- FINAL -

WILDFIRE HAZARD ASSESSMENT AND PLAN

for

Orinda Grove

Pulte Homes
Orinda, CA

Prepared by
Wildland Resource Management, Inc.
Alamo, CA
January 15, 2015

Approved by:

Kathy Leonard
Fire Marshal
Moraga-Orinda Fire District

EXECUTIVE SUMMARY

This wildfire hazard assessment and plan for the Orinda Grove is intended to meet the requirements established by the Moraga-Orinda Fire District Ordinance #13-01 (2013 California Fire Code) which calls for a wildfire hazard assessment plan to be submitted for Fire District review. The assessment shall address the following items related to wildfire hazards:

- Provision of access for fire apparatus,
- Provision of water supply for fire protection, and
- Provisions to control the spread of fire.

In order to control the spread of fire, the following plan describes actions needed to maintain fuels (both vegetative and structural) in a fire-safe condition. To make vegetation management easier to implement, it is based upon (1) delineating vegetation fuel management zones, (2) establishing appropriate treatments for each, plus (3) documenting maintenance requirements and mechanisms for enforcement. Information on fire-resistant and drought-tolerant landscaping is provided so that homeowners can protect their properties against wildland fire. This plan also addresses fire-resistant design and construction, based on the Moraga-Orinda Fire District Ordinance 13-01.

The wildfire hazard assessment includes a detailed description of existing conditions and proposed fuel modifications that will, in part, direct maintenance of landscaping and open space areas. The project site includes steep southwest facing slopes above terraced areas with proposed buildings, parking lots and playfields. The north portion of the site is covered with grasslands, interspersed with oak woodland posing moderate fire hazards. Proposed fuel modifications emphasize actions to decrease fire intensity that facilitate fire suppression and minimize property loss. Development and maintenance of a defensible space zone for 100 feet from each structure, and 10 feet from roadside edge will help ensure fire safety. Open space management will prevent shrubby growth in the grasslands of the open space. Fire behavior under current environmental conditions and with mitigation measures in place will be generally less than two-feet flame length within 100 feet of a structure, with landscaping characterized by low ignition potential and rates of spread being two feet per minute or less.

- Section One -

FIRE HAZARD MITIGATION MEASURES

Fire damage can be mitigated through changing potential ignitions and the resulting fire behavior or enhancing fire suppression capabilities. This section addresses methods to reduce fire hazard by changing potential fire behavior on the site, done by modifying both vegetative and structural fuels.

The Orinda Grove development offers several layers of mitigations addressing wildfire hazards. These include:

- A roadway system that provides access for emergency vehicles simultaneous with evacuation of residents.
- A water system that supports effective fire suppression needs.
- Selection of landscaping species that are fire-resistive in nature as well as drought- and deer-resistive.
- Vegetation maintenance that ensure landscaping and vegetation in the open spaces will produce flames that will not promote structure damage. This is accomplished by maintaining vegetation to reduce heat output and fire spread (two feet near structures and prevention of crown fires anywhere on the Project site).
- Structure design that is ignition-resistant through using non-combustible roofs, interior fire extinguishing sprinkler systems, non-combustible siding, and decking, and otherwise complying with the 2013 California Building Code.

The objective for vegetation management is to modify fire behavior to reduce potential damage. In measurable terms of fire behavior, the goal of vegetation management would be to produce flame lengths shorter than two feet within 30 feet of a structure, and to less than eight feet when further than 100 feet from any structure. This goal is limited by property lines because structures are located within 30-ft of a property line in several locations, and therefore not in control of the management entity for Orinda Grove.

The following are strategies for reducing fire hazard and a qualitative description of actions to implement the strategy. These actions form the basis for the vegetation management standards that follow and are overarching sets of actions that may be used in every effort to reach stated objectives, from fire-resistant landscaping, roadside treatments, or treatments to facilitate fire containment.

1. Strategy: Reduce fuel volumes Actions:

- Remove deadwood from trees and shrubs
- Thin forest stands that produce great amounts of litter and debris
- Create shrub/grass mosaics from continuous shrub masses
- Remove shrubs beneath and around existing and emerging trees
- Select low-growing shrubs and ground covers as replacement plants
- Remove/reduce plant litter accumulations, especially large debris such as branches, replace with small particle mulch to prevent invasion of noxious weeds

2. Strategy: Reduce fuel flammability Actions:

- Mow grass as it cures
- Replace annual grass with plants that do not dry (or cure)
- Establish a formal irrigated landscape in carefully selected areas
- Remove sick and dead shrubs and trees in a timely manner

3. Strategy: Establish/maintain fuel discontinuity Actions:

- Remove/reduce laddering fuels
- Create shrub/grass mosaics from continuous masses
- Remove shrubs from beneath and around existing and emerging trees
- Thin thickets of small trees from large tree understories
- Create low fuel zone near windows in any structure (an especially vulnerable area)

4. Strategy: Reduce the possibility of fire traveling through tree crown Actions:

- Prune lower branches smaller than 3 inches in diameter to 8-10 feet above ground
- Perform fuel volume reduction actions mentioned above

VEGETATION MANAGEMENT REQUIREMENTS

1. Site-Wide Management Actions

Several management actions are universal although they may not be stipulated under every Fuel Management Zone as defined and described below. These include:

- Mowing of grasses or low herbaceous material after they have cured.
- Mowing can be replaced by other management techniques such as grazing with goats, or a prescribed burn.
- When mowing with a string line (commonly referred to as a weed whip), stay away from trees. Weed whip damage can kill trees.
- Remove noxious weeds such as leafy spurge, knapweed or capeweed, and other invasive species listed in the Natural Resources Conservation Service A list, at http://plants.usda.gov/java/noxious?rptType=State&sort=status&statefips=06
- Remove dead wood and declining shrubs and trees each year by start of fire season. Removal of dead wood should occur wherever found and usually as high as can be reached. Trees with a live crown ratio of under 30% should be removed. The live crown ratio is determined by comparing the percentage of the crown which is living with the total height of the crown.
- When pruning lower branches of small trees, leave six-inch stubs to strengthen young growing trunks. Continue this practice until trunk reaches two inches in diameter, at which point, entire branch can be removed.
- Prune pines and oaks from November to April only. This will avoid attracting pests.
- Bare or disturbed soil must always be covered with mulch to prevent erosion and establishment of invasive weeds. The mulch layer must be a minimum of two inches deep and can be composed of chipping from other vegetation removed.

- Note that limbing up and pruning generally apply only to branches smaller than three inches diameter.
- Trees will be selected for removal on the basis of several factors combined:
  - > Condition - health, structural integrity
  - > Spacing - good growing space, but maintain complete canopy coverage
  - > Screening - hillside position, foliage distribution, relation to other keeper trees, some smaller trees kept for screening assistance
  - > Amenity - contribution to views, outdoor use areas, general ambiance, tree quality

General

The concept behind pruning the lower 1/3 branches of small trees is to separate tree canopy from fuels on the ground without removing too much foliage area. The main justification for pruning lower branches is to prevent a fire from involving the tree crowns. Once a fire is actively burning the foliage of a tree, the ability of firefighters to suppress the fire plummets. If the branches are high, and understory fuels low, the possibility of producing a flame high enough to actively burn the tree foliage is remote.

To enhance wildlife habitat, patches of litter will be allowed to accumulate in a variety of locations and vegetation types that are deemed to be adequately fire safe (only in the Fuel Modification Zone defined and described below). These areas of refuge may be approximately 100 sq. ft. and cover an average of 10 percent of areas where litter would otherwise be removed. Spacing between patches should be no closer than 20 ft apart. Because disturbance should be avoided in these locations litter up to 6 inches deep may be allowed. As a general rule, treatments to reduce fire hazard in the patches would need to occur on a 10-15 year interval.

A. SUMMARY OF VEGATIVE FUEL MANAGEMENT ZONES

There are three Fuel Management Zones in this fire hazard mitigation plan:

- **The Defensible Space/Landscaping** Zone within the structure perimeter and Paseos or otherwise within three to 100 ft of any structure including the **Streetscape Vegetation Management Zone** (within 10 feet from pavement edge). The Defensible Space/Landscaping Zone encompasses the space nearest the structures, are designed to reduce ignitions near structures, support structural survival during a wildfire, and reduce the chance that an ignition will move off site. The Streetscape Vegetation Management Zone consists of vegetation near the roads and is designed to assist evacuation and emergency vehicle access and to limit roadside ignitions. The standards and actions to comply with both the Defensible Space/Landscaping Zone and the Streetscape Vegetation Management Zone are the same, with one exception. In
  the Streetscape Vegetation Management Zone there must also be a 15-foot vertical clearance created by tree-trimming the entire length of the roadway.
- **The Open Space Management Zone**: The Open Space Management Zone ensures that fuels do not exacerbate fire hazards to adjacent landowners and

structures. It is designed to limit fire intensity and spread by means of the pruning of trees, and reduction of understory plants.

B. STANDARDS FOR DEFENSIBLE SPACE/LANDSCAPING ZONE

This proposed set of maintenance standards will be used to certify compliance and to direct maintenance activities by the Homeowner Association in the Defensible Space/Landscaping Zone between three to 100 feet of any structure or to the Homeowner Association property boundary, whichever is less. This area encompasses all house perimeters, Paseos, internal roads, the Altarinda streetscape and/or the area within 100 feet from any structure. These vegetation management actions comply with the California State PRC 4291, the California Fire Code, MOFD Exterior Hazard Control Standards dated 1-2014, and Ordinance 13-01.

1. Remove all dead plants and dry vegetation to establish and maintain a defensible space. The following actions will provide the same level of fire safety as removing all combustible material.
    a. Cut grass and weeds yearly to less than 4 in. in height when 30% of the grasses have turned brown. Beginning May 15, inspect the grass on a weekly basis to determine the state of grass curing. Cut the grass within the week when 30% of the grass cover is cured, and no later than June 15. Re-mow if late-season rains promote grass growth after the first cutting. Optionally, delay cutting of native grass and wildflowers until after seed set if they do not constitute a means of rapidly transmitting fire to any structure.
    b. Keep the ground, roofs, gutters, decking, and balconies free of dead leaves or other plant debris.
    c. Clear leaves, bark, and humus under trees and shrubs (including vines and semi-woody species) every year. At no time should a buildup of leaves and humus exceed 1 in. in depth anywhere in a landscaped area. However, do not expose bare earth in over 50% of the site.
    d. Remove dead material that drapes over ground cover (including leaves, bark, and branches) annually, before June 15.
    e. From mature trees, remove all vines, loose papery bark, dead branches, and live branches smaller than 3 in. in diameter to a height of 8 ft above the ground.
    f. Remove all dead branches from within live ground covers, vines, shrubs (including semi-woody species), and immature and landscape trees.

2. Prune trees and large tree-form shrubs (e.g. oaks, bay) that are being retained to provide clearance of three times the height of the understory plant material, or 8 feet, whichever is higher. Prune limbs that are smaller than 3 in. in diameter up to 8 feet above the ground; in young trees, prune these branches the lower one-third of the height of the tree. (Thus, if a tree is 10 feet tall, prune the lower 3–4 feet and keep the understory plant material to less than 1 foot in height. Then as it grows to 24 feet in height, it can achieve the 8-foot distance from the ground, and the understory plant material can reach 2.5 feet in height.) Do not disturb or thin the tree canopy, because

these actions promote growth of more flammable vegetation (see Figure 1). Remove all branches within 10 feet of any chimney, flue, or stovepipe. Maintain 5 feet of vertical clearance between roof surfaces and overhanging portions of trees.

