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Burned Area Emergency Response (BAER)
Watershed Response Report Summary
Fairview Fire
(CA- RRU-129712)
Riverside County, California

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Objectives and Introduction

This report contains a summary of post-fire watershed responses that are expected after the Fairview Fire. Included here are observations, maps and modeled results of increased stream flows, surface erosion, and debris flow potential. Post-fire stream sedimentation and bulking are also addressed. USDA Forest Service Burned Area Emergency Response (BAER) teams use these data, paired with field observations of burned conditions to assess threats to critical values on Forest Service System land, although all products produced by the BAER team provide data for the whole fire footprint (including Federal and non-Federal lands. The purpose of this report is to compile the relevant modeling data and summarize the post-fire watershed responses that are possible for the entire Fairview Fire area.

The following are the primary duties and objectives of the Soil, Hydrology, and Geology Assessment.

- The "Soil" function on a BAER team is to determine the soil burn severity (SBS) caused by the fire and evaluate the resulting threat of increased post-fire erosion and sedimentation.

- The "Hydrology" function on a BAER team is to assess watershed changes caused by the fire, evaluate possible post-fire hydrologic threats, including post-fire flooding, slope instability, and bulking of flows from sediment and debris including bulking from dry ravel.

- The "Geology" function on a BAER team is to identify the geologic conditions and geomorphic processes that have helped shape and alter the watersheds and landscapes and assess the impacts from the fire on those conditions and processes that potentially could affect downstream critical values or values at risk (VAR's). This includes evaluating post-fire debris flow, hyper concentrated flows, rockfall, and mass wasting (geologic instability).

The Soils, Hydrology and Geology resource areas work together to develop a cohesive picture of post-fire watershed response. A range of storm event sizes and corresponding watershed responses are given by each resource area, but it should be noted that BAER is a rapid assessment. The data gathering and analysis occurred over approximately one week. Thus, these data should be used for informing relative risk within and downstream of the fire, but they may not be appropriate for predicting specific effects to property or resources downstream.

Resource Setting

General

The Fairview Fire started on September 5, 2022, near Riverside County's Simpson Park in the city of Hemet, California in Riverside County. The fire soon burned to the east and onto the San Bernardino National Forest. The drought, combined with dry, hot weather and strong winds, resulted in active fire behavior.

Since the fire started, southern California experienced scattered thunderstorms associated with tropical storm Kay. As recorded at the Cranston Remote Automatic Weather Station (RAWS) near the north end of the fire, 0.05" of rain fell on September 9 with an additional 0.21" on September11. At the Anza RAWS

near the southern end of the fire, there was 0.58" on September 9, 0.02" on September 10, and 0.05" on September 11.

On September 20, a BAER team began assessing the fire area. The team consisted of soil scientists, hydrologists and geologists focused on mapping soil burn severity and assessing imminent post-fire threats to human life and safety, property, and natural resources. Additional BAER specialists, including road engineers, wildlife biologists, archeologists, botanists, and recreation managers identified and evaluated Critical Values in their areas of expertise.

Dominant Soils

Dominant soils in the Fairview Fire burned area are derived from granodiorite and mixed sedimentary residuum and colluvium (CmE, CmF, DpF, DnG, ChFG). (Alluvium deposits in drainage and toe slope positions comprise a minor extent of the burned area (ChDE). Soils in the burned area are coarse textured and the most common surface texture is sandy loam. Processes influencing soil formation in the burned area include mountain building tectonic events and subsequent fluvial/erosional landform development. The soil moisture regime across the entire burned area is xeric which is typical for climates that experience very dry summers and moist winters (unimodal precipitation distribution). The mean annual soil temperature for most soils in the burned area is thermic (between 15°C and 22°C).

Table 1. Dominant Soils in the Fairview Fire Area

SSURGO[1] Map Unit	Surface Texture	Taxonomic Subgroup	Soil Depth Class	HSG[2]	Soil Erosion Hazard[3]	Percent of Burned Area[4]
Modesto-Osito families association (CmE)	Fine sandy loam	Thermic Mollic Haploxeralfs	Very Deep	C	Severe	21
Osito-Modesto families association (CmF)	Coarse sandy loam	Thermic Shallow Typic Xerochrepts	Shallow	D	Severe	14
Lithic Xerorthents warm-Rock outcrop complex (DpG)	Gravelly sandy loam	Lithic Xerorthents	Shallow	D	Severe	13
Trigo family-Lithic Xerorthents warm complex (DnG)	Coarse sandy loam	Thermic Shallow Typic Xerochrepts	Shallow	D	Severe	13
Typic Xerorthents, warm-Typic Haploxeralfs-Badland complex (ChFG)	Sandy loam	Thermic Typic Haploxeralfs	Very Deep	B	Severe	9
"Badland"[5] (G)	Sandy Loam	-	Very Deep	-	Severe	7
Ramona family-Typic Xerorthents, warm association (ChDE)	Sandy loam	Thermic Typic Haploxeralfs	Very Deep	C	Moderate	6

[1]Soil Survey of San Bernardino National Forest Area, California, 1987
[2]Hydrologic soil group
[3]Soil Erosion Hazard (Road, Trail) rating are shown in table. Map units do not have a rating for Soil Erosion Hazard (Off-road, Off-trail)
[4]The remaining 17 percent of the burned area is composed of 11 soil map units minimally contributing <1 to 4 percent.
[5]Badland soil map units do not have soils data rated in SSURGO. Surface texture, soil depth class, and erosion hazard were evaluated during field visitation.

