Watershed Emergency Response Team (WERT)
2024 Lake Fire

CA-LPF-001542

August 15, 2024

California Department of Conservation
California Geological Survey

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WERT REPORT AUTHORSHIP AND PROFESSIONAL REGISTRATION

REPORT TITLE: Watershed Emergency Response Team (WERT) Evaluation – 2024 Lake Fire

LIMITATIONS: This report presents the results of a rapid assessment to help communities prepare after wildfire by documenting and communicating postfire risks to life, property, and infrastructure posed by debris flow, flood, and rockfall hazards. 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 responsible jurisdictions and agencies in the development of more detailed postfire emergency response plans.

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Lake Fire – WERT REPORT EXECUTIVE SUMMARY

CA-LPF-001542 - WERT Evaluation

Mission Statement: The California Watershed Emergency Response Team (WERT) helps communities prepare after wildfire by rapidly documenting and communicating postfire risks to life, property, and infrastructure 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 Santa Barbara County Office of Emergency Management, Santa Barbara County Fire, CAL FIRE, local first responders, Santa Barbara County Public Works and Flood Control, California Department of Transportation, the California Governor's Office of Emergency Services, the United States Department of Agriculture Natural Resources Conservation Service, the United States Forest Service, utility companies, and other responsible agencies and entities in the development of more detailed postfire 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 Lake Fire started on 5 July 2024, near Zaca Lake in Santa Barbara County. The relatively large size of the fire (i.e., 60 mi^2, 38,664 acres on 27 July 2024 at 90% containment), occurrence of widespread moderate soil burn severity in steep, upland slopes means that parts of the Lake Fire and downstream area will be subject to postfire hazards such as sediment-laden flooding, debris flows, and increased erosion. Watershed response was already observed prior to the Lake Fire during the 9 January 2023 storm that caused flooding in the Zaca Lake area, along Alamo Pintado Creek, and other areas near the Lake Fire.

Due to the potential for increased postfire runoff, sediment-laden flooding, and debris flows, and proximity of the Lake Fire perimeter to residential areas and critical infrastructure, the burn area was evaluated by an interagency WERT. The WERT rapidly evaluated postfire watershed conditions, identified potential **Values-at-Risk (VARs)** related to human life-safety and property, and evaluated the potential for increased postfire hazards. The team also recommends 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 postfire watershed hazards (e.g., debris flows and flooding). Moderate and high soil burn severities typically create the most impacts.
- The Lake Fire produced mostly low soil burn severity. Lake Fire area soil burn severity: Unburned to Very Low (11%), Low (58%), Moderate (29%), High (1%).
- The WERT identified 16 VARs within and downslope/downstream of the fire. Eight (8) VARs are shown as polygons which encompass multiple individual sites subject to similar hazard and risk. The remaining 8 VARs are points, which are associated with discrete sites such as homes and road crossing structures.
- The road network within and downstream of the Lake Fire perimeter will be subject to increased potential for storm damage for the next two to five years. Specific crossing structures that provide ingress and egress to homes or road crossings of main channels were addressed as VARs. A community of homes below Figueroa Mountain that are accessed by Tunnel Road are particularly vulnerable to road damage from flooding and debris floods that may impact ingress and egress.
- Zaca Lake Road, Figueroa Mountain Road, Sycamore Valley (Neverland) Ranch, and Tunnel Road have several crossing structures subject to potential blockage and overtopping.
- Some homes and structures are at risk of flooding or debris flows. These structures primarily exist at the Midland School, Sycamore Valley (Neverland) Ranch, and Zaca Lake area.
- Model results are presented for postfire debris flow hazard and postfire flooding. The model results show that the fire has significantly increased the potential for these hazards compared to prefire conditions.
- Residents subject to postfire hazards need to have a clear understanding of these hazards and mitigation strategies (e.g., evacuation, deflection structures, culvert improvements), to effectively reduce risk to life, safety, and property.
- **To trigger the National Weather Service early warning system, the WERT suggests a fire-wide rainfall/duration thresholds of 0.35 inches in 15 minutes, 0.5 inches in 30 minutes, and 0.7 inches in 60 minutes.**
- Close coordination between Santa Barbara County Office of Emergency Management, the National Weather Service, local first responders, and Santa Barbara County Public Works will be necessary to effectively develop and implement a response plan that will minimize risk. WERT information provides critical intelligence for response planning and implementation.

Introduction

Background

The Lake Fire started on 5 July 2024 near Zaca Lake in Santa Barbara County, north of Los Olivos, California. It grew rapidly through grass and brush during a prolonged heat wave across the West Coast. The fire was divided into two zones, the North Zone led by CA-CIMT13 with USFS and the South Zone led by IMT5 with CAL FIRE. The purpose of zoning the fire was to ensure strategic, logistical, and operational functions are met as the fire grew in complexity. Santa Barbara County proclaimed a local emergency due to the Lake Fire, which threatened several communities including Santa Ynez and Los Olivos, as well as ranches, farms, homes, campgrounds, and State Routes 154 and 176. As of 27 July 2024, the fire was 38,664 acres[1] in size (60 square miles) and 90% contained. The incident had zero fatalities, seven firefighter injuries, and no civilian injuries. The fire destroyed four structures, damaged one structure, and threatened 56 structures.

Based on previous experience with postfire watershed responses, CAL FIRE Incident Management Team (IMT) 5 requested a postfire watershed evaluation. The California Geological Survey (CGS) remote screening recommended response with a Type-2 Watershed Emergency Response Team (WERT). Primary concerns for burned watersheds are the increased potential for damaging sediment and debris-laden flood flows, increased potential for debris flow occurrence, rockfall from steep slopes, and hillslope erosion resulting in excessive sedimentation due to storm run-off for several years following the fire. As the wet season approaches (typically October through May), it is critical that people who live in hazard areas within and downstream of the Lake Fire implement emergency protection measures (EPMs) where appropriate, check weather conditions and forecasts, stay alert to National Weather Service (NWS) flash flood watches and warnings, and monitor Santa Barbara County resources for guidance on evacuations. The fire area and upslope watersheds are subject to embedded convection in winter storms and, on rare occasions, summertime thunderstorms, which can generate localized heavy rainfall and resultant postfire flood and debris flow hazards.

This report presents the results of a rapid evaluation of postfire geologic and hydrologic hazards to life-safety and property (i.e., collectively known as “Values-at-Risk” or “VARs”) for private lands affected by the Lake Fire. Figure 1 shows the acreage and percentage of the burned area by ownership for the fire. Approximately 48 percent of the burned area is in private ownership, and almost 8 percent are lands managed by the state of California (i.e., Sedgwick Reserve). The Lake Fire WERT conducted field assessments from July 24 to July 26, 2024. WERT representatives interacted with Santa Barbara County personnel and other stakeholders during the WERT assessment and a draft summary and map of identified VARs was provided to stakeholders on July 30. A briefing providing the WERTs preliminary findings and VARs was subsequently conducted with Santa Barbara County emergency response personnel and other responsible agencies on 30 July 2024. Team members for the Lake WERT are listed in Table 1.

[1] Calculations in this report use a fire perimeter that contains 40,667 total acres.

Table 1. Lake Fire WERT members.

Name	Position	Agency	Expertise-Position
Don Lindsay; PG 7489; CEG 2323; PE 76899; GE3097	Team Leader	CGS	Engineering Geology; Civil Engineering
Drew Coe; RPF 2981	Team Member	CAL FIRE	Liaison
Brian Mattos; RPF 2476	Team Member	CAL FIRE	Forestry-Safety
Rebecca Rossi	Team Member	CGS	Engineering Geology
Paul Richardson	Team Member	CGS	Engineering Geology
Derek Cheung	Team Member	CGS	Hydrology
Adjunct Team			
David Cavagnaro	Adjunct Member	CGS	GIS
Michael Falsetto	Adjunct Member	CGS	GIS
Deshawn Brown	Adjunct Member	CGS	GIS

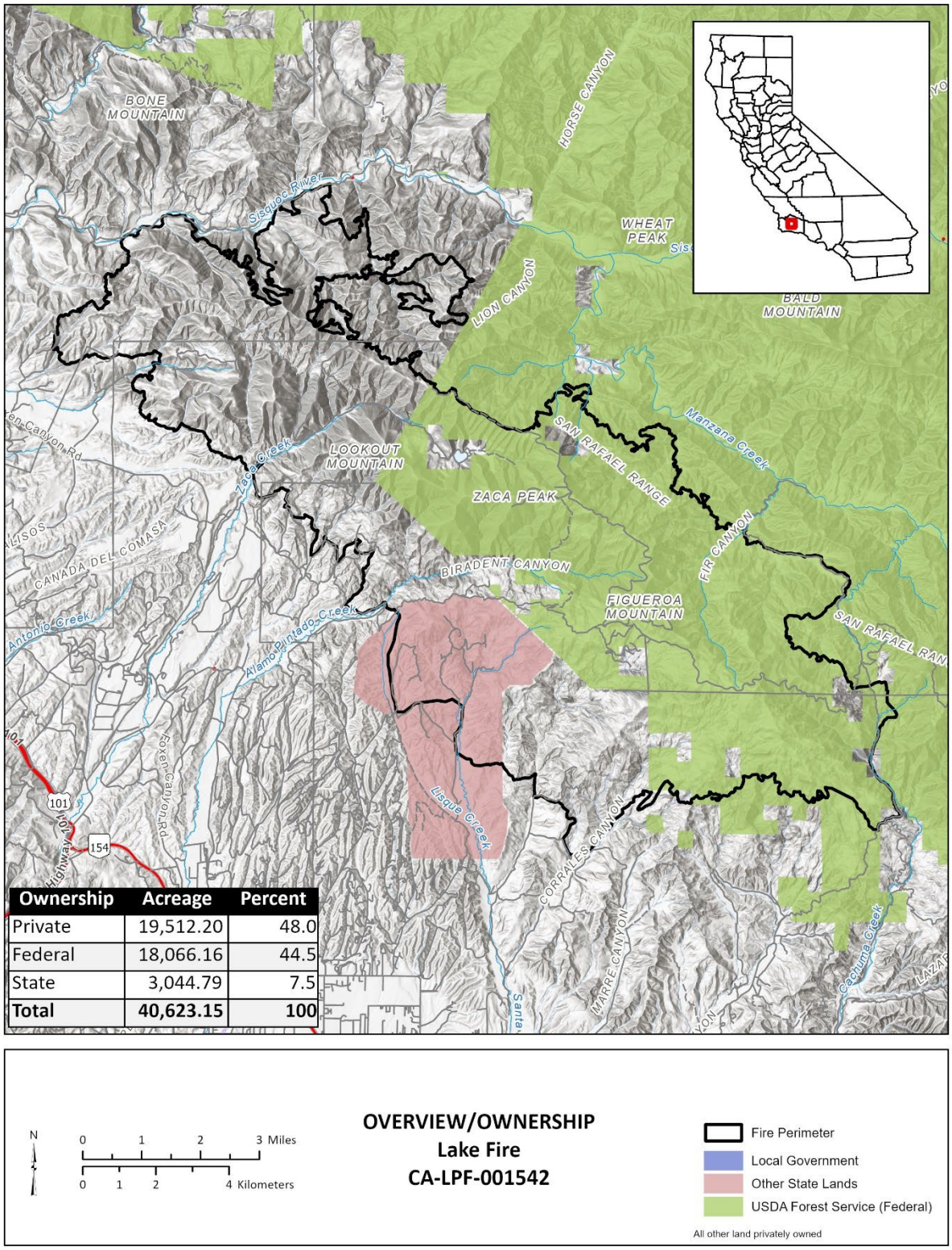


Figure 1. Ownership map of the Lake Fire burned area. Note that Birabent Canyon (in text) and Biradent Canyon (on map) are alternative spellings of the same canyon.

Objectives and Scope

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

- 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 postfire flooding, debris flows, rockfall, erosion, and other hazards that are elevated due to postfire conditions.
- Rapidly determine relative postfire risk to these values, using a combination of state-of-the-art analytical tools (e.g., USGS postfire debris-flow likelihood model) and the best professional judgement of licensed geohazard professionals (i.e., Professional Geologists; Certified Engineering Geologists; Professional Civil Engineers).
- Develop preliminary emergency protection measures (EPMs) needed to avoid or minimize threats to life-safety and property.
- Communicate findings to responsible entities and affected parties so that the information and intelligence collected by the WERT can be used in response planning to reduce risk from postfire watershed hazards.
- It is important to emphasize that the WERT performs a rapid evaluation of postfire hazards and risk. A complete characterization of postfire 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.
- This document summarizes downslope/downstream Values-at-Risk (VARs) and makes specific and general recommendations to reduce exposure to postfire, life-safety and property hazards on county and private lands. **While the report can provide useful information to emergency planners and first responders, the GIS data, in the form of a geodatabase, produced by the WERT is the most important source of information for postfire response planning. 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.**

Physical Setting

Topography and Climate

The Lake Fire burned an area north of the town of Los Olivos, primarily affecting the Zaca Creek, Foxen Canyon, Birabent Canyon, Santa Agueda Creek, and Sisquoc River watersheds. The topography within and downstream/downslope of the fire is predominantly low to moderate gradient slopes but varies from moderate to very steep in some areas. Elevations range from approximately 700 feet on the southern edges of the burned area to 4,500 feet at Figueroa Mountain in the southeastern portion of the fire.

The Lake Fire area is classified as having a warm-summer Mediterranean climate (Köppen Climate: Csb, Beck et al., 2018). Average annual precipitation at the Figueroa Mountain rain gauge (3250 ft) within the burn area is 21.44 inches and is primarily in the form of rain (Santa Barbara County Flood Control District, 2023). This area experiences high interannual variability in precipitation. Precipitation occurs primarily during the cool season (October-May) associated with winter storms, which may feature atmospheric rivers (e.g., Oakley et al., 2018). Convection

(i.e., thunderstorms) may be embedded within these winter storms, producing short-duration, high-intensity rainfall capable of triggering postfire floods and debris flows (Oakley et al., 2017). Summertime thunderstorms are rare, but possible, over the burn area.

Hydrology and Flood History

The Lake Fire burn area is primarily drained by tributaries including Zaca, Alamo Pintado, and Santa Agueda Creeks, which drain southwesterly into the Santa Ynez River (downstream of Bradbury Dam and Lake Cachuma reservoir). The northern side of the fire is drained by headwater tributaries, and Asphaltum and Davey Brown Creeks, which drain to the Sisquoc River. A smaller portion of the fire on the southeastern edge drains along Cachuma Creek to Lake Cachuma reservoir.

Two stream gages are located outside of the fire perimeter along two tributaries that drain to the Santa Ynez River. Gage Site Number 11129800 is located on Zaca Creek, approximately 10 miles downstream of the fire perimeter. This gage has confirmed data from 1963 to present and lists the top three highest flows occurring in 1969, 1998, and 2023, with estimated discharges of 1390 ft^3/s, 1070 ft^3/s, and 1060 ft^3/s, respectively (Figure 2). The second stream gage, Site Number 11128250, is located along Alamo Pintado Creek, approximately 21 miles downstream of the fire perimeter. This gage has confirmed data from 1970 to present and lists the top three highest flows occurring in 1998, 2023, and 1983 with estimated discharges of 3,680 ft^3/s, 2,190 ft^3/s, and 900 ft^3/s, respectively (Figure 3). On January 9, 2023, above bankfull flows were observed along Alamo Pintado Creek, near the Midland School (see VAR BC-02), that caused flooding at the base of a house located on the outside of a meander bend. Other post-storm impacts observed following the January 9, 2023, storm included shallow flooding and debris loading that impacted structures around Zaca Lake (see VAR ZC-04) and damaged crossing structures (e.g., see ZC-07) along the access road to Zaca Lake. Moreover, shallow landsliding, triggered during the 2023 storm event, is evident on aerial imagery within steep slopes and headwall swales throughout the burn area (see Geology and Landslides).

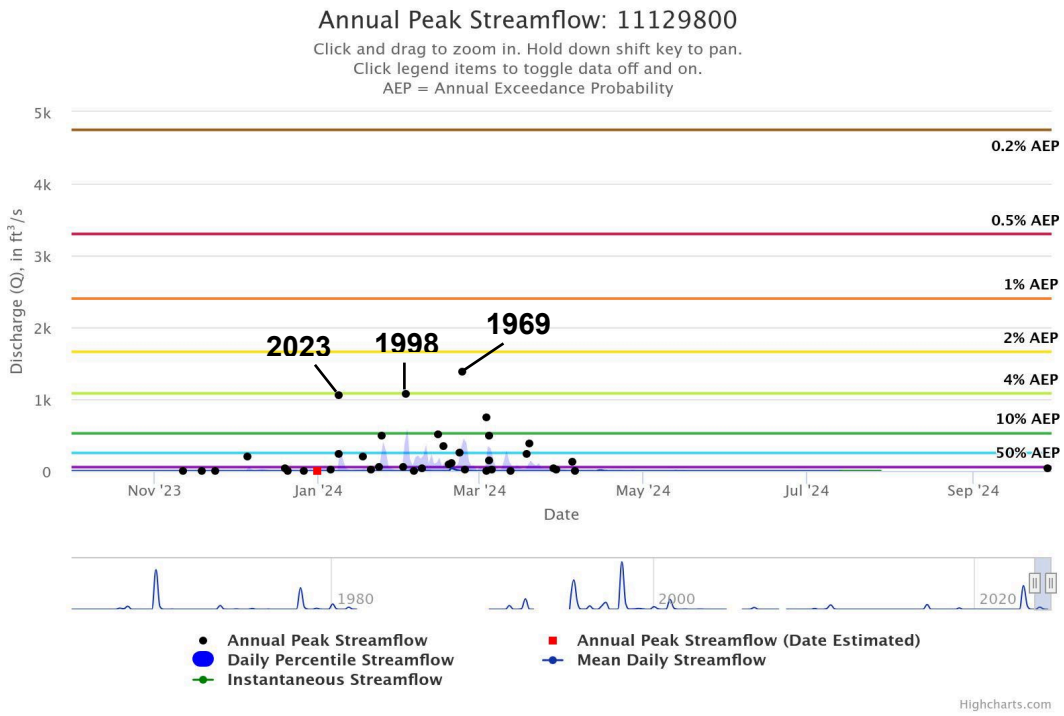


Figure 2. Annual peak streamflow for the USGS Zaca Creek stream gage (11129800) that highlights the top three flow events between 1963 to present (Source: StreamStats (usgs.gov)).

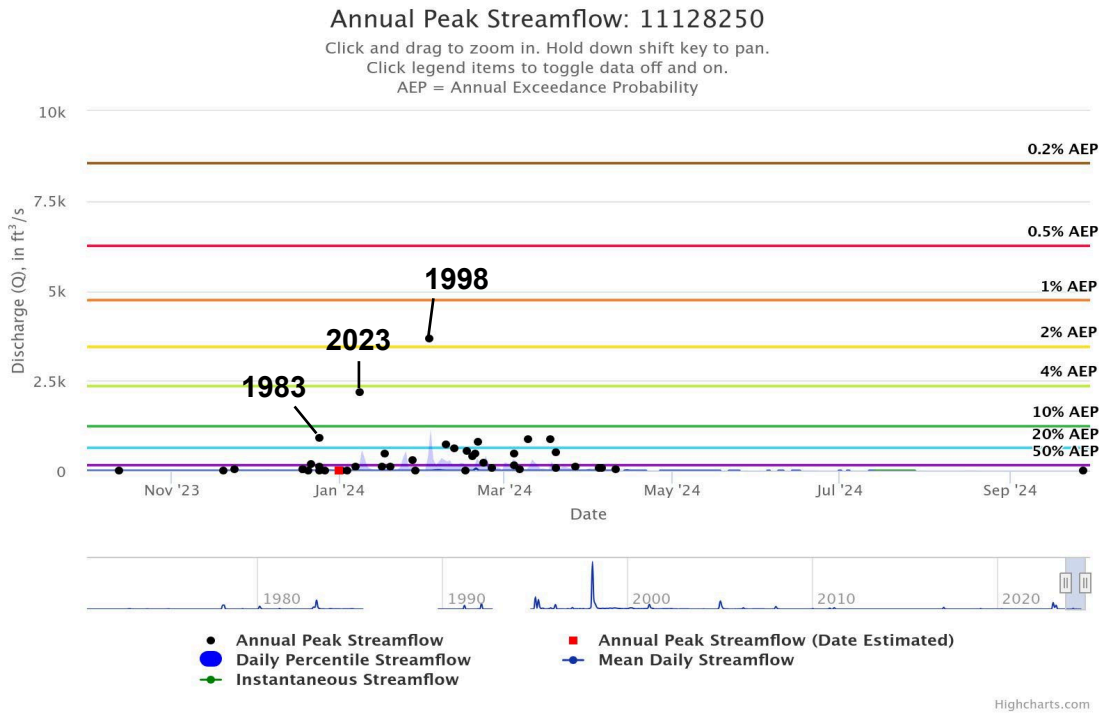


Figure 3. Annual peak streamflow for the USGS Alamo Pintado Creek gage (11128250) that highlights the top three flow events between 1970 to present (Source: StreamStats (usgs.gov)).

Vegetation and Fire History

The area burned by the Lake Fire was characterized by a mixture of grass, shrubs, woodlands, and forest. Grasslands covered the lowest slopes, with scattered blue oaks. Bands of low-elevation riparian woodlands grew along drainages with mature live oaks, bay laurel, sycamore, and willow. Uplands were grasslands or shrublands, with mature manzanita, ceanothus and some gray pines in areas without recent fire history. The highest elevations in the burn area grew grass, ceanothus, and live oaks, with Coulter pine. Coulter pine and Douglas-fir grew in some of the highest north aspects and drainages.

Santa Barbara County is known for its temperate Mediterranean climate with periods of prolonged drought. The local weather patterns combined with the adjacent steep mountains dominated by seasonally flammable grasses and chaparral, provide the conditions that make this region's ecosystem one which has included wildfires for thousands of years. A study of microscopic charcoal from the Santa Barbara Channel indicates that over the past 560 years, large wildfires (greater than 50,000 acres) have occurred in this area on an average of every 20 to 30 years. Many areas on the southern California coast, mountains, and valleys have seen fire frequencies increase dramatically over the last century with most of the increase associated with population growth occurring at the end of World War II. Since the 1950s, the greater Santa Barbara area averaged one large fire per decade; however, the number of large fires within and adjacent to the County has increased substantially over the last decade (Santa Barbara County Fire Safe Council, 2024; https://sbfiresafecouncil.org/fire-history-of-santa-barbara-county/).

The Lake Fire footprint occupies areas previously burned, including two large fires, the Marre Fire (1993) and the Zaca Fire (2007; Figure 4). Between 25 September and 8 October 1993, the stand-replacing Marre Fire burned 42,700 acres along the northern Santa Ynez Valley ranchlands and the Los Padres National Forest and into the San Rafael Wilderness, including most of the upper reaches of the Zaca Creek and Alamo Pintado Creek drainages.

From 4 July to 31 August 2007, the Zaca Fire burned 240,207 acres, mostly north of the Marre Fire in the Lake Fire area, but also well to the east into Ventura County, and was the largest California fire of 2007.

While the 2007 Zaca Fire was mostly held at the northern edge of the 1993 Marre Fire, along Forest Route 8N02 on the crest of the San Rafael Mountains, the 2024 Lake Fire actively burned onto both previous fire footprints, especially the older Marre Fire.

Drainages burned in the Lake Fire feeding Asphaltum Creek from the north, including Schoolhouse Canyon, do not have any previous documented fire history.

Another Lake Fire area without recorded fire history lies east of Lisque Creek and encompasses approximately 5 square miles, with about 1 square mile of that along the north aspects of lower Birabent Canyon, including Ballard Creek feeding Alamo Pintado Creek. In addition, some of the northern tributaries to Zaca Creek have no documented fire activity since the early 1900s.

Areas with less recent fire activity or no recorded fire history might have a higher potential for postfire response due to higher fuel loading which might lead to more severely damaged soil. Also, since these areas have not been subjected to recent postfire erosional processes, they may have a more abundant supply of sediment that can be entrained by amplified postfire runoff.

Geology and Landslides

The Lake Fire occurred in and near the San Rafael Mountains. The San Rafael Mountains are a small mountain range along the boundary of the Transverse Ranges and the Coast Ranges Geomorphic Provinces in southern California (CGS, 2002). The mountains trend northwest-southeast and are paralleled by the Zaca Anticline to the south and the Sierra Madre Mountains to the north (CGS, 1977). The Big Pine Fault trends eastward and is near the boundary of the San Rafael and Sierra Madre Mountains (CGS, 1977). The San Andreas Fault parallels the San Rafael Mountains and is approximately 30 miles east of the Lake Fire (CGS, 1977).

The southwest portion of the fire burned gentle topography underlain by sandstone, shale, and gravel deposits that are poorly consolidated and Pliocene-Pleistocene in age (CGS, 1977). These deposits and younger deposits underlay the mostly northeast-southwest trending valleys that drain the San Rafael Mountains. A belt of Franciscan Complex (sedimentary and metasedimentary rocks including shale, chert, limestones, and conglomerate) and ultramafic rocks high in serpentine are present at the southern range front where the slopes transition from relatively gentle topography to more rugged topography (CGS, 1977). Above the southern range front, slopes become substantially steeper, and the rock type is sandstone, shale, siltstone, conglomerate, and breccia that are moderately to well consolidated and Miocene in age (CGS, 1977). Other rock types inside the fire perimeter at high elevations in the San Rafael Mountains include Tertiary volcanic rocks and isolated exposures of ultramafic rocks (CGS, 1977). The eastern boundary of the fire is underlain by older sandstones, shales, and conglomerates that are Lower Cretaceous in age and extend to the northeast (CGS, 1977). Figure 5 provides a geologic map of the Lake Fire burn area.

Soils on hillsides above the range front were typically shallow (< 10 cm) and coarse with fractured rock fragments present at the surface. Bedrock was commonly exposed on hillsides in the steeper areas above the range front. Dry ravel loading was minimal and fluvial fan deposits were identified where channels had incised fans. Debris flow deposits were not identified in areas that were visited during the WERT field investigation. Ancient landslide deposits exist in the drainages to the south and west of Figueroa Mountain. Numerous homes were built on these deposits near the headwaters of Latigo Canyon.

Numerous shallow slope failures were observed within the burn area that were triggered during 2023 winter storms. These failures mostly initiate along steep concave slopes that support shallow-rooted vegetation, including grass and chaparral. Most of the observed failures have shear planes located just below the root zone, near the soil mantle/bedrock contact. Some failures appear to have transitions into debris flows as they progressed downslope, loading local channels with debris that can be mobilized during future runoff events.

