Watershed Emergency Response Team Evaluation BOND FIRE



CA-ORC-136890

January 8, 2021







Contents

1	Introduction	1
	Background	1
	Objectives and Scope	1
2	Physical Setting	4
	Topography and Climate	4
	Hydrology and Flood History	6
	Vegetation and Fire History	7
	Geology and Landslides	10
	Hazardous Minerals	15
3	. Remote Sensing and Modeling Results	20
	Soil Burn Severity	20
	Post-Fire Hydrology	22
	Post-Fire Debris Flow Modeling: Predicted Thresholds and Hazards	23
	Post-Fire Sediment Production	28
	Model Accuracy and Uncertainties	29
4	VAR Observations and Recommendations	29
	General Discussion	30
	Summary of Observations	31
	Modjeska Canyon Area	31
	Summary of the Modjeska Canyon Area	33
	Santiago Canyon Area	35
	Summary of the Santiago Canyon Area	35
	Williams Canyon Area	36
	Summary of the Williams Canyon Area	38
	Silverado Canyon Area	39
	White Canyon and Cabin Land Areas	41
	Summary of the Silverado Canyon Area	43
5	General Recommendations	45
6	Acknowledgements	49
7	References	49

Appendix A: Contacts

Appendix B: VAR Table

Appendix C: VAR Maps

Appendix D: Site-Specific VAR Data Sheets

State of California

Watershed Emergency Response Team (WERT)

BOND FIRE – WERT ASSESMENT EXECUTIVE SUMMARY

CA-ORC-136890 WERT Evaluation

<u>Mission Statement</u>: The California Watershed Emergency Response Team (WERT) helps communities prepare after wildfire by rapidly documenting and communicating post-fire risks to life and property posed by debris flow, flood, and rockfall hazards.

It should be noted that the findings included in this report are not intended to be fully comprehensive or conclusive, but rather to serve as a preliminary tool to assist Orange County Sheriff's Emergency Management Division, Orange County Fire Authority, local first responders, Orange County Public Works and other County Departments, California Department of Transportation (Caltrans), the California Governor's Office of Emergency Services, the United States Department of Agriculture Natural Resources Conservation Service, utility companies, and other responsible agencies and entities in the development of more detailed post-fire emergency response plans. It is intended that the agencies identified above will use the information presented in this report as a preliminary guide to complete their own more detailed evaluations, and to develop detailed emergency response plans and mitigations. This report should also be made available to local districts, residents, businesses, and property managers so that they may understand their proximity to hazard areas, and to guide their planning for precautionary measures as recommended and detailed in this document.

The Bond Fire started on December 2, 2020 in the Silverado Canyon area of Orange County, with containment occurring on December 10, 2020. Although the Bond Fire is small in terms of area burned (i.e., 6,681 acres as reported by the Orange County Fire Authority), the hazards and risk posed by the Bond Fire burned area are substantial. Previous history shows that the area affected by the Bond Fire has had numerous occurrences of fatalities and property damage due to geologic and hydrologic hazards, even in the absence of fire. As such, the WERT expects a high potential for hyperconcentrated flows, debris flows, and rockfall to occur within and downslope/downstream of the Bond Fire burned area because of the combination of geology, steep topography, previous history, and moderate soil burn severity. **The level of risk associated with the Bond Fire means that emergency planning, along with a clear understanding of the likely hazards, is critical if deaths, injuries, and/or property damage are to be avoided or minimized during future rain events.**

Due to its proximity to residential areas and critical infrastructure, the burn area was evaluated by an interagency WERT. The WERT rapidly evaluated post-fire watershed conditions, identified potential **Values-at-Risk (VARs)** related to human life-safety and property, and evaluated the potential for increased post-fire flooding, debris flows, and rockfall. The team also recommended potential emergency protection measures to help reduce the risks to those values.

Summary of the Key WERT Findings

- The degree of fire-induced damage to soil is called "soil burn severity" and is a primary influence on increased runoff and sediment generation and the occurrence of post-fire watershed hazards (e.g., debris flows and flooding). Moderate and high soil burn severity typically create the most impacts.
- The Bond Fire has 62 percent of the area burned at moderate (60%) to high (2%) soil burn severity, respectively.
- There are 64 VARs identified within and downslope/downstream of the fire. Some VARs are shown as polygons which encompass multiple individual sites. The majority of VARs (77%) have a moderate to high life-safety threat associated with them
- The majority of VARs are associated with an increased likelihood of combined debris flow and/or flood hazard.
- Nineteen (19) VARs were determined to have a high threat to life and safety. Some of these VARs are polygons that encompass dozens of residential structures. The majority of these occur in Silverado Canyon (e.g., Wildcat and White Canyons), and to a lesser degree in Williams and Modjeska Canyons.
- Thirty (30) VARs were determined to have a moderate threat to life and safety.
- USGS debris flow model results are presented in terms of "combined debris flow hazard", which reflects both the likelihood of debris flow occurrence and the magnitude of potential debris volume. Basins with a high likelihood of debris flow occurrence and/or relatively high magnitude of debris production have a "high combined hazard", whereas basins with a low likelihood of debris flow occurrence and/or a relatively low magnitude of debris production have a "low combined hazard."
 - A storm scenario of 0.20 inches in 15-minutes (i.e., 0.79 in hr⁻¹ or 20 mm hr⁻¹ for the 15-minute duration) equates to a moderate combined hazard for most of the areas with documented moderate to high threat life-safety VARs.
 - A storm scenario of approximately 0.31 inches in 15-minutes (i.e., 1.26 in hr⁻¹ or 32 mm hr⁻¹ for the 15-minute duration) equates to a high combined hazard for portions of the burned area that includes White Canyon and Modjeska Canyon. This equates to roughly a 1 to 2-year recurrence interval storm event for portions of the burned area.
- Rockfall hazards exist on and adjacent to steep slopes within and downslope of the fire areas due to post-fire effects.
- The ERMiT post-fire surface erosion model predicts elevated surface erosion across the burn area due to the preponderance of moderate Average erosion rates for the 2-year and 10-year storm event range from 1.5 to 6.6 tons per acre for the Bond Fires, respectively.

General Recommendations

The WERT's objectives for the burned area were to quickly identify potential post-fire geologic hazards to life-safety and property, including those from debris flows, flooding, rockfall, and erosion. General recommendations include:

- Utilize early warning systems available to the public, particularly those located in debris flow, flood-prone and rockfall areas. The WERT recommends the use of Orange County AlertOC system.
- Augment existing rain gauge networks to improve the efficacy of the early warning system.
- To refine rainfall thresholds over time, implement a formalized monitoring program that relates watershed response to measured rainfall intensities and/or weather radar imagery.
- Local governments should consider the need to evacuate the burned area, particularly the VARs with an elevated threat to life and safety.
- Increase the situational awareness of affected residents and the communities regarding the hazards and risks associated with living downstream/downslope of burned areas through outreach by local government agencies.
- Perform monitoring and maintenance of road drainage and storm drain infrastructure, particularly within the affected communities of Silverado, Williams Canyon, and Modjeska Canyon.
- Place temporary signage in areas of potential post-fire rockfall, debris flow, and flooding hazards.
- Consider conducting more detailed assessment of rockfall hazards.
- Consider temporarily closing roadways in potential hazard areas as storms approach.
- Utilize temporary flood control and structure protection (e.g. sand bags, super-sacks, K-rails, Muscle Wall, etc.) where appropriate.
- Monitor and/or remove accumulated debris from within channels and drainage structures that are subject to post-fire flooding where there is an elevated risk to life and/or property.

1. Introduction

Background

The Bond Fire started on December 2, 2020 in Silverado Canyon in Orange County, and burned a total of 6,681 acres (i.e., 10.4 square miles). A total of 32 structures were destroyed, with 21 structures damaged by the fire. The fire was contained on December 20, 2020.

A primary concern for burned watersheds is the increased potential for damaging flood flows, increased potential for debris flow occurrence, rockfall from steep slopes, and hillslope erosion resulting in excessive sedimentation. As winter approaches, it is critical that people who live in and downstream from large wildfires implement emergency protection measures (EPMs) where appropriate, remain alert of weather conditions, and be ready to evacuate if necessary prior to forecasted large and high intensity storms. The fire area and upslope watersheds are also subject to atmospheric river and monsoonal events which can generate localized heavy rainfall and resultant post-fire hazards. Documented fatalities and post-fire debris flows within and adjacent to the Bond Fire burn area indicate a high potential for watershed hazards with and without fire-affected slopes. As such, occupied structures, roadways, and critical infrastructure within and downslope/downstream of the Bond Fire burn area are subject to a potentially catastrophic level of risk.

This report presents the results of a rapid evaluation of post-fire geologic and hydrologic hazards to life-safety and property (i.e., collectively known as "Values-at-Risk") for private lands affected by the 2020 Bond Fire in Orange County, California (Figure 1). Figure 1 shows the acreage and percentage of the burned area by ownership for the fire. Approximately 96 percent of the burned area is in county, private, or non-profit ownership. The Bond Fire WERT arrived on-site December 10, 2020 and left the field on December 13, 2020. A briefing providing the WERTs preliminary findings and VARs was conducted with local emergency response and county agencies on December 15, 2020. Team members for the Bond WERT are listed in Table 1.

Objectives and Scope

This document summarizes downslope/downstream Values-at-Risk (VARs) and makes specific and general recommendations to reduce life-safety and property exposure to post-fire hazards on county and private lands. Other WERT /USGS products associated with this report include GIS data in the form of shapefiles and raster files. Clear communication of life-safety and property hazards is an objective of the WERT process, and the use of these spatial data is a critical component for communicating hazards in a planning and operational context. These data have been shared with federal, state, and local responsible agencies.

 Table 1. Bond Fire WERT members.

Name	Position	Agency	Expertise-Position
Drew Coe; RPF 2981	Team Lead	CAL FIRE	Hydrology/Forestry
John Oswald; PG 7219; CEG 2291	Co-Team Leader	CGS	Engineering Geology
Paul Burgess; PG 9619	Team Member	CGS	Engineering Geology
John Ramaley; RPF 2504	Team Member	CAL FIRE	Forestry
Dave Erickson	Team Member	OCFA	Resource Planning
Adjunct Team			
Pete Roffers; PG 9100; GISP 91498	Adjunct Member	CGS	Geology/GIS
Rachel Beard	Adjunct Member	CGS	GIS
Will Olsen	Adjunct Member	CAL FIRE	Hydrology/GIS
Francesca Rohr	Adjunct Member	CAL FIRE	GIS

Primary objectives for the WERT are to conduct a rapid preliminary assessment to:

- Identify types and locations of on-site and downstream threats to life-safety, property, and critical infrastructure (i.e., Values-at-Risk or VARs) from post-fire flooding, debris flows, rockfall, erosion, and other hazards that are elevated due to post-fire conditions.
- Determine relative risk to these values rapidly, using a combination of state-of-theart analytical tools (e.g., post-fire debris flow likelihood model) and the best professional judgement of licensed geohazard professionals (i.e., Professional Geologists; Certified Engineering Geologists).
- Develop preliminary emergency protection measures needed to avoid or minimize life-safety and property threats.
- Communicate findings to responsible entities and affected parties.

It is important to emphasize that the WERT performs a rapid evaluation of post-fire hazards and risk. A complete characterization of post-fire hazards and/or in-depth design of protection measures is beyond the scope of the WERT evaluation. However, findings from the WERT evaluation can potentially be used to leverage emergency funds for emergency treatment implementation and more detailed site investigation and/or treatment design.



Figure 1. Ownership map of the Bond Fire burned area. Inset table shows acreages and percentages of ownership within the Bond Fire perimeter only. Gray color indicates private land.

2. Physical Setting

Topography and Climate

The Bond Fire burned area is east of the communities of Irvine and Tustin along the northwestern foothills and slopes of the Santa Ana Mountains. The topography within and downstream/downslope of the fire is predominately moderately steep to very steep. Elevations range from approximately 800 feet near Irvine Lake in the western end of the burned area to approximately 2,233 feet on the southeastern end near Harding Canyon. Figure 2 shows the distribution of slope gradients within the burned area, and much of the burned area exceeds 55% slope, particularly in the southeastern portions of the burned area. The burned area is within the Santiago Creek watershed, with portions of the burn area draining tributaries such as Silverado Creek and Williams Canyon.

The Bond Fire burned area has a southern California Mediterranean climate with mild winters and hot, dry summers. Some monsoonal thunderstorms can occur in the summer and fall months which can generate localized heavy rainfall and runoff, although this isn't as common as areas to the east (e.g., Riverside and San Bernardino counties). Precipitation throughout the burned areas occurs almost entirely as rain. Average annual rainfall in the burned area is approximately 17 inches, with a standard deviation of 7.4 inches. Most of the annual precipitation occurs from November through March (OSU PRISM site; <u>http://prism.oregonstate.edu/explorer/</u>). Annual precipitation totals are highly variable from year to year and can be much higher during wet El Niño years.

Data from existing rain gages within and adjacent to the burned area are shown in Table 3. Depth-duration-frequency data from these rain gages show that 15-minute storm intensities for the 1-year recurrence interval (RI) storm range from 1.00 in hr^{-1} to 1.06 in hr^{-1} with an average rainfall intensity of 1.03 in hr^{-1} (Table 3). The average rainfall intensity for the 15-minute duration 2-year storm is 1.32 in hr^{-1} (i.e., approximately 34 mm hr^{-1}). This indicates that relatively intense rainfall is probable during the period of watershed recovery from the wildfire; this recovery period is expected to last several years.



Figure 2. Slope map for the Bond Fire burned areas. Areas over 55 percent slope (i.e., red shading) have a higher likelihood of landsliding and dry ravel.

Table 2. Rainfall intensities (in/hr) by recurrence interval for the 15-minute storm duration. Station data taken from NOAA Atlas 14.

		Rainfall Intensity (in hr ⁻¹) by Recurrence Interval (yrs)			
Location	Station No.	1	2	5	10	25	50	100
Silverado Ranger								
Station	90-0011	1.06	1.36	1.76	2.08	2.51	2.84	3.18
Santiago Dam	04-7987	1.00	1.26	1.62	1.93	2.36	2.71	3.07
Trabuco Canyon	04-8992	1.04	1.34	1.74	2.06	2.50	2.84	3.20
Average (in hr ⁻¹):		1.03	1.32	1.71	2.02	2.46	2.80	3.15
Average (mm hr ⁻¹)		26.2	33.5	43.3	51.4	62.4	71.0	80.0

Hydrology and Flood History

The Bond Fire is primarily drained by Santiago Creek, a large tributary of the Santa Ana River. Unlike the Santa Ana River, Santiago Creek is largely undeveloped, much of its' headwater areas are owned by the federal government within the Cleveland National Forest. Named tributary streams to Santiago Creek within the Bond Fire are Silverado, Harding, and Williams Creeks. Harding Creek drains into Santiago Creek in Modjeska Canyon, whereas Williams and Silverado Creeks intersect Santiago Creek along East Santiago Canyon Road.

Flooding in Orange County proper is well recorded, going back to Great Flood of 1862. Other "Great Flood" events took place in 1916, 1938, 1969, 1998, and 2010 as well as others within the county. The monsoonal nature of storm events in Southern California have resulted in a history where flooding of note occurs on an almost annual basis in Southern California, whether an event is noted as "Great" or otherwise. The events occur as individual "cells" of heavy rain impact discrete areas causing havoc downstream of those downpours. Of note, within the Bond Fire perimeter, the events of 1969 and 2010 are of most importance to this discussion as their impacts on human lives are well documented.

Non-native American Indian settlements within the three primary canyons of concern, Silverado, Williams and Modjeska, largely occurred around the early 1870's. With the exception of the silver boom in the late 1870's-early 1880's in Silverado Canyon, population was fairly low. By 1969 however, the more modern-day population density in the three canyons had appeared, making flood events in these canyons notable in their impact on human lives.

