Planning Tool User Guide

Single-Access Subdivisions Assessment Project:

Developing a Planning Tool for Evaluating Proposed Developments Accessible by Dead-End Roads

Prepared for

CAL FIRE and the California Board of Forestry and Fire Protection

By

California Polytechnic State University, San Luis Obispo

CAL POLY
SAN LUIS OBISPO

June 2016

This page intentionally left blank

TABLE OF CONTENTS

Planning Tool User Guide **1**

Introduction 1

Purpose of the User Guide 5

Intended Users 5

Nature of Tool 5

Hosting of Tool 5

Procedure for Applying the Planning Tool 6

Step 1 8

Step 2 13

Step 3 16

Step 4 17

Step 5 18

Step 6 19

This page intentionally left blank

PLANNING TOOL USER GUIDE

Introduction

When a wildfire threatens a single-access subdivision, potentially life-threatening problems may arise when occupants seek to evacuate to a safe location while fire and other responders try to manage the emergency. Even when access is not disrupted by fire or smoke, factors such as inadequate road widths, steep grades, traffic congestion, and obstacles in the road can interfere with safe and timely egress and ingress, possibly causing entrapment of occupants and preventing responders from gaining access to do their job.

Under California's Subdivision Map Act (known as the "Map Act"), authority is given to cities and counties to regulate and control the subdivision of real property (see Figure 1-1 for example of typical subdivision map). Under the provisions of recent legislation[1], the agency having jurisdiction must find (among other things) that the design and location of a proposed subdivision within a state responsibility area (SRA) or locally-adopted very high fire hazard severity zone must be consistent with applicable regulations adopted by the State Board of Forestry and Fire Protection (the "Board") pursuant to Sections 4290 and 4291 of the Public Resources Code (PRC). Under PRC 4290, regulatory standards established in 1991 govern the maximum length of dead-end roads, including all additional dead-end roads accessed from the initial dead-end road**, regardless of the number of parcels served** (see Table 1-1).[2]

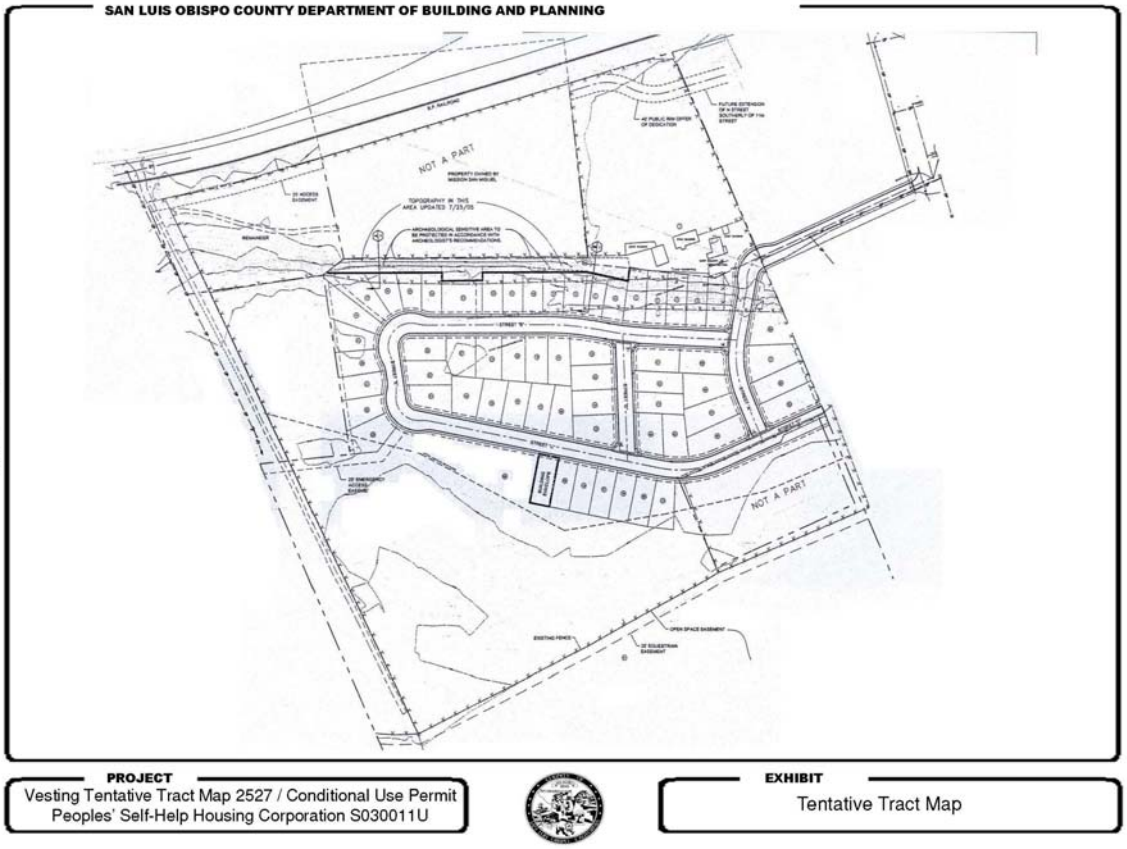
Table 0-1: Dead-End Road Maximum Lengths (Current Standards)

Parcel Size Allowed by Zoning	Maximum Dead-End Road Length
Less than 1 acre	800 feet
1 acre to 4.99 acres	1,320 feet
5 acres to 19.99 acres	2,640 feet
20 acres or larger	5,280 feet

The intent underlying the regulatory standards is to **"…provide for access for emergency wildland fire equipment and civilian evacuation concurrently, and…provide unobstructed traffic circulation during a wildfire emergency**."[3] Exceptions to the standards are permitted when it can be demonstrated that **"the same overall practical effect as the regulations"**[4] can be achieved, that is, if alternative practices effectively meet the regulatory intent of assuring safe egress and ingress of occupants and fire personnel/equipment.

[1] Senate Bill 1241 (2012), which amends Government Code Sections 65302 and 65302.5 and adds Sections 65040.20 and 66474.02 and adds Section 21083.01 to the Public Resources Code.
[2] Code of California Regulations, Title 14, Section 1273.09 Dead-End Roads.
[3] Code of California Regulations, Title 14, Section 1273.00 Intent.
[4] Code of California Regulations, Title 14, Section 1270.07 Exceptions to Standards.

Figure 0-1: Tentative Tract Map Example



Source: http://agenda.slocounty.ca.gov/agenda/sanluisobispo/5973/QXROY2ggMS5Qcm9qZWN0IEdyYXBoaWNzLnBkZg==/12/n/60920.doc

The maximum dead-end road lengths permitted by the standards depend **only** on parcel sizes allowed by zoning and do not take into account other factors affecting egress and ingress, such as:

- Land use (e.g., maximum allowable residential density under the general plan, square feet of commercial space, sizes of facilities such as schools, hospitals, etc. -- all determining the number of people potentially needing to exit the subdivision in the event of a fire)
- Demographics (e.g., proportions of youth, adults, seniors)
- Road system adequacy for proposed development (e.g., roadway width, grade, condition, connections to other roads, etc.)
- Fire hazard (e.g., presence and type of hazardous fuels, potential for extreme weather, adverse topography, etc.)
- The location of, and conditions at, the intersection where occupants exit from the dead-end road, which itself may not be safe in the event of a fire

Because they do not take into account these other factors, the current standards in many instances do not adequately provide for safe egress and ingress of occupants and fire personnel/equipment in the event of a fire. Furthermore, in situations where proposed dead-end roads would exceed the maximum lengths specified in the standard, the standards give no guidance on how to determine whether "the

same practical effect“ might be achieved by mitigation (e.g., by controlling the mix and intensity of residential and commercial land uses, adjusting the roadway characteristics, etc.).