Geologic Types

Geomorphology and Geology: The San Bernardino National Forest includes parts of two major geologic-geomorphic provinces of western North America - the Transverse Ranges and the Peninsular Ranges provinces. The San Gabriel and San Bernardino Mountains are part of the eastern Transverse Ranges, and

the San Jacinto, and Santa Rosa Mountains, Thomas Mountain, and Coahuila Mountain are all part of the San Jacinto Mountains block, which itself is part of the northern Peninsular Ranges. The geology of the two provinces is vastly different one from the other (Matti & Morton, 2000).

In contrast to the geology setting of the San Gabriel and San Bernardino Mountains, the San Jacinto Mountains block geologically is not very diverse. The region is underlain mainly by batholithic plutonic rocks of Mesozoic age that have invaded pre-batholithic metasedimentary rocks (Matti & Morton, 2000). Bedrock within the Fairview Fire burned area mainly consists of Granitic and other intrusive crystalline rocks of all ages; Cretaceous and pre-Cretaceous metamorphic formations of sedimentary and volcanic origins; Alluvial Fan and Valley Deposits of all ages; and Landslide Deposits.

The Fairview Fire occurred in the San Jacinto Mountains block, approximately 12-15 miles southwest of San Jacinto Peak. Physiography of the burned area is dominated generally by main ridgelines and drainages following in a southeast – northwest direction. The main drainage in the burn area is the Bautista Creek flowing northwest into the San Jacinto River (northwest of the burn scar). Elevations in the burn area range from about 4,563 feet above sea level at the Red Mountain peak, down to about 1,700 feet above sea level at the west end / lower end of the burn scar.

Post-Fire Watershed Response

Estimated Soil Response

Table 2. Results of Soil Burn Severity Mapping		
SBS Class	**Acres***	**Percent of total**
Unburned	3,053	11
Low	16,492	57
Moderate	8,928	31
High	304	1
Total Acres Assessed	**28,777**	

Table 2 shows the final soil burn severity classification with acres listed for each classification. GIS calculated acres are approximate.

Table 3. Summary of Burn Severity By Ownership					
Ownership	**Soil Burn Severity (Acres)**				
	Unburned & Very Low	**Low**	**Moderate**	**High**	**Total**
San Bernardino National Forest	1,015	6,332	5,947	277	13,571
Private / Other	1,481	7,825	2,564	27	11,897
Bureau of Land Management	505	2,194	357	-	3,056
State	52	141	60	-	253
TOTALS	**3,053**	**16,492**	**8,928**	**304**	**28,777**

Unburned acres were encountered within the Fairview Fire burned area. Soil productivity and hydrologic function in these areas will remain unchanged. Unburned acreage makes up approximately 3% of the burned area. Moderate to strong background hydrophobicity was observed in unburned soils.

Low soil burn severity makes up most of the burned area at 57%. In areas with low soil burn severity effective ground cover is mostly consumed, however pre-fire ground cover was very low. Litter may still be recognizable. Ash color is black, and the ash depth is no deeper than 2 centimeters. Ash is very patchy and discontinuous across the burned area. Roots and soil structure are unchanged. Strong hydrophobicity was observed in low soil burn severity areas. Vegetation mortality is approximately 75-100%.

Moderate and high burn severity areas showed 20% or less remaining effective vegetative ground cover. Vegetation mortality in the moderate and high soil burn severity ranged from 40 – 100% across both the Forest and Chaparral vegetation types. Moderate to strong hydrophobicity was encountered in these areas. Other soil characteristics common to areas with moderate high burn severity is charring and consumption of roots from approximately 0 – 3 inches and weakening of soil structure in the surface.

National Forest System (NFS) Lands

Erosion Potential
Erosion rates are for a 2-year storm modeled across soil map units on NFS lands. Reported erosion rates (ERMiT) are associated with the 2-year storm (50% probability). An approximately 2.87" storm total precipitation with 4-hour duration. Riparian (alluvial) map units were not modeled in ERMiT. See Table 4 below that displays estimated soil erosion /hazard rates.

Table 4. Soil Erosion Hazard Rating		
Rating	**Acres**	**Percent of Fire Area**
Severe	12,200	88
Moderate	1,193	9
Low	8	<1
Not Rated (Rock Outcrop)	447	3
[1]Acres are an estimate based on soil survey coverage and area assessed by soil burn severity. [2]Soil Erosion Hazard (Road, Trail) ratings are shown in table. Map units do not have a rating for Soil Erosion Hazard (Off-road, Off-trail).		

Estimated Hydrologic Response
Watershed conditions following a fire, such as loss of stabilizing vegetation, decreased soil porosity, and increased hydrophobicity in soils, are all factors that can influence the magnitude, timing, and volume of stormwater runoff. Additionally, the volume of sediment and ash that these flows can transport can cause aggradation, down cutting, and/or widening of stream channels that can significantly reduce the functioning condition of these channels. The increased peak flows pose a threat to life, property, and resources within and below the burned area.