In 1969, after many days of almost continuous rainfall and flooding, a debris flow inundated the Silverado Canyon Fire Station where people were sheltering in place. Five people perished in that event, and the mountain slope behind the station was deemed unstable, so the station was moved westward when reconstructed. That same mountain slope sent boulders through the general store in 2001 and 2005. The 2005 rockfall event took the life of a teenage girl in the upstairs apartment. The store remains closed to this day.

December 2010 saw another deluge hit the areas within the Bond Fire perimeter, causing widespread flooding and debris flows within Silverado, Williams, and Modjeska Canyons. Aerial imagery of the 2010 event shows widespread shallow landsliding and debris flow torrents. The most visible landsliding in 2010 occurred within the 2007 Santiago Fire perimeter, and debris flows were noted within the same fire perimeter in 2008, some of which were triggered during small sized rain events.

The 2014 Silverado Fire, a <1,000 acre fire upstream of the Bond Fire in Silverado Canyon, had multiple debris flows recorded in 2015 during monsoonal rain events. All of this indicates that while the area is highly susceptible to flooding and debris flows in general, fire activity appears to generate a significantly heightened potential for debris flow occurrences. In addition, several storms during 2019 affected portions of the Holy Fire (i.e., southeast of the Bond Fire) and resulted in flooding in portions of Riverside County.

Table 3.	USGS Gauge 11075800 in Modjeska Canyon recorded the 2	2010 and	1969
events as	s the fourth and highest events respectively.		

Date	Streamflow (cfs)
February 9, 1978	1,550
February 18, 1980	1,810
March 5, 1995	2,400
December 22, 2010	3,000
March 2, 1983	3,400
February 23, 1998	6,200
February 25, 1969	6,250

Vegetation and Fire History

The fire has a mix of vegetation types (Figure 3). The lowest elevations have coastal sage scrub, cactus scrub and grasslands. Progressing in elevation, chaparral vegetation types dominate the hillsides and riparian communities are along the main streams. Silverado, Williams, and Modjeska Canyons contain alder, sycamore, willow and cottonwood. The areas along Santiago Creek, after it exits Modjeska Canyon, are open, with very few large trees present, and cactus sage scrub / mixed grasslands being dominant in the riparian areas. The north-south orientation of this portion of Santiago Creek subjects the area to extended sunlight and heat, which may be limiting large tree occupancy. The east-west canyons of Silverado, Williams and Modjeska Canyons provide zones of northerly aspect where riparian vegetation thrives.

Fire history indicates that a large proportion of the Bond Fire footprint within Silverado Canyon has not burned for decades prior to 2020. About half of that unburned area last burned in 1975, and the other half of the area within Silverado Canyon has no recorded fire history (Figure 4). The northern portion of Williams Canyon has a similar fire history to Silverado Canyon, with half of that northern area burning in the 1975 fire, and the other portion with no recorded fire history. The combined area of the Bond Fire footprint that has not burned since at least 1975 is 1,490 acres, and is shown in a clip below with Values-at-Risk indicated. The western portion of the clip below also recorded the most severe soil burn severity of the Bond Fire.

The balance of the Bond Fire footprint has a fairly frequent history of fire activity, with the last large fire in 2007 burning almost the entirety of Modjeska Canyon and the south side of Williams Canyon. The northwestern portions of the Bond Fire have been subjected to much more frequent fire intervals. However, as the area is either in County Parks or otherwise unoccupied, it's direct impact to residents is low, although ingress-egress on East Santiago Canyon Road may be impacted as discussed in other sections of this report. Areas with the least frequent fire occurrence potentially correspond with the highest potential unit area biomass, indicating that sufficient fuels may exist to increase soil burn severity. As discussed above, the western half of the clipped picture suffered the highest degree of soil burn severity.

Aerial imagery indicates that recovery from the 2007 fire was slow, and the December 2010 flood events occurred on the areas burned in 2007 in what appears to be very lightly re-vegetated hillsides, especially on south aspects. The 2019 imagery shows the area located within the Bond Fire perimeter that had burned within the 2007 fire as mostly re-vegetated, with sparser vegetation on the south aspects, and very dense vegetation located in north facing slopes. It should be noted that the southern aspect slopes that burned in 2007 were still much less dense in 2019 imagery than what was present in 2005 imagery, pointing to potentially slower recovery times in the general area. Slower vegetative recovery periods may lengthen the time period from which postfire debris flows and flooding are generated. Also of note, debris flow initiation was prevalent throughout the headwater areas of Silverado and Williams Canyons in the December 2010 storm, even though this area had not burned since at least 1975, providing further evidence of the highly erosive and debris flow prone area included within the Bond Fire.



Figure 3. Wildlife habitat relationships and vegetation for the Bond Fire.



Figure 4. A close-up of the area, shaded in red, within the Bond Fire footprint with either no recorded fire history, or lasted burned in 1975. We posit that watershed response might be higher within this area due to higher fuel loading and potentially increased soil damage.

Geology and Landslides

Regional geologic mapping at 1:100,000 scale by Morton and Miller (2006) and at 1:100,000 scale by Bedrossian and Roffers (2012) indicate the Bond Fire occurred within the northern extent of the California Peninsular Ranges Geomorphic Province (CGS, 2002) and in the Santa Ana Mountains (Figure 5, Geology Map). The Peninsular Ranges Geomorphic Province is a series of northwest trending mountain ranges and valleys with sub-parallel fault structures branching off the San Andreas fault zone. The Peninsular Ranges are oriented parallel to the generally north-south trending California coastline. The Santa Ana Mountains within the burned area expose Jurassic-aged through Tertiary-aged marine and non-marine sedimentary rocks with Cretaceous intrusive and volcanic rocks in upper Williams Canyon.

The bedrock units exposed in the burned area, listed from oldest to youngest, include:

• Jurassic age (201.3 to 145 Ma [mega annum] b.p.[before present]) low grade metamorphic, pre-batholith sedimentary rocks of the Bedford Canyon Formation, comprised of well consolidated, folded and fractured interbedded argillite, graywacke, conglomerate, quartzite and minor limestone.

- Cretaceous age (145 to 66 Ma b.p.) post-batholith, meta-sedimentary of the Trabuco, Williams and Ladd Formations, comprised of consolidated folded and fractured interbedded mudstone, sandstone and conglomerate. Meta-volcanic rocks of the Santiago Peak Volcanics, and a discrete area of intrusive tonalite of the Peninsular Ranges Batholith that extends from upper Williams Canyon to the mouth of White Canyon at Silverado Canyon.
- Tertiary age (66 to 2.58 Ma b.p.) marine and nonmarine sedimentary rocks of the Sespe, Santiago, and Silverado Formations comprised of weakly to moderately consolidated interbedded, siltstone sandstone and conglomerate.
- Quaternary age (2.58 Ma to present) alluvium and colluvium containing unconsolidated silt, sand and gravel.

The Cretaceous rocks crop out in the eastern portion of the burned area and are comprised of interbedded resistant, bluff and steep slope forming, graywacke and conglomerate interbedded with highly fractured, slope forming argillite. The resistant bedrock readily forms bluffs and steeply inclined hillslopes that are often undermined by friable argillite. The steep slopes are prone to rockfall, talus slope formation, and shallow and deep-seated landslide processes. Bedrock is generally highly fractured in outcrops and combined with strong ground shaking generated on nearby active faults; deep-seated rockslides are common (Figure 6, Landslide Map). Bedding planes in the Cretaceous bedrock predominantly dip northeast and southwest and appear more steeply inclined in the eastern portion of the burned area that underlie White, Wildcat, upper Williams, and Harding Canyons. In the eastern portion of the burned area, where geologic strata is steeply dipping in the same direction as the hillslope, slope stability is significantly reduced. This adverse dipslope (dipping out of the slope) condition is a common casual mechanism of landslide initiation during regional landslide inducing precipitation events, strong ground shaking, and/or as a result of land use/development activities. To the west, Cretaceous strata becomes less steeply inclined and instability more commonly occurs on steeply inclined end slopes (anti-dipslope) (Figure 6).

Tertiary marine and nonmarine sedimentary rocks crop out in the western portions of the burned area and are comprised of moderately consolidated layered mudstone, sandstone and conglomerate. The sandstone and conglomerate rocks are generally relatively stable and form bluffs and steep slopes. In a similar fashion to the Cretaceous rocks, the more resistant strata are often undercut by more erosive mudstones creating areas of structurally controlled instability. The Tertiary rocks are predominantly gently to moderately inclined forming low hills with weathered rounded slopes. Debris flows initiating from source areas within the Tertiary rocks commonly contain lower amounts of rocky debris and higher percentage of fine-grained particles.

Recent alluvium and colluvium range from moderately consolidated to unconsolidated. The erosion potential generally increases with lack of consolidation and clay interbeds can be planes of weakness that are conducive to landsliding. Clay soils can also be expansive and form local aquitards that reduce slope stability. Young unconsolidated deposits can be easily eroded and become bed load in flood flows or debris in hyperconcentrated flows. Some recent alluvial deposits contain large boulders up to 2- to 3-feet in diameter. Detailed mapping of young alluvial deposits in the southern and western portion of the area are presented in Bedrossian and Roffers (2012). This mapping showing older and younger alluvial deposits can also be used to help identify areas more prone to flood and debris flow hazards (<u>https://maps.conservation.ca.gov/cgs/gsd/app/</u>).



Figure 5. Geologic map for the Bond Fire.

There is a documented history of landsliding, in addition to flooding, in the burned area and debris flow, rockfall, debris slides, and rockslide processes are clearly active in the region (Table 4, landslide history). Hazards from debris flows and hyperconcentrated flows are present in and downslope of the burned area as evidenced by historical records, alluvial fan landforms and debris flow deposits observed in exposure. Debris flows and hyperconcentrated flows are generally initiated by intense rainfall events common in narrow cold frontal rain bands during the winter and spring, and monsoonal rains that regionally occur in the late summer to early fall season. Deep seated landsliding in the area are more typical during the winter and spring months following wet winter seasons. Post-fire debris flow hazards and non-fire related landslide events are both documented in the burned area.

Year	Date	Location	Rainfall Data	Description
1969	February 25	Silverado Canyon, Modjeska Canyon	Min 0.25 in. hr ⁻¹	Three damaging debris slides. Two in Silverado Canyon and one in Modjeska Canyon. 5 killed and 20 injured by debris flow impact. 60 flood refugees take refuge in Silverado Canyon fire station.
1969	February 26	Santa Ana Mountains	none	One mudslide reported.
2005	February 18-23	Silverado Canyon	6.8" at Fullerton	A landslide sent boulders into a home in Silverado Canyon and killed one.
2008	January 4-7 January 23	Santiago Canyon Silverado Canyon Harding Canyon	Peak 27 mm hr ⁻¹ 15-min	Several debris flows from the Santiago Fire burn area. Commercial structure in Santiago Canyon damaged
2008	April 22	Santiago Burn Area	Heavy rain	Several debris flows occurred. In the Santiago burn area of eastern Orange County, damage was done to homes and businesses.
2008	May 23	Santiago Burn Area	Peak 40 mm hr ⁻¹ 15-min	Debris flows reported from Santiago Fire burned area.
2015	July.18-19	Silverado Canyon	Southern California. Rainfall ranged from 0.5-4"	A debris flow from the Silverado Canyon Fire burned area.
2015	September 15	Silverado Canyon	1-2" of rain common across the entire region.	Debris flow from Silverado Canyon Fire burned area.

Table 4. Landslide History of the Bond Fire burned area.

2016	January 5-7	Silverado Canyon	Three-day	Three debris flows from
	-		rainfall totals	Silverado Canyon Fire burned
			around 2-7" for	area.
			the coast	

Shallow debris slides, rockfall talus slopes, and debris flows are common in the steeply inclined canyons. Ground shaking from nearby active faults is an important process in preparing slopes for landsliding and initiating landslides (Keefer, 1984). These landslide-prone materials can add to the increased erosion and runoff expected because of post-fire soil hydrology changes. There are numerous active earthquake fault systems regionally capable of producing strong earthquakes that cause landslides. Earthquakes and subsequent landsliding during the 3- to 5-year post-fire recovery period can further increase flows by bulking with sediment and debris delivered to the channel networks. The material delivered to streams can in turn be mobilized in debris flow events increasing their magnitude and destructive power.

Soils in the burned area are predominantly comprised of sandy loams (SM to SC (USDA, 2020). The sandy loam soils contain various amounts of large gravel, cobble, and boulder clasts that are dependent on the density and resistance to weathering of the parent material. Soils derived from conglomerates contain well rounded pebbles and cobbles with diameters up to 2 feet. Some rock units such as the harder igneous and meta-sedimentary rocks are well fractured in the burned area and readily produce deposits of large diameter rock material at the base of steep slopes. These deposits can be subsequently mobilized downslope by fluvial and colluvial processes. Large areas of Silverado Canyon, Wildcat Canyon, and White Canyon are mapped as rock outcrop and delineate some of the areas more prone to rockfall processes. Fine-grained soils are formed on large areas of Cretaceous argillite or Tertiary mudstones common in the western portions of the burned area. The fine-grained bedrock produces hyperconcentrated flows that create low gradient landforms resembling flowing concrete slurry.

Hazardous Minerals

Figure 7 shows the locations of potential mineralogical hazards, including existing quarry locations and idle gas and oil wells. No appreciable historic mining operations are identified either within or downstream of the Bond Fire burned area within Silverado Canyon, Williams Canyon, Modjeska Canyon, as well as the other tributary drainages to these canyons. Though Silverado Canyon derives its name from a silver mining boom that initiated in the late 1800s with some mining extending until approximately 1950, the mining sites are located further east of the Bond Fire perimeter. Therefore, these mine locations are not deemed to be at risk for contributing to watershed hazards due to post-fire rainfall within or adjacent to the Bond Fire burned area. During the course of fieldwork for the WERT no mines or mine tailings were observed.



Figure 6. Landslide map for the Bond Fire.

According to mapping by the California Department of Conservation Division of Mine Reclamation, no active sand and/or gravel mining quarries, are located either within or adjacent to the Bond Fire perimeter. One sand and gravel quarry actively being reclaimed is located on the south side of Silverado Creek at its entrance into the eastern end of Lake Irvine. It is the assessment of this WERT that a very low potential of mineral hazards exists either within or adjacent to the Bond Fire perimeter, and that any impacts to drainages from mineral hazards will likely be minimal.

According to the California Department of Conservation, mapping in the area of the Bond Fire burned area does not identify any map-scale hazard due to Naturally Occurring Asbestos (NOA). NOA is typically found in serpentinite bearing rock formations native to plate boundary geologic settings, none of which are located within or adjacent to the Bond Fire burned area.

Based on our review of California Department of Conservation's online well finder, there are two plugged (sealed) oil and/or gas wells mapped downstream of the Bond Fire burned area. One is located on Baker Canyon Road on the north side of Silverado Creek, approximately 60 feet above the active alluvial channel, outside of the mapped FEMA flood zone. The second location is sited north of Silverado Canyon Road, on the floodplain of Silverado Creek. Based on data showing both wells are sealed, it is unlikely that flooding within the Silverado Creek drainage would have an adverse impact to the wells.

No potable drinking or thermal springs were identified by the WERT within or adjacent to the Bond Fire perimeter.

Information regarding the hazardous minerals discussed above can be found at the California Office of Environmental Health Hazard Assessment (<u>https://oehha.ca.gov/chemicals/</u>).

For additional information, see:

http://www.conservation.ca.gov/cgs/geologic_hazards/hazardous_minerals

http://pubs.usgs.gov/fs/2005/3014/

http://www.who.int/mediacentre/factsheets/fs361/en/

For the Department of Conservation's well finder see:

https://www.conservation.ca.gov/calgem/Pages/WellFinder.aspx

For the Department of Conservation's abandoned mines information see:

https://maps.conservation.ca.gov/mol/index.html

General Recommendations for Mine Sites:

Owing to the extreme relief and potential access limitations following significant rain events, it may be difficult to access known mine sites. Additional recommendations are as follows:

- Regularly inspect drainage culverts at road crossings for debris blockage before and after a weather event.
- Regularly monitor and maintain existing levees adjacent to active sand and gravel quarries located along potential high intensity drainages downstream from the Bond Fire boundary.
- Maintain quarry infrastructure adjacent to significant drainages, e.g. Silverado Creek at the site of the reclaimed sand and gravel quarry just east of Lake Irvine.
- Maintain channels free of debris upstream of structures; improve routing of drainage; consult with qualified professionals to review natural drainage and conveyance structures.