It should be noted that the current standards make no explicit reference to the time needed for safe egress or ingress. However, implicit assumptions about time are built in to the standards. For example, by specifying a maximum dead-end road length of 800 feet in a single-access subdivision zoned for parcels below 1 acre in size, the **implicit** assumption is made that the occupants could be evacuated along a road of this length in less time than it would take for a fire to overtake them. The standards also make no reference to where a fire might start, nor to the conditions (e.g., vegetation, topography, wind speed, moisture level, etc.,) that affect fire behavior once ignition has occurred.

The present study was intended to assess the current standards, to provide a defensible foundation for establishing new standards if needed, and to develop a simple-to-use planning tool based on computer modeling that can be applied by jurisdictions, developers, and others to (1) judge whether a project proposal is likely to satisfy the “same practical effect” criterion, and (2) assist them in identifying mitigation options that will enable this criterion to be met.

For these purposes, the Cal Poly team sought to devise procedures to model how long it takes, in the event of a fire, for:

- Occupants of a single-access subdivision to reach an intersection with a through road, defined for purpose of the study as a road that gives a choice of two or more directions in which to travel from the intersection; and
- Fire personnel/equipment to reach where they need to be in order to fight the fire.

The team’s modeling efforts led to the development of a planning tool that estimates how quickly occupants can leave a subdivision as a function of:

- Intensity of development or number of people to evacuate (expressed in number of vehicles);
- Physical size of development or distance to traverse;
- Potential travel speed for the given design speed of segments in the road network; and
- Design speed of roadway segments.

As it turned out, however, despite having response time data from around the state (as reported to CAL FIRE), it was not possible to model with adequate confidence the time taken for fire personnel/equipment to reach a fire (as opposed to occupants evacuating). Also, although the initial hope was to incorporate fire behavior as a variable directly into the access model and the resulting tool, without a fire behavior expert involved in each application of the tool, this did not prove possible. However, the team was able to develop a simplified fire behavior model allowing planners and others to consider evacuation time information (from applying the tool) in light of information about the likely rate of spread and intensity of a wildfire.

Based on findings from applying the models to both hypothetical and actual case study locations, the study led to several recommendations, including the following:[5]

1. **Replace Existing Table of Maximum Road Lengths.** The existing table of maximum road lengths specified in the Code of California Regulations, Title 14, Section 1273.09 Dead-End Roads regulation should be replaced, following sufficient beta testing, with the ***procedure for applying the planning tool*** described below, for the following reasons:

    a. Maximum dead-end road lengths are based solely on parcel size.
    b. The standards assume that subdivisions are only for single-family residential uses.
    c. The standards place no limit on the number of lots in subdivisions.
    d. The standards allow for stacking of multiple roadways within maximum length limits.
    e. The standards do not provide for reasonable evacuation times for all road length categories.
    f. The standards do not consider other land uses such as commercial uses, apartments, or schools.
    g. The standards do not take into account potential long-term land use intensification.
    h. There is no clearly stated enforcement mechanism or penalty for non-compliance.

2. **Seek Collaboration**. CAL FIRE and the Board of Forestry & Fire Protection should seek collaboration during beta testing with partner organizations such as the Governor's Office of Emergency Services (Cal OES), Governor's Office of Planning (OPR), League of California Cities, California State Association of Counties (CSAC), Rural County Representatives of California (RCRC), California Fire Chiefs Association (CalChiefs), and National Fire Protection Association (NFPA). Beta testing should be supported by training workshops organized by CAL FIRE. Collaborative attention should be given during beta testing to identification of sustainable funding mechanisms offsetting and financing hazard mitigation costs, such as Mello-Roos Community Facilities Districts.

3. **New Regulation**. When finalized, the recommended planning tool procedure should ***fully replace*** the current dead-end street length regulation through ***state adoption of a new regulation requiring application of the procedure*** by local agencies in:

    a. ***Single-access*** subdivisions proposed in an SRA area categorized as either a ***Moderate*** or ***High*** Fire Hazard Severity Zone (FHSZ),
    b. ***All*** subdivisions proposed in an SRA area categorized as a ***Very High*** FHSZ, and
    c. ***All*** single-access subdivisions in a state recommended and locally adopted ***Very High*** FHSZ within an LRA.

[5] The full set of recommendations is presented in section 6.0 of the report.

Purpose of the User Guide

The purpose of this guide is to explain how the planning tool developed by this study can be used to assess whether a proposed or existing single-access subdivision, with or without use of hazard mitigation measures, can meet the intent of California regulations implementing Section 4290 of the California Public Resources Code (PRC) to assure safe egress and ingress of occupants and fire personnel/equipment.

Intended Users

Intended users of the guide include developers, consultants, planners, engineers, fire protection and emergency response professionals, local governing bodies, and others charged with reviewing and/or approving development proposals under the Subdivision Map Act.

Nature of Tool

The tool is intended to be user-friendly. It is based on:

- Access modeling that estimates how quickly occupants can leave a subdivision as a function of:
  - Intensity of development or number of people to evacuate (expressed in number of vehicles);
  - Physical size of development or distance to traverse;
  - Potential travel speed for the given design speed of segments in the road network; and
  - Design speed of roadway segments.
- Fire behavior modeling under the conditions of a "normally severe fire weather day," providing (in look-up tables) rates of spread and flame lengths based on wind speed, with vegetation specified in one of four general categories.

Hosting of Tool

Online hosting of the tool by CAL FIRE is proposed, with maintenance and updates by Cal Poly.

Procedure for Applying the Planning Tool

The remainder of Section 1.0 gives a description of the recommended procedure for applying the Planning Tool. The recommended procedure focuses on maximizing the likelihood that a subdivision developer has control over, and can be required to implement, mitigation measures that will protect occupants attempting to evacuate in the event of a wildfire (or other hazard). The procedure combines estimates of the total time needed to evacuate a proposed subdivision and the fire spread rate without mitigation in order to calculate how near to evacuation routes a fire can be before its movement threatens to overtake occupants before they can clear the subdivision. It then considers whether vegetation management would shorten this distance, as necessary, in order to avoid the need for mitigation outside the subdivision's boundaries, over which the developer almost certainly lacks control. Depending on the circumstances, the procedure may point to the need for further mitigation measures, such as changes to the access layout (e.g., additional exits, more roadway lanes, etc.), size and numbers of lots, land uses, and/or development density.

