NUTMEG HOMES PROJECT
FIRE PROTECTION PLAN
APNs: 224-260-23, -46, and -47

Prepared for:

Escondido Fire Department

On behalf of Applicant:

Nutmeg South, LLC
1278 Glenneyre, Suite 110
Laguna Beach, California 92651

Prepared by:

DUDEK
605 Third Street
Encinitas, California 92024

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ACRONYMS AND ABBREVIATIONS

CAL FIRE	California Department of Forestry and Fire Protection
CBC	County Building Code
CFC	California Fire Code
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CSA	County Service Areas
EFD	Escondido Fire Department
FAHJ	Fire Authorities Having Jurisdiction
FMZ	Fuel Modification Zone
FPP	Fire Protection Plan
GPM	Gallons per minute
HOA	Homeowner's Association
IFC	International Fire Code
LRA	Local Responsibility Areas
NFPA	National Fire Protection Association
Project	Nutmeg Homes Project
SanGIS	San Diego Geographic Information Source

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EXECUTIVE SUMMARY

The Nutmeg Project is a proposed private residential development located on three parcels encompassing 7.66 acres within the City of Escondido, California. The project is located at 241 Nutmeg Street in northwestern Escondido, directly west of North Center City Parkway, east of I-15, and to the north and south of N. Nutmeg Street. Access to the north and south components of the Nutmeg Project will be taken from N. Nutmeg Street. The proposed development will include:

- A total of 137 attached residential units
- residential streets, driveways, fire hydrants, and associated infrastructure
- Access off of North Nutmeg Street with no requirement for secondary access
- Fuel Modification Zones and additional Fire Protection Measures for the north side, which exceed the Fire and Building Code.

The Nutmeg Project lies within an area statutorily designated a Local Responsibility Area (LRA) "Very High Danger," zone by Escondido Fire Department (EFD) based on topography, vegetation, and weather, amongst other factors. The nearest open space areas that include very high fire hazard severity designation occur east, north and northwest of the site. The site is currently undeveloped, with the northern portion mostly undisturbed and the southern portion mostly disturbed, having been graded at some point. There are no structures located on the property.

The terrain on, and within the vicinity of the project, is characterized by flat to steep terrain, with the steepest gradients reaching approximately 27%. The area, like all of San Diego County, is subject to seasonal weather conditions that can heighten the likelihood of fire ignition and spread. Given the site and its surrounding's terrain, and wind alignments, as described in Section 2.2, would be expected to result in primarily a moderate-intensity, short duration wildfire.

The project site is technically within the jurisdiction of the EFD and is situated in the upper section of Service Area District 1. The EFD Fire Station 3 can respond to an incident on the site in under 4 minutes travel time. In addition, automatic/mutual aid agreements are in place with neighboring fire agencies to augment response, especially at the fringe area of EFD's jurisdiction.

The project will be constructed to the ignition resistant code requirements of the 2016 California Fire and Building (Chapter 7-A) Codes as amended by the City of Escondido (Chapters 6 and 11 of the Escondido Municipal Code). Construction shall include enhanced ignition resistant features, automatic interior sprinklers, conforming fire flow and water capacity, roads, supporting infrastructure, and fuel modification areas, as well as additional fire protection features expected to compensate for structures where the intent of fuel modification requirements is met via alternative measures.

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1 INTRODUCTION

This Fire Protection Plan (FPP) has been prepared for the proposed Nutmeg Homes Project (Project) in Escondido, California, an incorporated city in northern San Diego County. The purpose of the FPP is to assess the potential impacts resulting from wildland fire hazards and identify the measures necessary to adequately mitigate those impacts. Additionally, this plan generates and memorializes the fire safety requirements of the Fire Authority Having Jurisdiction (FAHJ), which is the Escondido Fire Department (EFD). Requirements and recommendations are based on site-specific project characteristics and incorporate input from the project developer/applicant (Nutmeg South, LLC), project planners, engineers, and architects.

As part of the assessment, the plan has considered the property location, topography, geology, surrounding combustible vegetation (fuel types), climatic conditions, and fire history. The plan addresses water supply, access (including secondary), structural ignitability and fire resistive building features, fire protection systems and equipment, impacts to existing emergency services, defensible space, and vegetation management. The plan identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment that will protect the Project and essential infrastructures. The plan recommends measures that project applicant will take to reduce the probability of ignition of structures throughout the area addressed by the plan.

The following tasks were performed toward completion of this plan:

- Gather site specific climate, terrain, and fuel data;
- Collect site photographs;
- Process and analyze the data using the latest GIS technology;
- Predict fire behavior using scientifically based fire behavior models, comparisons with actual wildfires (e.g., 2004 Emerald and 2014 Cocos Fires) in similar terrain and fuels, and experienced judgment;
- Analyze and guide design of proposed infrastructure;
- Analyze the existing emergency response capabilities;
- Assess the risk associated with the proposed project and the project site; and
- Prepare this FPP detailing how fire risk will be mitigated through a system of fuel modification, structural ignition resistance enhancements, and fire protection delivery system upgrades.

Field observations were utilized to augment existing digital site data in generating the fire behavior models and formulating the recommendations presented in this FPP. Refer to Appendix A for site photographs of existing site conditions.

1.1 Applicable Codes

Applicable regulations to the proposed project include the City of Escondido Fire Code (Municipal Code Chapter 11, Article 6; Ordinance No. 2011-13) and Building Code (Municipal Code Chapter 6, Article 3). Further, it is consistent with the California Code of Regulations Titles 14 and 24 and California Fire and Building Codes (2016). The project will also be consistent with the latest edition of the California Building Code (CBC), Chapter 7A, and the latest edition of the CFC, Chapter 49, as adopted by City. Chapter 7A of the California Building Code focuses primarily on preventing ember penetration into homes, a leading cause of structure loss from wildfires. Thus, it is an important component of the requirements of this FPP given the project's location is within an area statutorily designated a Very High Fire Hazard Severity Zone (VHFHSZ) by EFD in cooperation with California Department of Forestry and Fire Protection (CAL FIRE). The EFD also indicates the project site is a "Very High Danger" zone. Both of these designations trigger application of ignition resistant building codes for the Nutmeg Homes Project.

1.2 Nutmeg Homes Project Summary

1.2.1 Location

The Nutmeg Homes Project (project) is located in the northern portion of the City of Escondido (City), County of San Diego (County), CA (Figure 1: Project Location). The project site is located to the east of Interstate–15 (I-15), to the north and south of North Nutmeg Street, and to the west of North Center City Parkway. The I-15 Freeway bounds the project site to the west and is substantially above the project site. North Nutmeg Street passes through the project site and travels to the west under the Freeway to the City. North Center City Parkway bounds the project site to the east and travels to the north and south providing access to the City. The project site is approximately 2.0 miles north of the intersection of State Route 78 (SR-78) and the I-15.

The project site is currently vacant and comprised of three County Assessor's Parcels (6.69 acres), I-15 right-of-way (0.86 acres), and Center City Parkway right-of-way (0.97 acres). The project site is located in Section 5, Township 12 South, Range 2 West on the U.S. Geographical Survey (USGS), 7.5-minute Valley Center quadrangle map. The project site Assessor's Parcel Numbers (APNs) include APNs: 224-260-23, 46, and 47. The Center City Parkway and I-15 right-of-way portions of the project site do not have assessor's parcel numbers.

1.2.2 Existing Land Use

The project site is currently vacant and undeveloped, and does not show evidence of previous development. Nutmeg Street passes through the project site, traveling east to west and separating the property into northern and southern parcels. The site is currently vacant and surrounded by residential and undeveloped land. Land to the north, east and west of the site is mostly undeveloped and low-density, rural residential land. Land to the south, southeast and southwest consists primarily of residential and some neighborhood commercial development.

The City General Plan Land Use Map shows the current land use designation on site as Office (O). The project site zoning is Residential Estate-20 (RE-20), which is inconsistent with the General Plan. The majority of the project site over the past several years has been routinely disked or mowed for weed abatement in accordance with the requirements of the City. The I-15 Freeway and Center City Parkway rights-of-way have not been disked and remain as coastal sage scrub habitat.

1.2.3 Project Description

The Nutmeg Homes Project proposes to construct 137 unit attached residential homes on 7.66 acres, off-street parking, on-site circulation improvements, a tot-lot, outdoor open space areas, and on-site water quality basins on a total of 8.52 acres in the City of Escondido. The overall density for the proposed project would be approximately 17.89 dwelling units (137 dwelling units / 7.66 acres = 17.89 dwelling units per acre). The project will provide 274 parking spaces for residences and 35 guest space, totaling 305 off-street parking spaces. There would be two entrances (one to the north and one to the south) on Nutmeg Street for vehicles and pedestrians. Figure 2 presents the project's site plan including roads and access points.

The project would also include off-site improvements for Center City Parkway, Nutmeg Street, and I-15, which are described as follows.

Center City Parkway

Proposed project improvements to Center City Parkway would include the installation of improvements including: pavement, curb and gutter, sidewalk, and landscaping. Additionally, improvements would include the extension of the sewer line south along Center City Parkway.

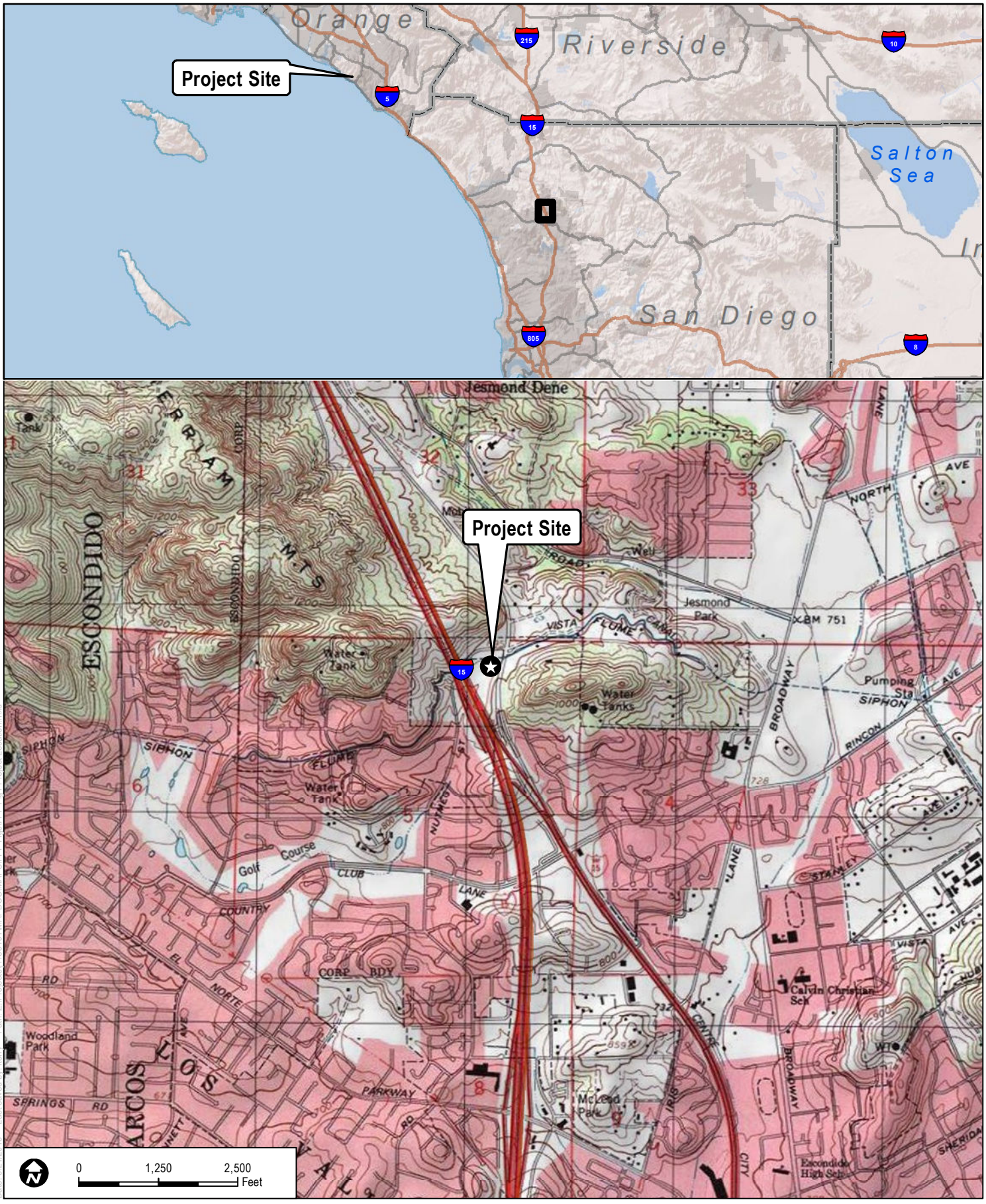
Nutmeg Street

Proposed project improvements to Nutmeg Street would include the realignment and installation of improvements including: pavement, curb and gutter, sidewalk, and landscaping.

I-15 Freeway

Proposed project improvements to I-15 Freeway right-of-way would include: grading, fill, and fire resistive landscaping.

The proposed land use improvements described above would be completed according to the City's Fire and Building code standards in effect at the time of building plan submittal and would include ignition-resistant construction, residential fire sprinkler systems, structure setbacks, required fire flow, and designated fuel modification areas, among other requirements, as described further in this FPP.



SOURCE: USGS 7.5 Minute Series,Valley Center Quadrangle

DUDEK

0 1,000 2,000 Feet

FIGURE 1

Project Location

Fire Protection Plan for the Nutmeg Homes Project

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SOURCE: AERIAL- SANGIS IMAGERY 2017; DEVELOPMENT PLAN - EXCEL ENGINEERING 2019

DUDEK

0 75 150 Feet

FIGURE 2

Project Site Plan

Fire Protection Plan for the Nutmeg Homes Project

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2 PROPOSED PROJECT SITE RISK ANALYSIS

2.1 Field Assessment

Dudek conducted a field assessment of the project site on September 29, 2018, in order to confirm/acquire site information, document existing site conditions, and to determine potential actions for addressing the protection of the project's structures. While on site, a Dudek Fire Planner assessed the area's topography, natural vegetation and fuel loading, surrounding land use and general susceptibility to wildfire. Among the field tasks that were completed are:

- Vegetation estimates and mapping refinements
- Fuel load analysis
- Topographic features documentation
- Photograph documentation
- Confirmation/verification of hazard assumptions
- Ingress/egress documentation.
- Nearby Fire Station reconnaissance

Field observations were utilized to augment existing site data in generating the fire behavior models and formulating the recommendations detailed in this report.