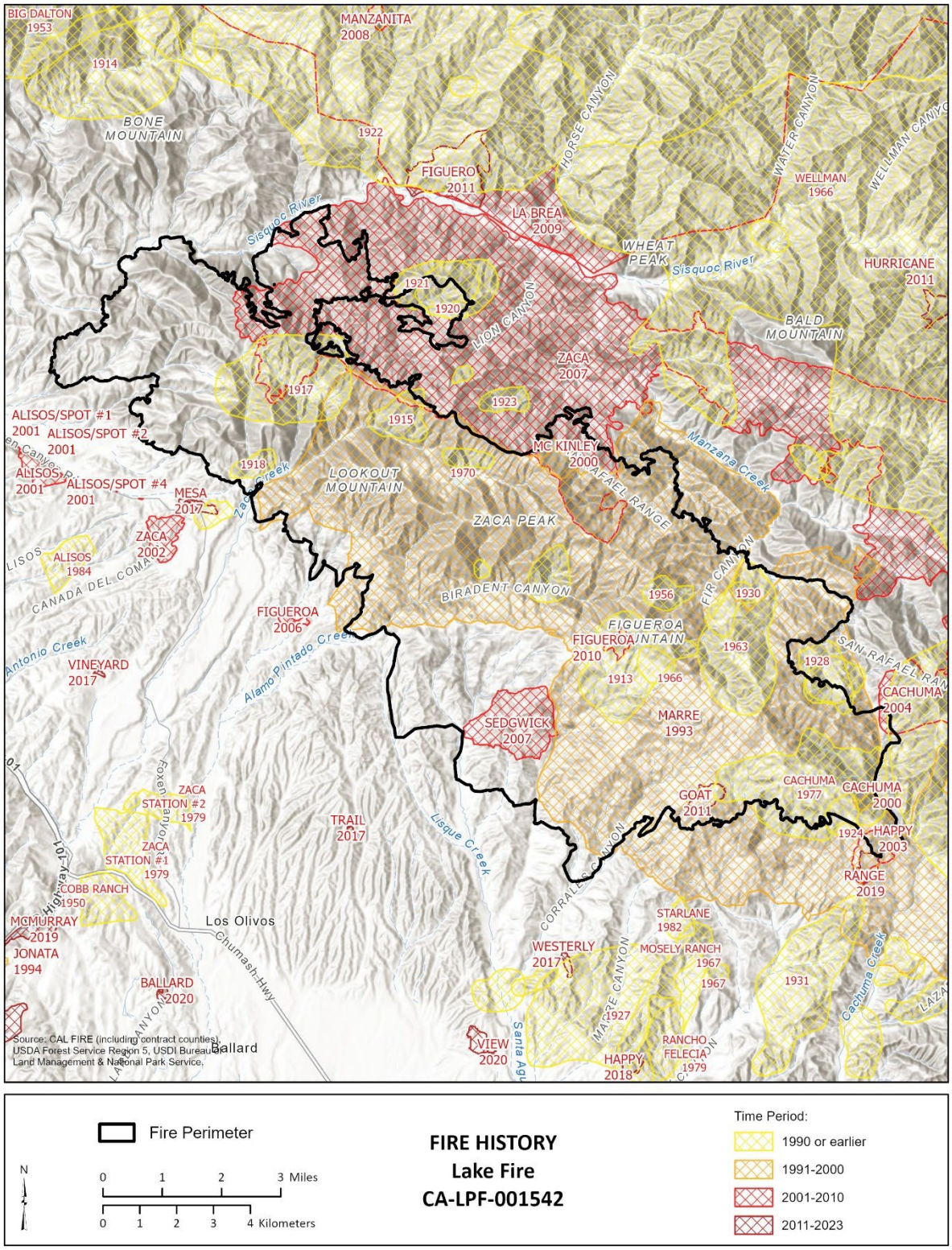


Figure 4. Fire history for the Lake Fire. Note: Areas that haven't burned for many decades have a potentially higher erosional response than areas that have been subject to recent fire.

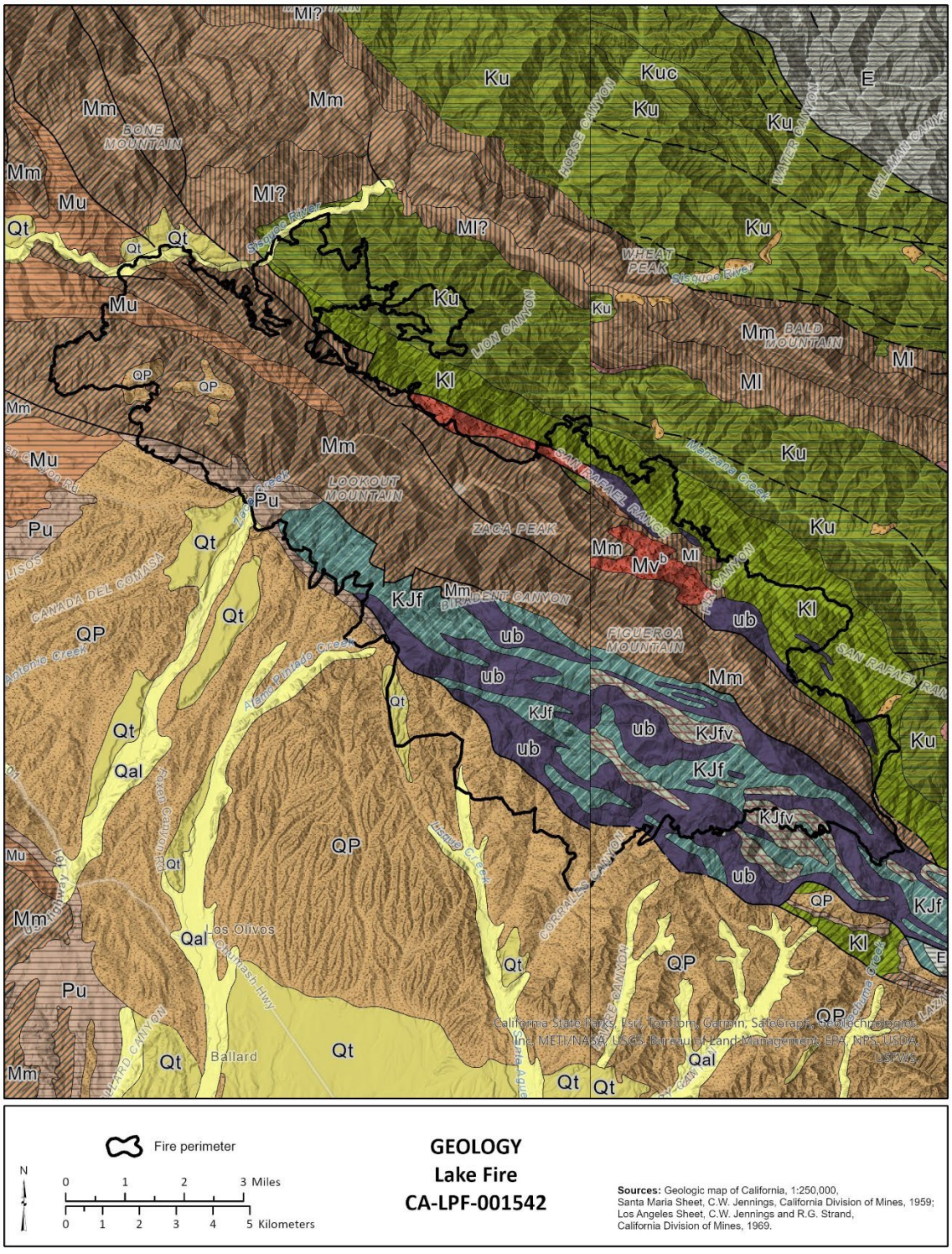


Figure 5a. Geologic map for the Lake Fire. *Note map is a slightly offset combination of Santa Maria and Los Angeles geologic maps.

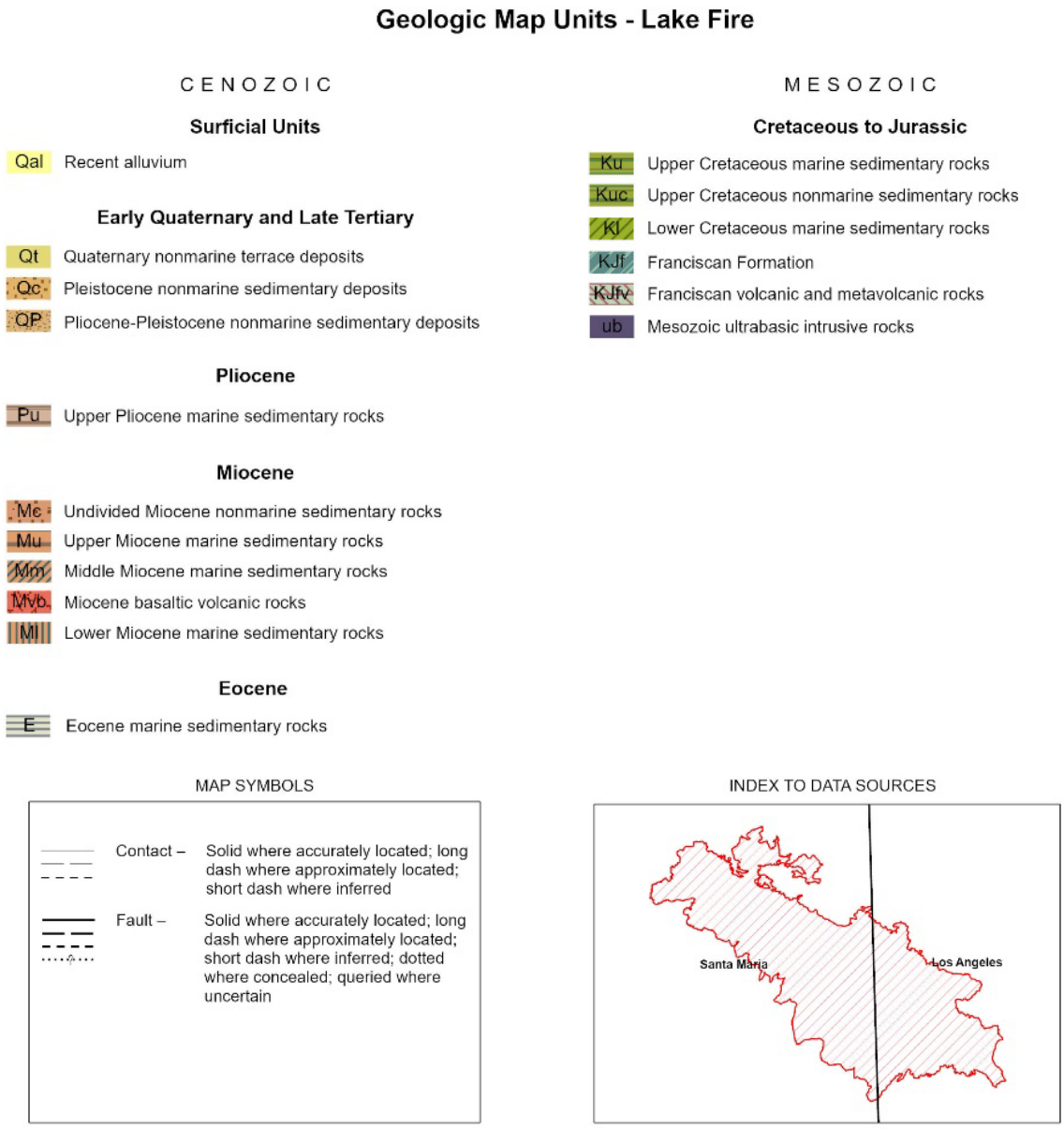


Figure 5b. Legend for geologic map in Figure 5a for the Lake Fire.

Mineral Hazards and Wells

The locations of mines, prospects, wells and areas of potential mineralogical concern are shown on Figure 6. This map indicates that numerous oil and gas wells are present within the burned area primarily northwest of Zaca Creek. These wells are reportedly plugged and dry so were not assessed for hazards. Several commodity mines southeast of Zaca Creek are present as well. There are an estimated 8 Chromium and 4 Mercury mines identified on the map that are within the fire perimeter. The map also identifies the approximate locations of rock bodies composed of either gabbro, mélange or metavolcanic rock that have the potential to contain naturally occurring asbestos, chromium, cobalt, copper, or nickel, which could be potentially hazardous if present in sufficient quantity. However, these bodies are in remote portions of the burned area

and therefore the potential for fire-related impacts to health and safety is also considered negligible.

Based on our limited review of regional geologic maps (Figure 5) and our field observations, partially serpentinized ultramafic rock units are present within the burn area that may contain asbestos from minerals. Asbestos is classified as a known carcinogen by state, federal and international agencies. State and federal health officials consider all types of asbestos to be hazardous. There is no agreed-upon “safe” level of asbestos exposure because there is insufficient scientific information to support the identification of an exposure level at which there would be a risk of cancer.

Naturally occurring chromium, manganese, and mercury are known metals found in metamorphic and ultramafic rocks of the Coast Ranges. These rocks occur throughout the burned area. Contributions of metals to local creeks and watersheds can be anticipated.

The locations of potential mineralogical hazards, including ultramafic rocks and known mine locations are shown below in the Mineral Hazard Map (Figure 6.)

Two prospects and one mine were identified to be near or within stream channels. The mine is an open-pit mine located in a watershed directly east and adjacent the Zaca Lake watershed. It spans both sides of the stream channel. Neither mine nor mine prospects showed signs of recent use, structures, or human activity, so they were not assessed for postfire hazards. These mining operations may still contain mine tailings and mine waste that may contain potentially harmful concentrations of heavy minerals. The use of mercury was common practice to enhance gold recovery in all the various types of mining operations since 1850. Potential adverse impacts to health and safety from these three features related to postfire conditions is considered negligible given their remote nature.

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

We recommend consultation with the Santa Barbara County Air Pollution Control District (ourair.org/asbestos/) to develop mitigations that are centered on limiting dust generation and limiting dust exposure.

For general review information on hazardous minerals, see:

https://www.conservation.ca.gov/cgs/minerals/mineral-hazards

https://www.oehha.ca.gov/air/asbestos-fact-sheet-information-health-risks-exposures-asbestos

For additional mineral hazards information, see:

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

https://www.mindat.org/loc-30702.html

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

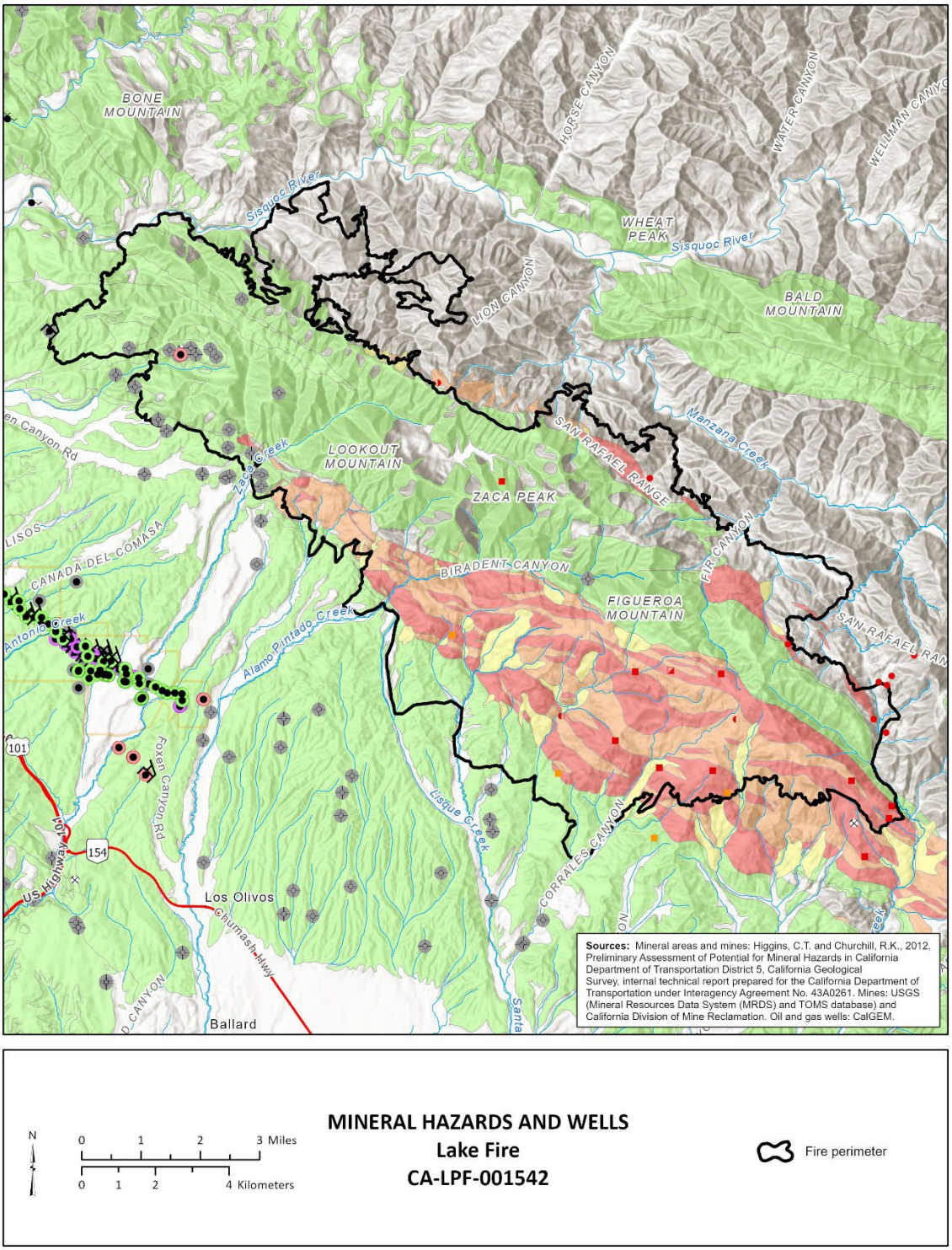


Figure 6a. Mineral Hazards and Wells map for the Lake Fire.

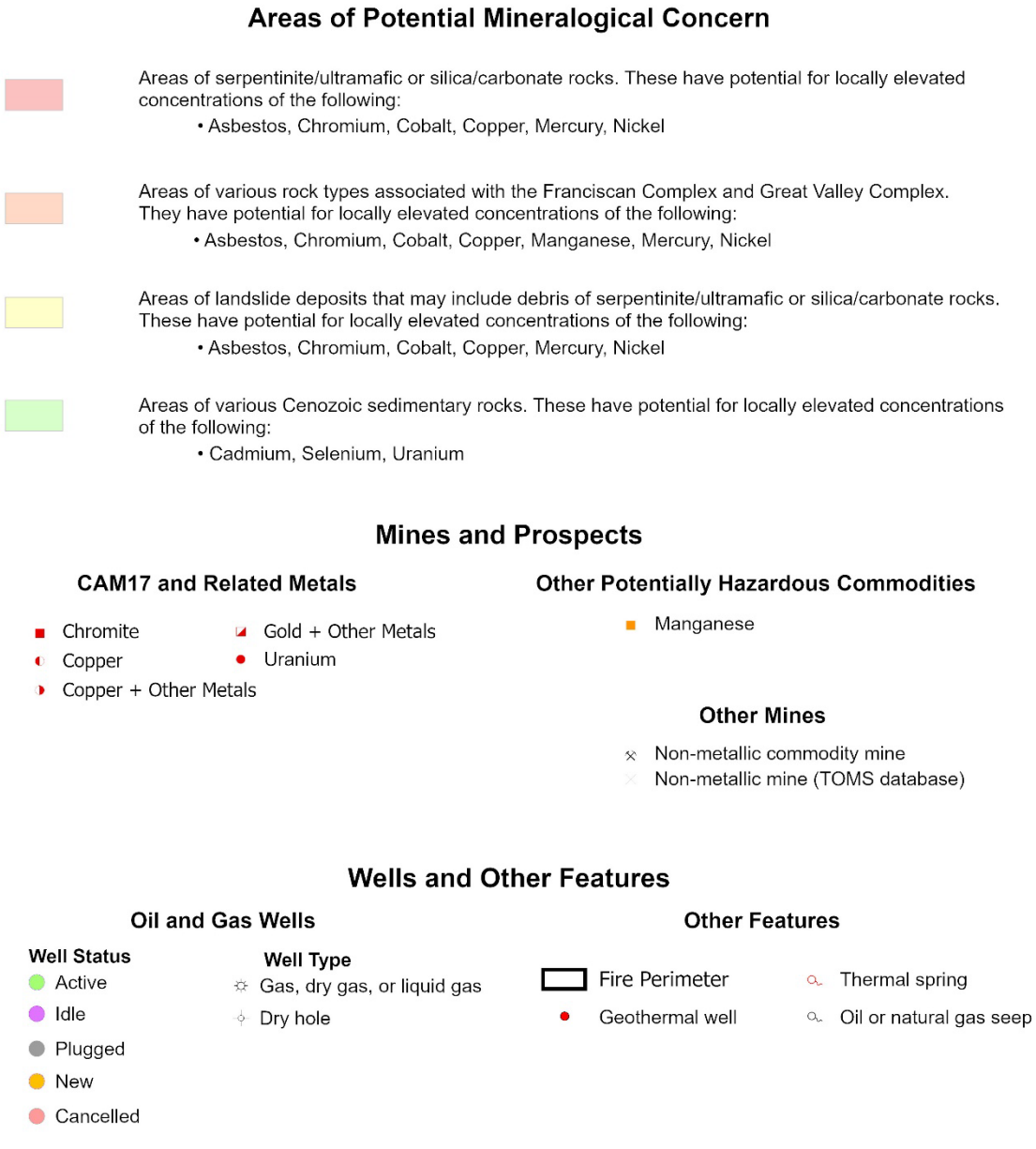


Figure 6b. Legend for Mineral Hazards and Wells map for the Lake Fire, Figure 6a.

Modeling Postfire Response

Soil Burn Severity

The initial field assessment by the WERT was conducted using a Burned Area Reflectance Classification (BARC) map that was field validated and edited to create a Soil Burn Severity (SBS) map of the burn area (Figure 7). In general, the SBS map reflects lower burn severity than initially indicated by the BARC map. Additional field verification of the WERT-generated SBS map will be done at a later date by a USFS BAER team assigned to the Lake Fire.

Within the Lake Fire footprint, fifty-eight percent (58%) of the area was burned at low severity, twenty-nine (29%) at moderate severity, and one percent (1%) at high severity. Eleven percent (11%) is classified as very low/unburned soil burn severity. Some of the highest proportions of moderate and high soil burn severity are located within a large area of mountainous terrain along the northwest to southeast portion of the fire.

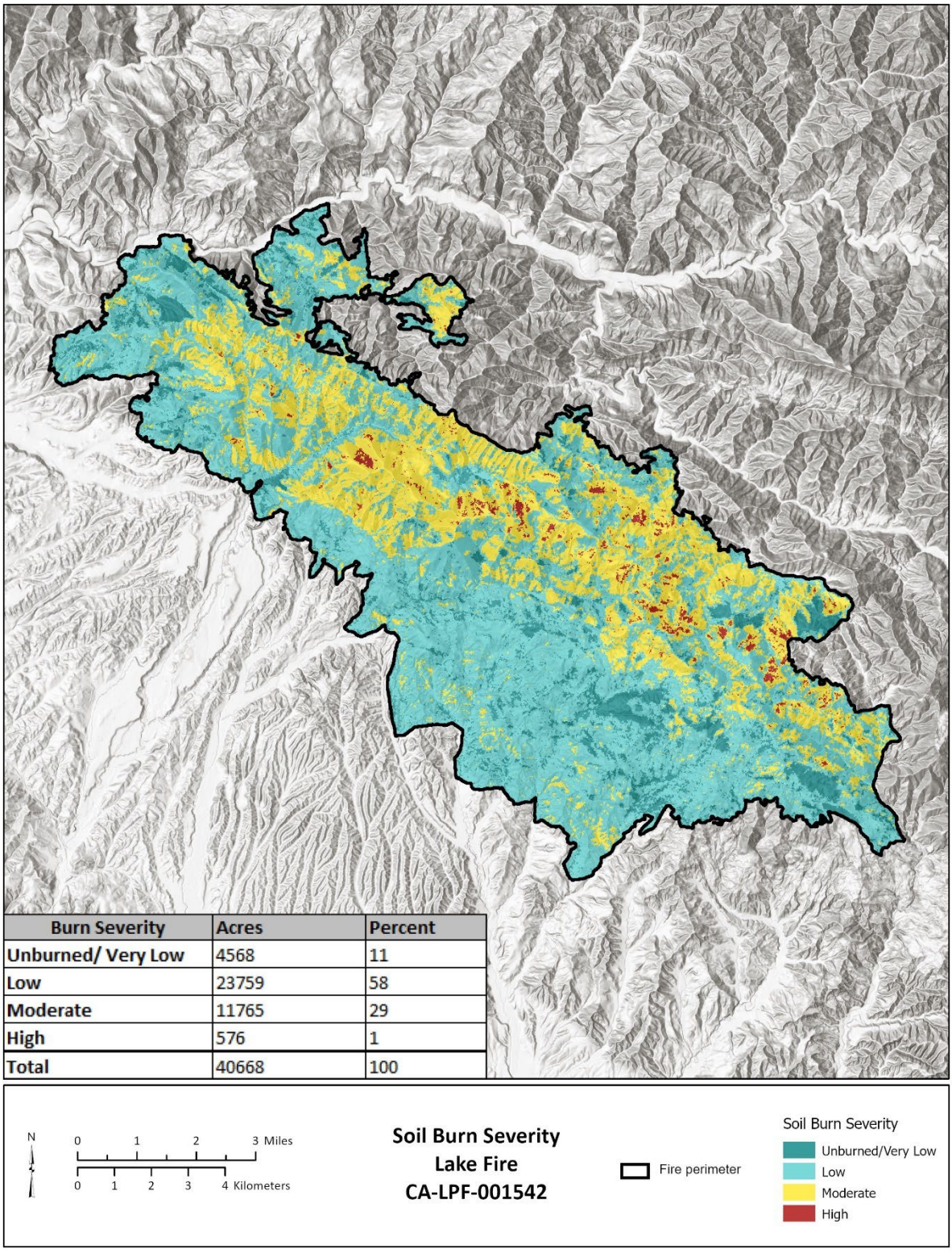


Figure 7. Soil Burn Severity map for the Lake Fire.

