Running head: WILDFIRE PLANS FOR AN ELEMENTARY SCHOOL

Emergency Plans at Santiago Elementary School: Are Current Plans Adequate for Responding to Wildfire Threats?

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Assistance in acquiring emergency plans from other jurisdictions was received from Tara Miali, Administrative Assistant, and Paul Guns, Administrative Captain, both of the Orange County Fire Authority.

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Abstract

Schools within or adjacent to wildland urban interface areas are at risk of exposure to wildfire. The problem is that while school emergency plans address building fires, school emergency plans do not always address wildfire threats, and this could lead to inappropriate emergency response actions. The purpose of this applied research was to evaluate the effectiveness of current wildfire emergency plans at Santiago Elementary School by comparing the calculated rate of fire spread through a *Eucalyptus* forest against the observed speed of the school's evacuation. The researcher examined the following five questions: (a) What are the school's current emergency plans for wildfire threat, (b) what is the maximum theoretical calculated rate of spread of wildfire through a *Eucalyptus* forest, (c) under ideal conditions, how fast can an elementary school evacuate all students,(d) given the speed of a wildfire and the speed of evacuation, is it possible to evacuate a school before the fire impacts the school, and (e) for schools adjacent to fire-prone forests, what protective options should be included in school emergency plans? To answer these questions, the researcher reviewed emergency plans for three school districts, assessed fuel hazards in 10 *Eucalyptus* forest plots, observed one school evacuation drill, and observed the fire resistant features of school buildings. Results indicated that a fully

developed wind-driven fire could spread from the northern edge of the *Eucalyptus* forest to Santiago Elementary School at the forest's southern edge within 21 minutes. Observations also showed that, under ideal conditions with pre-staged buses, the school could evacuate in nine minutes. This discovery suggests that a fire closer to the school or a prolonged evacuation time could place children directly in the wildfire's path. It is recommended that vulnerable schools include multiple protective options specifically for wildfire in their emergency plans.

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Introduction

The Orange County Fire Authority (OCFA) serves a population of 1.3 million residents in 22 cities within the County of Orange, California, including the City of Lake Forest. In the center of Lake Forest is a moderately dense forest containing several species of tall trees within the genus *Eucalyptus*. The *Eucalyptus* forest occupies an estimated area of 65 hectares (160 acres or 0.25 square miles) according to Google Maps (2009). The *Eucalyptus* forest is an occluded interface, bounded on all sides by suburban residential and commercial areas. There are 5,100 homes and four schools within the *Eucalyptus* forest according to J. Burrows and C. Valdes (personal communication, November 23, 2009).

The problem identified for this research is that Saddleback Valley Unified School District plans do not specifically address measures to be taken by school teachers and children in the event the school is threatened by an encroaching wildfire.

The purpose of this research project was to evaluate the effectiveness of current school response plans at Santiago Elementary School and to make recommendations on whether or not to continue with or change current school emergency plans.

The evaluative research method was used in this study to answer the following questions:(a) What are the school district’s current emergency plans for wildfire emergency

response, (b) what is the maximum theoretical calculated rate of spread of a wildfire in a *Eucalyptus* forest,(c) under ideal conditions, how fast can an elementary school evacuate all students,(d) given the speed of a wildfire and the speed of evacuation, is it possible to evacuate a school before the head of the fire impacts the school, and (e) for schools adjacent to fire-prone forests, what protective action options should be included in school emergency plans?

Background and Significance

Strong Santa Ana winds in southern California are caused when a high-pressure system over Northeastern Nevada drives winds toward a low-pressure area off the California coast (Raphael, 2003). Raphael reports an average of 20 Santa Ana wind events each year in the late fall and early winter with a standard deviation of five (M = 20, SD = 5). Raphael found that “the average duration of an event is 1.5 days” (p. 6) and the wind direction is “predominantly from the northeast quadrant” (p. 12).

According to Halsey (2005), “Santa Ana winds dry the brush and create conditions conducive to explosive wildfires” (p. 49). Examples of catastrophic wildfires in Orange County under Santa Ana wind conditions, according to Halsey, include the Santiago Fire in September 1889 (121,405 hectares or 300,000 acres) and the Laguna Canyon Fire in October 1993 (6677 hectares or 16,500

acres). The Orange County Fire Authority (2009) reports that firestorms also attacked Orange County during the 1980 Carbon Canyon Fire (5665 hectares or 14,000 acres), the 1980 Owl Fire (7284 hectares or 18,000 acres), the 1982 Gypsum Fire (7689 hectares or 19,000 acres), the 2006 Sierra Peak Fire (4250 hectares or 10,506 acres), the 2007 Santiago Fire (11,331 hectares or 28,000 acres), and the 2008 Freeway Complex Fire (12,140 hectares or 30,000 acres). All of these major wind-driven fires occurred in the fall and early winter during the months between September and February.

The fall months are also the driest time of the year in southern California. According to National Oceanographic and Atmospheric Administration (2000), an average of 5.38 cm (2.12 inches) of rain falls in the Los Angeles area each year between July 1 and November 30. The National Weather Service (n.d.) operates a fire weather watch and red flag warning program to alert land management agencies of hot dry weather that could lead to dangerous wildfires and extreme fire behavior.

The City of Lake Forest, California is a community of 4100 hectares (16 square miles) with 78,000 residents located approximately 79 km (49 miles) south of Los Angeles (City Of Lake Forest, 2008). Within the center of the City of Lake Forest is a 65 hectare (0.25 square mile or 160 acre) *Eucalyptus* forest that is bounded approximately by Lake Forest Drive, Serrano

Road, Ridge Route Drive, and the Metrolink Railroad. The *Eucalyptus* forest is an occluded interface, which is defined by Queen (1993) as an “isolated area of wildland within an urban area” (p.3). Except for a 15 m deep ravine and several small ephemeral streams, the *Eucalyptus* forest is essentially flat and level.

Within the *Eucalyptus* forest are numerous residential streets along with 5,100 homes and four schools according to J. Burrows and C. Valdes (personal communication, November 23, 2009). Santiago Elementary School lies near the southern edge of the *Eucalyptus* forest on Rivendell Drive near Jeronimo Road. The school was built on 4 hectares (10 acres) of land in 1973, and current enrollment is approximately 420 elementary students in kindergarten through sixth grades (F. Manzo, personal communication, November 24, 2009). Santiago Elementary School is at risk of wildfire exposure in the event that a wind-driven fire ignites in the nearby *Eucalyptus* forest.