Post-fire hydrologic response for 2 and 5-year, 6-hour precipitation events were modeled using HEC-HMS (Hydrologic Engineering Center- Hydrologic Modeling System) 4.9 for the Bautista Creek 6th code watershed. HEC-HMS was chosen as the modeling method due to the size of the watershed of interest being over 5 square miles

Runoff from the 2-year, 6-hour frontal storm (~1.40”) was modeled to result in approximately 3 times greater flow than unburned conditions as a function of burn severity distribution throughout the watersheds.

Runoff from the 5-year frontal storm (~1.85") was modeled to result in approximately 1.3 times greater flow from unburned conditions. The decrease in percent change as recurrence intervals lower in probability is due to increased precipitation depths resulting in higher peak flows instead of curve numbers dictating the model outputs.

Overall, moderate severity burn within the chaparral vegetation type throughout the watershed will result in significant increase in hydrologic response. However, the lack of a deep litter layer present in chaparral vegetation types lowers pre to post fire response. Although hydrologic response will increase, there will likely not be any long-term changes to stream morphology or departure from the watershed's historical natural hydrograph.

Table 5 below displays modeled results of post-fire increased runoff. *See map in Appendix A.*

Table 5. Predicted Post-Fire Increased Run-Off		
Storm Event (6-hour duration)	**Precipitation Depth (in.)**	**Percent Change (%)**
2-year	1.40	338.48
5-year	1.85	127.94

Geology and Geomorphology - Geologic Response

Within the burned area of the Fairview Fire, some evidence of mass wasting as debris slides, debris flows, and rock fall was observed throughout portions of the burn area. Based on our observations, it appears that most slopes and channels in the burn area are loaded with unsorted / unconsolidated materials comprised of rocks of all sizes including boulders, cobbles, gravels, and fine sediments ready to be mobilized by flooding and/or debris flow events. Based on some of the steep slopes in the burn area, the soil burn severity, and the amounts of stored sediments in most drainages in the burn area, it is our estimate that because of short duration, high intensity storms (>28 mm/hr.), the probabilities of hyper-concentrated flows and/or debris flows are moderate to high in most channels in the southeast corner of the Fairview Fire burn area. These channels mostly flow into Bautista Creek. Most other channels in the burn scar present low to moderate probabilities of debris flow initiations under these same rainstorm conditions. Details of this analysis are found below.

Now, because of the removal of vegetation by the fire, soils are exposed and have become weakened, hydrophobicity conditions have changed and rocks on slopes have lost their supporting vegetation. Due to these post-fire conditions, Forest Service roads and trails, and private, county and state infrastructure, facilities, roads, water systems and other utilities are at risk from numerous geological hazards as rolling rocks, debris slides, debris flows, and hyper-concentrated floods. Risks to human life, and safety is of particular concern in and downstream of the Fairview Fire during up-coming storm events. Beyond threats to life and property, because of the fire, excessive sedimentation and debris could adversely affect cultural resources and critical habitats for Federally Listed Species in and below the burn area.

Debris Flow Potential: The US Geological Survey (USGS) - Landslide Hazards Program, has developed empirical models for forecasting the probability and the likely volume of post-fire debris flow events. To run their models, the USGS uses geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm (Staley, 2016). Estimates of probability, volume, and combined hazard are based upon a design storm with a peak 15-minute rainfall intensity of 12 – 40 millimeters per hour (mm/h) rate. We selected a design storm of a peak 15-minute rainfall intensity of 28 millimeters per hour (1.1 inch/hr.) rate to evaluate debris flow potential and volumes since based on the NOAA Atlas 14 Point Precipitation Frequency Estimates, this magnitude of storm seems likely to occur in any given year.

Based on USGS debris flow modeling it appears that under conditions of a peak 15-minute rainfall intensity storm of 28 millimeters per hour (1.1 inches/hour) corresponding to a 1-year storm, most of the drainages in the southeast corner of the burn scar (Between Bautista Canyon, Red Mountain and the southeast boundary of the fire) are predicted to initiate debris flows with moderate (40-60%) to high (60-80%) probability, including a few drainages with very high (80-100%) probabilities. These drainages for the most case are un-named drainages flowing to the north and northeast into Bautista Canyon. Most other drainages in the burn scar are predicted to initiate debris flows with relatively low probabilities of 0-20% or 20-40%. Under this same magnitude of storm, predicted volumes in most of the main channels impacted by the Fairview Fire range from 1K-10K cubic meters. Most of the side channels feeding into these main channels are predicted to produce volumes of less than 1K (<1K) cubic meters. Just a few drainages in the burn scar are predicted to produce volumes of 10K-100K cubic meters.

Regarding combined hazard, the USGS debris flow model estimates most of the area burned by the Fairview Fire to be under a moderate combined hazard, with exceptions of areas in the west end of the fire presenting a low combined hazard, and some drainages in the southeast corner of the fire, flowing into Bautista Canyon, presenting a high combined hazard.