Postfire Debris Flow: Predicted Thresholds and Hazards

The USGS postfire debris flow hazard model (Staley et al., 2016) was run using the WERT-generated SBS map for the Lake Fire to assist in the WERT's assessment of locations where hazards to life, property, and infrastructure may exist. The 'combined hazard' model results reflect the potential likelihood of a debris flow occurring as well as the volumetric yield of the debris flow. These results are combined into an overall categorical ranking that ranges from low to high. Figure 8 shows the combined debris flow hazard for the 15-minute, 24 mm/hr (0.94 in/hr) intensity storm. Figure 8 indicates that the combined debris flow hazard is low to moderate in general, including areas containing critical VARs at a rainfall intensity of 24 mm/hr (0.94 in/hr); high combined hazard is present within two small basins along Zaca Lake Road. Combined debris flow hazard is consistently moderate for Zaca and Sycamore Canyons and Figueroa Mountain area and tributaries. Birabent Canyon and tributaries contain low to moderate combined hazard (low combined hazard for north facing slopes). Figure 9 illustrates 15-minute rainfall intensities required to generate a 50 percent likelihood of debris flows for each basin across the burned area. The fire-wide basin average 15-minute rainfall intensity threshold is about 39 mm/hr (1.5 in/hr) but this debris-flow triggering threshold decreases along Zaca Lake Road where basins are steep and burned mostly at moderate and high soil burn severity.

Debris Flow Model Accuracy and Limitations

For basins (sub-watersheds) burned in the Lake Fire, the results of the USGS debris flow model (Staley et al., 2016) give an indication of potential postfire watershed response but may not accurately predict debris-flow likelihood or volume for a given design storm.

The USGS model results do not constitute a site-specific analysis of debris-flow hazards. Additional on-the-ground evaluation should be conducted by qualified and licensed professionals where necessary and appropriate, rather than taking the model results at face value. The model results are also limited in that they do not show hazards for basins that are less than approximately 5 acres in area, and do not specifically identify hazards in areas where one or more tributaries may contribute flood and debris flows (drainage areas approximately greater than 2,000 acres denoted as watch stream segments that are symbolized as blue lines in Figures 8 and 9). For areas not shown as having a debris flow hazard along a segment that is associated with a drainage network, a hazard may still be present yet undefined because the segment model results are limited based on the resolution of the input digital elevation model (DEM). Additionally, other hillslope processes such as rockfalls, debris slides, and deep-seated slides are not included in the model results.

It should also be noted that the debris-flow model does not predict runout and inundation areas beyond the modeled source basin and does not consider potential increased hazards from multiple storm events that may load channels with sediment that could be entrained in future debris flows.

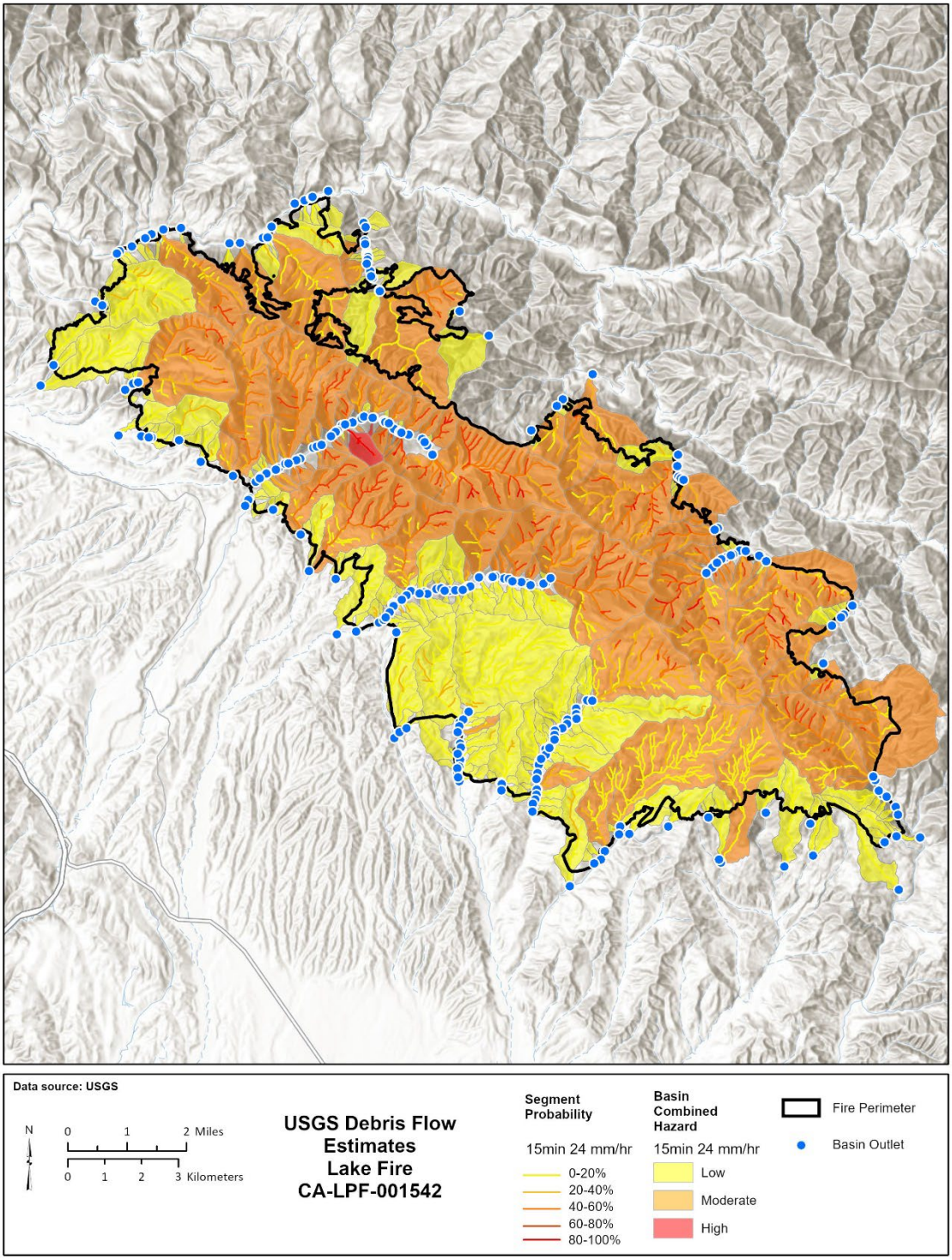


Figure 8. Combined debris flow hazard on the Lake Fire for the 24 mm/hr (0.94 in/hr) 15-minute storm event.

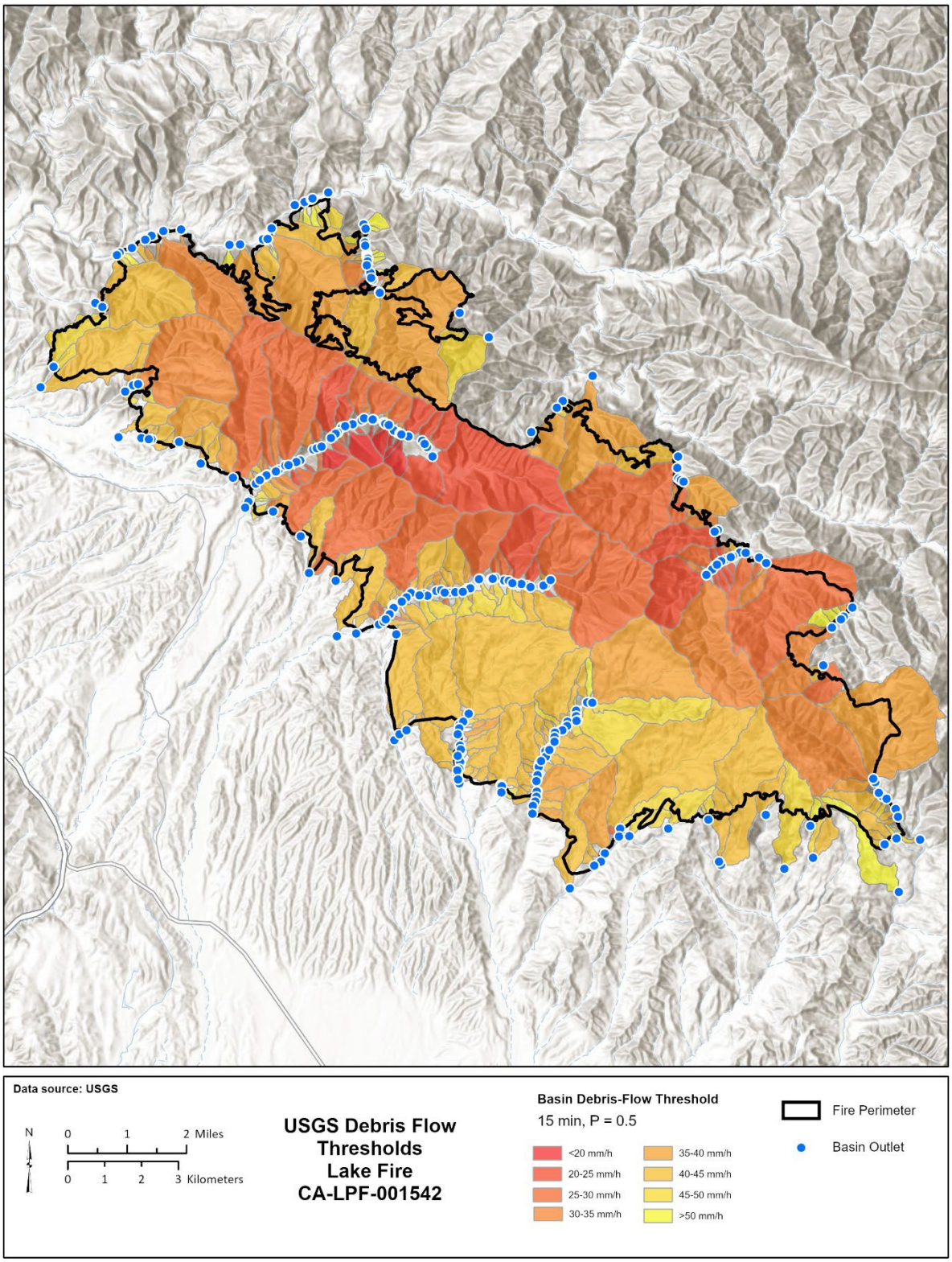


Figure 9. Predicted 15-minute rainfall intensity with a 50 percent likelihood of triggering a debris flow for the Lake Fire.

Postfire Hydrology

Peak flows increase following wildfire as a result of reduced vegetation, surface cover, reduced infiltration, and the formation of water repellent soils. The largest peak flows occur during intense, short duration rainfall events on watersheds with steep slopes (Neary et al., 2005). Research conducted in southern California indicates that postfire peak flows can increase as much as 30-fold for moderate storms (0.1- to 5-year RI) and approximately 2- to 3-fold for large magnitude storms (5- to 100-year RI) (Rowe et al., 1949; Moody and Martin, 2001). Kinoshita et al. (2014) reported that commonly used flood flow prediction methods have lower confidence with larger recurrence interval events (25- and 50-year); therefore, we analyzed pre- and postfire flows assuming 2-year and a 10-year storm events.

The WERT selected four watersheds, or “pour points”, to estimate potential postfire peak flow increases to Values-at-Risk from flooding and sediment-laden flood (debris flood) hazards. Figure 10 shows the four pour point locations. These pour points represent elevated flood hazard and/or debris flood impacts to public safety and property. Pour points located close to the fire perimeter and burned at moderate and high soil burn severity (SBS) yield larger postfire flow increases than those far below the fire perimeter and those burned at lower severity.

Prefire peak flow estimates were first produced for the four pour point watersheds using the South Coast USGS regional regression equations for 2-year and 10-year recurrence interval discharges (USGS StreamStats, 2024; Gotvald et al., 2012) and by performing a flow transfer using gaged data and the difference in drainage area between the gaged watershed and the pour point watershed (ungaged) following methods outlined in Waananen and Crippen (1977). The stream gage used in performing the flow transfer was the USGS Alamo Pintado gage (11128250) located downstream of the Midland School and the Figueroa Road bridge VARs at latitude 34.618319, longitude -120.120703. The Alamo Pintado gage was selected for use in the flow transfer method based on its long history of peak flow records and similar basin characteristics as those shared by the pour point watersheds.

Changes in postfire peak flows were estimated using two methods. The first method uses procedures outlined by USFS BAER teams (unpublished), referred to here as the BAER method. The BAER method uses the proportions of the watershed that are unburned and burned at low, moderate, and high SBS to account for postfire runoff increases. For this analysis, the postfire 2-year recurrence interval flow is estimated by assuming areas that are unburned or have low SBS undergo no change in runoff (Q2); runoff from moderate SBS areas are assumed to respond similarly to a 10-year recurrence interval discharge (Q10); and runoff from the high SBS areas are assumed to respond similarly to a 25-year recurrence interval discharge (Q25). To estimate postfire10-year recurrence interval flow, unburned and low SBS areas are assumed to be unchanged (Q10); runoff from moderate SBS areas are assumed to respond similarly to a 25-year recurrence interval discharge (Q25); and runoff from the high SBS areas are assumed to respond similarly to a 50-year recurrence interval discharge (Q50). Applicable USGS regression equations for the Q2, Q10, Q25, and Q50 flows are applied to each category (USGS StreamStats, 2024; Gotvald et al., 2012). The area-weighted flow estimates by soil burn severity class are then summed to derive the runoff response that would typically generate a 2-year peak flow and a 10-year peak flow.

The second method estimates peak flow using Moody’s level 2 empirical model (Moody, 2012) and calculates a postfire runoff coefficient for a burned watershed as a function of mean

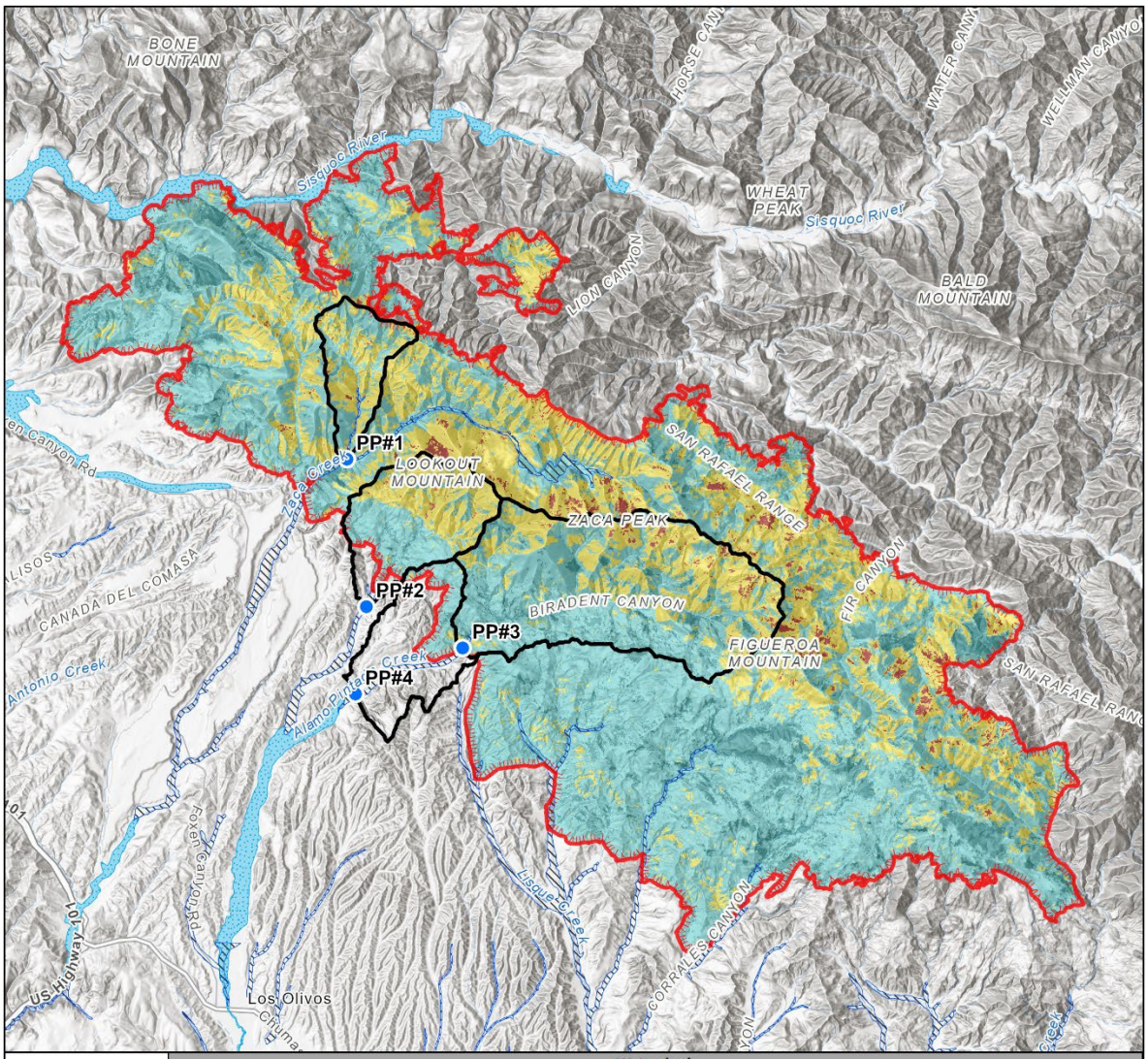
difference in normalized burn ratio (dNBR), 30-minute rainfall intensities in excess of 7.6 mm/hr (0.3 in/hr), and basin area in square kilometers.

Field experience shows that the BAER method generally underestimates peak flows in central California, particularly for short return period storms (<10-year RI) and for small watersheds that respond quickly to high-intensity, short-duration (<30 min.) rainfall. Conversely, Moody's (2012) empirical model, which is derived using data from geoclimatic unique regions along the front range of the Rocky Mountains and from southern California and northern Nevada, generally overestimates peak flows in central California.

To account for the range in model results, the average of the two modeled flows were used to estimate peak postfire flow responses at the four pour points (Table 2). The predicted postfire peak flow for the 2- and 10-year storm events were then compared to flow frequencies derived for each modeled watershed using the USGS Regional Regression Equation for the South Coast (StreamStats, 2024; Gotvald et al., 2012) and reported in Table 2. Results indicate that the 2-year storm can result in bulked flows that have flow multipliers between 10 to 13 and can result in flow responses equivalent to 12- to 20-year RI floods. The 10-year storm can result in peak flow multipliers between 2.3 to 2.8 and the flow responses can be equivalent to 76- to 166-year RI floods. The estimated flow results calculated by these two approaches assume bulked-flow conditions. Flooding in excess of the postfire responses presented here may occur at tributary confluences, bridges directly below tributary confluences, or other areas that trap large wood if high volumes of woody debris are transported.

We defined a flow multiplier by calculating the average postfire flow estimated by the BAER and the Moody approach and divided the average postfire flow value by the equivalent prefire flows determined by the USGS Regional Regression Equations and the flow-transfer method. These flow multipliers can be used to estimate postfire flow at different locations within the watersheds by applying it to estimates of prefire flow using either USGS Regional Regression Equations (StreamStats) or the flow transfer method at the point of interest.

These flow estimates are intended for emergency response planning purposes only and are not to be used for design. Moreover, they are most appropriately applied to flows within the first year following the fire or until ground cover within the burned area is well established. As knowledge is obtained through monitoring the runoff response of stressing storms in the first wet season after fire or as the slopes in the watersheds become revegetated, these flow multipliers may be adjusted down to decrease predicted postfire flows and reduce conservatism.



Soil Burn Severity	Watersheds							
	PP#1 - Zaca Lake Rd Culvert		PP#2 - Sycamore Canyon Xing		PP#3 - Figueroa Mountain Rd Bridge		PP#4 - Midland School Bridge	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Unburned/ Very Low	10	1	53	3	398	8	441	7
Low	486	46	775	42	2909	57	3240	48
Moderate	541	52	802	44	1744	34	1763	26
High	10	1	11	1	78	2	78	1
Outside Fire Unburned	0	0	193	11	1	0	1232	18
Total	1047	100	1834	100	5130	100	6753	100

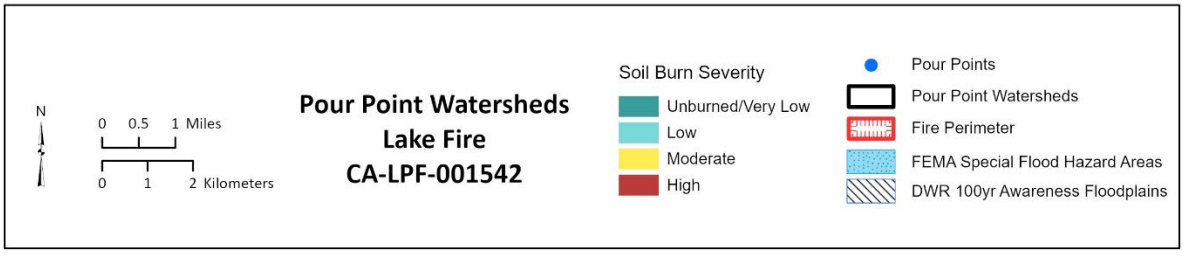


Figure 10. Pour Point locations within and downstream of the Lake Fire.

Table 2. Basin metrics, pre- and postfire Q2 and Q10 flow estimates, postfire Q2 and Q10 flow recurrence intervals, and prefire Q2 and Q10 flow multipliers used to estimate increased relative flood response for four watersheds assessed for flood hazard (i.e., "pour points").

Pour Point #	Description	Basin Area (mi^2)	Relief (feet)	Mean Basin Elevation (feet)	Mean Annual Precipitation (in.) (USGS StreamStats)	Q2 postfire flow following BAER[2]	Q2 postfire flow following Moody[3]	Average Q2 postfire flow	Average postfire flow equivalent recurrence interval (RI) (Gotvald, 2012)
PP-1	Zaca Lake Rd culvert	2	1724	2268	28	117	406	261	17-yr RI
PP-2	Sycamore Canyon Xing	3	2366	2172	28	174	619	396	15-yr RI
PP-3	Figueroa Mtn Rd bridge	8	3239	2713	31	433	1903	1168	20-yr RI
PP-4	Midland School bridge	11	3377	2419	30	436	1760	1098	12-yr RI

Pour Point #	Description	Q10 postfire flow following BAER[4]	Q10 postfire flow following Moody[3]	Average Q10 postfire flow	Average postfire flow equivalent recurrence interval (Gotvald, 2012)	Flow multiplier used to predict postfire flow within watersheds when using USGS StreamStats to estimate pre-fire flow		Flow multiplier used to predict postfire flow within watersheds when using flow transfer method and the Alamo Pintado Gage	
						Q2 prefire flow multiplier	Q10 prefire flow multiplier	Q2 prefire flow multiplier	Q10 prefire flow multiplier
PP-1	Zaca Lake Rd culvert	244	704	474	99-yr RI	13.1	2.6	13.6	3.7
PP-2	Sycamore Canyon Xing	391	1082	736	76-yr RI	12.1	2.4	13.8	3.7
PP-3	Figueroa Mtn Rd bridge	1029	3410	2219	166-yr RI	12.0	2.8	19.4	4.9
PP-4	Midland School bridge	1151	3259	2205	77-yr RI	10.1	2.3	15.0	3.9

[1]2-yr Recurrence Interval (Q2) flow estimated using USGS regional regression equations (Gotvald, 2012)

[2]Postfire, 2-yr Recurrence Interval (Q2) flow (clearwater) following BAER protocol: non&low = Q2; moderate = Q5; High =Q10. See report text for explanation.

[3]Postfire flow using Moody's Level 2 empirical model (Moody, 2012).

[4]Postfire, 10-yr Recurrence Interval (Q10) flow (clearwater) following BAER protocol: non&low = Q10; moderate = Q25; High =Q50. See report text for explanation.

VAR Observations and Discussion

This evaluation is not intended to be comprehensive and/or conclusive, and additional VARs may be identified through more detailed evaluation by responsible agencies. This includes more detailed site investigation for the development and design of appropriate mitigation measures. Several limitations are summarized below.

- FEMA, state, and 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 postfire runoff and/or blockage of drainage structures (e.g.,

culverts and bridges) by postfire debris. As such, local agencies should consider these previously mapped hazard areas in addition to the VARs identified in this report.

Specific Values-at-Risk (VARs) are contained within the geodatabase (VAR point and polygon feature classes) created by WERT, and these are the best product for use in response planning because they provide spatial location along with attribute data captured in the field. General observations for exigent VARs (i.e., moderate to high life-safety risk), key infrastructure, and sites where temporary housing may be located/constructed are included in the narrative below. More detailed observations and potential mitigations are provided in the geodatabase (VAR point and polygon feature classes), VAR summary table (Appendix I) and VAR site information sheets (Appendix II). A summary of VARs by relative risk to life-safety and property are shown in Table 3.

Table 3. Values-at-Risk (VARs) classified by risk to life-safety and property.

		Risk to Life-Safety		
		Low	**Moderate**	**High**
Risk to Property	**Low**	LC-01, FM-01, FM-02, FM-03, ZC-03, SHC-01, FC-01		
	Moderate	BC-01, SC-01, ZC-01	ZC-02, ZC-04, ZC-05, ZC-06, ZC-07, BC-02	
	High			

Exigent Values-at-Risk

Exigent VARs are those that should receive priority attention for pre-planning and emergency protection measure implementation. The exigent VARs on the Lake Fire are the six VARs with moderate risk to both life-safety and property risk (Table 3): **ZC-02; ZC-04; ZC-05; ZC-06; ZC-07; and BC-02.**

VAR Details

Figueroa Mountain community (FM-01, FM-02, FM-03): Multiple homes are accessed by Tunnel Road below Figueroa Mountain. There is an animal barn (FM-01) on old fan deposits that is downslope from an unchannelized valley that is sourced from Figueroa Mountain. The upstream basin area was burned mostly at moderate severity. Although the drainage does not show evidence of recent incision near the animal barn, incision was present upstream where the same drainage crosses Figueroa Mountain Road. The drainage has substantial available sediment that could be transported in a debris flood. Although the likelihood is low, flow could be

diverted to the barn. The property owners should be aware of the potential risks and watch for storm warnings (for example, the National Weather Service Flash Flood Watches and Warnings). Another potential risk is that a house located in the southwest corner of the community appears to be built on an old, deep-seated landslide deposit and postfire hydrological changes could reactivate the landslide, although we expect that reactivation is unlikely.