This research paper will evaluate the maximum theoretical rate of spread of fire through the *Eucalyptus* forest under dry Santa Ana wind conditions. This rate of spread will be compared to the evacuation speed for students at Santiago Elementary School, which lies along the southern edge of the *Eucalyptus* forest. Results from this study could lead to revised emergency response plans to enhance the safety of schoolchildren during

wildfires. Without a study that compares maximum fire rate of spread relative to evacuation speed, school officials and fire responders may be inadequately prepared to make appropriate choices when confronted with a wildfire emergency. Results from this research may assist other school districts, fire service organizations, law enforcement, city managers, and property mangers who encounter similar wildfire threats.

This applied research project is directly related to the Executive Fire Officer Program course *Executive Analysis of Community Risk Reduction* (United States Fire Administration, 2009). The course examines the Executive Fire Officer as a community risk-reduction leader, assesses community risk, develops a draft plan for a local risk-reduction initiative, applies change management models, and addresses organizational and community politics.

Study results from this applied research project may also help “Reduce risk at the local level through prevention and mitigation,” and “Improve local planning and preparedness,” which are two of the five strategic goals established by the United States Fire Administration (United States Fire Administration, 2009).

Literature Review

The literature review for this research focused on topics pertaining to fire behavior modeling in *Eucalyptus* forests,

wildland-urban interface fire case studies, botany, and emergency planning. The reviewed literature included fire management books, journals, and emergency planning documents. School district and fire department administrative files and publications were reviewed for current emergency plans. The researcher interviewed the safety director at Saddleback Valley Unified School District, and the internet was used to access documents relating to fire behavior and emergency plans.

Eucalyptus Trees in California

The genus, *Eucalyptus*, describes evergreens native to Australia, where there are over 600 species of the plant, according to Santos (1997). Some *Eucalyptus* species are among the largest trees in the world, while other members of the genus are more shrub-like in appearance. Non-scientists tend to group the various species of *Eucalyptus* into common name categories such as gum, mahogany, box, and stringy bark.

Eucalyptus can survive in a variety of climates and soils. As miners and settlers arrived in California following the 1849 gold rush, there was a large demand for trees for the production of lumber for construction, for firewood, and for beauty and shade. According to Santos (1997) *Eucalyptus* were introduced into California during the 1850s and now “blue gum is by far the most common [species of] California *Eucalyptus*” (p.2). By the 1870’s, *Eucalyptus* extract had also found its way into medicine

and railroading. “In 1877, Assistant Chief Engineer for the Central Pacific Railroad, J.D. Scupham, bought 40,000 *Eucalyptus* seedlings, mostly blue gum, from nurseries in Oakland and Hayward” (Santos, p. 12). Railroad companies, such as the Central Pacific and the Santa Fe planted millions of trees until they discovered that railroad ties made from *Eucalyptus* wood tended to crack and could not hold a spike in place securely. By 1926, state foresters advocated yet another use of *Eucalyptus* trees as windbreaks in California’s citrus groves.

According to Santos (1977), prospectors, railroaders, and industrialists in California finally realized that *Eucalyptus* wood warped, cracked, twisted, and became too tough once cured. Nevertheless, the groves of *Eucalyptus* remain a part of California’s history and ecology.

Eucalyptus Forest Health

Santos (1997) reports that cold weather, insects, and drought can influence the health of a *Eucalyptus* forest. Some *Eucalyptus*, such as blue gum, will drop their leaves if they are exposed to freezing weather; the excessive leaf litter builds up on the forest floor and increases the fire hazard. Another source of distress for *Eucalyptus,* according to Santos, is the longhorned beetle, *Phoracantha semipunctata*, which was discovered in October 1984 near El Toro, California. According to Hoddle (n.d.) a second species of borer, *Phoracantha recurva,*

was discovered in southern California in 1995. Santos reports that the longhorned beetle “Lays its eggs deep into the *Eucalyptus* bark. When it bores into the inner bark, it cuts off the supply of nutrients the tree needs and [sic] thereby killing it” (p.4). Beetles are attracted to trees that suffer from lack of water, consequently, “the Orange County Agricultural Commission gave this advice, ‘To prevent beetle infestation, irrigate eucalyptus trees with a trickling hose over a 24-hour period every few weeks during the summer’" (Santos, 1997, Volume 3, p.5).

Eucalyptus and Wildfire Behavior

Fire prevention. Fires are initiated and sustained by combining heat, fuel and oxygen, while fires can be prevented by keeping heat and fuel separated. Blue gum *Eucalyptus*, according to Essner (1993) “is highly flammable and should not be planted near homes or other structures” (p.4). Essner also warns that “fuel buildup occurs very rapidly in unmanaged blue gum *Eucalyptus* stands in California. Fuel reduction programs can reduce wildfire hazard, as can the establishment of fuel breaks” (p. 8). Fuel breaks maybe natural or human-made, and they include “rocks, bare soil, lakes, streams, roads and trails” (Long and Kennard, n.d., p. 489).

Fire behavior and intensity. The National Fire Protection Association (2005) reports that a wildfire’s behavior,

intensity, and rate of spread depends upon the fuel, the fuel moisture content, the weather, and the topography of the landscape. According to Santos (1997), *Eucalyptus* can create piles of flammable litter on the forest floor, consisting of bark, leaves, branches, and seed pods. The *Eucalyptus* oil in the litter slows the decomposition speed and adds to the flammability of the litter.

Fuel moisture. “The moisture content of vegetative fuels is critical, since it directly controls the combustibility of dead and living plant material” (National Fire Protection Association 2005, p. 8). Fine dead fuels, such as ribbons of bark, fallen leaves, and grasses, are known as 1-hour fuels because they can absorb or lose moisture very rapidly, and “their flammability can respond very quickly from no flammability to very high flammability in a short period of time” (National Fire Protection Association, 2005, p. 9). According to Long and Kennard (n.d.) “fuel moisture determines fuel availability” (p. 488). Vegetative matter that is moist is not available as a fuel because heat that enters the fuel must first vaporize all of the water. “Until all water is vaporized, temperatures cant [sic] increase further toward ignition temperatures” (Long and Kennard, n.d., p. 490).

Weather. Relative humidity is the amount of moisture in the air, relative to the maximum amount of humidity the air can hold

at that temperature. The relative humidity “measures the drying capacity of the air and is directly correlated with fuel moisture” (National Fire Protection Association, 2005, p. 12). A drop in relative humidity signals an increase in flammability of fine fuels. Wind speed and direction also influence the fire’s direction and behavior; furthermore, “wildfires often create their own winds, further complicating fire behavior and wildfire suppression activities” (National Fire Protection Association, 2005, p. 11).