2.2 Site Characteristics and Fire Environment

Fire environments are dynamic systems and include many types of environmental factors and site characteristics. Fires can occur in any environment where conditions are conducive to ignition and fire movement. Areas of naturally vegetated open space are typically comprised of conditions that may be favorable to wildfire spread. The three major components of fire environment are topography, vegetation (fuels), and climate. The state of each of these components and their interactions with each other determines the potential characteristics and behavior of a fire at any given moment. It is important to note that wildland fire may transition to urban fire if structures are receptive to ignition. Structure ignition depends on a variety of factors and can be prevented through a layered system of protective features including fire resistive landscapes directly adjacent the structure(s), application of known ignition resistive materials and methods, and suitable infrastructure for firefighting purposes. Understanding the existing wildland vegetation and urban fuel conditions on and adjacent the site is necessary to understand the potential for fire within and around the Nutmeg Homes project.

2.2.1 Topography

Topographically, the portion of the site north of Nutmeg Street is relatively flat and gradually rises to the north, with elevations ranging from 880 feet above mean sea level adjacent to Nutmeg Street to 995 feet above mean sea level adjacent to the vacant lands to the north. At the I-15 right-of-way, the project site elevation lowers to 925 feet above mean sea level.

As previously discussed, Nutmeg Street divides the project site into northern and southern parcels. Elevations along Nutmeg Street range from 892.7 feet above mean sea level at intersection of Center City Parkway to 890 feet above mean sea level at the intersection of I-15.

The topography of the project site to the south of Nutmeg Street is relatively flat with elevations ranging from approximately 865 to 890 feet above mean sea level. This portion of the project site is at a relatively low gradient of less than an estimated 10% to the southwest. The lowest point on the project site is located on the south at approximately 875 feet above mean sea level.

2.2.2 Climate

Throughout southern California and specifically at the project site, climate has a large influence on fire risk. The climate of northern San Diego County is typical of a Mediterranean area, with warm, dry summers and wetter winters. Precipitation typically occurs between December and March. The prevailing wind is an on-shore flow (20 miles per hour (mph) maximum sustained winds) with fall, offshore flow (40 mph maximum sustained winds) from the east. Occasionally, extreme Santa Ana winds from the northeast may gust to 50 mph or higher. Drying vegetation (fuel moisture of less than 5% for 1-hour fuels is possible) during the summer and fall months becomes fuel available to advancing flames should an ignition occur.

2.2.3 Vegetation (Fuels)

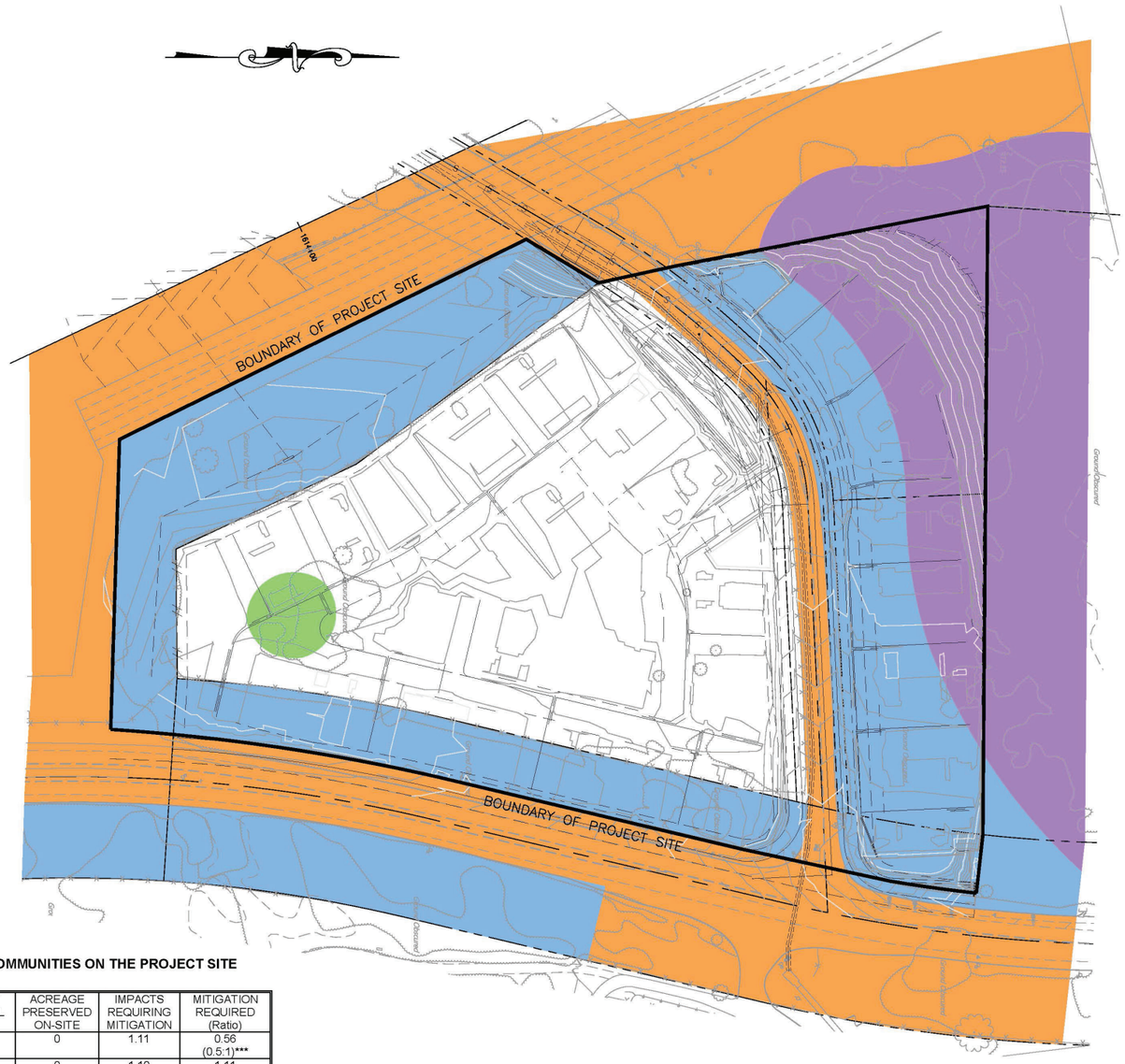
Based on the project's biological letter report (Everett and Associates 2018), four vegetation communities occur on the project site: Non-native Grassland (NNG), Diegan Coastal Sage Scrub (CSS), Southern Mixed Chaparral (SMC), and Coast Live Oak (*Quercus agrifolia*) woodland. Currently, the southern parcel contains ruderal non-native and invasive plants interspersed with NNG with the exception of a small area of Coast live oaks. Contiguous with the west and east parcel boundaries is a narrow strip containing CSS. These areas are within the ROW for I-15 and Center City Parkway, respectively. The two parcels on the north side of Nutmeg Street contain undisturbed CSS and SMC. The SMC occurs in the steeper topography in the northern half of the parcel and above the property. These habitat types are discussed below, shown on Figure 3: Biological Resources Exhibit, and are illustrated with photographs appended to this report. Additionally, the documented vegetation types on and adjacent to the property were confirmed by a Dudek Fire Protection Planner in the field and assigned fuel models for use during fire behavior modeling (see Section 4.1).

LEGEND

- NON-NATIVE GRASSLAND HOLLAND CODE 42200
- COASTAL SAGE SCRUB HOLLAND CODE 32500
- URBAN/DEVELOPED HOLLAND CODE 12000
- SOUTHERN MIXED CHAPARRAL HOLLAND CODE 37120
- COAST LIVE OAK WOODLAND HOLLAND CODE 71160

0 60 120 180 240

SCALE 1"=60'



EXISTING AND IMPACTED VEGETATION COMMUNITIES ON THE PROJECT SITE

PLANT COMMUNITY	ACREAGE ON-SITE	IMPACTED ACREAGE	IMPACT NEUTRAL	ACREAGE PRESERVED ON-SITE	IMPACTS REQUIRING MITIGATION	MITIGATION REQUIRED (Ratio)
Southern Mixed Chaparral	1.11	1.11	0	0	1.11	0.56 (0.5:1)***
Coastal Sage Scrub	3.30	3.30	2.20*	0	1.10	1.11 (1:1)***
Non-Native Grassland	4.01	4.01	4.01**	0	0	0
Coast Live Oak Woodland	0.25	0.25	0	0	0.25	0.75 (3:1)
TOTAL	8.67	8.67	6.21	0	2.46	2.42

*WITHIN CALTRANS OR CENTER CITY PARKWAY RIGHT OF WAY
**WITHIN AREA PREVIOUSLY MITIGATED
***MITIGATION RATIO FOR IMPACTS OUTSIDE OF A FOCUSED PLANNING AREA

BASE MAP PREPARED BY:

EXCEL ENGINEERING
440 STATE PLACE
ESCONDIDO, CA 92029
(760) 745-8118

BIOLOGICAL RESOURCES MAP PREPARED BY:

7/13/2018

WILLIAM T. EVERETT
EVERETT AND ASSOCIATES
ENVIRONMENTAL CONSULTANTS
POST OFFICE BOX 1085
LA JOLLA, CALIFORNIA 92038
858 456-2990

NOTE:
VEGETATION COMMUNITY MAPPING IS PREPARED USING OVERLAYS OF CURRENT AERIAL PHOTOGRAPHS AND IS VERIFIED ON THE GROUND TO THE GREATEST DEGREE POSSIBLE IN THE ABSENCE OF A SYSTEMATIC LAND SURVEY. ALL VEGETATION AREAS, BOUNDARIES, AND FUEL MODIFICATION ZONE LIMITS ARE ESTIMATES SUBJECT TO FINAL DELINEATION BY A LICENSED PROFESSIONAL LAND SURVEYOR.

SOURCE: EVERETT AND ASSOCIATES 2018

FIGURE 3
Biological Resources Exhibit
Fire Protection Plan for the Nutmeg Homes Project

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Non-Native Grassland (4.01 acres)

The flora of non-native grasslands includes a dense to sparse cover of introduced grasses and often have been mowed or disked for weed abatement. As noted above, the NNG occurs in the area of the south parcel, which was previously cleared in 2007. The NNG area on the site is dominated by weedy herbaceous non-native species, including non-native grasses.

Diegan Coastal Sage Scrub (3.30 acres)

Diegan coastal sage scrub is one of the two major shrub types that occur in San Diego County. This habitat type occupies xeric sites characterized by shallow soils. Diegan coastal sage scrub is dominated by subshrubs whose leaves abscise during drought. On the project site, CSS is located on the less steep portions of the south facing slopes on the northern parcel and within the ROW for both I-15 and Center City Parkway. The areas of CSS on the site primarily contain California sagebrush (*Artemesia californica)*, black sage (*Salvia mellifera)*, laurel sumac (*Malosma laurina)*, California flat-top buckwheat (*Adenostoma fasciculatum).*

Southern Mixed Chaparral (1.11 acres)

Chaparral is a shrubland vegetation that is widely distributed throughout California on dry slopes and ridges at low and medium elevations where it occupies thin, rocky, or heavy soils. It is typically composed of hard-stemmed, leathery leaved shrubs, with a species composition that varies considerably with location. Along the northern boundary of the two parcels, on the northern side of Nutmeg Street, a steep south-facing slope contains SMC. The areas of SMC on the site contain a few typical CSS plant species, but also scrub oak (*Quercus berberidifolia)*, yucca (*Yucca schidigera)*, and mission manzanita (*Xyloccous bicolor).*

2.2.4 Vegetation Dynamics

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, the native shrub species that compose the coastal sage scrub and chaparral communities on site would exhibit higher potential hazard (higher intensity heat and flame length) than grass dominated plant communities (fast moving, but lower intensity) if ignition occurred. The corresponding fuel models for each of these vegetation types are designed to capture these differences.

As described, vegetation plays a significant role in fire behavior, and is an important component to the fire behavior models discussed in this report. A critical factor to consider is the dynamic nature of vegetation communities. Fire presence and absence at varying cycles or regimes disrupts plant succession, setting plant communities to an earlier state where less fuel is present for a period of time as the plant community begins its succession again. In summary, high-frequency fires tend to convert shrublands to grasslands or maintain grasslands, and fire exclusion tends to convert grasslands to shrublands over time as shrubs sprout back or establish and are not disturbed by repeated fires. In general, biomass and associated fuel loading will increase over time, assuming that disturbance (e.g., fire, grazing, or farming) or fuel reduction efforts are not diligently implemented. It is possible to alter successional pathways for varying plant communities through manual alteration. This concept is a key component in the overall establishment and maintenance of the proposed FMZs for the project site. The FMZs will consist of irrigated and maintained landscapes that will be subject to regular "disturbance" in the form of maintenance and will not be allowed to accumulate excessive biomass over time, which results in reduced fire ignition, spread rates, and intensity.

2.2.5 Fire History

Fire history information can provide an understanding of fire frequency, fire type, most vulnerable project areas, and significant ignition sources, among others. Fire history represented in this FPP uses the Fire and Resource Assessment Program (FRAP) database. FRAP summarizes fire perimeter data dating to the late 1800s, but which is incomplete due to the fact that it only includes fires over 10 acres in size and has incomplete perimeter data, especially for the first half of the 20th century (Syphard and Keeley 2016). However, the data does provide a summary of recorded fires and can be used to show whether large fires have occurred in the Project area, which indicates whether they may be possible in the future.

Appendix B, Vicinity Fire History Map, presents a graphical view of the recorded fire history. As presented in the exhibit, there have been 28 fires recorded since 1912 by CAL FIRE in the FRAP database [1] in the vicinity of the Project. No fires have burned through the site. However, two fires, ranging from 746 acres (1960 Outside Origin #29 Fire) to 494 acres (1985 Deer Fire) are noted to have burned just west and east, respectively, of the project site (CAL FIRE 2018).