Though no mines, active or abandoned were identified during the course of fieldwork by the WERT, if additional field exploration determines the presence of mines within or adjacent to the Bond Fire burn area:

- Manage surficial storm runoff to divert around waste containment ponds, mine tailings and overburden piles, fill caps, and other environmental cleanup infrastructure.
- Consider evacuation of active mine sites prior to a predicted high intensity storm event.
- Expect higher erosion and sedimentation rates, as well as increased runoff from these mining sites. Take appropriate actions to reduce the potential for these processes to further impact infrastructure and the environment.
- Regularly monitor environmental cleanup infrastructure before, during, and after forecasted storm events.



Figure 7. Mineralogical hazards for the Bond Fire.

3. Remote Sensing and Modeling Results

Soil Burn Severity

The Bond Fire burned areas are characterized by a high proportion of moderate and high soil burn severity (Table 5). Within the Bond Fire footprint, sixty two percent of the burn area is composed of moderate (60.3 percent) and high (1.5 percent) soil burn severity, with the remaining 38 percent in low (27.1 percent) or very low/unburned (11 percent) soil burn severity. The preponderance of moderate and high soil burn severity indicates a very high potential for post-fire watershed response. Some of the highest proportions of moderate and high soil burn severity are north of Williams Canyon in unnamed tributary streams that drain directly into Santiago Creek (Figure 8). While the majority of areas that registered as "high" soil burn severity occurred in basins with low, or no, populations downstream, the preponderance of moderate soil burn severity, the over-steepened hillsides and the naturally erosive nature of the geology are expected to potentially generate debris flows throughout the Bond Fire burn area.

Table 5.	Soil burn severity for	the Bond	Fire burned	area.	Burned a	rea is	larger	than
reported a	area for the incident.							

Soil Burn Severity	Acres	Percent of Total Burned Area
Very low/unburned	750	11
Low	1855	27
Moderate	4125	60
High	105	2
Total:	6835	100



Figure 8. Soil burn severity map for the Bond Fire burned area.

Post-Fire Hydrology

History indicates that the area affected by the Bond Fire is subject to periodic flooding in the absence of fire. The WERT has identified VARs at risk of post-fire flood and debris flow hazards, and has communicated the location and relative threat to life and property to local authorities, including Orange County Public Works. Figure 9 and Table 6 show areas where the WERT provides basin metrics to assist in developing pre- and post-fire hydrology estimates for drainage, and estimates the relative post-fire runoff response magnitude based on the extent of soil burn severity within each basin tributary to each VAR. Rather than generate rapid post-fire peak flow predictions which are relatively crude, the WERT suggests using soil burn severity data to calibrate existing hydrologic and hydraulic models to account for increased runoff and increased debris loading at key sites to better estimate post-fire impacts. Kinoshita and others (2014) demonstrate how to modify curve number approaches for post-fire conditions using soil burn severity.



Figure 9. Pour point watersheds assessed for relative post-fire flood potential.

Table 6. Post-fire watershed characteristics of pour-point watersheds. Higher proportions of a watershed with moderate and high soil burn severity will result in a larger flood response. Bulking considerations considers the flow classification used to determine bulking factors.

Watershed	Watershed	Watershed	% Unburned	%	%	%	Relative Post-Fire	Bulking
Name	ID#	Size (ac)	to Very Low	Low	Mod.	High	Flood Response	Consideration
Wildcat Canyon	1	287	4	34	62	0	Mod. to High	Hyperconcentrated+
White Canyon	2	156	5	25	68	3	Mod. to High	Hyperconcentrated+
Silverado Creek	3	12265	94	2	4	0	Low*	Normal streamflow
Williams Canyon	4	1400	32	25	41	1	Moderate	Hyperconcentrated+
Modjeska Canyon								
Tributary	5	115	3	32	64	0	Moderate to High	Hyperconcentrated+

*Flooding may occur at tributary confluences and at bridges directly below tributary confluences if high volumes of debris are transported.

Post-Fire Debris Flow Modeling: Predicted Thresholds and Hazards

The USGS debris flow model is capable of predicting spatially explicit short duration rainfall intensity thresholds as well as a firewide median for modeled basins. Assuming a debris flow probability of 50 percent, the firewide median values for 15, 30, and 60-minute durations for the Bond Fire are: 15-minute: 29 mm hr⁻¹, or 0.3 inches in 15 minutes; 30-minute: 22 mm hr⁻¹, or 0.4 inches in 30 minutes, and; 60-minute: 20 mm hr⁻¹, or 0.8 inches in 60 minutes.

Spatially explicit thresholds indicate that the predicted range in 15-minute duration rainfall intensities at the basin scale range from 16 mm hr⁻¹ to 40 mm hr⁻¹. Figure 10 shows the predicted 15-minute duration rainfall intensities at the basin and segment scale for the Bond Fire. Some of the lowest modeled 15-minute duration thresholds (<24 mm hr⁻¹) are associated with basins and segments draining towards developed portions of Silverado Canyon.

The combined hazard reflects the potential likelihood of a debris flow occurring as well as the volumetric yield of the debris flow (Figure 11). Figures 12 and 13 shows the combined debris flow hazard for the 20 mm hr⁻¹ (0.79 in hr⁻¹) and 32 mm hr⁻¹ (1.26 in hr⁻¹) storms, respectively. The simulations for these storms show a range of debris flow response for the initial early warning NWS threshold storm (i.e., 20 mm hr⁻¹) and a storm just under the 2-year recurrence interval for key portions of the burned area (i.e., 32 mm hr-1). This allows local entities to gauge the sensitivity of debris flow hazards to varying rainfall intensities, and can be an important factor in response planning.

Figures 12 and 13 and indicate that the combined debris flow hazard is moderate to high for areas containing critical VARs at rainfall intensities ranging from 20-32 mm hr⁻¹, with much of the burned area with VARs having a moderate to high combined debris flow hazard at a rainfall rates of 32 mm hr⁻¹. Overall, areas of moderate to high combined hazard are dominated by higher probabilities of initiating debris flows rather than high debris volumes. This is due to the smaller basin areas and relatively low relief in the burned area, which limits volumetric yield within the USGS debris flow model.



Figure 10. Modeled 15-minute duration rainfall intensity thresholds for the Bond Fire. The rainfall intensities shown in the figure have a probability of 50% for triggering a debris flow.

Combined Hazard Classification



Figure 11. A schematic demonstrating how the combined hazard classification factors debris flow probability and predicted debris volume into an overall combined hazard rating.



Figure 12. Combined debris flow hazard on the Bond Fire for the 20 mm hr⁻¹ (0.78 in hr⁻¹) 15-minute storm event.



Figure 13. Combined debris flow hazard on the Bond Fire for the 32 mm hr⁻¹ (1.26 in hr⁻¹) storm.

Post-Fire Sediment Production

The ERMiT model indicates relatively large increases between pre- and post-fire sediment production. Sediment production from the 2-year storm event will increase by more than an order of magnitude (Figure 14), whereas the 10-year storm will increase sediment production by a factor of four (Figure 15). The absolute values predicted by ERMiT correspond well with empirical data collected from the 2007 Santiago Fire (Wohlgemuth et al., 2010), indicating that the model did a reasonably good job of representing post-fire erosion processes.



Figure 14. Bond Fire predicted surface erosion rates for the 2-year storm event using the Erosion Risk Management Tool (ERMiT).



Figure 15. Bond Fire predicted surface erosion rates for the 10-year storm event using the Erosion Risk Management Tool (ERMiT).

Model Accuracy and Uncertainties

We consider the USGS debris flow model to be a relatively accurate predictor of combined debris flow hazards (i.e., probability and magnitude) for the Bond Fire burned areas, as data from the Santa Ana Mountains were used to formulate the debris flow likelihood model. There is some evidence that debris flows may not propagate all the way down some of the larger canyons (e.g. Wildcat, White, and Williams Canyons), and this is because the confinement (i.e., moderately confined) and relatively gentle gradient of the mainstem channels may lead to deposition of a debris flow surge front before it can propagate down the mainstem channels.

4. VAR Observations and Recommendations

Potential Values-at-Risk (VARs) are grouped into areas exposed to risk that are categorized according to the closest watersheds (catchment areas and appurtenant drainages) of which they are part. General observations and recommendations for each of the watersheds are provided below. More detailed observations are provided in the VAR summary table and VAR site information sheets (Appendix B and D). This evaluation is not intended to be
comprehensive and/or conclusive, and additional VARs may be identified through more detailed evaluation by responsible agencies. Several limitations include:

- FEMA, State, Local flood hazard mapping was not complete or non-existent in several areas.
- Not all roadway culverts and bridges in and adjacent to the burn area were evaluated.
- Some potential VARs were not evaluated, or evaluated from a distance, because of the lack of access.
- Hazards on alluvial fans could not be represented as single-points given the potential for avulsion (i.e., rapid channel shifting) and flow-path uncertainty. Alluvial fan VARs are generally presented as polygons or included in FEMA and DWR flood and awareness zones.
- VAR evaluation was not conducted within all mapped flood hazard areas that are downstream of the burn perimeter. Risk of flooding in these areas is preexisting and is anticipated to be increased by post-fire runoff and/or blockage of drainage structures (e.g., culverts and bridges) by post-fire debris. As such, local agencies should consider these mapped hazard areas in addition to the VARs identified in this report.

This report serves as a preliminary tool to assist emergency responding agencies (e.g., Orange County Fire Authority, local fire departments, Caltrans, Orange County's Emergency Management Division, utility companies, and other responsible agencies) in the development of more detailed post-fire emergency response plans and assessments.

It is intended that the responsible agencies will use the information presented in this report as a preliminary guide to complete their own more detailed evaluations and develop detailed emergency response plans and mitigations. These agencies may identify additional VARs through their more detailed evaluations.

General Discussion

Unstable slope conditions are visible within the burned areas upslope of residential and commercial developments, parks, campgrounds, open-space areas, and roadways adjacent to the burned area. Teams observed post-fire dry ravel indicative of shallow soil structure damage from fire and gravitational transport of sediment downslope into channels and canyon side slopes. There are areas of alluvial/colluvial deposits in steep drainages, along the steep canyon headwalls, and on side slopes upstream of the residential, commercial, roadways, parks, campgrounds, and open-space areas. While material observed near many of the canyon outlets near the upslope edge of the communities appeared fine-grained, alluvial deposits of cobble- to boulder-sized rocks are present at the outlets of 1) Wildcat Canyon, 2) White Canyon, 3) Upper Williams Canyon, 4) Harding Canyon, and 5) multiple other smaller drainages that empty into Silverado Canyon. We also observed numerous recent small-scale shallow landslides in steep headwalls and along steep streamside slopes that further confirm active slope instability within the burn area. These landslides also provide material to stream channels during heavy precipitation that can be mobilized by subsequent flood and debris flows. Additionally, it is possible that extensive past mining in the area may have altered hillsides, making them more unstable, and increasing sediment bedload in stream catchments.

Drainages downslope of the Bond Fire burned area are, in locations, modified by development, including roads and drainage structures in the communities of Silverado Canyon, Cabin Land, Williams Canyon, Modjeska Canyon, and portions of Santiago Canyon as well. This section of the report characterizes the VAR observed by hazard, level of hazard and describes hazards and preliminary protective measures.

Summary of Observations

The WERT identified 64 VARs within and adjacent to the Bond Fire perimeter. Table 7 shows the hazards and hazards level call for all VAR identified by the WERT. For description, the VARs are organized by the four main canyons within and downstream of the fire perimeter: 1) Modjeska Canyon, 2) Santiago Canyon, 3) Williams Canyon and 4) Silverado Canyon. The four areas are broken into drainages, listed by hazard type, hazard level. And brief descriptions of observed hazards are presented.

Modjeska Canyon Area

The Modjeska Canyon area is broken in to two sections based on geographic area and potential source of hazards. The two sections are: 1) Harding Canyon, and 2) Modjeska Canyon (Table 8).

Harding Canyon

Harding Canyon, a tributary to Santiago Creek in Modjeska Canyon, is a source of flood, hyperconcentrated flow, and debris flow hazards to residents, property, and infrastructure. Slopes within the burned area upstream of the developed areas are primarily burned at low to moderate SBS. A very small portion of slopes within the Harding Canyon watershed burned upstream of developments at Harding Canyon Road. The small area of steep convergent slopes that did burn have a history of post-fire and storm-induced debris flows that could locally bulk flows in Harding Canyon causing flooding. This area is also upstream of a bridge at BND-2 that has historically been an area of backwater flood flows on to Harding Canyon Road and residences. The magnitude of flood flows experienced in Harding Creek in the past is not expected to be significantly increased by post-fire changes in runoff from the Bond Fire because of the small amount of the Harding Creek watershed upstream of residential development being burned. BND-2 is a residence at the base of a steep convergent catchment that experienced significant debris flow events during the 2010-2011 storm season.

Bond Fire									
	Hazard Call								
VAR		Life-Safety			Property				
type	low	Mod	high	low	mod	high			
Flood 11 VARs	BND-22 BND-23 BND-25 BND-27	BND-1 BND-13 BND-14 BND-24 BND-36 BND-45 BND-58			BND-22 BND-23 BND-27 BND-45	BND-1 BND-13 BND-14 BND- 24 BND-25 BND-36 BND- 58			
Debris Flow 2 VARs	BND-17		BND-2		BND-17	BND-2			
Debris Flow / Flood 41 VARs	BND-3 BND-4 BND-8 BND-9 BND-11 BND-12 BND-18 BND-20 BND-35 BND-52	BND-10 BND-15 BND-16 BND-19 BND-26 BND-28 BND-30 BND-31 BND-32 BND-37 BND-41 BND-42 BND-49 BND-50 BND-51 BND-53 BND-54 BND-55	BND-5 BND-6 BND-7 BND-21 BND-29 BND- 33 BND-39 BND-40 BND- 44 BND-56 BND-57 BND- 61 BND-63	BND-4 BND-8	BND-3 BND-9 BND-12 BND-15 BND-18 BND-19 BND-20 BND-30 BND-31 BND-32 BND-35 BND-37 BND-41 BND-42 BND-44 BND-50 BND-51 BND-52 BND-53 BND-54 BND-55 BND-56	BND-5 BND-6 BND-7 BND-10 BND-11 BND- 16 BND-21 BND-26 BND- 28 BND-29 BND-33 BND- 39 BND-40 BND-49 BND- 57 BND-61 BND-63			
Rockfall 10 VARs		BND-34 BND-38 BND-48 BND-62 BND-64	BND-43 BND- 46BND-47 BND-59 BND- 60		BND-34 BND-43 BND-62 BND-64	BND-38 BND- 46 BND-47 BND-48 BND- 59 BND-60			
Total	15	30	19	2	31	31			

Table 7. VAR hazard calls by Process for the Bond Fire. Total number of VARs is 64.

Modjeska Canyon

Tributary catchments flowing south into Santiago Creek in Modjeska Canyon downstream of Harding Canyon, are a source of flood, hyperconcentrated flow, and debris flow hazards to residents, property, and infrastructure. Slopes within the burned area upstream of the developed areas are primarily burned at low to moderate SBS. Many residences along this section of the Modjeska Canyon area described flooding, hyperconcentrated flows and debris flows from previous storms.

Table 8. Drainages, VAR, and Hazards Modjeska Canyon Area. VAR in **bold** are municipal water infrastructure.