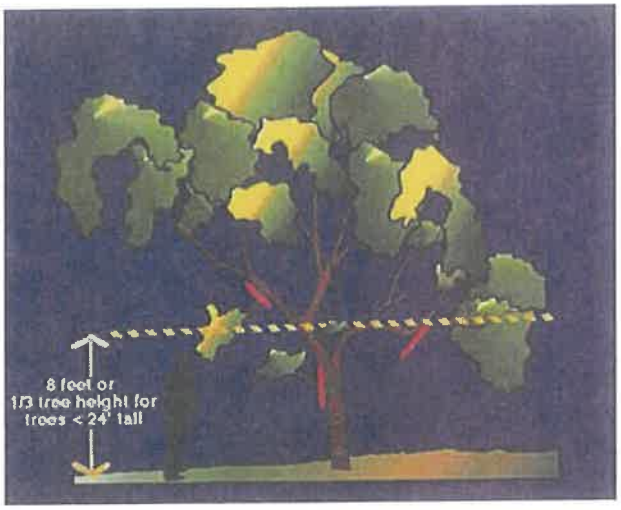


Figure 1 - Prune branches to a height of 8 feet above the ground. In young trees, prune branches on the lower one-third of the height of the tree. Do not disturb or thin the tree canopy. This promotes growth in the understory, which is more easily ignited.

3. Do not locate plants that are replacing ones that die, or oaks planted as a mitigation measure, under trees. To avoid creating "ladder fuel situations" (in which a fire can climb from one vegetation layer to the next higher one), do not plant any tall shrubs, vines, semi-woody species, or any chaparral species under trees. Low-growing shrubs and ground covers are suitable landscaping under trees.

4. Make sure that all landscaping and replacement plants are fire-resistant in nature. Prohibit planting of plants that are highly ignitable and burn with intensity.

5. Manage individual plants or shrub masses to maintain adequate horizontal spacing. Design distinct groupings of shrubs (including vines, semi-woody species, all types of brush, and all chaparral species) to dampen the spread of fire. Make sure that the plant groupings are small enough to provide adequate horizontal separation between groupings and to allow proper maintenance; groupings should measure no wider than two times the grouping height, or 120 sq. ft. However, one row of shrubs in a linear band with a maximum width of 7 feet, located at least 10 feet from the structure, need not comply with the 120 sq. feet area limit. The space between islands should be greater than three times the height of the shrubs. On emerging trees, clear a spacing of 12 feet from the edge of the canopy (see Figure 2).

6. Remove and safely dispose of all cut vegetation and hazardous refuse.

7. Allow chipped materials to remain on the site, provided the mulch layer is no greater than 2 in. in depth.

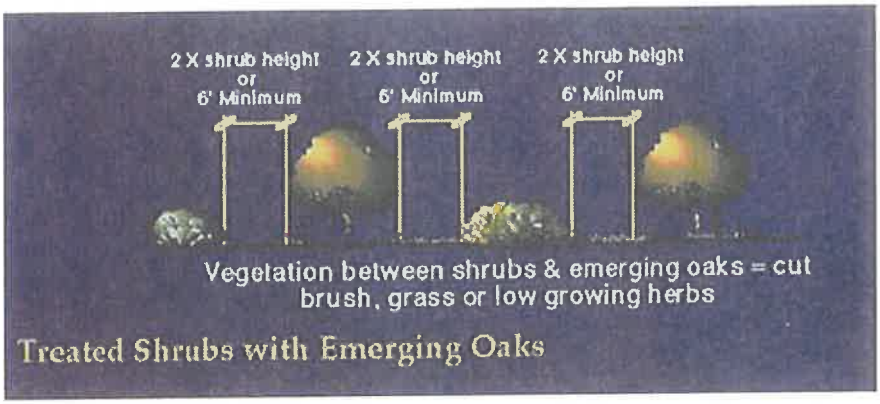


Figure 2. Shrub island spacing. Design groups of plants small enough to provide horizontal separation between groups. This allows proper maintenance and helps slow the spread of fire. Each shrub or group of plants should measure no wider than two times its height, or less than 120 sq. ft. (or 6 feet x 20 feet). The space between groups should be greater than three times the height of the shrubs.

C. STANDARDS FOR OPEN SPACE MANAGEMENT ZONE

The land anywhere beyond 100 feet from any structure to Homeowner Association boundary will be designated as an **Open Space Management Zone**. This zone will also include all the lands in Open Space and the Community Playfields.

1. All dead plants and combustible materials shall be removed to establish and maintain a defensible space. The following actions will provide the equivalent level of fire safety as removing all combustible material.
   a) Cut grass and weeds to less than 4 inches in height under short trees (trees under 24 feet in height) to preclude excessive pruning (see Item 2 below). This will be done yearly before June 15. Cutting of native grass and wildflowers may be delayed until after seed set provided they do not form a means of rapidly transmitting fire to any structures.
   b) Remove from mature trees all vines, loose papery bark, dead branches and live branches smaller than 3 inches in diameter, to 8 feet above ground.
   c) Remove all dead branches from within live ground covers, vines and shrubs, immature and landscape trees

2. Prune trees and large tree-form shrubs (e.g. oaks, toyon) that are being retained to provide clearance of three times the height of the understory plant material, or 8 feet, whichever is higher. Prune limbs that are smaller than 3 in. in diameter up to 8 feet above the ground; in young trees, prune these branches the lower one-third of the height of the tree. if a tree is 10 feet tall, prune the lower 3–4 feet and keep the understory plant material to less than 1 feet in height. Then as it grows to 24 feet in height, it can achieve the 8-ft distance from the ground and the understory plant material can reach 2.5 feet in height. Do not disturb or thin the tree canopy, because these actions promote growth of more flammable vegetation (see Figure 1).

D. STANDARDS FOR STREETSCAPE VEGETATION MANAGEMENT ZONE

The standards for the Defensible Space/Landscaping Zone will apply to the strip of land within 30 feet of the pavement edge from both sides of the roadways throughout the project. In the Streetscape Vegetation Management Zone there will also need to be an unobstructed vertical clearance of 15 feet over along the entire length of the roadway.

SUMMARY OF FIRE HAZARD OF PROJECT WITH MITIGATIONS

The Orinda Grove development offers several layers of mitigations addressing wildfire hazards. These include:

- A roadway system that provides access for emergency vehicles simultaneous with evacuation of residents.
- A water system that supports effective fire suppression needs.
- Vegetation management standards that ensure landscaping and vegetation in the open spaces will produce flames that will not promote structure damage. This is accomplished by maintaining vegetation such that it will produce flame lengths less than two feet within private yards and otherwise within 100 feet of a structure, and fire behavior that will not promote crown fires.

STATEMENT REGARDING COMPLIANCE WITH FIRE SAFETY CODES AND REGULATIONS

With the approval and implementation of this Wildfire Hazard Assessment and Plan, the Orinda Grove project complies with all fire safety codes and regulations relating to exterior risk mitigation.

The fuels within 100 feet of structures are managed to produce flames less than two feet in length, either through mowing of dried grass, and/or through removal of understory plant materials - both live and dead. The potential for crown fires is minimized through these actions, coupled with maintaining tree canopies (pruning trees of lower branches and removal of dead material in the tree canopy).

Mitigations Taken to Reduce/Lower Fire Risk

The following mitigations reduce the risk as low as possible, addressing the following factors in the MOFD risk rating system:

- Ignition-resistant construction (non-combustible roofs, siding and decking, eaves/vents that hinder ember entrance, spark arrestors, double-paned windows, enclosed decks/projections),
- Visible address signs,
- No bridge access issues,
- Maintained defensible space for 100 feet from structures and a managed open space throughout the Project site,

- Installation of interior fire extinguishing sprinklers.

- Section Two -

IMPLEMENTATION MECHANISMS

COMPLIANCE WITH THE CONDITIONS OF APPROVAL

Declarations of Covenants, Codes and Restrictions (CC&R's)

The following language is suggested for inclusion in the covenants, codes and restrictions (CC&R's) of the management entity, also called Homeowner Association (HOA), for the Orinda Grove Subdivision.

Fuel Management and Storage, Weed Abatement

"The Orinda Grove Homeowner Association shall be responsible for inspecting and maintaining the Common Area in compliance with the Wildfire Hazard Assessment and Plan fuel approved by the Moraga-Orinda Fire District (MOFD). Each Owner shall be responsible for maintaining the individual lot in compliance with the fuel management program approved by MOFD."

"No owner or resident shall permit any condition to exist on his or her Lot, including, within limitation, trash piles, or weeds, which creates a fire hazard or is in violation of local fire regulations."

"There shall be no outdoor storage of firewood, kindling, or compost material within 30-feet of any structure, unless the material is stored in an approved bin or enclosure."

Responsibility for Maintenance of Common Areas and Improvements

"The Homeowner Association shall be responsible for the maintenance of all Common Area improvements from the edges of the streets up to the property line".

"The Homeowner Association shall maintain all the landscaping installed by the Declarant within the Project as shown on the Maps. The Homeowner Association shall also maintain the following: The landscaping improvements within common areas".

"The City of Orinda shall maintain the city-owned property (community playfields) in accordance with the Moraga-Orinda Fire District Fire Code Ordinance #13-01 and Fire District Exterior Hazard Control vegetation standards."

"The Orinda Union School District (OUSD) shall maintain the OUSD property in accordance with the Moraga-Orinda Fire District Fire Code Ordinance #13-01 and Fire District Exterior Hazard Control vegetation standards."

"In compliance with the Fuel Management Program approved by the Fire Marshal, Individual Homeowners shall be responsible for maintaining the private open space within each lot, with enforcement authority provided to the Homeowner Association and the Moraga-Orinda Fire District."

"In compliance with the Fuel Management Program approved by the Fire Marshal, the Homeowner Association shall be responsible for maintaining the commonly-held open space, with enforcement authority provided to the Homeowner Association and the Moraga-Orinda Fire District."

"If an Owner fails to maintain and/or repair his Unit and Lot as provided herein in a manner which the Homeowner Association Board reasonably deems necessary to preserve the safety, appearance and/or value of the Project, the Board may notify the Owner of the work required and request that it be done within a reasonable and specific period. If the Owner fails to perform such maintenance and/or repairs within said period, the Board shall, subject to the notice and hearing requirements as set forth in the By Laws, have the right to enter upon the Lot to cause such maintenance and/or repair work to be performed. Costs of any such maintenance or repair shall be charged to the Owner."

"Notwithstanding the foregoing, in the event of an emergency arising out of the failure of an Owner to maintain and/or repair his Unit or Lot, the Board shall have the right, through its agents and employees, to immediately enter the Lot to abate the emergency and individually charge the cost thereof to the Owner."

Fuel Management Zones

"Fuel Management Zones as delineated on the final recorded map shall be established, funded, implemented, and commonly-held lands of Orinda Grove maintained by the Homeowner Association, City or the designated Long Term Land Owner to ensure the safety of the residents. The Wildfire Hazard Assessment and Plan includes components including but not limited to: fire-resistant and drought-resistant landscaping, along with fuel management zones (Defensible Space/Landscaping, Streetscape Vegetation Management Zone and Open Space Management Zone.")