The National Weather Service (n.d.) typically issues a fire weather *watch* 24 to 72 hours prior to the arrival of critical fire weather conditions. The National Weather Service typically issues a red flag *warning* within 24 hours before a critical fire weather event. Red flag warnings in southern California are issued when the relative humidity is predicted at 15% or less along with sustained winds of 25 mph or greater.

Topography. Fire behavior and rate of spread is also influenced by the topography of an area, including slope, altitude, and aspect. “The steeper the slope, the faster the rate of spread, all other factors remaining constant” (National Fire Protection Association, 2005, p. 13).

Crown fires. A fire that starts in ground fuels, such as grass, dead leaves, logs, and fallen branches can, under certain conditions, move into the canopy of the forest to become a crown

fire. Beighley and Bishop’s study (as cited in Long, n.d.) listed the ideal conditions for the development of a crown fire. These conditions included ”dry fuel, low humidity with high temperatures, heavy accumulation of dead and downed litter, conifer regeneration and other ladder fuels, steep slopes, strong winds, unstable atmosphere, and a continuous cover of coniferous trees” (p. 481). Queen (1993) reports that a crown fire is enhanced by ladder fuels that carry the fire from the ground into the crown. Pyne (1982) notes that a crown fire is sustained by a surface fire, and that a crown fire “requires, first, a tremendous accumulation of heat” and a “heavy fuel load, excluding, for example such fuels as grass, tundra, and forest litter” (p. 23). Secondly, according to Pyne, a crown fire requires a buoyant heated air mass to rise into the canopy without being sheared off by surface winds and without being suppressed by an inversion layer. Finally, Pyne notes that a crown fire requires a “triggering mechanism that affects burning intensity, such as spread into heavier fuel or breakup of an evening inversion layer” (p. 23).

Types of crown fires. Van Wagner (as cited in Long, n.d.) identified three major classes of crown fires. The *dependent* crown fire depends upon the heat of the fire from surface fuels. Individual trees or small clumps of trees may torch in a dependent crown fire; however, the fire does not spread through

the canopy from crown to crown. The *active* crown fire actively spreads through both the surface fuels and aerial fuels simultaneously. Finally, the *independent* crown fire spreads through the canopy, from crown to crown, independent of surface fires and surface fuels. “When crown fires occur, spotting potential is increased and control difficulty is increased” (Queen, 1993, p. 7). Gould, McCaw, Cheney, Ellis, and Matthews (2007) assume in a mathematical model that “maximum spotting distance coincides with peak rates of spread, which typically involve elevated and bark fuels, in addition to surface fuels” (p. 61).

Oakland/Berkeley Hills Fire

The National Fire Protection Association [NFPA] (n.d.) reports that a conflagration occurred in the hills above the cities of Oakland and Berkeley, California on October 20, 1991. Closely spaced *Eucalyptus* and Monterey pine trees had been influenced by a five-year drought when strong winds, high temperatures, and low relative humidity, moved into the area. This urban interface fire “killed 25 people, injured 150 others, and destroyed more than 3,000 structures” (National Fire Protection Assocation, n.d., p. 19). The National Fire Protection Association (n.d.) reports that the high resin content and the long shaggy bark of the *Eucalyptus* added to the ease of ignition of the fuels in the area. In some cases, lower

limbs of *Eucalyptus* trees barely cleared the ground, which provided a ladder for a ground fire to reach into the crown or canopy of the *Eucalyptus* forest. In addition to *Eucalyptus*, the hills of Oakland also contained thick stands of Monterey pine. The National Protection Association (n.d.) reports that “not only can the Monterey pine ‘crown’ easily, it will also sustain a crown fire, which can outpace fire suppression crews” (p.7).

Essner (1993) notes that *Eucalyptus* “bark catches fire readily, and deciduous bark streamers and lichen epiphytes tend to carry fire into the canopy and to disseminate fire ahead of the main front” (p. 7). Spotting is the “carrying of burning leaves and embers by the wind or the convection column from the fire to unaffected areas, which then ignite combustible roofs, ornamental shrubs and bushes, and other vegetation” (National Fire Protection Association, n.d., p. 8). Additional downwind fires caused by spotting “can combine into a massive firestorm or spread fire suppression forces so thin, over such a wide area, that they are ineffective” (NFPA, n.d., p. 8).

Fire Behavior Modeling

Predicting fire rate of spread. A wildfire’s rate of spread is influenced primarily by fuel, weather, and topography. According to Long and Kennard (n.d.) “rates of spread generally increase with increasing wind speed, slope and amount of fine fuels” p. 478). Long and Kennard also report that the fire

itself can influence its own rate of spread when the fire produces sufficient heat to modify local winds and to destabilize the atmosphere.

Types of fire behavior models. Perry (1998) identifies three types of fire behavior models as *physical, semi-physical,* or *empirical*. Physical models “are those based on the first principles of physics and thermodynamics” (Perry, p. 225). Physical models generally incorporate the chemistry of combustion and these models can be calibrated by test burning. Semi-physical models “adopt a combination of physical and empirical techniques” (Perry, p. 227). The most important semi-physical models, according to Perry, are the National Fire Danger Rating System (NFDRS) and the BEHAVE fire prediction system. Empirical fire behavior models, according to Perry, are models where there is “no attempt to involve physical mechanisms and [empirical models] are, in essence, statistical descriptions of test fires” (p. 229). Regarding empirical models, Perry warns that “their lack of physical basis means that they can only be used cautiously outside the test conditions” (p. 229).

Fuel Hazard Assessments

Fuel hazard assessments can help foresters, landowners and emergency managers in the prediction of potential fire behavior. Gould, McCaw, Cheney, Ellis, and Matthews (2007) developed a fire spread model based upon wind, fuel structure, fuel

moisture, and topography to predict maximum rates of fire spread and maximum spotting distance in a dry *Eucalyptus* forest during summer conditions. Surface fuels, near-surface fuels, elevated fuels, and bark hazard scores are assessed and then coupled with weather inputs to predict fire spread rates and spotting distance.

Surface fuels. The surface fuel layer of dead leaves, twigs, and bark and forest litter "usually makes up the bulk of the fuel consumed and provides most of the energy released by the fire," according to Gould et al. (p.8). Surface fuel hazard ratings can range from nil (hazard score of zero) on bare ground to extreme (hazard score of four) when the surface is thick with continuous litter and duff. According to Santos (1997), a dense *Eucalyptus* forest with a closed canopy absorbs sunlight before it reaches the ground; consequently, grasses are unable to survive.