Based on an analysis of the CAL FIRE FRAP fire history data set, specifically the years in which the fires burned, the average interval between wildfires in the area (includes areas up to roughly

[1] Based on polygon GIS data from CAL FIRE's FRAP, which includes data from CAL FIRE, U.S. Forest Service Region 5, the Bureau of Land Management, the National Park Service, Contract Counties, and other agencies. The data set is a comprehensive fire perimeter GIS layer for public and private lands throughout the state and covers fires 10 acres and greater between 1911–2017.

5 miles from the project site was calculated to be 4.3 years with intervals ranging between 1 and 31 years. Based on this analysis, it is expected that wildfire that could impact the project may occur, if weather conditions coincide, roughly every 4 to 5 years with the realistic possibility of shorter or longer interval occurrences, as observed in the fire history records. Further, the large expanses of open space surrounding the project site and potential ignition sources originating from I-15 and Nutmeg Street or Center City Parkway, contribute to increased potential risk and wildfire hazard in the area.

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3 DETERMINATION OF PROJECT EFFECTS

FPPs provide an evaluation of the adverse environmental effects a proposed project may have from wildland fire. The FPP describes the project design features that would ensure that the project would not unnecessarily expose people or structures to a significant loss, injury or death involving wildland fires. Significance is determined by answering the following guidelines:

Would the project expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?

According to the City's Fire Severity Zone Map, the proposed project is located in a "Very High Danger" zone. The wildland fire risk in the vicinity of the project site has been analyzed and it has been determined that wildfires may occur in wildland or naturally vegetated areas off-site to the east, northwest and south of the project site, but would not be significantly increased in frequency, duration, or size with implementation of the project. The closest off-site fuels that form large fuel beds are located to the north and east of the site.

The site currently includes a variety of potential vegetation that could serve as fuel sources. The types of potential ignition sources that currently exist in the area include vehicle and roadway, electrical transmission lines, machinery associated with agricultural operations and off-site residential neighborhoods. The proposed project would include the development of 137 homes, off-street parking, on-site circulation, tot-lot, and outdoor open space areas. As such, the site would be largely converted from readily ignited fuels to ignition resistant structures and landscaped areas. The proposed project would be developed to meet all existing development codes and fire codes, including landscaping and vegetation requirements as indicated in *Sec. 4907.4.1* of the City of Escondido Fire Code. The project would include conversion of fuels to maintained urban development with designated landscaping and fuel modification areas. Fuel modification zones will be designed according to all applicable development codes and the Escondido Fire Code, and indicated on the project site plan.

The project would introduce potential ignition sources, but would also include conversion of ignitable fuels to lower flammability landscape and include better access throughout the site, managed and maintained landscapes, more eyes and ears on the ground for early fire detection, and generally a reduction in the receptiveness of the areas landscape to ignition. Fires from off-site would not have continuous fuels across this site and would therefore be expected to burn around and/or over the site via spotting. Burning vegetation embers may land on project structures, but are not likely to result in ignition based on ember decay rates and the types of non-combustible and ignition resistant materials that will be used on site.

The project would comply with applicable ignition resistant fire and building codes and would include a layered fire protection system inclusive of site-specific measures that will result in a project that is less susceptible to wildfire than surrounding landscapes and that would facilitate fire fighter and medical aid response.

Would the project result in inadequate emergency access?

The project would result in the development of a currently undeveloped area, including the development of site access. The project would involve the construction of new structures, roadways, and intersections and would generate new trips to and from the project site. The project site would be accessible from public roadways and access into the site would be provided via two entrances on Nutmeg Street for vehicles and pedestrians. The project would be required to comply with the City's development review process, including review for compliance with the City's Development Code and Fire Code as well as compliance with applicable emergency access standards that would facilitate emergency vehicle access during project construction and operation. Additionally, an adequate water supply and an approved paved access roadway shall be installed prior to any combustibles on site.

The project applicant would be required to design, construct, and maintain structures, roadways, and facilities to comply with applicable local, regional, state, and federal requirements related to emergency access. Drive aisles, turning radii, and both access points would be designed with adequate emergency access. The project would be required to provide fire apparatus turnarounds on all access roadways over 150 feet in length, and provide a 28-foot inside turning radius on all corners. All access roadways would have a minimum of 24 feet in width throughout the project site, with no parking on either side. Driveways or alleys between buildings would have widths of 24 feet. All access roadways would have a vertical clearance of at least 13'6" for the full 24-foot road width to allow access for fire apparatus. However, the alleys between buildings will have a vertical clearance of 13'6" for 20 feet of the width. The proposed site plan is subject to approval by the City and the City's Fire Department. Further, the project would be required to provide walking access to the rear of buildings, and ladder access for any windows facing the rear of the buildings.

The City and the City's Fire Department will need to review proposed modifications to existing roadways to ensure that adequate emergency access or emergency response would be maintained. Additionally, emergency response procedures would be coordinated through the City in coordination with the police and fire departments. Adherence to these requirements would ensure that that the project would not result in inadequate emergency access.

Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental

impacts, in order to maintain acceptable service ratios, response times or other performance service ratios, response times or other performance objectives for fire protection?

Fire protection would be provided to the proposed project via the Escondido Fire Department (EFD). The EFD provides fire protection and emergency medical services to the City and, through a contractual arrangement established in 1984, the Rincon Del Diablo Fire Protection District. A staff of 93 full-time safety (including Chief Officers), 18 full-time non-safety, 10 full-time administration, 3 part-time administration, and 27 senior volunteers provides services to a population of approximately 153,614 in an area covering 50 square miles.

The project is projected to add an estimated maximum of 36 calls per year to the EFD's existing call load. This estimate is a conservative estimate in that it uses San Diego County wide data, which incorporates call volumes from typically higher volume areas than would be expected from this site. The primary response (first in) would be provided by Station 3, located at 1808 Nutmeg Street, Escondido, CA 92026, approximately 0.8 miles south of the project site. The station houses one E133 Type I engine, one B133 Type II engine and one RA133 ambulance. The Project is projected to add an estimated 44 calls per year (0.12 calls per day) for a Station that currently responds to an existing call load of approximately 5.7 calls per day (2,100 calls per year in 2017). The addition of approximately 1 call per week is considered insignificant based on that increase alone. This level of impact is not expected to require the construction of additional Fire Station facilities based on that increase alone. For perspective, urban fire stations that respond to five calls per day are considered average and 10 calls per day would be considered a busy station. Further, Station 3 can respond to the entire project within the City's target response time standard (7.5 minutes) for first arriving. Therefore, no additional facilities would be needed for response coverage. A portion of the project's parcel tax revenue will be allocated to fire protection, which can be used to maintain current levels of protection without impacting existing citizens.

Would the project have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?

The project will be served by Rincon Del Diablo Municipal Water District and sufficient water supplies will be available to serve the project from existing entitlements and resources. The Water District requires new development to meet a dual 2,500 gpm fire flow. The pressures in the development will remain above 20 psi for a minimum 2 hour duration when meeting the fire requirements for the water district.

The measures described in the responses to these significance questions are provided more detail in the following sections.

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4 ANTICIPATED FIRE BEHAVIOR

4.1 Fire Behavior Modeling

Following field data collection efforts and available data analysis, fire behavior modeling was conducted to document the type and intensity of fire that would be expected adjacent to the project site given characteristic site features such as topography, vegetation, and weather. Dudek utilized BehavePlus software package version 5.5 (Andrews, Bevins, and Seli 2004) to analyze potential fire behavior for the northern, eastern, southern, and western edges of the project site, with assumptions made for the pre- and post-project slope and fuel conditions. Results are provided below and a more detailed presentation of the BehavePlus analysis, including fuel moisture and weather input variables, is provided in Appendix C.

4.2 BehavePlus Fire Behavior Modeling Analysis

An analysis utilizing the BehavePlus software package was conducted to evaluate fire behavior variables and to objectively predict flame lengths, intensities, and spread rates for four modeling scenarios. These fire scenarios incorporated observed fuel types representing the dominant on-site and off-site vegetation on vacant land to the north, east, south and west, in addition to measured slope gradients, and wind and fuel moisture values derived from County weather data sets (County of San Diego 2010). Modeling scenario locations were selected to better understand different fire behavior that may be experienced on or adjacent the site.

Vegetation types, which were derived from the field assessment for the project site, were classified into a fuel model. Fuel Models are simply tools to help fire experts realistically estimate fire behavior for a vegetation type. Fuel models are selected by their vegetation type; fuel stratum most likely to carry the fire; and depth and compactness of the fuels. Fire behavior modeling was conducted for vegetative types that surround the proposed development. Fuel models were selected from *Standard Fire Behavior Fuel Models: a Comprehensive Set for Use with Rothermel's Surface Fire Spread Model* (Scott and Burgan 2005). Fuel models were also assigned to the perimeter fuel management areas to illustrate post-project fire behavior changes. Based on the anticipated pre- and post-project vegetation conditions, four different fuel models were used in the fire behavior modeling effort presented herein. Fuel model attributes are summarized in Table 1.

Table 1
Fuel Model Characteristics

Fuel Model Assignment	Description	Tons/acre, Btu/lb.	Fuel Bed Depth (Feet)
8	Fuel Modification Zone 1 – irrigated, landscapes	5.0 tons/acre; 8,000 Btu/lb.	<3.0
Gr1	Short, Sparse Dry Climate Grass	0.4 tons/acre; 8,000 Btu/lb.	<1.0 ft.
Sh1	Fuel Modification Zone 2 – 50% thinning	2.0 tons/acre; 8,000 Btu/lb.	3.0
SH5	Dry Climate Shrub (sage scrub/chaparral)	6.4 tons/acre; 8,000 Btu/lb.	<6.0 ft.

The results of fire behavior modeling analysis for pre- and post-project conditions are presented in Tables 2 and 3, respectively. Identification of modeling run (fire scenarios) locations is presented graphically in Figure 4, BehavePlus Fire Behavior Analysis exhibit.

Table 2
Nutmeg Homes BehavePlus Fire Behavior Model Results
Existing Conditions

Fire Scenarios	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph[1])	Spotting Distance[2] (miles)
Scenario 1: Coastal sage scrub, 35% slope, 40 mph sustained winds				
Fuel Model Sh5	49.3	27,196	9.0	2.2
Scenario 2: Coastal sage scrub, 25% slope, 40 mph sustained winds				
Fuel Model Sh5	49.1	26,870	9.0	2.2
Scenario 3: Caltrans ROW and natural 27% slope, 20 mph sustained winds				
Caltrans ROW (Gr1)	2.3	35	0.3	0.2
Coastal sage scrub vegetated slope	24.0	5,673	2.2	0.9
Scenario 4: Coastal sage scrub, 27% downhill slope, 20 mph sustained winds				
Coastal sage scrub vegetated slope	24.6	6,014	2.3	0.9

Table 3
Nutmeg Homes BehavePlus Fire Behavior Model Results
Post-Project Conditions

Scenario	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph[1])	Spotting Distance[2] (miles)
Scenario 1: Fuel treatments on south-facing natural and manufactured slopes, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Fuel modification zone 2 (Sh1)	10.6	964	1.5	0.8
Scenario 2: Fuel treatments on flat, fully landscaped area, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Scenario 3: Fuel treatment on natural 27% slope, 20 mph maximum winds				
Fuel modification zone 1 (FM8)	2.3	34	0.10	0.2
Fuel modification zone 2 (Sh1)	0.9	4	0.03	0.1
Scenario 4: Fuel treatments on relatively flat fill slope, 20 mph maximum winds				
Fuel modification zone 1 (FM8)	2.3	34	0.10	0.2
Fuel modification zone 2 (Sh1)	0.9	4	0.03	0.1

Note:
1 mph = miles per hour
2 Spotting distance from a wind driven surface fire.

The results presented in Tables 2 and 3 depict values based on inputs to the BehavePlus software and are not intended to capture changing fire behavior as it moves across a landscape. Changes in slope, weather, or pockets of different fuel types are not accounted for in this analysis, but the models provide a worst-case wildfire behavior condition as part of a conservative approach. For planning purposes, the averaged worst-case fire behavior is the most useful information for conservative fuel modification design. Model results should be used as a basis for planning only, as actual fire behavior for a given location would be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns.

4.3 Fire Behavior Summary

As presented, wildfire behavior in non-treated, coastal sage scrub and southern mixed chaparral (Fuel Model Sh5) vary based on timing of fire. A fire being fanned by 20 mph, onshore winds (fire scenarios 3 and 4) would result in a fire spreading in sage scrub at roughly 2.0 mph with 24 feet high flames. During the fall when there are gusty Santa Ana (offshore) winds and low fuel moistures, a wildfire in sage scrub-chaparral habitat (fire scenarios 1 and 2) is expected to be moving at 9.0 mph with highest flame length values reaching approximately 49 feet in specific portions of the property. Maximum spotting distance for both onshore and offshore wind-driven fires is projected to occur between 0.9 and 2.2 miles, respectively, downwind.

As previously mentioned, Dudek conducted modeling of the site for post-fuel modification zones. Typical fuel modification includes establishment of minimum 50-foot wide irrigated zone (Zone 1) and 50-foot wide thinned zone (Zone 2) on the periphery of the project site, beginning at the structure. For modeling the post-FMZ treatment condition, the fuel model assignment for coastal sage scrub-Southern mixed chaparral was re-classified according to the specific fuels management (e.g., irrigated, fire resistive landscaping vs. 50% thinned native brush) treatment.

As depicted in Table 3, the FMZ areas experience a significant reduction in flame length and intensity. The 49-foot flame lengths predicted for sage scrub-chaparral habitat during pre-treatment modeling for fire scenarios 1 and 2 are reduced to approximately 11 feet at the outer edges of the FMZ (Zone 2) and to three feet by the time the inner portions of the FMZ (Zone 1) are reached. During onshore weather conditions, a fire approaching from the west towards the development footprint would be reduced from 24-foot tall flames to less than 1.0-foot tall in Zone 2 and two feet in height in Zone 1 (taller flame length in zone 1 is due to mulch layer in landscaped areas) with low fire intensity and spotting distances due to the higher live and dead fuel moisture contents. These reduction of flame lengths and intensities are assumed to occur within the full 100 feet of fuel modification (a combination of Zones 1 and 2), which is not achievable on the Nutmeg site.