Most of those drainages located in the southeast corner of the fire (which are represent a high combined hazard) require rainfall rates of 20-24 mm/hour (0.78-0.94 inches/hour) to exceed a 50% likelihood of debris-flow initiation. A few smaller drainages in that area require a smaller amount of rain, 16-20mm/hour (0.63-0.78 inches/hour) to exceed a 50% likelihood of debris-flow initiation. Most other areas impacted by the fire require high rainfall intensities (28mm/hour (0.94 inches/hour) or higher) to exceed a 50% likelihood of debris-flow initiation.

These conditions leading potentially for the geological hazards described above will stay in affect till vegetation in the burned watersheds re-establishes itself, which depending on rain and other conditions, could take 2-5 years after the fire.

Methodologies

Each specialist report contains additional information about the models and methods used to derive the information above. These reports will be made available on request, after the BAER assessment process and approval is complete.

References:

Matti, J.C. and Morton, D.M., 2,000, unpublished manuscript, Geologic setting San Bernardino National Forest, p.1-31.

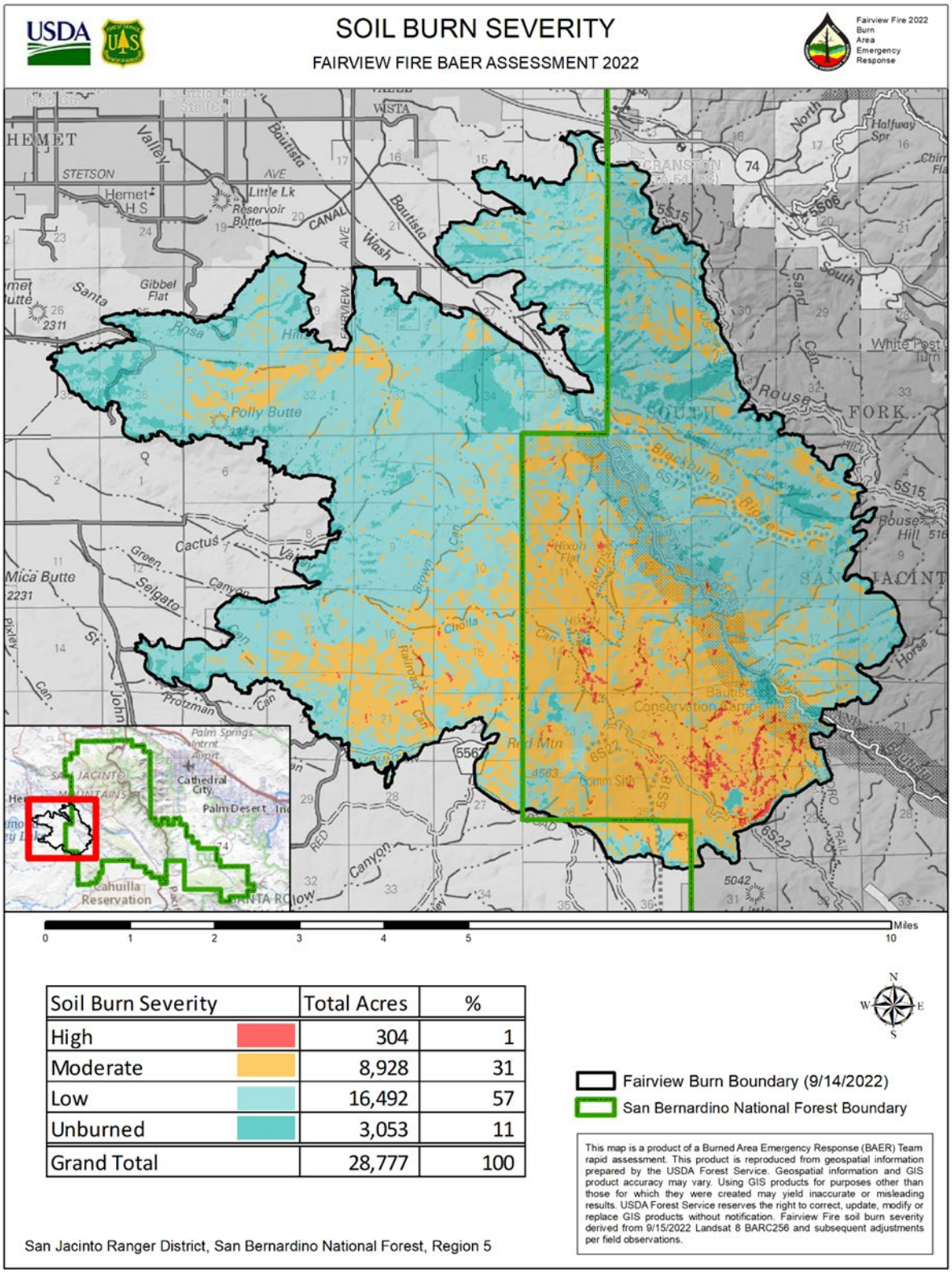
NOAA Atlas 14 Point Precipitation Frequency Estimates. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

Staley, D.M., Negri, J.A., Kean, J.W., Tillery, A.C., Youberg, A.M., 2016, Updated logistic regression equations for the calculation of post-fire debris-flow likelihood in the western United States: U.S. Geological Survey Open-File Report 2016-1106, 20 p., available at https://pubs.er.usgs.gov/publication/ofr20161106