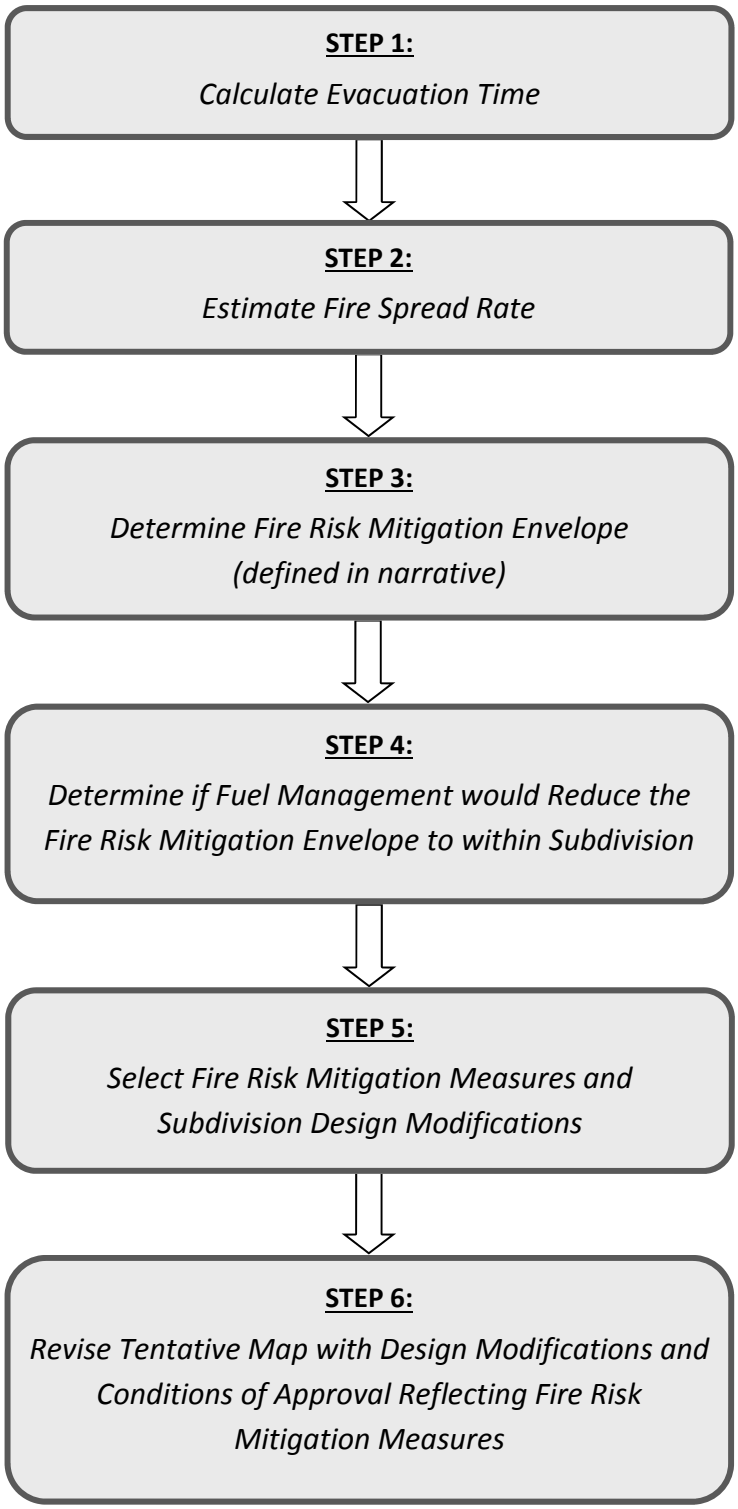
The steps in the procedure are outlined in Figure 1-2 below and explained in the narrative. It should be noted that this Planning Tool is useful for mitigating wildfire hazards in ***existing*** as well as proposed subdivisions, as will be seen in the following discussion.

NOTE: The planning procedure presented here is based on a fire that is a "NO NOTICE EVENT," meaning that incident managers do not have adequate time to plan or coordinate an evacuation though advance warnings. Occupants typically will receive notice to evacuate via Reverse 9-1-1 ©, other warning systems, or personal observation. There may or may not be response personnel present to assist in evacuation.

The procedure requires use of the following input data common to land use planning and environmental analysis under the California Environmental Quality Act (CEQA) procedures:

- Tentative subdivision map
- Road network map of subject property and vicinity, including through road connections to other road networks
- Existing land ownership parcel map of subject property and vicinity
- Land use map of subject property and vicinity
- Existing zoning map of subject property and vicinity
- Map of general plan designations for ultimate land uses of subject property and vicinity
- Vegetation map of subject property and vicinity
- Wind speed
- Topographic map and average slope of subject property and vicinity

Figure 0-2: Single-Access Tentative Subdivision Map Review Procedure

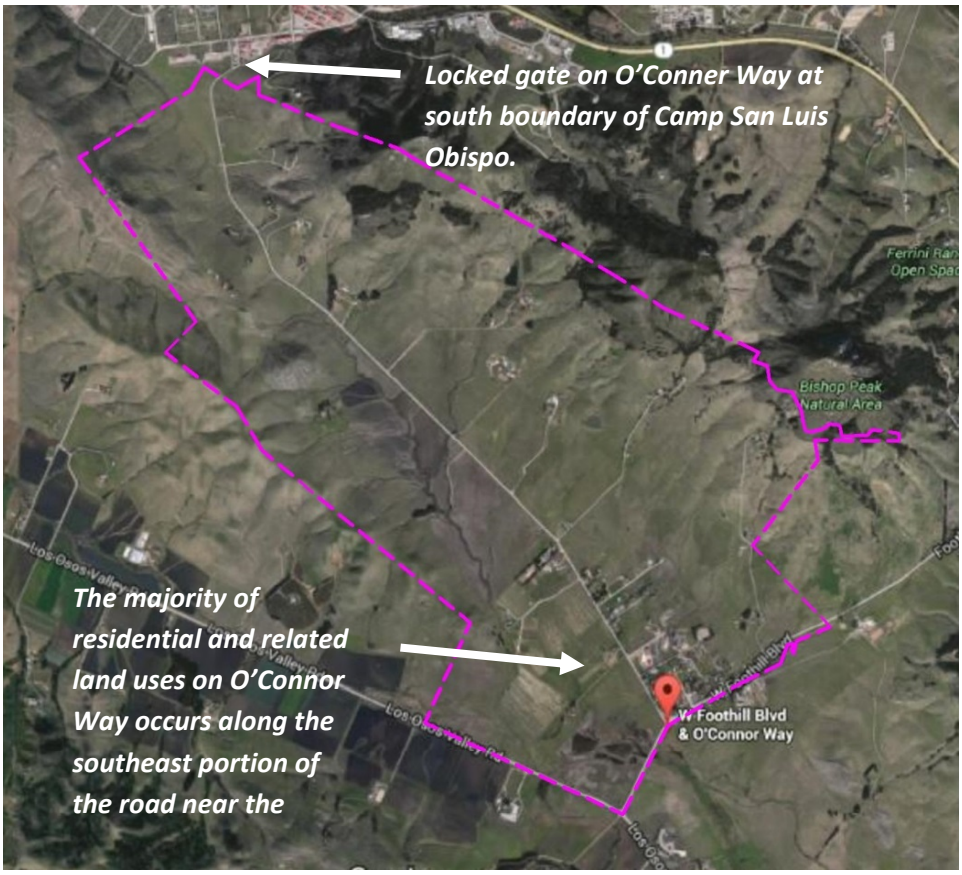


Step 1

Step 1: Calculate Evacuation Time. Use the access tool (pre-programmed Excel spreadsheet) to estimate evacuation clearance time in minutes for proposed subdivision.