4.4 Project Area Fire Risk Assessment

Wildland fires are a common natural hazard in most of southern California with a long and extensive history. Southern California landscapes include a diverse range of plant communities, including vast tracts of shrublands, like those found adjacent to the proposed project site. Wildfire in this Mediterranean-type ecosystem ultimately affects the structure and functions of vegetation communities (Keeley 1984) and will continue to have a substantial and recurring role (Keeley and Fotheringham 2003). Supporting this are the facts that 1) native landscapes, from forest to grasslands, become highly flammable each fall and 2) the climate of southern California has been characterized by fire climatologists as the worst fire climate in the United States (Keeley 2004) with high winds (Santa Ana) occurring during autumn after a six-month drought period each year. Based on this research, the anticipated growing population of north San Diego County WUI areas, and the regions fire history, it can be anticipated that periodic wildfires will occur in the open space areas of the northern Escondido area, being no exception.

Although the project site has never burned, wildfires have occurred within 5 miles of the site. As such, wildlands near the Nutmeg Project are expected to be vulnerable to recurring wildfire ignition and spread and may be subject to nearby wildfire that could, under worst case conditions, spread through the chaparral-covered hillsides to the north and east and burn along the periphery of the Project's developed areas. However, the Proposed Project site, once developed, would not facilitate wildfire spread and would reduce projected flame lengths to levels that would be manageable by firefighting resources for protecting the site's structures, especially given the ignition resistance of the structures and the planned ongoing maintenance of the entire site landscape.

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INPUTS

BehavePlus Fire Behavior Modeling Inputs

Variable	50th Percentile (Onshore flow)	97th Percentile (Offshore/Santa Ana condition)
1h Moisture	3%	2%
10h Moisture	5%	3%
100h Moisture	7%	5%
Live Herbaceous Moisture	60%	30%
Live Woody Moisture	90%	50%
20-foot Wind Speed	10-20 mph	30-40 mph (50 mph gusts)
Slope Steepness	3% to 35% manufactured slopes = 50%	3% to 35% manufactured slopes = 50%
Wind Adjustment Factor	0.6	0.6

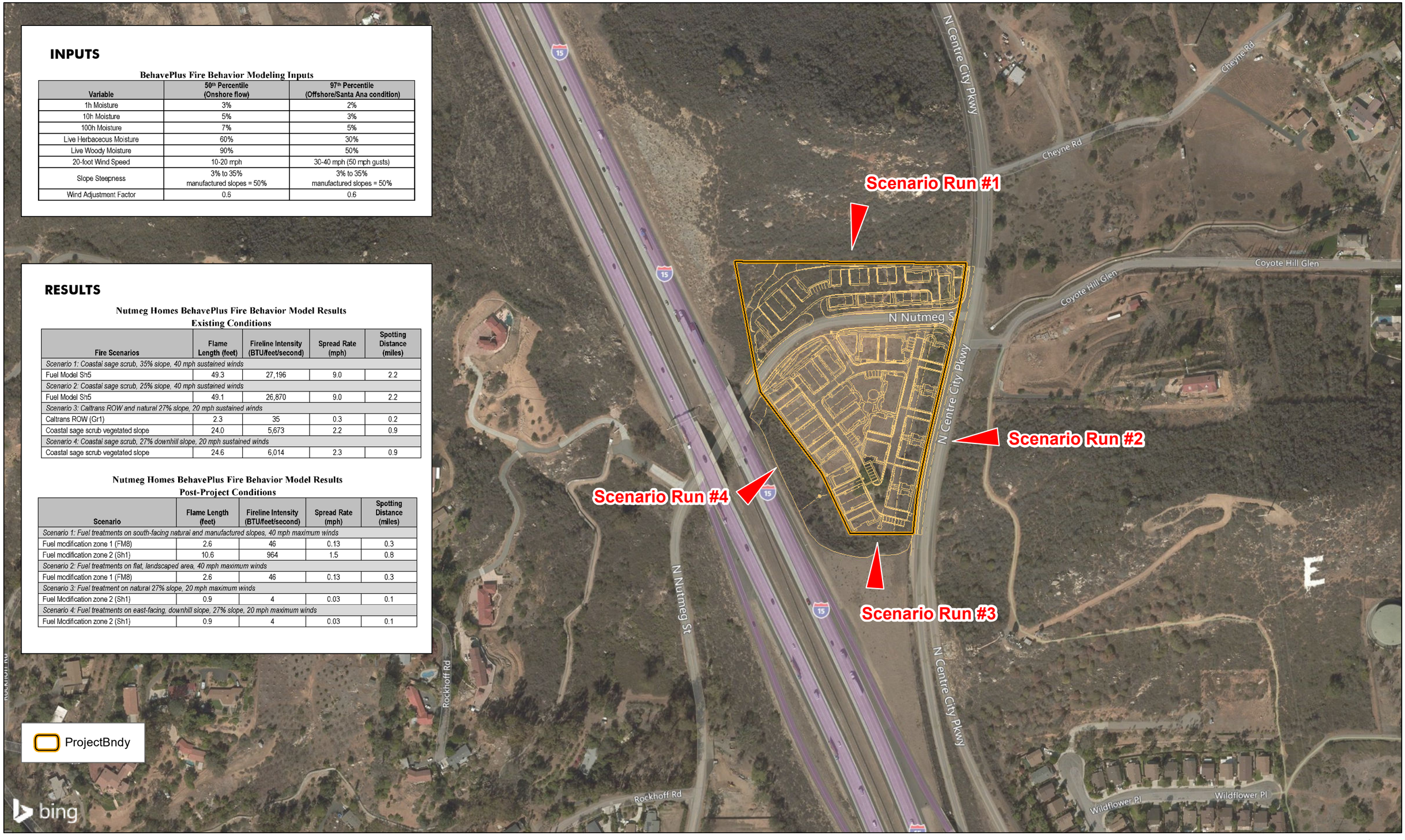
RESULTS

Nutmeg Homes BehavePlus Fire Behavior Model Results
Existing Conditions

Fire Scenarios	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph)	Spotting Distance (miles)
Scenario 1: Coastal sage scrub, 35% slope, 40 mph sustained winds				
Fuel Model Sh5	49.3	27,196	9.0	2.2
Scenario 2: Coastal sage scrub, 25% slope, 40 mph sustained winds				
Fuel Model Sh5	49.1	26,870	9.0	2.2
Scenario 3: Caltrans ROW and natural 27% slope, 20 mph sustained winds				
Caltrans ROW (Gr1)	2.3	35	0.3	0.2
Coastal sage scrub vegetated slope	24.0	5,673	2.2	0.9
Scenario 4: Coastal sage scrub, 27% downhill slope, 20 mph sustained winds				
Coastal sage scrub vegetated slope	24.6	6,014	2.3	0.9

Nutmeg Homes BehavePlus Fire Behavior Model Results
Post-Project Conditions

Scenario	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph)	Spotting Distance (miles)
Scenario 1: Fuel treatments on south-facing natural and manufactured slopes, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Fuel modification zone 2 (Sh1)	10.6	964	1.5	0.8
Scenario 2: Fuel treatments on flat, landscaped area, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Scenario 3: Fuel treatment on natural 27% slope, 20 mph maximum winds				
Fuel Modification zone 2 (Sh1)	0.9	4	0.03	0.1
Scenario 4: Fuel treatments on east-facing, downhill slope, 27% slope, 20 mph maximum winds				
Fuel Modification zone 2 (Sh1)	0.9	4	0.03	0.1



SOURCE: AERIAL-BING MAPPING SERVICE 2017; DEVELOPMENT PLAN - EXCEL ENGINEERING 2018

DUDEK 0 300 600 Feet

FIGURE 4
BehavePlus Fire Behavior Analysis Map
Fire Protection Plan for the Nutmeg Homes Project

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5 EMERGENCY RESPONSE AND SERVICE

5.1 Emergency Response

The project is located within the Escondido Fire Department (EFD) jurisdictional response area of approximately 50 square miles with a population of approximately 153,614 residents[2]. EFD currently operates seven Fire Stations, three of which are analyzed herein due to their proximity to the proposed project site.

Within the area's emergency services system, fire and emergency medical services are provided by Fire Departments (Escondido Fire Department, San Marcos Fire Department) or Fire Protection Districts (Rancho Santa Fe Fire Protection District), County Service Areas (CSA) and CAL FIRE. Generally, each agency is responsible for structural fire protection and wildland fire protection within their area of responsibility. However, mutual aid agreements enable non-lead fire agencies to respond to fire emergencies outside their district boundaries. In the project area, fire agencies cooperate on a statewide master mutual aid agreement for wildland fires and there are mutual aid agreements in place with neighboring fire agencies (north zone agencies) and typically include interdependencies that exist among the region's fire protection agencies for structural and medical responses, but are primarily associated with the peripheral "edges" of each agency's boundary. These agreements are voluntary, as no local governmental agency can exert authority over another.

Table 4 presents a summary of the location, fire apparatus, staffing levels, maximum travel distance, and estimated travel time for the nearby stations that would respond to a fire or medical emergency at the Project. Travel distances are derived from Google road data while travel times are calculated applying the nationally recognized RAND Corporation formula used by the Insurance Services Office (ISO) Public Protection Classification Program's Response Time Standard: (T=0.65 + 1.7D, where T=time and D= distance). The response travel time formula discounts speed for intersections, vehicle deceleration and acceleration, and does not include turnout donning time.

Table 4
Summary of Escondido Fire Department Responding Fire Stations

Station	Location	Equipment	Staffing/ Per Shift	Maximum Travel Distance*	Travel Time**
1	310 North Quince Street Escondido, CA 92029	Paramedic Engine Truck Co. Brush Engine 2 Ambulances Command Vehicle	9	3.76 miles	7 minutes

[2] https://fire.escondido.org/the-organization.aspx

Table 4
Summary of Escondido Fire Department Responding Fire Stations

Station	Location	Equipment	Staffing/ Per Shift	Maximum Travel Distance*	Travel Time**
3	1808 Nutmeg Street Escondido, CA 92029	Paramedic Engine Brush Engine	3	1.44 miles	3 minutes 6 seconds
7	North Ash Street Escondido, CA 92029	Paramedic Engine Ambulance	3	3.39 miles	6 minutes 25 seconds

* Distance measured to most remote portion of project site.
** Assumes travel to the Project's furthest structure on the site, and application of the ISO formula, Time=0.65+1.7(Distance).

The EFD response time standard for all priority Level One or Emergency type calls is 7 minutes and 30 seconds, a total of 90% of the time. In 2017, EFD's response time for all stations was 5 minutes and 16 seconds for all urgent calls. Response to the project from nearby fire stations will be well below the response time standard for first arriving. Response from Station 3 is calculated to be approximately 3 minutes to most remote portion or southern tip of the site. The full effective firefighting force is estimated to arrive within 7 minutes. Therefore, the project complies with the City's response time standards.

5.2 Emergency Service Level

Using San Diego County and City of Escondido fire agencies' calculated 82 annual calls per 1,000 population, the project's estimated 427 residents (calculated based on 3.12 persons per dwelling; SANDAG 2013), would generate up to 36 calls per year (roughly 2.9 calls per month), most of which would be expected to be medical-related calls, consistent with typical emergency call statistics. These estimates are likely overly conservative due to the per capita call factors, which are based on an average of all demographics and sociological populations, including dense, urban areas which, on average, result in higher call volumes. A development, like Nutmeg Homes, would typically include a demographic that results in fewer calls, per capita, resulting in an overly conservative estimate.

Service level requirements are not expected to be significantly impacted with the increase of less than 36 calls per year for a station (EFD Station 3) that currently responds to roughly 6 calls per day (2,100 calls in 2017) in its primary service area. For reference, a station that responds to 5 calls per day in an urban setting is considered average and 10 calls per day is considered busy. Therefore, the project is not expected to cause a decline in EFD's emergency response times. EFD responded to 16,664 calls in 2017 from its 7 stations. Additional response, rounding out the effective firefighting force (the manpower needed to effectively fight a structure fire and/or respond to serious medical emergency) would be provided by Stations 1 and 7.

6 BUILDINGS, INFRASTRUCTURE AND DEFENSIBLE SPACE

The City's Municipal Building and Fire Codes govern the building, infrastructure, and defensible space requirements detailed in this FPP. While these standards will provide a high level of protection to structures for the Nutmeg Project, as with any project located in a VHFHSZ or "Very High Danger" zone, there is no guarantee that compliance with these standards will prevent damage or destruction of structures by fire in all cases.

A response map update in a format compatible with current department mapping shall be provided to the EFD (Section 505.5).

The following summaries highlight important fire protection features.

6.1 Site Access

Project site access, including road widths and connectivity, will be consistent with the City's roadway standards and the 2016 CFC Section 503.

6.1.1 Fire Access

The project would be accessible from public roadways. The primary project access for the Nutmeg Homes Project will be via two entrances on Nutmeg Street. A gated, emergency vehicle access entry on Nutmeg Street will be provided at the eastern portion of the northern parcel. Nutmeg Street is currently built as a 24-foot wide, two-lane local collector road, which is proposed at 42 feet wide. Interior roads will be a minimum for 24 feet wide with 13'6" unobstructed vertical clearance. Driveways or alleys between buildings will be 24 feet wide with 13'6" vertical clearance for 20 feet of the alley width due to an overhang on the building. A reflector or some other device approved by EFD will be placed on the corner of each building warning emergency vehicles as they enter the alley of the low overhang on the building. All units are accessible from fire apparatus access roads within 150 feet for any portion of an exterior wall of the first story.

The grade for new roads and driveways will be less than 15% within the Nutmeg Homes Project. Should any sections of road or driveway exceed 15%, they will be provided heavy broom finish or equivalent surfacing to EFD approval. Sections exceeding 15% grade will be constructed with Portland Concrete surface and capable of supporting the dynamic weight of a 75,000 pound fire apparatus. Access roads shall provide fire department access and turnaround with an all-weather surface acceptable to the EFD prior to issuance of building permits and prior to combustible construction occurring.