Near-surface fuels. According to Gould et al. (2007) the near-surface fuel layer of grasses, low shrubs, and collapsed understorey [sic] can create fuel hazard ratings from nil (hazard score of zero) to extreme (hazard score of four) where very large amounts of leaves, twigs, bark, and dead material is suspended within a meter of the ground.

Elevated fuels. According to Gould et al. (2007) the elevated fuel layer of shrubs and understorey [sic] plants can

create fuel hazards from nil (hazard score of zero) to extreme (hazard score of four) where the fuel is difficult to walk through, and where there is vertical continuity of fuels from the ground up.

Bark. The Centre for Plant Biodiversity Research (1996) classifies *Eucalyptus* bark into two types: (a) persistent type bark also known as rough barks, and (b) shedding barks, also known as smooth barks. Examples of persistent rough bark *Eucalyptus* species include stringy barks, boxes, peppermints and ironbarks. Examples of shedding smooth bark species include the gum *Eucalyptus* species, such as blue gum. Gould et al. (2007) classifies *Eucalyptus* bark as either (a) smooth bark, (b) platy and sub-fibrous bark, or (c) stringy bark.

Smooth bark *Eucalyptus* species, such as the gums, produce bark that sheds annually into long ribbons. The long ribbons of bark fall from the trunks and sometime lodge in the tree's branches. "This bark may burn for half an hour or more, and is sometimes called 'candle bark' " (Gould, 2007, p. 14). Gould et al. rates smooth bark hazards as a low (hazard score of zero) to moderate (hazard score of one).

Platy and sub-fibrous bark *Eucalyptus* species, such as the peppermints, box, bloodwoods, and ironbarks, produce bark that is held tightly to the tree's truck and branches; however, Gould et al. (2007) notes that this bark is "capable of flaking and

losing small chunks as a result of burning or weathering" (p. 14). Gould et al. rates platy and sub-fibrous loose bark hazards as moderate (hazard score of one) to high (hazard score of two).

Stringy bark *Eucalyptus* species, such as the stringybark *Eucalyptus* and ash *Eucalyptus*, produce persistent old dead bark in a spongy fibrous mass with deep fissures. Bark from these trees "can produce massive amounts of burning embers" (Gould et al., 2007, p.14). Gould et al. rates stringy bark hazards as very high (hazard score of three) to extreme (hazard score of four).

School District Emergency Plans

The National Clearinghouse for Educational Facilities [NCEF] (2008) recommends that schools create a survivable space of cleared fuels between the school and the wildland to ensure that school buildings can survive without extensive effort from either school officials or the fire department responders.

Fire Prevention and Mitigation

Construction features. "The roof is the most vulnerable part of the school to wildfires" (National Clearinghouse for Educational Facilities [NCEF],2008, p. 2), and if firebrands from a wildfire can blow onto a roof, and if the roof is vulnerable to fire, or if the roof holds flammable debris, the roof itself can ignite. According to the NCEF, "the best way to

avoid this situation is to make sure the roof is free of debris and fire-resistant” (p. 3). ASTM International (n.d.) reports in ASTM Standard E-108, that class-A roof coverings and roof systems are the most fire resistant because they effectively resist fire penetration when exposed to a fire originating from sources outside the building.

Fire and Emergency Preparedness

Fire drills. The California Education Code mandates one fire drill per month in elementary schools (California Education Code, Section 32001). Kano et al. (2007) found that the elementary schools surveyed in Los Angeles County, had conducted an average of 6.4 fire drills over the past eight months.

Emergency response plans. Kano, Ramirez, Ybarra, Frias, and Bourque (2007) surveyed school administrators and staff from 12 public schools in Los Angeles County and reported that 32.8 percent of respondents reported being effected in the past by a fire at their school, and 48.1 percent of respondents had been effected in the past by a fire in the neighborhood. Kano et al. also found that “eighty-four percent of respondents said they have a personal copy of their school’s current written emergency response plan” (p. 407).

Emergency Response

Sheltering and evacuation response plans. Kano et al. (2007) reported that, “whereas 90% of respondents indicated that

their school had an evacuation plan, less than half of the respondents said that they had a sheltering plan” (p. 410).

Interagency cooperation. Kano et al. (2007) asked school officials in Los Angeles County to indicate the local agencies with which their school cooperates on emergency response and preparedness issues. “The police department (49.6%), fire department (47.6%), and sheriff’s department (42.7%) were most frequently mentioned. Some respondents also indicated working with city offices/managers (17.7%)” (Kano et al., 2007, p. 411).

Findings within the literature influenced this research by guiding the researcher toward objective techniques for the prediction of fire behavior. The literature also provided background about emergency plans in other schools, which influenced the questions to be considered in this applied research project.

Procedures

The purpose of this research project was to evaluate the effectiveness of current wildfire emergency response plans at Santiago Elementary School and to recommendation whether to continue current practices or to alter school emergency plans related to wildfire.

The parameters of this evaluative study include comparing school evacuation speed against the rate of spread of a wildfire

in a *Eucalyptus* forest under Santa Ana wind conditions. Additional parameters included an assessment of current written emergency procedures in the three school districts in southern Orange County and an examination of the fire resistant properties of school grounds and structures at Santiago Elementary school.

The key indicator of a successful and effective elementary school wildfire emergency plan would be for school officials to acquire timely information under emergency conditions and to implement safe and appropriate protective actions, such as evacuation, shelter in place, or school closures.

Research Procedures

Research procedures followed during this project included the following: (a) development of an evaluation instrument for timing an evacuation drill; (b) observing a full-scale timed evacuation drill at Santiago Elementary School in Lake Forest, California; (c) acquisition of scaled maps of the area; (d) conducting field assessments of fuel hazard characteristics in 10 *Eucalyptus* forest plots north of Santiago Elementary School; (e) calculation of estimated maximum theoretical rates of fire spread within the *Eucalyptus* forest; (f)observation of school grounds and school structures for resistance to external fire attack; (g) a review of school fire emergency plans from

Capistrano Unified School District, Laguna Beach Unified School District, and Saddleback Valley Unified School District, (h) interviews with officials from Saddleback Valley Unified School District, and (i) a review of after action reports from the Orange County Fire Authority.

Evacuation drill. Santiago Elementary School lies along the southern edge of the 65 hectare (160 acre) *Eucalyptus* forest. The elementary school would potentially be at risk from an encroaching wildfire that was driven by a north wind.

