15. WILDFIRE

15.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can occur naturally and are important to many ecosystem processes, but most are started by people. Wildfire is a normal part of most forest and range ecosystems in temperate regions of the world. Fires historically burn on a fairly regular cycle, recycling carbon and nutrients stored in the ecosystem and strongly affecting the species within the ecosystem.

15.1.1 Fire Hazard Severity Zones

The California Department of Forestry and Fire Protection (CAL FIRE) has modeled and mapped wildfire hazard zones using a computer model that designates moderate, high, or very high fire hazard severity zones (FHSZ). FHSZ ratings are derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. CAL FIRE's model derives fire frequency from 50 years of fire history data. Fire behavior is based on factors such as the following (CAL FIRE, 2013):

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. When the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation, so vegetation is dry, conditions are very favorable for extensive and severe wildfires. These conditions occur more frequently inland where temperatures are higher, and fog is less prevalent.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates.

15.1.2 Local Conditions Related to Wildfire

Because natural vegetation and dry-farmed grain areas are extremely flammable during late summer and fall, wildfire is a serious hazard in undeveloped areas and on large lot home sites with extensive areas of un-irrigated vegetation. Grassland fires are easily ignited, particularly in dry seasons. These fires are relatively easily controlled if they can be reached by fire equipment; the burned slopes, however, are highly subject to erosion and gullying.

While brush-lands are naturally adapted to frequent light fires, fire protection in recent decades has resulted in heavy fuel accumulation on the ground. Brush fires, particularly near the end of the dry season, tend to burn fast and very hot, threatening homes and leading to serious destruction of vegetative cover. A brush fire that spreads to a woodland can generate a destructive hot crown fire. No suitable management technique of moderate cost has been devised to reduce the risk of brush fires. Early research is exploring the impact that soil amendments to open space and high-fire risk areas has on reducing the risk of fires.

Peat fires represent a special hazard in that, once ignited, they are extremely difficult to extinguish. In some instances, islands have been flooded to extinguish peat fires. Any area lying landward of the mean high-water line may be peaty because of the marshy origin of the soil.

Structure Fires

Structure fires are not typically considered to be community emergencies unless the fire can spread to adjoining structures. Older structures are often more vulnerable to fire because they do not conform to modern building and fire codes and do not contain fire detection devices. These structures are also prone to faulty electrical, heating, and other utility systems because of their age. Older structures that were constructed close together enable fire to spread rapidly from one to another.

Often, defensive measures such as fire-resistant vegetation and defensible space are not in place, increasing the probability that structural fires in older buildings will spread to local vegetation and surrounding wildlands. These vulnerabilities can facilitate the spread of a wildfire to structures, or vice versa.

Newer residential structures are not as vulnerable to fire as are older structures. These structures include fire-resistant features that conform to modern fire and building codes, as well as fire detection or extinguishing systems. The likelihood that a major structural fire will expand into a wildfire before it can be brought under control is therefore significantly reduced.

The storage and use of hazardous materials by commercial and industrial occupancies increase the risk of fire and pose a threat to firefighters and the community if they should become involved in a fire. Certain materials have been designated by the National Fire Protection Association as flammable and combustible, such as propane or petroleum; if a wildfire ignites a building or container with these materials, it exacerbates the severity and damage associated with the fire.

Toxic chemicals can present public health hazards if a wildfire reaches an industrial sector or building, releasing toxic fumes as clouds of smoke. Hazardous materials-associated fires also can introduce toxins that damage the local environment, destroying or altering important habitats.

15.1.3 Wildland-Urban Interface

Wildland-urban interface (WUI) areas are places where combustible vegetation meets combustible structures. The hazard in such areas is bi-directional: wildfires can burn homes, and home fires can burn into wildlands. In non-urban communities, such areas are often characterized by sub-standard water supplies and a distant location from fire stations. In urban areas, although the WUI area is generally outside the most densely developed core areas, it often is still adequately served by fire protection agencies; the increased fire risk is due to the development's location adjacent to or intermixed with undeveloped areas that have vegetation that can serve as wildfire fuel.

WUI fires require firefighters trained to fight both wildfires and structure fires. Firefighters responding to such fires may need to make choices between protecting homes and structures, protecting wildland resources, or working to slow the overall fire itself. Owners of structures within the WUI can take preventive measures to

reduce the risk of a wildfire igniting a structural fire. CAL FIRE recommends protective measures such as using fire-resistant plants, maintaining 100 feet of defensible space, and providing property hardening.