"The Orinda Grove Homeowner Association will retain a professional with wildland fire-management expertise, approved by the MOFD, as an independent contractor. This professional will submit a certificate of compliance to the Moraga-Orinda Fire District that the area has been maintained according to the approved fire-management plan. This certificate will need to be submitted to the Moraga-Orinda Fire District by June 15 of each year."

Refer to the map on the following page that indicates the locations of the responsibilities for maintenance.

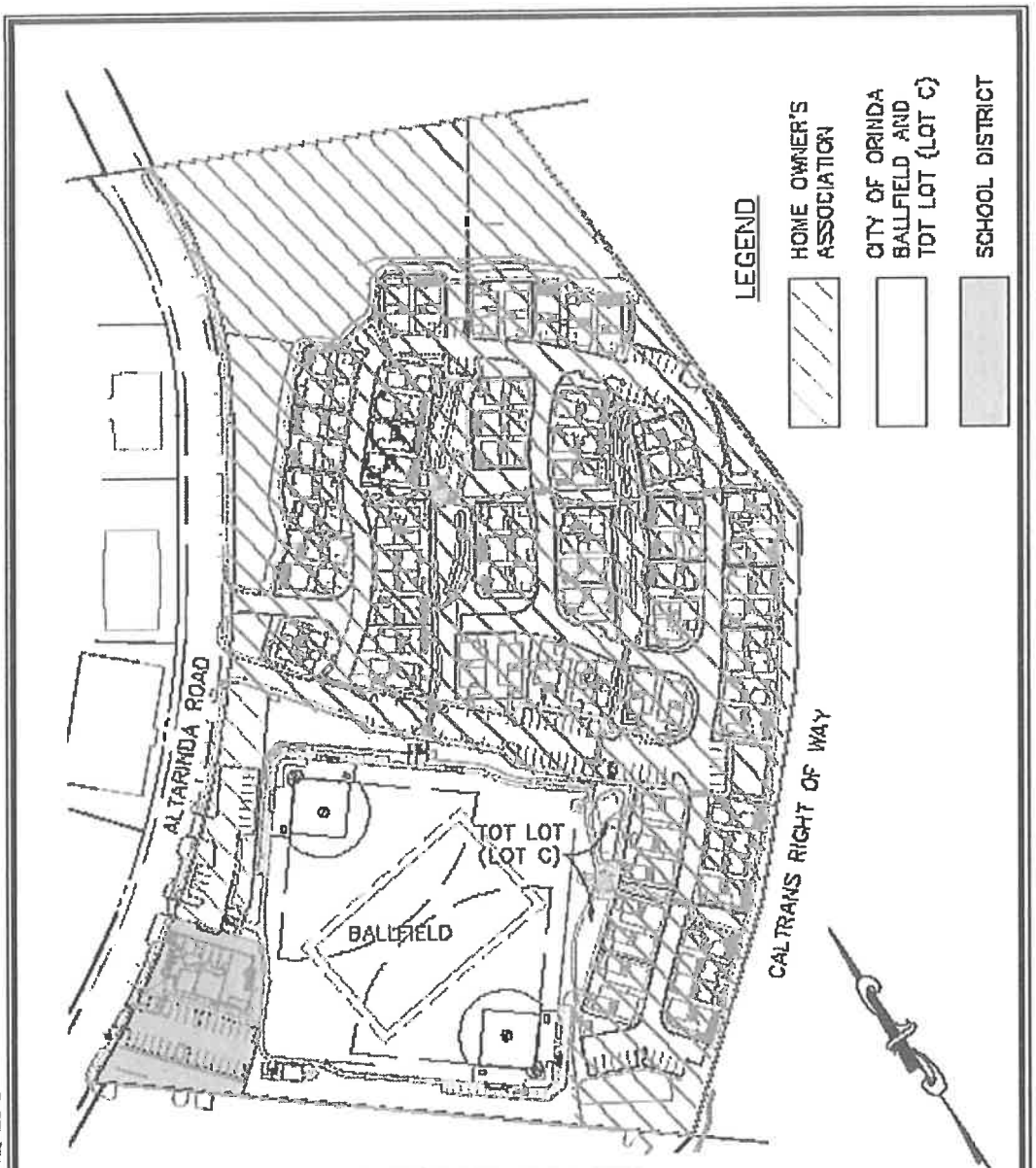


EXHIBIT 'B'

ORINDA GROVE - MAINTENANCE EXHIBIT

Civil Engineering Associates
Civil Engineers • Planners • Surveyors
224 Airport Parkway, Suite 525
San Jose, CA 95110
T: (408) 453-1066

BY: LRN
DATE: 1/12/15
SCALE: 1"=150'
JOB NO. 04-113
1 SHT.NO.

04113 MAINTNCE Exhibit Jan 12, 2015

DELEGATION OF FUEL MANAGEMENT AND CONSTRUCTION RESPONSIBILITIES

Construction Responsibilities

Pulte Homes will be responsible for the design and construction of all improvements of the project including site grading, roads, driveways, emergency access roads, fire roads, trails, homes, community facilities, landscape improvements, utilities and improvements in the Orinda Grove development.

Management Responsibilities

Management of Development Area

A Homeowners Association (HOA) will maintain the common area facilities, landscaping and other common area management and maintenance functions within the project area.

Orinda Union School District (OUSD)

Orinda Union School District (OUSD) will maintain the parking lot and landscaping around their facility.

City of Orinda Responsibilities

The Community Playfields will be dedicated to the City of Orinda upon completion and will be owned and maintained by the City.

PHASING OF MAINTENANCE RESPONSIBILITY AND FUEL MANAGEMENT

- Hydrants and paved streets will be in place before framing begins.
- Initial fuel management actions will be completed before construction of the first lot begins. These actions include tree removal, tree pruning, and grass cutting (if construction takes place between June 20 and Nov. 1).
- A separate construction fire-prevention plan must be approved by the MOFD Fire Marshal before building permits are issued. This plan will include precautions to carry out during high fire danger, a list of tools to have on hand, a description of available communications, specifications for the supply of water to have on hand, and descriptions of other actions that will reduce the risk of ignition and immediate control of an incipient fire.
- MOFD will inspect roadways, including emergency vehicle access, hydrants, and fuel management before framing begins.

- Any cutting or welding operations on site will be done "permitted" by the MOFD and performed in compliance with the California Fire Code provisions.

- All required clearing and cutting of annual grass will be completed before June 15th of each year. Mowing must begin as soon as 30% of the grass has cured, generally between April and May, with completion by June 15th. "No-mow turn is exempt from mowing requirements if it stays green throughout the year.

- Grass cuttings and clippings will be removed the day they are cut. No clippings are permitted to remain in piles or scattered, unless approved by the MOFD Fire Marshal.

- All brush piles and tree clippings are to be removed within one week of cutting. No brush or clippings are permitted to remain in piles, unless so approved by the MOFD Fire Marshal.

- Annual fuel management measures include:
  - Removal of all combustible vegetation along roadways, driveways, access roads, and trails according to stated standards
  - Maintenance of the emergency-access easement
  - Maintenance of the defensible space around structures according to stated standards for the various fuel management zones (Defensible Space/Landscaping, Streetscape Vegetation Management Zone and Open Space Management Zone.)

Orinda Grove Homeowner Association will retain a professional with wildland urban interface inspection expertise, approved by the MOFD, as an independent contractor. This professional will submit a certificate of compliance to the MOFD that the area has been maintained according to the approved fire-management plan. This certificate will need to be submitted to the MOFD by June 15 of each year.

MECHANISMS FOR COMPLIANCE

Long-Term Financial Assurances

All homeowners within Orinda Grove will be members of the Orinda Grove Homeowners Association and will pay HOA assessments to fund the Orinda Grove Homeowners Association's long-term management costs. These assessments will provide full funding of the long-term management and maintenance of the defensible space zones fuel transition zones and management areas within the commonly-held lands of Orinda Grove

Reporting

Annual Report

Starting with the first year in which a building permit is obtained, the Developer, then the Homeowner Association will obtain a certification by June 15 that the minimum standards have been achieved and maintained. The Developer, then the Homeowner Association will retain a professional with wildland urban interface inspection expertise, as approved by the MOFD, as an independent contractor. This professional will certify on an annual basis to the MOFD that the area encompassed by this plan has been maintained as detailed in the Wildfire Hazard Assessment and Plan. This professional will submit a certificate of compliance by June 15. Compliance with vegetation management requirements will need to be done yearly in advance of inspection.

If compliance of the vegetation management has not taken place within the time specified the Homeowner Association will have the work done under contract; the cost of which will be levied as a reimbursement Assessment on the non-compliant property/properties within the project. Conformance to the previous standards for structural protection for remodeling and additions will be assured through the operations of a homeowner association Design Review Board. The standards will be provided in this report to the DRB to incorporate into their design review requirements.

Frequency of Future Maintenance

The frequency of vegetation management is linked to the vegetation type.

Annual grass (or any grass that cures during the year) will need to be mowed annually when 30% of the grass cover has cured (any time from April 15 - June 20). Should rains occur late in the season and produce more grass growth, the grass may need to be treated again. "No-mow turf is exempt from this requirement as long as it stays green year-round.

The expected frequency of treatment of shrubs is estimated as every three years. Shrub removal or pruning may be done any time of year. Application of an herbicide to prevent re-sprouting may be more effective in the spring, but will follow the PCA recommendation.

Initial pruning of lower small branches will be a substantial effort. Because trees typically grow from the top and ends of branches, subsequent pruning needs to occur only every five years or so, depending on the rate of growth, and significant events which may cause dead wood to develop or breakage to occur. Pruning of oaks, other trees and tree-like shrubs can be done at any time of the year, depending on recommendations from a professional arborist.

Removal of a litter layer deeper than the standards is expected to be necessary only once every 10 years.

Summary of Frequency of Vegetation Management

Annual management

- Mow or graze grass near structures and under trees and shrubs
- Hand crew cut shrubs and weeds in grasslands
- Monitor site for weed and shrub encroachment
- Inspect trees for deadwood, vertical clearances
- Re-establish vertical clearance in Defensible Space Zone
- Remove weeds, all dead material in Defensible Space Zone

Management that will occur every 3 years

- Remove new understory shrubs

Management that will occur every 3 years

Prune trees of lower branches to re-establish vertical clearance

Process for Plan Revision

While this plan presents recommendations that cover future actions, the Moraga-Orinda Fire District will have authority to review periodically the conditions addressing structures, plants and landscaping to provide input and direction. Potential issues that should be addressed during this review include:

- Lot line adjustments that may change the distances and areas for which the Orinda Grove Homeowner's Association is responsible.
- Easement encroachments, such as shrub plantings or fence installation into the buffer open space area that are on private property.
- Changed fuel hazard conditions including: height of tree branches, size, density or species of vegetation, or the relationship of fuel load and erosion control or slope stability conditions.

A five-year interval of review is recommended. For example, if the expansion of shrub cover warrants additional action, this process provides for revisions of required maintenance options. Input of the Fire District would be based on site visits, results and observations from the annual inspections conducted by this department and experiences from recent wildfires or changes in ordinances or regulations.

The leadership of Homeowner Associations will submit this plan, along with suggested revisions to the Moraga-Orinda Fire District for their input. The fire district input will be incorporated and the plan revised. The revised plan would be implemented the following year.

- Section Three -

EXISTING CONDITIONS

SETTING & CONTEXT

General Location of Project

The project site is located in western Contra Costa County northeast of the SR24 freeway fronting on Altrinda Road approximately 700 feet north of the intersection with Orinda Way, in the Orinda Village area. The 14.2-acre site is entirely within the City of Orinda Boundaries. Orinda Grove is bounded on the north, east and south by steep slopes, with the lowest elevation of site approximately 530 ft, rising to an elevation of approximately 675 feet.