6.1.2 Road Widths and Circulation

On-site roads will be constructed to current City of Escondido Road standards and 2016 CFC, including minimum 24-foot road widths unobstructed by parking, and shall be improved with asphalt paving materials that support the imposed loads of fire apparatus (not less than 75,000 lbs.). Turning radius for fire apparatus access roads will be 28 feet as measured on the inside edge of the improved width. All residential parking will be off-street parking spaces. Parking will be restricted throughout development by posting of signs stating "No Parking- Fire Lane CVC (California Vehicle Code) 22500.1" to preserve the unobstructed width for emergency response. Signs that are legally enforceable shall be posted at each entrance gate and throughout the property. Signs shall be securely mounted facing the direction towards oncoming traffic entering the area and clearly visible indicating that "violating vehicles will be towed at owner's expense." Prior to a final fire inspection for the proposed development, a written agreement for services with a towing company per CVC 22658(a) will be in place.

6.1.3 Maximum Dead-End Road Length

The project provides looped roadways or turnarounds throughout the site. In addition, the Nutmeg Project will provide two secondary emergency access points (See Figure 2, Project Site Plan). The first emergency access point is to Nutmeg Street from the southeast corner of the northern parcel. The other emergency access point is to North Centre City Parkway from the east side of the southern parcel. Therefore, all roadways are compliant with the City's dead-end road length standard.

6.2 Gates

Automatic gates are proposed as a northeast entry on Nutmeg Street to the northern parcel and as an east entry on North Centre City Parkway to the southern parcel (Refer to Figure 2 for gate locations). These gates are provided for emergency vehicle access (EVA) and will be equipped with a Knox, emergency key-operated switch overriding all command functions and opening the gate. Additionally, these EVA gates will be equipped with approved emergency traffic control-activating strobe light sensor, which will activate the gate from both directions of travel on the approach of emergency apparatus. Both automatic gates will have a battery back-up or manual mechanical disconnect in case of a power failure.

6.3 Premise Identification

Identification of roads and structures will comply with EFD Fire Code, Section 505.1, as follows:

- All structures shall be identified by street address. Numbers shall be 4 inches in height, 1/2 -inch stroke, and located 6 to 8 feet above grade. Addresses on multi-

residential buildings shall be 6 inches high with 1/2-inch stroke. Numbers will contrast with background.

- Multiple structures located off common driveways will include posting structure identification on structures, on the entrance to individual driveways, and at the entrance to the common driveway.
- If the structure is 100 feet from the roadway, structure identification should also be located at the entrance to the driveway.
- Access roads to construction areas shall be completed and paved prior to issuance of building permits and prior to combustible construction occurring.

Illuminated directory maps will be installed at driveway entrances for the north and south residential parcels. Final location of directory maps and content shall be approved by the EFD Fire Marshal.

6.4 Structures

6.4.1 Ignition-Resistant Structural Requirements

All new structures will be constructed to City of Escondido Fire Code standards. Each of the proposed buildings will comply with the enhanced ignition-resistant construction standards of the 2016 California Building Code (Chapter 7A). These requirements address roofs, eaves, exterior walls, vents, appendages, windows, and doors and result in hardened structures that have been proven to perform at high levels (resist ignition) during the typically short duration of exposure to burning vegetation from wildfires.

There are two primary concerns for structure ignition: 1) radiant and/or convective heat and 2) burning embers (NFPA 1144 2008, IBHS 2008, and others). 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. Likewise, radiant and convective heat impacts on structures have been minimized through the Chapter 7A exterior fire ratings for walls, windows and doors. Additionally, provisions for modified fuel areas separating wildland fuels from structures have reduced the number of fuel-related structure losses. As such, most of the primary components of the layered fire protection system provided the Nutmeg Homes Project are required by City and state codes but are worth mentioning because they have been proven effective for minimizing structural vulnerability to wildfire and, with the inclusion of required interior sprinklers (required in the 2016 Building/Fire Code update), of extinguishing or limiting the spread of interior fires, should embers succeed in entering a structure (such as through a window inadvertently left open). Even though these measures are now required by the latest Building and Fire Codes, at one time, they were used as mitigation measures for buildings in WUI areas, because they were known to reduce

structure vulnerability to wildfire. These measures performed so well, they were adopted into the code. The following project features are required for new development in WUI areas and form the basis of the system of protection necessary to minimize structural ignitions as well as providing adequate access by emergency responders.

6.5 Fire Protection Systems

6.5.1 Water

The project will be served by Rincon Del Diablo Municipal Water District and will be consistent with EFD requirements for a residential development within a VHFHSZ or "Very High Fire Danger" zone. The Water District requires new development to meet a dual 2,500 gpm fire flow in the district for a total fire flow of 5,000 gpm. The calculation assumes one structure fire in the Nutmeg Homes development and a second fire in another area of the same district zone. The pressures in the development will remain above 20 psi for a minimum duration of two hours when meeting the fire requirements for the water district and EFD fire flows.

6.5.2 Fire Hydrants

Hydrants shall be located along fire access roadways as determined by the EFD Fire Marshal to meet operational needs, at intersections, at the beginning radius of cul-de-sacs, and every 500 feet (on-center) of fire access roadways, regardless of parcel size. Hydrants will be consistent with EFD Design Standards (507.5.1.1). Reflective blue dot hydrant markers shall be installed in the street to indicate location of the hydrant. Crash posts will be provided where needed in on-site areas where vehicles could strike fire hydrants or fire department connections.

6.5.3 Automatic Fire Sprinkler Systems

All structures, of any occupancy type, will be protected by an automatic, interior fire sprinkler system. Fire sprinklers systems shall be in accordance with EFD and National Fire Protection Association (NFPA) Standards. The Project is proposing to install NFPA 13-D systems for each living unit. The requirements for the NFPA 13-D systems are two-fold. First, a two-hour vertical separation is required between individual living units from floor level to underside of roof. Secondly, each unit must have its own dedicated and properly sized water meter for the NFPA 13-D system. The sprinkler system will be remotely supervised by an approved 24/7 central-station (NFPA 71). Fire sprinkler and monitoring plans for each building will be submitted to EFD for approval before installation.

6.5.4 Fire Alarm Systems

All residential units shall have electric-powered, hard-wired smoke detectors and fire alarm systems in compliance with EFD, 2016 CFC, and NFPA 72: National Fire Alarm and Signaling Code.

6.6 Structure Setback Requirements

The Escondido Fire Code (Section 4907.1.2), addresses structures located at the top of slopes that are exposed to natural vegetation conditions to be set back 15 feet for single story structures and 30 feet for two story structures. Consistent with the code, structures at the toe of slope or at the top of interior slopes that will be part of the managed landscape do not require the 15 and 30 foot setbacks. Therefore, the structures for this Project do not have a setback requirement.

6.7 Pre-Construction Requirements

Prior to bringing combustible materials onto the site, utilities shall be in place, fire hydrants operational, an approved all-weather roadway in place, and fuel modification zones cleared of vegetation.

6.8 Defensible Space and Vegetation Management

6.8.1 Fuel Modification

An important component of a fire protection system for this Project is the provision for ignition resistant landscapes and modified vegetation buffers. FMZs are designed to provide vegetation buffers that gradually reduce fire intensity and flame lengths from advancing fire by strategically placing thinning zones and irrigated zones adjacent to each other. Fuel modification for the Project would be needed for the entire periphery of the site, along roadways, and also interior portions of the development.

6.8.1.1 Escondido Fuel Modification Zone Standards

The purpose of this section is to document EFD's standards and make them available for reference. However, the Project is proposing a site-specific fuel modification zone program with additional measures that are consistent with the intent of the standards, since the project site is constrained on the northern edge, providing 12 to 68 feet of achievable fuel modification. As such, the Nutmeg Homes site will include mitigation measures for additional fire prevention, protection, and suppression in compensation for the reduced FMZs on the north side of the property.

It should be noted that EFD is consistent with the 2016 California Fire Code (Section 4907 — Defensible Space), Government Code 51175 – 51189, and Public Resources Code 4291, which require that fuel modification zones be provided around every building that is designed primarily for

human habitation or use. Fuel modification consists of at least 100 feet, measured in a horizontal plane, around all structures. A typical landscape/FMZ installation consists of a 50-foot-wide, irrigated landscaped area (Zone 1), and a 50-foot-wide, 50% thinning of native brush (Zone 2).

6.8.1.2 Specific Nutmeg Homes Fuel Modification Zones

1. The area (Zone 1) within 50 feet of a building or structure shall be cleared of vegetation that is not fire resistant and re-planted with fire-resistant plants. In the area between 50–100 feet (Zone 2) from a building (where applicable), all dead and dying vegetation shall be removed. Native vegetation may remain in this area provided that the vegetation is modified so that combustible vegetation does not occupy more than 50% of the square footage of this area. Weeds and annual grasses shall be maintained at a height not to exceed 6 inches. The chips from chipping of vegetation that is completed on-site may remain if the chips are dispersed so they do not exceed 6 inches in depth. Trees may remain in both areas provided that the horizontal distance between crowns of adjacent trees and crowns of trees and structures is not less than 10 feet. Mature trees shall be trimmed to a height of six feet above the ground or surrounding vegetation.
2. When a building or structure in a hazardous fire area is setback less than 100 feet from the property line, the person owning or occupying the building or structure shall meet the requirements in subsection (1) above, to the extent possible, in the area between the building or structure and the property line.
3. The building official and EFD may provide lists of undesirable and recommended plants. This FPP includes a proposed list of undesirable plants specifically for the Project Area (Appendix D).
4. The FMZs proposed for portions of this project are not standard EFD widths as some areas include reduced Zone 1 and/or Zone 2 areas and are less than 100 total feet within the property borders. These reductions are related to grading extents or property boundaries that restrict Zone 1 and 2. Figure 5 illustrates the FMZ extents and Table 5 summarizes the breakdown for FMZs on the periphery of the site. The adequacy of the provided FMZ widths is based on a variety of analysis criteria including predicted flame length, fire intensity (BTUs) and duration, site topography, extreme weather, position of structures on the property, position of roadways, adjacent fuels, and type of construction.

Table 5
Nutmeg Homes Fuel Modification Zone Summary

Area	Fuel Modification Distance	Comments
Northern Edge	Zone 1 = 12 to 68 feet on-site and Zone 2 = 0 to 107 feet on-site	On-site FMZ Zone 1 is irrigated and would be maintained by HOA. Available on-site FMZ Zone 2 includes a triangular portion of the property in the northwest corner. Residential homes would receive additional fire protection measures as addressed in Section 7.1.
Eastern Edge	77 to 100-foot wide; Zone 1 occurs within property	Zone 1 consist of irrigated landscaping maintained by HOA combined with paved road and ROW (North Center City Parkway).
Southern Edge	minimum 100 feet in width	Minimum 15+ feet of HOA-maintained landscaping (on site) and up to 85 feet of HOA-maintained landscaping within Caltrans ROW (off-site).
Western Edge	Zone 1 = minimum 13 feet on-site and Zone 2 = 87 feet off-site	On-site FMZ Zone 1 is irrigated and would be maintained by HOA. Off-site FMZ Zone 2 (within Caltrans ROW) would be graded, replanted, and maintained by HOA as well.

6.8.2 Other Vegetation Management

6.8.2.1 Roadway-Adjacent Defensible Space

As required under Escondido Fire Code, an area of 20 feet from each side of Nutmeg Street and the curbside facing the project site along North Center City Parkway shall be improved and maintained to Zones 1 or Zone 2 standards. This area shall be maintained by the HOA or another approved entity. Vertical clearance of 13.5 feet shall also be maintained along these apparatus access roads.

6.8.2.2 Community Development Landscapes

The following requirements are provided for landscapes within the interior portions of the proposed development.

1. Plants used in the interior landscapes will include drought-tolerant, fire resistive trees, shrubs, and groundcovers that are approved by the EFD Fire Marshal. All landscaping shall be maintained by the HOA or another approved entity.
2. Throughout the project site, trees and vegetation shall be planted so that it does not impeded fire rescue window access. Palm trees that have fibrous tissue or leaf stem bases along the trunk shall be planted and maintained no closer than 30 feet from the trees drip line to any combustible structure. Some examples of tree species with fibrous tissue are *Chamaerops humilis* (Mediterranean Fan Palm), *Phoenix canariensis* (Canary Island Date Palm), *P. dactylifera* (Date Palm), *P. reclinata* (Senegal Date Palm), *P. roebelenii* (Pygmy Date Palm), and *Trachycarpus fortunei* (Windmill Palm). The *Washingtonia*

robusta (Mexican Fan Palm) and *W. filifera* (California Fan Palm) are examples of palm trees with leaf bases. Palm tree maintenance includes removing dead palm fronds and cleaning (i.e., skinning) palm trunks of fibrous tissue or leaf bases as needed to eliminate the presence of ember catching palm trunks.

- **Exception:** Properly skinned palms may be allowed to be planted no closer than 10 feet from the palm's drip line to structure, if the palms listed above are planted within recreation centers that are adjacent to non-residential buildings and they do not occur within Zone 1.

6.8.2.3 Special Fuel Management Issues

Trees may be planted within FMZs as long as they are not on the undesirable plant list in Appendix D. On the Project site, tree planting in the fuel modification zones and along roadways is acceptable, as long as they meet the following restrictions as described below:

- For streetscape plantings, fire resistive trees can be planted 10 feet from edge of curb to center of tree trunk. Care should be given to the type of tree selected, that it will not encroach into the roadway, or produce a closed canopy effect.
- Crowns of trees located within defensible space shall maintain a minimum horizontal clearance of 10 feet for fire resistant trees. Mature trees shall be pruned to remove limbs one-third the height or 8 feet, whichever is greater, above the ground surface adjacent to the trees.
- Dead wood and litter shall be regularly removed from trees.
- Ornamental trees shall be limited to groupings of 2–3 trees with canopies for each grouping separated horizontally as described in Table 6.