A full-scale timed evacuation drill was conducted by the school district, with prior parental permission, on Tuesday, September 29 at 9:00 a.m., at Santiago Elementary School in Lake Forest, California. The objective was to evacuate all 420 children from kindergarten through sixth grades, via bus, in the shortest feasible time. Six full-sized school buses, six bus drivers, and a transportation supervisor were pre-staged in front of the school. Upon a signal from the school principal, all classrooms were evacuated, and the six buses were loaded with approximately 70 children per bus. Approximately 90% of the 420 children participated in the evacuation. Those children without parental permission slips were sheltered in place in the school’s multi-purpose room.

Four Orange County Fire Authority observers were assigned to watch and time the evacuation drill. Two observers were

randomly assigned to two different classrooms to observe the classroom aspects of the evacuation, while two other observers were assigned to watch the transportation aspects of the evacuation. See evaluation instrument in Appendix B.

Estimation of Rate of Fire Spread

Selection of Test Plots

Maps. Scaled maps of the area were acquired from Google Maps (2009). Using protocols specified in Gould, McCaw, Cheney, Ellis, and Matthews (2007) a 300 m path was plotted by the researcher, starting near the intersection of Toledo Way and Fallen Leaf Road, proceeding south, through the *Eucalyptus* forest to Santiago Elementary School. This path simulates a fire's hypothetical route of travel from north to south, toward the school, under the influence of a north wind.

Plot locations. The researcher conducted fuel assessments on 10 plots over the 300 m distance, with each sampling point separated by approximately 30 m. Fuel plots were assessed on October 21 and November 1, 2009 and plot locations are listed in Table 1.

Table 1

Plot Locations for Fuel Assessments in a Eucalyptus Forest

Plot	Location	Description of Area
1	Fallen Leaf at Dove Tree	Residential intersection
2	Fallen Leaf at Knollwood Street	Ravine
3	North of Foresthill Cul-de-sac	Ravine
4	Springwood and Foresthill	Residential intersection
5	Springwood and Meadowood	Residential intersection
6	Ridge Route & Costa Bella (North)	Urban forest
7	Ridge Route & Costa Bella (South)	Urban forest
8	Ridge Route & Winterwood (South)	Urban forest
9	North of Rivendell	Urban forest
10	School property	Bare ground/mature trees

Fuel hazard inputs. At each plot location, the researcher assigned a fuel hazard score to surface fuels, near-surface fuels, elevated fuels, and bark as illustrated in Gould et al. (2007). Fuel hazards scores between zero and four were recorded for each fuel type at each of the 10 plots according to protocols in reference tables F1, F2, F3, and F4 as described by Gould et al. (2007). Fuel hazards scores for each of 10 plots are recorded in Appendix A.

Weather inputs. Plausible severe weather data inputs were derived from historical weather records in Santa Ana, California during recent Santa Ana wind events, and plotted in Table 2.

Table 2

Plausible Weather Data Inputs

Date	Wind Speed (km/hr)	Relative Humidity (%)	Air Temperature (^{0}C)
October 21, 2007	42.6 km/hr	5%	26
November 15, 2008	27.8 km/hr	6%	29
Red Flag Criteria	40.2 km/hr	15%	Not Listed

The first wind speed input had been actually observed during a recent Santa Ana wind event on Sunday, October 21, 2007 at 6:06 p.m., according to Weather Underground (n.d.) in Santa Ana, California. The second wind speed input had been recorded on Saturday, November 15, 2008 at 8:53 a.m., according to Weather Underground (n.d.) in Santa Ana, California. The third hypothetical wind speed input was acquired from the National Weather Service (n.d.) which has established a speed of 40.2 km/hr (25 miles per hour) and a relative humidity of 15% as

threshold weather criteria for alerting the public of a red flag warning.

School Facility and Emergency Plan Assessment

School Grounds and School Structures

School grounds. The researcher observed the school grounds at Santiago Elementary School for vegetation fuel hazards, as recorded in Table 1 plot-10.

School structures. The researcher also observed the construction features of the school building's exterior walls and roof from the perspective of vulnerability to exterior fire attack.

School Emergency Response Plans

The researcher reviewed emergency plans from the three school districts in southern Orange County, including Capistrano Unified School District, Laguna Beach Unified School District, and Saddleback Valley Unified School District. School district emergency plans were assessed for inclusion of wildfire encroachment as a specific risk, and for the plan's ability to incorporate a variety of wildfire action strategies.

Limitations

Evacuation Drill

Sample size. The researcher observed only one single evacuation drill at one elementary school, which may not have been a representative sample of the entire population of elementary schools and elementary school transportation systems.

Pre-staging. Buses were pre-staged for the drill, whereas in an actual emergency, bus drivers would need to be notified by radio, and buses would need to travel 2.3 km (1.5 miles) to Santiago Elementary from the bus storage facility in Mission Viejo. Without traffic and stoplights, at 40 km/hr (25 miles per hour), the six buses would have needed approximately three and a half minutes to travel that distance, after the evacuation order was given.

Rate of Spread Calculations

Australian model. Fuel moisture content was estimated using Model 1 in Gould et al. (2007) which is useful during the months of November, December, January, or February in Australia. The researcher made the assumption that this model corresponds to May, June, July or August in California.

Slope adjustments. Except for a ravine and a few small ephemeral streams, the 65 hectare *Eucalyptus* forest lies on flat level ground. The elementary school is level with the 300 m path

that was selected as the hypothetical route of fire travel. Consequently, no adjustments for slope were made.

Time for fire build-up. The model developed by Gould et al. (2007) is used to predict “rate of spread of a fire burning under summer conditions *after* the fire has undergone its initial growth phase” (p.20). According to Gould et al. (2007) “the time taken to reach [the fire’s maximum] potential rate of spread may be as short as 12 minutes or as long as 45 minutes” (p.4). Thus, the rapid rate of spread predicted by the model may not materialize immediately.

Barriers and fuel breaks. The fire spread model developed by Gould et al. (2007) “only relates to open dry eucalypt [sic] forest” (p.6). The urban forest being studied, however, is crossed by 12 m wide asphalt streets. The asphalt streets would presumably act as fuel breaks and slow the spread of a forest fire. The streets are densely populated with up to 84 homes per km along one or both sides of the streets. Homes with non-combustible roofs may also act as fuel breaks, as long as the homes do not ignite as the fire passes.