15.1.4 Wildfire Protection Responsibility in California

Hundreds of agencies have fire protection responsibility for wildland and WUI fires in California, and primary legal (and financial) responsibility for wildfire protection is divided by local, state, tribal, and federal organizations. In many instances, two fire organizations have dual primary responsibility on the same parcel of land—one for wildfire protection, and the other for structural or "improvement" fire protection. According to the *2013 California Multi-Hazard Mitigation Plan*, this layering of responsibility and resulting dual policies, rules, practices, and legal ordinances can cause conflict or confusion. To address wildfire jurisdictional responsibilities, the California state legislature in 1981 adopted Public Resource Code Section 4291.5 and Health and Safety Code Section 13108.5 establishing the following responsibility areas:

- **Federal Responsibility Areas (FRAs)**—FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdictional authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually not the responsibility of the federal land management agency; structural protection responsibility is that of a local government agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where CAL FIRE has legal and financial responsibility for wildfire protection and where CAL FIRE administers fire hazard classifications and building standard regulations. SRAs are defined as lands that meet the following criteria:
  - Are county unincorporated areas
  - Are not federally owned
  - Have wildland vegetation cover rather than agricultural or ornamental plants
  - Have watershed or range/forage value
  - Have housing densities not exceeding three units per acre.

  Where SRAs contain built environment or development, the responsibility for fire protection of those improvements (non-wildland) is that of a local government agency.
- **Local Responsibility Areas (LRAs)**—LRAs include land in cities, cultivated agriculture lands, non-flammable areas in unincorporated areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city fire departments, fire protection districts, and counties, or by CAL FIRE under contract to local governments. The City of Oakland is located in incorporated LRAs. LRAs may include flammable vegetation and WUI areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

SRAs were originally mapped in 1985, and LRAs were originally mapped in 1996. At that time, many local governments made similar designations under their own authority. CAL FIRE recognized the need to remap both SRAs and LRAs with more recent data and technology to create more accurate zone designations. Updated SRA maps were released in May 2011 and again in August 2012. SRA and LRA maps released in 2007 and 2008 are available at the county level for Alameda County on CAL FIRE's Fire and Resource Assessment Program (FRAP) website (CAL FIRE, 2013).

FRAP not only contains maps showing high hazard fire zones in SRAs and LRAs, it also offers a multitude of fire management prevention and planning tools. Other maps and GIS data include bioregions, fire management environments, fire perimeters, fire threat, fuel rank, surface fuels, land cover, watersheds, historical and anticipated development, and more. FRAP also conducts a periodic assessment on state forests and rangelands to determine the amount and extent of these resources, analyze their conditions, and identify alternative management and policy guidelines. The assessment enhances inter-agency collaboration between state and federal agencies on forest and rangeland resources.

California's SB 1241 (adopted in 2012) requires local governments to update the safety elements in their general plans to recognize wildfire risks in SRAs and "Very High Fire Hazard Severity Zones" (based on consistent statewide criteria and the severity of fire hazard that is expected to prevail in those areas). SB 1241 correlates with AB 2140, which requires local jurisdictions to adopt a federally approved hazard mitigation plan through reference in the safety elements of their general plans. This bill also notes the requirement for the safety element to include information and policies on unreasonable risk from potential hazards, including fire. These bills are both designed to encourage integration within and between jurisdictions to enhance mitigation and prevention efforts. Information from a local general plan safety element should be considered with the development of a hazard mitigation plan, response procedures, evacuation planning, and long-term development.

15.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from wildfires (City of Oakland, 2012):

> *General factors that affect an area's risk from fire hazards include its location, land uses, distance from fire stations, ease of accessibility by firefighting equipment, and adequacy of water supply. More specifically, the extent, severity and damage of fires are determined by several key factors affecting vulnerability. For… [wildfire], these vulnerabilities include:*
>
> > *… Steep and rugged topography, dense and unmanaged vegetation (especially woods and brush), accessibility to human activities, exposure to wind and sun, drought conditions, and the presence of above-ground utility lines. The wildland urban interface is an especially hazardous area because it combines a resident population with large areas of combustible material (including structures), and is often characterized by sub-standard water supplies and a distant location from fire stations. The time of the year of high wildfire danger is from May to October, when temperatures are higher and humidity is lower. The closer to the end of this "fire season," the more critical the danger is, as vegetation becomes increasingly dry.*

15.2.1 Wildfire Factors for the Planning Area

Topography

Oakland lies on the eastern side of the San Francisco Bay and is divided into flatlands and hills:

- Much of the flatland area is just above sea level and includes residential neighborhoods, industry, businesses, urban areas, and transportation routes. The Bayside area is relatively flat with varying minor changes in elevation.
- Oakland Hills forms the eastern border of the city, along the East Bay Regional Park District. The highest point in the City is near Grizzly Peak Boulevard and is just over 1,760 feet above sea level. The northern neighborhoods of the Hills was devastated by the 1991 Oakland Firestorm. That fire burned more than

1,520 acres and included forested, WUI, and suburban areas. Offshore winds and dry conditions greatly contributed to the fire's devastation. The eastern edge of the city is designated as a very high FHSZ.