Table 6
Distance Between Tree Canopies by Percent Slope

Percent of Slope	Required Distances Between Edge of Mature Tree Canopies [1]
0–20	10 feet
21–40	20 feet
41+	30 feet

1 Determined from canopy dimensions as described in Sunset Western Garden Book (Current Edition)

6.8.2.4 Pre-Construction Requirements

- Perimeter fuel modification areas must be implemented and approved by the EFD prior to combustible materials being brought on site.

- Existing flammable vegetation shall be reduced by 50% on undeveloped portions of the project site upon commencement of construction.
- Dead fuel, ladder fuel (fuel which can spread fire from ground to trees), and downed fuel shall be removed and trees/shrubs shall be properly limbed, pruned, and spaced per this plan.

6.8.2.5 Undesirable Plants

Certain plants are considered to be undesirable in the landscape due to characteristics that make them highly flammable. These characteristics can be physical or chemical. The plants included in the Undesirable Plant List (Appendix D) are unacceptable from a fire safety standpoint, and shall not be planted on the site unless otherwise approved by the EFD's Fire Marshal.

6.8.3 Fuel Modification Area Vegetation Maintenance

All fuel modification area vegetation management shall be completed annually by May 15 of each year and more often as needed for fire safety, as determined by the EFD. The project HOA shall be responsible for all vegetation management throughout the common areas of the project site, in compliance with the requirements detailed herein and EFD requirements. The project HOA shall be responsible for ensuring long-term funding and ongoing compliance with all provisions of this FPP covering common areas and off-site fuel management easements, including vegetation planting, fuel modification, vegetation management, and maintenance requirements throughout the common portions of the Nutmeg Homes site.

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8-Ft High Fire Wall

Retaining Wall

Project Site

Fuel Modification Zones

Zone 1 - Irrigated

Zone 2 - 50% thinning (Onsite)

Water Quality Basin

Interior Landscaping

Building

Roadway/Hardscape

Off-site FMZ Easement (50% thinning only)

Gated Emergency Vehicle Access

SOURCE: AERIAL: SANGIS IMAGERY 2017; DEVELOPMENT PLAN: EXCEL ENGINEERING 2018

DUDEK

0 60 120 Feet

FIGURE 5

Conceptual Fuel Modification Plan

Fire Protection Plan for the Nutmeg Homes Project

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7 ADDITIONAL EDGE MITIGATION

As previously mentioned, due to site constraints, it is not feasible to achieve the standard FMZ width on the north side of the development. This FPP incorporates additional analysis and measures that will be implemented to compensate for potential fire related threats. These measures are customized for this site based on the analysis results and focus on providing functional equivalency as a City-defined, full fuel modification zone.

The specific structures that are affected by this analysis are those that cannot provide at least 100 feet of structural setback from off-site fuel beds. A 12- to 68-foot setback is less than typically required from wildland fuels including coastal sage scrub, chaparral and other high fire prone vegetation communities. Standard fuel modification zones are 100 feet in many jurisdictions (or to property line – PRC 4291).

As experienced in numerous wildfires, including the most recent fire storms in San Diego County (2003, 2007, and 2017), homes in the WUI are potential fuel. The distance between the wildland fire that is consuming wildland fuel and the home ("urban fuel") is the primary factor for structure ignition (not including burning embers). The closer a fire is to a structure, the higher the level of heat exposure (Cohen 2000). However, studies indicate that given certain assumptions (e.g., 10 meters of low fuel landscape, no open windows), wildfire does not spread to homes unless the fuel and heat requirements (of the home) are sufficient for ignition and continued combustion (Cohen 1995, Alexander et al. 1998). Construction materials and methods can prevent or minimize ignitions. Similar case studies indicate that with nonflammable roofs and vegetation modification from 10–18 meters (roughly 32–60 feet) in southern California fires, 85–95% of the homes survived (Howard et al. 1973, Foote and Gilless 1996). Similarly, San Diego County after fire assessments indicate strongly that the building codes are working in preventing home loss: of 15,000 structures within the 2003 fire perimeter, 17% (1,050) were damaged or destroyed. However, of the 400 structures built to the 2001 codes (the most recent at the time), only 4% (16) were damaged or destroyed. Further, of the 8,300 homes that were within the 2007 fire perimeter, 17% were damaged or destroyed. A much smaller percentage (3%) of the 789 homes that were built to 2001 codes were impacted and an even smaller percentage (2%) of the 1,218 structures built to the 2004 Codes were impacted (IBHS 2008). Damage to the structures built to the latest codes is likely from flammable landscape plantings or objects next to structures or open windows or doors (Hunter 2007).

These results support Cohen's (2000) findings that if a community's homes have a sufficiently low home ignitability (i.e., 2010 City of Escondido Building Code), the community can survive exposure to wildfire without major fire destruction. This provides the option of mitigating the wildland fire threat to homes/structures at the residential location without extensive wildland fuel reduction.

Cohen's (1995) studies suggest, as a rule-of-thumb, larger flame lengths and widths require wider fuel modification zones to reduce structure ignition. For example, valid SIAM results indicate that a 20-foot high flame has minimal radiant heat to ignite a structure (bare wood) beyond 33 feet (horizontal distance). Whereas, a 70-foot-high flame may require about 130 feet of clearance to prevent structure ignitions from radiant heat (Cohen and Butler 1996). This study utilized bare wood, which is more combustible than the ignition resistant exterior walls for structures built today. Fire behavior modeling conducted for this project indicates that fires in the oak woodlands would result in roughly 15-foot flame lengths under summer conditions. Extreme conditions may result in crown fire, where tree crowns burn and create more intense fire and longer flame lengths. Fire during extreme conditions would be less likely to affect residents of this community because it is anticipated that they would be evacuated well before wildland fire from the east or north encroached upon this semi-rural area of Escondido.

As indicated in this report, the FMZs and additional fire protection measures proposed for the north side of the development provide equivalent wildfire buffer, but are not standard zones. Rather, they are based on a variety of analysis criteria including predicted flame length, fire intensity (Btu), site topography and vegetation, extreme and typical weather, position of structures on pads, position of roadways, adjacent fuels, fire history, current vs. proposed land use, neighboring communities relative to the proposed project, and type of construction. The fire intensity research conducted by Cohen (1995), Cohen and Butler (1996), and Cohen and Saveland (1997) and Tran et al. (1992) supports the fuel modification alternatives proposed for this project.

7.1 Additional Structure Protection Measures for North Side of Development

The following additional measures will be implemented to "mitigate" potential structure fire exposure related to the provided FMZs for the north side of the development. These measures are customized for this site, its unique topographical and vegetative conditions, and focus on providing functional equivalency as a full fuel modification zone. In order to provide compensating structural protection in the absence of a full FMZ, and in addition to the residences being built to the latest ignition resistant codes, these structures will also include the following features for additional fire prevention, protection, and suppression:

1. Windows will be upgraded on the preserved vegetation side of the structures to include dual pane, both panes tempered, exceeding the code requirement;
2. A noncombustible, 8-foot wall at the rear or side yard, as applicable, to function as a heat-deflecting landscape wall above the planned retaining wall;

3. Propose to conduct a formal landscaping plan review for structures with a façade facing open space area. Landscape plans would be reviewed and approved by HOA's or similar entity's landscape committee.
4. Annually hire a 3rd party inspector to evaluate whether designated FMZ areas meet the requirements of this FPP and EFD.

The information provided herein supports the ability of the proposed structures and FMZs to withstand the predicted short duration, low to moderate intensity wildfire and ember shower that would be expected from wildfire burning in the vicinity of the site or within the site's landscape.

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8 HOMEOWNER'S ASSOCIATION WILDFIRE EDUCATION PROGRAM

The residents and visitors of the Nutmeg Homes Project will be provided a proactive educational component disclosing the potential wildfire risk and this report's requirements. This educational information must include maintaining the landscape and structural components according to the appropriate standards and embracing a "Ready, Set, Go" stance on evacuation.

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9 CONCLUSION

This FPP is submitted in support of an application for project entitlement of the Nutmeg Homes development project. It is submitted in compliance with requirements of the EFD and the City Fire Code. The requirements in this document meet fire safety, building design elements, fuel management/modification, and landscaping recommendations of the EFD. Where the project does not strictly comply with the Code, such as with some fuel modification zone widths, alternative materials and methods have been proposed that provide functional equivalency as the code intent. The recommendations provided in this FPP have been designed specifically for the proposed construction of structures adjacent the WUI zone at the north edge of the Nutmeg Homes project site. The project site's fire protection system includes a redundant layering of protection methods that have been shown through post-fire damage assessments to reduce risk of structural ignition and compensate for fuel modification area reductions.

Modern infrastructure will be provided along with implementation of the latest ignition resistant construction methods and materials. Further, all structures are required to include automatic sprinklers consistent with City's Fire Code and NFPA 13-D. Fuel modification will occur on exposed edges and adjacent open space areas and ROWs of the project site. The fuel modification zone will be maintained and inspected annually by the HOA. Maintenance includes removing all dead and dying materials and maintaining appropriate horizontal and vertical spacing. In addition, plants that establish or are introduced to the fuel modification zone that are not on the approved plant list will be removed, unless occurring in a protected habitat, which would require agency approvals.

Ultimately, it is the intent of this FPP to guide, through code and other project specific requirements, the construction of structures that are defensible from wildfire and, in turn, do not represent significant threat of ignition source for the adjacent native habitat. It must be noted that during extreme fire conditions, there are no guarantees that a given structure will not burn. Precautions and mitigating actions identified in this report are designed to reduce the likelihood that fire would impinge upon the proposed structures. There are no guarantees that fire will not occur in the area or that fire will not damage property or cause harm to persons or their property. Implementation of the required enhanced construction features provided by the applicable codes and the mitigating fuel modification requirements provided in this FPP will accomplish the goal of this FPP to assist firefighters in their efforts to defend these structures and reduce the risk associated with this project's WUI location. For maximum benefit, the developer, contractors, engineers, and architects are responsible for proper implementation of the concepts and requirements set forth in this report. Homeowners and HOA are responsible to maintain their structures and landscaping as required by this report, the applicable Fire Code, and the EFD.

Although the proposed development and landscape will be significantly improved in terms of ignition resistance, it should not be considered a shelter-in-place community. It is recommended that the homeowners or other occupants who may reside within the Nutmeg Homes development adopt a conservative approach to fire safety. This approach must include maintaining the landscape and structural components according to the appropriate standards and embracing a "Ready, Set, Go[3]" stance on evacuation. Accordingly, occupants should evacuate the residence and the area as soon as they receive notice to evacuate, or sooner, if they feel threatened by wildfire or structure fire in a nearby residence. Fire is a dynamic and somewhat unpredictable occurrence and it is important for residents to educate themselves on practices that will improve their home survivability and their personal safety.

[3] International Fire Chiefs Association "Ready, Set, Go" website link: http://wildlandfirersg.org/

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12 LIST OF PREPARERS

Project Manager/Senior Fire Protection Planner:

Michael Huff
Principal/Fire Protection Planner; San Diego County California Environmental Quality Act Consultant List
Dudek

Fire Protection Planner, Fire Behavior Modeling:

Michael Scott
Urban Forester /Fire Protection Planner
Dudek

Fire Protection Analyst

Dana Link-Herrera
CEQA/NEPA Associate Analyst
Dudek

Computer Aided Design/Drafting

Lesley Terry
CADD Specialist
Dudek

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APPENDIX A

Representative Site Photograph Log

Appendix A
Representative Photographs

Photograph 1

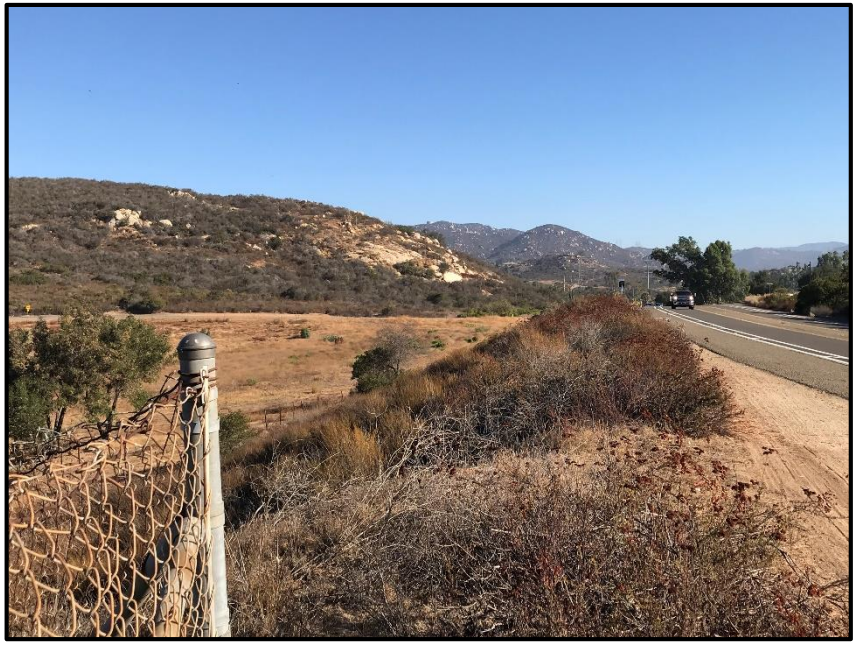
Photograph 2

Photographs #1 and #2 (facing toward the west) show the typical fuel types ((coastal sage scrub (Sh5)/mowed grasslands (Gr 1)) and fuel loading in the southern-southwestern edges of the project site. Both photographs illustrate the flat to steep (manufactured) sloping terrain.

Photograph 3

Photograph 4

Photographs #3 and #4 (facing north) show the typical fuel type (mixed chaparral (Sh5)) on hillside above northern portion of development footprint. Photograph #4 shows Nutmeg Street looking to the east.



Photograph 5

Photograph 6

Photograph #5 is a view of the northeast corner of the property. Photograph #6 is a close-up of the fuel type (mixed chaparral) in the open space north and east of the project site.