Drainage	Associated VAR	Descriptions
Harding Canyon	BND-1 BND-2 BND-3 BND-4	 Small area of burned steep raveling slopes upstream of developments is a potential source of local bulked flood flows impacting residences and improvements (BND-1) Area of burned steep slopes upslope of residences (BND-2, BND-3, BND-4) with a history of instability. Coarse diameter cobbles and boulders in creek bed. History of flooding at bridge to BND-2.
Tributaries to Modjeska Canyon	BND-5 BND-6 BND-7 BND-8 BND-9 BND-10 BND-11	 Two large tributary canyons deliver to alluvial landform with residential subdivision. History of debris flows and flooding (BND-5). Alluvial fan landform at mouth of two catchments source of flood and debris flow hazards and has history of damage to road access and residences (BND-5). Small, steep unmodeled catchments and steep slopes leading to residential structures along Modjeska Canyon Road. Some coarse-grained sediment sources available but majority of flows appear largely fine-grained. Water storage/treatment facility with constructed protection measures designed for debris and flood.

Some of the residences closest to Modjeska Creek and Harding Creek are mapped in the FEMA 100-year flood zone. The residences in the FEMA flood zone are not mapped as VARs because the small watershed area upstream of the residences in Modjeska and Harding Canyon that was burned is not expected to significantly increase runoff. Localized flooding could occur as a result of increased runoff from burned catchments draining to Santiago Creek.

Summary of the Modjeska Canyon Area

A total of 11 VARs are in Modjeska Canyon area that encompass individual structures and municipal water infrastructure. Generally, all the VARs observed within the Modjeska Canyon area are considered a low to high risk to public safety, or a moderate to high risk to property. VAR BND-2 in Harding Canyon is considered at high risk to life and property. There are two VARs identified as "consider evacuation" in the Modjeska Canyon area (Table 9).

Table 9. VAR preliminary measures by hazard level for the Modjeska Canyon Area. VAR may have multiple measures.

	Modjeska Canyon								
VAR		VAR Hazard Call							
Preliminary		Life-Safety	,		Property				
Measures	low	mod	high	low	mod	high			
Early Warning	BND-3	BND-1	BND-2		BND-3	BND-1 BND-2			
Deflection Structure	BND-3	BND-1			BND-3	BND-1			
Sand Bags	BND-4			BND-4					
Evacuate		BND-1	BND-2			BND-1 BND-2			

Recommendations Modjeska Canyon Area

- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider evacuation of residences in polygon BND-1 and BND-2 during predicted high magnitude flood flow events and predicted debris flow events from NWS/Orange County Emergency Management Division (OCEMD).
- Cleanout and monitor culverts and drainage structures prior to and during large rain events where they cross residential streets.
- Perform storm infrastructure monitoring along access roads, including but not limited to Modjeska Canyon Road and Harding Canyon Road
- Perform storm monitoring of bridge crossings on Harding Canyon Road and Modjeska Canyon Road.
- Consider installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences when high flood flows and debris flows are predicted along drainages.
- Consider installing stormwater control structures including sand bags, concrete Krails, and berms to contain flow in Harding Canyon to the active channel in case of crossing failure at VAR BND-2.
- Ensure residents are aware of flood hazards and how to get flood early warning information.
- Provide Williams Canyon residents and local utility agencies with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in hydrology, geotechnical engineering, soil erosion, and engineering geology.

• Consider evacuation of residences in polygon BND-1 and BND-2 during predicted high magnitude flood flow events and predicted debris flow events from NWS/OCEMD.

Santiago Canyon Area

This area includes the area draining to Santiago Creek downstream of Modjeska Canyon. Tributaries to Santiago Canyon are a source of flood, hyperconcentrated flow, and debris flow hazards to residents, property, and infrastructure (Table 10). Slopes within the burned area upstream of the developed areas are primarily burned at moderate SBS with low SBS mapped in the lower elevations of canyons and draws. Some scattered high SBS is mapped upstream of VAR at BND-13, BND-14 and BND-15.

A very small proportion of the upstream drainage area within this portion of the Santiago Creek watershed burned in the Bond Fire. Several tributaries to Santiago Creek that are within the Bond Fire and Silverado Fire burned areas that did burn have a history of post-fire and storm-induced debris flows that could locally bulk flows in Santiago Canyon causing localized impacts to Santiago Canyon Road. The magnitude of flood flows experienced on Santiago Creek is not expected to be significantly increased by post-fire changes in runoff because of the relatively small burned watershed area upstream of residential developments.

Drainage	Associated VAR	Descriptions
Tributaries to Santiago Creek	BND-12 BND-13 BND-14 BND-15	 Hazards to residential and commercial properties at the mouths of tributaries to Santiago Creek. Predominantly flood hazards to VAR at the lower end of large catchments with debris flow hazards noted at VAR BND-12, BND-14 and BND-15. Largely fine-grained deposits observed with potential for coarse flood deposits at BND-13. Potential for some localized flooding along Santiago Canyon Road where large burned catchments intersect road and drainage structures could be overwhelmed by debris input from burned area.

Table 10. Drainages, VAR, and Hazards Santiago Canyon Area.

Summary of the Santiago Canyon Area

A total of 4 VARs are in the Santiago Canyon area that encompass individual structures and commercial properties. Generally, all the VARs observed within the Santiago Canyon Area are considered a moderate risk to public safety, or a moderate to high risk to property (Table 11).

Santiago Canyon										
VAR		VAR Hazard Call								
Preliminary		Life-Safety		Property						
Measures low mod high low					mod	high				
Early Warning	BND-12	BND-13 BND-14 BND-15			BND-12 BND-15	BND-13 BND-14				
Deflection Structure		BND-13 BND-15			BND-15	BND-13				
Clear channel or structure	BND-12	BND-15			BND-12 BND-15					

Table 11. VAR preliminary measures by hazard level. VAR may have multiple measures.

Recommendations Santiago Canyon Area

- Utilize existing early warning systems, linked to up-to-date storm information.
- Cleanout and monitor culverts and drainage structures prior to and during large rain events where they cross residential streets.
- Perform storm infrastructure monitoring along Santiago Canyon Road.
- Consider installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences when high flood flows and debris flows are predicted along drainages.
- Ensure residents are aware of hazards and how to get hazard early warning information.
- Provide Santiago Canyon Area residents and local utility agencies with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Consider the applicability of constructing diversion structures where debris and flood flow channels may adversely impact residential development or restrict residential access roads where flooding is anticipated during predicted high intensity rain events. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in hydrology, geotechnical engineering, soil erosion, and engineering geology.

Williams Canyon Area

The Williams Canyon area is broken in to two sections for description (Table 12). Williams Canyon and Tributaries to Williams Canyon are a source of flood, rockfall, hyperconcentrated flow, and debris flow hazards to residents, property, and infrastructure. Slopes within the burned area upstream of the developed areas are primarily burned at moderate SBS with low

SBS mapped in the lower elevations of canyons and draws. Some isolated high SBS is mapped.

Drainage	Associated VAR	Descriptions
Williams Canyon Creek	BND-22 BND-23 BND-24 BND-25 BND-27 BND-29	 Potential source of bulked flood flows and hyperconcentrated flows impacting residential and commercial values. Numerous private bridge and culvert crossings of Williams Canyon Creek with potential for plugging and local backwater flooding along access roads and residences. Engineered channel at BND-23 and BND-24 has degraded levees and potential for flooding. Increased flooding for historically affected, low lying residences that could be exacerbated by debris and increased flow from side canyons.
Tributaries to Williams Canyon	BND-16 BND-17 BND-18 BND-19 BND-20 BND-21 BND-26 BND-28	 Potential source of bulked flood flows and debris flows impacting residences and private roads. Small unmodeled catchments are potential sources of rockfall, debris flow, hyperconcentrated flow, and flooding to downstream residential properties and access roads.

Table 12.	Drainages.	VAR.	and Hazards	within	Williams	Canvon /	Area.
	Dramagoo,	v/,	ana nazarao	****	v v manio	Curryon /	nou.

Williams Canyon Creek

The WERT identified VARs subject to postfire flood and debris flows hazards within the Williams Canyon area. The potential for elevated post-fire flood flows increase downstream within Williams Canyon because the upper watershed was not burned but several tributaries to Williams Canyon were burned at a moderate SBS.

The access road through Williams Canyon is private and not maintained by the County and is in need of maintenance prior to winter storms to reduce the potential for flooding and impacts to access and downstream residences.

The upper 73 percent of the Williams Canyon watershed is burned. The magnitude of flood flows and the potential flood hazard in the upper portions of Williams Canyon is expected to be increased due to the relatively large proportion of area burned upstream of residential developments. There is expected to be relatively significant increased runoff and bulked flood flows in lower Williams Canyon (downstream of VAR BND-27) where all the tributaries have been burned at low to moderate SBS with isolated areas of high SBS.

Tributaries Williams Canyon

Several tributaries to the lower Williams Canyon are within burned areas that have a history of post-fire and storm induced flooding and debris flows that could locally bulk flows in lower Williams Canyon and cause impacts to roads in Williams Canyon Road and downstream residences. Dry ravel is commonly filling channels and swales in the steep slopes surrounding the tributaries and side slope to Williams Canyon. Large amounts of dry ravel were observed in an unnamed canyon at VAR BND-16 and BND-17 which suggests post-fire runoff could carry

large amounts of fine-grained material to bulk flood flows in the tributary canyons and Williams Creek.

Summary of the Williams Canyon Area

The WERT identified a total of 14 VARs in Williams Canyon area that encompass residential structures, improvements, and road infrastructure. Generally, most of the VARs observed within the Williams Canyon area are considered a low to moderate risk to public safety, or a moderate to high risk to property. Two VARs, BND-21 and BND-29, are identified a high risk to life from debris flow and flood hazards (Table 13).

Williams Canyon Area							
VAR			VAR Haz	zard Call			
Preliminar		Life-Safety			Proper	ty	
y Measures	low	mod	high	low	mod	high	
Early Warning	BND-17 BND-18 BND-20 BND-23 BND-27	BND-16 BND-19 BND-24 BND-26 BND-28	BND-21 BND-29		BND-17 BND- 18 BND-19 BND-20 BND- 23 BND-27	BND-16 BND-21 BND-24 BND-26 BND-28 BND-29	
Maintain Structure	BND-23 BND-27	BND-24 BND-26			BND-23 BND- 27	BND-24 BND-26	
Deflection Structure	BND-17 BND-18 BND-20 BND-22 BND-25	BND-19 BND-26 BND-28	BND-21 BND-29		BND-17 BND- 18 BND-19 BND-20 BND- 22	BND-21 BND-25 BND-26 BND-28 BND-29	
Signage	BND-27				BND-27		
Evacuate	BND-25	BND-16 BND-19 BND-28	BND-21 BND-29		BND-19	BND-16 BND-21 BND-25 BND-28 BND-29	

Table 13. VAR preliminary measures by hazard level. VAR may have multiple measures.

Recommendations for Williams Canyon Area

- Cleanout and monitor culverts and drainage structures prior to and during large rain events where they cross residential streets.
- Perform storm infrastructure monitoring along access roads and bridges.
- Consider closure of access to open space areas prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated flows, debris flows, and/or floods.
- Consider installing stormwater control structures, including sand bags and/or concrete K-rails, along stream banks and around residences and infrastructure when high flood flows and debris flows are predicted along drainages.

- Utilize existing early warning systems, linked to up-to-date storm information.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report.
- Ensure residents are aware of hazards and how to get hazard early warning information.
- Provide Williams Canyon residents and local utility agencies with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.
- Consider evacuation of residences in polygon BND-16, BND-19, BND-21, BND-25, BND-28, and BND-29 during predicted high magnitude flood flow events and predicted debris flow events from NWS/OCEMD.

Silverado Canyon Area

The Silverado Canyon area is broken in to five sections based on geographic area and potential source of hazards (Tables 14 and 15). The five sections are: 1) upper Silverado Canyon, 2) lower Silverado Canyon, 3) Wildcat Canyon, 4) White Canyon, and 5) Cabin Land. Upper Silverado Canyon extends from just east of the village of Silverado (28652 Silverado Canyon Road) to just east of the Silverado Canyon Fire Station (29502 Silverado Canyon Road).

Upper Silverado Canyon

Upper Silverado Canyon is a source of potential rockfall, flood, and hyperconcentrated flow hazards to residents, property, and infrastructure (Table 14). Slopes within the burned area upstream of the developed areas are primarily burned at low to moderate SBS, with locally found high SBS areas. North-facing slopes on the south side of Upper Silverado Canyon are particularly at risk for rockfall and debris flows, with documented fatalities occurring in 1969 and in 2005. In the vicinity of BND-54 and BND-55, a hyperconcentrated flow emanated from the north-flowing unnamed drainage upstream of both VARs in December 2010 and inundated a home on Sleepy Hollow Road up to its eaves. This property is currently unoccupied according to local residents.

The WERT observed numerous potential flooding hazards in Upper Silverado Canyon, adjacent to Silverado Creek and also rockfall hazards below north-facing canyon slopes on the south side of Silverado Canyon Road. BND-46, -47, -48, -59, and -60 represent values at particular risk for rockfall hazard, with BND-59 and -60 being sites of known fatalities due to rockfall (BND-60, in 2005) and/or a combination of shallow landsliding, debris flow, and rockfall (BND-59, in 1969). Areas adjacent to and within the Silverado Creek floodplain may be at risk for flood related hazards such as backwatering to debris blocking flow paths, for example if drainage infrastructures such as culverts are blocked (BND-50, BND-51, and BND-52).

Lower Silverado Canyon

In Lower Silverado Canyon, informally designated by the WERT as the downstream reach of the canyon west of Cabin Land, the hazards identified are south of Silverado Creek and adjacent to drainages flowing to the north from south-ascending hills that were burned primarily

with a mix of moderate and high SBS. As such, hyperconcentrated flow and flooding hazards were identified to impact structures and property in BND-30, BND-31, BND-32, and BND-33.

Wildcat Canyon

Slopes bounding the north-draining Wildcat Canyon face east and west. The west-facing slopes in Wildcat Canyon represent a significant risk for rockfall given a preexisting history of rockfall in the area. The Wildcat Canyon drainage represents a significant risk for multiple hazards based on field observations and documented anecdotal evidence provided by local residents. The primary hazard risks present in Wildcat Canyon are debris flow, hyperconcentrated flow, sediment-laden flow, and flooding. Each of these hazards occurred in variable reaches of Wildcat Canyon in 2010 and are well documented through the local oral history that was obtained in the field, and verified via collection and viewing of online video footage posted by local canyon residents. The hazards for Silverado Canyon and Wildcat Canyon are documented in Table 14.

The WERT observed large diameter sediment (boulder +) in recent deposits in the upper reach of Wildcat Canyon, stretching from the south end of BND-57 up the drainage, including adjacent to BND-61, and within BND-62 and -63. Downstream of BND-57 predominantly boulder-sized and finer-grained deposits are found and appear to have been entrained in flood flows, including deposits identified by local residents and attributed to flooding that occurred as recently as 2010. The source of the large diameter material for the upper reach of Wildcat Canyon may be due to erosion of existing material in old alluvial fan deposits within the canyon. However, there is also abundant evidence that some of the cobble and boulder size deposits in the canyon may have the potential to block flow at the bridge over Sleepy Hollow, causing localized flooding adjacent to Silverado Creek (VAR BND-58). During our fieldwork, some members of the WERT witnessed dry-ravel/rockfall occurring on the north-facing slopes above BND-59 and -60 as well as on the west-facing slope above the central area of BND-57.

Table 14. Drainages, VARs, and Hazards within the Upper Silverado Canyon, Lower Silverado Canyon, and Wildcat Canyon areas.