Weather

Oakland's primary wildfire season typically starts in late summer and ends in November. In the fall, the fog recedes earlier in the day and vegetation begins to dry out from regular offshore winds, leading to a higher chance of fire. The Diablo winds are primarily the cause of fires in Oakland. They are warm, dry winds that flow from warmer and drier inland areas, which flow over the Oakland Hills and down to the Bay. The fire season ends once winter rains, cooler temperatures, and higher relative humidity come to the city. Fires are less common between December and August, but with the effects of climate change expected to extend fire seasons around the state, fire may become a year-round occurrence in the city.

Vegetation and Fuels

Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.

15.2.2 Past Events

According to the 2016 Alameda County Local Hazard Mitigation Plan, wildfires are common in the Bay Area, with large historic wildfires recorded in 1961, 1962, 1964, 1965, 1970, 1981, 1985, 1988, and 1991. Between 1954 and 2020, FEMA issued major disaster (DR), emergency (EM) and fire management assistance declarations for 262 fire hazard-related events in California. Alameda County was included in two of these, as listed in Table 15-1; impacts on the planning area were not identified in the available sources reviewed.

Table 15-1. FEMA Declarations for Wildfire Events in Alameda County

FEMA Declaration (Name)	Event Date	Event Type	Location	Damage
DR-295 (Buckingham/ Norfolk Fire)	September 29, 1970	Forest & Brush Fires	Six counties including Alameda County	37 homes destroyed, 21 homes damaged, 204 acres burned
DR-919 (Oakland Hills Fire)	October 20-29, 1991	Oakland Hills Fire	Alameda County	$1.7 billion in losses. Burned 1,520 acres, destroyed 3,354 homes and 456 apartments, injured 150 people and took the lives of 25 people

Source: FEMA, 2020

CAL FIRE maintains statistics on historical wildfire activity through its annual reports (Redbooks). Details include state and county information, cause and size, acres burned, and dollar damage. Table 15-2 shows the identified causes of wildfires in Alameda County between 2010 and 2019, the most recent annual report available. CAL FIRE has Redbooks available for every year since 1942. Based on this data, Alameda County experienced approximately 39 fires per year from 2010 to 2019.

Table 15-2. CAL FIRE Wildfire Activity Statistics for Alameda County

Year	Arson	Campfire	Debris Burning	Electric Power	Equipment Use	Lightning	Miscellaneous	Powerline	Playing With Fire	Railroad	Smoking	Undetermined	Vehicle	Total
2019	7	2	0	3	4	0	4	0	0	0	0	9	11	**40**
2018	3	0	0	0	5	0	11	0	0	0	0	19	3	**41**
2017	3	0	0	4	2	1	7	0	0	0	0	16	2	**35**
2016	0	0	0	8	4	0	4	0	0	0	0	16	7	**39**
2015	0	1	2	6	5	2	4	0	0	0	0	21	9	**50**
2014	0	1	0	6	5	0	1	0	0	0	1	13	6	**33**
2013	1	0	1	7	8	0	1	0	0	0	1	15	12	**46**
2012	0	0	0	0	0	0	3	5	0	0	0	7	0	**15**
2011	1	0	0	0	9	0	16	5	0	0	0	14	4	**49**
2010	0	0	1	0	8	0	12	0	1	0	0	21	2	**45**
Average	**1.5**	**0.4**	**0.4**	**3.4**	**5**	**0.3**	**6.3**	**1**	**0.1**	**0**	**0.2**	**15.1**	**5.6**	**39.3**

Note: Wildfire causes tracked by CAL FIRE include natural, human, and technological. More detailed information is available in each applicable Redbook. For instance, power line-caused fires may be a result of animals or vegetation disrupting or connecting with a power line, sparking a fire. They may also be the result of a technological issue or line down (causes not listed but could include storm events).

Source: CAL FIRE, 2020

The most significant wildfire in recent history was the 1991 Tunnel Fire (aka Oakland Hills Fire and East Bay Hills Fire; see Figure 15-1). The fire started October 19 and was brought under control on October 23. It burned 1,520 acres, destroyed more than 3,200 structures, and had 25 confirmed deaths. Northeasterly winds, known as Diablo Winds, that periodically occur in the fall contributed to the growth of the grass fire eventually generating its own wind, now known as a firestorm.

Figure 15-1. Scenes from the 1991 Oakland Hills Fire (Tunnel Fire)

On December 2, 2016, the fire known as the Ghost Ship Fire started in a former warehouse in the Fruitvale neighborhood that had been converted into artist studios. At the time of the fire, the studio was being used for entertainment purposes for a music concert. Of the 100 people attending the concert, 36 were killed, making it the deadliest fire in Oakland history.