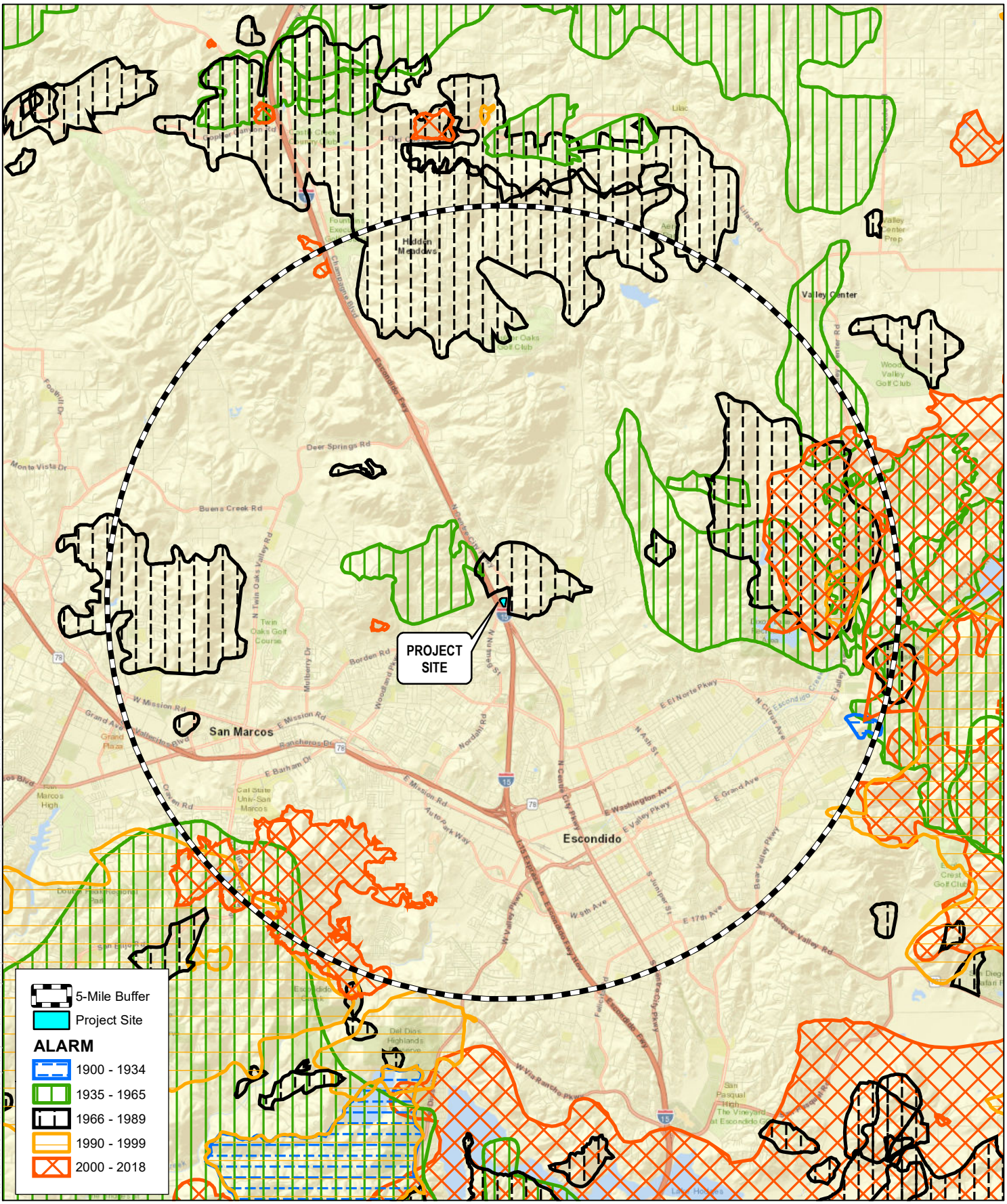
Photograph 7

Photograph 8

This denser, chaparral-covered slopes in photograph #7 is the steep terrain and fuel type (Sh5) modeled in BehavePlus Fire Scenario 2. Photograph #8 shows North Centre City Parkway looking to the east.

APPENDIX B

Nutmeg Homes Project Vicinity
Fire History Exhibit



SOURCE: AERIAL- BING MAPPING SERVICE; FIRE DATA-CALFIRE 2017

DUDEK

APPENDIX B

Fire History Map

Fire Protection Plan for the Nutmeg Homes Project

APPENDIX C

BehavePlus Fire Behavior Analysis

APPENDIX C
Fire Behavior Modeling Analysis
Nutmeg Homes Project

BEHAVEPLUS FIRE BEHAVIOR MODELING

Fire behavior modeling has been used by researchers for approximately 50+ years to predict how a fire will move through a given landscape (Linn 2003). The models have had varied complexities and applications throughout the years. One model has become the most widely used as the industry standard for predicting fire behavior on a given landscape. That model, known as "BEHAVE", was developed by the U. S. Government (USDA Forest Service, Rocky Mountain Research Station) and has been in use since 1984. Since that time, it has undergone continued research, improvements, and refinement. The BehavePlus fire behavior modeling software incorporates years of research and testing. Numerous studies have been completed testing the validity of the fire behavior models' ability to predict fire behavior given site specific inputs. One of the most successful ways the model has been improved has been through post-wildfire modeling (Brown 1972, Lawson 1972, Sneeuwjagt and Frandsen 1977, Andrews 1980, Brown 1982, Rothermel and Rinehart 1983, Bushey 1985, McAlpine and Xanthopoulos 1989, Grabner, et. al. 1994, Marsden-Smedley and Catchpole 1995, Grabner 1996, Alexander 1998, Grabner et al. 2001, Arca et al. 2005). In this type of study, Behave is used to model fire behavior based on pre-fire conditions in an area that recently burned. Real-world fire behavior, documented during the wildfire, can then be compared to the prediction results of Behave and refinements to the fuel models incorporated, retested, and so on.

Fire behavior modeling includes a high level of analysis and information detail to arrive at reasonably accurate representations of how wildfire would move through available fuels on a given site. Fire behavior calculations are based on site-specific fuel characteristics supported by fire science research that analyzes heat transfer related to specific fire behavior. To objectively predict flame lengths, spread rates, and fireline intensities, the BehavePlus 5.0.5 fire behavior modeling system was applied using predominant fuel characteristics, slope percentages, and four representative fuel models observed on site.

Predicting wildland fire behavior is not an exact science. As such, the movement of a fire will likely never be fully predictable, especially considering the variations in weather and the limits of weather forecasting. Nevertheless, practiced and experienced judgment, coupled with a validated fire behavior modeling system, results in useful and accurate fire prevention planning information.

To be used effectively, the basic assumptions and limitations of BehavePlus must be understood.

- First, it must be realized that the fire model describes fire behavior only in the flaming front. The primary driving force in the predictive calculations is dead fuels less than one-quarter inch in diameter. These are the fine fuels that carry fire. Fuels greater than one inch have little effect while fuels greater than three inches have no effect on fire behavior.

- Second, the model bases calculations and descriptions on a wildfire spreading through surface fuels that are within six feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.
- Third, the software assumes that weather and topography are uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel model must be carefully considered to obtain useful predictions.
- Fourth, the BehavePlus fire behavior computer modeling system was not intended for determining sufficient fuel modification zone widths. However, it does provide the average length of the flames, which is a key element for determining "defensible space" distances for minimizing structure ignition.

Although BehavePlus has some limitations, it can still provide valuable fire behavior predictions which can be used as a tool in the decision-making process. In order to make reliable estimates of fire behavior, one must understand the relationship of fuels to the fire environment and be able to recognize the variations in these fuels. Natural fuels are made up of the various components of vegetation, both live and dead, that occur on a site. The type and quantity will depend upon the soil, climate, geographic features, and the fire history of the site. The major fuel groups of grass, shrub, trees, and slash are defined by their constituent types and quantities of litter and duff layers, dead woody material, grasses and forbs, shrubs, regeneration, and trees. Fire behavior can be predicted largely by analyzing the characteristics of these fuels. Fire behavior is affected by seven principal fuel characteristics: fuel loading, size and shape, compactness, horizontal continuity, vertical arrangement, moisture content, and chemical properties.

The seven fuel characteristics help define the 13 standard fire behavior fuel models (Anderson 1982) and the five custom fuel models developed for Southern California (Weise 1997). According to the model classifications, fuel models used in BehavePlus have been classified into four groups, based upon fuel loading (tons/acre), fuel height, and surface to volume ratio. Observation of the fuels in the field (on site) determines which fuel models should be applied in BehavePlus. The following describes the distribution of fuel models among general vegetation types for the standard 13 fuel models and the custom Southern California fuel models:

- Grasses Fuel Models 1 through 3
- Brush Fuel Models 4 through 7, SCAL 14 through 18
- Timber Fuel Models 8 through 10
- Logging Slash Fuel Models 11 through 13

In addition, the aforementioned fuel characteristics were utilized in the recent development of 40 new fire behavior fuel models (Scott and Burgan 2005) developed for use in BehavePlus modeling efforts. These new models attempt to improve the accuracy of the standard 13 fuel

models outside of severe fire season conditions, and to allow for the simulation of fuel treatment prescriptions. The following describes the distribution of fuel models among general vegetation types for the new 40 fuel models:

- Non-Burnable Models NB1, NB2, NB3, NB8, NB9
- Grass Models GR1 through GR9
- Grass-shrub Models GS1 through GS4
- Shrub Models SH1 through SH9
- Timber-understory Models TU1 through TU5
- Timber litter Models TL1 through TL9
- Slash blowdown Models SB1 through SB4

BehavePlus software was used in the development of the Nutmeg Homes Project (Project) Fire Protection Plan (FPP) in order to evaluate potential fire behavior for the project site. Existing site conditions were evaluated, and local weather data was incorporated into the BehavePlus modeling runs.

BEHAVEPLUS FUEL MODEL INPUTS

Dudek utilized BehavePlus software to evaluate fire behavior potential for the project site. Four fire scenarios were evaluated, including two summer (Onshore winds, 50th percentile) weather conditions) and two more extreme fall (Offshore winds, 97th percentile) weather conditions. BehavePlus software requires site-specific variables for surface fire spread analysis, including fuel type, fuel moisture, wind speed, and slope data. The output variables used in this analysis include flame length (feet), rate of spread (feet/minute), fireline intensity (BTU/feet/second), and spotting distance (miles). The following provides a description of the input variables used in processing the BehavePlus models for the project site. In addition, data sources are cited and any assumptions made during the modeling process are described.

Vegetation/Fuel Models

To support the fire behavior modeling efforts conducted for this FPP, the different vegetation types observed adjacent to the site were classified into the aforementioned numeric fuel models. Dudek analyzed fire behavior for the fuels adjacent to the property in all directions. As is customary for this type of analysis, the terrain and fuels directly adjacent to the proposed development and fuel modification zones (FMZ) are used for determining flame lengths and fire spread. It is these fuels that would have the potential to affect the project's structures from a radiant and convective heat perspective as well as from direct flame impingement. Fuel beds, including coastal sage scrub, disturbed grasslands, and mixed chaparral, are adjacent to the

structures in the proposed development. These fuel types can produce flying embers that may affect the project, but defenses have been built into the structures to prevent ember penetration. Table 1 provides a description of the two fuel models observed in the vicinity of the site that were subsequently used in the analysis for this project. Modeled areas include the mowed grasslands (Fuel Model Gr1) in the Caltrans Right-of-Way (ROW), coastal sage scrub (Fuel Model Sh5), which are found to the west, east, and south, and mixed chaparral (Fuel Model Sh5), which is primarily found to the north of the property. A total of four fire modeling scenarios were completed for the Project area. These sites were selected based on the strong likelihood of fire approaching from these directions during a Santa Ana wind-driven fire event (fire scenarios 1 and 2) and an on-shore weather pattern (fire scenarios 3 and 4). Dudek also conducted modeling of the site for post-Fuel Modification Zones' (FMZ) recommendations for this project (Refer to Table 2 for post-FMZ fuel model descriptions). Fuel modification includes establishment of irrigated and thinned zones on the periphery of the Project as well as interior landscape requirements. For modeling the post-FMZ treatment condition, fuel model assignments were re-classified for the FMZ 1 (Fuel Model 8) and FMZ 2 (Fuel Model Sh1).

Table 1
Existing Fuel Model Characteristics

Fuel Model Assignment	Vegetation Description	Location	Fuel Bed Depth (Feet)
Gr1	Short, Sparse Dry Climate Grass	Represents treated grasses within Caltrans ROW	<1.0 ft.
Sh5	High Load Dry Climate Shrub	Sage scrub occurs along southern, western, and eastern edges of property. Mixed chaparral is concentrated to the north and east of the project site.	<6.0 ft.

Table 2
Post-development Fuel Model Characteristics

Fuel Model Assignment	Vegetation Description	Location	Fuel Bed Depth (Feet)
8	Compact litter	Fuel Modification Zone 1: irrigated landscape	<0.5 ft.
Sh1	Low Load, Dry Climate Shrub	Fuel Modification Zone 2: thinning of brush	<4.0 ft.

Topography

Slope is a measure of angle in degrees from horizontal and can be presented in units of degrees or percent. Slope is important in fire behavior analysis as it affects the exposure of fuel beds. Additionally, fire burning uphill spreads faster than those burning on flat terrain or downhill as

uphill vegetation is pre-heated and dried in advance of the flaming front, resulting in faster ignition rates. Natural slope values ranging from 3% to 35% were measured around the perimeter of the project site from U.S. Geological Survey (USGS) topographic maps. Slope gradients for landscape areas are assumed to be flat (3%) or 50% (2:1 Manufactured slopes), as presented on the project's site plan.

Weather Analysis

The County of San Diego, Department of Planning and Land Use (County of San Diego 2010) developed guidelines to identify acceptable fire behavior modeling weather inputs for fire conditions during summer months and Santa Ana fire weather patterns. The County analyzed and processed fire weather from Remote Automated Weather Stations (RAWS) between April 15 to December 31 in order to represent the general limits of the fire season. Data provided by the County's analysis included temperature, relative humidity, and sustained wind speed and is categorized by weather zone, including Maritime, Coastal, Transitional, Interior, and Desert.