Adjacent Properties

The project site's south eastern boundary parallels the SR24 Freeway, located approximately 30 feet below the proposed residential development. The south western boundary is the existing Pine Grove Office complex with access off of Altarinda Road and Orinda Way. West of the site, across Altarinda Road, is additional existing commercial development with access from Altarinda Road. The northern portion of the site will be retained as open space where it abuts the open space at the edge of the multi-family Orindawoods residential community.

Project Description

The residential development covers approximately 10.25 acres (72% of the project site). See *Drawing C-2 Site Plan.* This includes a mix of residential unit types, streets and parking areas, as well as pedestrian walkways, landscaped areas and non-irrigated natural open space areas. Approximately 3.48 acres (24% of the project site) will be developed to replace the existing city owned community ball fields, community park and tot lot. The remaining 0.51 acres (3.6% of the project site) will be developed for the Orinda Union School District building and parking lot.

65 single family detached villa residences and 8 duplex style residences are proposed. The project includes a mix of architectural forms sited along the looped roads of the project site, not in formal rows. Structures and a three-foot width of land surrounding each structure will be privately owned. The remainder of the property will be owned and maintained by a homeowner association. The structures are designed and sited to step down the slopes following the grade of the road. The 37 three story villas are designed to be built into the steeper slopes, with garages typically located in the lower story. Conceptual layout of the proposed residences in relation to the site topography is shown on *Drawing C-3 Grading and Drainage Plan.*

Setbacks, Building Siting and Open Space

The proposed structures align the project roadways. Most structures have a minimum of six-foot side setback between structures, forming groups that are two to seven structures long. These groups are divided by pedestrian walkways and landscaped "Paseos" varying in width from 30 to 40 feet. The front setbacks vary from 5 to 20 feet from the paved roads, with the majority of structures set close to the roadway. The front of structures typically open onto pedestrian walkways and perimeter landscaped areas, and rear of structures open onto private alleys.

- Seven structures are located along the main access road of the development. These structures are two stories from the south, but have a garage story accessible from the north interior road for a typical overall rear height of 34 feet. This cluster has the largest front setback in the project varying from 18 to 38 feet.
- Within the development a total of 28 structures are grouped to form two "Paseos" with landscaped common open space between the rows of structures. These paseos are designed with pedestrian walkways on both sides and drainage "bioswale" down the center. The central area is proposed to be planted with trees, shrubs and groundcovers. These structures have front entries that connect to the "Paseo" walkways; the rear of structures back onto private alleys, and garages in the back open onto the internal project drives.
- The northern end of the project is steeply sloped up to Altarinda Road; it is proposed to be maintained as a non-irrigated area with existing native oaks and pine trees, as well as newly planted native trees (on drip irrigation). The understory will be either mowed annual grasses or ignition-resistant ground cover.
- The southern portion of the site will be developed as irrigated turf for the community ball fields.
- In the southwest corner of the site the Orinda Union Site Building is surrounded by Altarinda Road to the north, parking lots on the east and west, and the playfields on the south.

Architecture and Building Materials - The buildings will be designed as clusters of smaller forms. Where possible, the ridges of dominant roof planes will run perpendicular to the slope of the land. Large roof planes will be broken by three-dimensional elements (dormers, clerestories, gables). Facades will feature three dimensional elements (dormers, second story step backs, bays, decks, overhangs) to break up large walls. Buildings will be designed to avoid large, flat surface planes such as exposed garage roofs, by integrating parking into the house footprints.

Building Materials - The proposed architectural design of the homes would be one of four designs: Monterey, Colonial, Cape Cod or Craftsman style, characterized by rustic textures, broad overhangs with exposed rafter tails, trellises and porches. Roofs would be composition shingles with fire-rated Class A assemblies and standing metal seam roofs on some overhangs. Walls will be clad in Hardiplank or stucco. Windows would consist of vinyl windows with internal grids. Each home would contain a sectional roll-up garage

door(s); some with windows. Buildings will be equipped with automatic fire extinguishing sprinklers.

Grading and Retaining Walls - The grades throughout the developed area will be modified. The existing drainage pattern will be modified to run through the two Paseo bioswales. The slopes on which structures are to be located are no greater than 30%, with few exceptions. Most lots are terraced with two moderately sloping building pads divided by a side yard with a steeper slope. The larger of the two building pads are typically adjacent to the streets or shared driveways and have a moderate slope of 6% to 12%. A steeper slope up to 50% divides this terrace from a lower terrace that typically slopes 12% to 16%. The rear of most of the lots are slopes that vary from 30% to 50% from 30ft to 110 feet in length.

Retaining walls on the west and east of the Project are proposed to accommodate the proposed structures. On the north and west edges of the developed area a series of two to six retaining walls separating the proposed structures from the adjacent open space with overall grade changes of up to approximately 22 feet. On the east perimeter of the site a retaining wall separates the walkway adjacent to structures from the top of the slope that drops to the freeway below. The retaining walls and stairs also take up grade changes within the Paseo open space. Similar stepped walls are located on the north perimeter of the ball fields.

Landscape Improvements

A proposed planting concept plan has been prepared for the project. A mix of large, deciduous canopy trees, broad-leaf evergreen trees (native oak), smaller flowering trees, flowering and woody shrubs, and perennial groundcovers are proposed along the internal roads, paseos, and structure perimeters.

The project proposes to plant additional native oaks in the open space at the top of the retaining walls. The vegetation under and between the oaks will continue to be annual grasslands. The oaks will not be irrigated in order to avoid oak root fungus, a leading cause of oak mortality.

Grading and landscaping are proposed to screen views of buildings and make them less prominent and conspicuous. The southeast perimeter of the site will be planted with redwoods to supplement the existing pine trees and screen the freeway below.

The landscape in the project site will be managed by three different entities. The Orinda Union School District will manage its building parking lot and landscape areas surrounding its new administration building. The City of Orinda will manage the playfields. The Homeowner's Association will manage the remainder of the site.

Access & Circulation

Site Access

Primary access to the project area is provided via Altarinda Road. Altarinda Road connects with Camino Pablo, the primary east west arterial in Orinda, approximately a 1/4 mile southwest of the site. To the north Altarinda Road becomes Orinda Woods. Access to the SR 24 Freeway is at Camino Pablo, with a partial interchange at St. Stephens Drive approximately a mile to the north.

Site Circulation

Vehicular access to the site is provided from Altarinda Road by four driveway cuts. The southern most driveway serves the Orinda Union School District parking lot. The next two driveways provide access and egress respectively to the community ball field/resident parking lot. The northern most driveway provides access to the residential development.

The internal circulation roads will be paved with a curb to cub width of typically 20 feet (24 feet behind parking areas). The entry drive traverses the site west to east ending at a "T" intersection. The southern drive extends approximately 320 foot toward the property line, ending in a parking lot that can serve as a hammerhead turn around (with 24-foot wide travel way with 65 and 70 foot length arms).

The main access drive loops to the north returning back on the entry drive approximately 160 feet east of the access point with Altarinda Road. A second internal drive loops within this main access drive. Off of this internal loop is a second dead end road approximately 90 feet long that provides access to two structures and the northern paseo.

Emergency Access Roads

The project includes an emergency vehicle access (EVA) to provide a second access/ egress for the structures. This EVA is located approximately 165 feet north of the main entry. The EVA will consist of a 20 foot wide, 15% sloped travel way surfaced with a combination of four-ft wide strips of grass-block pavers on the sides and concrete in the middle. The EVA will be signed for "emergency only" and gated with a locked "Knox-Box" (or similar non-destructive emergency access rapid entry system - see www.knoxbox.com/store/firedepartment.cfm).

Parking

Each residence will contain two -car garages for a total of 146 off street parking spaces. In addition, 82 spaces are provided in designated parking areas along the roads. There is no parking along the proposed project roads except in these designated areas. Two additional parking lots provide 14 parking spaces for the ball fields and guests of the residences and 25 spaces for the Orinda Union School District.

Pedestrian Trails

The project includes a system of walkways that connect the fronts of the houses around the perimeter of the project site and through the two paseos. These walkways connect to the adjacent community playfields and link to other sidewalks and pedestrian ways on adjacent sites.

Fire protection services

The Moraga-Orinda Fire District (MOFD) provides fire protection services to all areas of the City, including the Orinda Grove project site. The closest MOFD station to the project site is Station 45 located about one mile north of the project site, at 33 Orinda Way.

Regulatory Context

Fire Safety Regulations - Ordinance No. 13-01

Effective January 1, 2014 Ordinance #13-01, and the 2013 edition of the California Fire Code, including Appendix Chapters A, B, C, E, F, G, H, I, J, (with certain amendments) and by reference, the International Fire Code, 2012 Edition became effective. This code regulates and governs the safeguarding of life and property from fire hazards. The code specifically requires exterior structural design and construction become ignition resistant, including exterior wall siding and sheathing, exterior windows, venting, and decking. It further regulates roofing and attic venting, building assemblies, structure projections, (including, but not limited to, porches, decks, balconies), and eaves, and structure openings, including, but not limited to, eave vents and windows.

This ordinance requires plans be submitted for Fire District review. It also requires that construction address, among other issues, the following three items that related to wildfire hazard: provision of access for fire apparatus, provision of water supply for fire protection, and provisions to control the spread of fire including vegetation management on private lots. Appendix D of the California Fire Code outlines the local standards beyond those provided by the IFC and CFC.

The code itself is available at http://www.mofd.org/content/ordinances/file/10-04%20Ordinance%20Fire%20Code.pdf.

State-wide Codes

Public Resources Code 4290 and 4291 apply to those lands under the fire protection responsibility of the California Department of Forestry and Fire Protection. However, these codes are often used as a "de-facto" set of codes because they are seen as prudent and reasonable methods to achieve fire safety. Where codes and standards established by the Moraga-Orinda Fire District (MOFD) are more stringent than the statewide codes, MOFD codes will be in force.

Government Code 51182 requires that owners of lands designated as high fire hazard in local jurisdiction need to create and maintain defensible space for 100 feet from each structure, or to the property line, whichever is closer. Guidelines to clarify actions compliant with the regulations are available from the California Department of Forestry and Fire Protection website.

Site-specific Assessment of Fire Hazard

The site-specific assessment of the project's fire hazard is based upon an analysis of the fuels and topography that influence fire behavior. The potential effectiveness of fire suppression efforts as influenced by access and water supply on the project site is included in the analysis. The hills surrounding Orinda are identified as Very High Fire Hazard by the California Department of Forestry and Fire Protection. These areas may experience fires that are challenging to control. However, the Project area itself is not designated as within the Very High Fire Hazard Severity Zone as adopted by the Moraga-Orinda Fire District

Project Site and Surrounding Terrain

Influence of Topography of Fire Hazard

Topographic features - such as slope, aspect (orientation with respect to sun and wind), and the overall form of the land - have a profound effect on an area's ecology and the pattern of heat transfer in a wildfire. Topography affects a wildfire's intensity, burning rate (consumption of fuels), direction, and rate of spread. The larger area's topography also affects local winds, which are either "bent" or intensified by topographic features. Topographic features can also induce diurnal upslope and down slope winds. The speed, regularity, and direction of winds directly influence the direction of wildfire spread and the shape of the flame front.