15.2.3 Location

In Alameda County, wildfire risk is primarily in the WUI areas with moderate, high, or very high fire threat risk. These are high-density areas in the mountainous and hillside areas of eastern Oakland and Berkeley, central Union City, and some portions of the southeastern corner of Alameda County (CAL FIRE, 2021). CAL FIRE's FRAP website includes maps of the communities most at risk for wildfire that are within 1.5 miles of a high or very high wildfire threat on federal or non-federal lands. The threat is based on the FRAP fuels and hazard data. Figure 15-2 shows the fire hazard severity zone (FHSZ) map for Alameda County.

In Oakland, built-up urban areas with little or no exposure to vegetative fuel areas are located primarily to the west of the City's very high FHSZ. Within the very high FHSZ, WUI areas consist of two general conditions (Dudek, 2019):

- Urban-level development abutting undeveloped areas with vegetative fuels, such as parklands and open space
- Areas where the size and density of housing units and structures is lower and the space between structures consists of vegetative fuels (sometimes called wildland urban intermix areas)

The Oakland Hills present a complex wildfire environment that presents a significant risk to public and firefighter safety and the built and natural environment. This area is one of the highest risk areas in the country for devastating WUI fires, and is the location of one of the state's most destructive historical wildfires, the 1991 Tunnel Fire (Dudek, 2019).

The wildfire risk assessment for this plan uses the best available data and maps on the extent and location of the wildfire hazard. This data represents only the wildfire risks that can be modeled. Some risk factors, such as floating embers driven by very strong wind events, can lead to dangerous wildfire conditions in areas not identified as high risk in the available mapping.

15.2.4 Frequency

Wildfires will continue to present a risk to Alameda County and the planning area. It is difficult to estimate the number of wildfires that will occur in the planning area because of the number of factors that impact the potential for a fire and because some conditions exert increasing pressure on the WUI zone (e.g., ongoing development). An analysis of the frequency of past occurrences can give a rough guide as to how many events may occur each year if current trends continue.

The Association of Bay Area Governments has evaluated wildfire frequency in the Bay Area using the California Fire Alliance map of past wildfires and the FHSZ maps. Table 15-3 shows the record of fires over the past 130 years (1878 to 2008). In that time, only 0.24 percent of areas mapped in an extreme FHSZ have burned, 22.8 percent of those mapped as very high, and 18.5 percent of those mapped as high. In addition, 4.5 percent of the WUI areas have burned.