APPENDIX

Soil Information

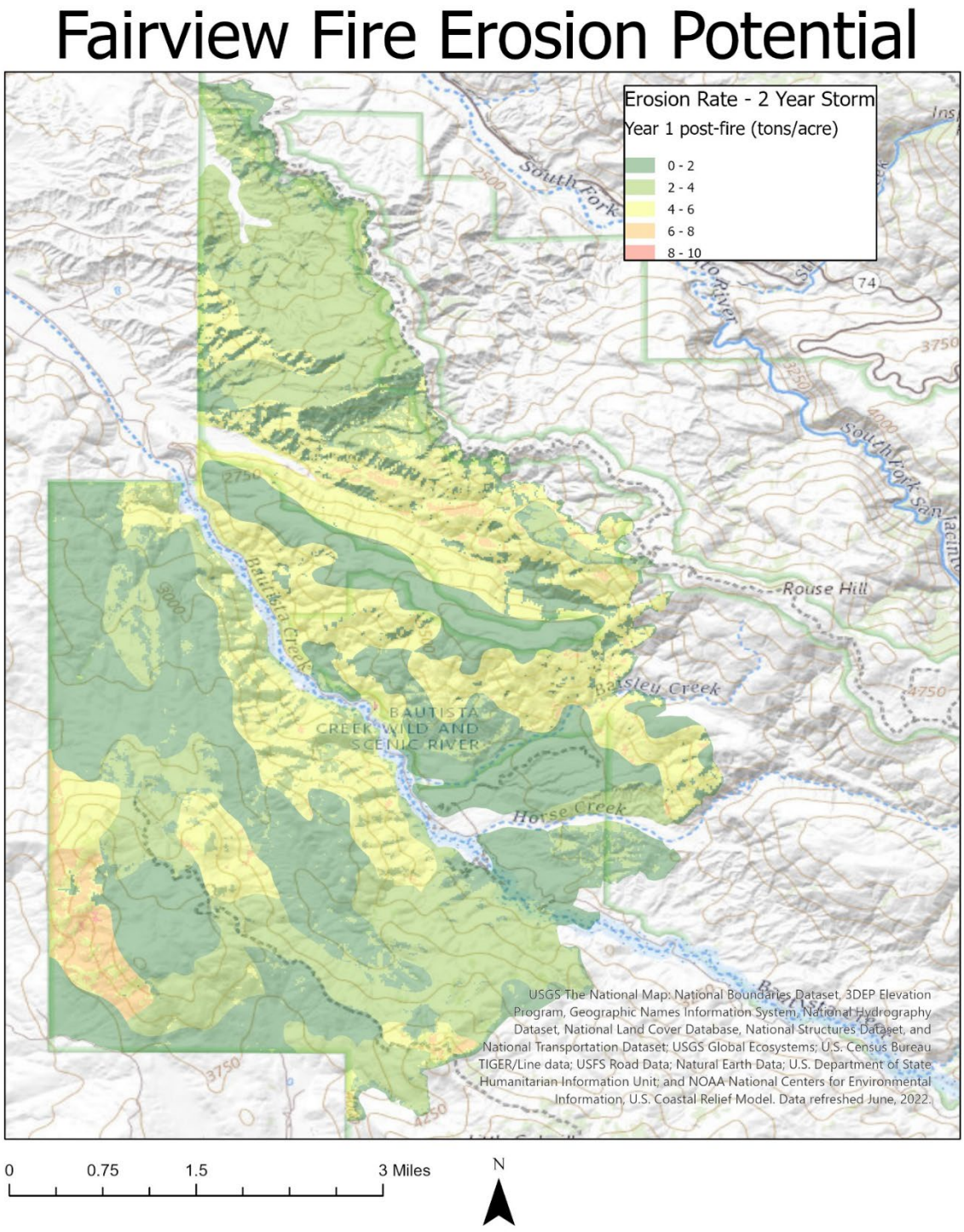
Map 1- Soil Burn Severity



Soil Burn Severity	Total Acres	%
High	304	1
Moderate	8,928	31
Low	16,492	57
Unburned	3,053	11
Grand Total	28,777	100