Birabent Canyon community (BC-01, BC-02): This canyon may be subject to flood flows or debris floods. Figueroa Mountain Road crosses Alamo Pintado Creek at a small bridge (BC-01). This bridge is situated at the mouth of a large basin burned at predominantly low and moderate severity. Debris transported downstream may plug the bridge causing it to be overtopped and cut off access. The county should be aware of the potential risks associated with road usage and watch for storm warnings. We recommend clearing and maintaining the channel to facilitate flood conveyance. Midland School (BC-02) located downstream of BC-01 may be subject to floods/debris floods. The bridge crossing along Alamo Pintado Creek west of the property may become blocked with debris, forcing flow to divert outside of channel margins and inundate adjacent buildings and infrastructure. Large debris is unlikely to reach the bridge given the lack of large debris deposits along the floodplain. We recommend clearing and maintaining the channel around the bridge as necessary. BC-02 is likely to experience flooding similar to a prefire flood event in 2023. Structures in BC-02 at risk of partial inundation are the bridge, adjacent solar panels, and near-stream structures adjacent and downstream of the solar panels. The property owners should be aware of the potential risks and watch for storm warnings. We recommend that the property owners consult a licensed engineer to consider implementing a deflection structure, or other mitigation options, to help reduce flood damages to structures adjacent to the channel. Care should be given to the placement of deflection structures to prevent ponding of flood flows behind them, which could flood structures in the community.

Zaca Lake (ZC-01—ZC-05): Multiple cabins and other structures are located near Zaca Lake. Some of the buildings are near the lake edge while other structures are located in a large valley northeast of the lake. Steep drainages near the lake present multiple risks to the structures. The primary concern is flooding impacting the cabins near the lake (ZC-04). The westernmost cabins could be impacted by floods or debris floods near a new culvert that may be plugged or overtopped during high streamflow. Additionally, there are other nearby cabins between a road and the lake that could be flooded upstream of the culvert where the stream makes a sharp turn to run parallel to the road (ZC-04). A low berm currently separates the channel from the road but could be overtopped. We recommend that the property owner consult with a licensed engineer to discuss building a deflection structure near the cabins below the culvert and heightening the berm along the road. There is a small, steep northwest drainage that drains towards a building in the main valley north of the lake; streamflow and debris from that drainage may impact the building (ZC-03). Immediately north of the lake, there are multiple single-story buildings, an old two-story cabin, and a construction site that are located near the outlet of a steep drainage. High streamflow or debris floods could impact these sites. Northeast of the lake on the other side of the valley, a small basin with a moderately incised channel is located upstream of an outbuilding (ZC-02). The channel has been modified and filled near the outbuilding which may increase the likelihood that flooding could impact the building. Another steep drainage is located directly upslope of a water tank (ZC-01) that could be impacted by debris and high streamflow.

Sycamore Valley / Neverland Ranch (SC-01): Multiple valleys drain to the northern portion of the ranch. These drainages burned at predominantly low and moderate severity. Multiple

buildings and structures adjacent to the stream channel may be subject to flood flows or debris floods. A garage used to store trains is near a channel in Sycamore Canyon and is upstream of a major confluence. The train garage is the most northern building on the ranch. There are downed oak trees in the channel and live trees along the bank margins. A fence immediately upstream of the train garage spans the channel and may act as a barrier for large debris but will likely promote more damaging flows through backwatering or by failure of a debris jam. The property owner should consider removing the fencing in and around the channel, and the live and dead oak trees in-channel and along channel margins. Flooding of the train garage appears unlikely. Further downstream is a multi-barrel, culvert crossing composed of five 36-inch diameter corrugated metal pipes (CMP) that supports a road and an elevated narrow-gauge railroad track. The culverted crossing may become plugged and overtopped, sending flood waters into surrounding low-lying areas before re-entering the channel. The property owner should consider clearing and maintaining the culvert to facilitate flood conveyance. Downstream of the culverted crossing is a ranch house that is adjacent to a low-water, concrete crossing. The area adjacent to the occupied ranch house may become flooded; however, unless large flows occur that mobilize woody debris and cause debris jam that divert flows toward the house, the house appears adequately setback from the channel. The property owner should consider clearing and maintaining the channel when necessary. It is also noted that the 9 January 2023 flood event fully inundated multiple bridges downstream of the cinema. The property may experience similar flooding characteristics as the 2023 flood event from smaller storms due to increased postfire runoff. The property owner should consider consulting with a licensed engineer to discuss improvements to road crossings.

Key Infrastructure

Road and highway infrastructure allowing access into and through the burned area are discussed below.

County Roads

The county road network potentially affected by the Lake Fire was not completely evaluated by the WERT. All roads, stream crossings, and drainage structures downstream and downslope of hillslopes and drainages burned at moderate to high SBS are at risk to storm damage. Monitoring, maintenance, and repair costs are expected to be high until the Lake Fire burn area revegetates and recovers: a period that typically can take 2 to 5 years. Crossings and drainage along all county roads within and downstream of the burned area should be evaluated and maintained as soon as possible and monitored and cleaned out after significant storm events. In addition, crossings that pose a high risk of failure and sediment delivery may be reconstructed with properly sized culverts, lower fill-slope heights, and rock armor. **We recommend receiving regional alerts (for example, the National Weather Service) and watching storm forecasts so problematic roads can be avoided during storms.** Some specific areas of concern are discussed below.

Tunnel Road (FM-03) is the only source of ingress and egress to some of the homes below Figueroa Mountain. Tunnel Road may be impacted by high streamflow or a debris flood near FM-01. The drainage is unchannelized near the road but is channelized further upstream where it crosses Figueroa Mountain Road. Sediment is readily available in the channel. Increased postfire runoff due to moderate burn severity in most of the basin may cause the channel to be

reactivated and damage the road. In addition, other stream crossings in the community may be impacted by increased runoff and erosion.

Zaca Lake Road (ZC-06, ZC-07) is the only source of ingress and egress to cabins and structures at Zaca Lake. Multiple low-water stream crossings exist along Zaca Lake Road that are designed to be overtopped. A low-water crossing (ZC-06) is at risk of being overtopped by streamflow and debris. Erosion on the downstream end of the hardened road surface is present and additional erosion and damage may occur to the stream crossing during future storms. In addition, another location of primary concern is potential blockage of an undersized culvert (ZC-07) that could result in flooding along Zaca Lake Road and damage to the stream crossing. We recommend that the property owner consult with a licensed professional engineer to consider improvements to the stream crossing to mitigate blockage and improve its capacity to transmit flood flows, sediment, and woody debris.

Figueroa Mountain Road (BC-01) serves as the only western access road to communities located on or near Figueroa Mountain. The bridge at this stream crossing may be impacted by woody debris that could block flows, causing it to be overtopped. Although the upstream and downstream banks are armored with large rock, overtopping flows may scour the banks. We recommend maintaining the channel to reduce debris jams and maximize conveyance through the bridge. County documents indicate that a debris rack was installed about 200 feet upstream of the bridge following the 1997 Marre fire. The debris rack was later removed and the County is considering its reinstallation, which we support.

Midland School Bridge (BC-02) serves as the western access point to the Midland School area. Though unlikely, inundation or plugging of the bridge may prevent road/bridge access. We recommend considering the installation of deflection structures along the eastern bank of the channel downstream of the bridge to protect solar panels and adjacent downstream structures. Caution should be exercised when installing deflection structures so as not to cause deposition of sediment or ponding of floodwater within the larger community by impounding floodwaters.

Signage should be placed along portions of the county road network, specifically Figueroa Mountain Road, to alert drivers of potential debris flow, flooding, and/or rockfall. Owners of non-public road networks should be aware of the potential hazards along roadways following fire and should implement signage accordingly.

Rockfall Hazards exist along Figueroa Mountain Road and other roads that are located near steep, rocky slopes. Increased rock exposure and root damage from the fire will increase the likelihood of rockfall. In high risk rockfall areas during significant storm events we suggest having local agencies patrol these areas for hazards, staging proper heavy equipment for response and provide signage to adequately warn drivers.

General Recommendations

Implement an Early Warning System

An effective early warning system requires the implementation of different components (Figure **11**) for hazard risk reduction, as well as linkages between these components so that the goals of protecting life, safety, and property are accomplished. In previous sections, this report characterizes the spatial distribution of hazard and risk within and downstream of the burned area, greatly increasing knowledge about potential risk from postfire hazards. This report also

contains a fire-specific rainfall threshold to be used as a trigger point for forecast-based watches and warnings. Each VAR is characterized by the potential postfire hazard, relative risk from the hazard, and the potential emergency protective measures that can be implemented for risk reduction. The granular nature of VAR characterization allows for more targeted communication and response planning by emergency responders, public works/flood control agencies, and other entities tasked with implementing risk reduction activities (e.g., NRCS).

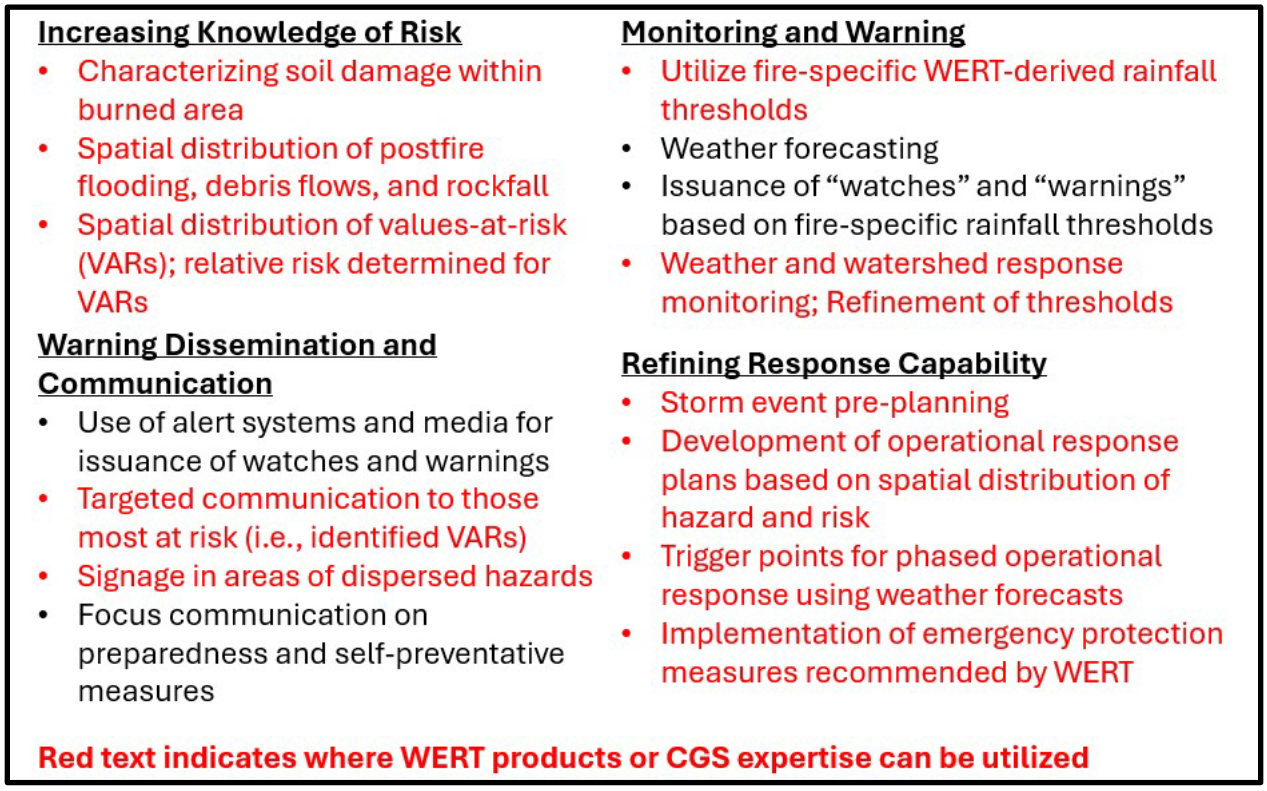


Figure 11. The four components of "people-centered" early warning systems (adapted from Garcia and Fearnley, 2012), along with steps necessary to implement each component specific to minimizing risks from postfire watershed hazards. This WERT report provides knowledge to implement each of these components in a manner specific to the fire.

Prescribed Rainfall Thresholds

The initial year rainfall thresholds are determined by WERT for the Lake Fire by considering data such as the USGS modeled rainfall thresholds, regional debris-flow thresholds, previous flood and rainfall history, geologic/geomorphic conditions of the burned area, and the hazard and relative risk associated with each VAR. The following thresholds have been developed by the WERT and approved by the National Weather Service (NWS) and the USGS (Table 4).

Table 4. Year 1 rainfall thresholds for the Lake Fire.

Duration	*Year 1 Threshold Intensity mm/hr (in/hr)*	*Year 1 Threshold Depth mm (in)*	*Recurrence Interval*
15 minutes	36 (1.40)	9 (0.35)	2-years
30 minutes	25 (1.00)	13 (0.50)	2-years
60 minutes	18 (0.70)	18 (0.70)	2-years

The WERT strongly recommends that Santa Barbara County Public Works, Santa Barbara County OEM, Santa Barbara County Fire, and Santa Barbara County Sheriff's Office work with the NWS and the California Geological Survey to monitor forecasts and rainfall intensity during storms, as well as observe postfire response following storm events. If the initial rainfall threshold is too conservative, and little response occurs during storm events, data and observations will be necessary to adjust the threshold upward in a defensible manner. Alternatively, rainfall thresholds can also be lowered based on gage data and observations.

Existing early warning systems should be used and iteratively 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. Early warning systems for the Lake Fire should take advantage of the services described below.

Utilize 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 postfire debris flow "watch" and "warning" notifications in burn areas.

> **Watches** are issued when the likelihood of hazardous weather or a hydrologic event has increased significantly, but it's occurrence, location, and/or timing is still uncertain. Watches provide lead time for pre-storm planning and response.
>
> **Warnings** are issued when hazardous weather or hydrologic events are occurring, are imminent, or have a very high probability of occurring.

For additional information, see the NWS Los Angeles/Oxnard Forecast Office webpage (https://www.weather.gov/lox/).

Residents Potentially Affected by Postfire Hazards Should Sign Up for ReadySBC Alerts

This report identifies areas within and downstream of the Lake Fire burn area with the highest potential for postfire flooding, debris flows, and rockfall. Santa Barbara County has implemented Ready Santa Barbara County (ReadySBC), a state-of-the-art emergency notification system to alert residents and businesses about natural disasters and other crises. The emergency notification system enables Santa Barbara County to provide essential information quickly in a variety of situations, including in the event of fire-induced flooding and debris flows. **Residents can sign up for ReadySBC through the following link**: https://www.readysbc.org/.

Wireless Emergency Alerts (WEA)

Residents should be aware of what to do when receiving an alert through WEA. WEA is an alert system originated by the NWS that can inform residents, visitors, 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. Since WEA alerts can be disabled by phone users, residents and businesses potentially subject to hazards associated with the Lake Fire are urged not to opt out of WEA. You can find more information at the following link: https://www.weather.gov/crp/wea.

Communicating Hazard and Risk Associated with Lake Fire

Increasing awareness is the key to minimizing risk on the Lake Fire. While the potential for debris flows exists within and downstream of the Lake Fire, the primary hazard of concern is flooding and debris flooding along Zaca Creek/Zaca Lake, Sycamore Canyon, and Birabent Canyon (i.e., tributary to Alamo Pintado Creek). These hazards constitute a potential threat to life-safety and property. Residents and property owners downstream of these burned areas recently experienced flooding from the January 2023 storms. Flooding from this storm was approximately a 25-year recurrence interval, or a flood event that has a 4 percent chance of occurring each year. **Due to damaged soils within the burned area, a 2-year short duration storm may induce floods that could approach the January 2023 storm event. Lower frequency, higher magnitude storms may exceed these impacts.** Public outreach should focus on communicating this to these affected residents and property owners.

Hazards exist to transportation corridors that allow ingress and egress along Figueroa Mountain Road and Zaca Lake Road. If these transportation corridors are affected by postfire hazards, they may leave residents stranded after storm events, and prevent the delivery of emergency services to these residents. This constitutes a potential life-safety threat if emergency medical care is needed for residents stranded by storm events.

For those interested, the following are links to additional information about postfire geohazards:

- CGS Burned Watershed Geohazards website: https://www.conservation.ca.gov/cgs/bwg/program

- CAL FIRE post wildfire safety website: https://readyforwildfire.org/post-wildfire/
- Cal OES postfire geohazards article: https://news.caloes.ca.gov/flood-after-fire-preparing-for-the-post-disaster-danger
- FEMA postfire factsheet: https://www.fema.gov/sites/default/files/documents/fema_flood-after-fire_factsheet_nov20.pdf

Response Planning for the Lake Fire

An objective of the WERT process is to provide operational intelligence to those tasked with implementing risk reduction activities (e.g., emergency planners, fire departments, flood control agencies). WERT information should be used to narrow the decision-space for operational planning, strategy, and tactics. Key information provided by the WERT includes the following:

- VAR location (map and spatial data)
- Whether the VAR is a discrete structure (point) or a grouping of structures (polygon)
- The types of hazards posing risk to the VAR
    - The report discusses whether hazards are debris flows, debris flood/flooding, or rock fall
- What is the relative risk to life-safety and/or property?
    - Relative risk is characterized as low, moderate, and high
    - Response efforts should prioritize VARs with moderate to high life-safety and/or property risk
    - Low risk is associate with a nuisance level of hazard
- Emergency protective measures are recommended to reduce risk
    - WERT does not design direct protection measures (e.g., deflection structures)
    - Some measures need more intensive evaluation and design to reduce risk

Informing and empowering the public is a key step in risk reduction. Santa Barbara County has resources listed that can help reduce risk from postfire flooding and debris flows. This includes tips for storm preparedness guidelines, links to weather resources (i.e., rain gages and weather radar), and links for purchasing flood insurance.

https://www.readysbc.org/576/Stormeadiness

The WERT recommends that local government conduct public outreach so that residents and property owners can make informed decisions that reduce their risk exposure to postfire hazards.

Increased Flood Flows, Erosion, Sedimentation, and Water Quality Impacts

First responders and Emergency Planning personnel should work in conjunction with Santa Barbara County Public Works and Caltrans to coordinate response planning for increased flood flows and resultant sedimentation in the area of the Lake Fire. Postfire flood inundation mapping should be performed for areas downstream of the burn area 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

Potential debris flow hazards were identified that could impact Zaca Lake Road and structures positioned below steep slopes by Zaca Lake. Models used to predict postfire debris-flow runout are currently under development. Thus, WERT geologists rely partially on geomorphic evidence to estimate the downstream extent of potential debris-flow inundation. Some 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 postfire conditions. In areas below larger, severely burned drainages, the areal extent of debris-flow inundation is highly uncertain.

Increased Rockfall Hazards

Existing rockfall hazards were identified during field evaluations, particularly along Zaca Mine Road and Figueroa Mountain Road. 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.

General Recommendations for Mine Sites

No large mine sites are present within the burned area; therefore, significant postfire impacts related to mines are not anticipated from the Lake Fire.

Road Drainage Systems, Storm Monitoring, and Storm Maintenance

Due to the presence of areas burned at moderate and high soil burn severities, increased flows on slopes and onto the road and storm drain systems can be expected. Increased erosion can inundate roads 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, hyper concentrated floods, debris torrents, debris flows, and sedimentation resulting from storm events. Equipment should be staged in areas where risk is high and access is necessary. Spatial data generated by the USGS and the WERT (e.g., USGS debris-flow model and flood flow predictions) can be used to screen potential at-risk areas for increased monitoring and maintenance presence.

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Appendix A – Lake Fire WERT Contact List

Lake Fire WERT Contact List

Name	Affiliation	Position	Phone	Email
Kelly Hubbard	Santa Barbara OEM	Director	805-319-0110	khubbard@countyofsb.org
Pat Byde	Santa Barbara County Fire	Division Chief - Operations	N/A	pbyde@countyofsb.org
Dave Ericson	CAL FIRE - SLU	Forester I	805-903-3406	david.ericson@fire.ca.gov
Matt Griffin	Santa Barbara Flood Control	Engineering Manager	805-568-3444	mgriff@countyofsb.org
Floyd Holmes	Santa Barbara Flood Control	Maintenance Superintendent	805-568-3440	fholmes@countyofsb.org
Walter Rubalcava	Santa Barbara Flood Control	Deputy Director	805-896-6468	wrubalc@countyofsb.org
Chris Sneddon	Santa Barbara Public Works	Director	805-568-3008	csneddo@countyofsb.org
Mostafa Estaji	Santa Barbara Transportation	Deputy Director	805-568-3064	mestaji@countyofsb.org
Udy Loza	Santa Barbara Transportation	Maintenance Manager	805-455-3323	uloza@countyofsb.org
Emma Chow	NRCS	District Conservationist	805-345-8612	emma.chow@usda.gov
Doug Toews	NRCS	Engineer (P.E. - Retired)	808-265-2688	doug_toews@msn.com
Ariel Cohen	NWS - Oxnard	Meteorologist	805-988-6626	ariel.cohen@noaa.gov
John Dumas	NWS - Oxnard	Meteorologist	805-988-6626	john.dumas@noaa.gov
Jonathan Schwartz	USFS	Geologist / BAER	805-698-9752	jonathan.schwartz@usda.gov
Emily Fudge	USFS	Hydrologist / Lake BAER Lead	619-430-3092	emily.fudge@usda.gov
Zaca Lake	Private Resort	Property Manager	949-533-2353	
Sycamore Valley Ranch (Neverland Ranch)	Private Ranch	Security	310-689-8749	
Midland School	Private School		805-688-5114	

Shaded cells = VAR polygons
White cells = VAR points

Appendix B – Values-at-Risk Summary Table

Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
ZC-01	Zaca Lake	34.78050173	-120.034026	Small, steep drainage with erodible material directly upslope of water tank.	Aggradation around base of water tank, but low risk/impact to overall tank structure. Inflow structure likely nearby the water tank but did not directly observe in the field.		Water tank and inflow structure.	utilities	low	moderate	Monitor and maintain			Deflect material from base of water tank. See additional photos.
ZC-07	Zaca Lake Road	34.78043916	-120.0908489	Potential blockage of culvert could result in flooding along road.	Potential moderate impacts to culvert and road. Low traffic, private road, but people accessing road may be at moderate risk. 48 inch diameter, undersized culvert (CMP); large fill.	debris flow / flood	Culvert and road crossing	drainage structure	moderate	moderate	Monitor and maintain	Early Warning		Early warning for people accessing roadway. Monitor and maintain culvert.
ZC-02	Zaca Lake	34.77999258	-120.0341789	Small basin with moderately incised channel upstream of structure. Channel has been filled near structure which may increase likelihood of being impacted.	Small shop at outlet of channel. The drainage is small but could easily be diverted towards structure.	debris flow / flood	Workshop /stable	other	moderate	moderate	Deflection structure			
BC-01	Figueroa Mountain Road crossing Alamo Pintado Ck	34.74179296	-120.0618362	Debris jam could impact bridge, causing loss of access. Little diversion potential.	Concrete bridge structure with a hydraulic area of 18'w x 8'h and a native substrate composed of cobble to boulders up to 2' diameter. Extensive vegetation (willow) along banks. Angled wingwall with sloped banks armored with riprap. Width of bridge normal to channel is approx 16'.	debris flow / flood	Bridge on county road.	drainage structure	low	moderate	Monitor and maintain	Early Warning		Reinstallation of debris rack upstream of bridge.

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White cells = VAR points

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Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
FC-01	Tres Herman's Ranch	34.79642281	-120.1840769	Flooding of channel. Low potential of overbanking flow.	Box culvert that's also a bridge. 7ft deep and 5ft wide. Concrete head wall flared 30 degrees. Trapezoidal channel downstream. Barn and paddocks adjacent but elevated above channel. Flows may overtop and impact adjacent structures if jammed.	flood	Bridge	drainage structure	low	low	Clear and maintain culvert			Clear and maintain culvert
ZC-03	Zaca Lake	34.78029815	-120.0375645	Potential debris flood or nuisance flooding from primary basin.	Small, steep northwest drainage with 30% surface cover. Minimal anticipated flows.	debris flow / flood	House	home	low	low	Early Warning			Residents should be aware that the structure may be impacted by flooding or debris during storms.
FM-01	Figueroa Mountain	34.72971729	-119.9902272	Barn is located on a fan. Upstream basin area was burned mostly at moderate severity. Drainage does not show evidence of recent incision near structure, but incision was present upstream at the Figueroa Mountain Rd.	An unchannelized swale exists to the east of the animal barn and is likely to capture future flows. However, an unchannelized drainage upstream of the barn could route flow and sediment towards the barn during a large event.	debris flow / flood	Animal barn	other	low	low	Early Warning			
FM-02	Figueroa Mountain	34.72701028	-119.9919814	House appears to be built on an old, deep-seated landslide deposit and postfire hydrological	Old landslide deposit that may be reactivated, but is unlikely.	other	House	home	low	low				

Shaded cells = VAR polygons
White cells = VAR points

Appendix B – Values-at-Risk Summary Table

Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
				changes could reactivate the landslide.										
ZC-06	Zaca Lake Road			Low-water crossings are at risk of being overtopped with flow and debris. Increased erosion and deposition could occur along roadway.	Tributary drainages can deliver sediment and debris that can impact road.	debris flow / flood	Zaca Lake Road	other	moderate	moderate	Early Warning	Monitor and maintain		Access along road should be avoided during storm events. Monitor and maintain road and crossing structures.
ZC-04	Zaca Lake			Potential flooding of the westernmost cabins at culvert. At cabins near lake, stream takes sharp turn to parallel road and flows to the northwest; stream could overbank over small berm along road.	Land manager noted substantial flooding to cabins during large storm in January 2023. Floodplain was graded after January 2023 storm.	debris flow / flood			moderate	moderate	Deflection structure	Debris barrier	Early Warning	Consider installing deflection structure near cabin at lake near 24” culvert. Heighten berm along road.
ZC-05	Zaca Lake			Potential debris flood of multiple, single-story structures upslope of new construction on lake shore.	Flow from primary drainage could cause potential flooding to two-story house (northern-most structure). Small swale to the west was unchannelized. Electrical infrastructure present near channel.	debris flow / flood	Two story and single story log cabins	home	moderate	moderate	Early Warning	Deflection structure		

Shaded cells = VAR polygons
White cells = VAR points

Appendix B – Values-at-Risk Summary Table

Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
LC-01	Latigo Canyon vineyard			Low potential for flooding or debris floods to barn and stream crossing. Channel is deeply incised (~10 ft) with substantial floodplain on stream right for area upstream of barn. There is a large culvert at the stream crossing.	In the unlikely event that the culvert is plugged, flooding on road will reenter channel immediately downstream.	flood	Barn and stream crossing	business	low	low	Early Warning			
BC-02	Midland School			Potential blockage of bridge at high flow could redivert water outside of channel towards structures.	Far distance from burned mountain front, incised channel, low channel slope and depositional reach with sinuous/braided morphology upstream of bridge. At bridge, the active channel is incised and contains two terraces. The lower elevation terrace is vegetated with dense willows. Observed flood flows during 2023 partially inundated structure and solar panels along upper floodplain at inside meander bend downstream of the bridge.	flood	Bridge, structures across road	utilities	moderate	moderate	Early Warning	Deflection structure		Installation of deflection structure to protect house along the inside of meander bend.