Drainage	Associated VAR	Descriptions
Upper Silverado Canyon	BND-46 BND-47 BND-48 BND-49 BND-50 BND-51 BND-52 BND-53 BND-54 BND-55 BND-56 BND-59 BND-60	 Potential source of bulked flood flows and hyperconcentrated flows impacting residential, commercial, and municipal values. Historical rockfall west of BND-46, and recorded historical rockfall fatalities at BND-59 and BND-60. Documented hyperconcentrated flow covering home up to eaves at 29141 Sleepy Hollow, within the BND-54 and BND-55 VARs, during 2010.
Lower Silverado Canyon	BND-30 BND-31 BND-32 BND-33	 Calvary Chapel of the Canyons church and auxiliary buildings at risk for hyperconcentrated flow and flooding hazards at BND-30 & -31. Historic hyperconcentrated flow hazard at BND 32 according to local resident. BND-33 has hazard for hyperconcentrated flow and potential inundation of home sited in flow path at outlet of north-flowing drainage. Also space available for deflection structures to be installed between channel and home.
Wildcat Canyon	BND-57 BND-58 BND-61 BND-62 BND-63	 Potential source of bulked flood flows, hyperconcentrated flows impacting residential, municipal, and utility values. Potential for debris flow in Upper Wildcat Canyon to impact values within BND-57, -61, -62, & -63 based on observed deposits in channel, terrace deposits, and reported local oral history. High likelihood of rockfall hazard at BND-61 from west-facing ascending slope behind home. Historical flooding throughout entirety of BND-57. Flow from Wildcat Canyon will impact values surrounding outlet of Wildcat Canyon into Silverado Canyon, within BND-57 and BND-58, with numerous values at risk for backwatering and flooding due to debris blockage in the Silverado Creek floodplain.

White Canyon and Cabin Land Areas

The areas of White Canyon and Cabin Land are located within and immediately downslope of the Bond Fire burn area. These areas contain numerous and varied potential hazards from rockfall, flood, and hyperconcentrated flow hazards to residents, property, and infrastructure (Table 15). Slopes within the burned area upstream of the developed areas are primarily burned at low to moderate SBS, with locally found high SBS areas. Northeast-facing slopes on the west side of the mouth of White Canyon (above Cabin Land), as well as west-facing slopes on the east side of White Canyon are particularly at risk for rockfall.

The primary hazard risks present in White Canyon are localized debris flow in the upper reach of the canyon that may transition to hyperconcentrated flows, sediment-laden flows, and

flooding in the downstream reach of the canyon. The hazards for White Canyon and Cabin Land are documented in Table 15.

Drainage	Associated VAR	Descriptions				
White Canyon	BND-36 BND-39 BND-40 BND-41 BND-42 BND-43 BND-44 BND-45 BND-64	 Potential source of bulked flood flows and hyperconcentrated flows impacting residential, commercial, and municipal values. BND-39 features a home sited directly in the White Canyon drainage flow path. Historical rockfall west of BND-46, and recorded historical rockfall fatalites at BND-59 and BND-60. Potential backwatering and flooding adjacent to Silverado Creek if inundation from White Canyon plugs drainage infrastructure with debris, affecting ingress/egress to Cabin Land. 				
Cabin Land	BND-34 BND-35 BND-37 BND-38	Potential rockfall hazard at BND-34 and BND-38. Historic hyperconcentrated flow according to reported le oral history at BND-35. Historic flooding and hyperconcentrated flow according reported local oral history at VAR within BND-37.				

Table 15. Drainages, VAR, and Hazards within the White Canyon and Cabin Land areas.

The WERT observed numerous potential flooding hazards in White Canyon and Cabin Land. Of special note is the pattern of local population density and property locations, many of which are situated in flow paths without adequate or safe drainage infrastructure for protection. BND-39 is a VAR that typifies this hazard, where a home (28362 Water Way) is situated directly in the flow path of the White Canyon drainage. Where BND-39 covers the junction between White Canyon and Silverado Creek the WERT observed a higher concentration of half meter to meter scale boulders in the Silverado Creek channel that likely represent deposition from natural debris flow and alluvial fan processes that characterize the geomorphic signature of outflow from White Canyon. Debris from White Canyon may have the potential to block flow at the bridge over Kitterman Drive, causing localized flooding adjacent to Silverado Creek (VAR BND-36).

Similarly to BND-39, BND-37 in Cabin Land is directly in the flow path from drainage directed from the intersections of Shady Drive and Bond Way to the south of BND-37. BND-37 is also opposite the site of a former structure that was destroyed due to historic flooding according to local residents. Additionally, a home in BND-40 is in the floodplain of White Canyon, on the eastern side of the drainage just south of the outflow of the White Canyon alluvial fan into Silverado Creek.

The WERT observed abundant rockfall hazard in BND-34 and BND-38. At the northern end of BND-35, a local resident pointed out a quarter-meter diameter boulder adjacent to the

intersection of Thisa Way and Bytha Way, stating that it had been deposited during 2010 flooding in the area. In that regard, BND-35 is a dynamic VAR that contains risk from rockfall, hyperconcentrated flow, and flooding that can impact ingress and egress to several properties along Thisa Way.

Summary of the Silverado Canyon Area

There are 35 VARs in the Upper Silverado Canyon, Lower Silverado Canyon, Wildcat Canyon, White Canyon and Cabin Land areas that include residential areas, roadways, and infrastructure, including drainage infrastructure. Generally, VARs were considered to be a moderate to high risk to public safety, or a moderate to high risk to property. Two VARs have documented fatalities associated with them (BND-59 and BND-60), and four VARs (BND-37, - 54, -55, -57) have historic documentation of significant debris flow, hyperconcentrated flow, and flooding activity. Table 16 lists VARs in the Silverado Canyon area by hazard level call and preliminary protective measures.

Table 16. VAR preliminary measures by hazard level for Upper Silverado Canyon, Lower Silverado Canyon, Wildcat Canyon, White Canyon and Cabin Land areas. VARs may have multiple measures.

Upper Silverado Canyon, Lower Silverado Canyon, Wildcat Canyon, White Canyon, and Cabin Land Areas									
VAR		VAR Hazard Call							
Prelimin		Life-Safety			Property				
ary Measure s	low	mod	High	low	mod	high			
Early Warning	BND-35	BND-32 BND-34 BND-36 BND-37 BND-38 BND-41 BND-42 BND-45 BND-48 BND-51 BND-53 BND-58 BND-62 BND-64	BND-39 BND- 40 BND-43 BND-44 BND- 46 BND-47 BND-57 BND- 59 BND-60 BND-61 BND- 63		BND-32 BND-34 BND-35 BND-37 BND-41 BND-42 BND-43 BND-44 BND-45 BND-46 BND-51 BND-53 BND-62 BND-64	BND-36 BND- 38 BND-39 BND-40 BND- 47 BND-48 BND-57 BND- 58 BND-59 BND-60 BND- 61 BND-63			
Deflection Structure / Debris Barrier / Sand bags		BND-49 BND-55	BND-33 BND- 56		BND-55	BND-33 BND- 49 BND-56			

Clear and Maintain Structure	BND-52	BND-30 BND-31 BND-50 BND-54		BND-30 BND-31 BND-50 BND-52 BND-54	
Evacuate		BND-30 BND-31 BND-48 BND-49 BND-53 BND-54 BND-55 BND-58 BND-62 BND-64	BND-33 BND- 39 BND-40 BND-43 BND- 44 BND-46 BND-47 BND- 56 BND-57 BND-59 BND- 60 BND-61 BND-63	BND-30 BND-31 BND-43 BND-44 BND-46 BND-53 BND-54 BND-55 BND-62 BND-64	BND-33BND- 39 BND-40 BND-47 BND- 48 BND-49 BND-56 BND- 57 BND-58 BND-59 BND- 60 BND-61 BND-63

Recommendations for Upper Silverado Canyon, Lower Silverado Canyon, Wildcat Canyon, White Canyon and Cabin Land Areas

- Utilize existing early warning systems linked to up-to-date storm information.
- Cleanout and monitor bridges, culverts, basins, and drainage structures prior to and during large rain events where they cross residential streets. Undersized bridges proximal to debris producing drainages (e.g., Wildcat and White Canyons) have the potential to become plugged and cause localized flooding (VARs BND-36 and BND-58).
- Perform storm infrastructure maintenance along public, commercial, and (private) residential roads downstream of the fire area along and adjacent to Silverado Creek, Wildcat Canyon, and White Canyon.
- Monitor areas downslope of the burned area during storm events, including but not limited to residential developments in Cabin Land south of Silverado Canyon Road, and especially adjacent to Anderson Way, Grundy Lane, Water Way, Bond Way, Sullivan Lane, Shady Drive, Thisa Way, and Hidea Way and other areas subject to increased risks of rockfall and inundation by flood flows.
- Evaluate the potential for installing stormwater control and deflection structures, including sand bags and/or concrete K-rails, along stream banks and around residences when high flood flows and debris flows are predicted.
- Consider closure of public parks, campgrounds, and open space areas prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to hyperconcentrated flows, debris flows, and/or floods and other public parks located within identified flood zones by FEMA and DWR.
- Consider the use of appropriate professionals to review and design additional engineered mitigations not provided in this report
- Consider the applicability of constructing diversion structures and/or temporary debris basins where debris and flood flow channels may adversely impact residential development or restrict residential access roads during predicted high flows. For

instance, there is potential to construct a debris basin in White Canyon at the end of Anderson Way. Site specific mitigations and containment and diversion structures should be designed by licensed professionals specializing in hydrology, geotechnical engineering, soil erosion, and engineering geology.

- Provide Upper and Lower Silverado Canyon, Wildcat Canyon, White Canyon, and Cabin Land burned area subregion residents, public facility operators, and businesses with this VAR information so they may understand their proximity to hazard areas and take appropriate actions.
- Ensure residents are aware of hazards and how to get hazard early warning information.
- Evaluate the adequacy of uncompacted, native earth levees along stream channels at risk of flooding.

5. General Recommendations

Early Warning Systems

Existing early warning systems should be used and improved such that residents can be alerted to incoming storms, allowing enough time to safely vacate hazard areas. In areas where cellular reception is poor or non-existent, methods should be developed to effectively contact residents. For example, installation of temporary mobile cellular towers should be considered. Additionally, responsible agencies should conduct an outreach campaign to encourage residents and business to sign up for early warning systems. Early warning systems for the Bond Fire should take advantage of the following services:

National Weather Service Forecasting

Flash flood and debris flow warnings with practical lead times of several hours must come from a combination of weather forecasts, rainfall measurements of approaching storms, and knowledge of triggering thresholds. The following information is from the National Weather Service (NWS); they provide flash flood and post-fire debris flow "watch" and "warning" notifications in burn areas:

The NWS provides 24/7 information on watches, warnings and advisories for California. For additional information, see:

NWS – San Diego Forecast Office: https://www.weather.gov/sgx/

NWS - Post-wildfire flash flood and debris flow guide

http://www.wrh.noaa.gov/lox/hydrology/files/DebrisFlowSurvivalGuide.pdf

Augmenting Existing Rain Gauge Networks

The WERT suggests that Orange County and the NWS discuss the need to augment existing rain gauge networks to increase the efficacy of early warning systems. Initial discussions with Alex Tardy (NWS) suggest that an additional rain gauge in Silverado Canyon would improve the ability to respond to rainfall events. Also, an additional gauge in Limestone Canyon Park would also improve gauging capability.

Refinement of Rainfall Thresholds

The WERT, NWS, and the USGS have purposefully prescribed a conservative initial rainfall threshold for the Bond Fire burned area. This initial threshold may be found to be too conservative if storm rainfall intensities at or above the prescribed threshold result in little to no watershed response. For this reason, the WERT suggests that Orange County implement a formalized monitoring programs where response is monitored and related to rain gauge data and weather radar imagery. Rain gauge data is critical for testing the effectiveness of the initial thresholds in predicting damaging levels of watershed response. Weather radar imagery can be used to look at the relative variability in rainfall intensity, how it relates to specific rain gauge data, and how it relates to observed watershed response.

Alert OC (Orange County)

AlertOC is a mass notification system designed to keep Orange County, California residents and businesses informed of emergencies that may require immediate life saving actions.

https://member.everbridge.net/453003085613900/login

Wireless Emergency Alerts (WEA)

WEA is an alert system originated by the NWS that can inform residents and businesses of flash flood warnings and other potential hazards. WEA alerts are emergency messages sent by authorized government alerting authorities through mobile carriers. Government partners include local and state public safety agencies, FEMA, the FCC, the Department of Homeland Security, and the National Weather Service. No signup is required, and alerts are automatically sent to WEA-capable phones during an emergency. Residents and businesses interested in this function must turn on the emergency alert setting for their phone.

https://www.weather.gov/wrn/wea

Emergency Alert System (EAS)

EAS is a national public warning system that may also be used by state and local authorities to delivery important emergency information, such as weather information, to targeted specific areas.

https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warningsystem/public/emergency-alert-system

Integrated Public Alert and Warning System (IPAWS)

IPAWs is a FEMA-originated system that integrates federal, state, and local emergency warning systems (e.g., WEA, EAS) into a single interface.

https://www.fema.gov/integrated-public-alert-warning-system

Education for Residents and General Public

First and foremost, it is critical that residents heed evacuation warnings from local officials. In the absence of an official notice, residents should pay attention to evolving conditions around their homes.

Suzanne Perry, disaster scientist from the USGS, suggests the following:

- Be ready for debris flows for 2-5 years after a wildfire. Don't worry about every storm, as it takes more intense rain (typically about ½ inch per hour like being in a thunderstorm) on a recently burned slope to trigger a debris flow.
- Follow all evacuation orders. Debris flows can destroy everything in their path.
- Pay attention to official weather forecasts. The National Weather Service will issue a Flash Flood "Watch" or "Warning" for your area when rainfall is anticipated to be intense. Also and this is important the rain back in the mountains can be different than where you are. It's the rain in the mountains that will start the debris flow.
- Don't rely on what you've seen in past floods and debris flows. Debris flows and floods can hit new areas or return to previous areas; they might be smaller or larger the next time. Whatever happened before, the next time could be different.
- If you must shelter in place, choose your spot in advance and stay alert. Find the highest point nearby (such as a 2nd story or roof) and be ready to get there with a moment's notice. Listen and watch for rushing water, mud, unusual sounds. Survivors describe sounds of cracking, breaking, roaring, or a freight train.
- Never underestimate a debris flow. Unlike other landslides, debris flows can start in places they've never been before. They can leave stream channels and plow through neighborhoods. When a debris flow is small, people can control it with walls, K-rails, and sandbags. When a debris flow is big enough, nothing can stop it.
- Expect other flood dangers. Storms that can cause debris flows can also cause more common flooding dangers.
- Turn Around, Don't Drown! Rever drive, walk, or bicycle through a flooded road or path. Even a few inches of water can hide currents that can sweep you away. Also, the water level can rise before you finish crossing.

For an easy to understand summary of what a debris flow is see Geology.com, <u>What is a Debris</u> <u>Flow</u>.

Increased Flood Flows, Erosion and Sedimentation

First responders and Emergency Planning personnel should work in conjunction with Orange County Public Works to coordinate response planning for increased flood flows following the Bond Fire. Post-fire flood inundation mapping should be performed for areas downstream of the burn scar, and should be used as the basis for response planning and potential evacuations. All areas downstream/downslope of the burned areas will potentially be subject to nuisance flooding and sedimentation at the minimum.

Debris Flow Runout

No tools are currently available to rapidly predict post-fire debris flow runout. WERT geologists rely partially on geomorphic evidence to estimate the downstream extent of debris flow inundation. However, many of the at-risk sites are within built environments where geomorphic evidence has been altered or destroyed through grading and/or construction. Also, geomorphic evidence may not be sufficient to predict the downstream extent of debris flows under these post-fire conditions. In areas below larger, severely burned drainages (e.g., Wildcat and White Canyons), the areal extent of debris flow inundation is highly uncertain. The WERT strongly recommends more detailed analysis to further refine the identification downstream debris flow inundation areas.

Increased Rockfall

Numerous rockfall hazards were identified during field evaluations, and areas within the Bond Fire have a history of damaging and/or fatal rockfalls. However, due to the rapid nature of the evaluation, a fully comprehensive evaluation of rockfall hazard was not possible. DeGraff and Gallegos (2012) provide an overview of rockfall hazard following wildfire, along with suggested approaches for identifying these hazards. The WERT strongly recommends more detailed analysis to further refine the identification of rockfall hazard areas.