For example, fires burning on flat or gently sloping areas tend to burn more slowly and to spread more horizontally than fires burning on steep slopes. Therefore, structures located at the top of slopes such as Villas 52 through 66 above the SR 24 freeway are more vulnerable than those at the bottom of a slope. The confluence of two or more canyons, such as the area surrounding the project site, is often a place where fire whirlwinds develop. At such locations, fuel consumption increases exponentially and fires can become uncontrollable.

Topography at Orinda Grove and Related Fire Hazards.

As described in detail in Section I, Orinda Grove is located on south facing slopes. This topography, landscape treatment and maintenance of these steeper slopes will greatly influence the potential fire hazards for the home sites as described below:

- The main orientation of the regional topography funnels winds from the southeast into the Orinda Grove area.
- Villas 51 to 66 are located at the top of a slope point from the SR 24 freeway exit ramp leading into Orinda village; this slope varies with a 44% grade at the steepest.

- In the open space area to the north of the Villas 2 to 9 and 20 to 26, retaining walls are from three to six feet tall. These walls may serve as barriers to firefighters accessing the oak-grassland slope above.

- Similarly the retaining walls adjacent to the community ball fields are from two to eight feet tall. These walls may serve as barriers to firefighters accessing the site.

- The hills located to the north above the project area if ignited could cast embers from the pines onto the site and ignite spot fires.

- Up slope winds from freeway could bring fire into the mature pines on the southern boundary of the site, which could produce and distribute embers that could cause numerous new spot fires.

Fuels Assessment

Vegetation Types

Onsite plant communities reflect the site's climatic, geotechnical characteristics and variations in water sources throughout the year.

- Grasslands and mixed oak woodlands - Non-native grasslands scattered with mixed oak woodland dominate the undeveloped portions of the site.
- Shrub - The edges of the mixed oak forest have dispersed understory of shrubs and small trees.
- Monterey Pine Stands – A row of mature Monterey pines dominate the southern boundary of the site.

Fuel Type and Fire Behavior in Different Fuels

The term "fuel" is used to describe any material that will burn, whether vegetative or structure component. A single fire may consume shrubs, grasses, trees, woodpiles, and homes as fuels.

Fire managers in virtually all US agencies (as well as in other countries where wildland fire hazards are significant) use fuel model systems for the various computerized fire behavior prediction systems (FBPS). Within the US, information regarding fuel volumes and fire-behavior descriptions is based upon fuel models described in *How to Predict the Spread and Intensity of Forest and Range Fires*, by Richard C. Rothermel (1983), published by the USDA Forest Service Intermountain Forest and Range Experiment

Station, General Technical Report INT–143. Fuel models relevant to the Pine Grove project include grasslands (each with tall and short grass having different models), shrub lands, oak woodlands and riparian areas (with and without understory vegetation). Each fuel model is given a number designation, which is interpreted by fire managers across the continent to mean the same thing.

Fuel models describe vegetation structure in addition to typical species composition. The most significant factor is the amount and distribution of smaller-diameter fuels, because these materials generally spread wildland fires.

Another important factor is the amount of dead biomass and the ratio of live-to-dead material in terrain with significant brush and numerous tree stands, since dead biomass contributes fine fuel litter as well as carries flames more readily. Fuel models include these considerations.

This section describes conditions that are planned and conditions that would develop over time without fuel management. For example, the existing vegetation, such as the trees around existing buildings will be removed by grading operations and thus is not discussed. However, shrubs can be anticipated in the grasslands on the open space hillsides and thus is addressed.

Annual Grasslands (FBPS Fuel Model #1)

Currently, the majority of the undeveloped portion of the project site is dominated with annual grasses, generally located on the southern and eastern portion of the site. The open space at the north end of the project will continue to be a naturalized grassland and mixed oak woodland.

Grass fuels do not produce much heat, but they produce a fire that travels quickly. Therefore, containment is the greatest challenge posed by these fuel types. In particular, grass can serve as a wick for more hazardous fuels whose ignition is apt to cause greater damage. Grass thus provides an avenue for fire to travel to densely vegetated areas, allowing it to build up enough of a "head of steam" to burn into landscaping or other types of fuels under conditions that would not otherwise be fire-sustaining.

Grassland fuels (both annual and perennial) are fairly uniform and homogeneous in comparison to other fuel types. Generally, grasslands have a light total fuel load, consisting entirely of fine herbaceous material that cures in the summertime. This material responds markedly to changes in humidity and ignites easily in dry periods.

Oak Savanna and Monterey Pine Stands (FBPS Fuel Model #2)

Currently, oak savannas covers approximately one-third of the site, located on the eastern center of the project. Another example of this fuel model, Monterey Pine Stands, is located in a linear stand on the southern edge of the project. Both types of vegetation are characterized as Fuel Model #2.

In oak savannas the primary carrier of the fire is grass beneath the canopy. In pine stands the primary carrier of the fire is pine needles. In both, the expected rate of spread and fireline intensities are moderate to high. Fire spread is through the fine herbaceous fuels, either curing or dead, or pine needles. Oak leaf litter and dead-down stemwood, contribute to fire intensity. In pine stands the tendency is stronger for the tree to torch. Where lower branches connect with flames produced by the surface fire, torching is likely, creating embers and a high potential for widespread spot fires.

North Coastal Scrub (FBPS Fuel Model # 5)

Currently North Coastal Scrub is not present on the site, however, without maintenance this fuel type can develop on the dry south-facing grassy slopes. This occurs as young shrubs scattered in the annual grasslands start to develop in size and cover (in approximately 10-15 years), absent management. All areas of annual grass will gradually (over a span of 15-25 years) convert into this fuel type without some sort of disturbance (which may be in the form of gophers, grazing animals, or mechanical mowers). This vegetation community is considered potential habitat for the state and federally listed Alameda whipsnake and would then be subject to management restrictions.

This fuel type is characterized by the Fire Behavior Prediction System Fuel Model #5. Total fuel loads are approximately five ton/ac, with most of the fuels occurring in the smaller diameter fuels. A preponderance of dead fuels can be found in the smallest size class, those under 1/4 inch in diameter. The dead to live ratio of mature stands is usually quite high - an equal proportion of living and dead material is often found. Additionally, live foliage on the plants comprises over half of the total fuel load.

During the mid-1980's, the fuel volumes, structure, and distribution of size classes of 16 scrub sample sites from the East Bay Regional Park District were inventoried. Total fuel loading averaged 3.18 tons/acre, equally distributed between fine fuels (smaller than 1/4 inch in diameter), kindling (from 1/4 to 1 inch in diameter) and larger. The amount of dead material in the scrub is almost always one-half or more of the total volume. Fire behavior is not normally explosive; however, it was this fuel type that fueled the Oakland Fire of 1991 on Saturday, October 19, and the morning of October 20th. Rates of spread are quite fast, but flame lengths are low (usually under five feet) and heat output minimal under normal conditions. Obviously, under extreme weather conditions erratic and explosive fire behavior can result.

Oak Woodland (FBPS Fuel Model #8)

The project site includes a small band of Coast Live Oak woodland on the northeastern border of the project.

As additional oaks or other hardwood species are added to the landscape as mitigation, this fuel type will cover more of the area. While the small band of woodland now is more open, it is likely the canopy will close and the understory will be relatively undeveloped, consisting primarily of leaf duff.

Figure 1. Fire Behavior Predictions

Chart of fire-behavior predictions using BEHAVE subprogram TSTMDL, standard environmental factors of low and medium for the fuel types presently found in the development, a 20% slope steepness, and a wind parallel with the slope (In this case, westerly winds). Oak woodlands are included as a contrast to annual grasslands.

Fuel Type	Fuel Moisture Low	Medium
Grassland – FBPS #1		
rate of spread, ft/min	95	74
fireline intensity, Btu/ft/sec	162	112
flame length, ft	5	4
Oak savanna and Monterey Pine Stands - NFFL #2		
rate of spread, ft/min	40	27
fireline intensity, btu/ft/sec	369	215
flame length, ft	7	5
North coastal scrub - FBPS #5		
rate of spread, ft/min	33	11
fireline intensity, btu/ft/sec	416	72
flame length, ft	7	3
Oak Woodland - FBPS #8		
rate of spread, ft/min	2	2
fireline intensity, Btu/ft/sec	9	6
flame length, ft	1	1

Standard Environmental Factors:	***Low***	***Medium***
Midflame windspeed = 4 mi/hr		
Fuel moisture		
0–1/4 in. diameter	*3*	*6*
1/4 – 1 in. diameter	*4*	*7*
1 – 3 in. diameter	*5*	*8*
Live herbaceous material	*70*	*120*
Live foliage of woody plants	*70*	*120*

Fire intensity, flame lengths, and scorch heights are usually low in the oak woodland areas that do not have a well-developed understory. These areas are characterized as follows in the USDA Forest Service Fire Behavior Prediction System:

"Slow-burning ground fires (carried in the compact litter layer) with low flame heights are the rule, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and some twigs since little undergrowth is present in the stand."

The resulting fire behavior is rather benign (refer to Figure 1). Rates of fire spread are slow, approximately 2 feet per minute. Flame lengths are predicted to be one foot. Leisurely spread rates, combined with the relatively short flame lengths of the predicted fire behavior demonstrate a manageable, moderate fire hazard in this fuel type.

Fuel conditions in the oak woodland areas vary with the slope, age, height, and canopy closure of the overstory, the depth of the litter and density of understory shrub cover. Ground-layer and understory fuel loads beneath dense canopy may be minimal (well under one ton per acre), but horizontal fuels may be continuous and ladder fuels present where the vertical distribution of foliage is continuous. The foliage of both bay and coast live oak is very flammable should the fire reach the crowns.

Landscaped Areas (No FBPS #)

Project landscaping will occur throughout the developed area. The two paseos and house perimeter areas of the development are proposed to be planted with a diverse species mix. These include flowering and deciduous trees, native evergreen oaks and coast redwood. The planting concept plan also indicates a mix of shrubs and groundcovers in these areas.

Even though almost all of the area to be landscaped will be stripped of vegetation during the grading process, top-soil and amendments will allow for vegetation to develop over time. Because this type of vegetation is situated nearest structures and evacuation routes, this fuel type can be the most damaging or provide an additional layer of safety/protection.

Domestic landscapes typically fall into a spectrum of fire hazards:

1. Landscapes are moist, and therefore won't burn; or
2. They contain large amounts of fuel, which will burn with great intensity; or
3. They contain fire-resistant plants, and will burn slowly with little resistance to control, or
4. They are maintained to be of low fuel volume, so provide little heat when they do burn.

Problems to avoid in landscaped areas are poor maintenance, breakage in irrigation pipes, and unremoved dead plant material. These problems can result in a large dead-fuel component amounting to a large volume of fuel.

Best practices in creating defensible space focus on three areas:

- Incorporating fire-resistant landscaping in the selection of plant types
- Designing the spacing and placement of plants so that fuel continuity, and volume are limited, and
- Maintaining the landscape to be free of dead and unhealthy plant materials.

The City of Orinda has a list of "dis-allowed plants". Typically a mixture of drought-tolerant and native plant species is integrated into well-designed defensible space landscapes.

Also see a discussion of the properties of fire resistant landscaping in the vegetation management section entitled **Fire Hazard Mitigation Measures**. See also Appendix A for a list of prohibited plants, and Appendix B for a more detailed discussion of Fire Resistant Landscaping.