Shaded cells = VAR polygons
White cells = VAR points

Appendix B – Values-at-Risk Summary Table

Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
FM-03	Figueroa Mountain			Ingress and egress along primary roads to the community could be impacted floods or debris floods.	Near FM-01, there is a large unchannelized swale that may be impacted by floods or flood flows. The same drainage is incised near Figueroa Road upstream. The basin was burned at mostly moderate severity and sediment appears to be readily available for transport. No culvert was present along the main road near FM-01. The road is the only source or ingress and egress for multiple homes and may be damaged during a storm. There are multiple additional small crossings in the community. Some of them have culverts and some of them do not.	debris flow / flood	Multiple stream crossings	other	low	low	Early Warning			
SC-01	Sycamore Valley Ranch (Neverland Ranch)			An incised channel crosses the ranch and may flood multiple buildings during storms.	Near the small train station on the north end of the ranch, flooding may occur. Downstream, flooding may occur at a stream crossing with five culverts if the culverts are plugged or streamflow is high. Further downstream, an Arizona crossing may flood, which could impact a ranch house and small structure on the other side of the channel. There is also potential for nuisance flooding near the theater and to other buildings and crossings downstream. The land manager mentioned prior flooding during a large storm in	flood	train garage, theater, ranch house, etc	multiple	low	moderate	Early Warning	Clear and maintain culvert		The property owner/land manager should consider consulting with a licensed engineer to discuss improvements to road crossings.

Shaded cells = VAR polygons
White cells = VAR points

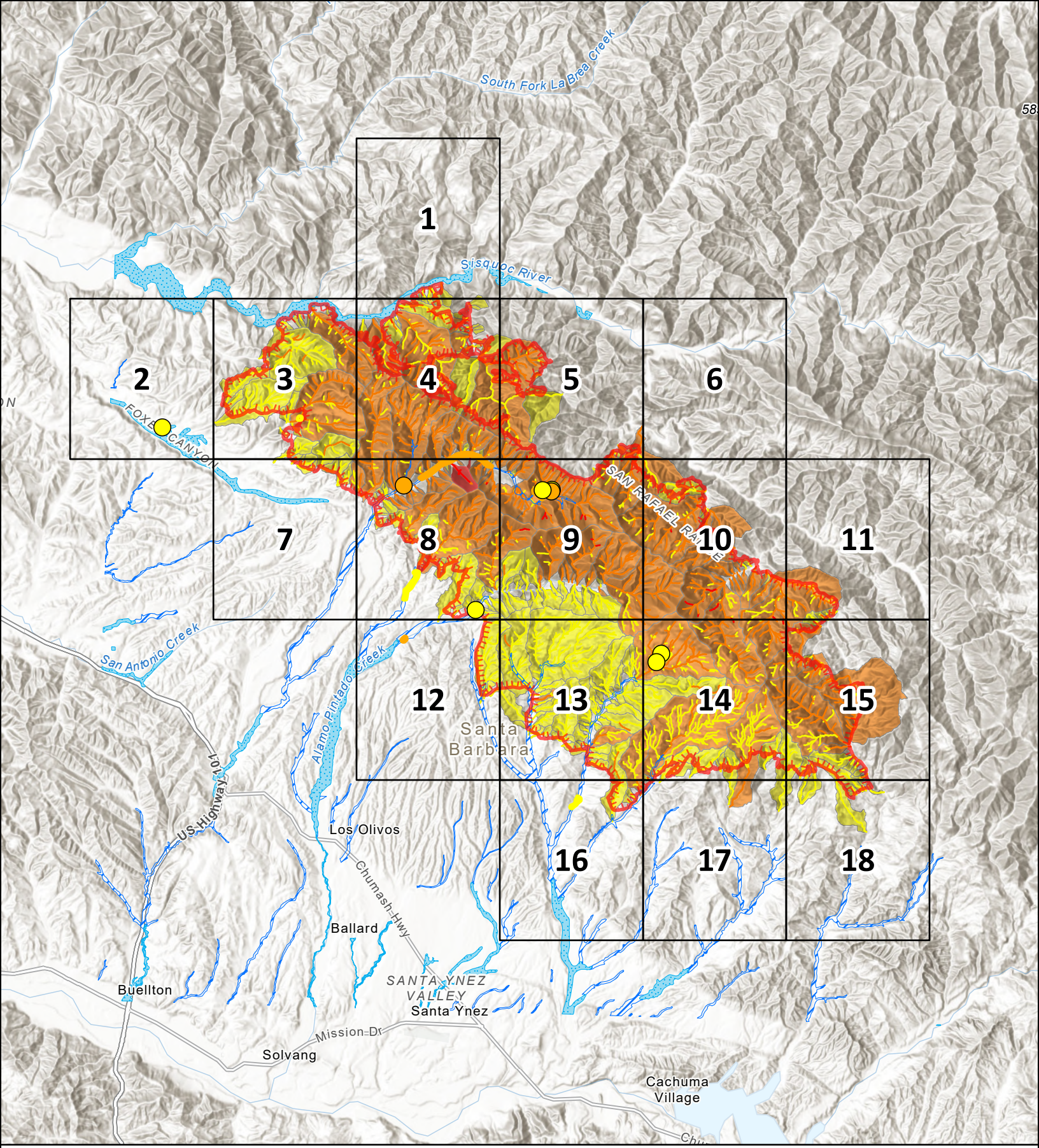
Appendix B – Values-at-Risk Summary Table

Site Number	Community / Local Area	Latitude	Longitude	Potential hazard / Field observation	Remarks	Hazard Category	Specific at-risk feature	Feature Category	Potential hazard to life?	Potential hazard to property?	EPM	EPM2	EPM3	EPM Text
					January 2023. Structures and stream crossings below the theater were not visited.									
SHC-01	Branquinho : The Union Ranch			Potential flooding to structure and crossings. Unable to access locked gate.	Assessment performed remotely.	debris flow / flood	Structure and crossing.	multiple	low	low	Early Warning			

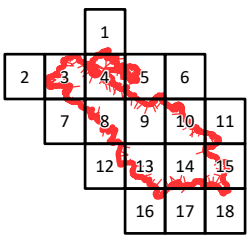
Summary of General Recommendations and Findings

- Utilize early warning systems available to homeowners, particularly those located in flood-prone areas. The WERT recommends using the Santa Barbara County emergency alter notification system (ReadySBC) and the National Weather Service early warning system and forecasts.
- Increase the situational awareness of affected residents and the communities regarding the hazards and risks associated with living downstream/downslope of burned areas.
- The WERT strongly recommends that Santa Barbara County Public Works, Santa Barbara County OEM, Santa Barbara County Fire, and Santa Barbara County Sheriff's Office work with the NWS and the California Geological Survey to monitor forecasts and rainfall intensity during storms, as well as observe postfire response following storm events. The initial rainfall thresholds can be adjusted accordingly after assessing hydrological response to storms.
- Monitor and/or remove accumulated debris from channels that are upstream of culverts and bridges in areas that are subject to postfire flooding where there is an elevated risk to life and/or property.
- While the potential for debris flows exists within and downstream of the Lake Fire, the primary hazard of concern is flooding and debris flooding along Zaca Creek/Zaca Lake, Sycamore Canyon, and Birabent Canyon (i.e., tributary to Alamo Pintado Creek). These hazards constitute a potential threat to life-safety and property.
- Hazards exist to transportation corridors that allow ingress and egress along Figueroa Mountain Road and Zaca Lake Road. If these transportation corridors are affected by postfire hazards, they may leave residents stranded after storm events, and prevent the delivery of emergency services to these residents.
- The WERT recommends that local government conduct public outreach so that residents and property owners can make informed decisions that reduce their risk exposure to postfire hazards.

Appendix C – Values-at-Risk Map Book



Incident: CA-LPF-001542: Lake Fire



Values at Risk (Polygon)

Potential hazard to life

- Low
- Moderate
- High

Value at Risk (Point)

Potential hazard to life?

- Low
- Moderate
- High

Basin Combined Hazard

15 min 24 mm/h

- Low
- Moderate
- High

Segment Combined Hazard

15 min 24 mm/h

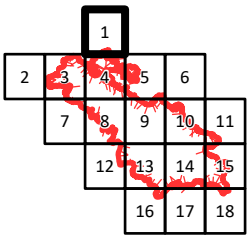
- Low
- Moderate
- High

- Fire Perimeter
- FEMA Special Flood Hazard Areas
- DWR 100yr Awareness Floodplains

0 5,000 10,000 ft

0 2,500 m

Incident: CA-LPF-001542: Lake Fire



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Values at Risk (Polygon)

Potential hazard to life

- Low
- Moderate
- High

Value at Risk (Point)

Potential hazard to life?

- Low
- Moderate
- High

Basin Combined Hazard

15 min 24 mm/h

- Low
- Moderate
- High

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15 min 24 mm/h

- Low
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- High

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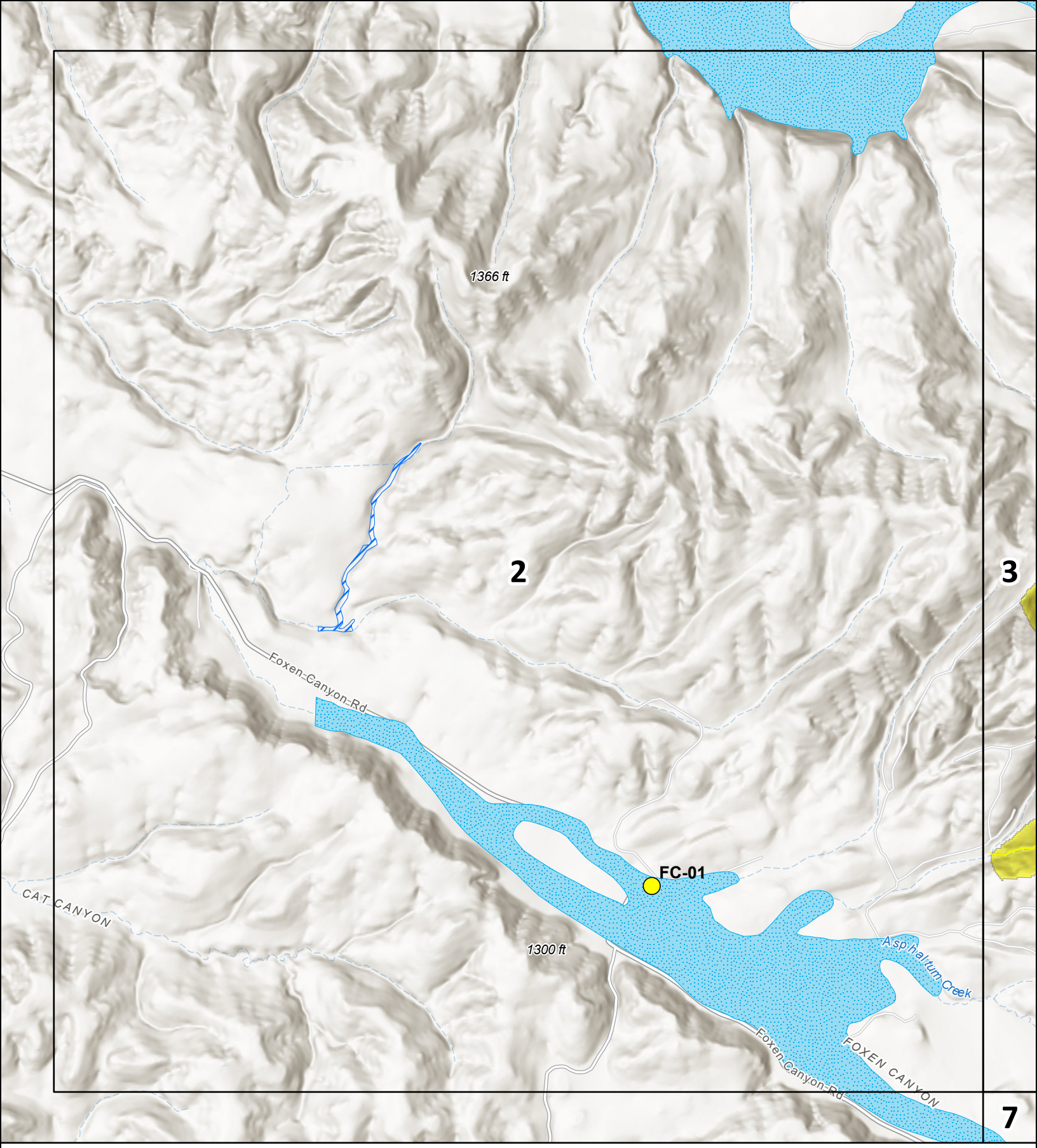
0 1,000 2,000 ft

0 250 500 m



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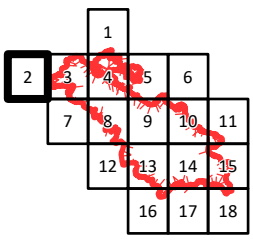

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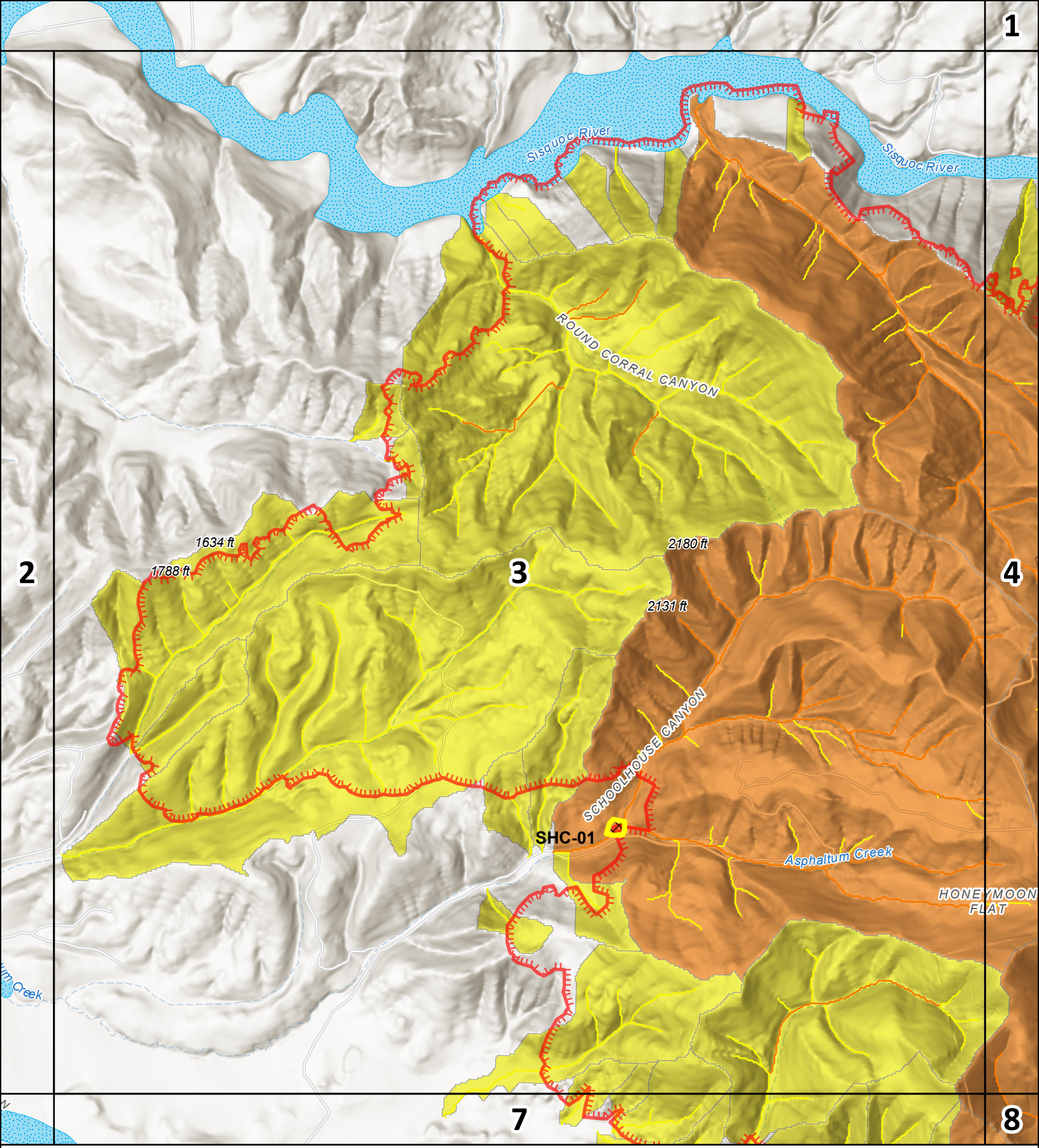
0 250 500 m



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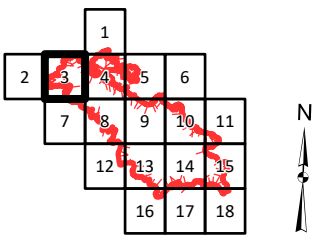

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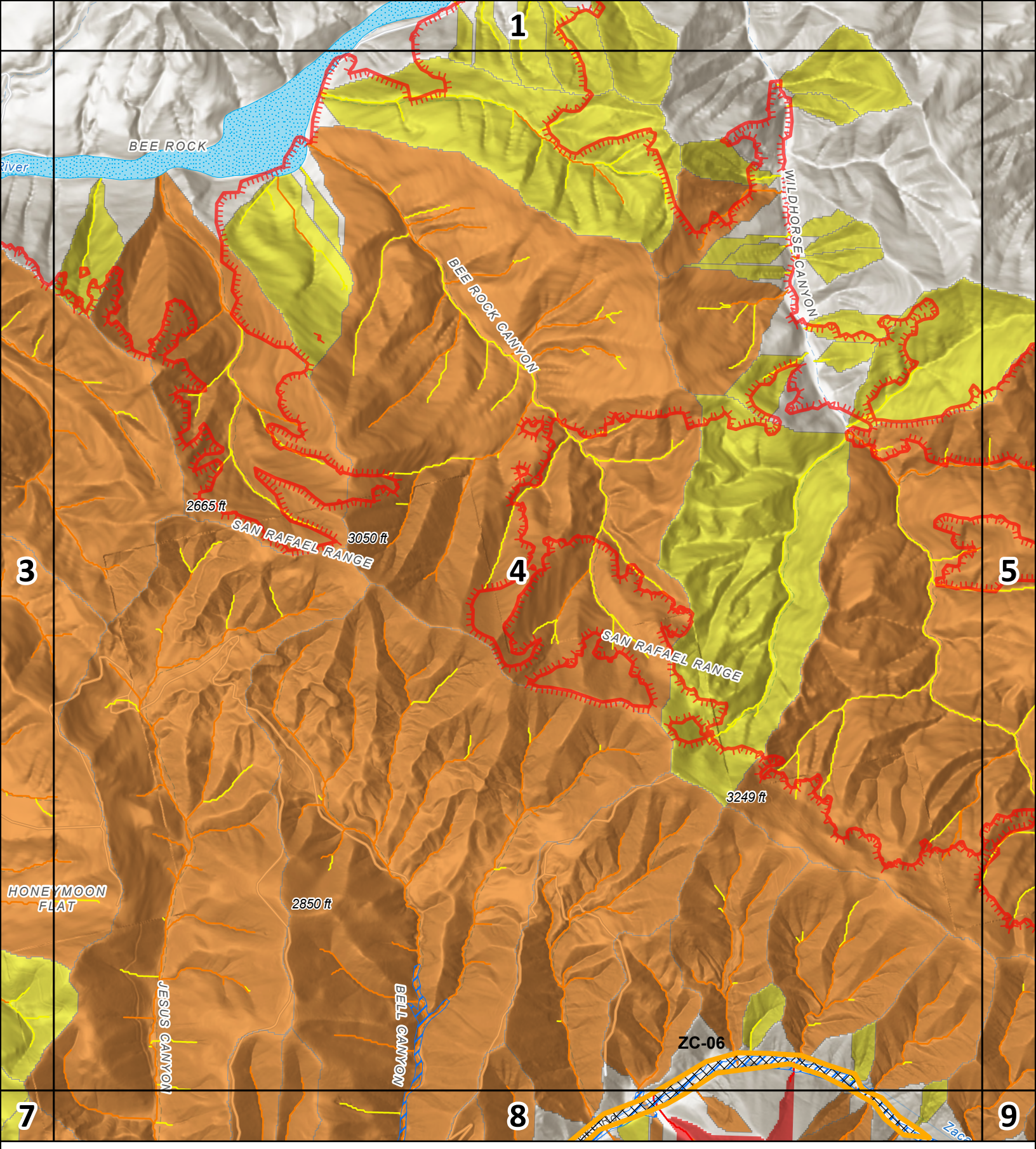

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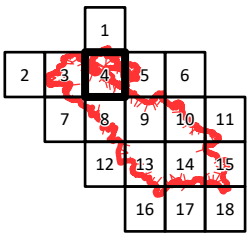

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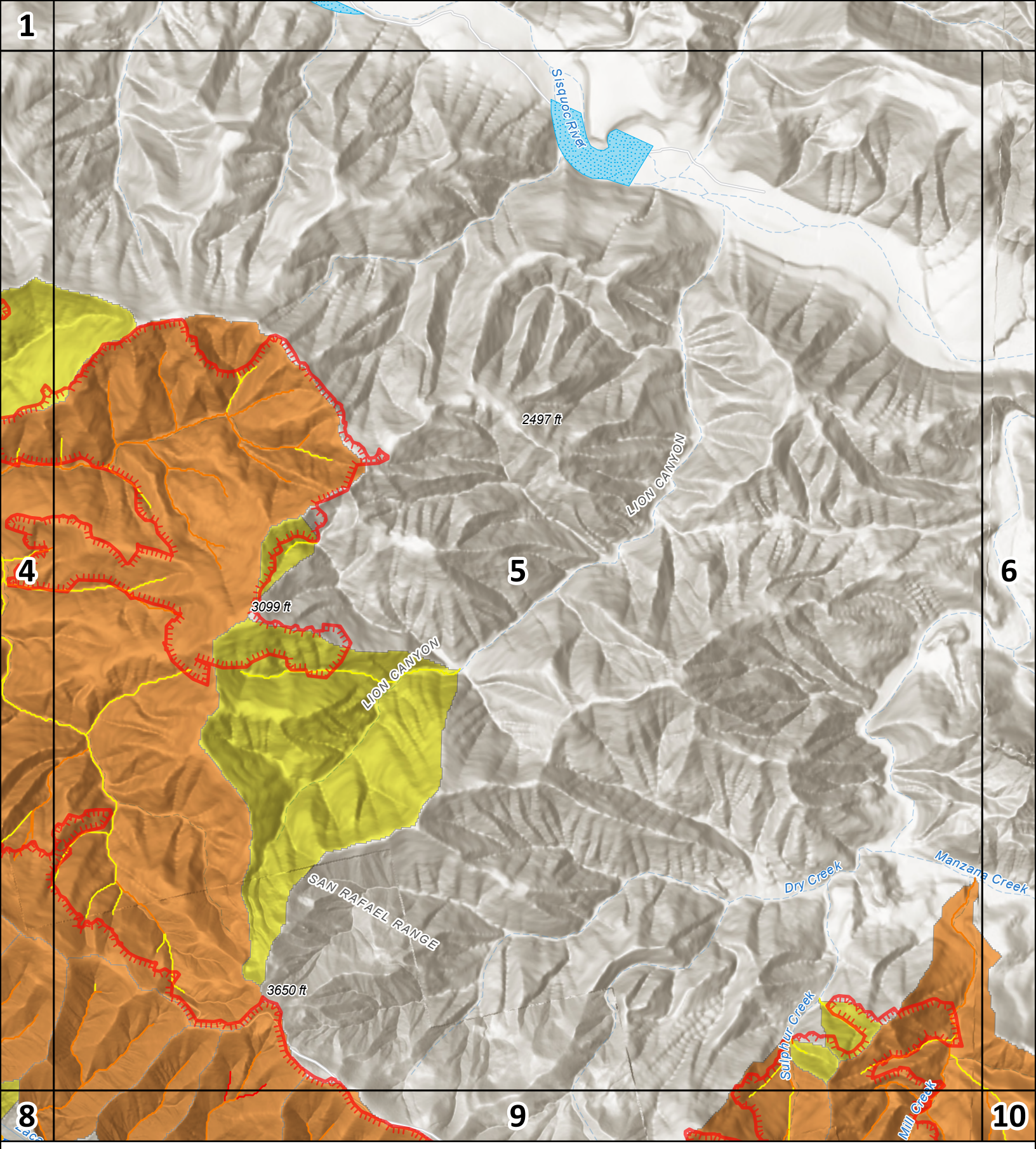
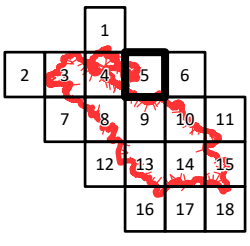


Incident: CA-LPF-001542: Lake Fire



N

Values at Risk (Polygon)

Potential hazard to life

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Value at Risk (Point)

Potential hazard to life?

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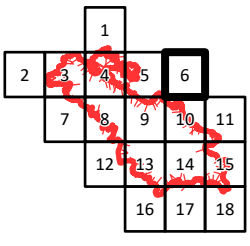
- Moderate
- High

- Fire Perimeter
- FEMA Special Flood Hazard Areas
- DWR 100yr Awareness Floodplains

0 1,000 2,000 ft

0 250 500 m

Incident: CA-LPF-001542: Lake Fire



N

Values at Risk (Polygon)

Potential hazard to life

- Low
- Moderate
- High

Value at Risk (Point)

Potential hazard to life?