Road Drainage Systems, Storm Monitoring, and Storm Maintenance

The residential communities within and downstream of the burn area are serviced via a network of roads and highways. Caltrans, Orange County Public Works, and unincorporated communities within and downstream of the burn area. Due to the preponderance of moderate soil burn severity, increased flows on slopes and onto the road system and into storm drain systems can be expected. Loose and erodible soils that mantle the slopes could wash down, inundate, and plug these drainage systems. Flows could be diverted down roads and cause erosion and possible blockage, and/or loss of portions of the road infrastructure and structures along roads. The WERT did not evaluate the potential for rockfall, sedimentation, flooding, or debris flow hazards at all roads or watercourse crossings along federal, state, county, or municipal road corridors. Existing road drainage systems should be inspected by the appropriate controlling agency to evaluate potential impacts from floods, hyperconcentrated floods, debris torrents, debris flows and sedimentation resulting from storm events. Spatial data generated by the USGS and the WERT (e.g., USGS debris flow model, ERMiT model, and flood flow predictions) can be used to screen potential at-risk areas for increased monitoring and maintenance presence.

Storm Drains

Storm drains in and around the built environment will be subject to increased flooding, sediment, and debris. In addition, flooding below debris flow prone areas is difficult, if not impossible to predict. It was beyond the scope of this evaluation to examine every storm drain. The WERT recommends further evaluation of the storm drain systems so that they are free to drain and appropriate protective measures are put into place.

Signage

Place temporary signage in areas of potential post-fire rockfall and flooding hazards. Place signage along roads, bridges, and other types of crossings identified at risk of flooding, rockfalls and debris flows. The WERT suggests responsible agencies consider installing gates, warning signs, or other measures to alert and keep people out of areas of identified risk.

Parks, Campgrounds, and Open Space

Responsible entities should consider closure of public parks, picnic areas, campgrounds, and open space areas prior to and during predicted intense storms located within flood-prone areas, and at the base of steep canyons and steep side slopes that may be subject to rockfall, hyperconcentrated flows, debris flows, and/or floods. At a minimum these facilities should be evaluated in more detail with these hazards in mind.

6. Acknowledgements

The WERT wishes to thank the United States Geological Survey, the National Weather Service, Orange County Fire Authority, Orange County Public Works, Orange County Sheriff's Emergency Management Division, and residents affected by the Bond Fire in assisting with our evaluation.

7. References

Bedrossian, T.L., and Roffers, P.D., 2012, Geologic Compilation of Quaternary Surficial Deposits in Southern California Santa Ana 30' X 60' Quadrangle: California Geological Survey Special Report 217, Plate 16, scale 1:100,000.

Kinoshita, A.M., Hogue, T.S. and Napper, C., 2014. Evaluating pre-and post-fire peak discharge predictions across western US watersheds. JAWRA Journal of the American Water Resources Association, 50(6), pp.1540-1557.

Morton, D.M., and Miller, F.K., 2006, Geologic map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California: U.S. Geological Survey, Open-File Report OF-2006-1217, scale 1:100,000.

Morton, Douglas M., Alvarez, Rachel M., Campbell, Russell H., Digital preparation by Bovard, Kelly R., Brown, D. T., Corriea, K. M., Lesser, J. N., 2003, Preliminary Soil-Slip Susceptibility Maps, Southwestern California: U. S. Geological Survey Open-File Report 03-17, 14 pp., *http://pubs.usgs.gov/of/2003/0017/*.

Wohlgemuth, P.M., Beyers, J.L. and Robichaud, P.R., 2010. The effectiveness of aerial hydromulch as a post-fire erosion control treatment in southern California. In In: Proceedings of the Joint Federal Interagency Conference, 9th Federal Interagency Sedimentation Conference and 4th Federal Interagency Hydrologic Modeling Conference, June 27-July 1, 2010, Las Vegas, NV.

	BOND Ir	cident WERT Contact	t List	
Name	Agency	Position	Phone Number	Email
WERT TEAM Members				
Nochella Funes	CAL FIRE	Liason	(916)-531-7402	nochella.funes@fire.ca.gov
Drew Coe	CALFIRE	Lead	(916)-217-4764	drew.coe@calfire.ca.gov
John Ramaley	CALFIRE	Forester	(530)-941-7179	john.ramaley@calfire.ca.gov
John Oswald	CGS	Co-Lead/Field Geologist	(707)-599-0429	john.oswald@conservation.ca.gov
Paul Burgess	CGS	Field Geologist	(213)-598-0642	paul.burgess@conservation.ca.gov
Pete Roffers	CGS	Remote-GIS	(916)-995-7518	pete.roffers@conservation.ca.gov
Rachel Beard	CGS	Remote-GIS	(916)-323-9276	rachel.beard@conservation.ca.gov
Dave Erickson	OCFA	OCFA Field Rep	(949)-447-0549	daviderickson@ocfa.org
Cooperators				
Kevin McArthur	Orange County Sheriff	County EOC Contact	(714)-612-6710	kmcarthur@ocsd.org
		OC Public Works Main	(714)-647-3939 office	-
Kevin Onuma	OC Public Works	Contact	(714)-277-9741 cell	kevin.onuma@ocpw.ocgov.com
Penny Lew	OC Public Works	Flood Control	(714)-647-3990	penny.lew@ocpw.ocgov.com
Eric Smalstig	Geosyntec (OC Public Works)		(714)-465-1219	esmalstig@geosyntec.com
Tracy Knapp	USFS		(619)-599-5683	
Chris Lorenzi	OC Parks		(714)-425-3498	christopher.lorenzi@ocparks.com
Alex Tardy	Forecast Meteorologist		(858)-442-6016	alexander.tardy@noaa.gov
Agency Contacts				
David Frickson	OCFA	Pre-Fire		daviderickson@ocfa.org
Ron Roberts	OCFA	Division Chief - Bond IC		ronroberts@ocfa.org
Jennifer Bower	OCFA			ienniferbower@ocfa.org
Baryic Hunter	OCFA BAT 4	Division Chief - Division 4		baryichunter@ocfa.org
Phil Johnson	OCFA	Division Chief - ECC		philjohnson@ocfa.org
Gregg Bratcher	RRU Unit Forester			gregg.bratcher@fire.ca.gov
Rick Carr	CSR Resource Management Staff Chief			rick.carr@fire.ca.gov
Glen Barley	Assistant Southern Region Chief			glenn.barley@fire.ca.gov
Bill Weiser	RRU Unit Chief			bill.weiser@fire.ca.gov
Eric Huff	CAL FIRE Sac HQ Staff Chief			eric.huff@fire.ca.gov

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-01	Modjeska Canyon			House and outbuildings on low surface adjacent stream, small burn area upstream. Local bulking from burned steep raveling slopes upstream of residences could deposit and bulk flows and cause avulsion.	flood	House and improvements	moderate	high	Early Warning, Deflection structure
BND-02	Modjeska Canyon	-117.626	33.712836	House downslope of steep bluffs with history of debris flow, slides and rockfall. Property not accessed.	debris flow	Residence	high	high	Early Warning, Consider evacuating in predicted heavy rains. Rockfall hazards as well
BND-03	Modjeska Canyon	-117.627	33.711235	House in potential flow path from unmodeled catchment.	debris flow / flood	Residence	low	moderate	Early Warning, Deflection structure
BND-04	Modjeska Canyon	-117.629	33.708988	Residence downslope of unmodeled catchment. Based on location of house and outbuildings to channel mouth it appears to be nuisance flooding issue.	debris flow / flood	Outbuildings	low	low	Sandbags
BND-05	Modjeska Canyon			Residences on alluvial fan at mouth of two modeled high debris flow hazard catchments. Several small unmodeled catchments deliver to western end of fan complex. History of flows down Mark Road and eastern drainage impacting houses on Markuson Road.	debris flow / flood	Residences	high	high	Early Warning, Deflection structure
BND-06	Modjeska Canyon			Houses at mouth of high debris flow potential modeled catchment.	debris flow / flood	House	high	high	Early Warning, Deflection structure

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-07	Modjeska Canyon	-117.638	33.709847	House in flow path of small catchment. History of debris and burned area mitigations in place.	debris flow / flood	House	high	high	Early Warning, Consider evacuating in predicted high flows
BND-08	Modjeska Canyon	-117.64	33.710355	House in potential flow path of unmodeled catchment with history of debris flow flooding. Rail at Modjeska Canyon reduces potential as well as ditch across street.	debris flow / flood	Residence	low	low	Early Warning, Sandbags
BND-09	Modjeska Canyon			Houses in potential flow path of high modeled debris flow catchment.	debris flow / flood	Residences and improvements.	low	moderate	Early Warning, Deflection structure
BND-10	Modjeska Canyon			House in flow path of unmodeled catchment. Berming at driveway suggests prior issues.	debris flow / flood	Residences and improvements	moderate	high	Early Warning, Deflection structure
BND-11	Modjeska Canyon	-117.642	33.714204	Water treatment facility in flow path of unmodeled catchment. Newer debris wall shows recognition of potential hazards.	debris flow / flood	Water treatment infrastructure	low	high	Monitor and maintain
BND-12	Santiago Canyon	-117.647	33.712892	Livestock coup and equipment in channel. Resident stated "No flow "ever" observed in channel" but blocked culvert upstream appears to pond flow and infiltrate.	debris flow / flood	Outbuildings and livestock.	low	moderate	Early Warning, Remove items of value from channel before potential heavy flows.
BND-13	Santiago Canyon			Houses and business structures in floodplain. History of flooding and debris in barn and around house.	flood	Residence and commercial structures.	moderate	high	Early Warning, Deflection structure
BND-14	Santiago Canyon			House on low surface adjacent to flow path.	debris flow / flood	Residences and improvements.	moderate	high	Early Warning, Deflection structure

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-15	Santiago Canyon	-117.65	33.731359	Partially clogged culvert with potential to divert flow onto road and into commercial nursery downslope. Catchment modeled high debris flow hazard.	debris flow / flood	Access road and commercial structures.	moderate	moderate	Clear and maintain culvert, Early Warning, Deflection structure
BND-16	Williams Canyon			Residence and outbuilding in flow path / channel.	debris flow / flood	House and improvements.	moderate	high	Early Warning
BND-17	Williams Canyon	-117.644	33.729732	House below small unmodeled catchment with lots of dry ravel filling channel.	debris flow	Yard improvements and house.	low	moderate	Early Warning, Potential to increase height of existing retaining wall.
BND-18	Williams Canyon	-117.641	33.728183	House at mouth of small unmodeled catchment. History of mudflow onto driveway.	debris flow / flood	Residence and improvements.	low	moderate	Early Warning, Deflection structure, Existing deflection structures need to be rebuilt from last fire in 2014.
BND-19	Williams Canyon	-117.633	33.727416	House in flow path. High debris flow hazard downstream.	debris flow / flood	Residence.	moderate	moderate	Early Warning, Deflection structure, Consider evacuation in predicted high flows.

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-20	Williams Canyon	-117.633	33.729024	House on low surface adjacent to creek and at mouth of high debris flow modeled catchment. Impacted by debris flows in 2008. Some mitigations put in.	debris flow / flood	Residence.	low	moderate	Early Warning, Deflection structure, Potential for k-rail or muscle wall structure across driveway.
BND-21	Williams Canyon	-117.633	33.730685	Residence and improvements on low surface adjacent creek modeled with high debris flow potential.	debris flow / flood	Residence	high	high	Early Warning, Deflection structure, Consider evacuating in predicted debris flow events.
BND-22	Williams Canyon	-117.632	33.729618	Pool and improvements on low surface adjacent to creek.	flood	Pool.	low	moderate	Deflection structure
BND-23	Williams Canyon	-117.63	33.729647	Storage buildings on protected floodplain with low spot on upstream end of levee.	flood	Residences and improvements.	low	moderate	Early Warning, Maintain levee
BND-24	Williams Canyon	-117.629	33.729646	House on low surface in path of possibly engineered, diverted channel.	flood	Residence and improvements.	moderate	high	Early Warning, Have engineer evaluate and maintain levee to appropriate height.

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-25	Willams Canyon	-117.629	33.731361	Storage building on low surface adjacent to channel. Deflection wall in place before fire.	flood	Building.	low	high	Deflection structure, Replace fire damaged muscle wall components. Do not occupy during high predicted high flow events.
BND-26	Williams Canyon	-117.628	33.730582	House in flow path of unmodeled catchment. Diversion ditch directs flow away from structure. Channel needs deepening at bend to diversion ditch.	debris flow / flood	House.	moderate	high	Early Warning, Deflection structure, Maintain diversion ditch.
BND-27	Williams Canyon	-117.629	33.730238	Undersized partially clogged culvert.	flood	Homes and Improvements downstream.	low	moderate	Early Warning, Clear and maintain culvert, Signage
BND-28	Williams Canyon	-117.627	33.729861	House in flow path of unmodeled catchment. Old sand bag deflection wall upstream of house.	debris flow / flood	Residence/prop erty.	moderate	high	Early Warning, Deflection structure, Rebuild deflection structure. Evaluate size and strength with engineer. Consider evacuating in predicted debris flow events.
BND-29	Williams Canyon			Residences on flood plain adjacent to channel with history of flooding. Downslope of steep unmodeled catchments with history of flows and flooding.	debris flow / flood	House and improvements.	high	high	Early Warning, Deflection structure

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-30	Silverado Canyon			Mud and debris and flooding potential risk to rear of church auxiliary building. Window facing drainage on west rear side needs to be hardened and drainage channel needs to be cleared of existing debris and storage materials. Sandbag west- side entrance.		Church buildings and driveways.	moderate	moderate	Clear and maintain culvert, Deflection structure, Sandbags, Early Warning
BND-31	Silverado Canyon			Drainage channel may be overtopped with debris, mud, and hyperconcentrated flow. Drainage channel is aimed at corner of church auxiliary building.	debris flow / flood	Auxiliary building and church.	moderate	moderate	Clear and maintain culvert, Monitor and maintain, Sandbags, Early Warning
BND-32	Silverado Canyon			Nuisance mud with history of mud and debris on the road way, according to report from local resident	debris flow / flood	Roadways, infrastructure.	moderate	moderate	Early Warning, Deflection structure, Debris barrier, Monitor and maintain
BND-33	Silverado Canyon			Flooding and debris flow.	debris flow / flood	Home.	high	high	Deflection structure, Monitor and maintain, Debris barrier, Early Warning,
BND-34	Silverado Canyon			Rockfall from north-facing slopes.	rock fall	Homes, roadways, infrastructure.	moderate	moderate	Early Warning, Debris barrier, Deflection structure
BND-35	Silverado Canyon			Flooding and debris flow capable of damaging roadway and homes. Boulder in roadway at bottom of hill on west side of intersection between Thisa Way and Thata Way deposited in 2010 storm according to anecdote from local resident.	debris flow / flood	Homes.	low	moderate	Early Warning, Sandbags, Deflection structure, Monitor and maintain

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-36	Silverado Canyon			Debris from White Canyon may reduce capacity of Silverado Creek, resulting in backwatering and flooding of structures and infrastructure in floodplain. Debris may also reduce flow capacity of bridge at Kitterman Drive, causing backwatering and flooding.	flood	Homes and infrastructure in floodplain	moderate	high	Early Warning, Monitor and maintain, Sandbags
BND-37	Silverado Canyon			Debris and flooding.	debris flow / flood	Homes, roadways, infrastructure.	moderate	moderate	Early Warning, Monitor and maintain, Sandbags, Debris barrier
BND-38	Silverado Canyon			Rockfall and debris flow.	rock fall	Homes, roadways, infrastructure.	moderate	high	Early Warning, Debris barrier, Deflection structure, Monitor and maintain
BND-39	Silverado Canyon			Flooding and debris flow.	debris flow / flood	Homes, roadways, infrastructure.	high	high	Early Warning, Monitor and maintain, Clear and maintain culvert, Deflection structure
BND-40	Silverado Canyon			Homes in the active floodplain.	debris flow / flood	Homes, roadways, infrastructure.	high	high	Early Warning, Clear and maintain culvert, Deflection structure, Debris barrier