As identified in the County's guidelines, Dudek utilized the Fine Dead Fuel Moisture (FDFM) tool within BehavePlus fire behavior modeling software package to determine potential fuel moisture values to be input into the BehavePlus runs. The temperature, relative humidity, and wind speed data for the Transitional (County of San Diego 2010) weather zone were utilized for this FPP based on the project's location. Reference fuel moistures were calculated in the FDFM tool and were based on site-specific topographic data inputs. Table 3 summarizes the FDFM inputs and the resulting fine dead fuel moisture values.

Table 3
BehavePlus Fine Dead Fuel Moisture Calculation

Variable	Summer Weather (50th Percentile)	Peak Weather (97th Percentile)
Dry Bulb Temperature	90 -109 deg. F	90 -109 deg. F
Relative Humidity	10 - 14 %	5 -9 %
Reference Fuel Moisture	2 %	1 %
Month	May June July	May June July
Time of Day	12:00 - 13:59	12:00 - 13:59
Elevation Difference	Level (within 1,000 ft.)	Level (within 1,000 ft.)
Slope	30% +	30% +
Aspect	East	East
Fuel Shading	Exposed (< and > 50% shading)	Exposed (< and > 50% shading)
Fuel Moisture Correction	1 %	1 %
Fine Dead Fuel Moisture	3 %	2 %

The weather variables presented in Table 4 are based on the calculated FDFM (Table 3) and the wind speed values identified in the County of San Diego standards.

Table 4
Weather Variables From County of San Diego Standards

Variable	Summer Weather (Onshore Winds)	Peak Weather (Offshore Winds)
1h Moisture	3%	2%
10h Moisture	5%	3%
100h Moisture	7%	5%
Live Herbaceous Moisture	60%	30%
Live Woody Moisture	90%	50%
20-foot Wind Speed	10-20 mph	30-40 mph
Wind Adjustment Factor (BehavePlus)	0.6	0.6

Note:
[1] mph = miles per hour

Fire Modeling Scenarios

Based on slope and fuel conditions, four different fire scenarios were evaluated for the project site, including:

- **Scenario 1:** Extreme fire weather with off-shore, Santa Ana winds and fall fire burning in coastal sage scrub and mixed chaparral along northern portion of project site. The terrain is steep (35% slope) and fire would be burning downhill toward the site. Potential ignition sources could be from vehicles travelling on Interstate 15 (I-15) or from a wildfire starting in open space areas to the north or east.
- **Scenario 2:** Extreme fire weather with off-shore, Santa Ana winds and a fall fire burning in primarily coastal sage scrub along the eastern edge of the property. The terrain slopes downhill towards the project site at approximately 27% slope. Potential ignition sources could be from vehicles traveling on North Centre City Parkway, a wildfire burning from the east, or possibly from adjacent semi-rural residential neighborhoods.
- **Scenario 3:** Typical summer fire weather with on-shore winds and fire burning in the well-maintained grasslands in Caltrans ROW and the steep slope to the south that is vegetated with coastal sage scrub. Potential ignition sources from vehicles traveling on I-15 or possibly from adjacent residential communities. Fire in this area would be moving on flat terrain and downhill toward the project site.
- **Scenario 4:** Summer fire weather with on-shore winds and fire burning in the coastal sage scrub along the western edge of the project site. The terrain is steep (30% slope)

with potential ignition sources from vehicles travelling on I-15. Fire in this area would be moving downhill toward the project site.

Fire Behavior Modeling Analysis

As mentioned, the BehavePlus fire behavior modeling software package was utilized in evaluating anticipated fire behavior adjacent to the project site. Four focused analyses were completed, each assuming worst-case fire weather conditions for a fire approaching the project site from the northeast, east, southwest, and northwest. Four fire behavior variables were selected as outputs from the BehavePlus analysis conducted for the project site, and include flame length (feet), rate of spread (mph), fireline intensity (BTU/feet/second), and surface fire spotting distance (miles). The aforementioned fire behavior variables are an important component in understanding fire risk and fire agency response capabilities. Flame length, the length of the flame of a spreading surface fire within the flaming front, is measured from midway in the active flaming combustion zone to the average tip of the flames (Andrews, Bevins, and Seli 2008). Fireline intensity is a measure of heat output from the flaming front, and also affects the potential for a surface fire to transition to a crown fire. Fire spread rate represents the speed at which the fire progresses through surface fuels and is another important variable in initial attack and fire suppression efforts (Rothermel and Rinehart 1983). Spotting distance is the distance a firebrand or ember can travel down wind and ignite receptive fuel beds. The results of fire behavior modeling analysis are presented in Tables 5 and 6. Identification of modeling run locations is presented graphically in Figure 5 of the FPP.

Table 5
Nutmeg Homes BehavePlus Fire Behavior Model Results
Existing Conditions

Fire Scenarios	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph)	Spotting Distance (miles)
Scenario 1: Coastal sage scrub, 35% slope, 40 mph sustained winds				
Fuel Model Sh5	49.3	27,196	9.0	2.2
Scenario 2: Coastal sage scrub, 25% slope, 40 mph sustained winds				
Fuel Model Sh5	49.1	26,870	9.0	2.2
Scenario 3: Caltrans ROW and natural 27% slope, 20 mph sustained winds				
Cal Trans ROW (Gr1)	2.3	35	0.3	0.2
Coastal sage scrub vegetated slope (Sh5)	24.0	5,673	2.2	0.9
Scenario 4: Coastal sage scrub, 27% downhill slope, 20 mph sustained winds				
Coastal sage scrub vegetated slope (Sh5)	24.6	6,014	2.3	0.9

Table 6
Nutmeg Homes BehavePlus Fire Behavior Model Results
Post-Project Conditions

Scenario	Flame Length (feet)	Fireline Intensity (BTU/feet/second)	Spread Rate (mph)	Spotting Distance (miles)
Scenario 1: Fuel treatments on south-facing natural and manufactured slopes, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Fuel modification zone 2 (Sh1)	10.6	964	1.5	0.8
Scenario 2: Fuel treatments on flat, landscaped area, 40 mph maximum winds				
Fuel modification zone 1 (FM8)	2.6	46	0.13	0.3
Scenario 3: Fuel treatment on natural 27% slope, 20 mph maximum winds				
Fuel modification zone 1 (FM8)	2.3	34	0.10	0.2
Fuel modification zone 2 (Sh1)	0.9	4	0.03	0.1
Scenario 4: Fuel treatments on relatively flat fill slope, 20 mph maximum winds				
Fuel modification zone 1 (FM8)	2.3	34	0.10	0.2
Fuel modification zone 2 (Sh1)	0.9	4	0.03	0.1

As presented in Table 5, wildfire behavior in non-treated coastal sage scrub and mixed chaparral, presented as a Fuel Model Sh5, represents the most extreme conditions, varying with different wind speeds. In this case, flame lengths can be expected to reach up to approximately 48.3 feet with 40 mph maximum wind speeds (extreme fire weather conditions) and 24.6 feet with 20 mph wind speeds (Onshore weather conditions). Spread rates for sage scrub fuel beds range from 2.3 mph (summer-Onshore winds) to 9.0 mph (extreme-Offshore winds). Spotting distances, where airborne embers can ignite new fires downwind of the initial fire, range from 0.9 miles (summer condition) to 2.2 miles (extreme condition).

As presented in Table 6, Dudek conducted modeling of the site for post-FMZ fuel recommendations for this project. Fuel modification includes establishment of irrigated and thinned zones on the periphery of the project's neighborhoods and roads as well as interior landscape requirements. For modeling the post-FMZ treatment condition, fuel model assignments were re-classified for the FMZ 1(Fuel Model 8), and FMZ 2 (Fuel Model Sh1). Fuel model assignments for all other areas remained the same as those classified for the existing condition. As depicted, the fire intensity and flame lengths in untreated, biological open space areas would remain the same. Conversely, the FMZ areas experience a significant reduction in flame length and intensity. The 49.3-foot tall flames predicted during pre-treatment modeling during extreme weather conditions are reduced to 10.6 feet tall at the outer edges of the FMZ (i.e., FMZ 2) and under 3.0 feet by the time the inner portions i.e., (FMZ 1) of the FMZ are reached. During summer weather conditions, a fire approaching from the west would be reduced from 24.6-foot tall flames to less than 1.0-foot tall in Zone 2 and 2.3 feet in height in Zone 1

(taller flame length in zone 1 is due to mulch layer within landscaped areas) with low fire intensity due to the higher live and dead fuel moisture contents.

It should be noted that the results presented in Tables 5 and 6 depict values based on inputs to the BehavePlus software. Changes in slope, weather, or pockets of different fuel types are not accounted for in this analysis, but models provide a worst-case wildfire condition as part of a conservative approach. Further, this modeling analysis assumes a correlation between the project site vegetation and fuel model characteristics. Model results should be used as a basis for planning only, as actual fire behavior for a given location will be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns.

The information in Table 7 pertains to interpretation of flame length and fireline intensity as it relates to fire suppression efforts.

Table 7
Fire Suppression Interpretation

Flame Length (ft)	Fireline Intensity (Btu/ft/s)	Interpretations
Under 4 feet	Under 100 BTU/ft/s	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 to 8 feet	100-500 BTU/ft/s	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 to 11 feet	500-1000 BTU/ft/s	Fires may present serious control problems -- torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Over 11 feet	Over 1000 BTU/ft/s	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

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APPENDIX D

Undesirable Plant List

APPENDIX D
Undesirable Plants List

Botanical Name	Common Name	Comment*
Trees		
Abies species	Fir	H
Acacia species (numerous)	Acacia	H
Agonis juniperina	Juniper Myrtle	H
Araucaria species (A. heterophylla, A. araucana, A. bidwillii)	Araucaria (Norfolk Island Pine, Monkey Puzzle Tree, Bunya Bunya)	H
Cedrus species (C. atlantica, C. deodara)	Cedar (Atlas, Deodar)	H
Chamaecyparis species	False Cypress	H
Cryptomeria japonica	Japanese Cryptomeria	H
Cupressocyparis leylandii	Leyland Cypress	H
Cupressus species (C. fobesii, C. glabra, C. sempervirens,)	Cypress (Tecate, Arizona, Italian, others)	H,Tecate=SDC
Eucalyptus species (numerous)	Eucalyptus	H
Juniperus species (numerous)	Juniper	H
Larix species (L. decidua, L. occidentalis, L. kaempferi)	Larch (European, Japanese, Western)	H
Palm species	Palms	H
Picea (numerous)	Spruce	H
Pinus species (P. brutia, P. canariensis, P. b. eldarica, P. halepensis, P. pinea, P. radiata, numerous others)	Pine (Calabrian, Canary Island, Mondell, Aleppo, Italian Stone, Monterey)	H
Platycladus orientalis	Oriental arborvitae	H
Podocarpus gracilior	Fern Pine	H
Pseudotsuga menziesii	Douglas Fir	H
Taxodium species (T. ascendens, T. distichum, T. mucronatum)	Cypress (Pond, Bald, Monarch, Montezuma)	H
Taxus species (T. baccata, T. brevifolia, T. cuspidata)	Yew (English, Western, Japanese)	H
Thuja species (T. occidentalis, T. plicata)	Arborvitae/Red Cedar	H
Tsuga species (T. heterophylla, T. mertensiana)	Hemlock (Western, Mountain)	H
Groundcovers & Shrubs		
Acacia species	Acacia	H
Adenostoma fasciculatum	Chamise	H,SDC
Adenostoma sparsifolium	Red Shanks	H,SDC
Artemisia species (A. abrotanium, A. absinthium, A. californica, A. caucasica, A. dracunculus, A. tridentata, A. pynocephala)	Sagebrush (Southernwood, Wormwood, California, Silver, True tarragon, Big, Sandhill)	H,SDC
Bambusa species	Bamboo	H
Dodonaea viscosa	Hopseed Bush	H
Eriogonum fasciculatum	Common Buckwheat	H,SDC
Heteromeles arbutifolia	Toyon	M
Heterotheca grandiflora	Telegraph Plant	H,SDC
Juniperus species	Juniper	H
Lonicera japonica	Japanese Honeysuckle	H
Malosoma Laurina	Laurel Sumac	M
Miscanthus species	Eulalia Grass	H
Muehlenbergia species	Deer Grass	H,SDC

Botanical Name	Common Name	Comment*
Groundcovers & Shrubs (cont.)		
Pennisetum setaceum	Fountain Grass	H
Pickeringia montana	Chaparral Pea	H,SDC
Quercus dumosa	Scrub Oak	M
Rosmarinus species	Rosemary	H
Rhus integrifolia	Lemonade Berry	M
Salvia mellifera	Black Sage	H,SDC
Thuja species	Arborvitae	H
Urtica urens	Burning Nettle	H,SDC
Xylococcus bicolor	Mission Manzanita	M

* H = High Fuel Plants, M = Moderate Fuel Plants, SDC = San Diego County Native Species

Notes:

1. This list was prepared by Dudek for Nutmeg Homes Project. Certain plants are considered to be undesirable in the landscape due to characteristic that make them highly flammable. These characteristics can be either physical or chemical. Physical properties would include large amounts of dead material retained within the plant, rough or peeling bark, and the production of copious amounts of litter. Chemical properties include the presence of volatile substances such as oils, resins, wax, and pitch. Plants with these characteristics should not be planted close to structures in fire hazard areas. These species are typically referred to as "Target Species" or "Moderate to High Fuel Plants", since their complete or partial removal from the landscape is a critical part of hazard reduction. High Fuel Plants are highly flammable and should not be planted within 50 feet of a structure. Moderate Fuel Plants are considered moderately flammable and should be avoided when only slow burning/low fuel species are permitted within a given fuel modification zone. Many of these species, if existing on the property and adequately maintained (e.g., pruning, thinning, irrigated, litter removal and weeding), could remain as long as the potential for spreading a fire has been reduced or eliminated.
2. For the purpose of using this list as a guide in selecting plant material, it is stipulated that all plant material will burn under various conditions.
3. The absence of a particular plant, shrub, groundcover, or tree, from this list does not necessarily mean it is fire resistive.
4. All vegetation used in Vegetation Management Zones and elsewhere in this development shall be subject to approval of the Fire Marshal.
5. Landscape architects may submit proposals for use of certain vegetation on a project specific basis. They shall also submit justifications as to the fire resistivity of the proposed vegetation.

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