- Low
- Moderate
- High

Basin Combined Hazard

15 min 24 mm/h

- Low
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Segment Combined Hazard

15 min 24 mm/h

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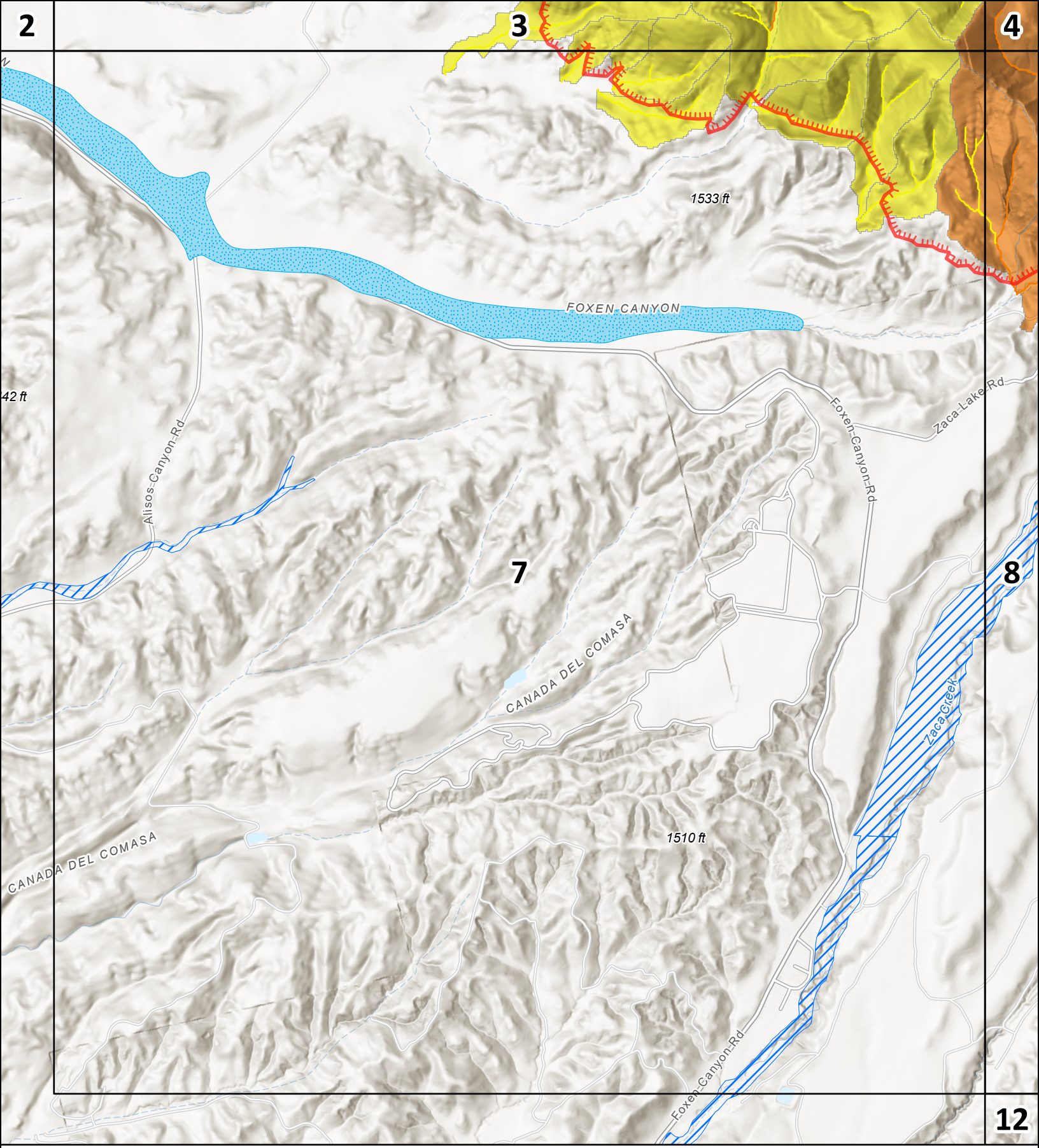

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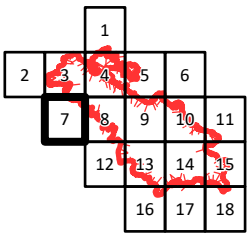

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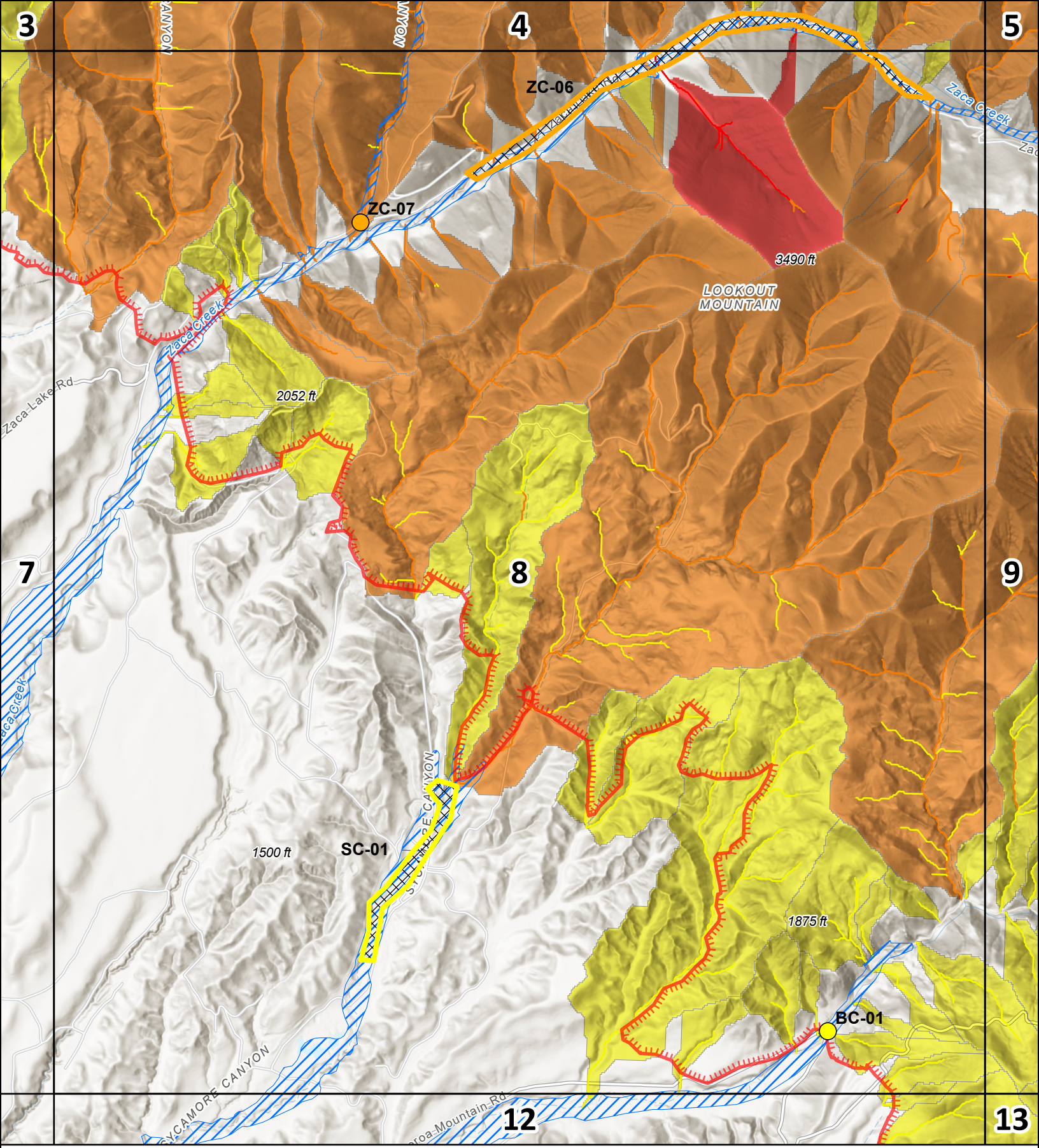
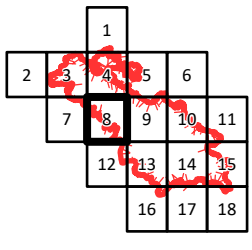


Incident: CA-LPF-001542: Lake Fire



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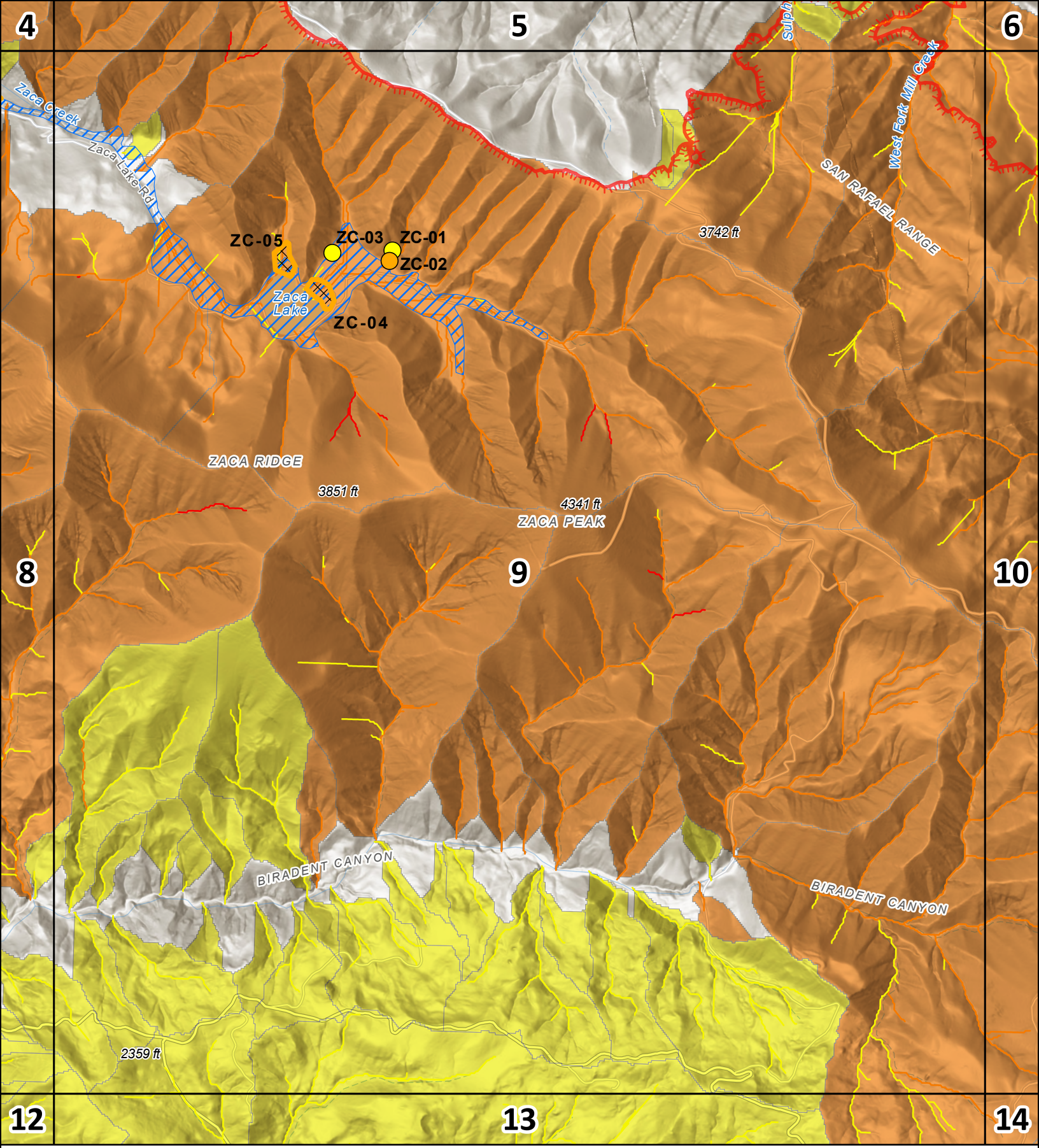
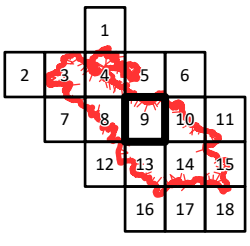


Incident: CA-LPF-001542: Lake Fire



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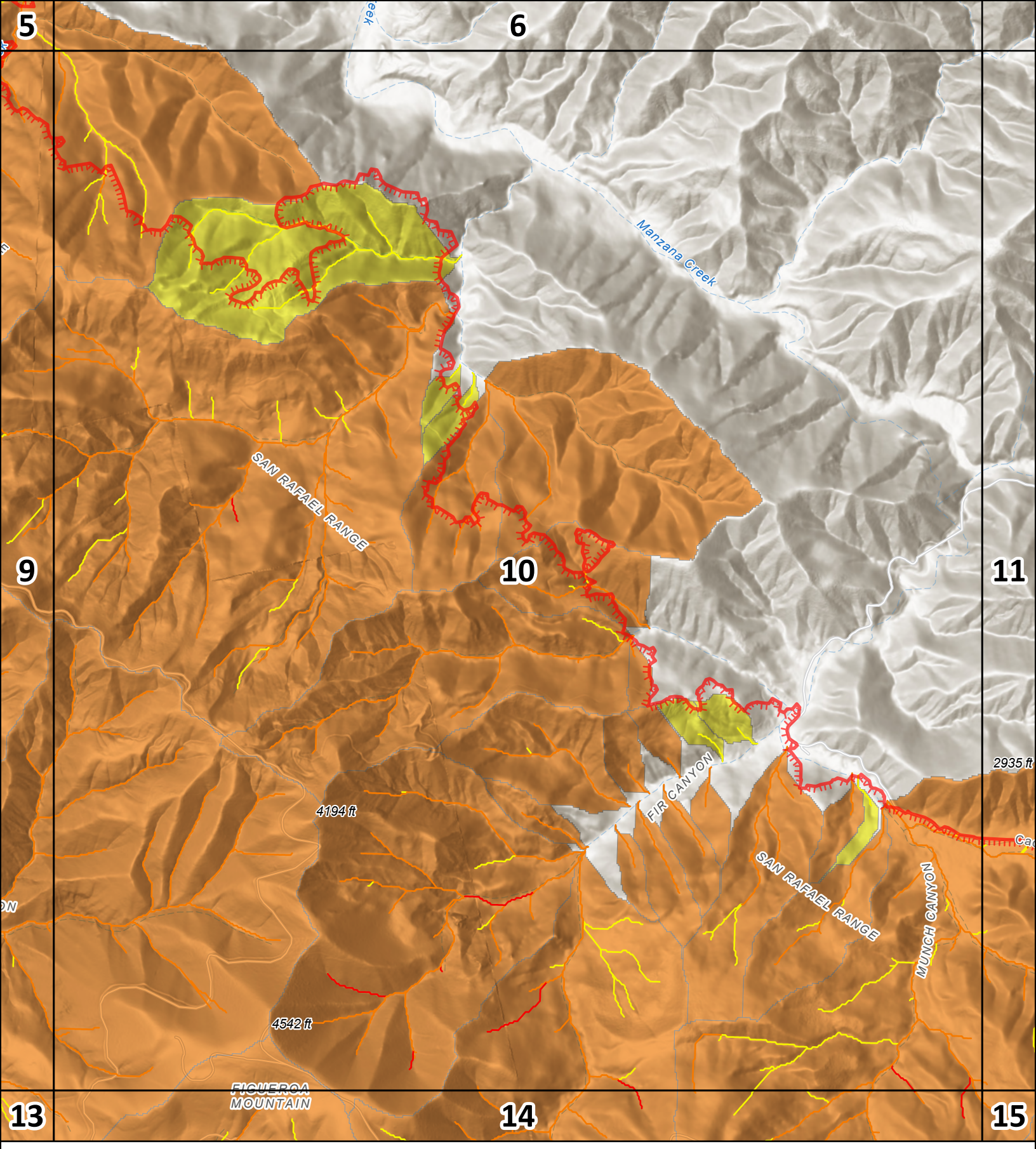
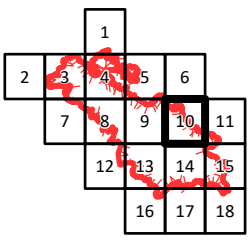


Incident: CA-LPF-001542: Lake Fire



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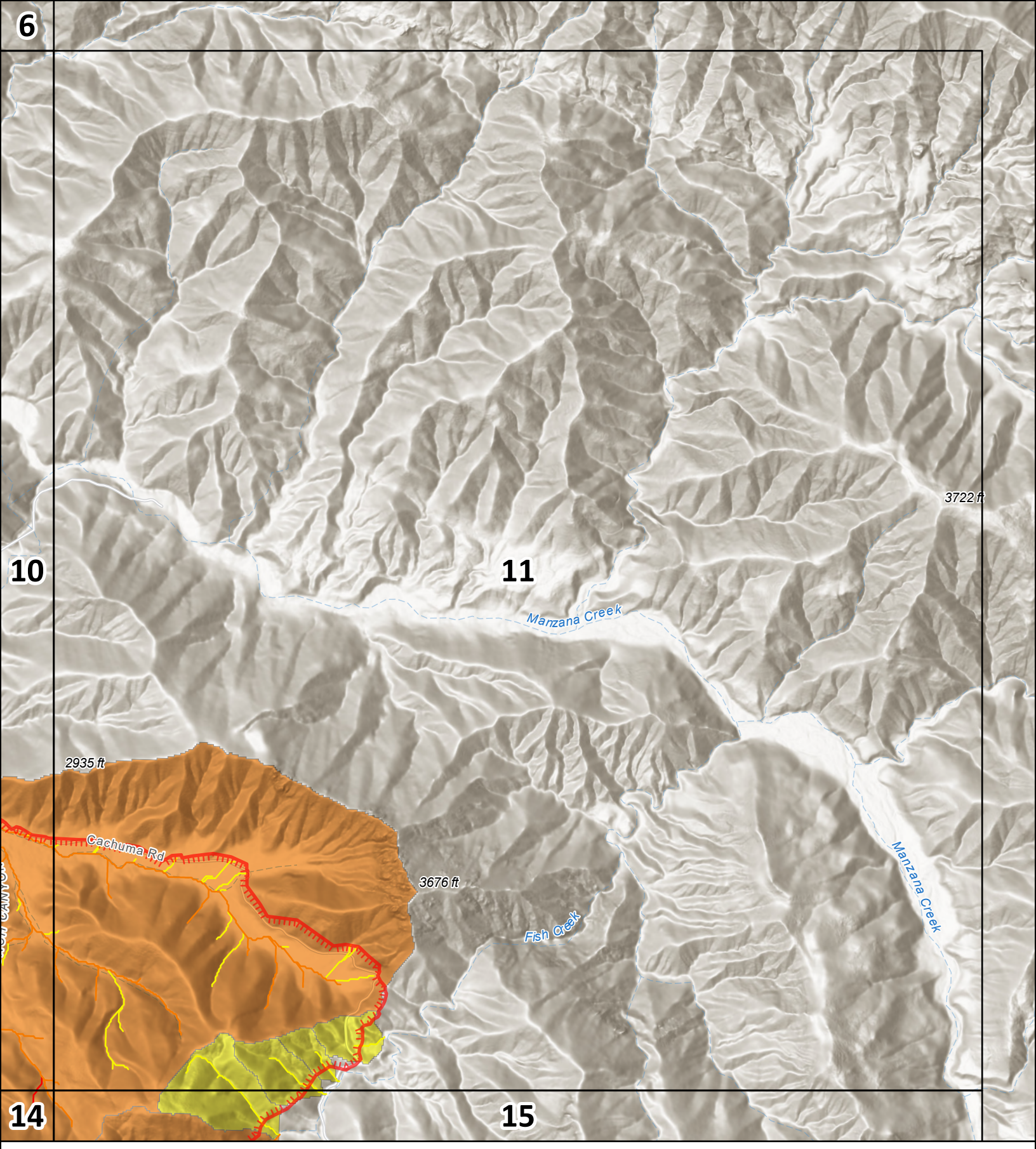
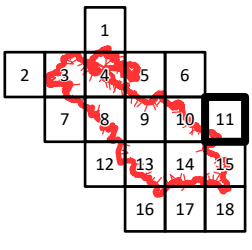


Incident: CA-LPF-001542: Lake Fire



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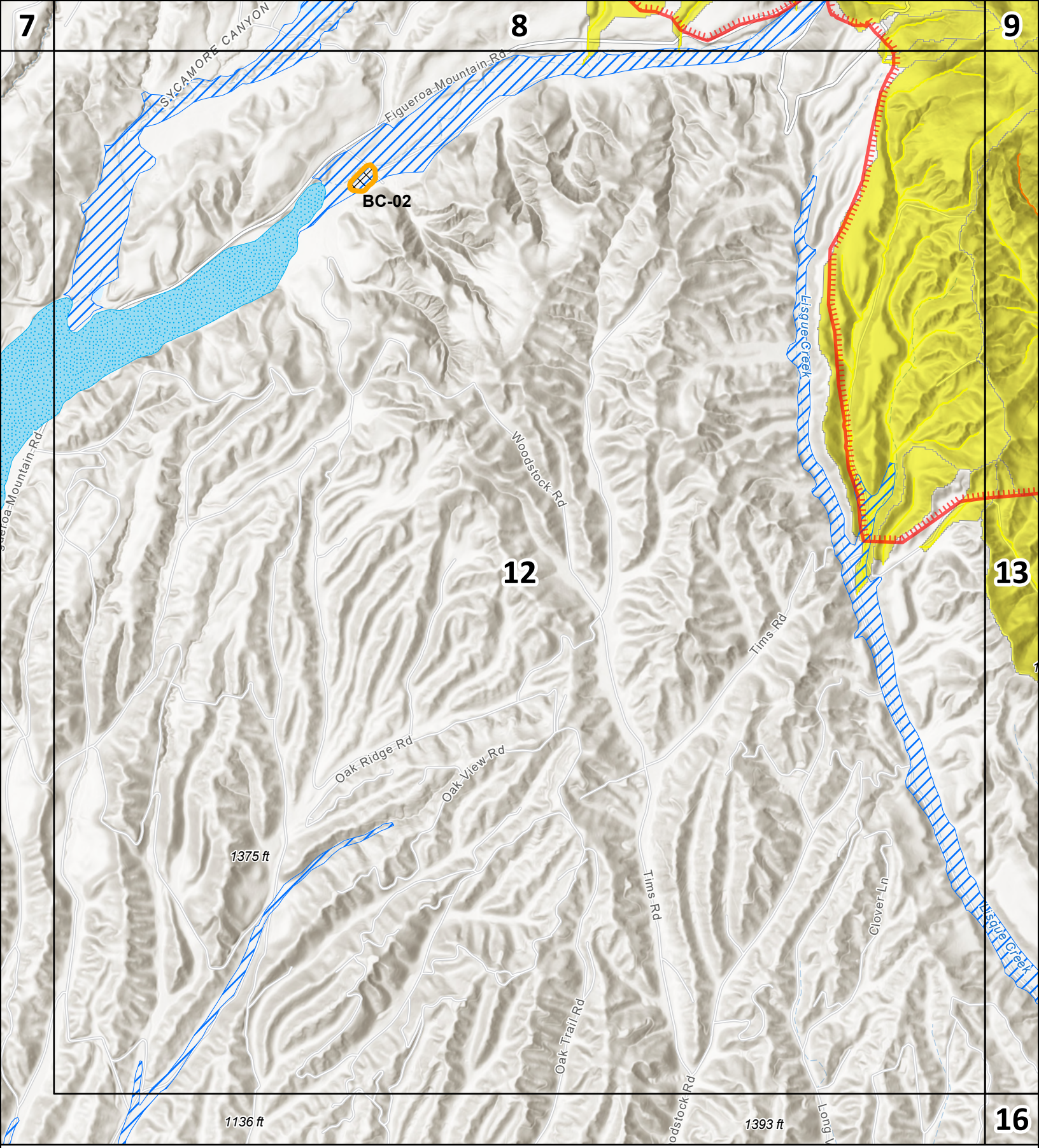
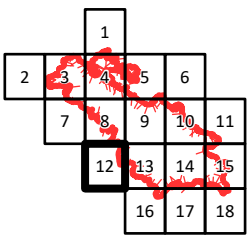


Incident: CA-LPF-001542: Lake Fire



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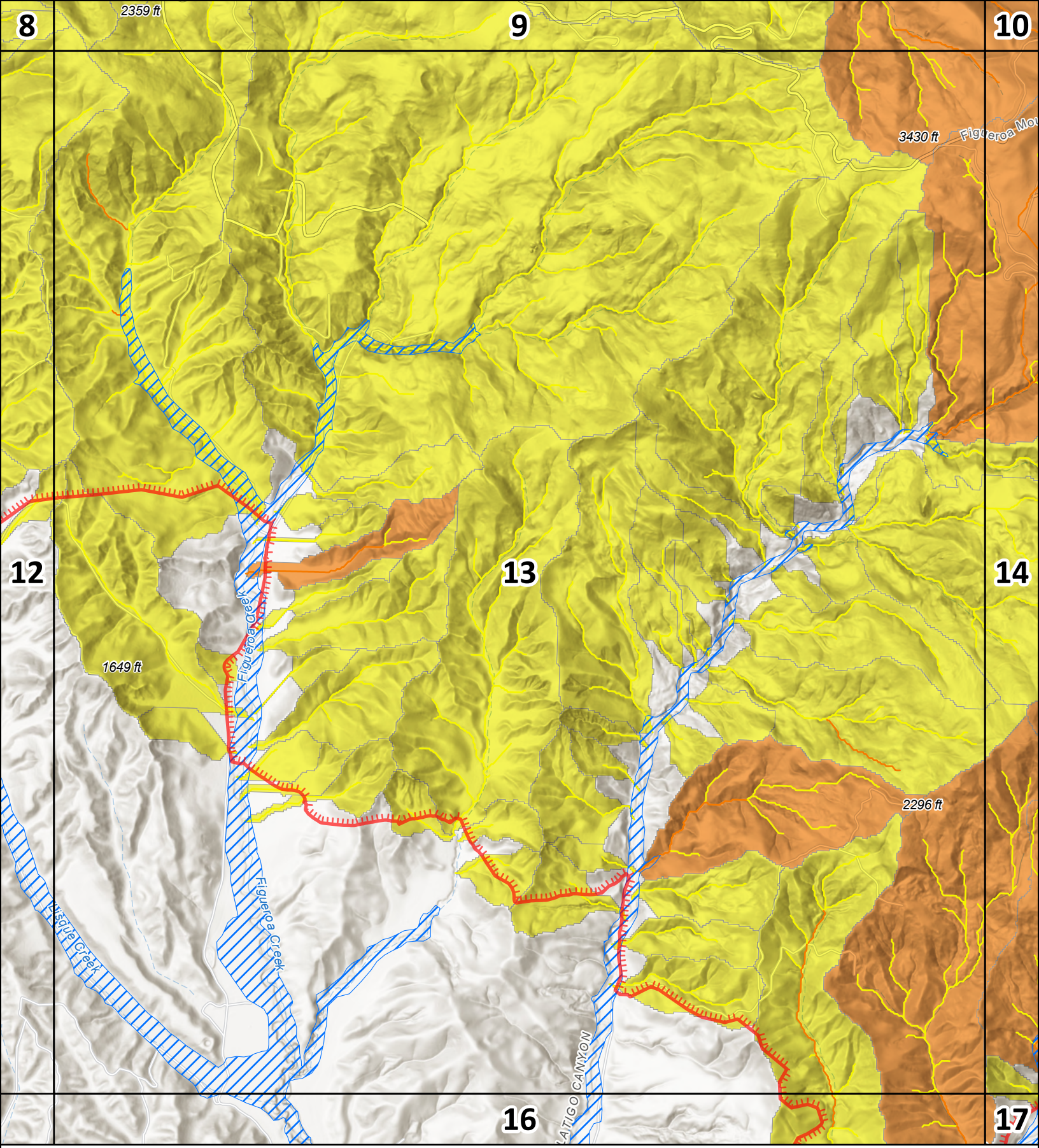