Erosion Modeling Results

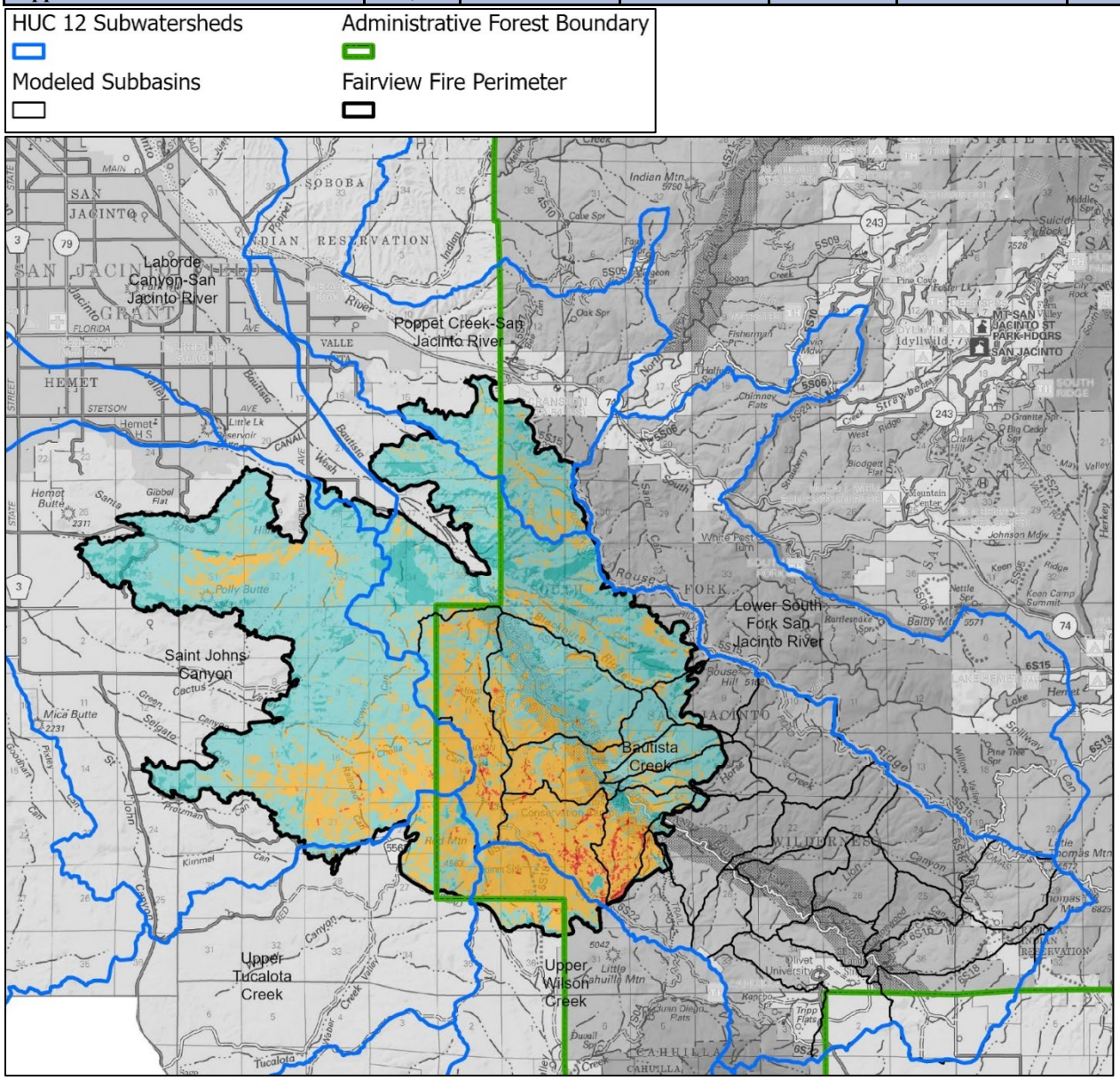
Map 2- Fairview Fire Erosion Potential. Erosion rates displayed in the map are associated with the 2-year storm in year 1 post-fire. Units are tons per acre.