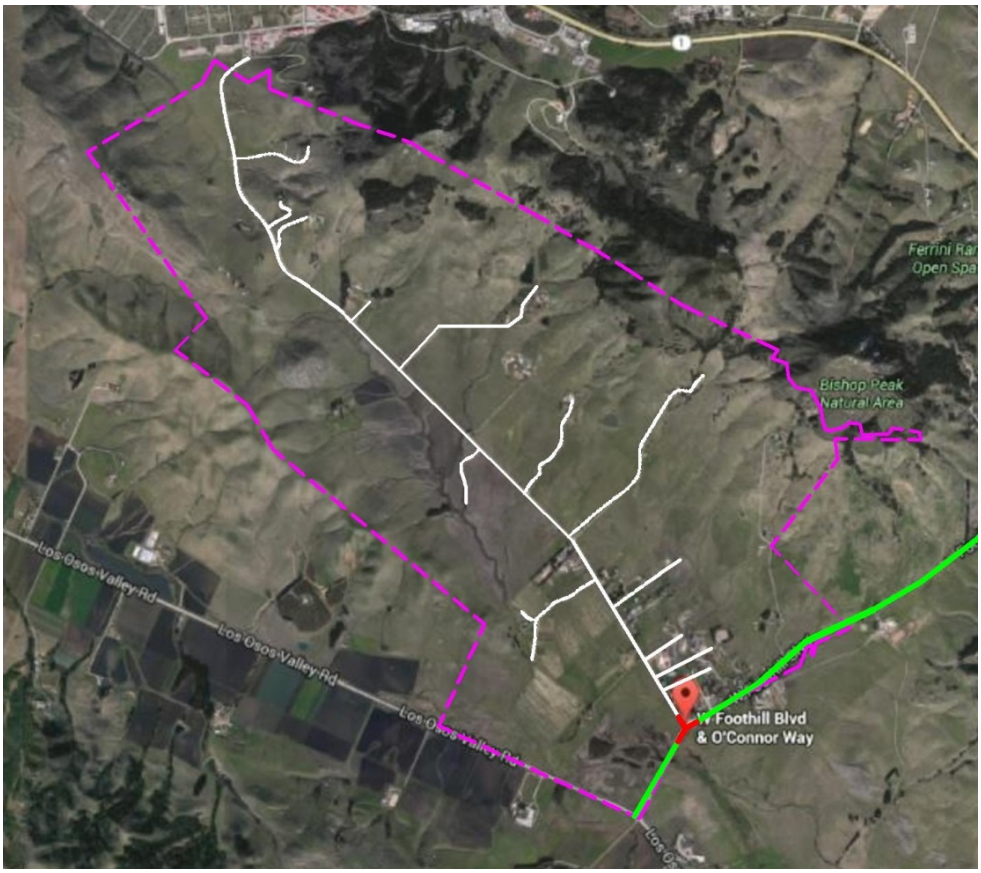
The following indicates how to estimate the time needed to evacuate an area using, **as an example**, details taken from the Foothill Boulevard and O'Connor Way case study (page 37 of this report). O'Connor Way is a dead-end road because its northerly outlet is blocked by a gate at the Camp San Luis Obispo California National Guard facility which closes it to through traffic. Figure 1-3 shows the entire Foothill Boulevard and O'Connor Way Case study area.

Figure 0-3: Foothill Boulevard and O'Connor Way Case Study Area



Intersecting with Foothill Boulevard near San Luis Obispo, O'Connor Way serves as an access spine for other dead-end streets as it extends northwest to Camp San Luis Obispo. Figure 1-4 shows this multiple dead-end street network.

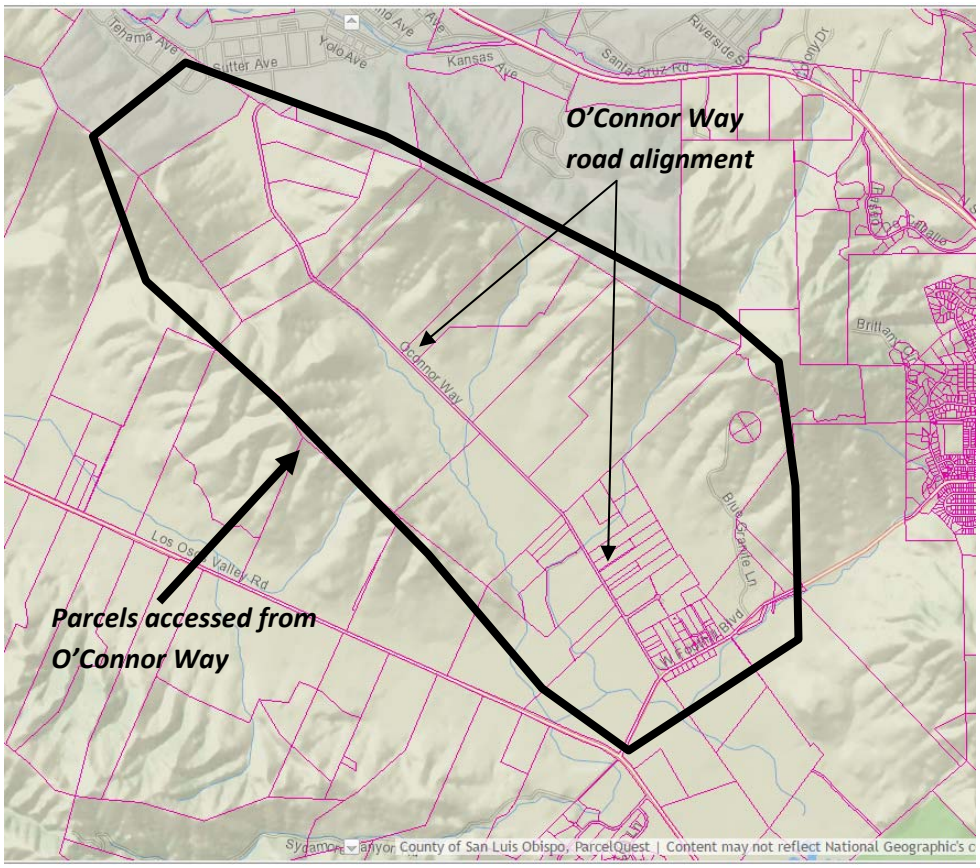
Figure 0-4: O'Connor Way Street Network



The O'Connor Way neighborhood is zoned rural residential and agriculture, and includes a mixture of comprising 95 homes, a school (120 persons occupancy), a church (400 persons occupancy), and a synagogue (200 persons occupancy). Most of these land uses are clustered near the southeast juncture with Foothill Boulevard.

Figure 1-5 on the following page illustrates each parcel accessed from O'Connor Way.

