs and their corresponding hazard ranking**, which would be identified for the project being evaluated and entered into the assessment equation. Projects located in a FHSZ will be assigned a hazard rating as classified by CAL FIRE: Moderate, High or Very High.

Fire Hazard Severity Zone	Hazard Ranking
Moderate	1
High	2
Very High	3

The ranking is not a measurement but rather a comparison of the different zones one to another. The FHSZ classification is determined by referring to the CAL FIRE Office of the State Fire Marshal map designation. A lower ranking represents a lower level of risk.

4.3.2 Wildfire Ignition Risk Assessment

4.3.2.1 California Attorney General Best Practices Guidelines

As stated in a recent guidance document by the California Attorney General's Office (California OAG 2022), development in fire-prone areas increases the likelihood that more fires will ignite. The guidance document was designed to assist lead agencies in complying with CEQA when considering whether to approve projects in wildfire-prone areas. The document further states that many of California's largest and most destructive fires have been caused by human activities. According to this guidance, there are **three reasons why residential developments in the WUI increase the risks of wildfire**: (1) there is an increase of wildfire ignitions due to the **increased presence of people**, and increase of ignitions becoming wildfires because of homes placed among flammable vegetation; (2) building housing units in the WUI **places more people in harm's way**; (3) fires in **remote locations require significant fire-fighting resources** and mobilization of fire-fighters.

Table 5 summarizes the various elements of a project's design and ranks them by category based on the Attorney General's Office guidance document's assessment of features and characteristics that result in increased or decreased ignition risk. The ranking was determined by comparing the elements with each other, analyzing whether each element was more or less of a risk than other elements, and does not represent an actual measurement or scoring. Instead, the ignition risk factors are assessed as more impactful, or less impactful, than other factors and ranked accordingly, just as the FHSZs are "ranked" as Moderate, High and Very High. A lower ranking represents a lower risk; a higher ranking represents a higher risk.

[8] "Hazard" is based on the physical conditions that create a likelihood and expected fire behavior over a 30- to 50-year period without considering mitigation measures such as home hardening, recent wildfire, or fuel reduction efforts (CAL FIRE 2023).

Table 5. Ignition Risk: Wildfire Ignition Risk Assessment for Development Projects[1]

Wildfire Ignition Risk Variables	Ignition Risk Impact Factor*	Ranking
Wildfire Risk Variables Related to the Project's Design		
Variable A. Project Density		
Choose either A1 or A2, but not both; select A3 if applicable.	A1. Low or intermediate density: not concentrated, fragmented, isolated clusters (more exposure to wildland vegetation)	2
	A2. High density: concentrated (disrupts fire spread)	1
	A3. Remote or disconnected from existing development (difficult fire department access)	3
Variable B. Project Location in the Landscape		
Select all that apply.	B1. Aboveground power lines (power lines located in a wind corridor may become a source of ignition)	3
	B2. Structures sited in rugged terrain or on top of steep hills (may increase wildfire risk)	2
Variable C. Water Supply and Infrastructure		
Select all that apply.	C1. The project's water supply and infrastructure are adequate for firefighting needs	0
	C2. There is a potential for loss of water pressure during a fire that may decrease available water supply	1
	C3. There is a potential for loss of power that may eliminate the water supply	2
	Sum of Ignition Risk Assessment Ranking	**13**

1 Based on California Atorney General Guidance.
Note: *Ignition Risk Assessment: High risk factor (3); Moderate risk factor (2); Low risk factor (1); Not a risk factor (0).

Sum of Ignition Risk Factors Ranking	Ranking for Matrix
Sum of 0 to 1: Not a risk factor	0
Sum of 2 to 5: Low risk factor	1
Sum of 6 to 10: Moderate risk factor	2
Sum of 11 to 14: High risk factor	3

Notes:
1 Select the applicable risk impact factors based on the project's density, location, and water supply variables.
2 Select the corresponding value on the table.
3 Sum the values.
4 Select the appropriate matrix ranking based on the sum of risk factors.
5 Enter the Wildfire Ignition Risk Assessment ranking on the Wildfire Ignition Risk Matrix.

Table 6. Applicable Fire and Building Code Sections that Influence Potential Off-site Ignition Risk

Code Section	Code Description	Risk Factor or Mitigation Measure
CFC Sec. 4901.1 Scope	CFC Chapter 49 contains the minimum requirements to mitigate conditions that might cause a fire originating in a structure to ignite vegetation in the WUI Area, and conversely, a wildfire burning in vegetative fuels to transmit fire to buildings and threaten to destroy life, overwhelm fire suppression capabilities or result in large property losses.	WUI mitigation strategies help to reduce the potential of a fire igniting within the Project site's landscaping or spreading outwardly off-site through the landscaping if a structure was to ignite.
CFC Sec. 4907 Defensible Space	The purpose of CFC 4907 is to manage hazardous vegetation and fuels to reduce the severity of potential exterior wildfire exposure to buildings and to reduce the risk of fire spreading to buildings.	Defensible space helps to reduce the potential of a fire igniting in vegetative fuels around buildings and structures or outwardly spreading off-site.
CRC Sec. R337; CBC Ch. 7A; CBC Sec. 903; CFC Sec. 903, Building construction	The purpose of these code sections is to establish minimum standards for the protection of life and property by increasing the ability of a building located in any FHSZ to resist the intrusion of flame or burning embers projected by a vegetation fire and thereby contribute to a systematic reduction in conflagration losses.	Buildings constructed to exterior wildfire exposure standards can help to reduce the potential of a fire originating within a structure from leaving the property and even escaping its confines (sprinkler system, fire resistant exterior walls, dual paned windows, fuel modification, etc.). In addition, if a structure were to ignite, these construction methods could reduce the potential of a fire from communicating to adjacent structures or becoming a conflagration with multiple structures involved (sprinkler system, fire resistant exterior walls, dual paned windows, fuel modification, etc.).
CFC Sec. 4903, Project Site	The purpose of CFC 4903 is to determine the acceptability of fire protection and life safety measures designed to mitigate wildfire hazards presented for the property (proposed Project site). [This code section authorizes the fire code official to require the preparation of a fire protection plan. The plan is prepared to determine the acceptability of fire protection and life safety measures designed to mitigate wildfire hazards which would then be reviewed and approved by the fire code official.] (CFC 4903.1).	The inherent nature of a Project's site may have characteristics that affect wildland fire behavior. The Project's design itself may impact wildland fire ignition and behavior. Assessing and mitigating these factors can help to reduce potential ignitions and ultimately wildland fire behavior.
CFC Sec. 4903, Surroundings	The purpose of CFC 4903 is to determine the acceptability of fire protection and life safety measures designed to mitigate wildfire hazards presented for the property [proposed Project site] (CFC 4903.1).	The inherent nature of the land surrounding a proposed project may have characteristics that affect the ignition and behavior of wildland fire. The current land uses and management practices may have an impact as well. Assessing these factors can help to determine the likelihood and potential fire

Table 6. Applicable Fire and Building Code Sections that Influence Potential Off-site Ignition Risk

Code Section	Code Description	Risk Factor or Mitigation Measure
		behavior of a wildland fire if it were to ignite from within a proposed project and spread to its surroundings, compared to the existing conditions without the proposed Project.

Notes: CFC = California Fire Code; Ch. = Chapter; WUI = wildland–urban interface; FMZ = fire management zone; Sec. = Section; CRC = California Residential Code; CBC = California Building Code; FHSZ = Fire Hazard Severity Zone.

4.3.3 Wildfire Ignition Risk Mitigation Assessment

Table 7 provides a description of California Attorney General guidance mitigation measures that are used to evaluate a project's potential for igniting fires that spread off-site into adjacent wildlands.

Table 7. Mitigation: Wildfire Ignition Risk Mitigation Measures

Wildfire Ignition Risk Mitigation Measure[1]	Category	Ranking for On-site Ignition Risk	Ranking for Off-site Ignition Risk[2]
Siting projects to maximize the role of low-flammability landscape features to buffer the development from fire spread	Project siting	2	2
Limiting development along steep slopes and amid rugged terrain (decreases exposure to rapid fire spread and increases accessibility for firefighting)	Project siting	2	1
Placement of development close to existing or planned ingress/egress and designated evacuation routes (for efficient evacuation while allowing emergency access and rapid fire suppression)	Project siting	1	1
Placement of projects close to adequate emergency services	Project siting	3	2
Increasing housing density and consolidated design, relying on higher-density infill developments as much as possible	Housing density	3	2
Avoidance and minimization of low-density exurban development patterns or leapfrog-type developments	Housing density	3	0
Decreasing the extent and amount of "edge" or interface area that is adjacent to undeveloped wildlands	Housing density	3	2

Table 7. Mitigation: Wildfire Ignition Risk Mitigation Measures

Wildfire Ignition Risk Mitigation Measure[1]	Category	Ranking for On-site Ignition Risk	Ranking for Off-site Ignition Risk[2]
Construction of additional points of ingress and egress and modification of evacuation routes	Ingress/egress	2	0
Undergrounding power lines	Infrastructure	3	3
Requiring fire-hardened communication to the project site	Infrastructure	1	0
Parking limitations to ensure roads are not clogged with parked vehicles	Infrastructure	1	1
On-site water supply/storage to augment ordinary supplies	Infrastructure	2	2
Fire hardening structures and homes to requirements provided in Chapter 7A of California Building Code (CBC) and Section R237 of the California Residential Code (resistance to heat, flames, and embers)	Construction features	2	1
Creation of buffer zones and defensible space within and adjacent to the development	Vegetation management/FMZ/ defensible space	3	2
Ensuring that vegetation will not touch structures or overhang roofs	Vegetation management/FMZ/ defensible space	2	1
Structure legal obligations so that defensible space measures are retained over time	Vegetation management/FMZ/ defensible space	1	0[9]
Enhanced communication to the project population about emergency evacuation plans and evacuation zones[10]	Training	1	0

[9] Legal obligations would only apply to the project or its future residents and not to off-site lands or neighbors. Therefore, the obligations would only be able to directly address on-site risk factors. The risk of an on-site ignition spreading to off-site is always a possibility, but legal obligations would not have a significant impact in that regard.

[10] While evacuation communication may not on its face seem to play a role in reducing ignition risk, the practice of regular communication keeps residents engaged in the preparedness process and more aware of wildfire hazards/risks and their role in prevention and response. See the points below from the U.S. Fire Administration.

- When residents are informed about potential wildfire threats early, they have time to prepare their homes, gather essential items, and make informed decisions about evacuation, reducing the likelihood of rushed actions that could lead to accidental ignition.
- Active communication with residents helps build awareness of fire risks, encourages proactive measures like defensible space creation, and fosters a sense of preparedness within the community.
- By regularly communicating evacuation procedures and the consequences of not evacuating promptly, residents are more likely to heed warnings and take necessary actions to protect themselves and their property.

Table 7. Mitigation: Wildfire Ignition Risk Mitigation Measures

Wildfire Ignition Risk Mitigation Measure[1]	Category	Ranking for On-site Ignition Risk	Ranking for Off-site Ignition Risk[2]
Mitigation Rating Sum		35	20

Notes: FMZ = Fire Management Zone.

1 Potential mitigation measures and design alternatives that may reduce wildfire risk impacts (not exclusive).

2 Potentially impacting existing structures in proximity to the new development.

Rankings (derived by comparing the listed mitigation measures against each other using a scale from 0 to 3): 3 = High reduction of ignition risk; 2 = Moderate reduction of ignition risk; 1 = Low reduction of ignition risk; 0 = NA.

Sums of On-site Mitigation Measures	Ranking for Matrix
Sum of 0 to 3: No significant reduction of ignition risk	0
Sum of 4 to 13: Low reduction of ignition risk	1
Sum of 14 to 24: Moderate reduction of ignition risk	2
Sum of 25 to 35: High reduction of ignition risk	3

Sums Of Off-Site Mitigation Measures	Ranking for Matrix
Sum of 0 to 2: No significant reduction of ignition risk	0
Sum of 3 to 7: Low reduction of ignition risk	1
Sum of 8 to 13: Moderate reduction of ignition risk	2
Sum of 14 to 20: High reduction of ignition risk	3

Notes:

1 Select the applicable wildfire ignition risk mitigation measures based on the project's design (siting, density, ingress/egress, infrastructure, construction, and FMZ).
2 Select the corresponding ranking on the table for on-site or off-site ignition.
3 Sum the rankings.
4 Select the appropriate matrix ranking based on the risk factor ranking categories.
5 Enter the wildfire ignition risk mitigation measures ranking on the Wildfire Ignition Risk Matrix.

4.4 Application of the Wildfire Off-site Ignition Assessment Matrix

Based on the variables and ranking parameters for each risk factor and mitigation measure an experienced professional fire protection planner can evaluate a project from an overall wildfire risk and mitigation perspective to assess the project in terms of its potential to result in off-site ignitions that may threaten off-site habitats and communities. Exhibit 4 provides the complete matrix.

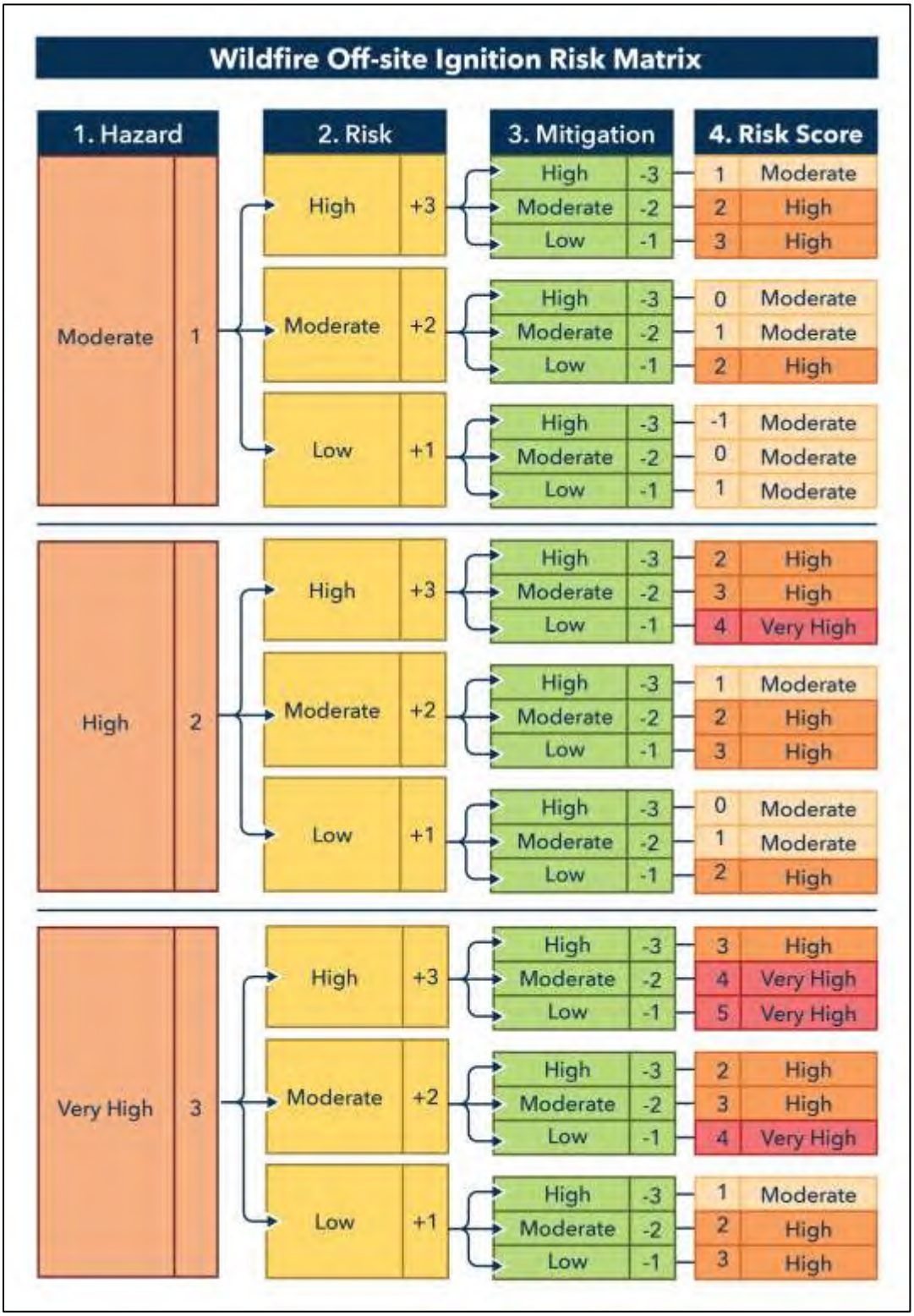


Exhibit 4. Wildfire Off-site Ignition Risk Matrix

Notes: CAL FIRE = California Department of Forestry and Fire Protection; FHSZ = Fire Hazard Severity Zone.
* Risk = Hazard + Ignition Risk – Mitigation

Once the matrix is used to identify the appropriate Hazard, Ignition Risk and Mitigation rankings for the project, the rankings can then be entered as terms into the risk equation to determine the Off-site Risk ranking and the corresponding Off-site Risk Level.

Hazard + Ignition Risk – Mitigation = Off-site Risk

The risk results can be classified into the following categories:

Ranking	Off-site Risk Level
WORL ≤ 1	Moderate
1 < WORL < 4	High
WORL ≥ 4	Very High

WORL = Wildfire Off-site Risk Level

Moderate risk represents an acceptable level of risk based on the risk vs. mitigation evaluation.

High risk represents a potential cause for concern and the possible need for additional mitigation measures to reduce to a Moderate level unless a specific site condition or overriding determination is justified and found acceptable to the local fire authority.

Very High risk would be unacceptable and subject to additional mitigations to reduce the potential ignition risks to Moderate or High with overriding acceptance from the fire authority.

4.5 Application of the Wildfire Off-site Ignition Assessment Matrix to the Centennial Project

Based on the site-specific analysis and considering the various input factors for the fire environment, the Project's hazard, ignition risk and mitigation measures, the overall Project Wildfire Off-Site Ignition Risk Level is considered by the Dudek team to result in a Moderate level, as shown below.

Hazard + Ignition Risk – Mitigation = Off-site Risk

Step 1. Hazard Ranking: Very High Fire Hazard Area = **3**

Fire Hazard Severity Zone	Hazard Ranking
Moderate	1
High	2
Very High	3

Step 2. Risk Factor Ranking: Moderate = **1**

Table 8. Centennial Specific Ignition Risk: Wildfire Ignition Risk Assessment for Development Projects[1]

Wildfire Ignition Risk Variables	Ignition Risk Impact Factor*	Ranking
Wildfire Risk Variables Related to the Project's Design		
Variable A. Project Density		
Choose either A1 or A2, but not both; select A3 if applicable.	A1. Low or intermediate density: not concentrated, fragmented, isolated clusters (more exposure to wildland vegetation)	2
	A2. High density: concentrated (disrupts fire spread)	1
	A3. Remote or disconnected from existing development (difficult fire department access)	3
Variable B. Project Location in the Landscape		
Select all that apply.	B1. Aboveground power lines (power lines located in a wind corridor may become a source of ignition)	3
	B2. Structures sited in rugged terrain or on top of steep hills (may increase wildfire risk)	2
Variable C. Water Supply and Infrastructure		
Select all that apply.	C1. The project's water supply and infrastructure are adequate for firefighting needs	0
	C2. There is a potential for loss of water pressure during a fire that may decrease available water supply	1
	C3. There is a potential for loss of power that may eliminate the water supply	2
	Centennial Project Sum of Ignition Risk Assessment Ranking	4

1 Based on California Atorney General Guidance.
Note: *Ignition Risk Assessment: High risk factor (3); Moderate risk factor (2); Low risk factor (1); Not a risk factor (0).

Sum of Ignition Risk Factors Ranking	Ranking for Matrix
Sum of 0 to 1: Not a risk factor	0
Sum of 2 to 5: Low risk factor	1
Sum of 6 to 10: Moderate risk factor	2
Sum of 11 to 14: High risk factor	3

Notes:
1 Select the applicable risk impact factors based on the project's density, location, and water supply variables.
2 Select the corresponding value on the table.
3 Sum the values.
4 Select the appropriate matrix ranking based on the sum of risk factors.
5 Enter the Wildfire Ignition Risk Assessment ranking on the Wildfire Ignition Risk Matrix.