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-41	Silverado Canyon			Roadway flooding.	debris flow / flood	Road crossings.	moderate	moderate	Early Warning, Clear and maintain culvert, Deflection structure, Sandbags
BND-42	Silverado Canyon	-117.636	33.74443	Flood and/or debris flow affecting lower story and garage of house.	debris flow / flood	Side of Home.	moderate	moderate	Early Warning, Monitor and maintain, Clear and maintain small bridge to convey flow.
BND-43	Silverado Canyon	-117.635	33.743962	Rockfall above home. Existing retaining wall will provide some help against rocks traversing the channel which is aimed at the driveway. Slope above home has some existing chain-link debris fences adjacent to steep drainage aimed at retaining wall and driveway of home; however, more adequate debris- catching mitigation could be installed.	rock fall	Home, infrastructure, roadway.	high	moderate	Early Warning, Monitor and maintain, Debris barrier, Consider Evacuation.
BND-44	Silverado Canyon	-117.635	33.74352	House sited between creek and hillside. The house faces risk from above and below	debris flow / flood	Rockfall and debris flow/flooding.	high	moderate	Early Warning, Monitor and maintain, Debris barrier, Sandbags, Consider Evacuation.
BND-45	Silverado Canyon	-117.636	33.744435	Flooding on roadway will impact lower level of home. Additional possible risk from slope erosion and rockfall above home.	flood	Lower portion of home.	moderate	moderate	Early Warning, Sandbags, Clear and maintain culvert, Monitor and maintain

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-46	Silverado Canyon			Rockfall, mud, debris originating from steep ascending north- facing slope to rear of several homes adjacent to roadway.	rock fall	Homes, roadway, infrastructure.	high	high	Early Warning, Monitor and maintain, Debris barrier, Deflection structure
BND-47	Silverado Canyon				rock fall	Homes and roadways.	high	high	Early Warning, Monitor and maintain
BND-48	Silverado Canyon			Rockfall.	rock fall	Homes, roadways, infrastructure.	moderate	high	Early Warning, Deflection structure, Debris barrier, Monitor and maintain
BND-49	Silverado Canyon			Debris flow and flood hazard. Seasonal waterfall present according to homeowner. Rear yard channel is partially filled with dry ravel debris currently.	debris flow / flood	Home(s), roadways, infrastructure.	moderate	high	Debris barrier, Clear and maintain culvert, Early Warning, Monitor and maintain
BND-50	Silverado Canyon	-117.627	33.746158	Potential blocked culvert will impact BND-49 house on north side of road.	debris flow / flood	Double Culvert could be blocked.	moderate	moderate	Clear and maintain culvert, Early Warning, Sandbags, Monitor and maintain
BND-51	Silverado Canyon			Mud and flood potential. Bedrock channel adjacent to driveway. According to resident, water traverses the roadway and flows east.	debris flow / flood	Roadway, infrastructures.	moderate	moderate	Early Warning, Monitor and maintain, Sandbags

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-52	Silverado Canyon	-117.627	33.746538	Potential damage to outbuildings on either side of the stream channel. Culvert between is at risk of blockage.	debris flow / flood	Outbuildings and infrastructure.	low	moderate	Clear and maintain culvert, Monitor and maintain, Early Warning, Deflection structure
BND-53	Silverado Canyon			Moderate modeled debris flow hazard including flood damage to homes on both sides of drainage adjacent to roadway. High velocity flow possible.	debris flow / flood	Homes, infrastucture, roadways.	moderate	moderate	Early Warning, Monitor and maintain
BND-54	Silverado Canyon			Culverts require cleaning and maintenance to prevent impact to houses.	debris flow / flood	Homes, roadway, infrastructure.	moderate	moderate	Clear and maintain culvert, Monitor and maintain, Debris barrier, Sandbags
BND-55	Silverado Canyon			Landslide activity visible in the hillsides east of roadway/dirt track. Area has history of mud and flood with half-meter scale boulders and debris, especially following 2010 fire.	debris flow / flood	Homes, roadways, infrastructure.	moderate	moderate	Deflection structure, Debris barrier, Early Warning, Clear and maintain culvert
BND-56	Silverado Canyon			Upstream burned basin pours out on top of house and roadway below. New home is being built directly in the channel/flow path.	debris flow / flood	Homes and roadway.	high	high	Early Warning, Debris barrier, Deflection structure, Monitor and maintain
BND-57	Silverado Canyon			High debris flow and flood hazard. High danger to life. Hyperconcentated flow, debris-heavy, is possible based on historic anecdotal evidence provided by local residents.	debris flow / flood	Homes, roadway, infrastructure.	high	high	Early Warning, Clear and maintain culvert, Deflection structure, Debris barrier

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-58	Silverado Canyon			Debris from Wildcat Canyon may reduce channel capacity in Silverado Creek at the tributary junction or at road crossing at Sleepy Hollow Drive. Debris blockage may cause backwatering with resultant flooding to structures in the Silverado Creek floodplain	flood	Houses and stream crossings	moderate	high	Early Warning, Monitor and maintain, Sandbags
BND-59	Silverado Canyon	-117.618	33.746248	History of rockfall caused destruction of old fire station in 1969. A debris barrier wall appears to have been constructed on the rear slope. This entire north-facing slope is one massive hazard.	rock fall	Fire station, homes, roadway.	high	high	Early Warning, Debris barrier, Deflection structure, Traffic control, Consider Evacuation
BND-60	Silverado Canyon			Hillside oversteepened and site of previous fatality at Old Shadybrook Country Store. Ascending north-facing slope requires additional analysis of hazard.		Homes, roadways, infrastructure.	high	high	Early Warning, Monitor and maintain, Debris barrier, Deflection structure
BND-61	Silverado Canyon			Oversteepened channel behind home extends upwards into a chute channeling rockfall. Existing debris flow deposits uphill of home. Resident described previous flooding on north and south sides of home.	debris flow / flood	Home	high	high	Early Warning, Deflection structure, Debris barrier
BND-62	Silverado Canyon	-117.619	33.74309	Trailer pad below steep slope.	rock fall	Trailer pad with temporary housing.	moderate	moderate	Early Warning, Monitor and maintain, Deflection structure, Consider Evacuation. Presently occupied trailer pad at risk without proper mitigation

Site	Community / Local area	Latitude	Longitude	Potential hazard / Field observation	Hazard Category	Specific at-risk feature	Potential hazard to life	Potential hazard to property	Preliminary EMP
BND-63	Silverado Canyon			Debris flow hazard, stream flooding and hillslope failure hazard.	debris flow / flood	Trailer pads, roadway creek crossings.	high	high	Early Warning, Debris barrier, Clear and maintain culvert, Deflection structure
BND-64	White Canyon			Outbuildings and property are located at the base of a small but steep catchment. There is a risk for rockfall at this location. Additional ingress/egress problems if White Canyon creek inundates drainage structures at Anderson Road.	rock fall	Outbuildings and property.	moderate	moderate	Early Warning, Debris barrier, Deflection structure

General Recommendations (see dicussion in report)

- 1 Communicate the risks associated with post-fire debris flows and flooding to residents and the general public
- 2 Utilize early warning systems to warn residents of hazards
- 3 Close parks/trails during predicted intense storms
- 4 Monitor and maintain drainage and storm water control infrastructure
- 5 Place signage and stage equipent on public roads that may be impacted by flooding and/or debris flows



00010. 1.10,000



1358 ft

1313 ft

Canyon

Saniago Canyon Ra

Eastern Fransportation Correct

COMA RIDGE

1322 ft









Segment Combined Hazard	Basin Combined Hazard	USGS Watchstre	eam
15 min 32 mm/hr	15 min 32 mm/hr	FEMA/DV Floodplai	/VR n
Moderate	Moderate	Fire	
— High	High	Perimeter	rs
	N	files Scale: 1	:12,0

Scale: 1:12,000






Scale: 1:12,000

FEMA/DWR

Fire Perimeters





Scale: 1:12,000

USGS

Fire

Watchstream

FEMA/DWR

Perimeters















_1768 ft

P

Limestone Canyon Regional Park

1654 ft

1692 ft

1597 ft

Value at Risk Values at Risk Segment **Basin Combined** USGS Incident: (Polygon) Watchstream (Point) **Combined Hazard** CA-ORC-136890 Bond Fire Hazard Potential hazard to Potential hazard to 15 min 32 mm/hr 15 min 32 mm/hr FEMA/DWR life life 🗹 Floodplain 3 Low Low 😣 Low Low 4 (8 Moderate Moderate Fire Perimeters Moderate Moderate – High High Date Saved: 12/17/2020 3:17 PM High igh 🗱 0.25 0.5 **__** Miles Scale: 1:12,000



SINKS

1485 ft









Shere and a second seco	HARDING CANYON
E CLAY KAND	
CALER LEON RUNYE	20111000
NAN BERTHER LAN	
WARDS ALLEND	
	VIAFFEED
	read for
2939 ft	KK DAS
	Maller
RANKICK	NE I A CARA
J JI TE THANK	3438 ft
	NON PAR
SANTIA CO	A the star
ANTON	AND AND AND



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-11

Feature: Water treatment infrastructure

Feature Category: utilities

Field Observation Water treatment facility in flow path of unmodeled catchment. Newer debris *or Potential Hazard:* wall shows recognition of potential hazards.

Potential Hazard to Life: low

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Monitor and maintain

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Santiago Canyon

Site Number: BND-12

Feature: Outbuildings and livestock.

Feature Category: other

Field Observation Livestock coup and equipment in channel. Resident stated "No flow "ever" *or Potential Hazard:* observed in channel" but blocked culvert upstream appears to pond flow and infiltrate.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Remove items of value from channel before potential heavy flows.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Santiago Canyon

Site Number: BND-15

Feature: Access road and commercial structures.

Feature Category: drainage structure

Field Observation Partially clogged culvert with potential to divert flow onto road and into *or Potential Hazard:* commercial nursery downslope. Catchment modeled high debris flow hazard.

 Potential Hazard to Life: moderate
 Potential Hazard to Property: moderate

 Preliminary Emergency Protective Measures (1):
 Clear and maintain culvert

 Preliminary Emergency Protective Measures (2):
 Early Warning

 Preliminary Emergency Protective Measures (3):
 Deflection structure

 Preliminary Emergency Protective Measures (4):
 NA

 Description:
 NA



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-17

Feature: Yard improvements and house.

Feature Category: home

Field Observation House below small unmodeled catchment with lots of dry ravel filling channel. *or Potential Hazard:*

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Potential to increase height of existing retaining wall.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-18

Feature: Residence and improvements.

Feature Category: home

Field Observation House at mouth of small unmodeled catchment. History of mudflow onto *or Potential Hazard:* driveway.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Existing deflection structures need to be rebuilt from last fire in 2014.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-19

Feature: Residence.

Feature Category: home

Field Observation House in flow path. High debris flow hazard downstream. *or Potential Hazard:*

 Potential Hazard to Life: moderate
 Potential Hazard to Property: moderate

 Preliminary Emergency Protective Measures (1): Early Warning

 Preliminary Emergency Protective Measures (2): Deflection structure

 Preliminary Emergency Protective Measures (3): NA

 Preliminary Emergency Protective Measures (4): NA

 Description: Consider evacuation in predicted high flows.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-2

Feature: Residence

Feature Category: home

Field Observation House downslope of steep bluffs with history of debris flow, slides and rockfall. *or Potential Hazard:* Property not accessed.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuating in predicted heavy rains. Rockfall hazards as well



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-20

Feature: Residence.

Feature Category: home

Field Observation House on low surface adjacent to creek and at mouth of high debris flow *or Potential Hazard:* modeled catchment. Impacted by debris flows in 2008. Some mitigations put in.

 Potential Hazard to Life:
 Iow
 Potential Hazard to Property: moderate

 Preliminary Emergency Protective Measures (1):
 Early Warning

 Preliminary Emergency Protective Measures (2):
 Deflection structure

 Preliminary Emergency Protective Measures (3):
 NA

 Preliminary Emergency Protective Measures (4):
 NA

 Description:
 Potential for k-rail or muscle wall structure across driveway.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-21

Feature: Residence

Feature Category: home

Field Observation Residence and improvements on low surface adjacent creek modeled with high *or Potential Hazard:* debris flow potential.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuating in predicted debris flow events.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-22

Feature: Pool.

Feature Category: recreational

Field Observation Pool and improvements on low surface adjacent to creek. *or Potential Hazard:*

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Deflection structure

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-23

Feature: Residences and improvements.

Feature Category: multiple

Field Observation Storage buildings on protected floodplain with low spot on upstream end of *or Potential Hazard:* levee.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Maintain levee



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-24

Feature: Residence and improvements.

Feature Category: home

Field Observation House on low surface in path of possibly engineered, diverted channel. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Have engineer evaluate and maintain levee to appropriate height.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Willams Canyon

Site Number: BND-25

Feature: Building.

Feature Category: other

Field Observation Storage building on low surface adjacent to channel. Deflection wall in place *or Potential Hazard:* before fire.

Potential Hazard to Life: low

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Deflection structure

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Replace fire damaged muscle wall components. Do not occupy during high predicted high flow events.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-26

Feature: House.

Feature Category: home

Field Observation House in flow path of unmodeled catchment. Diversion ditch directs flow away *or Potential Hazard:* from structure. Channel needs deepening at bend to diversion ditch.

 Potential Hazard to Life: moderate
 Potential Hazard to Property: high

 Preliminary Emergency Protective Measures (1): Early Warning

 Preliminary Emergency Protective Measures (2): Deflection structure

 Preliminary Emergency Protective Measures (3): NA

 Preliminary Emergency Protective Measures (4): NA

 Description: Maintain diversion ditch.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-27

Feature: Homes and Improvements downstream.

Feature Category: drainage structure

Field Observation Undersized partially clogged culvert. *or Potential Hazard:*

 Potential Hazard to Life:
 Iow
 Potential Hazard to Property:
 moderate

 Preliminary Emergency Protective Measures (1):
 Early Warning

 Preliminary Emergency Protective Measures (2):
 Clear and maintain culvert

 Preliminary Emergency Protective Measures (3):
 Signage

 Preliminary Emergency Protective Measures (4):
 NA

 Description:
 NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-28

Feature: Residence/property.

Feature Category: home

Field Observation House in flow path of unmodeled catchment. Old sand bag deflection wall *or Potential Hazard:* upstream of house.

Potential Hazard to Life:moderatePotential Hazard to Property:highPreliminary Emergency Protective Measures (1):Early WarningPreliminary Emergency Protective Measures (2):Deflection structurePreliminary Emergency Protective Measures (3):NAPreliminary Emergency Protective Measures (4):NADescription:Rebuild deflection structure. Evaluate size and strength with engineer. Consider evacuating in

predicted debris flow events.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-3

Feature: Residence

Feature Category: home

Field Observation House in potential flow path from unmodeled catchment. *or Potential Hazard:*

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-4

Feature: Outbuildings

Feature Category: home

Field Observation Residence downslope of unmodeled catchment. Based on location of house *or Potential Hazard:* and outbuildings to channel mouth it appears to be nuisance flooding issue.

Potential Hazard to Life: low

Potential Hazard to Property: **low**

Preliminary Emergency Protective Measures (1): Sandbags

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-42

Feature: Side of Home.

Feature Category: home

Field Observation Flood and/or debris flow affecting lower story and garage of house. *or Potential Hazard:*

 Potential Hazard to Life: moderate
 Potential Hazard to Property: moderate

 Preliminary Emergency Protective Measures (1): Early Warning

 Preliminary Emergency Protective Measures (2): Monitor and maintain

 Preliminary Emergency Protective Measures (3): NA

 Preliminary Emergency Protective Measures (4): NA

 Description: Clear and maintain small bridge to convey flow.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-43

Feature: Home, infrastructure, roadway.