Figure 0-5: Parcels Accessed from O'Connor Way



1.1: Input data – From a street network map, input data into the access tool spreadsheet to prepare roadway schematic of development proposal or existing neighborhood with the following information, using the legend below and following the format shown in Figures 1-6 and 1-7:

1. Lengths of roadway segments (intersection-to-intersection in feet)
2. Directional lanes on roadway segments
3. Posted speed limit OR design speed (mph) on roadway segments
4. Number of houses (existing or proposed) on roadway segments
5. Other uses (retail, schools, churches, etc.) on roadway segments

LEGEND	
0.0	Length of segment (intersection to intersection in feet)
0.0	Number of houses on segment
0.0	Other uses on segment
	Subdivision roadway segment
	Potential bottlneck upon exit of development
	Nearby through road

Figure 0-6: Example of Roadway Schematic

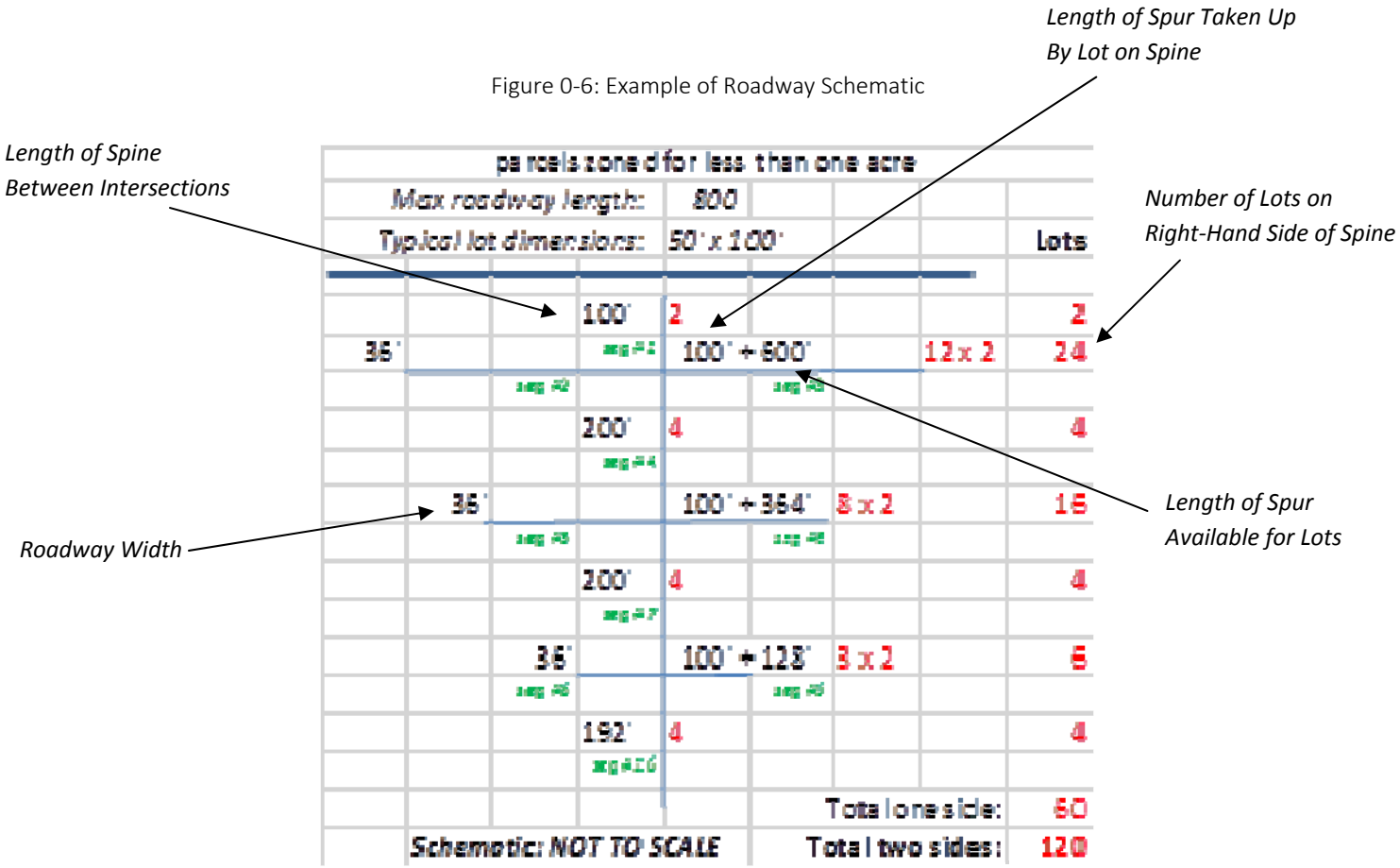
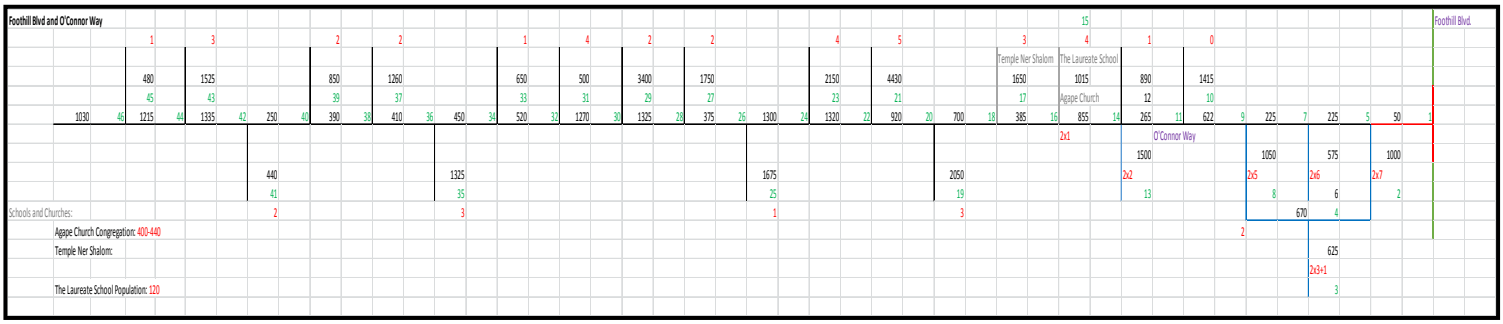


Figure 1-6 is a **simplified example** roadway schematic sample of a dead-end spine road with shorter dead-end roads branching from it. This example roadway schematic is shown in the access model spreadsheet. Figure 1-7 illustrates the roadway schematic created when entering the O'Connor Way data into the access tool spreadsheet

Figure 0-7: Roadway Schematic Created for Foothill Blvd and O'Connor Way



1.2: Calculate evacuation time – using the access tool spreadsheet:

1. Enter required data into blue cells for each roadway segment (number ID, length, speed, number of lanes, number of intersections to and including main road exit)
2. Read off results in green or yellow-highlighted cells (average travel time, clearance time)

Figure 1-8 illustrates the access tool spreadsheet calculating average travel time and clearance time for the Foothill Blvd and O'Connor Way case study. *(Refer to Appendix 2 for a full size copy of this schematic.)*

Figure 0-8: Access Tool Spreadsheet with O'Connor Way Inputs

Step 2

Step 2: Estimate Fire Spread Rate - Use applicable vegetation-specific lookup tables to estimate fire spread rate with no mitigation.