Hydrology

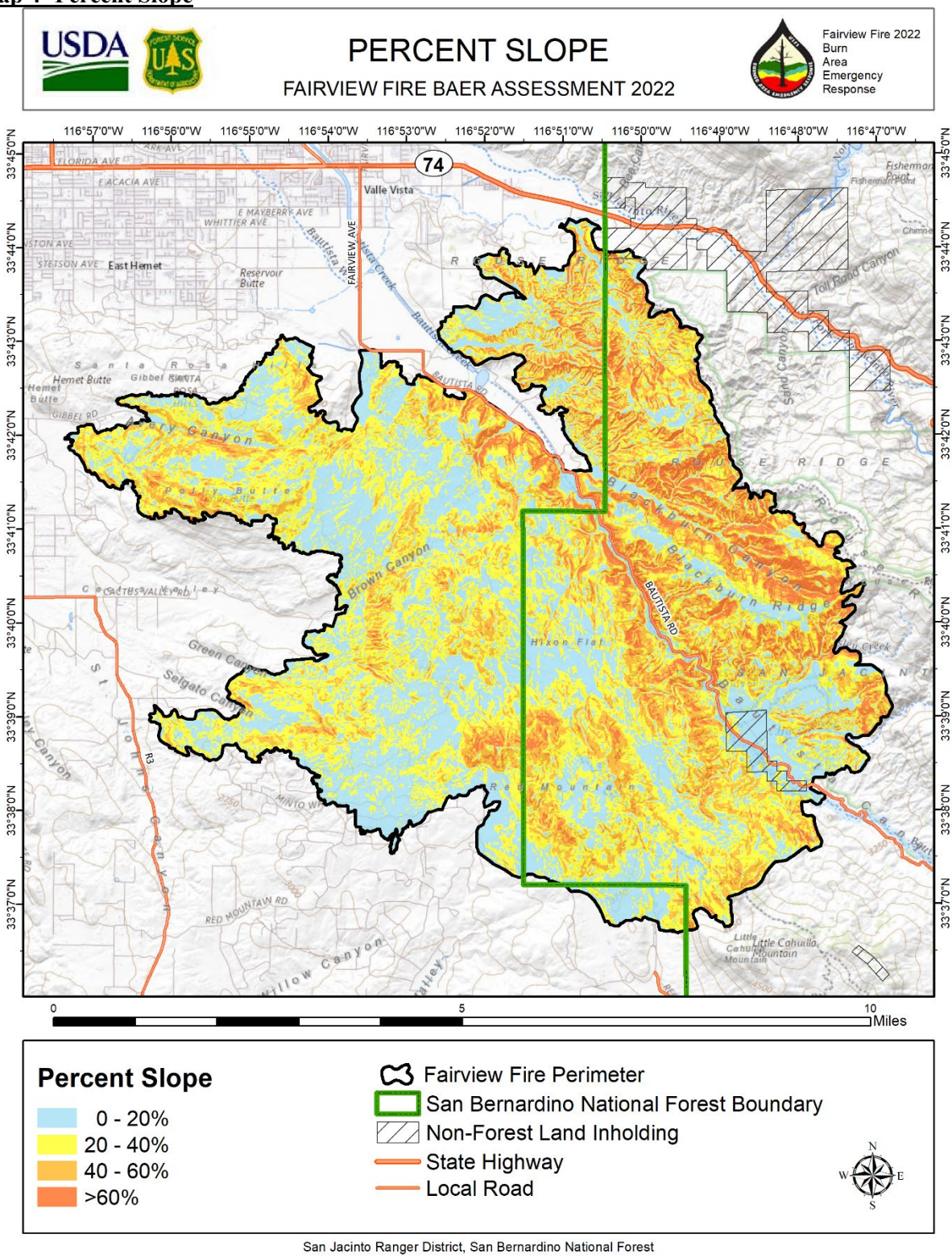
Map 3- Watersheds on National Forest

Name	Acres Burned	Outside Burn Perimeter %	Unburned/ Very Low %	Low Burn Severity %	Moderate Burn Severity %	High Burn Severity %
Bautista Creek	12,381	13	54	45	53	85
Poppet Creek-San Jacinto River	1,581	13	7	8	3	0
Saint Johns Canyon	9,451	11	34	42	27	8
Upper Tucalota Creek	1,014	12	2	3	6	1
Upper Wilson Creek	1,149	10	2	1	10	5