Crown Fire Potential

Fire that involves the tree crowns is a challenge for fire suppression because the fire becomes extremely intense - with high heat output - and because burning foliage and twigs are lofted in the air to fall well in advance of the body of the fire. These embers often start countless new fires, thereby increasing the demand on fire suppression and increasing the overall rate of fire spread. These characteristics make this the greatest native hazard in the open space under severe weather, both in terms of starting new fires via spotting and the difficulty of containment and extinguishment.

The main factors involved in crown fire potential are understory vegetation (ladder fuels), height at which the tree canopy starts and flammability of the foliage (based on foliar moisture content and oil content). A thick understory, and/or dry and oily foliage and oily contribute to the higher probability of crown fires and associated new spot fires.

The crown fire potential in the project area is highest along the southern perimeter if the existing pines and proposed redwood trees are not pruned up or if they are under planted with other vegetation.

Proposed Access

The access and circulation roads described in Section I are proposed to be designed to MOFD's width, slope and clearance requirements. A hammerhead "T" with 60 feet depth is provided at the end of the roadway that exceeds 150 feet. An EVA is included in the project to improve egress and access for fire equipment. There are no bridges to restrict access to the project.

The following are features at the Orinda Grove Project that comply with the Fire Apparatus Access Roadways Standard as revised January, 2014 and are offered to enhance fire safety access:

- Turning radius not less than 20 feet
- Vertical clearance of 15 feet
- Covering materials on road gradients that exceed 15% will be approved by MOFD and include such things as coarse-grained asphalt for better traction of emergency vehicles
- Cross slopes of roadways, fire roads and EVAs not less than 20-ft width, in compliance with the California Fire Code as adopted and amended by the MOFD

Current Risk of Project Site and Surroundings

Fire History of the Area

No fires larger than 10 acres have occurred on the project site since records have been kept. However, fires in the area indicate the potential for large fires to occur. For example, on May 21 of 2007 a fire started off Bear Ridge Road in the Sleepy Hollow area threatened three homes and damaged an outbuilding. In this fire, the Mayor of Orinda was quoted as saying, "It is another example of how our city is living close to the edge in terms of fire safety...If it had been a windy day, this hillside fire in the middle of a dozen homes could have been a citywide conflagration". Another large wildfire occurred approximately 15 years ago near the Crestview neighborhood. More recently, a 6-acre fire burned in 2004 near the San Leandro Reservoir.

General Weather Information

Weather conditions significantly impact the potential for fire ignition and the rate, intensity, and direction in which fires burn. The most important weather variables used to predict fire behavior are wind, temperature, and humidity.

Wind direction and velocity profoundly affect fire behavior, but wind is considered the most variable and unpredictable weather element. Wind increases the flammability of fuels both by removing moisture through evaporation and by angling the flames so that they heat the fuels in the fire's path. The direction and velocity of surface winds can also control the direction and rate of the fire's spread. Aloft winds, defined as those that blow at least 20 ft above the ground, can carry embers and firebrands downwind. These burning fuels can ignite spot fires that precede the primary front. Gusty winds cause a fire to burn erratically and make it more difficult to contain.

The winds that create the most severe fire danger, known as the "Santa Ana" or "Diablo" winds, typically blow from the northeast. However, winds from the northwest are also likely to cause unacceptable damage, particularly to the project site. The worst-case scenario is a fire driven by a northwest wind that follows a northeast wind. Because the northeast wind is normally associated with low humidities and high temperatures, it dries the fuels. At the end of this "Santa Ana," or "Diablo" wind condition, the fog often moves quickly shoreward, preceded by a brisk, high-speed northwest wind. Under these conditions, the fuels would still be dry from the previous weather conditions. The combination of the northwest wind and the west-facing regional slopes could quickly spread a fire into the densely developed portion of Orinda with the San Pablo Valley funneling the winds into the Orinda Village.

Local Weather Conditions

The project site's location in proximity to the coast influences its weather conditions. It has the warm, dry summers and cool, moist winters characteristic of the fog belt area. The area averages about 30 in. of precipitation a year, primarily in the fall and winter. Most of the measurable rainfall generally occurs during the winter months (mid-October

to mid-April). Thus, the fire season (the time of highest fire danger) comprises the dry months of May to October.

Weather observations taken from the Oakland North weather station are considered to represent those of the project site. This station reported ninetieth percentile values for relative humidity as 27%, temperature as 78° F, and wind speed as 12 mph. Times of extreme fire danger coincided with winds from the northeast during the months of October (and, in 2005, November). Extremely dry, windy days occurred during October 19-23, 2000, October 25-28, 2003, and November 2005 for a two-week period. During these episodes, winds routinely exceeded 20 miles per hour (enough to blow burning shakes off roofs) and humidities stayed below twenty percent for days.

Average percentiles 2003 - 2005

90th percentile temperature	78 degrees
95th percentile temperature	83 degrees
97th percentile temperature	86 degrees
highest temperature	101 degrees
90th percentile windspeed	12 mph
95th percentile windspeed	14 mph
97th percentile windspeed	15 mph
highest windspeed	30 mph
90th percentile relative humidity	27%
95th percentile relative humidity	22%
97th percentile relative humidity	20%
lowest relative humidity	6%

Although summertime temperatures are usually quite warm (75 to 85 ° F), it is common for the fog to roll in during the early evenings and creep over the ridge tops to the site. Thus, proximity to the bay often creates a pattern of hot days and cool nights. Fog also sometimes keeps summertime temperatures cool in the project site.

Northeasterly winds (typical fire weather conditions) will be especially conducive for transport of embers. The most extreme weather values from 2003 through 2005 were all recorded during Diablo wind events in October. The driest recorded relative humidity was 9%; the highest recorded temperature was 101 ° F, and the greatest recorded wind speed was 30 mph. All of the days with lowest recorded relative humidities and highest windspeeds were associated with Diablo wind events.

Diablo events generally last from 15 to 35 hours, but in 2000, 2003 and 2005, these events lasted for 5 to 14 days. During a Diablo wind event, the wind direction is somewhat sporadic, sometimes even exhibiting a complete reversal for 2–4 hours. The wind speed ramps up slowly—from 1–2 mph up to its maximum speed, and then down again—similar to a bell-shaped curve.

The wind normally blows from the west but, as discussed above, the most severe fire conditions occur in association with strong north or northeast winds. Under these conditions (common in the fall), humidities drop to 10% and temperatures soar to over 100 ° F.

In addition, occasional episodes consisting of several still, stagnant days formed by stationary highs occur during summer months. During these periods—characterized by continuous high temperatures and low relative humidities—fuels dry to an National Fire Danger Rating System rating of over 81 for the Burning Index, indicating extreme resistance to fire-control. This overall weather pattern creates extremely low humidities and enhances the possibilities of ignition and extreme fire behavior.

Description of Wildfire Hazard Without Mitigations

1. Description of Fire Hazards from MOFD Wildfire Risk Evaluation Map In May of 2006, Moraga-Orinda Fire District developed a Wildland Fire Risk Assessment Map. The mapping project and risk assessment provided fire risk at the parcel level. Parcel ratings were developed by evaluating variables from three subcategories: fire suppression, fire behavior and property owner intervention. Each item within the subcategory was given a value, with each subcategory given a percentage of the overall weight to determine the overall parcel rating.

The Orinda Grove parcel has not been rated. The majority of the parcels immediately adjacent to the project have been rated "Very High Risk," interspersed with parcels rated "High Risk." These parcels all have factors that reduce their risks including: non-combustible fire safe roofs, visible address signs, chimney screens or spark arrestors and no bridges constrict access to the site. The factors that increase their risk include: eaves/ vents that are not designed to prevent intrusion of embers or flames; and un-enclosed decking/ balcony. The difference in rating between very high and high risk in the adjacent properties occurs when the properties have less than 30 feet of vegetation clearance (the high risk properties have between 30 and 99 feet of defensible space clearance).

Using the same criteria it is anticipated that the Orinda Grove project would be rated as High or Moderate risk the next time rating is done for the parcel (anticipated to be within three years). The project includes several factors that reduce the risks: non-combustible roof; visible address signs; and no bridge access issues.

2. Description of Fire Behavior using FlamMap

a. FlamMap Development

FlamMap is a computerized fuel and fire behavior prediction model developed by the USDA Forest Service at the Intermountain Forest Fire Research Laboratory. FlamMapintegrates the factors of topography, fuels, and weather for any one time based on heat transfer algorithms. FlamMap and FARSITE use the same input files. Results of the model are predictions of flame length, rates of spread, fireline intensity, and heat per unit area.

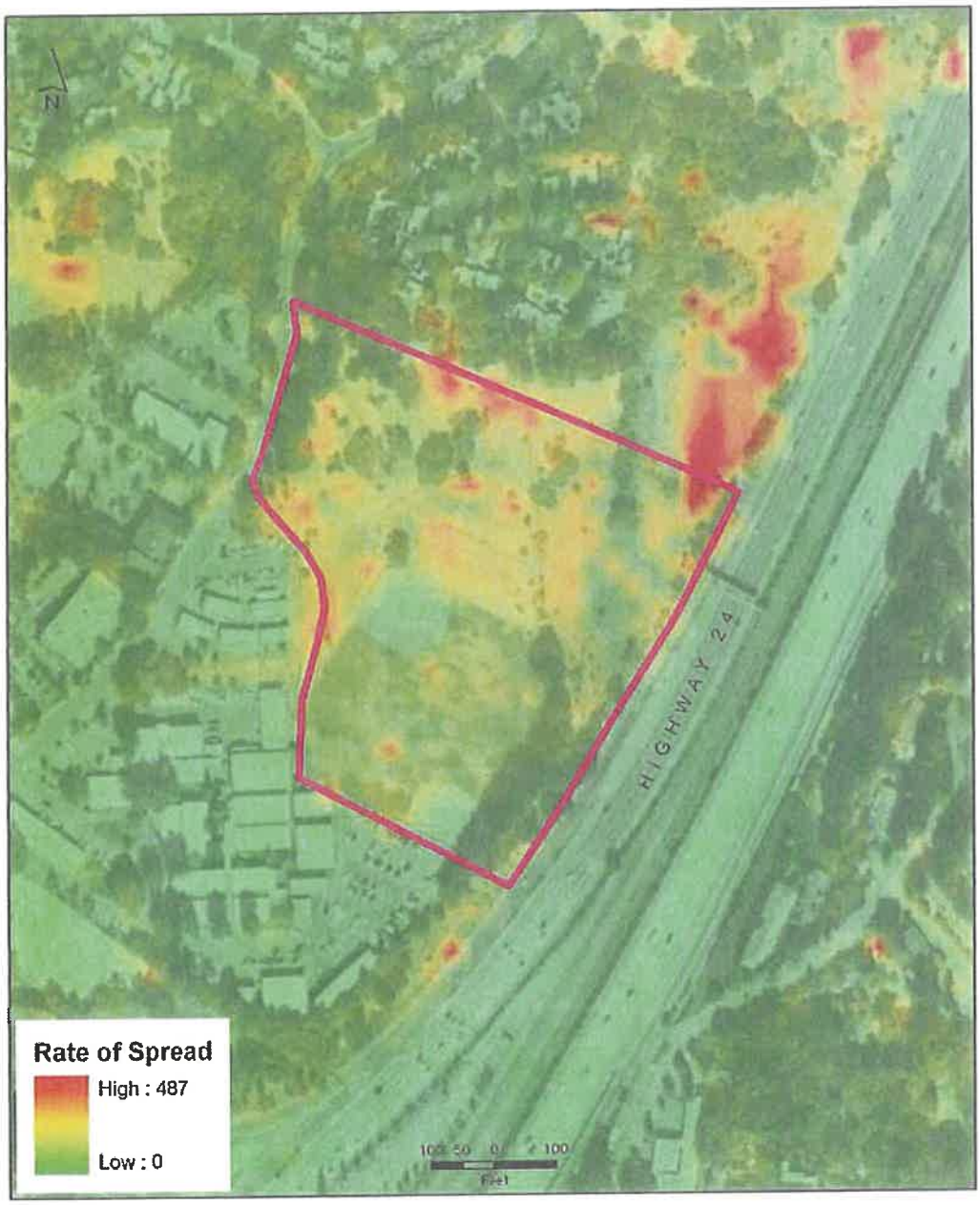
FlamMap predicts the fire behavior on all the Project simultaneously so a spatial distribution of hazards could be represented. It is as if all the study were aflame under the same conditions at the same time.

b. FlamMap Output

FlamMap displays a variety of fire behavior outputs based on existing conditions. Two factors are especially pertinent for identifying areas of high fire hazard: flame length and crowning activity. Flame length closely corresponds to fire intensity, and it is this factor that most influences probability of structure damage and ease of fire control. Crowning activity indicates locations where fire is expected to travel into and possibly consume the crowns. When a fire burns through tree crowns, countless embers are produced and are distributed, sometimes at long distances. These embers can start new fires, which can each grow and confound the finest fire suppression forces.