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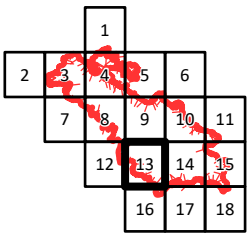

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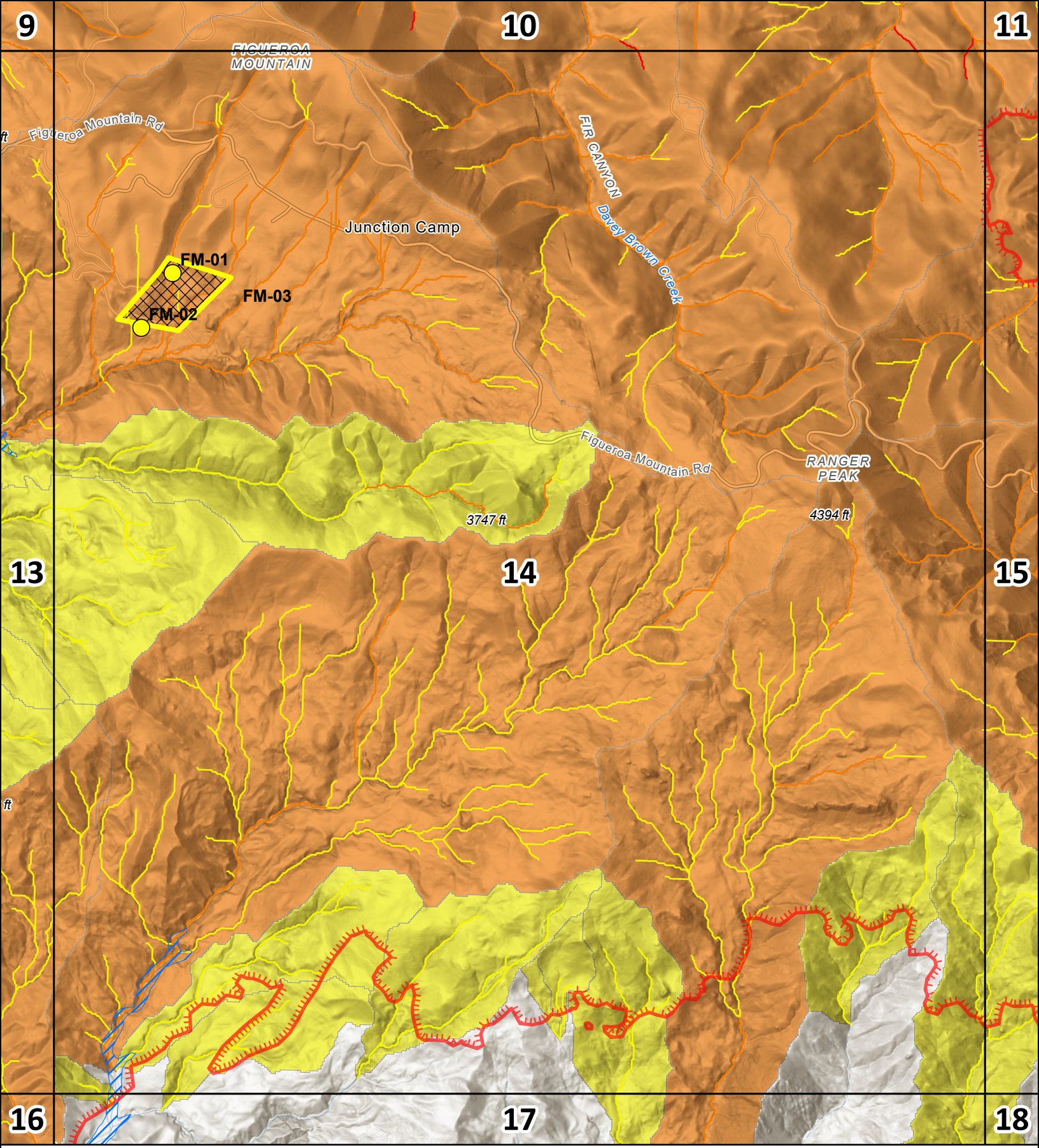

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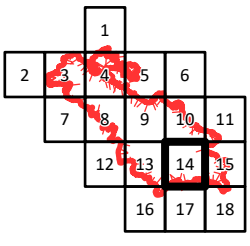

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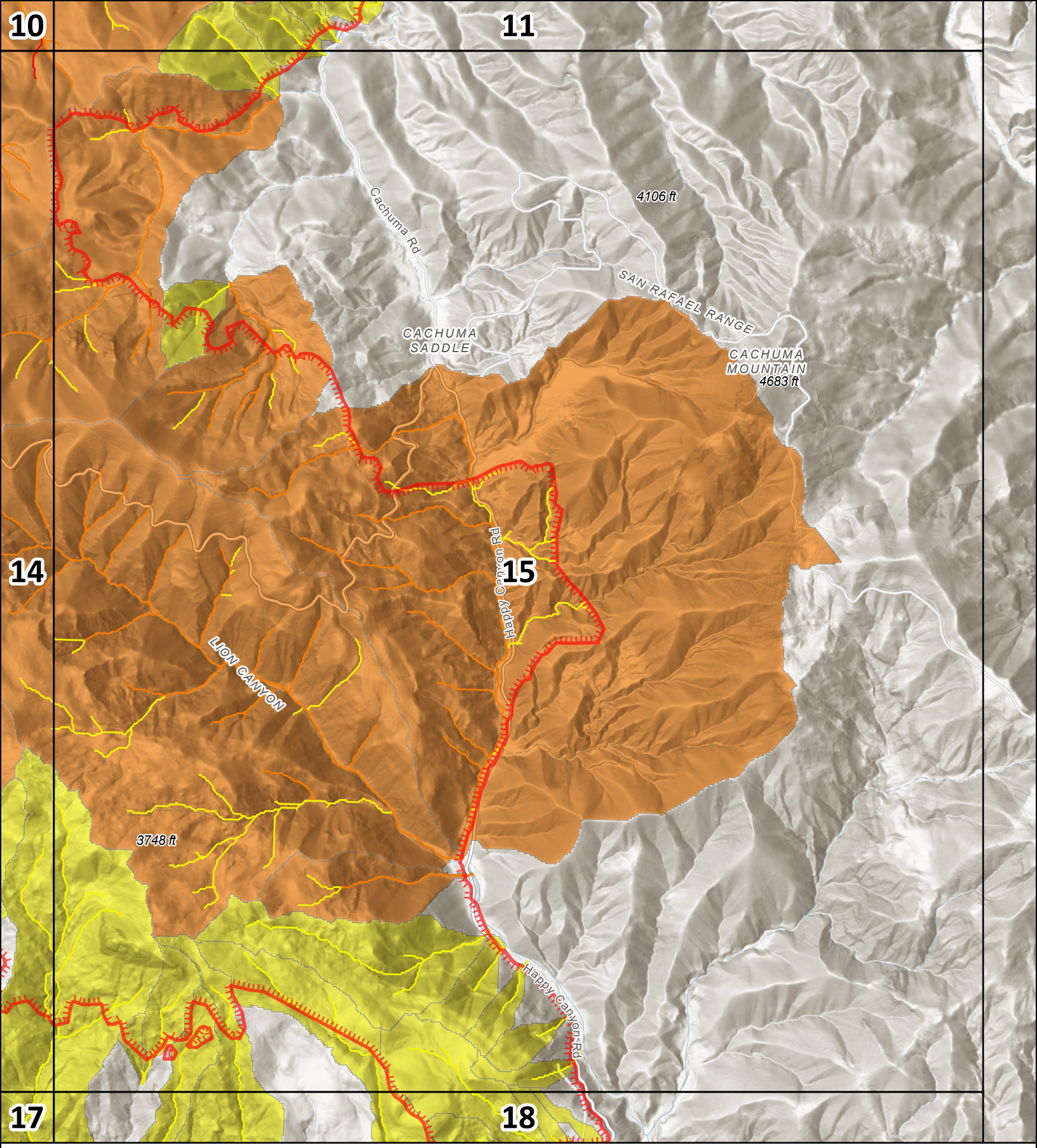

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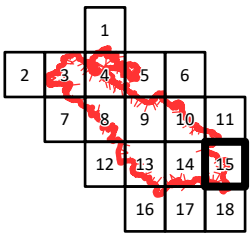

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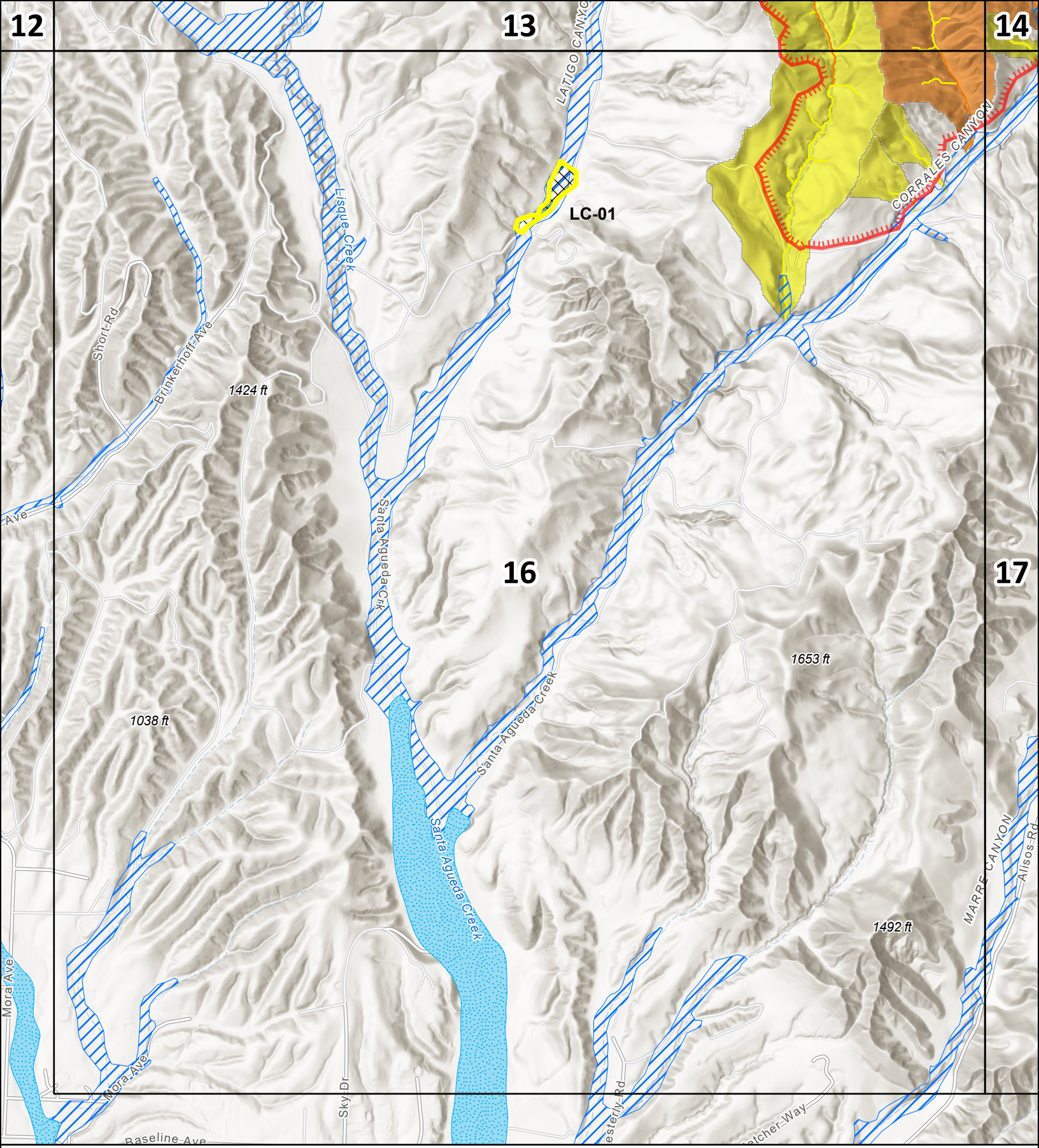
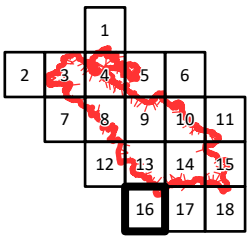


Incident: CA-LPF-001542: Lake Fire



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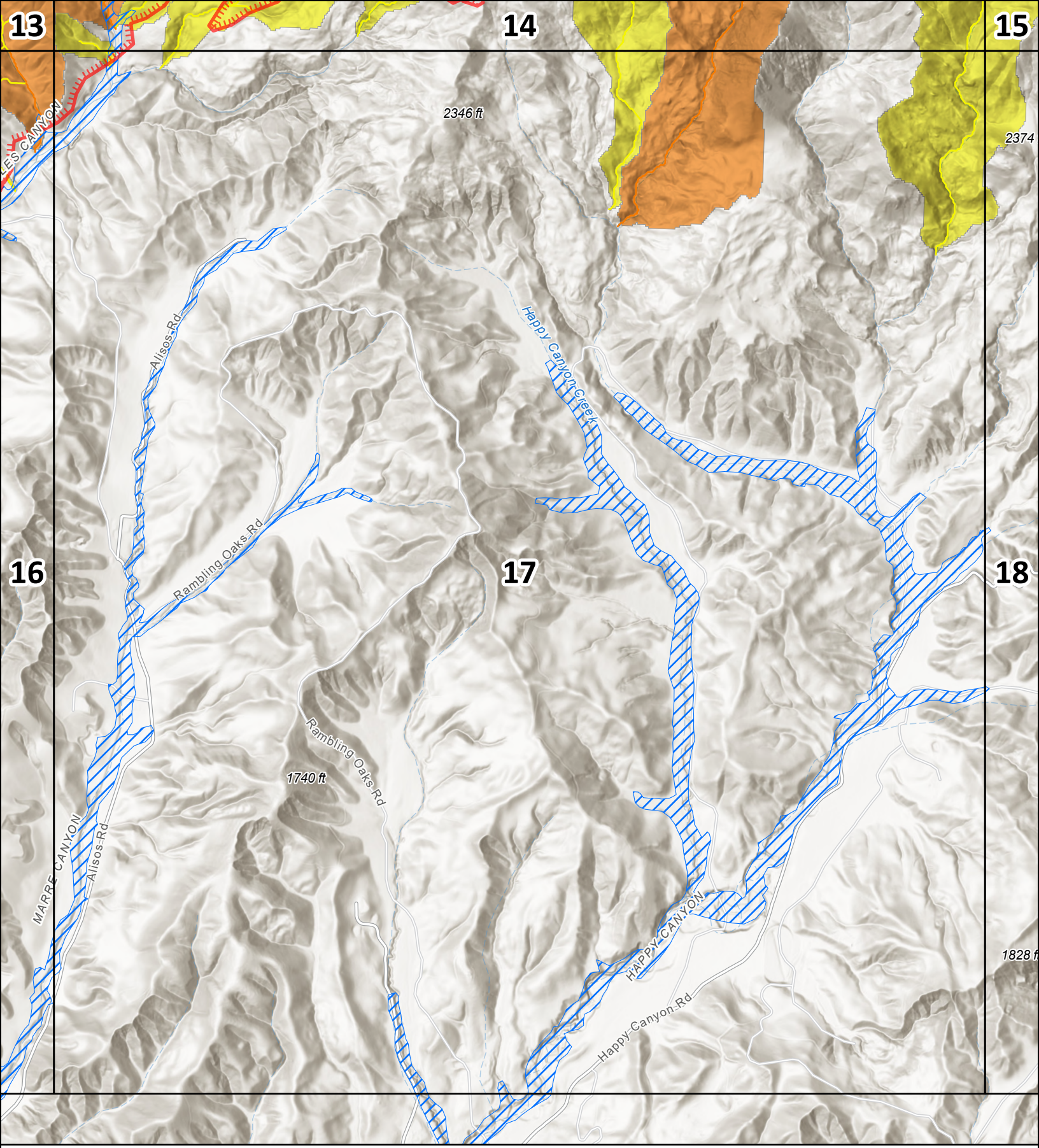

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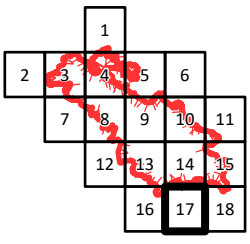

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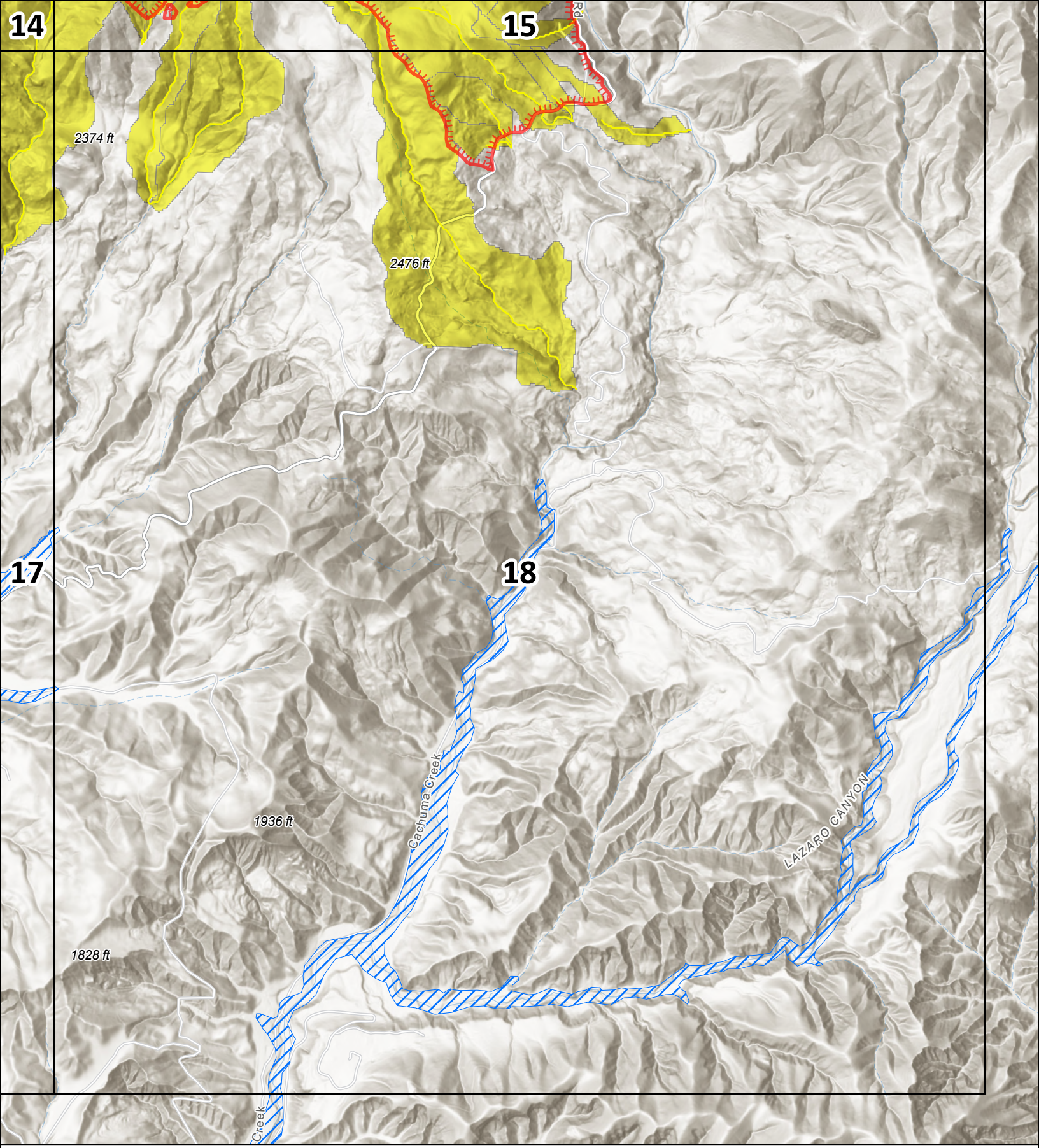

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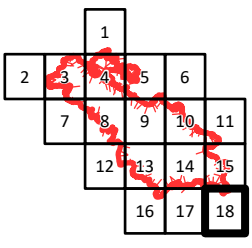

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Appendix D – Values-at-Risk Detail Sheets

VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Figueroa Mountain Road crossing Alamo Pintado Ck**

Site Number: **BC-01**

Feature: **Bridge on county road.**

Feature Category: **drainage structure**

Field Observation or Potential Hazard: Debris jam could impact bridge, causing loss of access. Little diversion potential.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **moderate**

Preliminary Emergency Protective Measures (1): **Monitor and maintain**

Preliminary Emergency Protective Measures (2): **Early Warning**

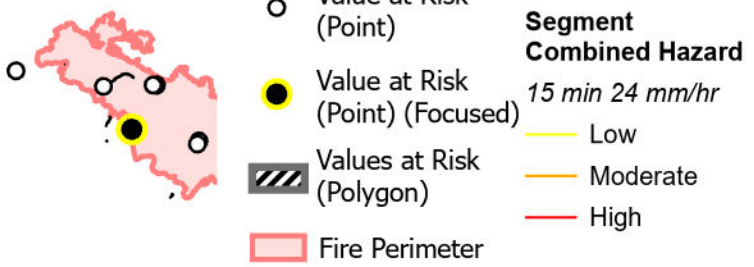
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

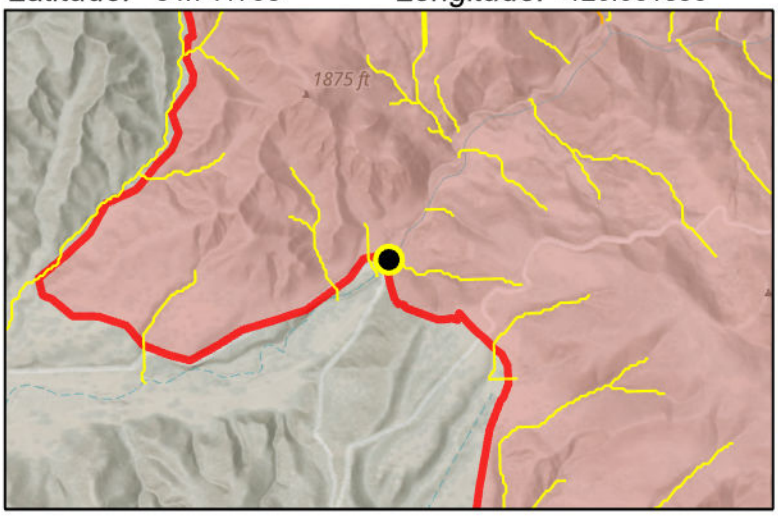
Preliminary Emergency Protective Measures (text): Reinstallation of debris rack upstream of bridge.

Description: Concrete bridge structure with a hydraulic area of 18'w x 8'h and a native substrate composed of cobble to boulders up to 2' diameter. Extensive vegetation (willow) along banks. Angled wingwall with sloped banks armored with riprap. Width of bridge normal to channel is approx 16'.

LOCATION AND PHOTO



Latitude: 34.741793 *Longitude:* -120.061836



VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Tres Herman's Ranch**

Site Number: **FC-01**

Feature: **Bridge**

Feature Category: **drainage structure**

Field Observation or Potential Hazard: Flooding of channel. Low potential of overbanking flow.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **low**

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

Preliminary Emergency Protective Measures (2): **NA**

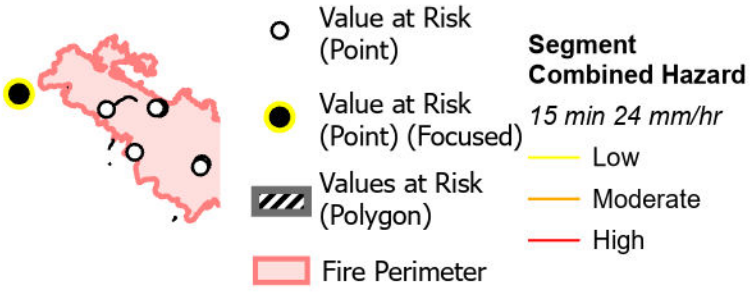
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

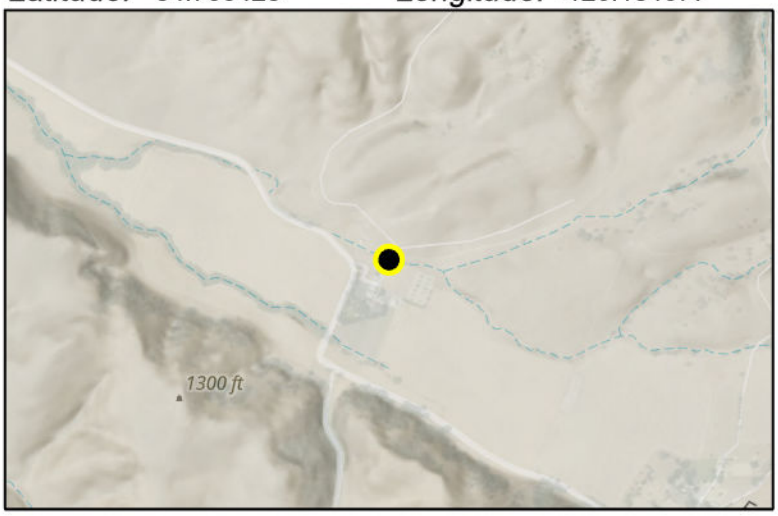
Preliminary Emergency Protective Measures (text): Clear and maintain culvert

Description: Box culvert that's also a bridge. 7ft deep and 5ft wide. Concrete head wall flared 30 degrees. Trapezoidal channel downstream. Barn and paddocks adjacent but elevated above channel. Flows may overtop and impact adjacent structures if jammed.