Step 3. Mitigation Level Ranking: High = **3**

Table 9. Centennial Specific Mitigation: Wildfire Ignition Risk Mitigation Measures

Wildfire Ignition Risk Mitigation Measure[1]	Category	Ranking for On-site Ignition Risk	Ranking for Off-site Ignition Risk[2]
Siting projects to maximize the role of low-flammability landscape features to buffer the development from fire spread	Project siting	2	2
Limiting development along steep slopes and amid rugged terrain (decreases exposure to rapid fire spread and increases accessibility for firefighting)	Project siting	2	1
Placement of development close to existing or planned ingress/egress and designated evacuation routes (for efficient evacuation while allowing emergency access and rapid fire suppression)	Project siting	1	1
Placement of projects close to adequate emergency services	Project siting	3	2
Increasing housing density and consolidated design, relying on higher-density infill developments as much as possible	Housing density	3	2
Avoidance and minimization of low-density exurban development patterns or leapfrog-type developments	Housing density	3	0
Decreasing the extent and amount of “edge” or interface area that is adjacent to undeveloped wildlands	Housing density	3	2
Construction of additional points of ingress and egress and modification of evacuation routes	Ingress/egress	2	0
Undergrounding power lines	Infrastructure	3	3
Requiring fire-hardened communication to the project site	Infrastructure	1	0
Parking limitations to ensure roads are not clogged with parked vehicles	Infrastructure	1	1
On-site water supply/storage to augment ordinary supplies	Infrastructure	2	2
Fire hardening structures and homes beyond what is required in applicable building codes	Construction features	2	1

Table 9. Centennial Specific Mitigation: Wildfire Ignition Risk Mitigation Measures

Wildfire Ignition Risk Mitigation Measure[1]	Category	Ranking for On-site Ignition Risk	Ranking for Off-site Ignition Risk[2]
(resistance to heat, flames, and embers)			
Creation of buffer zones and defensible space within and adjacent to the development	Vegetation management/FMZ/ defensible space	3	2
Ensuring that vegetation will not touch structures or overhang roofs	Vegetation management/FMZ/ defensible space	2	1
Structure legal obligations so that defensible space measures are retained over time	Vegetation management/FMZ/ defensible space	1	1
Enhanced communication to the project population about emergency evacuation plans and evacuation zones[11]	Training	1	0
Mitigation Rating Sum		35	21

Notes: FMZ = Fire Management Zone.

1 Potential mitigation measures and design alternatives that may reduce wildfire risk impacts (not exclusive).

2 Potentially impacting existing structures in proximity to the new development.

Centennial Specific Sum of On-site Mitigation Measures	Ranking for Matrix
Sum of 0 to 3: No significant reduction of ignition risk	0
Sum of 4 to 13: Low reduction of ignition risk	1
Sum of 14 to 24: Moderate reduction of ignition risk	2
Sum of 25 to 35: High reduction of ignition risk	3

Centennial Specific Sum Of Off-Site Mitigation Measures	Ranking for Matrix
Sum of 0 to 2: No significant reduction of ignition risk	0

11 While evacuation communication may not on its face seem to play a role in reducing ignition risk, the practice of regular communication keeps residents engaged in the preparedness process and more aware of wildfire hazards/risks and their role in prevention and response. See the points below from the U.S. Fire Administration.

- When residents are informed about potential wildfire threats early, they have time to prepare their homes, gather essential items, and make informed decisions about evacuation, reducing the likelihood of rushed actions that could lead to accidental ignition.
- Active communication with residents helps build awareness of fire risks, encourages proactive measures like defensible space creation, and fosters a sense of preparedness within the community.
- By regularly communicating evacuation procedures and the consequences of not evacuating promptly, residents are more likely to heed warnings and take necessary actions to protect themselves and their property.

Sum of 3 to 7: Low reduction of ignition risk	1
Sum of 8 to 13: Moderate reduction of ignition risk	2
Sum of 14 to 20: High reduction of ignition risk	3

Notes:
1 Select the applicable wildfire ignition risk mitigation measures based on the project's design (siting, density, ingress/egress, infrastructure, construction, and FMZ).
2 Select the corresponding ranking on the table for on-site or off-site ignition.
3 Sum the rankings.
4 Select the appropriate matrix ranking based on the risk factor ranking categories.
5 Enter the wildfire ignition risk mitigation measures ranking on the Wildfire Ignition Risk Matrix.

Enter the assigned ranking from each step into the risk assessment formula and sum.

3 (Hazard) + 1 (Ignition Risk) – 3 (Mitigation) = 1 (Off-site Ignition Risk)

Complete Step 4 by referring to Table 10 (Wildfire Off-site Fire Risk Categories).

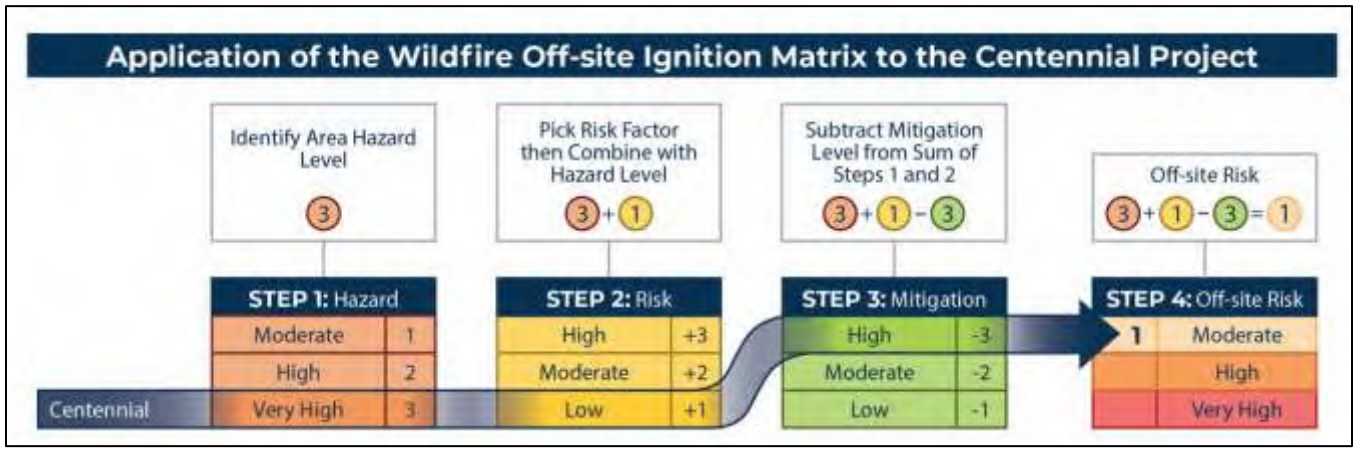
Step 4. Wildfire Off-site Ignition Risk Level: 1 = Moderate

Table 10. Wildfire Off-site Fire Risk Categories.

Ranking	Off-site Risk Level
WORL ≤ 1	Moderate
1 < WORL < 4	High
WORL ≥ 4	Very High

WORL = Wildfire Off-site Risk Level

The figure below provides a graphical representation of following the four steps to determine the Wildfire Off-site Ignition Risk Level.



Off-site Risk Ranking	Wildfire Off-site Risk Level
Ranking (1) ≤ 1	Moderate Risk

Moderate risk represents an acceptable level of risk based on the risk vs. mitigation evaluation. Note the description below from the USDA Forest Service[12] regarding moderate fire danger:

*When the fire danger is "moderate" it means that fires can start from most accidental causes, but the number of fire starts is usually pretty low. If a fire does start in an open, dry grassland, it will burn and spread quickly on windy days. Most wood fires will spread slowly to moderately. Average fire intensity will be moderate except in heavy concentrations of fuel, which may burn hot. Fires are still not likely to become serious and are often easy to contro*l.

Cal Fire[13] provides an explanation on the differences between the various fire hazard ratings:

Classification of a wildland zone as Moderate, High or Very High fire hazard is based on the average hazard across the area included in the zone, which have a minimum size of 200 acres. In wildlands, hazard is a function of modeled flame length under the worst conditions and annual burn probability. Both these factors generally increase with increasing hazard level, but there may be instances where one value is Very High and the other is low, pushing the overall hazard into a more intermediate ranking. On average, both modeled flame length and burn probability increase by roughly 40-60% between hazard classes. Classification outside of wildland areas is based on the fire hazard of the adjacent wildland and the probability of flames and embers threatening buildings.

As described above, this indicates that a moderate ranking would be significantly lower flame lengths and burn probabilities than high or very high, thus with the proposed mitigation measures for the project's building in these areas, an acceptable level of risk.

[12] USDA Forest Service, National Fire Danger Rating System, https://www.fs.usda.gov/detail/inyo/home/?cid=stelprdb5173311

[13] Cal Fire, Fire Hazard Severity Zones FAQs, https://osfm.fire.ca.gov/what-we-do/community-wildfire-preparedness-and-mitigation/fire-hazard-severity-zones

5 Findings and Conclusion

Findings

Methodology development

Developing a method for determining the potential off-site ignition risk associated with a new development project involved considerable research, application of experience, and adoption of frameworks already in use in various forms. The evaluation process and method evolved over the course of several months during development, from an overly complex series of matrices utilizing numerous factors and limited to use by seasoned wildfire planning experts to a method and process that is based on the most commonly used guides for new community planning, i.e., the CFC, CBC, and/or the California Attorney General's Office Wildfire Guidance Best Practices. The evaluation process presented herein represents the culmination of the Dudek fire protection planning team's efforts, and while it would not be appropriate for use by an inexperienced person for evaluating a project's overall off-site ignition risk, it is considered useable by WUI-familiar fire prevention officers, fire protection planners, fire inspectors, fire-protection-focused foresters and landscape architects, and others, if they have demonstrated their experience evaluating wildfire hazards and mitigating them through proven and justified methods.

The method has been developed so that it provides a narrow possibility of achieving a Moderate off-site fire ignition risk if a project is located within a Very High FHSZ. In this case, a project would need to meet a very high bar for mitigating wildfire hazards as the only path to achieve a Moderate final ranking. It is far more common for projects to result in a High or Very High off-site ignition risk result than Moderate, unless the project provides a strategic, targeted set of mitigation measures addressing the primary ways that fire could ignite and move to off-site fuels.

Data support

The off-site ignition risk evaluation of the proposed Project included reliance on a vast amount of site-specific information, fire environment data, fire behavior and spread modeling, and extensive mitigations that will be provided above and beyond the strict code requirements. This information was available for this effort because the Project applicant made considerable investment to evaluate wildfire risk and needed protections as part of its planning process. As such, the Project bases its off-site risk analysis on supporting information provided within the (1) Project WSP; (2) Project Construction Fire Prevention Plan (3) Fuel Modification Plan; and (4) a Project Wildfire Evacuation Study. In addition, extensive analysis and modeling was conducted as part of an FHSZ remapping comment exercise, based on which CAL FIRE corrected their initial remapping of the site, downgrading much of the site from High and Very High to Moderate and High.

Project Ignition Risk Rating

Based on Dudek's technical review of the site and surrounding areas and development of a comprehensive wildfire ignition risk and risk reduction method, it is our opinion that the Project's off-site ignition risk of Moderate, as determined by the presented method, is accurate and supported.

Risk Reduction Measures

The following sections discuss off-site wildfire risk and mitigations that reduce the potential risk associated with the Project, a properly designed and carefully mitigated project.

Potential Changes in Off-site Wildfire Risk

Commercial and residential development brings more people, as well as construction and routine occupancy activities, to a project site. Certain human activities result in sparks, flames, or heat that may ignite vegetative fuels unless proper prevention measures are in place. As described throughout this analysis, the Project includes comprehensive measures to prevent, protect, and contain on the Project site any potential on-site accidental ignitions. This section of the report is focused on the potential for increased risks of accidental off-site ignitions associated with commercial and residential construction and occupancy of the future Project, including the risk from airborne embers, a leading cause for structural loss and wildfire spread.

Additionally, there has been concern over structural fires from urbanized areas creating airborne burning embers, which can be transported large distances (in excess of 1 mile) downwind of a fire event. If the ember(s) remain viable, i.e., capable of igniting receptive fuels, a new fire can be ignited, and if that fire is within naturally occurring vegetation and the weather conditions are such that fire spread is facilitated, a wildfire may occur. This situation could lead to encroachment of wildfire on existing communities and residents. However, this potential has been contemplated and addressed during the Project wildfire hazard and risk analysis within the Project's EIR and Wildfire Safety Plan (Dudek 2024). The Project's layered design, construction, and maintenance requirements create a system of fire prevention and protection that minimizes the possibility of ember generation, which in turn minimizes the potential for off-site ember ignitions.

Mitigation Measures

Taken together, the fire prevention, suppression, and response measures incorporated into the Project and mandated by applicable regulatory requirements serve to adequately protect both on-site and off-site resources in the event of an on-site fire ignition, the most significant of which are as follows:

1. **Wide FMZ around the perimeter of the Project.** The Project's FMZ varies in width between 100 and 200 feet and would be improved with specified fire-resistant plant species at low fuel densities and subject to ongoing HOA-funded and applied maintenance. FMZs are also provided along all on-site roads and, as feasible, off-site roads. The strategic design and placement of FMZs works to disrupt fire spread, reduce fire intensity, and facilitate fire suppression within a landscape (Braziunas et al. 2021). This is true regardless of the direction a vegetation fire may be burning, whether toward a community or from within a community. The risk of a structure being destroyed is significantly lower when defensible space is implemented on both shallow and steep properties (Syphard et al. 2014). Even if just half the landscape is treated, the percentage of houses exposed to fire can decrease from 51% to 16% (Braziunas et al. 2021). Moreover, when FMZs are designed properly, they not only protect homes but also the surrounding environment. For example, when the Tahoe Basin experienced the Angora Fire in 2007, fuel treatments had the dual effect of saving homes and increasing forest survival (Safford et al. 2009). In areas where fuel management had been carried out prior to the Angora Fire, home loss was significantly reduced in the adjacent community, and 85% of the trees survived, as compared to the 22% that survived in untreated areas (Safford et al. 2009). Fuel management treatments also facilitated the ecological benefit of reduced fire severity, including higher post-fire soil litter cover, higher herbaceous plant cover, higher species diversity, and lower levels of invasive beetles (Safford et al. 2009). At a minimum, managing defensible space can reduce risk across multiple scales by dampening fire risk and reducing the impact of fire, and in turn reducing annual fire risk (Braziunas et al. 2021).

2. **Continued grazing of Project's open space.** Open spaces within the Project's interior and open edges will experience continual grazing following development of the Project. This will maintain the site's flashy fuels outside of developed and landscaped areas and will contribute to reduced fire hazard.
3. **Ignition-resistant structures.** All Project structures will be built to the CBC or California Residential Code ignition-resistant requirements that have been developed and codified as a direct result of after-fire save and loss assessments. Each facet of a building's exterior construction and appendages are addressed within Chapter 7A of the CBC and Section R337 of the California Residential Code, with a primary focus on requiring structures that can withstand heat, flame, and embers. The way to reduce a project's likelihood to cause a fire that may spread on- or off-site is to reduce the likelihood that the project's structural elements will ignite (Maranghides and Mell 2012; Calkin et al. 2014; Mockrin et al. 2020). There are two primary concerns for structure ignition: (1) radiant and/or convective heat; and (2) burning embers (NFPA 1144 2008 and IBHS 2008). Burning embers have been a focus of building code updates for at least the last decade, and new structures in the WUI built to these codes have proven to be very ignition resistant, which significantly decreases the likelihood of home-to-home fire spread and minimizes ember production that could ignite the surrounding environment.
4. **Interior fire sprinklers.** All Project structures, of any occupancy type, will be protected by an automatic, interior fire sprinkler system. All automatic internal fire sprinklers would be installed in accordance with NFPA 13, 13D, or 13R and LACoFD installation requirements. Interior fire sprinklers are very successful at assisting responding firefighters by either extinguishing a structural fire or containing the fire to the room of origin and delaying flashover. This benefit also reduces the potential for an open space vegetation ignition by minimizing the possibility for structure fires to grow large and uncontrollable, resulting in embers that are blown into wildland areas.
5. **Ignition-resistant, planned, and maintained landscape.** All landscaping of Project common areas will be subject to strict fire-resistant plant types with those closest to structures requiring irrigation to maintain high plant moistures, which equates to difficult ignition and reduced fire spread. These areas are closest to structures, where ignitions would be expected to be highest but will be prevented through ongoing maintenance efforts.
6. **Undergrounding of power lines.** Power lines are a common concern with respect to human-caused wildfires (Syphard and Keeley 2015). These fires are often started by the arcing between lower-voltage supply lines during high-wind events. The Centennial Specific Plan and applicable County regulations require the Project to underground all electric utility lines, and new aboveground power lines are prohibited on the Project site. These restrictions will significantly reduce, if not eliminate, the likelihood that power lines serving the Project will cause on-site or off-site fires.
7. **On-site fire stations.** The Project will provide at least three, and up to four, on-site fire stations and will thus provide a robust response capability to the Project site and the region, where there are currently long emergency response delays due to the rural nature of the area. This response capability includes fast response throughout the Project site and surrounding open space areas, and a heavy response (number of engine companies) that can respond within a short timeframe. Attacking fires in their incipient stages is critical to fire suppression and controlling fire spread. Thus, the Project's provision of significant firefighting resources will greatly improve the ability to control and suppress all fires in the Project area, both on site and off site, compared to existing conditions.
8. **Water availability and fire flow.** The Project is required to provide water meeting fire flow for each of the Project's proposed land uses. Thus, water will be available to firefighters at any of several hundred (or more) fire hydrants distributed throughout the community. Water is a key to fighting most urban fires and keeping

them from inadvertently spreading on or off site. Water is also critical for fighting wildfires and keeping them small in size.

9. **Fire access roads.** The Project is required to provide access roads for firefighting apparatus. Project roads provide code-consistent access throughout the community. Better access to wildland areas would result in faster wildfire response and continuation of the fire agencies' successful control of wildfires at small sizes. Such access would also allow firefighters to better prevent the spread of on-site fires to off-site locations.

   The methodology used to assess the Project's potential impacts related to wildfire conformed to industry standard protocols and accepted data sets. The Project agreed to commitments designed to mitigate off-site fire risk in the Climate Resolve agreement, which would provide for Project and regional efforts to reduce wildfire risk. As confirmed by LACoFD at the hearing at which the Project was finally approved, developments, like the Project, that implement modern land use planning and hazard mitigation strategies can be safely sited in WUI areas without significant risk to the community or the surrounding environments. At Project approval, the Project's fire protection features went above and beyond applicable codes. Moreover, the Project approvals require the Project to comply with stricter fire code standards as they are updated in the future. Project compliance with such regulatory mandates will ensure that the community's structures will have the ability to survive a wildland fire with little intervention of firefighting forces. Moreover, the Project's fire safety design will adequately reduce its potential to cause structure fires that could result in off-site fire starts by incorporating modern, fire-safe construction materials and by significantly increasing fire services response capacity to the Project site and surrounding area. As such, the Project will adequately reduce on-site and off-site impacts associated with wildfire risk.

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Appendix A

Fire Protection Team Resumes

Michael Huff, RCA

PRINCIPAL

Michael Huff is founder and manager of Dudek's Urban Forestry/Fire Protection Planning team with 29 years' experience as a forester and fire protection planner. Mr. Huff specializes in management of community-wide and project-specific fire protection plans (FPPs), wildland–urban interface (WUI) fire management plans, wildfire hazard reduction projects, California Environmental Quality Act (CEQA) supporting technical documents, Oak Woodland impact and mitigation plans, urban and community forest management plans, forest and tree inventories, impact analysis studies, and tree hazard evaluations. Mr. Huff possesses considerable project issue resolution experience and focuses on working within the regulations to provide creative, cost-saving solutions to his clients. He routinely participates in public hearings, strategy sessions, and provides public presentations.

Education

Northern Arizona University
BS, Forest Management, 1992

Certifications

Registered Consulting Arborist (RCA), No. 640

Certified Arborist, No. WE-4276A

San Diego County Department of Planning and Land Use-Approved Fire Protection Planner

Laguna Beach Fire Department-Approved Fire Protection Planner

Certified Wildland Fire Ecologist

Professional Affiliations

American Society of Consulting Arborists

National Fire Protection Association – International

California Fire Chief's Association – Fire Prevention Officers

Sample Project Experience

Development

Otay Ranch Village 13 FPP, Baldwin & Sons/Moller, San Diego County, California. Managed this mixed-use master planned community Fire Protection Plan project. The project includes 1,938 residential units along with commercial, school, fire station, open space, recreational areas, and related infrastructure. The project is located within a very high fire hazard severity zone, and the FPP analyzed the site's hazards, determined overall risk, and mitigated that risk through project design features. The project included development of fuel modification zones, emergency response times, evacuation planning, and ignition resistant building construction specifications.