> ***NOTE: It is recommended that a fire behavior expert be involved at various points in the procedure. For example, in executing Step 2, rather than using lookup tables (which are, of necessity, simplified) to estimate fire spread rate, greater accuracy might be achieved by asking an expert to do so instead. The expert should be a Registered Professional Forester with fire behavior expertise, retained by the local jurisdiction with CAL FIRE oversight.***

2.1: Determine Fire Behavior Inputs -

- Assign a fuel (vegetation) type using one of the four categories: ***grass, shrubs, coniferous forest, or broadleaf forest*** (detailed further in Section 4.0 and Appendix 3)
- Characterize topography and calculate average slope (for example, by using Cal Topo, https://caltopo.com/)
- Determine applicable wind speed (for example, by using Weather Underground, www.underground.com/history/)

The predominant vegetation type in the Foothill Blvd and O'Connor Way case study area is grassland. The images in Figure 1-9 show grassland vegetation examples

Figure 0-9: Vegetation Types in Foothill Blvd and O'Connor Way Case Study Area

Figures 1-10 and 1-11 shows steps to obtain average slope and wind speed from suggested websites. Other means may be used to obtain slope and wind speed information, if preferred.

Figure 0-10: Slope Calculation, Foothill Blvd and O'Connor Way Case Study Area

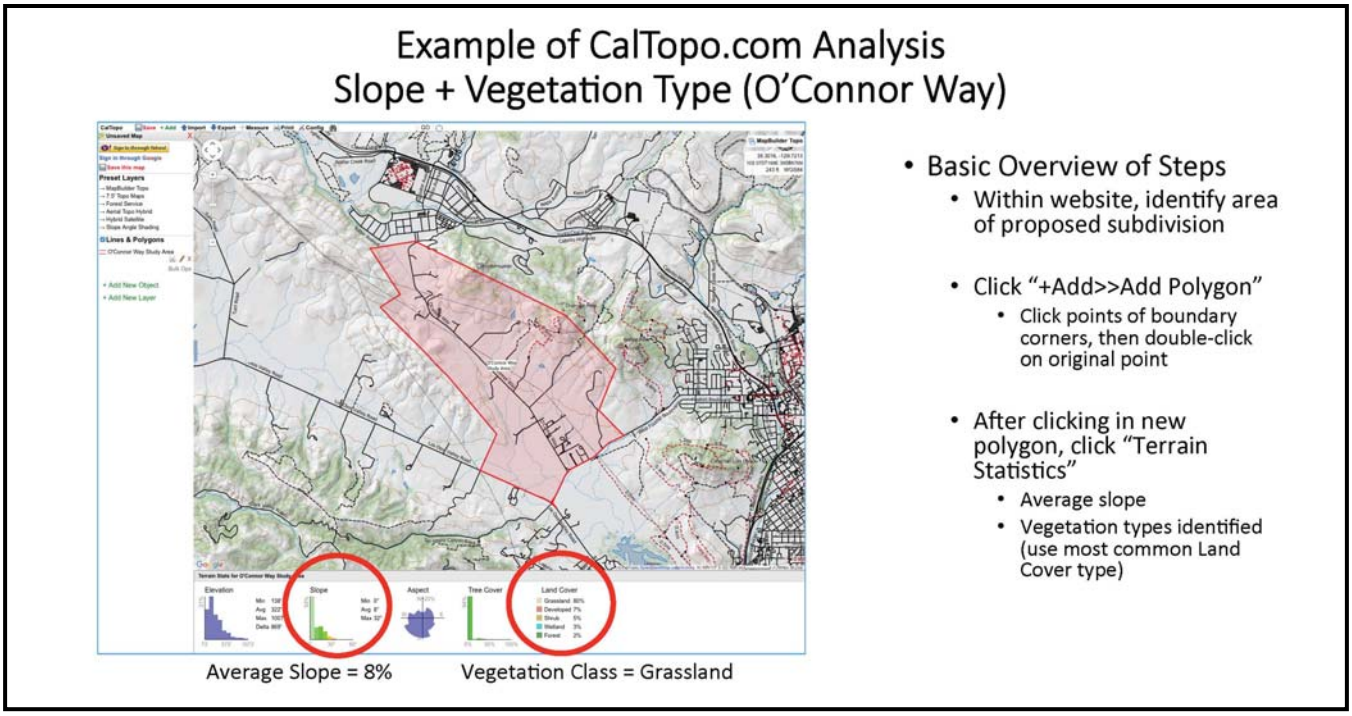
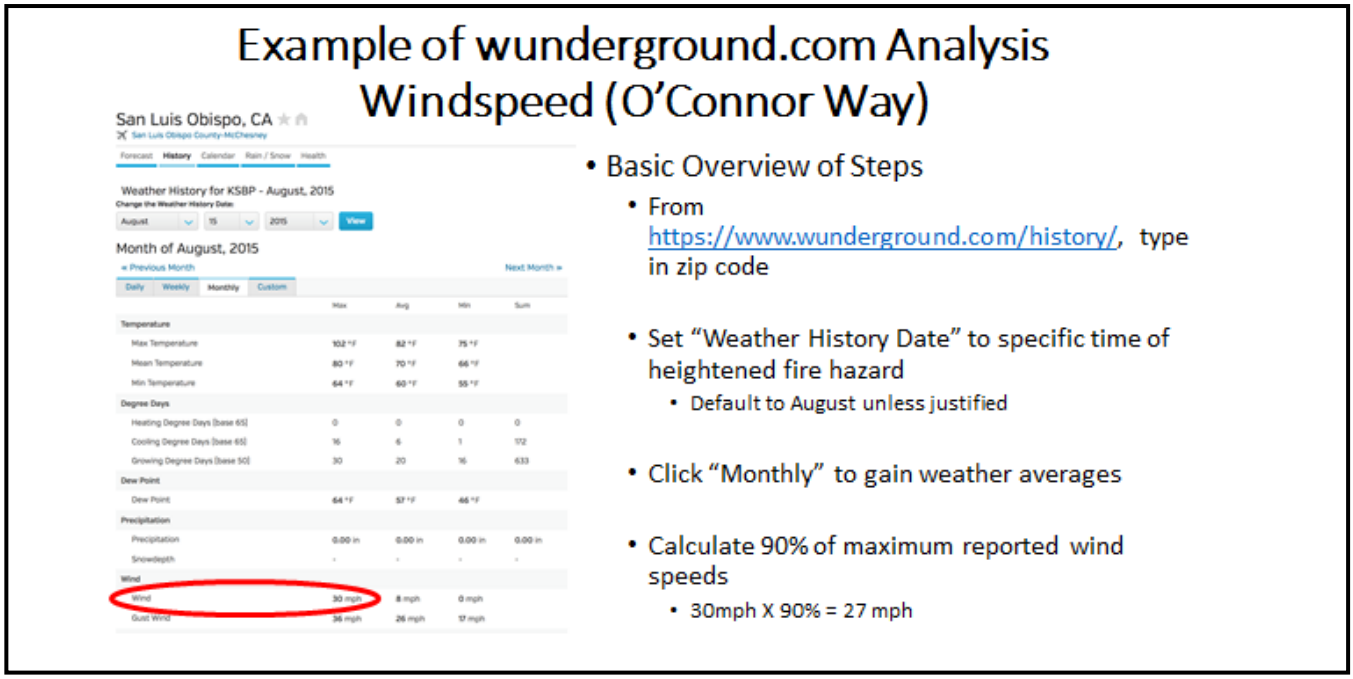


Figure 0-11: Wind Speed, Foothill Blvd and O'Connor Way Case Study Area



2.2 Estimate fire spread rate - Estimate the fire spread rate (feet per minute) using fire behavior l*ookup tables* (included in Appendix 3) with "No-Mitigation" and average wind speed.