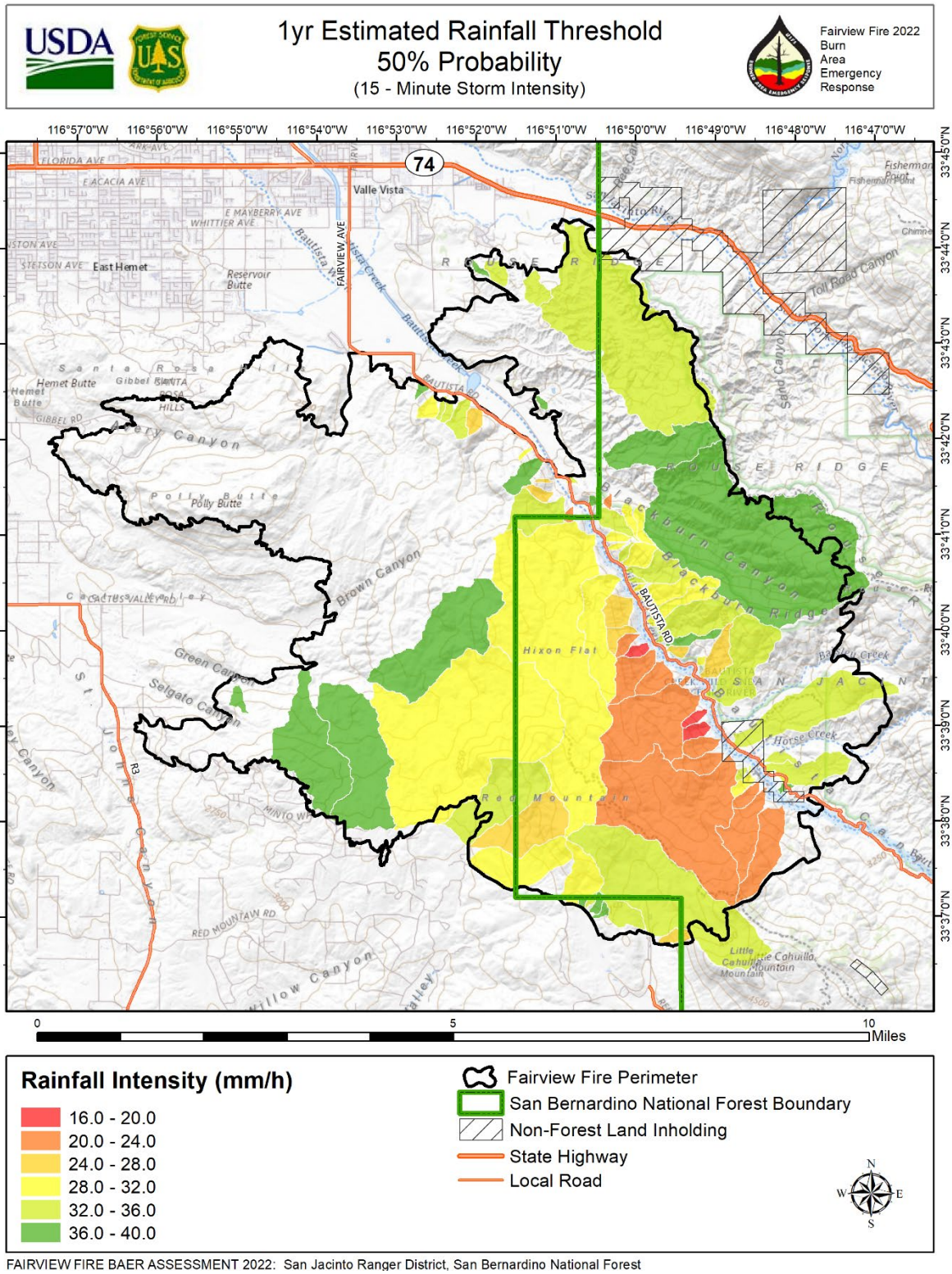
Geology

Map 4- Percent Slope



San Jacinto Ranger District, San Bernardino National Forest

Map 5-1-Year Estimated Rainfall Threshold - 50% Probability, 15-Min storm intensity



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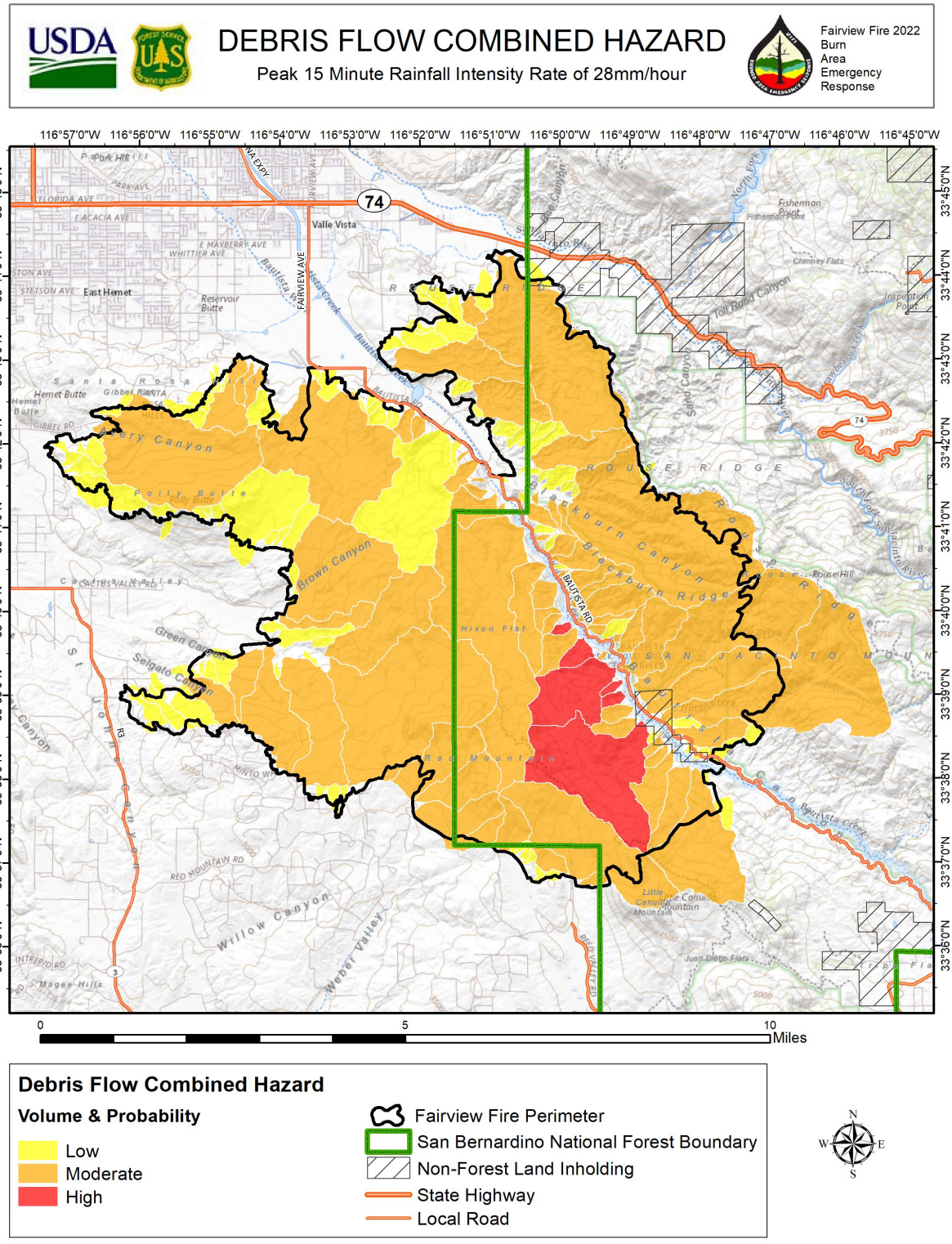
Map 6- Debris flow combined hazard



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