Point Molate Mixed Use Development, Argent Development, Richmond, California. Managed, wrote, reviewed, and coordinate the preparation of two emergency planning documents to satisfy project conditions of approval for the Point Molate project in Richmond, California. A Wildfire Emergency Response Plan that evaluated the potential wildfire risk for the proposed Point Molate mixed use community was prepared and made recommendations for addressing risk and providing for resident and fire department response. A second document, the Multi-Hazard Emergency Response Plan, was prepared to address the most likely natural- or human-caused disasters and the project's planned actions in response. This plan includes responses to earthquakes, tsunami, flooding, and other disasters and provides a framework for how the project would respond. Both emergency response plans include analysis and discussions of available response evacuation routes, discuss the potential for sheltering in place, and lay out mitigating measures that would be employed prior to these emergency situations as part of a pre-planning and readiness program. Presented at several public hearings to answer questions regarding the site's overall safety.

Otay Ranch Village 14/Adara FPP, Jackson Pendo Development, San Diego County, California. Managed this mixed-use master planned community. This 1,119 residential unit project includes a school, village center, fire station, related infrastructure, and open space/recreation areas. The project is located within a very high fire hazard severity zone and required comprehensive analysis of the site's potential hazards and overall wildfire risk. Dudek conducted analysis according to the San Diego County Fire Protection District guidelines that include fire behavior modeling, fire history analysis, emergency response travel time analysis, establishment of fuel modification zones, and requirements for code compliance and community fire safety.

Paraiso Springs Resort Fire Protection Planning, Paraiso Springs Resort, LLC., Soledad, Monterey County, California. Managed this hot springs resort project and provided authorship of a fire safety plan, evacuation plan, and an environmental impact report (EIR) wildfire section. Dudek's fire protection planning team performed a comprehensive review of the site's fire environment and developed approaches to address the hazards and reduce risk to acceptable levels. Provided support at several public hearings and answered questions regarding the site's safety for the planned use.

Confidential Ranch Fire Protection Planning, Confidential Client, San Diego County, California. Provides fire safety planning for a 25,000 plus acre ranch. Safety planning includes advisement on vegetation management, site activity restrictions during red flag warning weather conditions, improvements for fire fighter access, on-site fire response resources, and high-tech fire detection. In addition, coordination with fire agencies and familiarization with site resources, high risk areas, and assets is included in the scope.

Otay Ranch Villages 2, 3, 4, 6, 8, 9, and 10 Mixed-Use Projects, various clients, Chula Vista, California. Managed several Fire Protection Planning projects for Otay Ranch villages while coordinating with the Chula Vista Fire Department, project engineers, planners, landscape architects, and others; analyzing each site's risk potential; and customizing protection measures and features to result in fire safety projects receiving fire department acceptance. Among the tasks completed for the various projects are fire behavior modeling, emergency travel time response modeling, site plan reviews, site/field evaluations, digital data acquisition and review, and development of appropriate mitigating measures.

Sunset Crossroads FPP, MC Group, Riverside County, California. Managed this project which includes 5.3 million square feet of industrial and commercial space. The project is located within a high fire hazard severity zone. The project included developing appropriate measures to address the site's fire risk and confirming code compliance for access, building construction, emergency response, water availability, and related fire safety and protection requirements. In addition, Dudek prepared the wildfire section of the project's EIR, utilizing the results of the FPP to inform analysis regarding the four CEQA significance trigger thresholds.

The Junipers Age-Restricted Residential Development, Lennar Homes, San Diego, California. Managed the preparation of a comprehensive FPP and Evacuation Plan for this 550-unit project. Dudek's fire specialists performed extensive analysis of the fire environment and documented the project's compliance with enhanced fire safety requirements. In addition, Dudek provided extensive analysis of the ability to evacuate the area based on existing conditions and post-project, enhanced conditions, noting that the project provides additional options and capacity, resulting in a safer area than the current condition.

Hummingbird Nest Ranch FPP, Five S Properties, Ventura County, California. Prepared an FPP for this unique project that consists of a large ranch proposing site development to allow for on-site large events. The project's very high fire hazard severity zone location required careful consideration of the types of events and the restrictions and additional measures that would be required to enable the plan to proceed with an acceptable safety risk.

Murai Subdivision FPP, ColRich, San Marcos, California. Managed this 89 single-family unit project in San Marcos that resides within a high fire hazard severity zone. The project included constrained site characteristics that required development of prescriptive measures, including landscape and building hardening beyond code requirements to meet the intent of the code.

Murrieta Hills FPP, Pulte Homes, Murrieta, California. Managed and guided analysis, wrote the FPP, and coordinated with local fire personnel on this 750-unit residential master plan. The project required a code modification regarding dead-end road length with justifying measures to meet the intent of the code. Dudek performed a comprehensive analysis of the fire environment and prescribed a redundant system of protections to provide safe vehicle evacuation through the community to available evacuation routes while enabling emergency ingress. The project is within a very high fire hazard severity zone, and the site's wildfire risk was evaluated and addressed through site-specific design features.

Newland Sierra Master Planned Community FPP and Evacuation Plan, Newland Communities, San Diego County, California. Managed a team of fire protection planners to prepare this comprehensive FPP. The plan followed San Diego County Guidelines to evaluate the potential fire risk and address it such that an acceptable level of risk was achieved. Deer Springs Fire Protection District and San Diego County accepted the plan and approved the project. Provided reviews and authorship of the EIR wildfire/hazards sections, responded to comments, and spoke at public meetings to resolve questions and misinformation regarding the project's fire safety and provisions.

Sky Ridge Community Fuel Modification Zone Inspections, D.R. Horton, San Bernardino, California. Provided oversight and managed this project that included inspection of existing fuel modification zones in a very high fire hazard severity zone. Dudek's fire protection specialists inspected the perimeter fuel modification zones and documented issues. A report indicating where issues were noted and how they could be mitigated was prepared.

Emerald Heights Fire Safety Inspections, Emerald Heights Property Management, Escondido, California. Dudek provided two rounds of fire safety inspections of the Emerald Heights community. The inspections focused on perimeter fuel modification zones, evacuation route road-side vegetation management, and internal green space species inclusion and maintenance practices. Dudek prepared summary reports and attended community meetings to discuss the results and findings and to further define the recommended actions to improve fire safety.

Hidden Valley Ranch FPP, Shea Homes, Escondido, California. Managed this 179 single-family residential development project FPP. The project included customized fuel modification zones and incorporation of maintained avocado groves as part of the defensible space area.

Costco FPP and EIR Wildfire Chapter, Costco Corporation, Murrieta, California. Managed and guided an FPP for a planned Costco in a WUI area, specifically providing protection features for a reduced fuel modification zone area. Provided quality assurance/quality control (QA/QC) for the project's EIR wildfire chapter.

Hitch Ranch Residential Development FPP, Comstock Homes, Camarillo, California. Managed the preparation of an FPP for this 328 single-family home community. Dudek evaluated the site fire risk, product type details, access, water and fire flow, and provided mitigation for project components that were not code conforming.

Fairview Residential Development FPP, D.R. Horton, Bonsall, California. Provided project management, fire district coordination and interface, section preparation, review, and final QA/QC for the Fairview project. The project is a 73-unit detached condominium project that included outdoor living rooms. Special considerations were required to achieve code intent regarding fuel modification zones and setbacks.

Hidden Oaks Country Club FPP and Fuel Modification Plan, Hidden Oak Country Club, Chino Hills, California. Managed and prepared an FPP and Fuel Modification Plan for this 35-unit residential project in Chino Hills. Proposed approaches to resolve access issues and move the project forward. Fuel modification zones exceeding the local fire authority requirements were proposed due to the site's unique fire risk.

Stoneridge Commerce Center FPP, Richland Properties, Riverside County, California. Managed the preparation of a comprehensive FPP for the Stoneridge Commerce Center, which includes a total maximum building space of 8,803,470 square feet and establishes Light Industrial uses on approximately 442.8 acres with a maximum of 7,488,800 square feet of building space; Business Park uses on 83.4 acres with a maximum of 1,170,570 square feet of building space; Commercial Retail uses with a maximum of 144,100 square feet of building space on 13.3 acres; 36.6 acres of Open Space Conservation; and 81.6 acres of Open Space-Conservation Habitat. Provided client coordination, QA/QC review of all submittals, and budget and timeline management.

Wildland Fire Management Plan, Nature Reserve of Orange County, California. Managed and was primary author of a wildland fire management plan for the 36,000-acre preserve located on the Irvine Ranch from Laguna Beach and extending to Anaheim Hills. The project included extensive stakeholder outreach and coordination of the 38 stakeholder agencies. Goals of the plan were to minimize fire ignitions, protect natural resources, protect private property assets neighboring the Reserve, and prepare a guidance document that was implementable and included realistic measures for reducing fire frequency and impacts.

Oak View Estates, Third-Party Fire Plan Review, Michael Baker International (for City of Bradbury), Bradbury, California. Managed a residential project in the very high fire hazard severity zones of Bradbury and provided final review of a consultant-prepared FPP and QA/QC of the comment letter.

Third-Party Review of Assembly Bill 68–Accessory Dwelling Unit Law, City of Bradbury, California. Managed a team of retired fire prevention officers' review of Assembly Bill 68 as it applies to Bradbury. Was final author of the letter report indicating issues with the law and how it may impact Bradbury's residents' fire safety. Provided two City Council updates, including the final results presentation.

Fairmont Fire Station Fire Fuel Load Modeling Report, City of San Diego, California. Managed the preparation of a Fire Fuel Load Modeling Report and Brush Management Plan for a proposed fire station site within a high fire hazard severity zone. The project included evaluation of the fire hazards and overall risk and appropriate measures, including brush management and vertical, non-combustible walls, to protect the station from wildland fire.

Monarch Hills Residential Development, Richland Real Estate Fund, LLC, Fontana, California. Managed the preparation of an FPP for the 472-unit project in Fontana. Provided fire protection analysis along with coordination with the Fontana Fire Department towards completion of the project's FPP. The project is within a very high fire hazard severity zone and included several potential site plan issues that Dudek helped resolve through site plan changes and alternative materials and methods.

The Ranch at Laguna Beach Fire and Evacuation Planning, Laguna Beach, California. Provided an evaluation of fire safety at the site's event venue and golf course. Located at the ocean end of Aliso Canyon in Orange County, the interior portions of the project are located in areas considered very high fire hazard severity zones in Laguna Beach. The event venue would host large gatherings and required evaluation for fire safety and moving people quickly out of the area. Dudek's analysis provided steps that would increase efficiency during evacuations, prepare the site for the types of fires that could occur in the area, and reduce risk to acceptable levels.

West Oaks Residential Project FPP, Integral Communities, Carlsbad, California. Managed the preparation of an FPP for this 209-unit development. Site constraints required a creative approach to fuel modification zones, their configuration, allowable plant species, and required maintenance.

LaMoree Residential Development FPP, Integral Communities, San Marcos, California. Led Dudek's fire protection planners in the evaluation of this 8-unit project within a fire hazard severity zone. The FPP addresses the site's unique fire risk and provides for structural hardening, water supply, access, fuel modification, and emergency response.

Fanita Ranch Master Planned Community Project FPP and Evacuation Plan, HomeFed Corp., Santee, California. Managed the preparation of this comprehensive FPP. The project is a 2,638-unit development with a village core, fire station, school, agriculture, parks, trails, and related infrastructure. The FPP is a robust document that identifies the potential wildfire risk at the site and then defines and provides specifications for addressing the risk to acceptable levels. The project's evacuation plan provides future residents with a toolkit for preparedness and awareness so they are familiar with the potential evacuation declarations and actions they may need to take.

Post-Wildfire Landscape Assessments, AIG Insurance, Santa Barbara, Poway, and Rancho Santa Fe, California. Managed several projects involving the post-wildfire landscape assessments and loss valuations. The projects included landscape inventory with GPS technology, assessments of plant material for damage level and anticipated recovery, and appraised loss value calculations.

North River Farms, Integral Communities, Oceanside, California. Managed this residential development project FPP that included conversion of agricultural fields in a high fire hazard severity zone along the San Luis Rey River to a community of 689 lots with retail, fire station, parks, and infrastructure. The project required evacuation planning and prescription of appropriate fire safety features customized for the site. In addition, emergency response modeling was conducted and determined that existing stations could not serve the project in sufficient travel times, and an on-site station was proposed that included a reduced staffing model for a temporary period.

Harmony Grove Village South Fire Protection and Evacuation Plan, Harmony Grove Village South Partners, LLC., San Diego County, California. Project manager, lead fire protection planner, and primary author of this comprehensive FPP for a 554-unit project. The project required a modification for dead-end road length, and a package of 27 features was developed for justifying the modification as meeting the intent of the code. Worked with County fire planners, Rancho Santa Fe Fire Protection District fire prevention officers, and third-party fire operations experts to gain confirmation that the project would be safe and meets the code intent. The project can be considered a shelter in place community due to its robust wildfire hardening and improved evacuation capabilities.

Rio Estrella Residential Development FPP, California West Communities, Bonsall, California. This 93-lot subdivision encircling the Bonsall Elementary School included fire hazards requiring mitigation through design features. Mr. Huff coordinated with the North County Fire Protection District to address reduced fuel modification zones by requiring additional structural hardening and fire protection features. The project's FPP documented the site's risk and how it is addressed and guides future maintenance.

Ocean Breeze Residential Development Wildfire Evacuation Plan, Helios Property Solutions, Bonsall, California. Dudek provide a comprehensive evacuation plan for this 396 single-family home development in a very high fire hazard severity zone. The evacuation plan calculated the project area's evacuation timing currently and with the project and laid out steps the project would take to result in a prepared and aware population. The evacuation plan also contemplated the ability to refuge residents and area citizens on-site at various locations if there was not time to evacuate. Mr. Huff managed the project, wrote the evacuation plan, and presented it at the local planning group.

Valiano Residential Community Evacuation Plan, Integral Communities, San Marcos, California. Managed and was primary author of an evacuation plan for this 325-unit residential project. The evacuation plan focused on determining the project's ability to evacuate given available evacuation routes and planned enhancements. The road capacities were evaluated against the project's population numbers to determine the timing to move all residents out of the area. The evacuation plan was accepted by the local fire agency.

Lake Point FPP, Integral Communities, Chula Vista, California. Managed and authored this FPP for this mixed-use, multi-family condominium project in Chula Vista. The FPP evaluated wildfire, fire access, water and fire flow, and fire response, amongst other fire safety details, and provided recommended enhancements to improve the project's safety and defensibility.

Portola Parkway Residential Development FPP, Baldwin & Sons, Lake Forest, California. Dudek prepared a comprehensive FPP and fuel modification plan for this project in a very high fire hazard severity zone. Mr. Huff developed a habitat-based approach to the fuel modification zones, incorporating cactus wren (*Campylorhynchus brunneicapillus*) habitat in the form of prickly pear cacti to result in a functional equivalent fuel modification zone with habitat benefits. The FPP included evaluation of all fire environment hazards and development of unique and site-specific measures and design features to provide for public safety.

Olympic Pointe FPP, Integral Partners, Chula Vista, California. Managed this project's FPP to provide a fire safe community for the 423 planned units. The project is located within a high fire hazard severity zone and required analysis of the fire environment and related risk factors to determine if it required any additional measures for fire safety. The FPP provides a detailed documentation of the site's hazards and overall risk and how it is mitigated to acceptable levels.

Cheyenne Residential Development, MLL Investments, Santee, California. Prepared an FPP with alternative materials and methods for fire protection due to constrained fuel modification zones. The project is located within a very high fire hazard severity zone, and the FPP documents and analyzes the risk and provides appropriate features to mitigate the risk to acceptable levels.

PETCO Headquarters Wildfire Risk Assessment, PETCO, San Diego, California. Performed a site assessment of the headquarters' grounds to determine the potential wildfire vulnerability and provide recommendations to reduce the potential threat. Among the recommendations were active maintenance of unmaintained fuels on slopes, enforcement of smoking policies and use of butt receptacles, and regular maintenance of palm tree petticoats throughout the site.

Oak Tree and Woodland Inventory and Evaluations, NBC Universal, Hollywood, California. Participated in the inventory, mapping, and evaluation of oak trees and oak woodland on the Universal Studios Site in Hollywood. Proposed development on the site required preparation of an EIR, and Dudek's oak woodland management plan is a technical appendix of that document. Dudek provided impact analysis along with a comprehensive mitigation program.

Oak Tree Evaluations and Arborist's Reports, City and County of Santa Barbara, California. Managed and participated in several native oak tree arborist's reports in the City and County of Santa Barbara. The projects are primarily related to single-family residence construction within an oak woodland or near oak trees. Arborist's reports that addressed existing conditions, anticipated impacts, and mitigation measures according to local policies and ordinances were prepared.

Landscape Oak Tree Health Assessments and Recommendations, Sycuan Indian Reservation, San Diego County, California. With his team, evaluated declining oak trees for their health and prognosis throughout portions of the parking lots at the Sycuan Indian Reservation's Casino. Noted that pre-construction tree protections were minimal and that has led to the current decline. Mitigation measures designed to stabilize the tree decline and improve health, where possible, were provided in an oak tree arborists report.

Native Forest Preservation and Management Plans, Rutter Development, Eastbridge Partners, and The Irvine Company, Orange County, California. Managed multiple projects, including wildland oak and other native tree inventory, mapping, and assessment; project impact analysis, mitigation, revegetation, and monitoring plan preparation; and agency coordination and interaction. Projects include Saddle Creek/Saddle Crest, Rancho Potrero Leadership Academy, and Sakaida Nursery–all located in Orange County; Canyon Crest–City of Brea; Martin Ranch–City of San Bernardino; Areas 1, 2, 3, and 4–Eastern Orange County; and Mountain Park, City of Anaheim Hills. Most of these projects include large populations of native coast live oak trees, some of which are impacted by development.

Great Oak Management Plan, Golf Course Oak Tree Relocation Assessment, Pechanga Indian Reservation, Riverside County, California. Managed and performed technical analysis of the Great Oak management plan project at the Pechanga Indian Reservation. The Great Oak is the largest coast live oak (*Quercus agrifolia*) in California. Among the findings, Noted that the tree is younger than formerly estimated, the tree is in good condition, and the proposed plans to provide increased tourist access require a set of management guidelines to minimize impacts. In addition, over 2,000 native oak trees were inventoried, mapped, and assessed for relocation potential related to the footprint of a proposed golf course. Many of the oak trees were boxed and relocated during construction of the golf course. Of note, Dudek inventoried the only native valley oak known from Riverside County, and it was preserved based on our recommendations.

Native Oak Tree Inventory and Impact Analysis, Tierra Development, Santa Clarita, California. Provided on-site evaluation of native oak trees and prepared an oak tree report according to Santa Clarita and Los Angeles County tree protection ordinances. Based on the proposed project, several of the scrub oak on site would be impacted, and as such, a mitigation program providing equivalent offset was provided within the oak tree report.

Oak Tree Protection, Via Roble Affordable Housing Site, Trinity Housing Group, Escondido, California. Identified for preservation a stately and mature oak tree that had been encroached upon by a mobile home park. The tree is the focal point of the affordable housing project in downtown Escondido. Provided tree protection measures; monitored the tree during demolition of existing, and construction of new, structures; and provided public relations presentations regarding the tree.

Oak Tree Inventory and Evaluations, Various Clients, Southern California. Performed large- and small-scale evaluations of oak trees in communities throughout Orange, San Diego, and Riverside counties. The oak trees have typically been incorporated into development landscaping, and due to horticultural issues, were not performing well. Provided maintenance specifications and tree-by-tree recommendations for improving tree health.

Oak Tree Impact and Mitigation Report, Vista Hacienda, Vista, California. Provided a complete oak tree study on the site identifying tree locations related to the proposed project footprint, potential impacts, measures to reduce or avoid impacts, and proportional mitigation for impacts. An arborist's report was prepared for the project and included as a technical appendix of the project's EIR.

Sycamore Ranch, William Lyon Homes, Fallbrook, California. Oak trees preserved by project developers were in failing health but were desired for golf course features. Provided specific recommendations for improving tree health and monitored the trees over the course of nearly two years. The trees' condition improved throughout the course of the project, and they remain important landscape features on the Sycamore Ranch Golf Course.