Homes as a potential ignition source. Another limitation of the Gould et al. (2007) model is that it does not account for fires in the suburban environment where a fire starts in a house and spreads to the forest, or where a fire starts in the forest and spreads to a house. The vertical structure of the house

could potentially act as a ladder fuel to the forest crown, while the intense heat released from the house fire could possibly induce an active crown fire.

Fire spread rates in low fuel hazard zones. Fire spread tables provided by Gould et al. (2007) do not specify rates of spread for fires where fuel hazard scores approach zero on the school grounds as shown in Appendix A, plot-10. Presumably, a fire would slow significantly upon reaching the sparse well-maintained vegetation on the school grounds.

Results

The evaluative research method was used in this study to answer the following questions:(a) What are the school district's current emergency plans for wildfire emergency response, (b) what is the maximum theoretical calculated rate of spread of a wildfire in a *Eucalyptus* forest (c) under ideal conditions, how fast can an elementary school evacuate all students (d) given the speed of a wildfire and the speed of evacuation, is it possible to evacuate a school before the head of the fire impacts the school, and (e) for schools adjacent to fire-prone forests, what protective action options should be included in school emergency plans?

What are the school district's current emergency plans for wildfire emergency response?

The researcher reviewed fire emergency plans from three local school districts. According to the Capistrano Unified School District (n.d.), the district's emergency management plan contains sections on site evacuation, release and reunification, fire within a school building, and fire near the school. The Capistrano Unified School District plan, however, does not specifically address an encroaching wildfire that threatens the school, nor does the plan specifically address the option of sheltering in place during a wildfire.

According to the Saddleback Valley Unified School District (2001), the district's fire emergency management plan contains specific instructions for fire drills, classroom evacuation during fires within the school, and guidelines for fires near the school. The Saddleback Valley Unified School District plan, however, does not specifically address an encroaching wildfire that threatens the school, nor does the plan specifically address the option of sheltering in place during a wildfire.

Laguna Beach Unified School District's fire awareness code contains specific objectives for the management of students when wildfires threaten a school (D. Reed, personal communication, November 19, 2009). Options addressed in the plan include site evacuation, sheltering in place, and closing the school under certain conditions. The Laguna Beach Unified School District's fire awareness codes are displayed in Appendix C.

What is the maximum theoretical calculated rate of spread of a wildfire in a Eucalyptus forest?

Plausible severe weather data inputs were derived from weather records in Santa Ana, California during recent Santa Ana wind events, as recorded in Table 2. The researcher assessed 10 plots for fuel hazards along a 300 m north-south line through the *Eucalyptus* forest, accruing to protocols listed in Gould et al. (2007). The average hazard scores for surface fuels, near-surface fuels, elevated fuels, and bark are listed in Table 3.

Table 3

Summary of Fuel Assessment Field Data (Average of 10 Plots)

		Average
Surface fuels	Depth(mm)	23.5 mm
	Fuel hazard severity rating	2.1 out of 4.0
Near-surface fuels	Height(cm)	42.0 cm
	Fuel hazard severity rating	0.7 out 4.0
Elevated fuels	Height(m)	2.4 m
	Fuel hazard severity rating	0.4 out of 4.0
Bark	Fuel hazard severity rating	1.2 out of 4.0

Using plausible fire weather data from Table 2 and actual fuel hazard data from Table 3, the theoretical rates of fire spread through a *Eucalyptus* forest on level ground were calculated according to protocols established in reference table R2.1 in Gould et al. (2007). Fuel moisture content was estimated using reference table M1 in Gould et al. (2007) to reflect the actual moisture content of surface fuels under Santa Ana wind conditions. The terrain in the forest is essentially flat and level, except for a 15 m (45 foot) deep ravine and a few small ephemeral streambeds. Therefore, a slope correction was not used.

Rate of Spread Result

As displayed in Table 4, the maximum fire rate of spread was calculated at 1950 m/hr (1.2 miles per hour) according to reference tables M4.1 and M4.2 in Gould et al. (2007). Maximum spotting distance was calculated at 1360 m (0.85 miles) using reference table Sd 2.1 in Gould et al. (2007).

Table 4

Final Predicted rate of Spread - Santa Ana Wind Conditions

Wind Speed (km/hr)	Relative Humidity (%)	Air Temperature (^{0}C)	Corrected Predicted Fuel Moisture Content (%)	Final Predicted Rate of Spread (m/hr)	Maximum Spotting Distance (m)
27.8	6%	29	3%	1250	
40.2 (Red Flag)	15%	---	4%	1100	
42.6	5%	26	3%	1950	1360

Under ideal conditions, how fast can an elementary school evacuate all students?

All teachers, students, parents, and staff had been forewarned of the evacuation drill. Six school buses had been moved 2.3 km (1.5 miles) from the bus yard in Mission Viejo to the front of Santiago Elementary School in preparation for the drill. The weather during the evacuation drill was clear and warm with no wind.

The school principal gave notice to evacuate the school at 9:21 a.m., and all buses were loaded and had departed by 9:30 a.m. Observers noted that most teachers retrieved their evacuation packs from their classrooms as they proceeded toward the buses. Although most teachers carried room signs with

teacher names and room numbers, some of the teachers were difficult to distinguish from the 6th-grade students as they walked to the staging areas. All of the students were well behaved, cooperative, and followed directions throughout the drill. The principal coordinated with each teacher and assigned each class to the appropriate bus. Attendance was taken by most teachers in the staging areas; however, some teachers only counted heads instead of accounting for individual names. The multi-purpose room was used to shelter in place location for those students who did not have a parental permission slip.

Evacuation Speed Result

Within nine minutes of the drill's commencement, all 420 students were either evacuated by bus or sheltered in place in the multi-purpose room.

Given the speed of a wildfire and the speed of evacuation, is it possible to evacuate a school before the head of the fire impacts the school?

At a rate of 1950 m/hr (1.2 miles per hour), a fire, once fully developed, could theoretically travel the 700 m from the northern edge of the forest to Santiago Elementary School along the southern edge of the forest in approximately 21 minutes. [1 hr/1950 m x 700 m = 0.36 hours. 0.36 hours x 60 minutes/hr = 21 minutes]. If firebrands were blown 1360 m (0.85 miles) ahead of the main fire, spot fires could develop and carry the fire to

the school in less than 21 minutes. A fire that starts in the middle of the forest could reach the school in even less time.

Evacuation time, under ideal conditions, could require at least 12 minutes, which includes three minutes for bus retrieval, added to nine minutes for classroom evacuation.

For schools adjacent to fire-prone forests, what protective action options should be included in school emergency plans?