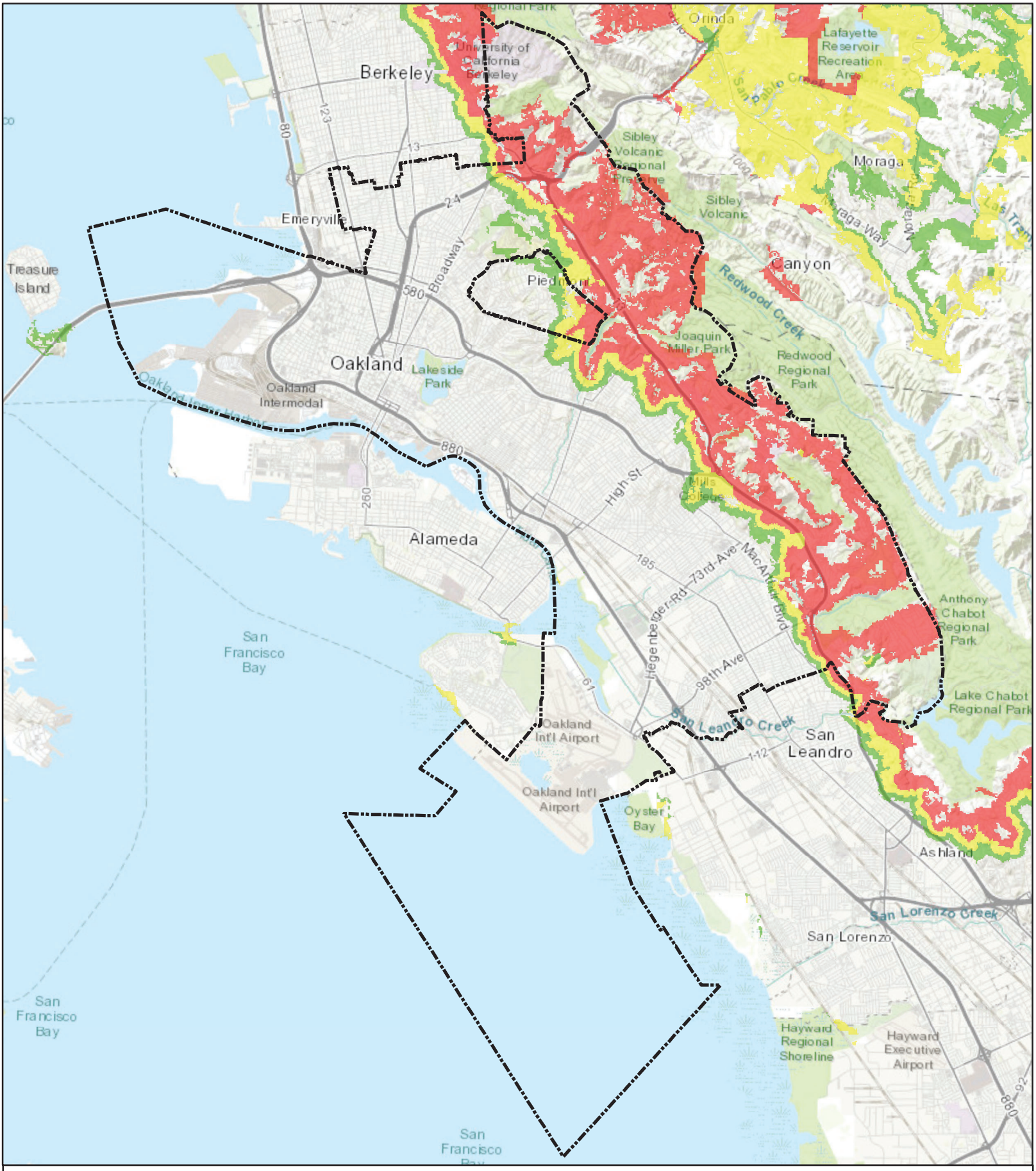

Figure 15-2. Fire Hazard Severity Zones

Fire Hazard Severity Zones within WUI

City Limits

Moderate

High

Very High

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, CAL FIRE

Table 15-3. Record of Wildfire Affecting Planning Area

FHSZ Category	Total Area in Zone (acres)	Area Burned, 1878 – 2008	
		Acres	Percent of Total
Moderate	1,300,662	41,651	3.2%
High	1,183,899	218,947	18.49%
Very High	1,344,664	306,264	22.78%
Extreme	2,272	5	0.24%

Source: Association of Bay Area Governments, 2020

15.2.5 Severity

Wildfires

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported fires and the proximity to firefighting resources, the likelihood of injuries and casualties is minimal. However, under the right conditions, fire can move quickly and overwhelm an initial response. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides) and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather.

Wildfire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure.

Economic impacts due to wildfires include costs and losses due to burned agricultural crops, damaged public infrastructure and private property, interrupted transportation corridors, and disrupted communication lines. They also include diminished real property values and thus tax revenues, loss of retail sales, and relocation expenses of temporarily or permanently displaced residents.

Urban Fires

Any large fire in a high occupancy, urban building is serious. The disruption to people's lives may be long term and the building owner will incur economic losses from the fire.

15.2.6 Warning Time

Wildfires are mostly caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest.

Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

The fire and life safety systems installed in high-occupancy urban buildings are designed to provide an early warning in the event of a fire. Automatic fire sprinkler protection in modern buildings is designed to control a fire and therefore lessen the need to evacuate all occupants.

15.2.7 Firefighting Resources

Oakland Fire Department is a full-time agency that provides fire and emergency services to the City. Twenty-five stations cover the city's 78 square miles including Oakland International Airport. Additionally, Oakland Fire is host to one of FEMA's 28 national Urban Search and Rescue teams, Task Force 4. Oakland Fire participates in mutual-aid county fire response and is part of the California Master Mutual Aid Agreement.

15.2.8 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Mass movement or major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This condition is sometimes referred to as scorched earth. This devastation increases the runoff generated by storm events, thus increasing the chance of flooding and soil erosion. These secondary impacts of wildfire can also affect the quantity and quality of water, which can pose a significant challenge to drinking water utilities.

The secondary impact of a high-occupancy building fire is the disruption to the population and area in the city. High occupancy / urban buildings can be in almost all parts of the City but are concentrated in the commercial planning zones.

15.3 EXPOSURE

Structural or industrial fires are unlikely to cause widespread damage, so the risk analysis and mitigation measures for this hazard mitigation plan focus on wildfire. Exposure to the wildfire hazard was assessed through a spatial analysis using Hazus. Mapped wildfire hazard areas with the highest severity (moderate, high, and very high, as shown on Figure 15-2), were overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

15.3.1 Population

Total Exposed Population

Table 15-4 summarizes the total population living in the highest-severity wildfire hazard areas. These estimates were developed by multiplying the total planning area population by the percentage of total residential buildings that are within the mapped hazard areas. See Appendix E for a detailed breakdown of exposure by sub-area.