Lincoln Ranch, Lincoln Properties, Murrieta, California. The site for a proposed new residential development in the City of Murrieta in Riverside County had extensive mature native trees. Inventoried, assessed, and appraised a total of 260 native trees were according to International Society of Arboriculture standards. The trees' positions were digitally captured and descriptive data digitally stored with the use of Trimble Pro-XL, a global positioning and data collection system. This digital data was then electronically transferred to AutoCAD for creation of tree base maps. The trees are located in an agricultural area proposed for development. The appraised value of the 260 trees is $815,000. GPS positioning allows the project developer to design grading plans that do not disturb the valuable native tree resources on site.

Vista Valley Country Club Oak Tree Evaluation, Vista Valley Country Club, Vista, California. Provided assistance with the golf course trees as many of the feature oaks were declining. Recommendations were made to reduce tree decline rates and provide for future forest as senescent trees were lost.

Oak Tree Impact Evaluation, Hidden Meadow Golf Course, Escondido, California. Evaluated the potential impacts from a proposed project on an existing golf course. A total of 160 native oaks were within the vicinity of the project. Determined that none of the trees would experience direct impacts and that anticipated indirect impacts could be mitigated to insignificant.

Oak Tree Health Evaluation, Rainbow Propane, Rainbow, California. Evaluated 40 native oak trees and provided the project owner with a summary report. The trees ranged from good to dead with most trees falling within the poor or fair categories. Many of the trees had been impacted by wildfire or were declining due to root or trunk rot.

EIR Technical Appendices Oak Tree Report, Greystone, Calimesa, California. Prepared a tree management plan in support of a planned community development EIR in Calimesa. The site included several hundred native oak trees, some of which were within the proposed project footprint and required appropriate mitigation measures. Dudek prepared a mitigation plan that meets local and state requirements to support the project's construction.

Great Park Tree Inventory and Assessments, Former El Toro Marine Corp Air Station, Irvine, California. Participated in tree inventory and data collection for several thousand trees located on the former El Toro Marine Corp Air Station. The Station was designated the site for the Orange County Great Park and many of the mature trees throughout the base and the base housing were identified by Dudek for preservation or relocation. Dudek provided oversight and monitoring of the trees for relocation and preservation through build-out of the park.

Tree Inventory, Impact Analysis, Mitigation Plan Arborist Report, Acacia Creek, Covina, California. Provided urban forestry services pertaining to potential impacts to mature trees and native oak trees within an impact sphere of the project's planned expansion. Dudek provided specifications to project engineers and planners for measures to avoid native oak impacts through grading alterations and provided a mitigation plan acceptable to the City of Covina for anticipated tree impacts. The resulting tree management plan was included in the project's overall mitigation measures and conditions of approval.

Community Forest Management Plan, Turtle Rock Pointe Homeowners' Association, Irvine, California. Provided tree inventory, tree mapping, and a comprehensive management plan detailing necessary facets of tree population management. Among the components of the management plan were species diversity, tree maintenance, trim cycle management, pest and disease management, water management, tree removal and replacement, and infrastructure conflicts.

Sunrise Residential Project Emergency Response Analysis, Integral Communities, San Marcos, California. Managed this project and prepared an analysis of the project's location and nearest fire station response times. Modeling included use of Network Analyst in a geographic information system (GIS) platform to determine the total travel time for each project lot. The goal was to show that the lots could be responded to within the San Marcos Fire Protection District's internal response time standards.

Meadowood Emergency Response Travel Time Analysis, Pardee Homes, Fallbrook, California. Managed this GIS analysis of response travel times to all project lots using customized models and response speeds to determine how many of the project's lots are within a 5-minute travel time from the nearest stations. The project included utilizing various approaches and methods and various routes and providing a visual, GIS created graphic to illustrate results.

Community Tree Management Plan, Turtle Rock Garden Homes, Irvine, California. Provided tree inventory, tree mapping, and a comprehensive management plan detailing necessary facets of tree population management. Among the components of the management plan were species diversity, tree maintenance, trim cycle management, pest and disease management, water management, tree removal and replacement, and infrastructure conflicts.

Tree Inventory and Arborist's Report, Stewardship Foundation, Escondido, California. A proposed senior living center on a vacant, treed parcel required the inventory, mapping, impact evaluation, and mitigation plan preparation within an arborist's report. Provided a comprehensive plan to avoid high quality trees, relocate trees that were worth relocating, and remove trees that were considered of low quality or little benefit.

Whittwood Mall Beautification Project, EPT Landscape Design, Whittier, California. Evaluated several hundred mature trees for their relocation desirability. The trees comprised much of the initial mall landscaping and are now, some 40 years after planting, slated for removal as part of a mall revitalization project. Approximately 110 of the trees were identified as relocation candidates.

Arboricultural Assessment, Inventory, Impact Analysis, and Mitigation, Leo Baeck Compound, Los Angeles, California. Managed this project which included site facility expansion. Numerous mature landscape and native trees occur throughout the site and would be impacted by the expansion. Dudek's report findings concluded that tree removal was consistent with applicable regulations subject to suitable mitigation, which was defined in the project's arborist's report.

Third-Party Review of Arborist Report for proposed Home Depot Project, Fontana, California. Reviewed the arborist report prepared by another arborist and commented on inadequacies. Recommendations included the following: include greater detail on protection measures; include greater detail on replacement tree sizes and planting techniques; perform closer evaluation of preserved windrow trees due to their tendency to become less stable when adjacent trees are removed; and include greater detail on parking lot trees within the report so net mitigation is easily discernible.

Northwood 5 Tree Evaluation, The Irvine Company, Irvine, California. Project manager for this evaluation of eight eucalyptus windrows in the Northwood 5 development of Irvine and the adjacent Hicks Canyon Wash. Inspected each tree in the eight windrows and prepared recommendations for which ones should be removed because of health, structure, or hazardous conditions. In addition, provided specifications for removal, pruning, irrigation, and maintenance, and supervised the tree removal. Additional services included recommendations of techniques for tree protection during and after construction, and providing a complete eucalyptus tree maintenance plan. This project involved close cooperation with the Orange County Environmental Management Agency.

Market Place Eucalyptus Windrow Inspection, Irvine Apartment Communities, Irvine, California. Project manager for an inspection and report of the condition of a windrow of 57 blue gum trees (*Eucalyptus globulus*) that formerly had served as a windbreak for crops, but was now on a site slated for development. The developer wished to retain as many of the trees as possible. Project tasks included tree inspection, coordination with site engineers and landscape architects, report compilation, and a review of the tentative grading plan for construction impacts to the trees, along with suggestions for mitigating possible impacts.

On-Call Fire Plan Review/Third-Party Consultant, Orange County Fire Authority, California. Provides as-needed review of fuel modification plans and provides special studies regarding alternative materials and methods for the Orange County Fire Authority. To date, Dudek has provided review and comment of fire behavior modeling and proposed fuel modification and structural hardening for a large, master planned community in southern Orange County. Also involved with research and preparation of a report on the efficacy of utilizing water cannons as an alternative for full fuel modification width.

Tustin Ranch, Irvine Community Development Company, Tustin, California. Served as project manager for multiple projects spanning a 5-year period involving eucalyptus plantation and windrow trees on a large site being developed into residential and commercial development. Projects included an analysis, written report, recommendations, contract specifications, assistance in the bid selection process, and supervision/inspection of contractor work. One of the projects was analyzed for fire and hazard management on a site containing over 20,000 trees with various understory growth, including coastal sage scrub. Recommended tree removal, tree pruning, understory management, plant density, and crown heights. Additionally, identified individual trees to be preserved, delineated preservable stands and fuel modification zones, recommended an irrigation system and scheduling, and provided demolition specifications. Recommendations considered tree protection, fire prevention, grading/construction plans, viewshed, tree health, structural hazards, aesthetics, and density. Another project involved evaluation of 1,656 eucalyptus trees on a 200-acre site, including numbering/tagging each tree and recording detailed information. Removals, pruning specifications, hazard reduction, and construction techniques were recommended.

FPP Third-Party Review, Rancho Cielo Shelter-in-Place Community, Rancho Santa Fe Fire Protection District, California. Provided third-party review of an existing FPP for the Cielo community. The existing plan was outdated and required updating according to new codes and new industry findings. Dudek confirmed fire behavior modeling results and provided updated language throughout the procedural manual which is distributed to Cielo homeowners.

FPP, Bella Vista Residential Development, Encinitas Fire Department, California. Prepared an FPP providing "same practical effect" justification for reduced fuel modification width on this ridge top project in Encinitas. Sensitive biological habitat constrained the possible disturbance area. Coordinated regularly with the fire marshal, attending on-site meetings to discuss the results of fire behavior modeling and the proposed measures to offset fuel modification. The FPP was approved by the fire department and enabled construction of two additional luxury homes that would not have been possible otherwise.

Fuel Modification Zone Analysis and Fuel Management Program Development, Various Developers, Orange County, California. Managed various fuel modification plan projects for a residential development in Orange County. Field assessments of existing vegetation types and fuel loads were followed by fuel model input and scenario outputs. In addition, managed the preparation of conceptual and precise fuel modification plans meeting Orange County Fire Authority guidelines.

On-Call Fire Consulting, Laguna Beach Fire Department, California. Provides as-needed consulting to the Laguna Beach Fire Department. Among tasks requested are site fire risk assessments, vegetation hazard assessments, shelter-in-place assessments, red flag warning action plans, and fuel reduction monitoring and inspections.

West Coyote Hills FPP and Assessment, Chevron, Fullerton, California. Manages the preparation of an FPP for a 500-acre, 1,600-unit planned community in Fullerton. The project includes WUI, and based on the fire behavior assessments and analysis on the site, proposed reduced fuel modification in areas that include reduced fire intensity. The net result of the proposed fuel modification zones is a reduction in native habitat impacts with fire behavior modeling backed justifications for the reduced impacts.

Barona Oak Tree Health Assessment and Recommendations, Barona Golf Course, California. Provided assessment and recommendations for improving the declining conditions of relocated native oak trees. Tree conditions improved steadily following implementation of Dudek's recommendations. Approximately six months after the project ended, wildfire encroached onto the golf course and damaged several trees. After revisiting the trees, further specific recommendations for minimizing decline and maximizing tree life expectancy were provided.

Fuel Modification Zone Analysis and Fuel Management Program Development, Various Developers, Orange County, California. Assisted a wildland fire ecologist on several residential development projects in Orange County. Field assessments of existing vegetation types and fuel loads were followed by fuel model input and scenario outputs. Fuel management programs that justified deviations from the Orange County Fire Authority standards were provided, along with agency coordination and meeting attendance.

Onyx Ridge Residential Development, Latitude 33, Rancho Santa Fe, California. Prepared a shelter-in-place FPP for this residential development project in Rancho Santa Fe. The project included development of nine residential units on a ridgetop with one access. Mitigation measures were integrated into the FPP to compensate for the access issue. Coordinated regularly with the Rancho Santa Fe Fire Protection District and the client through project approval.

Camp Expansion FPP, Salvation Army, Ramona, California. Managed and prepared an FPP for this 600-acre project site. The Salvation Army proposes facility expansion to include several new structures, including large multi-purpose facilities. The FPP outlines several customized mitigation measures for the site to compensate for the sole access identified as a key project issue. The project included FlamMap fire behavior modeling, site assessment, code review and application, customized fuel modification zone development, structural fire protection system recommendations, and planned infrastructure summaries.

Cross Creek Residential Development, Fallbrook, California. Managed and prepared an FPP letter report, per San Diego County format, for a 10-unit residential project in the community of Fallbrook. The FPP supports the project's EIR as a technical appendix. Coordinated with the local fire protection district, the client, the consulting team, and the County of San Diego Department of Planning and Land Use Fire Services through FPP approval.

Master Planned Community FPP, Confidential, Southern California. Assembled a fire protection planning team anchored by Dudek and Hunt Research on this 26,000-acre project site in Southern California. Authored the report, integrated subconsultant input, provided presentations to fire department personnel, managed fire behavior modeling using FlamMap, and worked closely with project biologists to minimize ecological impacts while providing fire protection.

Master Planned Community FPP, Confidential Project, Southern California. Revised, updated, and re-wrote an existing FPP based on a revised project footprint and updated fire and building codes. The FPP includes documentation of all fire protection features that will be provided for this community. Key issues included road width reductions, fire response travel times, fuel modification plant palettes, and fire station construction.

Master Planned Community FPP, Confidential Project, Los Angeles County. Managed and authored an FPP for a 12,000-acre project site in Los Angeles County. The FPP provided scientific data to support recommended fire protection features, fuel modification widths, and fire station locations for this new community. The FPP was not a requirement of the local fire department but was prepared to provide a single source for the numerous fire protection related components of this large community.

Master Planned Community FPP, Yokohl Ranch, Tulare County, California. Prepared an FPP for this 36,000-acre project site near Visalia. The FPP summarizes the site's current conditions, fire history, overall risk of wildfire, anticipated fire behavior, and required and recommended fire protection features. The site includes grasslands, chaparral, oak woodlands, and mixed conifer forest fuel types.

FPP for Hotel Resort Community, Aliso Creek, Laguna Beach, California. Managed this project to prepare a comprehensive FPP for a resort community within a very high fire hazard severity zone in Laguna Beach. The FPP included justifications for reduced fuel modification zones based on environmentally sensitive habitat area constraints. The use of shelter-in-place and water cannon technology are included as alternative materials and methods for non-conformances.

Master Planned Community FPP, Merriam Mountains, NNP, Stonegate Merriam LLC, San Diego County, California. Served as the fire protection planning team coordinator, leading a 6-person team of experienced fire protection planners with over 150 years of combined experience. Re-wrote and augmented the existing FPP, provided FlamMap fire behavior modeling to represent the pre- and post-project fire behavior predictions, and assembled additional reviewers with statewide recognition who ultimately endorsed the FPP. The originally stalled FPP was approved by the county fire services section following this strategically implemented process.

Fuel Modification Plans, Restoration Area FPP, Newhall Land, Santa Clarita, California. Provided support on this project which included preparation of conceptual and precise fuel modification plans for proposed residential development. The project also included assessment of a proposed sensitive species restoration site and pre-plans for fire department response to minimize damage to the restoration area.

FPP, Residential Development, Malibu, California. Managed and provided oversight and QA/QC for two FPPs in the City of Malibu. The FPPs provided single-source technical appendices of the project's EIR where all fire protection related information was summarized. The FPPs addressed structural ignition, water availability requirements, sprinkler requirements, roads/fire access, and fuel modification.

Post-Burn Oak Tree Evaluations, Mountain Park Development Site, Anaheim, California. Participated in this study of a large development site following the Sierra Fire in Orange County. Many of the site's oak trees were damaged by the wildfire, and Dudek conducted a post-burn analysis that documented oaks that were killed, moderately damaged, and minimally damaged. Dudek provided recommendations for tree management and restoration.

Post-Burn Oak Tree Assessments, Proposed Development Project, Trabuco Canyon, Orange County, California. Conducted a post-wildfire oak tree evaluation for approximately 200 oak trees occurring within a proposed project site. The oak trees were damaged by the Trabuco wildfire and varied from completely killed to minimally scorched. Dudek provided a narrative and photographic summary of the site as well as recommendations for recovery of some of the trees and potential restoration for areas most severely damaged.

Wildfire Hazard Assessment and Community Wildfire Protection Plan, Rancho Santa Fe Association and Fairbanks Ranch, Rancho Santa Fe, California. Provided assessment and recommendations for a 100-acre area that was previously burned in the Witch wildfire. Several homes were lost, and that prompted the associations to assess the hazard and develop recommendations to reduce the hazard. Dudek conducted fire behavior modeling using FlamMap to graphically display the priority areas and provided recommendations to reduce the hazard. Dudek also prepared a community wildfire protection plan for the area that was accepted by the FireSafe Council. This plan has been submitted with a grant application for fuel reduction funding.

The Enclave at Ivanhoe Ranch Residential Project FPP, PV Ivanhoe, LLC, San Diego County, California. Managed this FPP project which evaluated and designed appropriate fire protection features for a 119-unit residential dwelling unit project in a very high fire hazard severity zone. The project included evaluation of emergency fire and medical response, defensible space, water and fire flow, fire access, evacuation, and code consistency.

Education

University Innovation District, City of Chula Vista, California. Managed and was lead author of this FPP for a university campus and supporting academic uses, student housing, a research and development park, and public infrastructure (e.g., streets and utilities) to serve the proposed project. The project included analysis of appropriate wildfire protections as well as determining appropriate emergency response configurations from nearby fire stations.

University of California, San Diego Fire Protection Planning Study, University of California, San Diego Planning Department, La Jolla, California. Prepared a Fire Protection Planning Study to support the University of California, San Diego Long Range Development Plan (LRDP) process. The study evaluated the site's fire risk, which includes a large eucalyptus forest and native chaparral and coastal sage scrub landscapes, along with laying out best practices for fire protection. As the LRDP is realized, the fire protection measures and features defined in the Fire Protection Planning Study document will be used to guide fire safety requirements.

San Diego State University Campus Housing FPP, San Diego State University, California. Managed and was primary author of this FPP for new campus housing located next to a wildland canyon. The FPP addresses the potential fire risk and delineates fuel modification zones and building requirements for ignition resistance.

Santa Barbara Botanic Garden FPP, Santa Barbara, California. Managed the preparation of an FPP for the proposed botanic garden expansion. The FPP included site-specific fire behavior modeling, analysis of the option for on-site sheltering, and addressed all fire protection features that would be provided for the site's structures. Fuel modification was customized for this site based on the site's terrain and expected fire behavior.

Santa Barbara Museum of Natural History FPP, Santa Barbara, California. Was primary author and managed this FPP for the proposed expansion of the museum of natural history. The FPP addresses the site's unique fire hazards and guides future expansion, including considerations for evacuation, restricted on-site populations during Red Flag Warning weather, and provisions for defensible space.

Bonsall Unified School District New High School Fire Protection and Evacuation Plan, Bonsall, California. Lead author, fire protection planner, and manager of this project to assist the Bonsall Unified School District with fire safe planning for a new high school within a high fire hazard severity zone. The FPP documented the fire environment, related hazards, and overall fire risk while specifying safety features and measures that would result in low overall fire risk and the ability to shelter in place if considered safer than evacuating. Provided input on the EIR's wildfire chapter, responses to comments, and overall fire- and evacuation-related planning.

Site Fire Hazard Inspections, Red Flag Warning Action Plan, and Fuel Modification Monitoring, Anneliese's School's Willowbrook Campus, Laguna Beach, California. At the request of the Laguna Beach Fire Department, was retained to provide site-wide assessment of wildfire vulnerability. The site assessment included evaluations of vegetative fuels, structural composition, fire protection systems, combustible storage on site, ignition sources, and school location. Among other facets of this project, a red flag warning action plan was devised to close school during extreme fire weather days, an emergency preparedness plan was prepared to guide evacuations during various scenarios, and a structural retrofit timeline was put in place to increase the ignition resistance of the main administration building.

Laguna College of Art and Design Emergency Response and Evacuation Plan, Laguna College of Art and Design, Laguna Beach, California. Managed and authored the Emergency Response and Evacuation Plan (EREP) for the Laguna College of Art and Design (LCADD) several campus locations within Laguna Canyon. Chapters address the top several potential natural disasters or human-caused emergencies with appropriate actions that should be taken prior to, during, and following each. The EREP helps LCADD manage and mitigate potential risk at each of its campus locations through proactive measures.

Wildfire Hazard Assessment, Camp Hi Hill, The Planning Center, Angeles National Forest, California. Managed this project assessing a Long Beach Unified School District Camp (Camp) situated amongst mixed conifer and hardwood forest in the Angeles National Forest. The Camp is used for elementary school student exposure to the forest and the unique learning opportunities it provides. Dudek conducted fuel loading analysis, fire behavior modeling using BehavePlus, structural conditions, hazard assessment, relocation/evacuation potential, and provided fuel reduction recommendations. In addition, Dudek advised the Camp on a last-resort option of sheltering in place on site with the implementation of structural hardening procedures.

Chapman University Community Forest Management Plan, Chapman University, Orange, California. Conducted tree inventory and mapping using GPS technology. Data derived from the tree inventory and interviews with maintenance staff were used to develop a comprehensive management plan. The management plan included maintenance practices, trim cycle analysis, pest and disease issues, watering, fertilizing, species diversity, and tree removal and replacement. Provided a tree management software review and analysis of the tree inventory maintenance software used by Chapman University.