Figure 1-12 illustrates use of the applicable look up table for unmitigated grassland and identifies the slope range of 1-25% and open wind speed of 30 mph for the Foothill Blvd and O'Connor Way case study area.

Figure 0-12: Lookup Table for Grasslands UNMITIGATED, Foothill Blvd and O'Connor Way Case Study Area

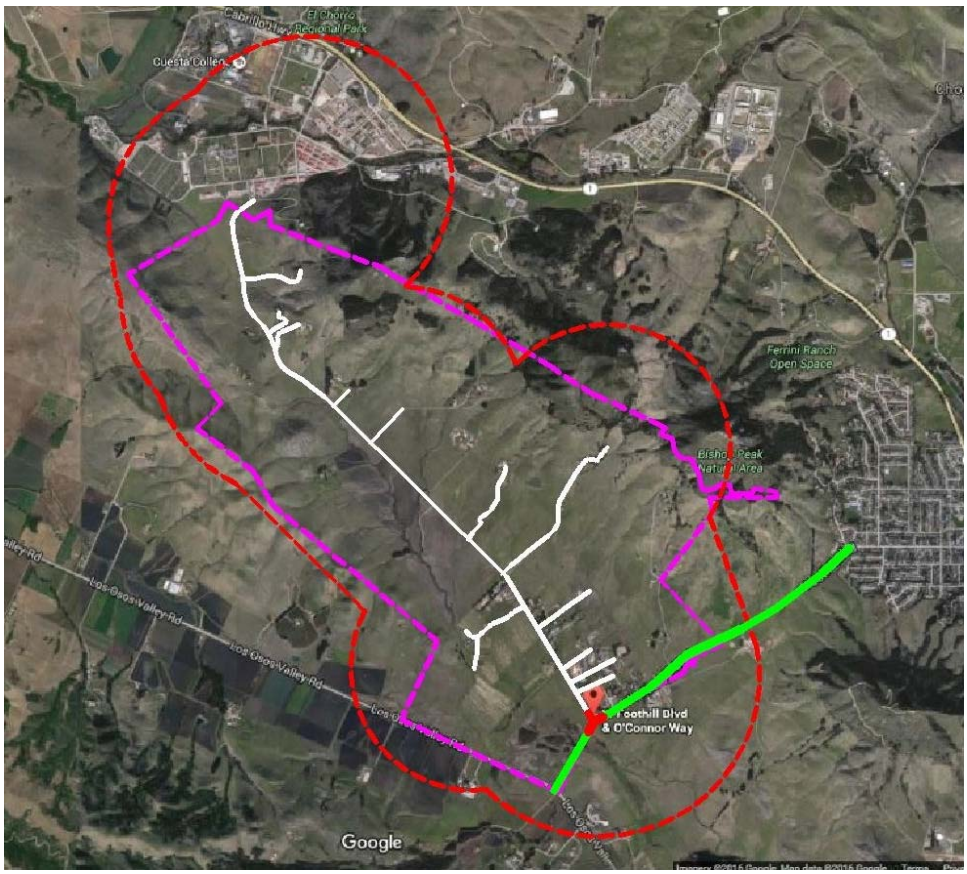
Vegetation: Grass						
	Open Wind Speed (mph)					
Slope (%)	0	10	20	30	40	50
0	ROS: 6'/min FL: 3'	ROS: 19'/min FL: 5'	ROS: 42'/min FL: 7'	ROS: 71'/min FL: 9'	ROS: 106'/min FL: 10'	ROS: 144'/min FL: 12'
1-25	ROS: 9'/min FL: 3'	ROS: 23'/min FL: 5'	ROS: 46'/min FL: 7'	ROS: 75'/min FL: 9'	ROS: 110'/min FL: 10'	ROS: 148'/min FL: 12'
26-40	ROS: 29'/min FL: 6'	ROS: 42'/min FL: 7'	ROS: 65'/min FL: 8'	ROS: 95'/min FL: 10'	ROS: 129'/min FL: 11'	ROS: 168'/min FL: 13'
41-55	ROS: 55'/min FL: 8'	ROS: 69'/min FL: 8'	ROS: 91'/min FL: 10'	ROS: 121'/min FL: 11'	ROS: 155'/min FL: 12'	ROS: 194'/min FL: 14'
56-75	ROS: 96'/min FL: 10'	ROS: 109'/min FL: 10'	ROS: 132'/min FL: 11'	ROS: 162'/min FL: 12'	ROS: 196'/min FL: 14'	ROS: 234'/min FL: 15'
>75	ROS: 159'/min FL: 12'	ROS: 173'/min FL: 13'	ROS: 196'/min FL: 14'	ROS: 225'/min FL: 14'	ROS: 260'/min FL: 15'	ROS: 298'/min FL: 16'

Step 3

Step 3: Determine Fire Risk Mitigation Envelope. The Fire Risk Mitigation Envelope is defined here as the area within which a fire burning is likely to compromise the ability of subdivision occupants to evacuate safely. It is delineated by calculating the distance a fire will spread in the evacuation clearance time and using this distance to establish an envelope around the evacuation routes. A fire outside this envelope will not have time to reach the evacuation routes before all occupants have exited from the subdivision.

3.1 Determine the Fire Risk Mitigation Envelope - Multiply evacuation clearance time (from Step 1) by the fire spread rate (from Step 2) to determine the Fire Risk Mitigation Envelope for evacuation routes. Draw this envelope around the subdivision roads.

Figure 0-13: Fire Risk Envelope UNMITIGATED, Foothill Blvd and O'Connor Way Case Study Area



3.2 Observe whether the Fire Risk Mitigation Envelope falls outside or within subdivision boundaries.

A. If the Fire Risk Mitigation Envelope is wholly within subdivision boundaries or study area, mitigation within the envelope is ***under the developer's or property owner's control***. By applying mitigation measures that reduce the fire rate of spread and/or the intensity, it should be possible for the developer to provide for subdivision occupants' safe evacuation from a fire starting inside or outside the subdivision.

B. If the Fire Risk Mitigation Envelope includes territory ***outside developer- or property owner-controlled land***, then it cannot be assumed that the developer or property owner would be able to apply appropriate mitigation measures to modify the fire rate of spread and/or intensity for the areas outside the subdivision. Consequently, a fire could compromise evacuation routes in less time than the clearance time.