Feature Category: home

Field Observation Rockfall above home. Existing retaining wall will provide some help against *or Potential Hazard:* rocks traversing the channel which is aimed at the driveway.

Potential Hazard to Life: high

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation. Slope above home has some existing chain-link debris fences adjacent to steep drainage aimed at retaining wall and driveway of home; however, more adequate debris-catching mitigation could be installed.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-44

Feature: Rockfall and debris flow/flooding.

Feature Category: home

Field Observation House sited between creek and hillside. *or Potential Hazard:*

Potential Hazard to Life: high

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Sandbags

Description: Consider Evacuation. The house faces risk from above and below.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-45

Feature: Lower portion of home.

Feature Category: home

Field Observation Flooding on roadway will impact lower level of home. Additional possible risk *or Potential Hazard:* from slope erosion and rockfall above home.

 Potential Hazard to Life: moderate
 Potential Hazard to Property: moderate

 Preliminary Emergency Protective Measures (1): Early Warning

 Preliminary Emergency Protective Measures (2): Sandbags

 Preliminary Emergency Protective Measures (3): Clear and maintain culvert

 Preliminary Emergency Protective Measures (4): Monitor and maintain

 Description: NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-50

Feature: Double Culvert could be blocked.

Feature Category: drainage structure

Field Observation Potential blocked culvert will impact BND-49 house on north side of road. *or Potential Hazard:*

Potential Hazard to Life:moderatePotential Hazard to Property:moderatePreliminary Emergency Protective Measures (1):Clear and maintain culvertPreliminary Emergency Protective Measures (2):Early WarningPreliminary Emergency Protective Measures (3):SandbagsPreliminary Emergency Protective Measures (4):Monitor and maintainDescription:NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-52

Feature: Outbuildings and infrastructure.

Feature Category: drainage structure

Field Observation Potential damage to outbuildings on either side of the stream channel. Culvert *or Potential Hazard:* between is at risk of blockage.

 Potential Hazard to Life:
 Iow
 Potential Hazard to Property:
 moderate

 Preliminary Emergency Protective Measures (1):
 Clear and maintain culvert

 Preliminary Emergency Protective Measures (2):
 Monitor and maintain

 Preliminary Emergency Protective Measures (3):
 Early Warning

 Preliminary Emergency Protective Measures (4):
 Deflection structure

 Description:
 NA

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-59

Feature: Fire station, homes, roadway.

Feature Category: NA

Field Observation History of rockfall caused destruction of old fire station in 1969. A debris barrier *or Potential Hazard:* wall appears to have been constructed on the rear slope. This entire northfacing slope is one massive hazard.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Traffic control

Description: Consider Evacuation.

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Wildcat Canyon (Silverado Canyon)

Site Number: BND-62

Feature: Trailer pad with temporary housing.

Feature Category: home

Field Observation Trailer pad below steep slope. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation. Presently occupied trailer pad at risk without proper mitigation awareness.

VALUE AT RISK DETAIL

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-7

Feature: House

Feature Category: home

Field Observation House in flow path of small catchment. History of debris and burned area *or Potential Hazard:* mitigations in place.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuating in predicted high flows.



VALUE AT RISK DETAIL

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-8

Feature: Residence

Feature Category: home

Field Observation House in potential flow path of unmodeled catchment with history of debris flow *or Potential Hazard:* flooding. Rail at Modjeska Canyon reduces potential as well as ditch across street.

Potential Hazard to Life: low

Potential Hazard to Property: **low**

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Sandbags

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Harding Canyon (Modjeska Canyon)

Site Number: BND-1

Feature: House and improvements

Feature Category: home

Field Observation House and outbuildings on low surface adjacent stream, small burn area *or Potential Hazard:* upstream. Local bulking from burned steep raveling slopes upstream of residences could deposit and bulk flows and cause avulsion.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuation in high flow events.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-10

Feature: Residences and improvements

Feature Category: home

Field Observation House in flow path of unmodeled catchment. Berming at driveway suggests *or Potential Hazard:* prior issues.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Structure at driveway entrance appears to be under construction.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Santiago Canyon

Site Number: BND-13

Feature: Residence and commercial structures.

Feature Category: multiple

Field Observation Houses and business structures in floodplain. History of flooding and debris in *or Potential Hazard:* barn and around house.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: There is potential for reducing hazard with appropriately designed and installed deflection structure. Some work has been done to reduce flood hazards on Williams Creek.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Santiago Canyon

Site Number: BND-14

Feature: Residences and improvements.

Feature Category: home

Field Observation House on low surface adjacent to flow path. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Culvert upstream of home appears undersized and could cause flow to home.

LOCATION AND PHOTO





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-16

Feature: House and improvements.

Feature Category: home

Field Observation Residence and outbuilding in flow path / channel. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): NA

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuation in predicted high flow events.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Williams Canyon

Site Number: BND-29

Feature: House and improvements.

Feature Category: home

Field Observation Residences on flood plain adjacent to channel with history of flooding. *or Potential Hazard:* Downslope of steep unmodeled catchments with history of flows and flooding.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuation in high flows.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-30

Feature: Church buildings and driveways.

Feature Category: drainage structure

Field Observation Mud and debris and flooding potential risk to rear of church auxiliary building. *or Potential Hazard:* Window facing drainage on west rear side needs to be hardened and drainage channel needs to be cleared of existing debris and storage materials. Sandbag west-side entrance.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Clear and maintain culvert

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): Early Warning

Description: Consider Evacuation.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-31

Feature: Auxiliary building and church.

Feature Category: drainage structure

Field Observation Drainage channel may be overtopped with debris, mud, and hyperconcentrated or *Potential Hazard*: flow. Drainage channel is aimed at corner of church auxiliary building.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Clear and maintain culvert

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): Early Warning

Description: Consider Evacuation.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-32

Feature: Roadways, infrastructure.

Feature Category: home

Field Observation Nuisance mud with history of mud and debris on the road way, according to *or Potential Hazard:* report from local resident..

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: NA

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Rdg (Silverado Canyon)

Site Number: BND-33

Feature: Home.

Feature Category: home

Field Observation Flooding and debris flow. or Potential Hazard:

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Deflection structure

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Early Warning

Description: Consider Evacuation. K-rail anchored to ground that will deflect flow coming out of canyon will be a great mitigation, if possible to install. Canyon is not steep; however, drainage empties directly into rear portion of home on the TipToe Ranch.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Hidea Way (Silverado Canyon)

Site Number: BND-34

Feature: Homes, roadways, infrastructure.

Feature Category: home

Field Observation Rockfall from north-facing slopes. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Thisa Way (Silverado Canyon)

Site Number: BND-35

Feature: Homes.

Feature Category: home

Field Observation Flooding and debris flow capable of damaging roadway and homes. Boulder in *or Potential Hazard:* roadway at bottom of hill on west side of intersection between Thisa Way and Thata Way deposited in 2010 storm according to anecdote from local resident.

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Sandbags

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: NA

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-36

Feature: Homes and infrastructure in floodplain

Feature Category: home

Field Observation Debris from White Canyon may reduce capacity of Silverado Creek, resulting in *or Potential Hazard:* backwatering and flooding of structures and infrastructure in floodplain. Debris may also reduce flow capacity of bridge at Kitterman Drive, causing backwatering and flooding.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): NA

Description: Maintain channels and bridge crossing. County should model flood inundation assuming reduced channel and bridge capacity.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Shady Drive (Silverado Canyon)

Site Number: BND-37

Feature: Homes, roadways, infrastructure.

Feature Category: drainage structure

Field Observation Debris and flooding. or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): Debris barrier

Description: It would be optimal to build a debris basin at the top of the roadway where it hits the fire perimeter. 28311 Bond Way will likely face the brunt of the upstream flow before it descends the north slope to impact homes on Grundy Lane sited in flow path.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Kitterman Drive (Silverado Canyon)

Site Number: BND-38

Feature: Homes, roadways, infrastructure.

Feature Category: home

Field Observation Rockfall and debris flow. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: Cliff behind homes appears unstable.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Water Way - Sullivan (Silverado Canyon)

Site Number: BND-39

Feature: Homes, roadways, infrastructure.

Feature Category: NA

Field Observation Flooding and debris flow. *or Potential Hazard:*

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Clear and maintain culvert

Preliminary Emergency Protective Measures (4): Deflection structure

Description: Consider Evacuation. There is a home sited in the active stream channel at high risk for inundation.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-40

Feature: Homes, roadways, infrastructure.

Feature Category: home

Field Observation Homes in the active floodplain. *or Potential Hazard:*

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Debris barrier

Description: Consider Evacuation. This is a high-hazard area.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Anderson Way (Silverado Canyon)

Site Number: BND-41

Feature: Road crossings.

Feature Category: multiple

Field Observation Roadway flooding. or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Sandbags

Description: NA

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-46

Feature: Homes, roadway, infrastructure.

Feature Category: home

Field Observation Rockfall, mud, debris originating from steep ascending north-facing slope to *or Potential Hazard:* rear of several homes adjacent to roadway.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Deflection structure

Description: Consider Evacuation. Debris barrier construction to guard against rockfall may be worth installing in future to deal with long-range risk since these homes are situated right at the base of the steep slope.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-47

Feature: Homes and roadways.

Feature Category: home

Field Observation NA or Potential Hazard:

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-48

Feature: Homes, roadways, infrastructure.

Feature Category: home

Field Observation Rockfall. or Potential Hazard:

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: Consider Evacuation.

LOCATION AND PHOTO





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-49

Feature: Home(s), roadways, infrastructure.

Feature Category: drainage structure

Field Observation Debris flow and flood hazard. Seasonal waterfall present according to *or Potential Hazard:* homeowner. Rear yard channel is partially filled with dry ravel debris currently.

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Debris barrier

Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): Early Warning

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: Consider Evacuation.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-5

Feature: Residences

Feature Category: home

Field Observation Residences on alluvial fan at mouth of two modeled high debris flow hazard *or Potential Hazard:* catchments. Several small unmodeled catchments deliver to western end of fan complex. History of flows down Mark Road and eastern drainage impacting houses on Markuson Road.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Potential for deflection structures at bottom of Mark Road.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-51

Feature: Roadway, infrastructures.

Feature Category: drainage structure

Field Observation Mud and flood potential. Bedrock channel adjacent to driveway. According to *or Potential Hazard:* resident, water traverses the roadway and flows east.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Olive Dr (Silverado Canyon)

Site Number: BND-53

Feature: Homes, infrastucture, roadways.

Feature Category: NA

Field Observation Moderate modeled debris flow hazard including flood damage to homes on both *or Potential Hazard:* sides of drainage adjacent to roadway. High velocity flow possible.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation. Large branches obstructing channel about 30 feet upstream of road crossing need to be cut.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Hazel - Sleepy Hollow (Silverado Canyon)

Site Number: BND-54

Feature: Homes, roadway, infrastructure.

Feature Category: drainage structure

Field Observation Culverts require cleaning and maintenance to prevent impact to houses. *or Potential Hazard:*

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Clear and maintain culvert

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Sandbags

Description: NA





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Hazel - Sleepy Hollow (Silverado Canyon)

Site Number: BND-55

Feature: Homes, roadways, infrastructure.

Feature Category: NA

Field Observation Landslide activity visible in the hillsides east of roadway/dirt track. Area has *or Potential Hazard:* history of mud and flood with half-meter scale boulders and debris, especially following 2010 fire.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Deflection structure

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Early Warning

Preliminary Emergency Protective Measures (4): Clear and maintain culvert

Description: Consider Evacuation.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Finn Lane (Silverado Canyon)

Site Number: BND-56

Feature: Homes and roadway.

Feature Category: home

Field Observation Upstream burned basin pours out on top of house and roadway below. New or Potential Hazard: home is being built directly in the channel/flow path.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Monitor and maintain

Description: Consider Evacuation. This resident needs a debris barrier, retaining walls, and adequate drainage. Additional landslide hazard due to likely non-permitted grading and construction.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Wildcat Canyon (Silverado Canyon)

Site Number: BND-57

Feature: Homes, roadway, infrastructure.

Feature Category: home

Field Observation High debris flow and flood hazard. High danger to life. Hyperconcentated flow, *or Potential Hazard:* debris-heavy, is possible based on historic anecdotal evidence provided by local residents.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Clear and maintain culvert

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): Debris barrier

Description: Consider Evacuation. Wildcat Canyon Creek is a high hazard zone for life and property..

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-58

Feature: Houses and stream crossings

Feature Category: home

Field Observation Debris from Wildcat Canyon may reduce channel capacity in Silverado Creek at or Potential Hazard: the tributary junction or at road crossing at Sleepy Hollow Drive. Debris blockage may cause backwatering with resultant flooding to structures in the Silverado Creek floodplain

Potential Hazard to Life: moderate

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Sandbags

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation. Heavy equipment may be necessary to maintain conveyance at Silverado Creek/Wildcat Canyon. Capacity of crossing at Sleepy Hollow will need to be maintained. Recommend County model flood inundation assuming blockage at both areas.



Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-6

Feature: House

Feature Category: home

Field Observation Houses at mouth of high debris flow potential modeled catchment. *or Potential Hazard:*

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: Consider evacuation in predicted high flows.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Silverado Canyon

Site Number: BND-60

Feature: Homes, roadways, infrastructure.

Feature Category: NA

Field Observation Hillside oversteepened and site of previous fatality at Old Shadybrook Country or Potential Hazard: Store. Ascending north-facing slope requires additional analysis of hazard.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Monitor and maintain

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): Deflection structure

Description: Consider Evacuation. There is a well-documented hazard in this area. A 16-year old girl died at 29442 Silverado Canyon (Old Shadybrook Country Store) in 2005 due to rockfall.





Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Wildcat Canyon (Silverado Canyon)

Site Number: BND-61

Feature: Home

Feature Category: home

Field Observation Oversteepened channel behind home extends upwards into a chute channeling *or Potential Hazard:* rockfall. Existing debris flow deposits uphill of home. Resident described previous flooding on north and south sides of home.

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): Debris barrier

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuation. This is a high risk location.

LOCATION AND PHOTO







Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Wildcat Canyon (Silverado Canyon)

Site Number: BND-63

Feature: Trailer pads, roadway creek crossings.

Feature Category: home

Field Observation Debris flow hazard, stream flooding and hillslope failure hazard. *or Potential Hazard:*

Potential Hazard to Life: high

Potential Hazard to Property: high

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Clear and maintain culvert

Preliminary Emergency Protective Measures (4): Deflection structure

Description: Consider Evacuation. This is a high hazard area.

LOCATION AND PHOTO






VALUE AT RISK DETAIL - Polygons

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: White Canyon

Site Number: BND-64

Feature: Outbuildings and property.

Feature Category: home

Field Observation Outbuildings and property are located at the base of a small but steep *or Potential Hazard:* catchment. There is a risk for rockfall at this location. Additional ingress/egress problems if White Canyon creek inundates drainage structures at Anderson Road.

Potential Hazard to Life: moderate

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Debris barrier

Preliminary Emergency Protective Measures (3): Deflection structure

Preliminary Emergency Protective Measures (4): NA

Description: Consider Evacuating if occupied and forecasted storms predict flood or debris flows.

LOCATION AND PHOTO



Scale: 1:1,000





VALUE AT RISK DETAIL - Polygons

Incident: Bond Fire

Incident Number: CA-ORC-136890

Community: Modjeska Canyon

Site Number: BND-9

Feature: Residences and improvements.

Feature Category: home

Field Observation Houses in potential flow path of high modeled debris flow catchment. *or Potential Hazard:*

Potential Hazard to Life: low

Potential Hazard to Property: moderate

Preliminary Emergency Protective Measures (1): Early Warning

Preliminary Emergency Protective Measures (2): Deflection structure

Preliminary Emergency Protective Measures (3): NA

Preliminary Emergency Protective Measures (4): NA

Description: NA

LOCATION AND PHOTO



Scale: 1:2,000