Energy

East County Substation/Tule Wind/Energia Sierra Juarez Gen-Tie Projects EIR/Environmental Impact Statement, California Public Utilities Commission and Bureau of Land Management, San Diego County, California. Responsible for preparation of the EIR/Environmental Impact Statement (EIS) fire and fuels management section of the EIR/EIS for San Diego Gas & Electric's East County Substation project, which includes a 500/230/138-kilovolt (kV) substation, approximately 14 miles of new 138 kV transmission line, and a rebuild of the Boulevard Substation. In addition to addressing the new substation project, the EIR/EIS also addresses as "connected actions" a 200-megawatt (MW) wind energy project encompassing approximately 15,000 acres and a generation tie-in required for a 500/230 kV transmission line to connect an approximately 1,200 MW wind energy project in Baja California, Mexico. The Draft EIR/EIS was prepared in December 2010.

Deimer Treatment Plant Walnut Woodlands Assessment and Monitoring, Metropolitan Water District of California, Yorba Linda, California. Managed this project that evaluated a habitat mitigation project of native California black walnut tree plantings for their establishment success and monitored them over the mitigation establishment period. Dudek documented the tree conditions, overall mitigation success criteria achievement, and made recommendations for improving the growing site. Photographs were collected throughout the monitoring period from established points to document the walnut tree mitigation success.

Confidential Solar and Wind Renewable Energy Projects, various clients, San Diego County, California. Managed fire protection and evacuation planning documents for large scale renewable energy projects, including solar farms and wind energy projects. Dudek's role was to evaluate the potential for wildfires related to the projects and develop measures to protect the facilities while minimizing potential ignitions associated with the projects. Additional planning documents included Construction FPPs, Technical Fire Response Plans, and Fire Safety Plans.

Suncrest Renewable Energy Facility Fire Protection and Evacuation Plan, Construction Fire Prevention Plan and Technical Report, San Diego County, California. Managed the preparation of three fire-safety-related documents for the Suncrest Facility, focusing on protecting the facility's assets and on minimizing the potential for a fire ignition that escapes to off-site vegetation. The FPP documents the site's fire environment and details design features to protect the site and contain fire that occurs on-site.

Suncrest Renewable Energy Facility Wildfire Mitigation Plan, HorizonWest Transmission, San Diego County, California. Prepared the first Wildfire Mitigation Plan for the Suncrest facility in 2019 with significant coordination and input from HorizonWest Transmission operations and planning personnel. Updated the plan to convert to the California Public Utilities Commission (CPUC) new format in 2020. The comprehensive Wildfire Mitigation Plan documents all policies, measures, and plans that are implemented or planned to be implemented to reduce risk of vegetation fires.

Burbank Water and Power Wildfire Mitigation Plan, City of Burbank Water and Power, California. Prepared a Wildfire Mitigation Plan for the City of Burbank Water and Power that is consistent with the CPUC requirements. The Wildfire Mitigation Plan documents risk categories and the efforts that have been made or will be made to minimize the potential for vegetation ignitions.

Wildfire Mitigation Plan Third-Party Reviews, various clients, California. Provided third-party review and acted as manager for several projects where Dudek was tasked with reviewing Wildfire Mitigation Plans for municipal utilities for CPUC requirement compliance. Dudek reviewed the plans, provided recommended corrections/additions, and presented findings at public meetings.

Oak Tree Damage Assessments, Confidential Oil Field, Santa Barbara County, California. Managed the evaluation of 250 oak trees scattered throughout a large oil field in Santa Barbara County. The trees were subjected to poor pruning, branch breakage and tearing, and in some cases, whole tree removal. Trees were inventoried, mapped, and assessed for damage level and likelihood of tree recovery. Measures were provided to address issues, as possible.

Navajo Transmission Project, Western Area Power, New Mexico, Arizona, and Nevada. Performed photo-interpretation and vegetation mapping along 2,400 miles of 1-mile-wide alternative corridors for a 500 kV electrical transmission project in New Mexico, Arizona, and Nevada. Mapped special-status species (fauna) habitats and calculated wood volume for potentially impacted forest stands on Native American land along the proposed corridors.

Unnamed Electrical Transmission Line Project, Western Area Power, Kingman, Arizona. Performed rare plant surveys in western Arizona for white margined beardtongue (*Penstemon albomarginatus*) on a proposed electrical transmission line corridor near Kingman and authored a biological report with recommendations.

Fiber Optic Infrastructure Project, IXC Communications, Inc., Boulder City, Nevada to Bullhead City, Arizona. Provided environmental monitoring on a large fiber optic cable installation project in Nevada and Arizona. Primary responsibilities consisted of enforcement of environmental regulations regarding desert tortoise (*Gopherus agassizii*) and archaeological resources.

Arizona Public Service, Unnamed Pipeline Project, Oak Creek Canyon, Sedona, Arizona. Performed delineation of Waters of the United States for a pipeline project in northern Arizona. Extensive use of GPS for determining distances, creek profiles, and creek bank locations was required.

United States to Mexico Electrical Transmission Line Project, Arizona Public Service, Yuma, Arizona to San Luis Rio Colorado, Mexico. Provided environmental monitoring at a construction site in southwestern Arizona for an Arizona-to-Mexico electrical transmission line. The species of greatest concern was the endangered flat-tailed horned lizard (*Phrynosoma mcallii*).

Mead–Adelanto Electrical Transmission Line Project, Southern Nevada to Southern California. Environmental monitor (over a 2-month period) at various substation and transmission line construction sites on a major transmission line from Nevada to California. Trained staff and conducted desert tortoise monitoring, surveys, and relocation on a daily basis in fulfillment of EIR measures.

Unnamed Electrical Transmission Line Project, Arizona Public Service, Salton Sea, California. Conducted flat-tailed horned lizard surveys along potential transmission line corridors near the Salton Sea in the Imperial Valley, California.

Military

Miramar Naval Station Fire Management Plan, K2U&A Consultants, San Diego County, California. Participated in field assessments across the Miramar Naval Station and prepared multiple sections of the Fire Management Plan. The Fire Management Plan focused on fire behavior on the site, creation of mosaic fuel patterns and discussion of fire history, likely fire scenarios, and use of prescribed fire as a fuel reduction tool.

Integrated Natural Resources Management Plans, United States Air Force and United States Marine Corps, Nellis Air Force Base, Nevada and Marine Corps Air Station Miramar, California. Assisted with the preparation of integrated natural resources management plans for Nellis Air Force Base (AFB) in Nevada and Marine Corps Air Station Miramar in California.

Legislative EIS – Barry M. Goldwater Air Force Range, United States Air Force, Southern Arizona. Assisted with preparation of a Legislative EIS for Barry M. Goldwater Air Force Training Range in Arizona. Responsible for sections within three chapters and assisted with coordination and completion of the final product. In addition, performed land-use field truthing and zone mapping.

Cactus Ferruginous Pygmy Owl Surveys, Various Private Clients, Tucson and Florence, Arizona. Performed multiple Ferruginous pygmy owl (*Glaucidium brasilianum*) surveys at sites proposed for residential and commercial development. Surveys were required by local permitting agencies and typically included a detailed report summarizing each site's vegetation/habitats, survey results, and the likelihood that pygmy owls would utilize the site.

Native Fish Capture and Relocation, United States Air Force, Nellis AFB, Southern Nevada. Assisted with the capture and relocation of native fish from a man-made pond scheduled for closure and draining at Nellis AFB in southern Nevada.

Disturbed Target Site Revegetation Project, United States Air Force, Nellis AFB, Southern Nevada. Participated in native species revegetation efforts on target sites on Nellis Air Force Range in southern Nevada. Disturbed target areas that were regularly bombed by fighter jets as part of the overall mission were revegetated with native creosote and saltbush plants.

Ferruginous Pygmy Owl Surveys, United States Air Force, Barry Goldwater Air Force Range, Southern Arizona. Performed dusk and dawn surveys for Ferruginous Pygmy Owl, a crepuscular species. Surveys were conducted in every primary dry river bed on the 2-million-acre air force range. Provided major contributions to the final report summarizing the status of pygmy owls on the range.

Legislative EIS, United States Air Force, Luke AFB, Glendale, Arizona. Senior author of biological resource chapter addressing bird-aircraft strike hazards in the EIS for a golf course project on Luke AFB in Arizona.

Maternal Bat Colony Surveys, United States Air Force, Barry M. Goldwater Air Force Range, Southern Arizona. Organized and participated in abandoned mine audit and shaft surveys for maternity bat colonies on Barry M. Goldwater Air Force Range in Arizona. Species encountered included California leaf-nosed Bat (*Macrotis californicus*), Cave Myotis (*Myotis velifer*), Western Pipistrelle (*Pipistrellus hesperus*), and Pallid bat (*Antrozous pallidus*).

Multiple Species Surveys, United States Air Force, Barry M. Goldwater Air Force Range, Southern Arizona. Conducted biological surveys on large expanses of habitat on the 2-million-acre Barry M. Goldwater Air Force Range in Arizona. Surveys were designed for sensitive species, such as desert tortoise, chuckwalla (*Sauromalus ater*), Gila monster (*Heloderma suspectum*), red-backed whiptail lizard (*Aspidoscelis xanthonota*), bats, and loggerhead shrike (*Lanius ludovicianus*).

Intensive Tortoise Population Study, United States Air Force, Barry M. Goldwater Air Force Range, Southern Arizona. Served as crew chief during intensive population estimate surveys for desert tortoise on the Barry M. Goldwater Air Force Range in Arizona. Responsible for field crews, data collection and analysis, and co-authoring the final report.

Native Vegetation Impact Study, United States Air Force, Barry M. Goldwater Air Force Range, Southern Arizona. Assisted with 3-year repeat photography study on an active bombing range on the Barry M. Goldwater Air Force Range in Arizona. The project's primary goal was to document effects of Air Force activity on natural plant communities.

Native Vegetation Impact Study, United States Army National Guard, Florence Training Center, Florence, Arizona. Authored methods and results sections of an assessment on potential impacts to a military training site operated by the Army National Guard in Florence, Arizona. Coordinated field crew and compiled and reduced field data, as well as mapping vegetation types across the range.

Environmental Monitoring, United States Air Force, Nellis AFB, Nevada. Conducted environmental monitoring at Nellis Air Force Base in southern Nevada during fence construction on sensitive habitat (bearpaw poppy [*Arctomecon californica]* and desert tortoise).

Urban Forest Management Plan, United States Air Force, Luke AFB, Glendale, Arizona. Conducted extensive field inventory using GPS, analyzed data, and authored the management plan for development of an urban forest management plan (UFMP) database for Luke AFB in Arizona.

Municipal

South Orange County Wastewater Authority Coastal Treatment Plant Fire Protection Planning, South Orange County Wastewater Authority, Aliso Canyon, California. Managed and prepared this FPP that provides a summary of the Coastal Treatment Plant's wildfire risk associated with specific operations, staffing, and its WUI location. In addition, the FPP provides a summary of existing conditions and recommended measures for "enhanced" fire protection and safety based on the site's unique function, facilities, and location within a wilderness park. Among the recommended measures are strategic fuel modification, building ignition resistance retrofits, fire suppression equipment, and training

On-Call Arboricultural Services, City of San Clemente, California. Responds to numerous requests for tree evaluations and assessments throughout the City of San Clemente. Tree evaluations often include assessment of potential sidewalk removal/installation impacts and assessment of trees exhibiting declining health. Provides objective analysis and reports regarding the trees from a sound arboricultural perspective.

Fuel Modification Plan Third-Party Review, Emerald Bay Service District, Laguna Beach, California. Managed this project to review the necessary fuel modification to protect the residential and infrastructure within the Emerald Bay Service District jurisdictional boundaries. Dudek provided research, fire behavior modeling, historical fire review, and overall risk at the site and developed a recommended approach within a letter report to support the District's negotiations with California State Parks.

Community Forest Management Plan, City of Carlsbad Public Works, California. Prepared a city-wide community forest management plan for the City of Carlsbad (City). The City has inventoried some 13,000 street and median trees as part of a city-wide GIS survey system. To ensure that the tree resources are managed appropriately, a comprehensive community forest management plan was developed that includes an evaluation of the existing tree inventory, implementation of a long-term maintenance program, and a recommended tree replacement program. In addition, the plan addresses the declining Hosp Grove, a large open space area forested with dying eucalyptus. The plan includes removal of nearly 9,000 dead and dying trees and replanting with native and drought-tolerant species.

On-Call Arboricultural Services, City of Irvine, California. Responds to numerous requests for tree evaluations and assessments throughout the City of Irvine. Tree evaluations often include assessment of potential sidewalk removal/installation impacts and assessment of trees exhibiting declining health. Provides objective analysis and reports regarding the trees from a sound arboricultural perspective.

First Step to a UFMP, City Plants/City of Los Angeles, California. Managed this comprehensive analysis of the existing Los Angeles urban forest management approach, personnel, budgets, and policies. The project included extensive stakeholder outreach and coordination along with preparation of a comprehensive status document that critically evaluates how Los Angeles' urban forest and its management compare with other well-run municipal urban forests. The study sets the stage for Los Angeles to make significant changes to their current approach and provides a launching pad for the eventual creation of a complete UFMP. Dudek presented results at two large public meetings.

UFMP, National City, California. Prepared a city-wide UFMP for National City. The project included tree inventory of some 10,000 street and median trees, analysis of tree-provided benefits, assessment of the City's urban forest, its tree policies and its management approach, and preparation of the comprehensive plan. To ensure that the tree resources are managed appropriately, a comprehensive community forest management plan was developed that includes an evaluation of the existing tree inventory, implementation of a long-term maintenance program, and a recommended tree replacement program.

UFMP, City of Irvine Public Works, California. Conducted analysis of city tree populations following collection of tree attribute information for over 50,000 city-owned trees. Analysis included species diversity and distribution, trim cycle breakdown, recommended species for future planting, park tree species, changes from initial plantings, and planting opportunity identification throughout the City.

UFMP, City of Beverly Hills, California. Managing the creation of a UFMP for Beverly Hills. Primary author of the Wildfire chapter that focuses on tree-related fire risks in the city's northern reaches that are within very high fire hazard severity zones. The project is critically evaluating the city's tree management practices, policies, and regulations, and providing a comprehensive path forward to meet city and resident stakeholder goals.

UFMP, City of Downey, California. Managed the preparation of a comprehensive UFMP, including graphically portraying common concepts and strategies. The project included analysis of tree inventory information, review of tree protection policies and climate adaptation plans, public and stakeholder surveys, setting up an urban forest working group, and goal setting.

Tree Assessments and Arborist's Report for Median Curb Replacement, Barranca Parkway, City of Irvine, California. Curb replacement on both sides of a Barranca Parkway median required root disturbances for median trees, root removal, and backfill soil placement at back of curb. Evaluated the potential tree impacts, provided specifications to minimize impact, and monitored selected trees considered at highest risk. All trees were retained in place and provided special measures to reduce potential impacts.

Illegal Tree Cutting Loss Appraisal, Avenida Pico, City of San Clemente, California. Several large City of San Clemente–owned eucalyptus trees were illegally and improperly pruned for coastal views. The tree damage was valued at $36,000 by using the trunk formula method of tree appraisal, and this amount was collected by the city from the guilty party.

Street Tree Impact Assessment for Sidewalk Placement Project, MacArthur Boulevard, City of Irvine, California. Managed this project that identified impact levels associated with sidewalk construction along the parkway of MacArthur Boulevard. Nearly 300 trees were located within or directly adjacent to the proposed sidewalk. Evaluations resulted in the removal of a small percentage of the trees and the preservation and special practices provided to most of the trees. Dudek is well-equipped to assess impacts and disposition of trees adjacent to construction projects.

Tree Protection and Monitoring at Cell Tower Site, Verizon, Mission Viejo, California. Managed this project directing buried utilities placement at an existing water tank site. The site was identified for placement of cell towers, and existing mature trees were identified as a project constraint. Dudek recommended horizontal boring to span the several-hundred-yard treed area and limited trenching for daylight areas. As a result of these recommendations, the existing trees were unharmed.

University Drive Median Tree Encroachment Evaluations, City of Irvine, California. Managed this project that focused on the assessment of tree impacts from curb replacement in the University Drive medians. Back of curb trenches, equipment operation, and backfill soil were evaluated, and recommendations regarding tree preservation or removal were provided within an arborist's report.

Eucalyptus Windrow Internal Decay Study, Irvine Public Works, City of Irvine, California. Currently managing this 5-year study of internal tree decay in the City of Irvine's historic eucalyptus windrow trees. The study includes internal probing of nearly 400 trees per year and statistical analysis of results to correlate external observations with likelihood of extensive internal decay. The project will result in valuable insight regarding eucalyptus trees converted from agricultural to urban environments and their ability to cope with harsh urban environments.

Streetscape, Park, and Windrow Tree Inventory and Mapping, Public Works, City of Irvine, California. Leads this perpetual tree inventory effort to capture locations and tree attribute information for over 50,000 trees within the City of Irvine. Skilled arborists conduct tree inventory and assessment while using GPS and a customized data interface to capture tree positions.

Vegetation Management Plans Sycamore Canyon, Stoneridge, Portrero Mason, Escondido Creek Parks, San Diego County, California. Managed and participated in completion of several San Diego County Parks Vegetation Management Plans to help pre-plan for wildfires, minimize the potential for wildfires, protect natural resources and neighboring private party assets, and plan for post-fire responses. The Vegetation Management Plans help guide efficient and effective approaches to preserving park resources.

T-Street Canyon Bank Stabilization, Beaches and Parks Department, City of San Clemente, California. Provided on-site monitoring and recommendations during this 5-year project designed to meet agency-set performance goals for regeneration success. Native vegetation was removed for placement of stabilization features, including a box culvert. Revegetation occurred, and as a result of monitoring efforts and issue resolution recommendations, the project accomplished success goals earlier than anticipated.

Street Tree Inventory, Beaches and Parks Department, City of San Clemente, California. Leading the team responsible for implementing tree inventory and establishment of TreePro management software for the City of San Clemente. The team is inventorying all of the street trees within the city using GPS technology. While in the field they are mapping each tree, as well as assessing each one for health, condition, and maintenance needs. The software, which includes a mapping component tied to a database, will allow city staff to more effectively manage and budget for the city's urban forest.

Integrated Pest Management Plan, San Clemente Pier, City of San Clemente, California. Managed preparation of an integrated pest management plan for bird over-population on the San Clemente Pier. The pigeons and sea bird populations on the pier had become too high, and the resulting public nuisance and rise in maintenance costs created the nexus for this project. Dudek provided an analysis of the situation and identified several non-poisonous methods for reducing the population within existing laws and using humane approaches.

Transplanted Canary Island Pine Tree Monitoring at Santa Ana Stadium Cell Tower Site, Sprint, Santa Ana, California. Provided arboricultural monitoring for four transplanted Canary Island pine trees (*Pinus canariensis*) located directly adjacent to a cell tower at Santa Ana Stadium. Issues encountered included vandalism, inadequate watering, and poor pruning practices.

Fawnskin Tree Planting Monitoring at Cell Tower Site, Verizon Wireless, Big Bear, California. Coordinated the planting of eight native cedar trees at a cell tower site. The trees were planted to provide, over time, visual mitigation for the facility from nearby residences. Monitoring occurred for a 6-month period and issues encountered included vandalism, deer browsing, inadequate watering, and hard freezes.

WUI Code Implementation Plan, Chula Vista Building Department, Chula Vista, California. Assembled a fire protection planning team, including Hunt Research and Scott Franklin Consulting, and managed this complex project that produced a document addressing fire behavior, structural and infrastructure fire code updates, and fuel reduction/vegetation management within the Natural Community Conservation Plan Open Space Preserve areas. The City of Chula Vista Building Department sought an update of the WUI code based on the natural areas that occur throughout the City of Chula Vista. Much of the preserve is adjacent to older construction residences that were not provided adequate set-backs. Dudek worked with the City of Chula Vista building, planning, fire, recreation, and landscape architecture departments to resolve conflicts and result in a safer situation for existing and new development.

Preplan Map Conversion, Newport Beach Fire Department, California. Managed a project that involved creation of a database for "pre-planning" fire management in high-priority structures for the Newport Beach Fire Department (NBFD). This project involved the creation of digital access, layout and fire equipment maps, and associated

property data for high-priority structures, which include hospitals, schools, apartments, and other high-occupancy buildings. Important components of the maps include site and building access and egress points, utilities, ventilation, elevators, and types of construction. These maps are also linked with associated property data that includes alarm and sprinkler conditions, property owner information, inspection schedules, and special hazard conditions. In addition, the maps are geo-referenced for future incorporation into the City of Newport Beach's GIS.