Table 15-4. Total Exposed Population in Mapped Fire Hazard Severity Zones

	Moderate FHSZ	High FHSZ	Very High FHSZ
Population Exposed	11,411	12,064	43,615
% of Total Planning Area Population	2.7%	2.9%	10.4%

In addition to populations who reside in risk areas where fires may occur, hikers and campers in the mountains may be exposed to wildfires, and the entire population of the planning area has the potential to be exposed to smoke from nearby wildfires.

Socially Vulnerable Populations

The socially vulnerable populations in the high and very-high wildfire severity zones were estimated based on data for the Census-defined blocks that lie at least partially within the mapped zones. Because many of those Census blocks extend outside the hazard zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 15-5 summarizes the estimated socially vulnerable populations.

15.3.2 Property

Buildings

Table 15-6 summarizes the Hazus-estimated number and value of properties within the highest-severity wildfire hazard zones. See Appendix E for a breakdown by sub-area.

Land Use

Table 15-7 shows the occupancy class of all buildings in the highest-severity wildfire hazard zones. See Appendix E for a breakdown by sub-area.

Table 15-5. Relative Exposure of Socially Vulnerable Populations in Wildfire Hazard Zone

	Number[a]	% of Total in High and Very-High FHSZ
Exposed Population by Age		
Over 65 Years	9,770	15.5%
Under 16	12,348	19.6%
Exposed Population by Race[b]		
White	33,416	53.1%
Black or African American	12,952	20.6%
American Indian and Alaska Native	127	0.2%
Asian	7,727	12.3%
Native Hawaiian and Other Pacific Islander	132	0.2%
Some other race	239	0.4%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	5,327	8.5%
Exposed Households by Income		
Households with Income Below $50,000	5,476	21.2%
Totals Used for Calculating Percentages[a]		
Population	62,887	
Households	25,836	

a. The methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

Table 15-6. Exposed Property in Mapped Fire Hazard Severity Zones

	Moderate FHSZ	High FHSZ	Very High FHSZ
Number of Buildings Exposed	3,563	3,845	15,403
Value of Exposed Structures	$1,241,025,632	$1,312,861,862	$5,933,027,216
Value of Exposed Contents	$824,701,758	$941,218,776	$3,618,290,879
Total Exposed Property Value	**$2,065,727,390**	**$2,254,080,639**	**$9,551,318,096**
Total Exposed Value as % of Planning Area Total	1.8%	1.9%	8.1%

Table 15-7. Building Occupancy Classes in Fire Hazard Severity Zones

Building Occupancy Class	Moderate FHSZ		High FHSZ		Very High FHSZ	
	Building Count	% of Total Exposed	Building Count	% of Total Exposed	Building Count	% of Total Exposed
Residential	3,504	98.34	3,814	99.19	15,160	98.42
Commercial	30	0.84	8	0.21	143	0.93
Industrial	0	0	0	0	1	0.01
Agriculture	0	0	0	0	1	0.01
Religion	11	0.31	4	0.10	28	0.18
Government	6	0.17	7	0.18	39	0.25
Education	12	0.34	12	0.32	31	0.20
Total	**3,563**	**100**	**3,845**	**100**	**15,403**	**100**

15.3.3 Critical Facilities

The breakdown of critical facilities exposure in the high and very high wildfire risk areas is shown in Figure 15-3.