Step 4

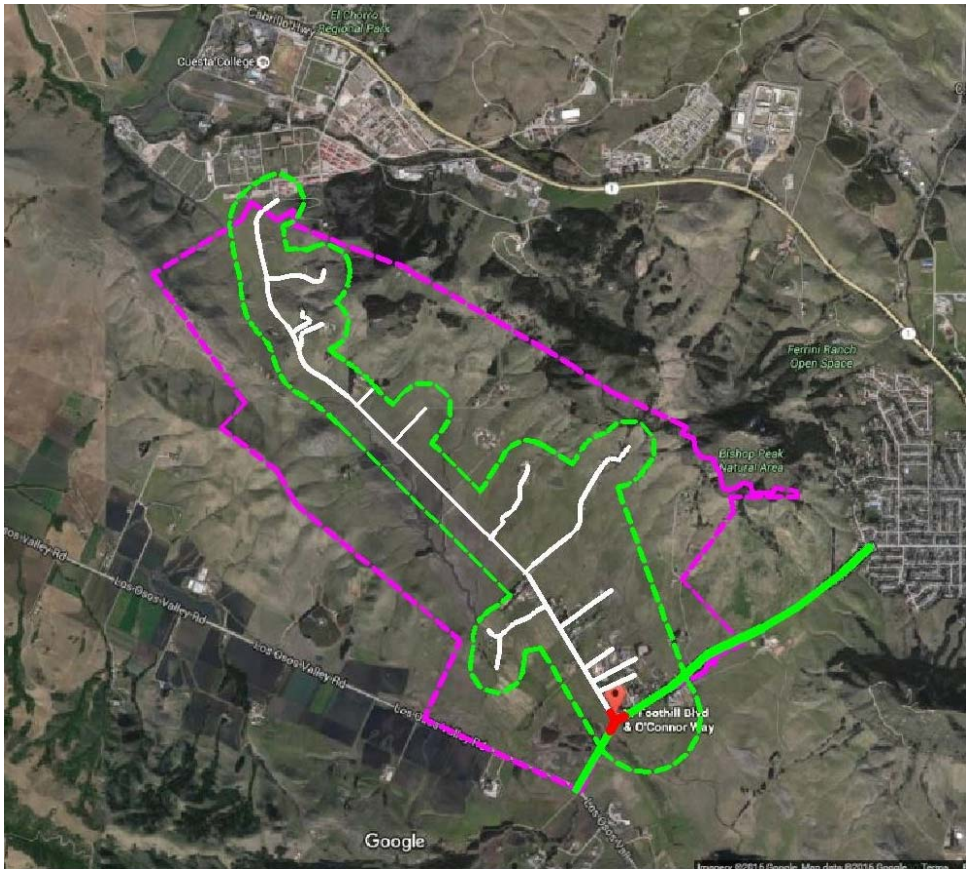
Step 4: Determine if Fuel Management Would Reduce Fire Risk Mitigation Envelope to Within Subdivision. Re-estimate the Fire Risk Mitigation Envelope using fire rate of spread derived from applicable vegetation-specific lookup table with mitigation to determine if mitigation measures addressing hazardous fuels would move the envelope wholly within the subdivision. [6]

Figure 0-14: Lookup Table for Grasslands MITIGATED, Foothill Blvd and O'Connor Way Case Study Area

Vegetation: Grass (Mitigated)						
	Open Wind Speed (mph)					
Slope (%)	0	10	20	30	40	50
0	ROS: 1'/min FL: 0'	ROS: 4'/min FL: 1'	ROS: 9'/min FL: 2'	ROS: 15'/min FL: 3'	ROS: 23'/min FL: 4'	ROS: 30'/min FL: 5'
1-25	ROS: 2'/min FL: 0'	ROS: 5'/min FL: 1'	ROS: 10'/min FL: 2'	ROS: 16'/min FL: 3'	ROS: 23'/min FL: 4'	ROS: 30'/min FL: 5'
26-40	ROS: 7'/min FL: 2'	ROS: 9'/min FL: 2'	ROS: 14'/min FL: 3'	ROS: 21'/min FL: 4'	ROS: 28'/min FL: 5'	ROS: 35'/min FL: 5'
41-55	ROS: 7'/min FL: 3'	ROS: 9'/min FL: 3'	ROS: 14'/min FL: 4'	ROS: 21'/min FL: 4'	ROS: 28'/min FL: 5'	ROS: 35'/min FL: 6'
56-75	ROS: 22'/min FL: 4'	ROS: 25'/min FL: 4'	ROS: 30'/min FL: 5'	ROS: 36'/min FL: 5'	ROS: 44'/min FL: 6'	ROS: 51'/min FL: 7'
>75	ROS: 37'/min FL: 5'	ROS: 40'/min FL: 6'	ROS: 44'/min FL: 7'	ROS: 51'/min FL: 14'	ROS: 59'/min FL: 7'	ROS: 66'/min FL: 8'

[6] Again, greater accuracy might be achieved by employing a fire behavior expert rather than relying on the lookup tables

Figure 0-15: Fire Risk Envelope, MITIGATED, Foothill Blvd and O'Connor Way Case Study Area



Step 5

Step 5: Select Fire Risk Mitigation Measures and Subdivision Design Adjustments, as applicable.

5.1 If the Fire Risk Mitigation Envelope without mitigation extends outside the proposed subdivision or existing area beyond the developer's or property owner's control, at a minimum the local agency shall specify hazardous fuel mitigation measures to reduce the envelope (now re-estimated) so that, if possible, it falls wholly within the subdivision or area boundaries.

5.2 If hazardous fuel mitigation measures are inadequate to ensure that the Fire Risk Mitigation Envelope will fall within the subdivision or area boundaries, the local agency shall specify subdivision design adjustments or cooperative actions which can be taken by property owners, such as changes to the access layout (e.g., additional exits, more roadway lanes, etc.), size and numbers of lots, land uses, and/or development density in order to achieve this objective by effectively reducing the evacuation clearance time (which is an alternative way of shifting the Fire Risk Mitigation Envelope).

5.3 In complex situations the local agency should utilize the expertise of a fire behavior expert, as characterized above, to identify and determine the effectiveness of fire risk mitigation measures to be applied within the subdivision to ensure that all occupants can evacuate safely in the event of a fire starting within the Fire Risk Mitigation Envelope. Survivability should be possible if occupants begin leaving immediately upon becoming aware of the need to evacuate **and** if flame lengths are less than 4 feet and fire line intensity is less than 100 BTU/ft/sec.[7] (This is sometimes referred to as the "Hauling Chart" fire line intensity for a fire controllable using only hand tools).

5.4 In using recommendations of a fire behavior expert, ***if mitigation measures cannot achieve "the same practical effect" criterion*** of assuring "safe egress and ingress of occupants and fire personnel/equipment during a wildfire" then the tentative map ***cannot be approved***, unless and until an appropriate combination of fire risk mitigation measures can effectively meet that criterion.

Step 6

Step 6: Revise the Tentative Map with Design Modifications and Conditions of Approval Reflecting Fire Risk Mitigation Measures. Prepare a revised tentative subdivision map including specified design adjustments, conditions of approval, and tentative map findings consistent with Map Act, SB 1241 (2012), and PRC 4290.

[7] Patricia L. Andrews, Faith Ann Heinsch, and Luke Schelvan (2011), How to Generate and Interpret Fire Characteristics Charts for Surface and Crown Fire Behavior, General Technical Report RMRS-GTR-253. Logan, UT: United States Department of Agriculture, Forest Service, Rocky Mountain Research Station.

This page intentionally left blank