Community Wildfire Protection Plans, Santa Clara County FireSafe Council, Santa Clara County, California. Project manager for preparation of community wildfire protection plans for the Santa Clara County FireSafe Council. The plans focus on two areas, the east foothills area and the Croy fire area. Responsible for interfacing with approximately 20 different fire personnel, along with community groups throughout Santa Clara County. Managed and participated in site fuel assessments, fire behavior modeling, risk assessments, and preparation of several chapters of the final plan.

Structural Preplan Project, NBFD, Newport Beach, California. Managed the digitization of hard copy pre-plan maps and the creation of electronic versions useful in on-board fire engine computers. Pre-plan information identified ingress and egress routes as well as floor-by-floor layouts and special fire-related apparatus.

Fuel Management in WUI Areas, NBFD, Newport Beach, California. Worked with NBFD to assess compliance with fuel modification zones in the WUI areas prone to wildfire. Vegetation type, spacing, and conditions were evaluated for compliance with established fuel modification zone ordinances. Oversaw database creation for use by Fire Chief and staff and managed a related project to inspect fuel modification zones annually.

Wildfire Hazard Reduction Project, Crest Canyon, City of Del Mar Fire Department, California. Managed this project for the Del Mar/Solana Beach Fire Department. The project included parcel by parcel inspection and assessment of 65 parcels within or directly adjacent to Crest Canyon. Dudek recommended fuel reduction treatments for each parcel, prepared specifications for contractor bid, and monitored contractor work for this project. Dudek also provided community education and outreach due to highly emotional ties to flammable trees and vegetation requiring removal. In all, 134 tons of fuels were treated with all but 15 tons remaining on site as chipped ground cover.

Wildfire Hazard Reduction Project, Saxony Canyon and Lake Val Sereno, City of Encinitas Fire Department, California. Dudek was contracted by the City of Encinitas Fire Department to perform a prioritization analysis and then focused fire hazard reduction projects in the city's WUI. Dudek performed lot-by-lot analysis for some 300 parcels, ran fire behavior models for each site, and prepared lot-by-lot treatment specifications. Dudek worked with in-house biologists and restoration specialists to ensure that fuel reduction work was being completed within governing regulations.

Resource Management

Stephens' Kangaroo Rat Habitat Management Plan, Riverside Habitat Conservation Authority, Riverside, California. Managed the Fire Management Plan for this project that provided overall fire management goals within each delineated Stephens' Kangaroo Rat (SKR; *Dipodomys stephensi*) management unit. The units were delineated based on existing habitat and long-term objectives for maintaining or improving habitat for SKR. Dudek researched and developed fire history analysis, vegetation type ecology and responses to wildfire fire behavior, specific response procedures for each management unit, and created response maps for responding fire department personnel.

Tree Encroachment in Meadows of Grand Canyon National Park, National Park Service, North Rim–Grand Canyon National Park, Arizona. Performed tree inventory and destructive sampling of native conifers on the north rim of Grand Canyon National Park. Extensive dendrochronology was performed to determine the age of encroaching trees and the rate of meadow loss.

Park Reforestation Project, 43 City Parks, City of Irvine, California. Utilized available electronic tree information and mapping and performed on-site evaluations to prepare a master park reforestation plan. The goal of the project was to identify parks and appropriate species that would become "signature" trees for each park. The final submittal included individual park plans with proposed planting areas, number of planting vacancies, and recommended species. This information was then used to prepare a grant funding application, and a grant was successfully obtained.

Tree Vandalism Damage Loss Value Appraisal, San Clemente Skate Park, San Clemente, California. Provided a trunk formula method appraisal of several Chinese elm (*Ulmus parvifolia*) trees located within a skate park. The trees were cut at 4 feet by an axe, leaving the moderately sized tree crowns on the ground. The trees were valued so that recovery of lost value would be possible as part of the case settlement.

Hosp Grove WUI Fire Behavior and Recommendation Study, City of Carlsbad Fire Department, California. Conducted a wildfire hazard evaluation of the Hosp Grove, an approximately 80-acre eucalyptus forest in an urban area of Carlsbad. Dudek conducted wildfire behavior modeling to model the potential for a crown fire and based on that outcome, addressed the adjacent home fuel modification requirements and provided a summary with graphical output illustrating our findings and recommendations.

Transportation

Oak Tree Restoration Site Maintenance, El Dorado Department of Transportation, El Dorado County, California. Coordinated and managed an oak tree restoration site maintenance project in El Dorado County. Dudek's subsidiary company provides labor to water the restoration trees and Dudek monitors their conditions on this multi-year project.

State Route 22 Rehabilitation Project–Tree Inventory and Management, Orange County, California. Participated in this project focusing on existing trees along the State Route (SR) 22 right-of-way (ROW). Road widening and other improvements required removal of a large quantity of trees, and Dudek provided tree mapping with GPS with recommendations for relocation and preservation possibilities. The result of Dudek's participation on this project was identification of approximately 60 trees suitable for relocation and inclusion in the post-road improvement landscape.

Highway 125 Expansion Tree Inventory and Management, County of San Diego, California. Worked with project surveyors to locate, identify, and assess trees within a proposed ROW for linear expansion of Highway 125. Approximately 700 trees were evaluated and the potential/recommendation for tree relocation for each tree was provided.

SR 76 Road Widening and Turn Lane Creation–Tree Evaluation, County of San Diego, Fallbrook/Bonsall, California. Provided assessment of five mature California sycamore trees adjacent to SR 76. A proposed widening for turn lane installation required the assessment of potential impacts. As a result of the project, three mature sycamore trees were removed and specified mitigation tree planting on a nearby mitigation area at a 3:1 ratio.

Sycamore and Oak Tree Arborist's Report, SR 241 Transportation Corridor Widening Project, Orange County, California. Conducted on-site and construction plan evaluations to determine the potential tree impacts from bridge widening on the SR 241 Transportation Corridor. Approximately 20 trees were identified as having the potential to be impacted by the project and specific measures were provided to avoid or reduce impacts.

Environmental Review, Arizona Department of Transportation, Northern Arizona. Conducted environmental field reviews for the Arizona Department of Transportation in northern Arizona. Environmental issues that could potentially affect proposed road-related projects were the primary concern.

Union Pacific, Southern Pacific Merger, Union Pacific Railroad, Various Locations throughout Arizona and New Mexico. Performed site assessments for the merger of Union Pacific and Southern Pacific railroads at construction sites in Arizona, Texas, and New Mexico, providing biological information to the project manager to be included in the final report.

Water/Wastewater

Recycled Water Pipeline Installation through Oak Woodlands, Las Virgenes Municipal Water District, Calabasas, California. Supporting Dudek's engineering and planning groups, provided tree inventory and mapping along with analysis of potential tree impacts from placement of a 24-inch underground pipeline near existing oak woodlands. Dudek's analysis resulted in pipeline placement that reduced potential impacts to 37 oak trees to insignificant and a waiver by the California Coastal Commission for further review.

Tree Threats to Buried Water Supply Pipelines Preliminary Study, San Diego County Water Authority, California. Managed a study of tree threats to buried water supply pipelines. The project included an analysis of tree biology and physiology, the subsurface environment, and pipeline or infrastructure condition. Based on these findings, Dudek's certified arborists and foresters made recommendations to the San Diego County Water Authority (Water Authority) regarding evaluation of ROW-encroaching trees as the first phase of a comprehensive tree management plan for the Water Authority's ROW. Understanding what the ROW-encroaching tree population characteristics are (i.e., total number of trees, tree sizes and ages, species presence, and distribution) is the first step to resolving the issue. Once the tree population is better defined, decisions can be made as to which trees are considered high-priority removals and which are considered to present relatively low risk.

Trunk Sewer Diversion Pipeline Project, Irvine Ranch Water District, Irvine, California. Proposed placement of a 30-inch-diameter force main and associated aboveground facilities required an assessment of the proposed project alignment for potential tree impacts. Numerous trees growing throughout the project area were evaluated for potential impact. Impacted trees were identified and mitigation recommendations were provided in an arborist's report.

Water Pipeline Eucalyptus Tree Encroachment Assessment and Construction Monitoring, Santa Ana Canyon Boulevard, Anaheim, California. Managed this project that included the trenching and placement of a 60-inch-diameter pipeline near several median eucalyptus trees. Dudek provided specifications to minimize impacts along with on-site monitoring during soil disturbing activities to ensure the trees' root systems were avoided.

Great Oak Management Plan, Pipeline 6, Metropolitan Water District of Southern California, Pechanga Indian Reservation, Riverside County, California. Evaluated the "Great Oak," the oak tree located on the Pechanga Indian Reservation commonly believed to be several hundred years old and one of the largest in the state. Advised that the tree was likely substantially younger than generally believed and provided analysis of potential impacts from a pipeline that would be constructed within the vicinity of the tree.

Oak Tree Health Assessments, Impact Analysis, and Protection for Storm Drain Improvements, Sycuan Indian Reservation, San Diego County, California. Evaluated potential impacts from site alterations necessary for storm drain improvements in a semi-natural riparian drainage. Permeable fabric and rip-rap placement near several native oak trees required specifications for tree protection. Provided on-site direction for minimizing tree impacts and submitted a specification for preservation of the trees during and following construction.

Oak Tree Encroachment and Protection for Sewer Line Expansion, Upper Chiquita Reservoir, Talega, Orange County, California. Delineated the tree protection zones for several native oak trees within the project vicinity for a proposed sewer line expansion. Where constraints negated the ability to avoid tree protection areas, Dudek prepared specifications for precise limb removals, enabling heavy equipment access within the alignment area. Dudek monitored the limb cutting so that the specifications were clearly communicated and understood and to minimize oak tree impacts.

Oak Tree Protection and Relocation Consulting, Sewer Pipeline Installation Project, Rose Canyon, City of San Diego, California. Provided consultation on methods to reduce impacts from heavy equipment necessary to trench and bury a sewer pipeline through the bottom of Rose Canyon. An additional 15 oak trees located directly within the pipeline alignment were identified for relocation to adjacent, undisturbed areas. Provided monitoring through the establishment period.

River Mountains Tunnel Project, County of Clark, Henderson, Nevada. Performed desert tortoise surveys in the River Mountains of southeastern Nevada prior to construction of a large water supply tunnel. Later served as environmental monitor to oversee activity compliance during geotechnical, seismographic, and exploratory drilling operations.

Sweetwater Reservoir Expansion, Sweetwater Authority, San Diego County, California. Authored the environmental setting section of an environmental assessment for a proposed Sweetwater Reservoir expansion in southern San Diego County.

Flood Control Basin Environmental Assessment, County of Clark, Las Vegas, Nevada. Coordinated multidisciplinary activities on an environmental assessment for a proposed detention basin in Clark County, Nevada.

Douglas Nickles, RPF

AS-NEEDED URBAN FORESTRY SPECIALIST

Douglas Nickles is a fire protection planner with more than 30 years' experience as a fire marshal, urban fire forester, open space planner, and licensed forester. Mr. Nickles specializes in preparing fire protection plans, wildland-urban interface fire management plans, evacuation plans, multi-hazard emergency response plans, and forest and natural resource management plans. He possesses considerable experience in fire and building code life safety regulations, wildland urban interface development project planning and protection, emergency preparedness, emergency response planning, and public education and information. He also serves as a Co-Chair for the So Cal Fire Prevention Officer's Wildland Urban Interface Committee. Mr. Nickles previously worked for the City of Glendale Fire Department, where he was responsible for vegetation management, wildland fire hazard mitigation, planning entitlement reviews, General Plan element updates, fire and building plan check, fire and life safety building inspections, fire code enforcement, hazardous materials program management, and industrial wastewater program management. He also has six years of forestry experience working for a forest and land management consulting firm in Northern California.

Education

California Lutheran University
MBA, Business Administration

Humboldt State University
BS, Forestry (Fire Management concentration)

Certifications

Registered Professional Forester (RPF), No. 2135

Wildland Fire Behavior Certificate, County of Los Angeles Fire Department

Archeology Certificate, CAL FIRE

Incident Information Officer Certificate, CAL FIRE

Professional Affiliations

SoCal Fire Prevention Officers Association

Relevant Previous Experience

Glendale Fire Department, Glendale, California. Served as assistant fire marshal**.** Administered all personnel and programs undertaken by the Fire Prevention Bureau including Vegetation Management, Hazardous Materials, Household Hazardous Waste Collection, Used Oil Collection, Industrial Waste Water, Fire and Life Safety inspections, Plan Review and New Construction inspection. The Bureau operates with four interrelated units: Administration, Development Services, Environmental Programs, and Special Projects/Prevention Programs. Overall administrative functions include personnel management, training and career development, organizational planning and development, intra- and interdepartmental coordination, code enforcement, records management, revenue and budget management, code adoption, and development of policies and procedures. (2017–2019)

Glendale Fire Department, Glendale, California. Served as fire prevention coordinator. Managed the Programmatic Inspection Unit with oversight responsibility for multiple programs. Oversee all inspection and regulatory operations and professional staff. Oversee annual fire and life safety inspection program for state mandated and permitted facilities. Make recommendations for enforcement of fire and life safety requirements. Prepare reports regarding code violations; issue violation notices; initiate enforcement as necessary. Direct all regulatory activities, inspections and reporting for the City's Certified Unified Program Agency (CUPA) and related hazardous materials management programs. Meet regularly with regional and state agencies to discuss and coordinate regulatory and enforcement activities. Oversee the Industrial Wastewater Inspection Program; coordinate with the City of Los Angeles. Oversee the Household Hazardous Waste Collection and Used Oil Curbside Collection Programs. Oversee the Vegetation Management Program. (2014–2017)

Glendale Fire Department, Glendale, California. Served as fire prevention coordinator. Managed the Fire Engineering Unit. Oversaw all plan check operations and professional staff. Evaluate and analyze plans, structures and processes to ensure adequate fire protection and conformance with federal, state and local fire safety laws and regulations. Planning entitlement reviews including Conditional Use Permits, CEQA and Environmental Impact Reports. Interpret fire and life safety laws and regulations and provide technical advice and assistance to the general public and other City departments, architects, contractors, engineers, builders, and owners. Assist with code adoption and enforcement activities. Assist with preparation and updating of General Plan Elements including Safety, Conservation and Open Space, and Recreation Elements. Oversee the Vegetation Management Program. (2004–2014)

City of Glendale Fire Department, Glendale, California. Served as urban fire forester. Managed the Vegetation Management Program. Responsibilities included start-up and development of the Vegetation Management Program including administration, inspection procedures and guidelines, preparation of program operations manual, development of policies and procedures, contract management and administration, and department-wide training program. Grant application, administration and implementation for City projects. Coordinated establishment of a Firewise Community in Glendale, one of the first seven in the nation. Managed the Fire Prevention Public Education and Public Information programs. (1991–2004)

City of Thousand Oaks, Thousand Oaks, California. Served as associate planner for the open space Joint Powers Authority between the City and Conejo Recreation and Park District. Responsibilities included daily administration of the agency and coordinating administrative support for public meetings. Established and served as support staff for the citizen advisory committee. (1988–1991)

Envicom Corporation/PHR Environmental, Calabasas, California. Served as environmental planner/analyst. Prepared environmental impact reports and conducted research, site inspection, development plan preparation, and preparation of due diligence reports for major development projects throughout Southern California. (1988)

HJW and Associates, Oakland, California. Served as forester, providing forest/natural resource management and timber harvesting consulting and contract administration services throughout Northern California. (1987-1988)

Interface Management Services, Thousand Oaks, California. As owner, consults part time in resource management, land use planning, fire prevention, fire protection plan preparation, wildland fire safety, vegetation management, oak woodland management, and urban forestry, with an emphasis in wildland-urban interface settings throughout Southern California. (1985–Present)

W.M. Beaty and Associates, Redding, California. Served as assistant district forester. Consulted in natural resource and forest management including timber harvesting, wildland fire protection, plantation management, and forest management plans throughout Northern California. (1979–1984)

California Department of Forestry and Fire Protection. Served as forestry aide, assigned to Latour Demonstration State Forest in Shasta County assisting with forestry and natural resource management activities. (1979)

California Department of Forestry and Fire Protection. Served as firefighter, assigned to Susanville in Lassen County in 1977, and Fortuna in Humboldt County in 1978. (1977–1978)

Publications

Nickles, Douglas V, (2001) The Urban-Wildland Interface Ecosystem: Integration of Fire and Resource Management. *Proceedings of the California's 2001 Wildfire Conference: 10 Years After the 1991 East Bay Hills Fire*. UC Forest Products Lab.

Nickles, Douglas V, (1997) Urban/Wildland Interface Management: A Coordinated Approach to Fire Safety. *Fire Safe Communities Regional Workshop*. California Urban Forest Council.

Nickles, Douglas V, (1997) Monitoring Survival and Vigor of Specimen Valley Oaks Influenced by Urban Development Sites. *Proceedings of a Symposium on Oak Woodlands: Ecology, Management and Urban Interface Issues*. General Technical Report. PSW-GTR-160. (peer reviewed)

Nickles, Douglas V, (1994) Hillside Development, Open Space and Hazardous Vegetation: A Coordinated Vegetation Management Approach to Urban Interface Fire Safety. *15th Forest Vegetation Management Conference*.

Conference Presentations

"Drought and Fire." Chevy Chase Canyon Property Owner's Association, Glendale, California, November 2014.

"Fire Prevention and Tree Protection in the Urban Wildland Interface." Southern California Fire Prevention Officers, Chino, California, May 2012.

"Fire Safety Requirements in the Wildland Urban Interface: The Inspector's Role: Enforcing the requirements of CBC Ch. 7A and CRC Sec. R327." Southern California Fire Prevention Officers, Camarillo, California, November 2012.

"Designing Firewise Friendly Landscape Ordinances: Regulating Ornamental Landscaping and Vegetation Management in an Urban Setting." National Wildland Urban Interface Conference, Denver, CO, November 2009.

"Coordinating Fire Hazard Reduction with Local Municipalities: Roadside and Public Open Space." Western Chapter International Society of Arboriculture, Arcadia, California, September 2009.

"Fire Prevention and Tree Protection." California Urban Forest Council Annual Conference, Long Beach, California, August 2008.

"Oaks and Fire in Yosemite Lakes Park: Living in the Front Woods." Yosemite Lakes Springs Property Owner's Association, Coarsegold, California, November 2007.

"Vegetation Management and Fires: Managing the Urban Forest." Public Applicators Training Program, Arcadia, California, May 2004.

"The Urban-Wildland Interface Ecosystem: Integration of Fire and Resource Management." Society of American Foresters Annual Convention, Washington, D.C., November 2001.

Specialized Training

- Leadership Academy, Society of American Foresters
- California Fire Prevention Institute Annual Conference (multiple), California Chiefs Fire Prevention Officers
- Fire Service Supervision (Q-318), National Fire Academy
- Incident Information Officer (I-403)
- Hydraulics for Fire Protection
- Sprinkler Plan Review and Inspection
- Wildland Firefighting, Lassen College

- Wildland Fire Suppression Tactics (S-336)
- Division/Group Supervisor (S-339)
- Wildland Fire Behavior (S-190)
- Intermediate Wildland Fire Behavior (S-290)
- Introduction to Wildland Fire Behavior Calculations (S-390)

Awards

Fellow Award, Society of American Foresters (2008), recognizing individuals for long standing service to forestry at the local, state, and national level.

Presidential Field Forester Award, Society of American Foresters (2003), recognizing individuals who have displayed uncommon talent, skill, and innovative methods to achieve a record of excellence.

Matthew Crockett

WILDFIRE PLANNING ANALYST

Matthew Crockett is a wildfire planning analyst with 3 years' cumulative experience in the natural resources management field, with expertise in forest science and community wildfire planning. Mr. Crockett's relevant work experiences include authoring community wildfire protection plans (CWPPs) and Fire Protection Plans (FPPs), conducting private forestry work, and advocating for environmental policy at the State Capital. His technical skills include geographic information system (GIS) analysis, fire behavior modelling, post-fire risk assessment, and carbon accounting. Mr. Crockett previously worked for the San Luis Obispo Fire Safe Council as a project manager for community wildfire risk reduction projects.