One school district's emergency plan addresses the wildfire threat by including several wildfire protective options in the district emergency plan, including site evacuation, shelter in place, and school closures.

Discussion

Relationship Between Study Results and Literature

Santos (1997) reported that a dense *Eucalyptus* forest with a closed canopy absorbs sunlight before it reaches the ground; consequently, grasses are unable to survive. During fuel hazard assessments, it was observed that those plots beneath a closed *Eucalyptus* canopy had very little grass as a surface fuel.

An active or independent crown fire, as reported in Beighley and Bishop's study (as cited in Long, n.d.) depends upon "dry fuel, low humidity with high temperatures, heavy accumulation of dead and downed litter, conifer regeneration and other ladder fuels, steep slopes, strong winds, unstable atmosphere, and a continuous cover of coniferous trees" (p.

481). The National Fire Protection Association (n.d.) reported that lower limbs of *Eucalyptus* trees barely cleared the ground on the slopes in the Oakland Hills in October 1991. This provided a ladder for the ground fire to reach into the crown of the *Eucalyptus* forest. The Oakland/Berkeley Hills conflagration "Killed 25 people including a police officer and a firefighter, injured 150 others, and did an estimated $1.5 billion in damage" (National Fire Protection Association, n.d., p.3). In addition to *Eucalyptus*, the hills of Oakland also contained thick stands of Monterey pine. The National Fire Protection Association (n.d.) reports that "not only can the Monterey pine 'crown' easily, it will also sustain a crown fire, which can outpace fire suppression crews" (p.7). The researcher found, during plot assessments, that the *Eucalyptus* grove in Lake Forest is essentially level. The researcher also found that most *Eucalyptus* trees in the study area had limbs well above the ground. Finally, the researcher found that most of the plots in the study area did not contain pine or other significant elevated fuels below the *Eucalyptus* canopy.

The National Clearinghouse for Educational Facilities (2008) reported that "the roof is the most vulnerable part of the school to wildfires" (p. 20). If firebrands from a wildfire can blow onto a roof, and if the roof is vulnerable to fire, or if the roof holds flammable debris, the roof itself can ignite.

During site assessments at Santiago Elementary, the researcher observed that the school's roof was very clean, and free of debris.

Kano et al. (2007) reported, "Whereas 90% of respondents indicated that their school had an evacuation plan, less than half of the respondents said that they had a sheltering plan" (p. 410). The researcher noted that only one of the three school districts studied had a sheltering plan specifically for wildfire emergencies.

Interpretation of Results

The results of this evaluative research demonstrate that a fire could theoretically, under extremely dry windy conditions travel from one end of the *Eucalyptus* forest to the other in a matter of 21 minutes, while spot fires could theoretically jump 1360 m (0.85 miles) ahead. The results also demonstrate that under ideal conditions, an entire elementary school can evacuate by bus in as little as nine minutes if all transportation resources are pre-notified and pre-staged.

In the researcher's opinion, the key indicator that would support evacuation as a successful protective strategy would be to evacuate all children safely via bus in sufficient time before the fire reaches the school grounds. This would ensure that all children were evacuated, free from exposure to smoke, heat, embers, and wind-blown debris. Alternatively, the key

indicator that would support shelter-in-place as a successful protective strategy, in the researcher's opinion, would be if the rate of fire spread left insufficient time to evacuate children ahead of the fire front. This would ensure that all children were sheltered in place within a central fire-resistant structure on school grounds free from exposure to smoke, heat, embers, traffic jams, and wind-blown debris.

In the opinion of the researcher, the effectiveness of a school district's emergency plan is increased if multiple options are provided in the plan to combat the wildfire threat. Emergency planning options for wildfire encroachment may include site evacuation, shelter in place, and school closures.

All occupied school buildings, offices, and the multi-purpose room are constructed with non-combustible masonry exterior walls and a built-up roof that meets ASTM Class-A fire-resistant criteria, according to Saddleback Valley Unified School District (F. Manzo, personal communications, November 30, 2009). These factors, in the opinion of the researcher, reduce the chances for a wildfire or flying embers to attack the exterior of the structures.

The school grounds at Santiago Elementary School provide a scarcity of fuel as shown in Table 1, plot-10. The surface of the school grounds facing north, toward the *Eucalyptus* forest, consists of bare dirt and an asphalt parking lot. Surface fuels,

near-surface fuels, and elevated fuels are non-existent on the school grounds, while all *Eucalyptus* trees on the campus have limbs well above ground level, and they have entirely smooth bark with a bark hazard score of zero. The *Eucalyptus* canopy is approximately 60% closed on the north side of the school, and this canopy becomes increasingly sparse on the south end of the school grounds. All trees are at least 10 m from the nearest school structure. The researcher found, during plot assessments, that the *Eucalyptus* grove in Lake Forest is essentially level, most *Eucalyptus* trees in the study area had limbs well above the ground, and most of the plots in the study area did not contain pine or other significant elevated fuels below the *Eucalyptus* canopy. These factors, in the opinion of the researcher, reduce the chances for the development of an active crown fire in the *Eucalyptus* of Lake Forest.

Implications for the Organization

If a significant fire ignited and built to its full potential in this *Eucalyptus* forest, the theoretical rate of fire spread (21 minutes from forest edge to forest edge) compared to the speed of evacuation plus transportation (12 minutes) provides a very slim margin of safety, in the researcher’s opinion. If the fire starts in the middle of the forest instead of the extreme northern edge, or if transportation or communication delays prolong the evacuation

process, then the fire could directly impact the evacuees during their movements outside, when they are most exposed.

Situations where time is inadequate would favor the shelter in place option for school emergency plans. Fire resistant school grounds and fire resistant school buildings enhance the safety of the schoolchildren by placing a barrier between the children and the encroaching wildfire. Conversely, given sufficient notification and transportation time, evacuation would be the favored option for school emergency plans. If the fire occurs when the school is not in session, a school closure for the following day may be a third option for the school's wildfire emergency plans.

An active or independent crown fire, as reported in Beighley and Bishop's study (as cited in Long, n.d.) depends upon "dry fuel, low humidity with high temperatures, heavy accumulation of dead and downed litter, conifer regeneration and other ladder fuels, steep slopes, strong winds, unstable atmosphere, and a continuous cover of coniferous trees" (p. 481). Even under these optimal fuel and weather conditions, a heat source, such as a vehicle fire, a house fire, or a careless or malicious act is required to ignite the fire.