The maps that follow indicate the spatial distribution of flame lengths on the Project, as well as areas of crown fire activity. Flame lengths are closely related to the fuel types described above. The longest flame lengths are found in on the northern slopes and the lowest in oak woodlands where no understory is present. Flame lengths are generally less than 4 feet, indicating that fire suppression can be done with direct methods. Fire spread rates are highest on the steep slopes on the border, but overall are fairly slow. Crown fire activity is significant where the oak trees on steep slopes are dense on the northern one-quarter of the site.

Spatial distribution of Rates of Spread



Spatial distribution of Flame Lengths

Spatial Distribution of Heat Output

Spatial Distribution of Crown Fire Potential

3. FARSITE Simulations

a. FARSITE Development

The fire growth prediction model, FARSITE, is frequently used in all aspects of wildland fire management from pre-planning through wildfire suppression. The heat transfer formulas in FARSITE are based on the software program BEHAVE, used in wildfire prediction since the 1970's. FARSITE calculates the direction and rate of fire growth using the same inputs (and more) as the BEHAVE program. While FARSITE does not portray fire behavior throughout the Project, it allows managers to see predictions of where a fire might spread over time under various weather conditions. All other fire

behavior predictions (such as flame length, rate of spread, heat per unit area) are all available on a site-specific basis during the time and in the location of the simulation.

While originally developed around 1991 to predict fire growth without fire suppression in "let-burn" conditions, it has become a vital tool in almost every extended wildfire on federal lands to predict fire growth during the next burning period. After the Oakland Tunnel Fire of 1991, a team of mechanical engineers and wildland fire behavior specialists were able to validate the spread of the fire using FARSITE, based on interviews, photographs, and physical evidence. Overall, the location of actual and predicted fire perimeters agrees, on the average, 88 percent of the time, indicating a high predictive capability.

The utility of FARSITE is to discern patterns of spread from numerous simulations with varying ignition locations. This model can also be used to show the value of fuel management by illustrating the changed fire growth pattern before and after the management is applied. All fire growth assumes no firefighting response, i.e. the fire is freely burning without intervention.

FARSITE employs several types of spatial information simultaneously to predict where the fire will spread, how fast the fire will spread, and the fire intensity of the various portions of the flaming front. The types of data FARSITE uses describe the terrain, weather, and fuels on the site. See Appendix D, FARSITE/FlamMap Data Sources and Assumptions, Input Files for further details on the data used, and assumptions made.

b. Description of Fire Growth Predictions

The growth of fires in the Project area depends on the location of simulated ignition. FARSITE predicts that fires will grow quickly when started in grasslands under strong winds and moves uphill. Under mild winds that usually blow from the west, spread is considerably slower, with resulting small burned areas after one hour of burning freely. Fires will not spread in the canopy of the oaks or where grass is particularly sparse.

Three simulations illustrate the pattern of fire growth with conditions that occurred on the same date that the 2003 fires in Southern California burned out of control. On the day of these simulations, the maximum temperatures were 79 degrees and relative humidity was 10 percent.

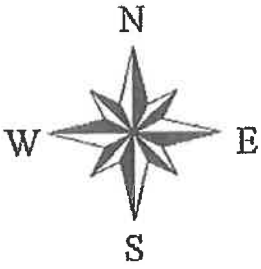
In these simulations the fire spread to 6, 10.6 and 7 acres within in the one-hour period of burning with no firefighting response. The number of new fires generated by the ignition is another important indicator of the fire's intensity and resulting complexity for containment. There were only three fires that were started from embers in one simulation, all others spread as grassfires.

FARSITE Growth potential 1

Fire growth with east wind

Farsite output1 orinda grove.shp

0	Fire Origin
15	Minutes
30	Minutes
45	Minutes
60	Minutes
75	Minutes

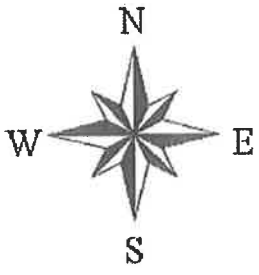


FARSITE Growth Potential 2

Fire growth with strong northeast wind

Farsite output2a orinda grove.shp

0	Fire Origin
15	Minutes
30	Minutes
45	Minutes
60	Minutes
75	Minutes

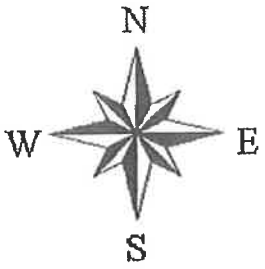


FARSITE Growth Potential3

Fire growth with west wind

Farsite output3 orinda grove.shp

0
15
30
45
60
75



Summary tables of fire growth potential under different weather scenarios and ignition locations

FARSITE GROWTH POTENTIAL 1

Date	Elapsed Time	Current Time	# of Fires	Area (acres)	Perimeter (miles)
24-Oct	00:00	13:30	1	0.0	0.0
24-Oct	0:15	13:45	3	1.4	0.1
24-Oct	0:30	14:00	3	3.1	0.2
24-Oct	0:45	14:15	2	4.1	0.3
24-Oct	1:00	14:30	1	6.0	0.4

FARSITE GROWTH POTENTIAL 2

Date	Elapsed Time	Current Time	# of Fires	Area (acres)	Perimeter (miles)
24-Oct	00:00	19:00	1	0.0	0.0
24-Oct	0:15	19:15	1	1.2	0.1
24-Oct	0:30	19:30	1	4.9	0.2
24-Oct	0:45	19:45	1	7.7	0.4
24-Oct	1:00	20:00	1	10.1	0.6

FARSITE GROWTH POTENTIAL 3

Date	Elapsed Time	Current Time	# of Fires	Area (acres)	Perimeter (miles)
24-Oct	00:00	13:30	1	0.0	0.0
24-Oct	0:15	13:45	1	0.5	0.1
24-Oct	0:30	14:00	1	2.1	0.2
24-Oct	0:45	14:15	1	4.5	0.4
24-Oct	1:00	14:30	1	7.6	0.5

Anticipated Fire Threat from and to Adjoining Properties

The fire hazards on the project site are influenced both by the structures located nearby and the proposed new development. Under a northerly wind, the area across Altarinda Road could loft embers from the pines located to the north. East of the project site, across SR 24 within the City of Orinda, are older residential neighborhoods along Bates Boulevard, Tara Road and Overhill Rd. The density of homes in these neighborhoods is hidden by the mature tree canopies of both native and ornamental trees. However under north east wind conditions the project could loft embers across the freeway into these older homes.

APPENDIX A
SPECIES LIST FOR PROHIBITED LANDSCAPING PLANTS

Due to their combustible nature, these plants shall be prohibited from the project area. These plants will not be allowed as replacement plants; where feasible, existing plants (except existing pines) should be removed during the next five years.

Botanical Name	Common name
*Abies spp.**	fir
*Acacia spp.**	acacia
*Adenostoma fasciculatum**	chamise
*Adenostoma sparsifolium**	red shanks
Artemsia californica	California sage
Baccharis *pilularis consanguinea**	coyote brush
*Bamboo spp.**	bamboo
Cedrus spp.	cedar
*Chamaecyparis spp. except dwarf**	*false cypress*
*Cortaderia selloana**	pampas grass
*Crytomaria japonica except dwarf**	*Japanese cedar*
*Cupressus spp.**	cypress
*Dodonaea viscose**	hopseed bush
*Erigonom fasiculatum **	California buckwheat
*Eucalyptus cladocalyx**	sugar gum
*Eucalyptus globulus**	blue gum
*Eucalyptus viminalis**	Manna gum
Hedera canariensis	Algerian ivy
*Juniperus spp. **	juniper
*Larch spp.**	*larch*
*Metasequoia**	*dawn redwood*
*Miscanthus spp.**	*maiden grass, silvergrass*
Muehlenbergia spp.*	*deer grass*
*Palms (all)**	*plams*
*Pennisetum setaceum**	fountain grass
*Picea spp.**	spruce
*Pinus spp.**	pines
Salvia mellifera	black sage
*Schinus spp.**	California pepper tree
*Tamarix spp**	*tamarix*
Taxodium spp.*	bald cypress
Taxus spp. except dwarf*	yew
Thuja spp.*	arborvitae
Tsuga spp.	hemlock

* indicates species appears on Orinda's "disallowed" plant list.

In addition, plants should not be established which could invade the neighboring park and open spaces. Refer to the Vegetation Management Almanac for the East Bay Hills (published by the Hills Emergency Forum, and available from the Tilden Nature Center) for a list of species which should not be planted because of their invasive nature. The list includes:

Blackwood acacia
coyote bush
Pampas grass
cotoneaster
Italian hawthorn
eucalyptus
broom
ivy
holly
Monterey pine
pyracantha
blackberry
vinca major
mayten

APPENDIX B FIRE-RESISTANT LANDSCAPING

Orinda and many other communities promote the use of fire-safe plants and implementing projects to demonstrate techniques for reducing fire risk to structures. Although there have been relatively few research results on the fire resistance of landscape plants, we can provide several important generalities. First, the spacing and design of the garden is more critical than the species planted. Spacing and design of landscaped areas are addressed in the previously described standards for fuel management zones. Leaving horizontal spaces between planting masses, specimen trees, and the house helps create a fire-safe landscape. Similarly, leaving vertical spaces between tree branches, shrubs, ground cover, and the structure (particularly windows) is important in designing a fire-safe garden.

Second, good maintenance of landscaped areas requires removing dead material and maintaining the vertical and horizontal spaces that create a fire-safe design. The significance of proper plant and landscape maintenance cannot be overemphasized. Maintenance requirements are incorporated in the standards previously described for the fuel management zones. Design landscapes to discourage the creation of "fuel ladders"—a continuous fuel path by which a fire can climb from the ground to a shrub, to a tree, and ultimately to the structure. Continuous removal of any potential fuel ladders needs to be part of routine landscape maintenance. *Poorly maintained landscapes can easily become fire hazards, even if many of the plants are favorably recommended for fire performance.*

Species Selection: Desirable landscaping plant species have a low fuel volume and high foliar moisture and do not have a tendency to produce and "hold" dead wood. They also have a proper growth form: for example, ground covers or fruit trees (which inherently have adequate vertical spacing or branches). An extensive list of fire-resistant plants can be found at http://nature.berkeley.edu/~fbeall/HODefSpaceGuide.pdf.