Education

California Polytechnic State University San Luis Obispo MS, Environmental Sciences and Management, 2022

California Polytechnic State University San Luis Obispo BS, Environmental Management and Protection, 2022

Professional Affiliations

Association of Environmental Professionals (AEP)

Society of American Foresters (SAF)

Dudek Project Experience

Los Angeles County Integrated Wildfire Safety Program, County of Los Angeles Department of Regional Planning, Los Angeles, California. Served as a supporting analyst and identified communities and critical infrastructure at risk from wildfire throughout Los Angeles County based on integrated wildfire hazard modelling.

Whitewood Condo/Apartment FPP, Melissa Krause, Murietta, California. Served as a supporting analyst and prepared the FPP for a residential development project. The FPP identified wildfire risk and identified fire protection measures that addressed structural hardening and fuels modification.

Relevant Previous Experience

City of Pismo Beach CWPP, City of Pismo Beach Fire Department (CAL FIRE), Pismo Beach, California. Lead author of a CWPP on behalf of the City of Pismo Beach Fire Department. The project involved conducting wildfire behavior modelling to identify assets at risk. Biophysical and sociopolitical mitigation measures were recommended to reduce risks to communities and other assets.

Avila Beach CWPP, City of Pismo Beach Fire Department (CAL FIRE), Pismo Beach, California. Co-author of a CWPP on behalf of the City of Pismo Beach Fire Department. Emphasized identifying ways to improve emergency evacuations from the Avila Beach area.

Project Manager, San Luis Obispo County Fire Safe Council, San Luis Obispo, California. Collaborated directly with community members and fire agencies to identify assets at risk from wildfire and priority mitigation practices to improve wildfire resilience in San Luis Obispo County.

Greenhouse Gas Emissions Analyst, CAL FIRE, San Luis Obispo, California. Quantified how state-sponsored fuels reduction projects impact greenhouse gas emissions and carbon sequestration utilizing tools such as Forest Vegetation Simulator (FVS), FlamMap, and IFTDSS.

Forestry Technician, Sierra Pacific Industries, Camino, California. Conducted field work, including timber harvest layout, wildlife surveys, and forest inventory. Other roles included assisting with Timber Harvest Plan documentation and performing fire suppression activities during the Caldor Fire.

Publications

Crockett, M. 2022. "*Post-Fire Erosion Following the CZU Lightning Complex Fire: Quantifying Hillslope Erosion and Providing Guidance Towards Improving Post-Fire Response.*" Graduate Project; California Polytechnic State University, San Luis Obispo.

Awards

Dave A. Bichsel Memorial Scholarship, California Forestry Association & California Forest Foundation, 2020. Awarded for demonstrating a zest for forestry and desire and experience relating to active forest management.

Sierra Pacific Industries Intern Scholarship, Sierra Pacific Industries, 2021. Awarded in response to my performance as an intern and academic credentials.

San Luis Obispo County Fire Safe Council Scholarship, San Luis Obispo Fire Safe Council, 2022. Awarded to acknowledge previous work and a future desire to continue working in the wildfire planning sector.

CHRISTOPHER A. DICUS, Ph.D.

Professor, Wildland Fire & Fuels Management
California Polytechnic State University
San Luis Obispo, California, U.S.A.

EDUCATION

Louisiana State University: Doctor of Philosophy, Forestry [Silviculture emphasis]
Utah State University: Master of Science, Forestry [Fire Ecology emphasis]
Louisiana Tech University: Bachelor of Science (*Summa cum laude)*, Forestry-Wildlife

PROFESSIONAL EXPERIENCE

Professor, Wildland Fire & Fuels Management – Natural Resources Mgmt. & Environmental Sciences Dept., California Polytechnic State University, San Luis Obispo, CA, September 2001-2013; September 2016-present.

- **Pertinent Courses Taught**
  - **NR-204: Wildland Fire Control**
  - **NR-305: Forest Ecology**
  - **NR-307: Fire Ecology**
  - **NR-308: Fire & Society**
  - **NR-312: Technology of Wildland Fire Management**
  - **NR-340: Wildland Fire Management**
  - **NR-365: Silviculture**
  - **NR-455: Wildland-Urban Interface Fire Protection**
  - **UNIV-339: Disaster Resistant Sustainable Communities**

Interim Associate Dean, Research & Graduate Programs – College of Agriculture, Food & Environmental Sciences**,** California Polytechnic State University, San Luis Obispo, CA, September 2015-August 2016.

Faculty Fellow to the Provost – Office of the Provost & Executive Vice President for Academic Affairs, California Polytechnic State University, San Luis Obispo, CA, Sept. 2013-September 2015.

AWARDS & HONORS

- Lead author on manuscript listed as 1 of 13 "Best Papers 2005-2015", *Fire Ecology* journal (2015)
- College of Agriculture, Food & Environmental Sciences Outstanding Researcher Award (2011)
- Distinguished Alumnus of the Year, Louisiana Tech University School of Forestry (2006)
- Phi Beta Delta Honor Society for International Scholars
- Phi Kappa Phi Honor Society

PROFESSIONAL LEADERSHIP

- **Association for Fire Ecology** (an international scientific society)
  - President (2018-2021)**;** Board of Directors (2006-2021)
- **California Fire Science Consortium**
  - Coordinator, Wildland-urban Interface Module (2011-present)
- **San Luis Obispo County FireSafe Council**
  - Board of Directors (2002-present)
- **Wildland-Urban Interface F.I.R.E. Institute**
  - Principle Investigator (2020-present)
- **Society of American Foresters**
  - Chair, Los Padres Chapter (2003-2010)

LITIGATION CASE HISTORY

Expert Witness in Litigation (by date of initial engagement)

- 2022: Rancho de Dias Alegres LLC, S-M Timber Farm 2, L.C., Aks 15, L.C., and AKS Ranch-15 Limited Partnership v. United States, for plaintiff
- 2021: Village Communities, LLC v. County of San Diego, for plaintiff
- 2021: Porter v. Debenedetto, for defendant
- 2020: [Insurers] v. Calpine Corporation, for defendant
- 2019: GSN Capital, LLC and Dave Zortman v. Shoshone City & Rural Fire District, for defendant
- 2019: Douglas et al. v. McCutchan et al., for plaintiff
- 2018: Alberta Motor Association Insurance Company v. Everest Reinsurance Company, for defendant
- 2018: [Insurers] v. Boeing Corporation, for defendant
- 2018: New Mexico Pension Fund v. PG&E, for plaintiff
- 2017: Ruffino v. United States, for defendant
- 2013: [Insurers] v. Asplundh Tree Expert Company, for defendant
- 2012: Aspen Insurance UK Limited v. Swiss RE Europe SA (UK branch), for defendant
- 2011: [Residents] v. Victoria (Australia) Department of Sustainability & Environment, for defendant

Technical Reports Submitted for Litigation

- **Dicus, C.A.** 2021. Wildfire hazard & risk at the proposed Lilac Hills Ranch, San Diego County, California. Technical report submitted to the United States District Court, Southern District of California.
- **Dicus, C.A.** 2021. Rebuttal to expert report of Chief Tony Mecham. Technical report submitted to the United States District Court, Southern District of California.
- **Dicus, C.A.** 2019. Fire Spread and structural loss during the 2016 Fort McMurray Wildfire. Technical report submitted to Court of Queen's Bench of Alberta (Canada).
- **Dicus, C.A.** 2019. Fire Spread and Loss During the 2017 Lagoon Fire, Shoshone, Idaho. Technical report submitted to the District Court of the Fifth Judicial District of the State of Idaho.
- **Dicus, C.A.** 2019. Potential fire risk posed by eucalyptus trees bordering 1950 Alexander Valley Road, Healdsburg, California. Technical report submitted to the Superior Court of California, County of Sonoma.
- **Dicus, C.A.** 2018. Implementation of pile and burn treatments to reduce wildfire risk near South Lake Tahoe, California. Technical report submitted to the U.S. Department of Justice.
- **Dicus, C.A.** 2012. Effects of fuel loading and building construction on the risk of bushfire loss to private property. Technical Report submitted to the Supreme Court of Victoria, Australia. 66p.

Testimony in Deposition/Court Proceedings

- 2022: Village Communities, LLC v. County of San Diego (California)
  - Re: Fire risk and mitigation in a proposed residential/commercial development
- 2021: GSN Capital, LLC and Dave Zortman v. Shoshone City & Rural Fire District (Idaho)
  - Re: Fire spread/behavior and timing of fire losses
- 2021: Porter v. Debenedetto (California)
  - Re: Combustion of pile burns
- 2019: Alberta Motor Association Insurance Company v. Everest Reinsurance Company (Alberta, Canada)
  - Re: Fire spread/behavior and timing of losses
- 2013: [Insurers] v. Asplundh Tree Expert Company (Texas)
  - Re: Fire spread/behavior and timing of losses

OTHER CONSULTING ENGAGEMENTS

Technical Reports Submitted to Clients/Government Entities

- **Dicus, C.A.** 2021. Review & Assessment: Risk of wildfire losses at Harmony Grove Village South. Technical report submitted to client.
- **Dicus, C.A.** 2020. Categorizing surface fuel models in Marin County, California. Technical report submitted to Marin County Fire Department.
- **Dicus, C.A.** 2020. Potential wildfire behavior & effects at Yellow Pine Solar Project: Comparison of two vegetation management options. Technical report submitted to US Bureau of Land Management.
- **Dicus, C.A.** 2020. Review & Assessment: Newland Sierra Fire Protection Plan. Technical report submitted to client.
- **Dicus, C.A.**, 2019. Lilac Hills Ranch Wildfire Risk Assessment. Technical report submitted to client.
- California Governor's Office of Emergency Services. 2018. State of California Multi-Hazard Mitigation Plan. (**C.A. Dicus** responsible for Chapter 8, Fire Hazards: Risks and Mitigation).
- **Dicus, C.A.** 2017. Potential impacts to coast live oak stands following defensible space at 3300 Kanan Dume Road. Technical report submitted to Los Angeles County Department of Regional Planning.
- **Dicus, C.A.** 2017. Rebuttal to Staff Comments: Potential impacts to coast live oak stands following defensible space at 3300 Kanan Dume Road. Technical report submitted to Los Angeles County Department of Regional Planning.
- 2016. Conn, W.D., C.K. Nuworsoo, **C.A. Dicus**, K.C. Topping, and D. Tuner. Single Access Subdivisions Assessment Project: Developing a planning tool for evaluating proposed developments accessible by dead end roads. Technical report submitted to Cal Fire and the California Board of Forestry & Fire Protection.
- California Emergency Management Agency. 2012. California Adaptation Planning Guide: Planning for Adaptive Communities. 60pp. (**C.A. Dicus** responsible for portions involving wildfire)
- California Emergency Management Agency. 2012. California Adaptation Planning Guide: Defining Local & Regional Impacts. 94pp. (**C.A. Dicus** responsible for portions involving wildfire)
- California Emergency Management Agency. 2012. California Adaptation Planning Guide: Understanding Regional Characteristics. 114 pp. (**C.A. Dicus** responsible for portions involving wildfire)
- California Emergency Management Agency. 2012. California Adaptation Planning Guide: Identifying Adaptation Strategies. 68 pp. (**C.A. Dicus** responsible for portions involving wildfire)
- **Dicus, C.A.** 2011. Fire Hazard & Mitigation for Stadium Park, Atascadero, California. Technical Report submitted to the City of Atascadero. 73p.
- California Emergency Management Agency. 2010. State of California Multi-Hazard Mitigation Plan. (**C.A. Dicus** responsible for Chapter 5.4, Wildfire Hazards, Vulnerability and Risk Assessment).

Testimony before Government Entities

- 2020: San Diego County Planning Commission
- 2018: Los Angeles County Department of Regional Planning
- 2017: Los Angeles County Department of Regional Planning
- 2016: California Board of Forestry & Fire Protection
- 2011: Atascadero (California) City Council
- 2005: California Board of Forestry & Fire Protection

SCIENTIFIC ENGAGEMENTS

Scientific Manuscripts (since 2009)

- **Dicus, C.A.** 2021. AFE, IAWF share common goals for diversity, education, cooperation. Wildfire Magazine.
- **Dicus, C.A.**, and K. Osborne. 2015. How fuel treatment types, locations, and amounts impact landscape-scale fire behavior and carbon dynamics in the Klamath Mountains. Pgs. 50-59 *In* Keane, Robert E.; Jolly, Matt; Parsons, Russell; Riley, Karin. 2015. Proceedings of the large wildland fires conference; May 19-23, 2014; Missoula, MT. Proc. RMRS-P-73. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 345 p.
- **Dicus, C.A.**, and K. Jacobson. 2014. Fine fuel dynamics following selection-harvest in Sequoia sempervirens. Pgs. 323-321 *In* Wade DD & Fox RL (Eds.), Robinson ML (Comp) (2014) 'Proceedings of 4th Fire Behavior and Fuels Conference', 1-4 July 2013, St. Petersburg, Russia.
- **Dicus, C.A.**, N.C. Leyshon, and D. Sapsis. 2014. Temporal changes to fire risk in disparate WUI communities in southern California, USA. Pgs. 969-978 *In* Viegas, D.X (Ed.). Advances in Forest Fire Research. University of Coimbra Press. ISBN 978-989-26-0884-6.
- **Dicus, C.A.**, T. Korman, C. Grant, D. Madrzykowski, F. Mowrer, C. Pascual, and D. Turner. 2013. Investigating the capabilities and limitations of compressed air foam systems for structural firefighting. Fire Engineering 166(7):65-69.
- **Dicus, C.A.** 2013. The burning question: Why is fire season becoming worse? California Forests Quarterly 2:2-3.
- Osborne, K., **C.A. Dicus**, C. Isbell, A. Ager, D. Weise, and M. Landram. 2011. Effect of landscape-level fuel treatments on carbon emissions and storage over a 50 yr time cycle. In Wade, D.D.; Robinson, M.L. (eds) Proceedings of the 3rd Fire Behavior and Fuel Conference, Oct. 25-29,2010, Spokane, Washington, USA. International Association of Wildland Fire, Birmingham, Alabama, USA. 5 p.
- **Dicus, C.A.** 2009. Changes to simulated fire behavior and societal benefits after two levels of thinning in a mixed-conifer wildland-urban interface community. Proceedings of the Royal Society of Queensland 115:37-44.
- **Dicus, C.A.** 2009. Fire on the landscape: Current policies and changing climate lead to higher costs, more severe wildfire. California Forests 13(2):16-17.
- **Dicus, C.A.**, K. Delfino, and D.R. Weise. 2009. Predicted fire behavior and societal benefits in three eastern Sierra Nevada vegetation communities. Fire Ecology 5(1):61-58.
- Kobziar, L., M. Rocca, **C.A. Dicus**, P. Morgan, N. Sugihara, A. Thode, and M. Varner. 2009. Challenges to educating the next generation of wildland fire professionals in the United States. Journal of Forestry 107(7):339-345.

Scientific Presentations

150+ oral presentations and 20+ posters presented at international, national, regional, and local conferences. Invited talks include oral presentations in 10 foreign countries, including Australia (×5), Portugal, France (x2), Italy, Finland, Russia, China, Japan, Thailand, and El Salvador. Selected oral presentations follow (others available upon request).

- **Dicus, C.A.**, R.D. Uribe, R.A. White, and S.R. Rein. 2022. Factors impacting home loss during a wind-driven wildfire in a Mediterranean ecosystem. Fire Across Boundaries: Connecting Science & Management Conference. Florence, Italy October 4-7.

- **Dicus, C.A.**, A. Meeder, and T. O'Rourke. 2022. Impacts to greenhouse gas emissions following fuel treatments in California Forests. International Fire Behavior & Fuels Conference. Pasadena, California, May 23-27.
- **Dicus, C.A.** 2022. Groundbreaking approaches for WUI fire mitigation in California. Wildfire Management Summit 2022 (Institute for Defense & Government Advancement). San Francisco, CA, April 25-26.
- **Dicus, C.A.** 2021. "Electrical utilities and wildfire in California". Foundations for Improving Resilience in the Energy Sector Against Wildfire on Alaskan Lands (FIREWALL). Virtual webinar and expert panel, September 15.
- **Dicus, C.A.** 2020. "Do I stay or do I go??? Shelter in Place vs. Evacuation". National Preparedness Month Webinars, Part 2: Wildfire Preparedness. Virtual webinar and expert panel, September 9.
- **Dicus, C.A.** 2019. Keynote Address – "California Ablaze: Is this (all of our) New Normal?" International Fire Behavior & Fuels Conference. Marseille, France, April 29-May 3.
- **Dicus, C.A.** 2018. Keynote Address – "The California Fire Experience: The good, the bad, and the downright tragic". Australian Bushfire Building Conference and Community Forum. Leura, Australia, September 6-7.
- **Dicus, C.A.** 2017. "On how to prevent and protect against wildfires". Tai'an, China, September 7-9.
- Dicus, C.A. 2017. "A global perspective on the ecology & management of wildfires". International Week, *Seinäjoki* University of Applied Sciences, *Seinäjoki, Finland, February 13-17.*
- **Dicus, C.A.**, N.C. Leyshon, and D. Sapsis. 2016. "Assessing WUI fire risk: A spatial analysis". International Fire Behavior & Fuels Conference, Melbourne, Australia, April 11-15.
- Dicus, C.A., N.C. Leyshon, and D.B. Sapsis. 2014. "Temporal changes to fire risk in disparate WUI communities in southern California, USA". International Conference on Forest Fire Research. Coimbra, Portugal, November 14-18.

Mass Media Presentations

Presentations and interviews in video, TV, radio, and print formats. Selected presentations follow (others available upon request).

- Examples of video presentations
  - 2021: Loopsider English (France). Wildfires are spiraling out of proportion in the US. Available at https://www.facebook.com/watch/?v=186618086851028&ref=sharing.
  - 2020: Seeker Media and Nissan. Watch how scientists in California are using prescribed burns to prevent more disastrous wildfires. Available at https://www.facebook.com/SeekerMedia/videos/250434539461491/UzpfSTcwMDA4MDE2MDozMDYwNjExMjk0OTk0MTQ6MTA6MDoxNTg4MzE2Mzk5Oi03MDg2Njc1MjI0NDIyMjY4OTAz/.
  - 2019: The New Yorker. Building for resilience in California's fire-prone future. Available at https://www.newyorker.com/culture/culture-desk/building-for-resilience-in-californias-fire-prone-future.