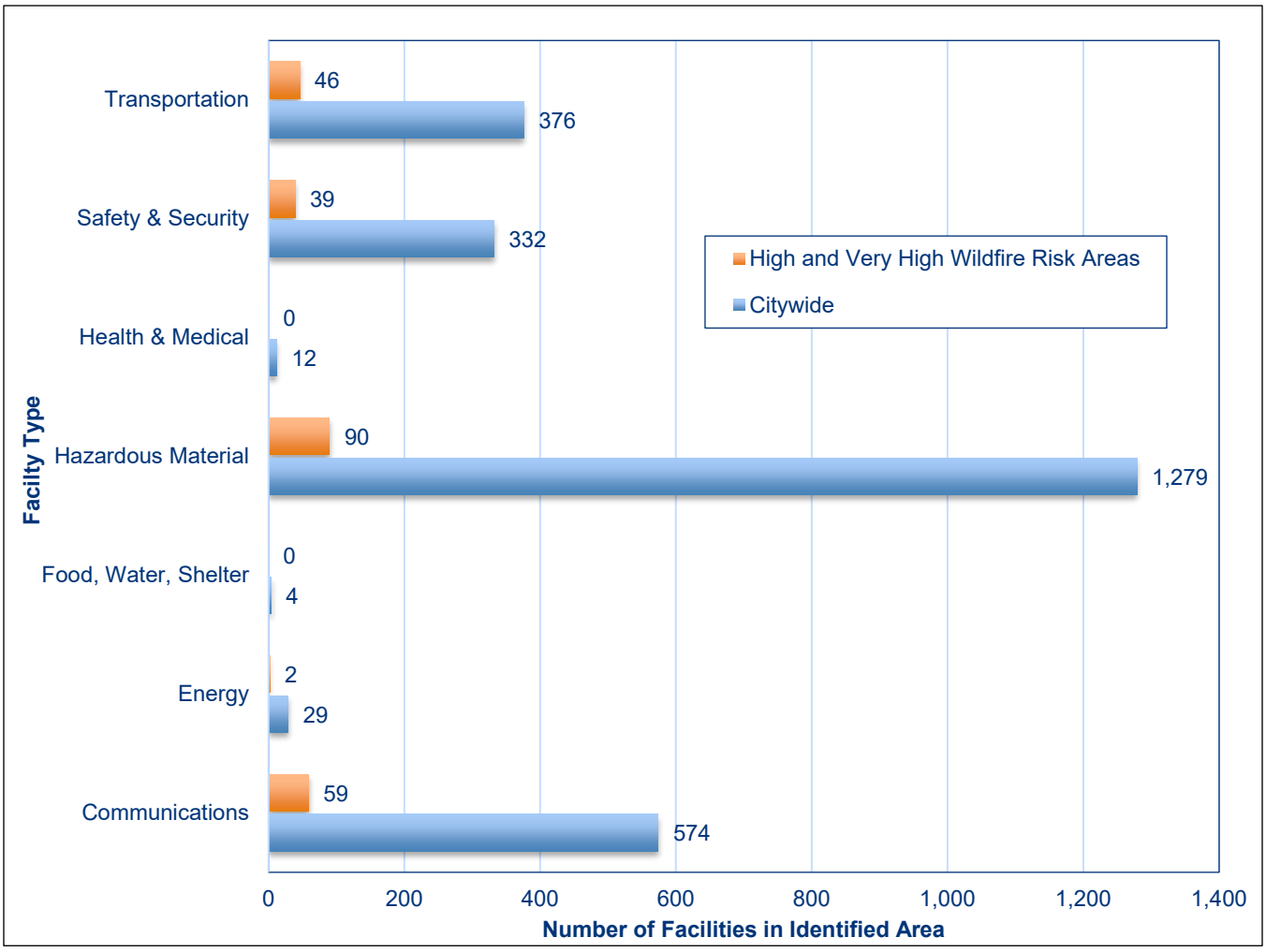

Figure 15-3. Critical Facilities in High and Very High Wildfire Risk Areas and Citywide

15.3.4 Environment

The environment in all areas within the highest-severity wildfire hazard zones is exposed to the wildfire hazard.

15.4 VULNERABILITY

15.4.1 Population

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Persons with access and functional needs, the elderly and very young may be especially vulnerable to a wildfire if there is not adequate warning time for them to evacuate if needed. In addition, people outside the mapped risk areas are susceptible to health hazards associated with smoke and air pollution from wildfires, especially sensitive populations including

children, the elderly, and those with respiratory and cardiovascular diseases. In addition, wildfires threaten the health and safety of those fighting the fires.

15.4.2 Property

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. As of 2008, California State Building code requires minimum standards be met for new buildings in fire hazard severity zones. Most housing in the planning area—84 percent—was built prior to this code requirement (U.S. Census, 2020). It is unknown how many of these structures are in fire hazard zones.

Estimates were developed to indicate the loss that would occur if wildfire damage were equal to 10, 30 or 50 percent of the exposed property value, as summarized in Table 15-8. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 15-8. Loss Estimates for Fire Hazard Severity Zones

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Moderate FHSZ			
Loss = 1% of Exposed Value	$2.1 billion	$21 million	Less than 1%
Loss = 10% of Exposed Value		$206 million	Less than 1%
Loss = 30% of Exposed Value		$618 million	Less than 1%
Loss = 50% of Exposed Value		$1.030 billion	Less than 1%
High FHSZ			
Loss = 1% of Exposed Value	$2.2 billion	$22.5 million	Less than 1%
Loss = 10% of Exposed Value		$225 million	Less than 1%
Loss = 30% of Exposed Value		$675 million	Less than 1%
Loss = 50% of Exposed Value		$1.125 billion	Less than 1%
Very FHSZ			
Loss = 1% of Exposed Value	$9.6 billion	$95 million	Less than 1%
Loss = 10% of Exposed Value		$955 million	Less than 1%
Loss = 30% of Exposed Value		$2.865 billion	2.4%
Loss = 50% of Exposed Value		$4.775 billion	4.04%