It is conceivable, in the opinion of the researcher, that an ignition source could coincide with the above fuel and weather factors, especially if a house fire occurred beneath the

Eucalyptus canopy and generated massive amounts of heat under dry Santa Ana wind conditions.

In this researcher's opinion, the relative scarcity of ladder fuels, the level terrain, and the low frequency of pine trees below the *Eucalyptus* canopy in Lake Forest makes the probability of an active crown fire less likely than in the hills of Oakland. Nevertheless, it is incumbent upon all school officials, teachers, parents, firefighters, law enforcement, landowners, and city officials to be familiar with this potential problem and to establish primary and alternate response plans and command plans for a wildfire that is advancing toward a school.

Recommendations

The purpose of this applied research was to evaluate the effectiveness of current wildfire emergency plans at Santiago Elementary School by comparing the rate of fire spread through a *Eucalyptus* forest against the observed speed of the school's evacuation. Results indicted that current fire emergency response plans at Santiago Elementary School do not specifically address the problem of wildfire encroachment. Results also indicated that a nearby fire with a rapid rate of spread coupled with a prolonged evacuation time would provide a very slim margin of safety for a safe evacuation. Based upon these findings, the following recommendations are made:

In order to improve the effectiveness of school emergency plans, school districts with wildland-urban interface issues should consider adding the risk of wildfire encroachment to their emergency response plans.

In order to enhance the versatility of school emergency plans, school districts should consider a variety of protective options in their wildfire emergency response plans, including site evacuation, shelter in place, and school closures.

In order to prepare for wildfires, school district officials and emergency responders should remain abreast of changing weather conditions, including fire weather watches and red flag warnings issued by the National Weather Service.

In order to improve accountability during an evacuation, teachers should consider taking attendance, by checking or calling the student’s name, as the class enters the bus.

In order to provide easy identification of teachers during an evacuation, school districts should consider brightly colored vests or jackets for teachers, preferably in a color other than yellow to avoid confusion with the firefighters’ clothing.

In order to promote further interagency cooperation, school districts should continue to cross-train with local fire, police, sheriff, and city management officials.

In order to promote speed and accuracy of information transfer during emergencies, the school district should consider

sending an agency representative to the field incident command post, while the fire department should consider sending a liaison to the school district emergency operations center.

In order to prevent the spread of an encroaching wildfire onto school grounds, school districts and other property managers should continue to maintain grounds with sparse surface fuels, an absence of elevated fuels such as pines beneath the *Eucalyptus* canopy, and *Eucalyptus* trees that are smooth-barked, well-maintained, well-watered, and limbed-up.

In order to prevent the spread of fire into school buildings and to create safety zones for the shelter in place option, school districts should continue to maintain all school structures with non-combustible siding and class-A fire resistant roofs, free of combustible debris.

In order to take advantage of the time required for a fire to undergo its initial growth phase, 911 should be called immediately for any sign of smoke or fire, and firefighters should respond aggressively to keep early-stage surface fires small and to prevent crown fires and spot fires.

Future readers who have an interest in or a responsibility for school fire safety in wildland urban interface areas may wish to replicate portions of this study in their own organization. Differences in fuels, weather patterns,

topography, transportation routes, and building construction may lead to different results.

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Appendix A

Detailed Fuel Hazard Assessments in 10 Plots

		Plot Number										
		1	2	3	4	5	6	7	8	9	10	Ave
Surface fuels	Depth (mm)	0	40	40	0	0	80	25	25	25+	0	23.5
	Fuel hazard severity rating	0	3	3	0	0	4	3.5	3.5	4	0	2.1
Near-surface fuels	Height (cm)	60	0	0	100	100	60	NA	N/A	100	0	42.0
	Fuel hazard severity rating	1	0	0	1	1	1	0	0	3	0	0.7
Elevated fuels	Height (m)	5	0	0	4	8	7	NA	NA	NA	0	2.4
	Fuel hazard severity rating	1	0	0	1	1	1	0	0	0	0	0.4
Bark	Fuel hazard severity rating	1	1	1	2	2	1	1	1	2	0	1.2

Appendix B

Observer Sheet – Classroom Factors

School: Santiago Elementary, 24982 Rivendell Dr.
Lake Forest, CA

Principal: A. Norman, Ed.D. Grades K-6

Observer Name: _____

Teacher's Name: _____

Grade Level: _____

Number of Students: _____

Classroom Number: _____

Classroom Distance From Departure Point: _____

Time--Class Notified: _____

Time—All Students and Teacher Left Classroom: _____

Time—All Students & Teacher Arrived at Departure Point: ___

Bus ID Number: _____

Time—Bus Began Loading This Class: _____

Time—Bus Fully Loaded with This Class and Teacher: _____

Time—Bus Departed: _____

Other Observations:

☐ Did teacher take roll?

☐ Did teacher take evacuation kit?

Observer Sheet – Transportation Factors

School: Santiago Elementary, 24982 Rivendell Dr.
Lake Forest, CA

Principal: A. Norman, Ed.D. Grades K-6

Final evacuation "Destination:" _____

Observer Name: _____

Bus Driver's Name: _____

Which Teachers Loaded Their Students Onto This Bus?

☐ _____ (Grade-____)

☐ _____ (Grade-____)

☐ _____ (Grade-____)

☐ _____ (Grade-____)

Time—When did bus arrive at loading point? _____

Time—When did bus begin loading? _____

Time—When did bus finish loading (doors closed)? _____

Time—When did bus depart? _____

Time--When did bus arrive at evacuation "destination" ____

Other Observations:

☐ Did teacher take roll on bus?

☐ Are drivers & buses normally available this time of day?

☐ How are drivers notified to initiate an evacuation?

☐ Traffic and routing issues?

☐ Other _____

Appendix C

Laguna Beach Unified School District
Fire Awareness Codes

	AM							PM							Non-Student Time					
Condition Code	1	2	3	4	5	6		1	2	3	4	5	6		1	2	3	4	5	6
Notice of Red Flag Condition	√	√	√					√	√	√					√	√				√
Verified fire in a zone of concern	√	√	√					√	√	√	√				√	√				√
Verified fire in a zone of proximity but slow moving	√	√	√	√	√			√	√	√	√	√			√	√				√
Verified FAST MOVING fire close proximity				√	√	√					√	√	√		√	√				√

Code 1: Site and District Command Consultation
Code 2: Stage buses and fire vehicle adjacent to school site
Code 3: Transport students off-site within LBUSD boundaries
Code 4: Transport students off-site to out of area site selected by Red Cross
Code 5: Shelter in place
Code 6: Cancel school for next day