- Examples of media outlets in which I've been featured (others available upon request)
  - TV
    - BBC (United Kingdom)
    - FOX Weather (USA)
    - KABC (Sacramento)
    - Fox 11 (Los Angeles)
    - TRT World (Turkey)
    - RT America (Russia)
  - Radio
    - NPR Weekend Edition (Washington, D.C.)
    - KNX (Los Angeles)
    - KABC (San Francisco)
    - KABC (Australia)
    - Global News Canada
  - Print
    - Time Magazine
    - USA Today
    - New York Times
    - Los Angeles Times
    - The Hill
    - National Geographic

OTHER SIGNIFICANT PROFESSIONAL ACCOMPLISHMENTS:

- **Certified Senior Fire Ecologist**

- **California Registered Professional Forester**

- **Steering/Program Committee:**
  - 2022: Association for Fire Ecology/Pau Costa Wildland Fire Conference; Florence, Italy
  - 2021: Ninth International Fire Ecology & Management Congress; Virtual
  - 2020: Association for Fire Ecology/Pau Costa Foundation Webinar Series; Virtual
  - 2019: Eighth International Fire Ecology & Management Congress, Tucson, Arizona
  - 2018: The Fire Continuum Conference: Preparing for the Future of Wildland Fire. Missoula, Montana
  - 2010 Australia – United States Joint Research Symposium: Fire in the Interface; Melbourne & Canberra, Australia

- **Fire Behavior Technical Specialist** on major wildland fires
  - 2009 La Brea Fire (89,489 acres)
  - 2007 Zaca Fire (240,207 acres)
  - 2006 Day Fire (162,700 acres)
  - 2004 Gaviota Fire (7,440 acres)

- **Federal Training Courses**
  - S-490: Advanced Fire Behavior
  - S-493: FARSITE (which is a GIS-based fire behavior modeling course)
  - S-125: Fire Operations in the Wildland Urban Interface
  - Forest Vegetation Simulator (which focused on the Fire and Fuels Extension)

- **Honorary Research Associate**
  - Univ. of Tasmania School of Geography & Environmental Studies (Australia) – March-June 2009

Appendix B

Photographs of the site and surrounding area

N

0 5,000 10,000 20,000 Feet


Photo 1


Photo 2


Photo 3


Photo 4


Photo 5


Photo 6

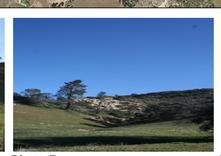
Photo 7


Photo 8


Photo 9

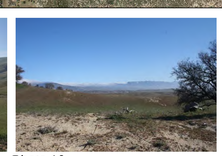
Photo 10


Photo 11

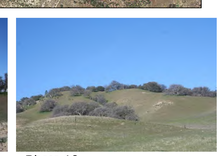
Photo 12


Photo 13


Photo 14


Photo 15


Photo 16


Photo 17


Photo 18


Photo 19


Photo 20


Photo 21


Photo 22


Photo 23


Photo 24


Photo 25


Photo 26


Photo 27


Photo 28


Photo 29


Photo 30


Photo 31


Photo 32


Photo 33


Photo 34


Photo 35


Photo 36


Photo 37


Photo 38


Photo 39


Photo 40

Photo 41

Photo 42

Photo 43

Photo 44

Photo 45

Photo 46

Photo 47

Photo 48

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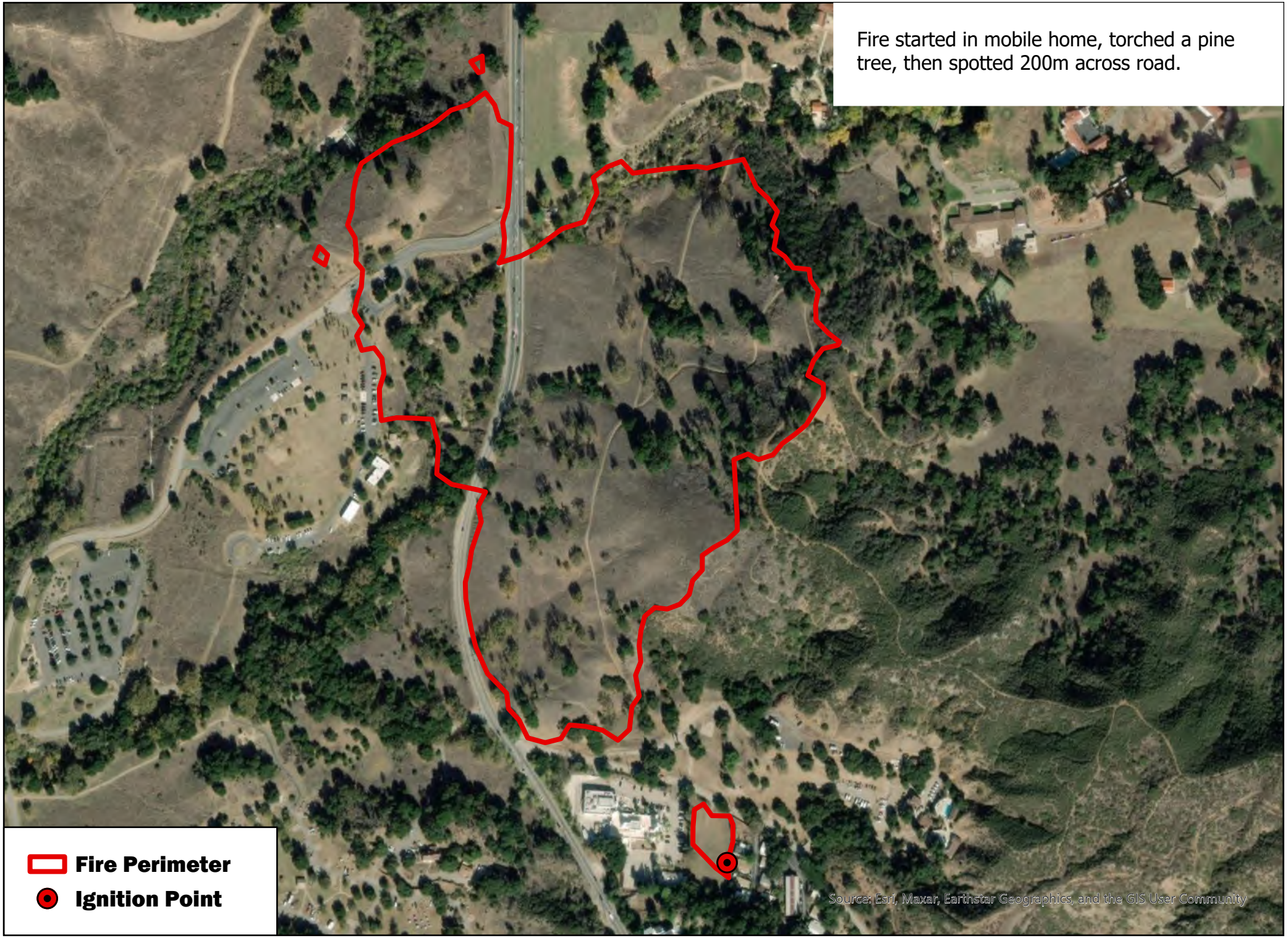
Appendix C

Historic Wildfires Caused by Structure Fires



DUDEK

Source: CAL FIRE FRAP, 2022

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Source: CAL FIRE FRAP, 2022

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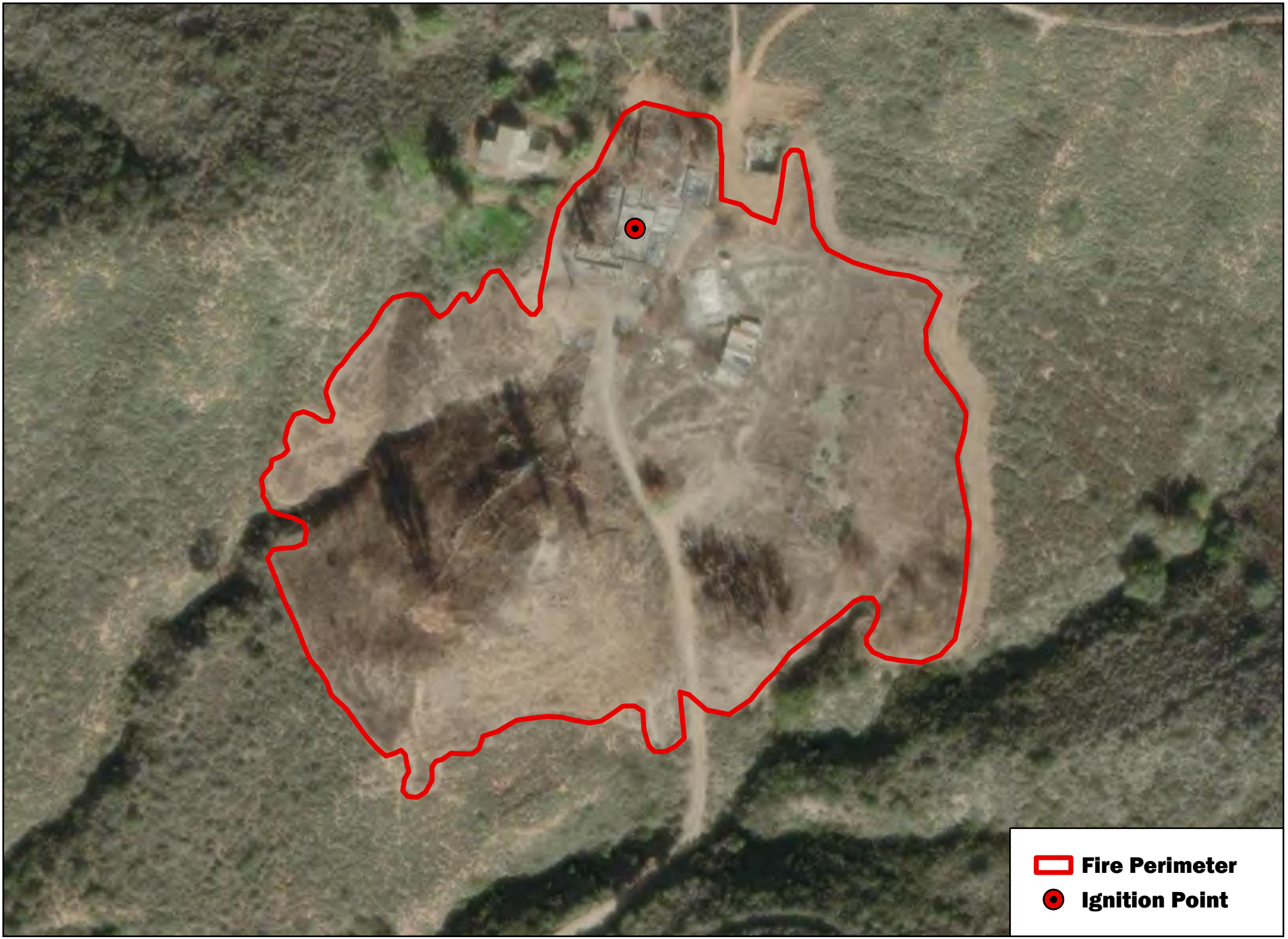
Source: CAL FIRE FRAP, 2022



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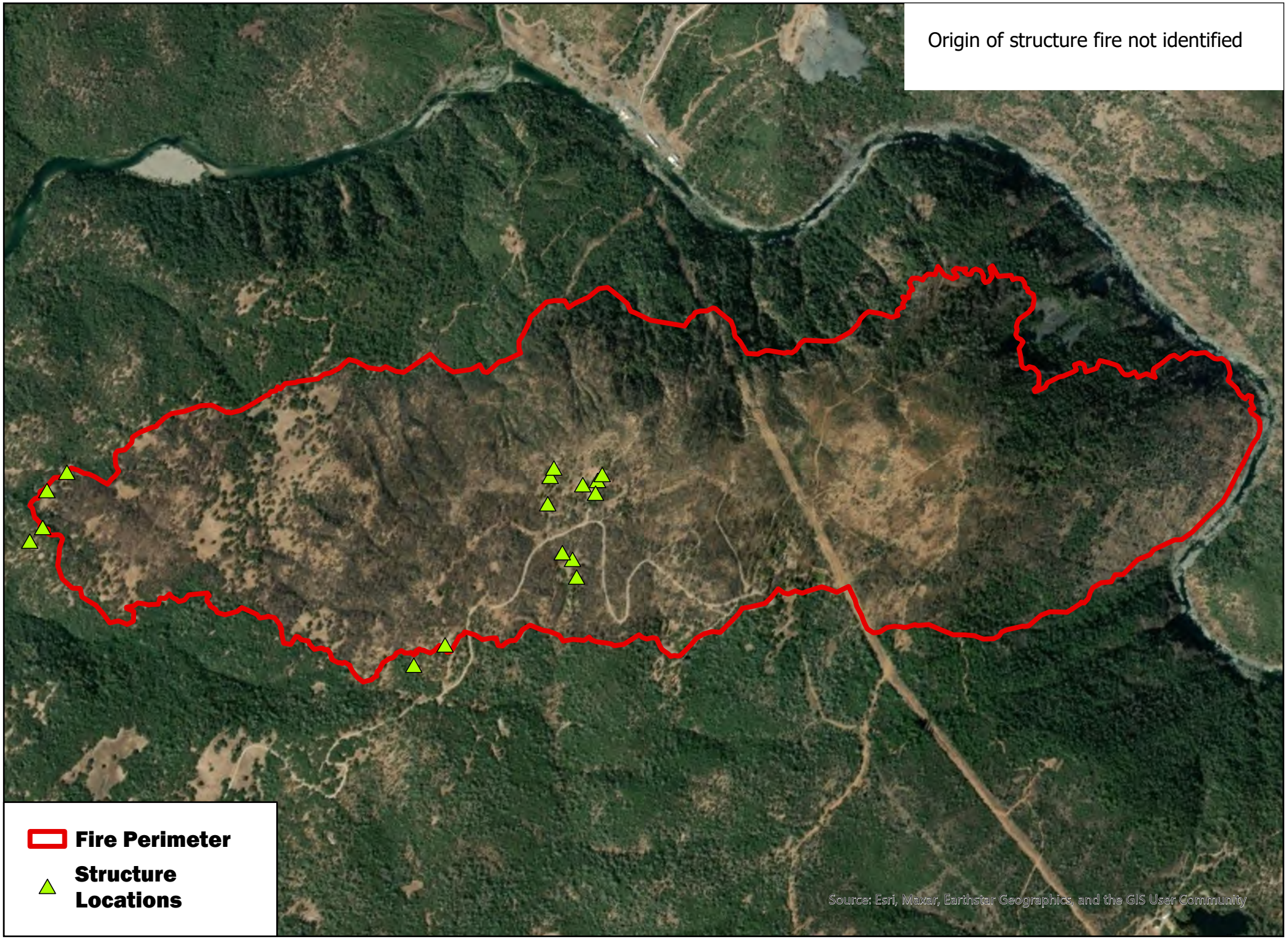

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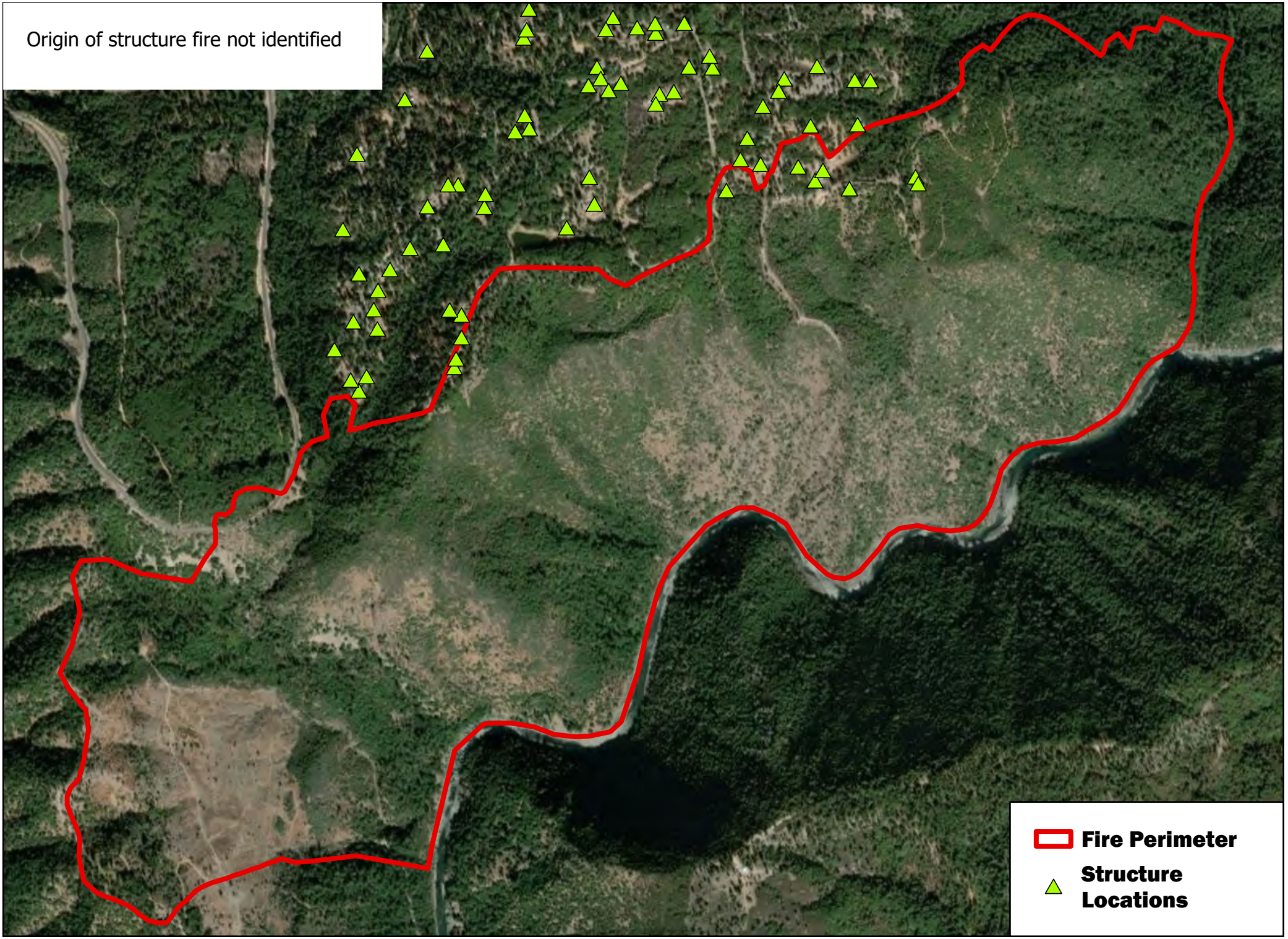

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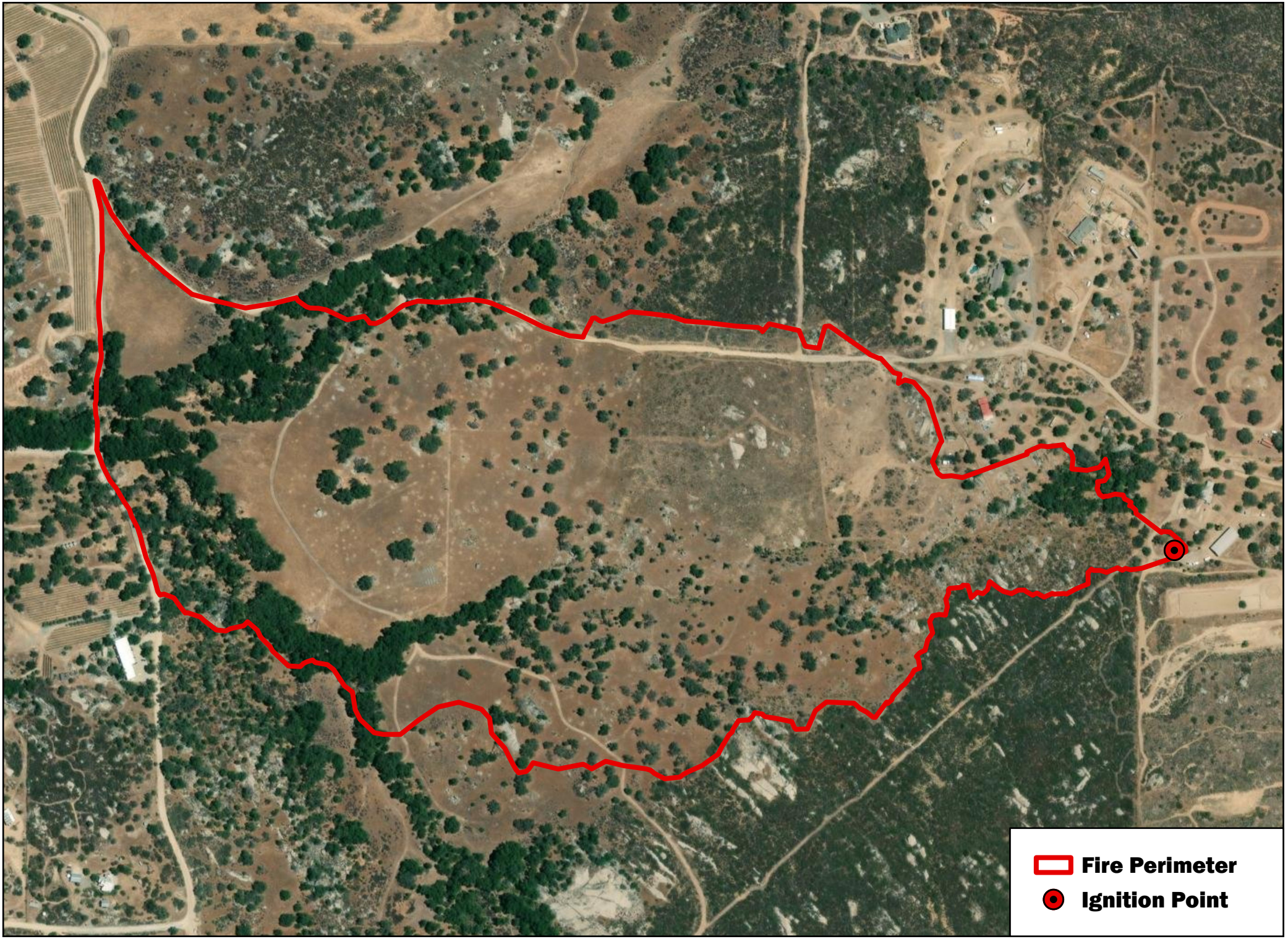
Source: CAL FIRE FRAP, 2022



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Source: CAL FIRE FRAP, 2022