Some common landscape species are explosive and can exhibit dramatic fire behavior. For example, a juniper that is 6 sq ft in area can produce flames over 15 ft in length. The Appendix A of this report contains a list of such prohibited plants.

Factors that must be considered in rating the fire performance of plants include:

- *Total volume.* The greater the volume of plant material (potential fuel) present, the greater the fire hazard.
- *Moisture content.* The moisture content of plants is an important consideration; high levels of plant moisture can both lower fire risk and act as a heat sink if a fire occurs, reducing its intensity and spread.
- *Amount and distribution of dead material.* The amount of dead material in a given plant influences the total amount of water in the overall plant; the dead material is usually much drier than living tissue. Whereas dead material rarely has a moisture content higher than 25%, live foliage moisture content ranges from 60 to 80% for chaparral species in xeric conditions to a high of 200 to 400% for succulent plants or plants under irrigation.

- *Size of leaves, twigs, and branches.* Materials with large surface areas (such as needles, twigs, or large flat leaves) dry more rapidly under fire conditions than materials with lower surface ratios (such as branches and fleshy leaves).
- *Geometry and arrangement of the plant (overall spatial distribution of the biomass).* The shape of a plant and the way in which the biomass is distributed throughout the plant is important because this bulk density affects the air flow and heat transfer through the plant. The arrangement of material within the plant affects its fuel continuity and its tendency to undergo preheating and promote fire spread.

All of the above-mentioned plant characteristics are related to maintenance issues. Plants with a higher moisture content generally have a lower fire risk. For example, the moisture content of a plant is absolutely influenced by regular and proper irrigation, and large amounts of dead material lower the plant's overall moisture content. To increase the plant's overall moisture content, it is important to remove and properly dispose of dead material. In addition, regular fire-prevention maintenance should include thinning or pruning to reduce fuel volume and improve plant geometry.

An appropriately landscaped and maintained defensible space will reduce the fire hazard and the fire risk to structures. A landscape environment that is inconsistently or improperly maintained does not function as defensible space, and it contributes to the fire hazard. Consult a nursery or landscape professional for their recommendations on plant spacing, pruning, aeration, fertilization, irrigation, and other cultivation practices.

Oak Planting: Although low-growing and low-volume plants are usually most suitable for a fire-safe landscape, the presence of less flammable trees (oaks, sycamores, and redwoods) is often also advantageous. Oaks foster a microclimate that tends to limit the number of ignitions and the rates of spread and intensity of most fires. When the trees are mature, the shade produced by the canopy limits grass growth and density. This canopy can easily be separated from ground fuels by pruning the lower one-third of the tree's branches as it grows. Also, the litter produced by oak trees is not extremely flammable. The canopy of a dense or large stand of oaks can slow wind and act as a windbreak. Moreover, on foggy days moisture collects on the canopy and forms small amounts of fog drip. This drip keeps the grass that does grow (and any other fuel) under the trees more moist and green longer. The moistness of the fuels under the trees acts as a heat sink, in which the fire's energy is consumed in trying to dry the fuels. In other words, moist fuels act to retard the fire instead of contributing to its energy.

APPENDIX C
Key Terminology

defensible space – the area within the perimeter of a parcel, neighborhood or community that provides a key point of defense from an approaching wildfire or defense against encroaching wildfires or escaping structure fires

fire intensity – the amount of heat released by a fire in an area in any given time period. Fire intensity is usually related to the flame lengths of a fire.

fuel break – an area in which flammable materials have been cleared away or thinned out to minimize fire spread to structures and/or natural resources

fuel – anything that will burn easily, such as vegetation or small woody material

topography – geographic elements on an area, such as slope steepness, aspect, existence of hills, canyons and rough terrain

wildland – areas which are not developed or farmed

APPENDIX D FARSITE/FLAMMAP INPUT FILES

Elevation: Measured in feet above sea level. This is necessary for adiabatic adjustment of temperature and humidity between elevations and for conversion of fire spread between horizontal and slope distances
Source: USGS digital elevation models

Slope: Percent of inclination from the horizontal. Slope is used to compute steepness effects on fire spread and solar irradiance.
Source: USGS digital elevation models

Aspect: Azimuth values degree clockwise from north. Aspect is used to compute effects on fire spread and solar irradiance.
Source: USGS digital elevation models

Fuel Model: The thirteen standard Fire Behavior Prediction System characterizations of fuel volume, structure, and chemistry. A custom model was developed to portray grazed grass
Source: CDF's 1980 Hardwood Data (polygon) by CSU SLO, updated in 1990 by Pacific Merdian Resources (pixelated).

Canopy Cover: Canopy cover is necessary to compute shading and wind reduction factors. Can be determined based on vegetation type and adjusted by field observations
Source: CDF's 1980 Hardwood Data (polygon) by CSU SLO, updated in 1990 by Pacific Meridian Resources (pixelated).

Tree Height: Tree height is used to compute spotting distance and crown fire characteristics. This data can be determined based on vegetation type.
Source: CDF's Hardwood Data using translation rules (attached), and field observation.

Crown Base Height, or Height to Live Canopy: Crown base height is an important parameter for determining the transition from surface fire to crown fire. This value incorporates the effects of ladder fuels in increasing vertical continuity and assisting transition to crown fire.
Source: CDF state-wide fuels mapping efforts, CDF's Hardwood Data using translation rules, and field observation.

Weather: Weather is important to determine environmental conditions during the simulation. The weather data theme describes the maximum and minimum temperature and relative humidity, and the time in which the maximum and minimum temperature occurs in order to dry and moisten fuels accordingly.
Source: RAWS stations from Oakland North, Mt. Diablo, or other local weather station

Wind: Wind provides a heat transfer mechanism and influences the direction of fire spread. The wind data theme describes the wind speed and direction every hour throughout the simulation.
Source: RAWS stations from Oakland North, Mt. Diablo, or other local weather station

FARSITE and FlamMap Inputs Files

The following discussion describes files used as inputs to the wildfire simulation program, FARSITE and FlamMap. These consist of:

1. ***conversion files*** (*.cnv), where the fuel model specified in the spatial categorization of fuels is changed to another fuel model, or a custom fuel model. No fuel conversion file was used.
2. ***adjustment files***, where the rates of spread for each fuel model are adjusted to account for the inherent over-prediction of spread rates by the heat transfer models.
3. ***custom fuel models*** (*.fmd) where fuels are defined that are not part of the standard fuel models (such as grazed grass, or an interpretation of mature landscaping). No custom fuel models were used.
4. ***fuel moisture files*** (*.fms), where for each fuel model, the initial fuel moisture for each size class of fuels is defined for each fuel model. The moisture content of live woody fuels and live herbaceous fuels are similarly defined for each fuel model.

In all files, the format follows that required by the FARSITE version 4.0, 1997, by Mark A. Finney. FARSITE is available from Systems for Environmental Management, PO Box 8868, Missoula, MT, 59807, or from www.fire.org/tools.

Adjustment file

An adjustment factor of .4 was selected for both fuel models because the spread of unadjusted simulations appeared to be unrealistic. The wind speeds were less than 20 miles per hour, and while quite windy, could not merit a higher adjustment factor. All fuel models were assigned an adjustment factor of 0.4.

Fuel Moisture file

This file specifies the moisture in the fuels of various sizes, and specifies how much moisture is in leaves as well. The weather files then dry out or add moisture depending on ambient conditions. These values were taken from a range of moistures monitored throughout the state for the last 20 years. All fuel models had the same fuel moisture for the various size classes. For fine fuels (< 1/4 inch diameter), the fuel moisture was two percent. For twigs (1/4 inch – 1 inch diameter), it was three percent. For larger dead material (larger than 1 inch) the fuel moisture was seven percent. For both herbaceous and woody foliage, the fuel moisture was 70 percent.

Log of Input Files

FARSITE Growth Potential 1

Log File: C:\Orinda\Pulte\FARSITE output1 Orinda Grove.LGS
Date File Created: 09\18\2007
Time File Created: 18:14

Landscape File: C:\Orinda\Pulte 9-18.LCP
Weather File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wea.wtr Wind File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wnd.wnd

Adjustment File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Pulteadjustment.adj
Fuel Moisture File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Stndlow345-70fms.fms
Conversion File: None
Custom Fuel Model File: None
Crown Fire: Enabled
Crown Density LINKED to Crown Cover
Ember Generation: Enabled
Spot Growth: Enabled
Backing Spread: Calculated from Elliptical Dimensions
Acceleration File Used: Default Values

Simulation Started (Day Hour:Min): 10/24 13:00
Simulation Ended (Day Hour:Min): 10/24 14:45
Elapsed Time (Days Hours:Mins): 00 01:15

Actual Time Step (min): 15.000000
Visible Time Step (min): 15.000000
Perimeter Resolution (m): 28.353654
Distance Resolution (m): 27.439020

FARSITE Growth Potential 2
Log File: C:\Orinda\Pulte\FARSITE output2a Orinda Grove.LGS
Date File Created: 09\18\2007
Time File Created: 18:31

Landscape File: C:\Orinda\Pulte 9-18.LCP
Weather File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wea.wtr
Wind File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wnd.wnd
Adjustment File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Pulteadjustment.adj
Fuel Moisture File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Stndlow345-70fms.fms
Conversion File: None
Custom Fuel Model File: None
Crown Fire: Enabled
Crown Density LINKED to Crown Cover
Ember Generation: Enabled
Spot Growth: Enabled
Backing Spread: Calculated from Elliptical Dimensions
Acceleration File Used: Default Values

Simulation Started (Day Hour:Min): 10/24 19:00
Simulation Ended (Day Hour:Min): 10/24 20:00
Elapsed Time (Days Hours:Mins): 00 01:00

Actual Time Step (min): 15.000000
Visible Time Step (min): 15.000000
Perimeter Resolution (m): 28.353654
Distance Resolution (m): 27.439020

FARSITE Growth Potential 3
Log File: C:\Orinda\Pulte\FARSITE output3 Orinda Grove.LGS
Date File Created: 09\18\2007
Time File Created: 17:56

Landscape File: C:\Orinda\Pulte 9-18.LCP
Weather File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wea.wtr
Wind File 1: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Weather\ONOOct3wnd.wnd
Adjustment File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Pulteadjustment.adj
Fuel Moisture File: C:\Orinda\Orinda-Colorado Springs\Fire Modeling 06\Stndlow345-70fms.fms
Conversion File: None
Custom Fuel Model File: None
Crown Fire: Enabled
Crown Density LINKED to Crown Cover
Ember Generation: Enabled
Spot Growth: Enabled
Backing Spread: Calculated from Elliptical Dimensions
Acceleration File Used: Default Values

Simulation Started (Day Hour:Min): 10/24 19:00
Simulation Ended (Day Hour:Min): 10/24 19:30
Elapsed Time (Days Hours:Mins): 00 01:00

Actual Time Step (min): 15.000000
Visible Time Step (min): 15.000000
Perimeter Resolution (m): 28.353654
Distance Resolution (m): 27.439020