15.4.3 Critical Facilities

Critical facilities not built to fire protection standards, utility poles and lines, and facilities containing hazardous materials are most vulnerable to the wildfire hazard. Most roads would not be damaged except in the worst scenarios, although roads and bridges can be blocked by debris or other wildfire-related conditions and become impassable. The following critical facilities are located in very high and high severity zones and their vulnerability could complicate response and recovery efforts during and following an event:

- **Hazardous Materials and Fuel Storage**—During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable

levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the planning area.
- **Protective Function Facilities (Police and Fire)**—Approximately 12 percent of these types of facilities are within the high or very high severity wildfire zone.

15.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades for ecosystems to recover. Some fires burn so hot that they sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

15.5 FUTURE TRENDS IN DEVELOPMENT

Risks associated with the expansion of the WUI as development occurs can be best managed with strong land use and building codes. The planning area is equipped with these tools, and this planning process has assessed their capabilities. These tools can be enhanced with higher standards as appropriate to address known risks as better data and science become available. As the planning area experiences future growth, the City will need to monitor the effectiveness of these regulatory tools for managing risk with, the objective that wildfire risk within the City will see no net increase with new development.

The California Building Code includes minimum standards related to the design and construction of buildings in fire hazard zones. Any newly permitted buildings within the City must conform to standards that manage

flammable materials from around the building (defensible space laws) and construct buildings from fire resistant material (Chapter 7A or the Building Code). New residential construction permitted in the City with wildfire risk have been built according to the standards of the 2007 California Building Code Chapter 7A, "Materials and Construction Methods for Exterior Wildfire Exposure" (effective January 1, 2008). In addition, the City of Oakland General Plan includes policies that address managing development in fire hazard severity zones. As the planning area experiences future growth, and if the recommendations of this plan are implemented, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

To further address wildfire hazards the City of Oakland applies a Standard Condition of Approval to all projects involving construction of new facilities in the designated Very High Fire Severity Zone. Details are provided in Appendix D.

15.6 SCENARIO

The City of Oakland has in essence already experienced its worst-case wildfire scenario with the 1991 Oakland Hills Fire. Smoldering embers from a small fire that was extinguished the day before erupted into what was at the time, the worst firestorm in the State of California's history. At its height, 1,500 firefighters and 450 engines from all over Northern California were fighting it. By the time it burned out, it had consumed 2.5 square miles of mostly residential neighborhoods. Twenty-five people were killed and 150 injured. The fire destroyed 3,469 homes and apartment units and 2,000 automobiles. Ten thousand people were evacuated. NOAA estimates that the fire cost $3.9 billion in present-day dollars. At the time it was the largest single fire in California history in terms of cost, homes lost, and people killed.

The Oakland Hills fire was the first of what has become the norm in the State of California in the beginning of the 21st century. Wildfire behavior has changed markedly in the west driven prolonged period of drought and warmer, windier falls that create ideal fire conditions. Looking forward, a major wildfire in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lightning storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers could be deep in forested areas. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily

double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

15.7 ISSUES

The major issues for wildfire are the following:

- The number of annual wildfire events within Alameda County has held steady over the last 10 years at about 40 fires per year. Any of these 40 fires could have the potential to escalate, especially in the Oakland Hills as was seen in 1991.
- Over 13 percent of the planning area's population lives in either high or very-high wildfire severity zones.
- Much of the planning area's building stock is of wood-frame construction built before 2008 when California building codes began requiring minimum standards for buildings in fire hazard severity zones. Large clusters of structures are wood-frame structures in high and very high severity zones.
- An estimated 35 percent of the critical facilities in the planning area are located in wildfire risk areas. A large number of the facilities are believed to be wood-frame structures. These facilities could have a significant amount of functional downtime after a wildfire. This creates not only a need for mitigation but also a need for continuity of operations planning to develop procedures for providing services without access to critical facilities.
- There are vulnerable and isolated populations in areas of high and very high risk for wildfire.
- Public education and outreach to people living in the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Analyses based on the degree of wildfire risk should be updated to match new calculations.
- Regional consistency, application and enforcement of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire departments require reliable water supply in high risk wildfire areas.
- The Oakland WUI is fully built out, and evacuation in the event of a widespread fire can be restricted by a dense population attempting to leave the area in many vehicles at the same time. This can be compounded by narrow urban streets with parked cars creating barriers to evacuation. Planners and traffic engineers must look at the entire evacuation route. Most roads leading out of the City's hills are one lane in each direction. This could inform mitigation strategies that address road infrastructure projects in the WUI.