LOCATION AND PHOTO



Latitude: 34.796423 *Longitude:* -120.184077



VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Figueroa Mountain**

Site Number: **FM-01**

Feature: **Animal barn**

Feature Category: **other**

Field Observation or Potential Hazard: Barn is located on a fan. Upstream basin area was burned mostly at moderate severity. Drainage does not show evidence of recent incision near structure, but incision was present upstream at the Figueroa Mountain Rd.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **low**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

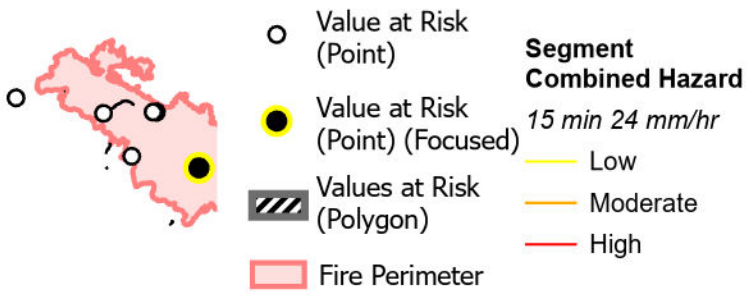
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: An unchannelized swale exists to the east of the animal barn and is likely to capture future flows. However, an unchannelized drainage upstream of the barn could route flow and sediment towards the barn during a large event.

LOCATION AND PHOTO



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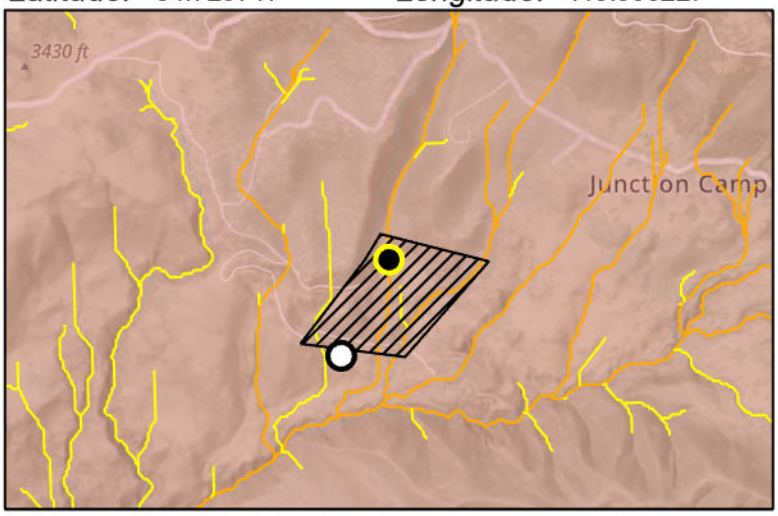


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Figueroa Mountain**

Site Number: **FM-02**

Feature: **House**

Feature Category: **home**

Field Observation or Potential Hazard: House appears to be built on an old, deep-seated landslide deposit and postfire hydrological changes could reactivate the landslide.

Potential Hazard to Life: **low**

Potential Hazard to Property: **low**

Preliminary Emergency Protective Measures (1): **NA**

Preliminary Emergency Protective Measures (2): **NA**

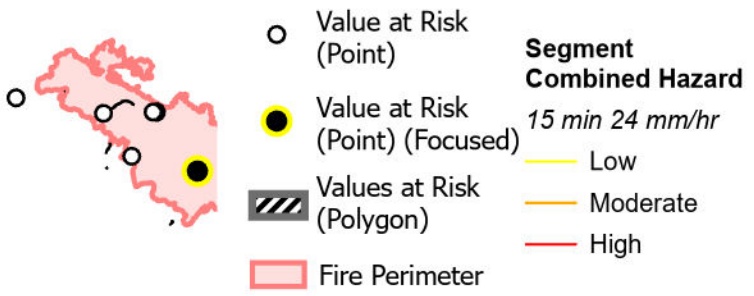
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

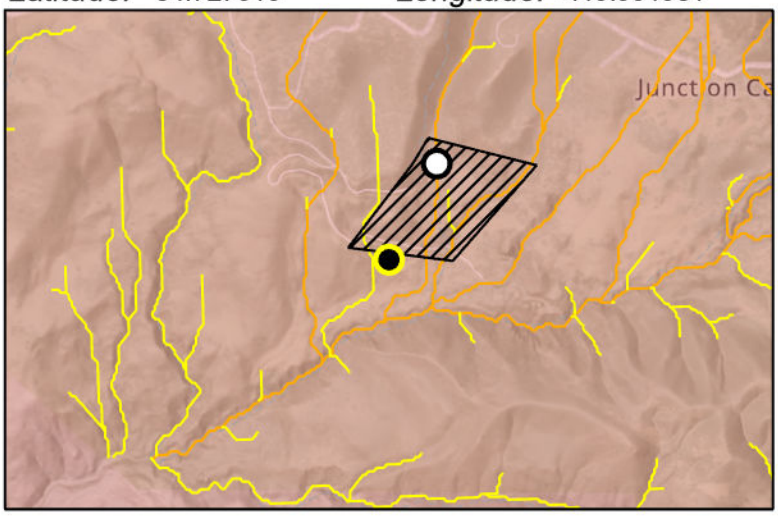
Preliminary Emergency Protective Measures (text): NA

Description: Old landslide deposit that may be reactivated, but is unlikely.

LOCATION AND PHOTO



Latitude: 34.727010 *Longitude:* -119.991981



VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Zaca Lake**

Site Number: **ZC-01**

Feature: **Water tank and inflow structure.**

Feature Category: **utilities**

Field Observation or Potential Hazard: Small, steep drainage with erodible material directly upslope of water tank.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **moderate**

Preliminary Emergency Protective Measures (1): **Monitor and maintain**

Preliminary Emergency Protective Measures (2): **NA**

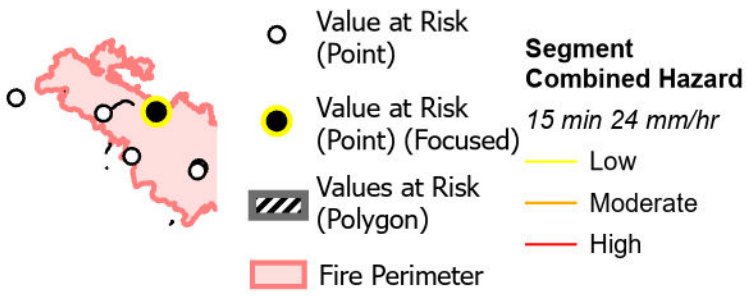
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

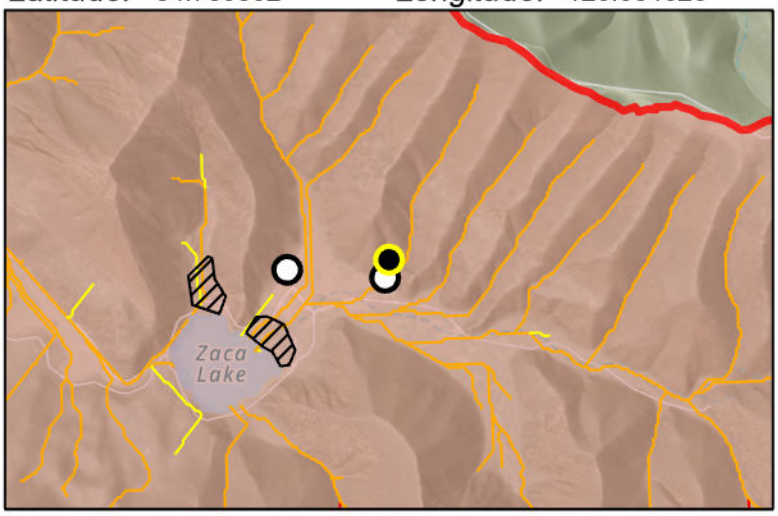
Preliminary Emergency Protective Measures (text): Deflect material from base of water tank. See additional photos.

Description: Aggradation around base of water tank, but low risk/impact to overall tank structure. Inflow structure likely nearby the water tank but did not directly observe in the field.

LOCATION AND PHOTO



Latitude: 34.780502 *Longitude:* -120.034026



VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Zaca Lake**

Site Number: **ZC-02**

Feature: **Workshop/stable**

Feature Category: **other**

Field Observation or Potential Hazard: Small basin with moderately incised channel upstream of structure. Channel has been filled near structure which may increase likelihood of being impacted.

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

Preliminary Emergency Protective Measures (1): **Deflection structure**

Preliminary Emergency Protective Measures (2): **NA**

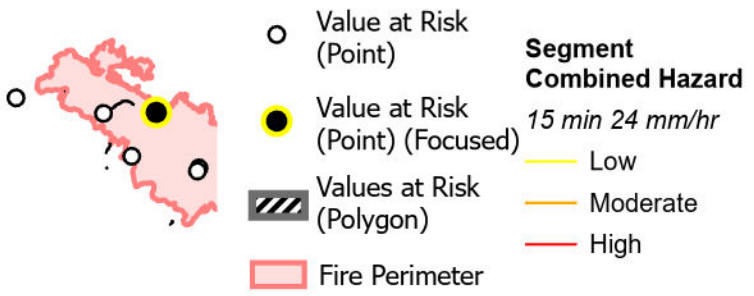
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: Small shop at outlet of channel. The drainage is small but could easily be diverted towards structure.

LOCATION AND PHOTO



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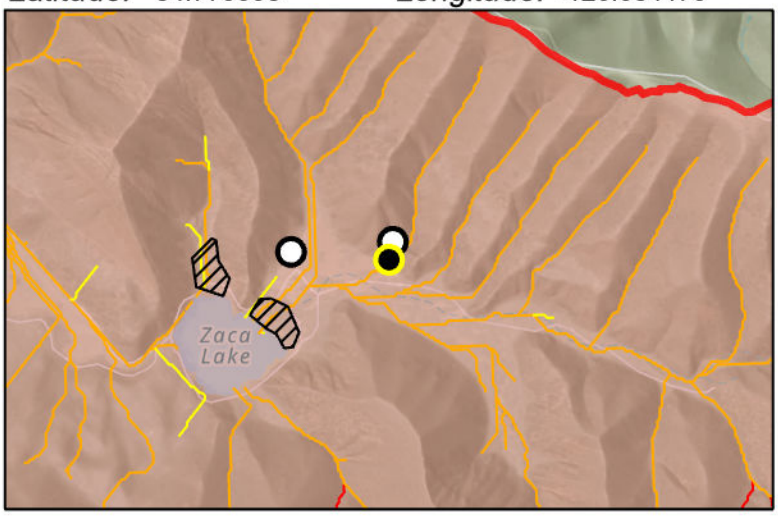


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Zaca Lake**

Site Number: **ZC-03**

Feature: **House**

Feature Category: **home**

Field Observation or Potential Hazard: Potential debris flood or nuisance flooding from primary basin.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **low**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

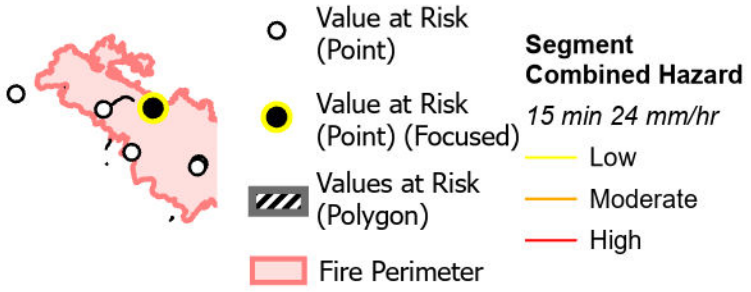
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): Residents should be aware that the structure may be impacted by flooding or debris during storms.

Description: Small, steep northwest drainage with 30% surface cover. Minimal anticipated flows.

LOCATION AND PHOTO



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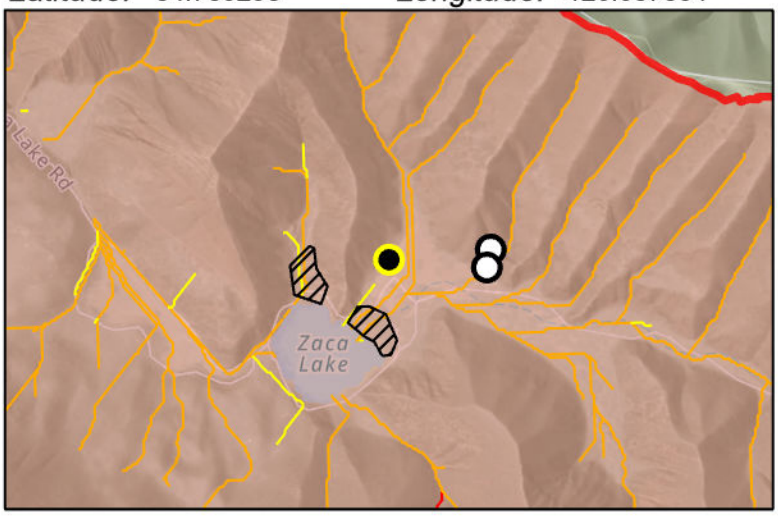


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Zaca Lake Road**

Site Number: **ZC-07**

Feature: **Culvert and road crossing**

Feature Category: **drainage structure**

Field Observation or Potential Hazard: Potential blockage of culvert could result in flooding along road.

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

Preliminary Emergency Protective Measures (1): **Monitor and maintain**

Preliminary Emergency Protective Measures (2): **Early Warning**

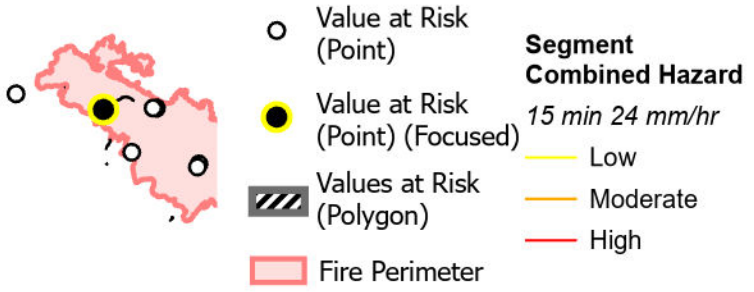
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): Early warning for people accessing roadway. Monitor and maintain culvert.

Description: Potential moderate impacts to culvert and road. Low traffic, private road, but people accessing road may be at moderate risk. 48 inch diameter, undersized culvert (CMP); large fill.

LOCATION AND PHOTO



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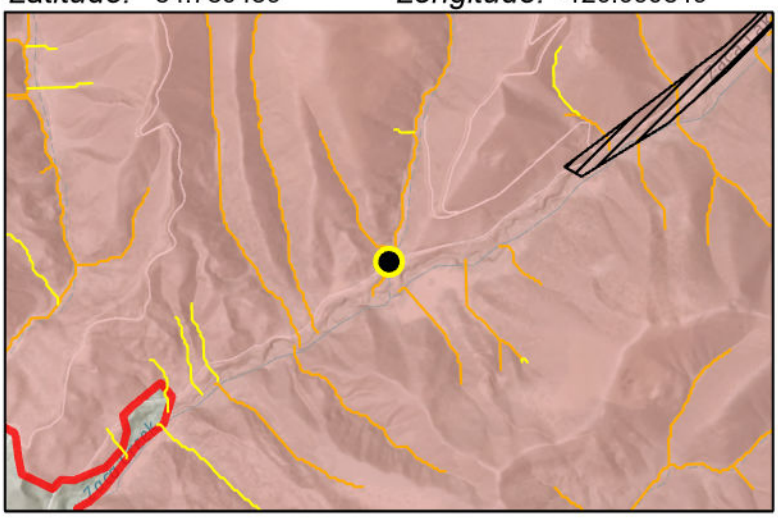


VALUE AT RISK DETAIL

Incident: Lake Fire — *Incident Number: CA-LPF-001542*

Community: **Midland School**

Site Number: **BC-02**

Feature: **Bridge, structures across road**

Feature Category: **utilities**

Field Observation or Potential Hazard: Potential blockage of bridge at high flow could redivert water outside of channel towards structures.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **Deflection structure**

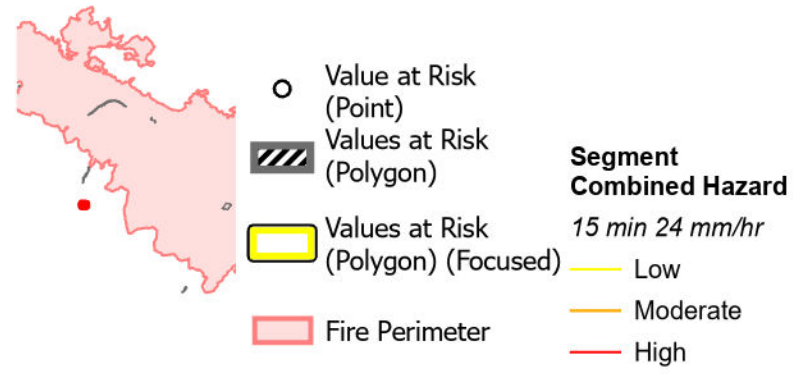
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): Installation of deflection structure to protect house along the inside of meander bend.

Description: Far distance from burned mountain front, incised channel, low channel slope and depositional reach with sinuous/braided morphology upstream of bridge. At bridge, the active channel is incised and contains two terraces. The lower elevation terrace is vegetated with dense willows. Observed flood flows during 2023 partially inundated structure and solar panels along upper floodplain at inside meander bend downstream of the bridge.

LOCATION AND PHOTO



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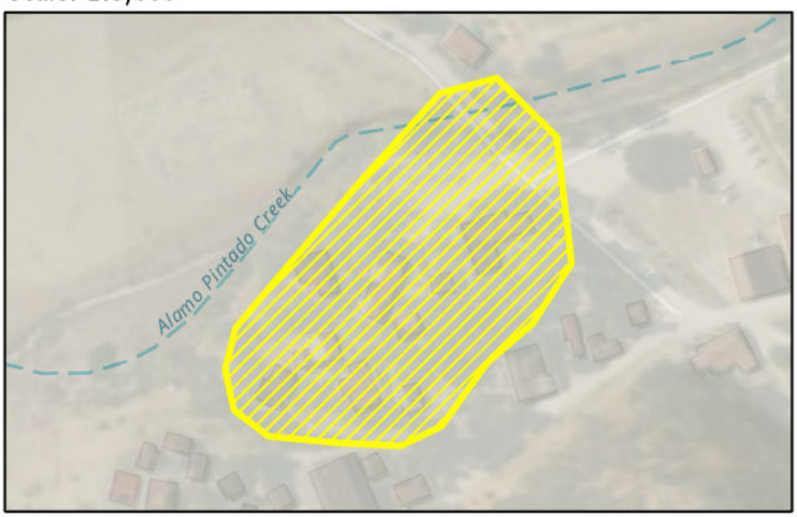


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Figueroa Mountain**

Site Number: **FM-03**

Feature: **Multiple stream crossings**

Feature Category: **other**

Field Observation or Potential Hazard: Ingress and egress along primary roads to the community could be impacted floods or debris floods.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **low**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

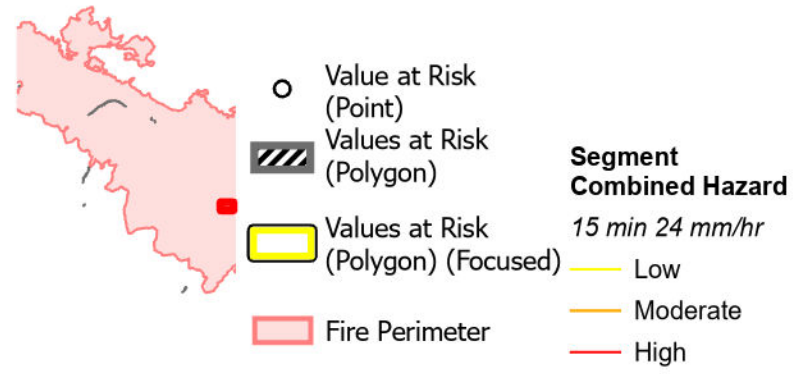
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: Near FM-01, there is a large unchannelized swale that may be impacted by floods or flood flows. The same drainage is incised near Figueroa Road upstream. The basin was burned at mostly moderate severity and sediment appears to be readily available for transport. No culvert was present along the main road near FM-01. The road is the only source or ingress and egress for multiple homes and may be damaged during a storm. There are multiple additional small crossings in the community. Some of them have culverts and some of them do not.

LOCATION AND PHOTO



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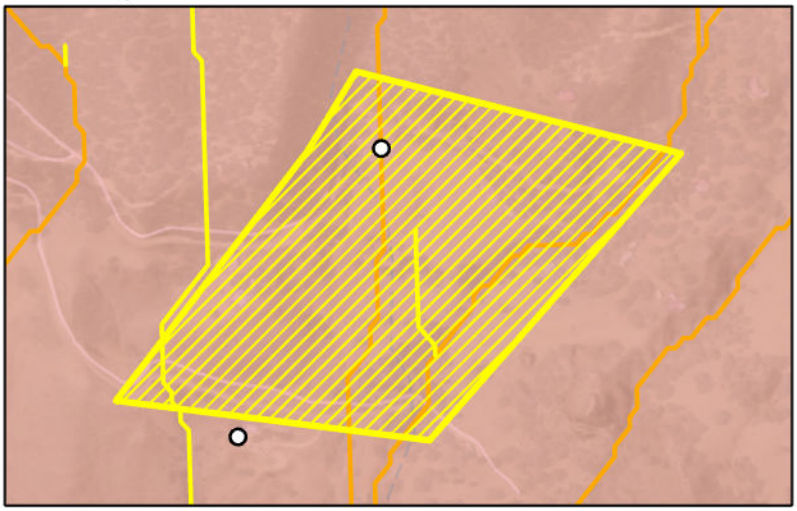


VALUE AT RISK DETAIL

Incident: Lake Fire — *Incident Number: CA-LPF-001542*

Community: **Latigo Canyon vineyard**

Site Number: **LC-01**

Feature: **Barn and stream crossing**

Feature Category: **business**

Field Observation or Potential Hazard: Low potential for flooding or debris floods to barn and stream crossing. Channel is deeply incised (~10 ft) with substantial floodplain on stream right for area upstream of barn. There is a large culvert at the stream crossing.

Potential Hazard to Life: **low**

Potential Hazard to Property: **low**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

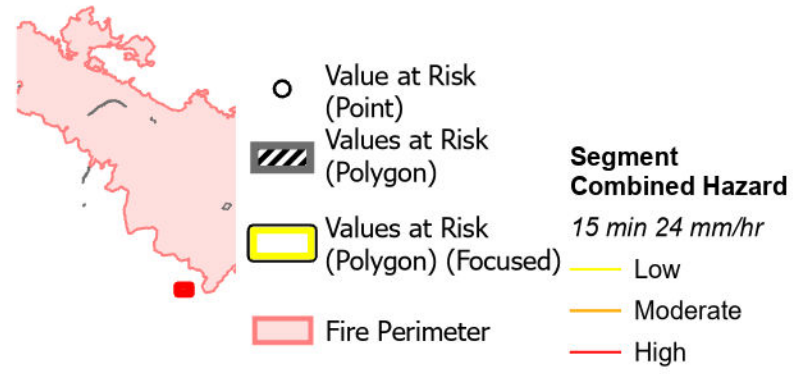
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: In the unlikely event that the culvert is plugged, flooding on road will reenter channel immediately downstream.

LOCATION AND PHOTO



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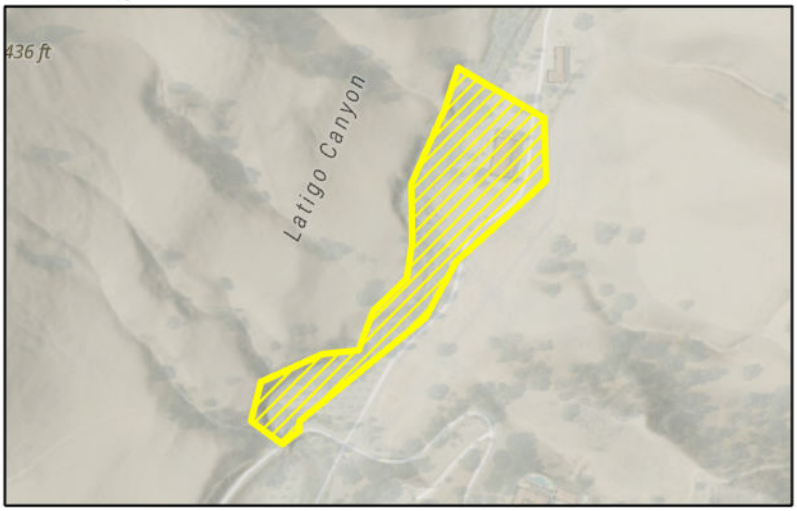


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Sycamore Valley Ranch (Neverland Ranch)**

Site Number: **SC-01**

Feature: **train garage, theater, ranch house, etc**

Feature Category: **multiple**

Field Observation or Potential Hazard: An incised channel crosses the ranch and may flood multiple buildings during storms.

Potential Hazard to Life: **low**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

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

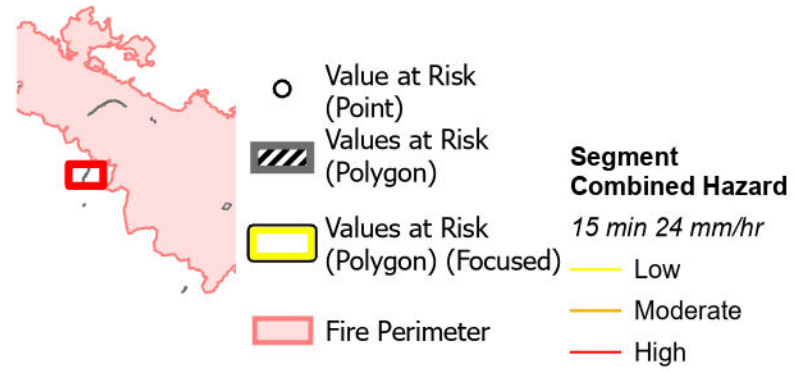
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): The property owner/land manager should consider consulting with a licensed engineer to discuss improvements to road crossings.

Description: Near the small train station on the north end of the ranch, flooding may occur. Downstream, flooding may occur at a stream crossing with five culverts if the culverts are plugged or streamflow is high. Further downstream, an Arizona crossing may flood, which could impact a ranch house and small structure on the other side of the channel. There is also potential for nuisance flooding near the theater and to other buildings and crossings downstream. The land manager mentioned prior flooding during a large storm in January 2023. Structures and stream crossings below the theater were not visited.

LOCATION AND PHOTO



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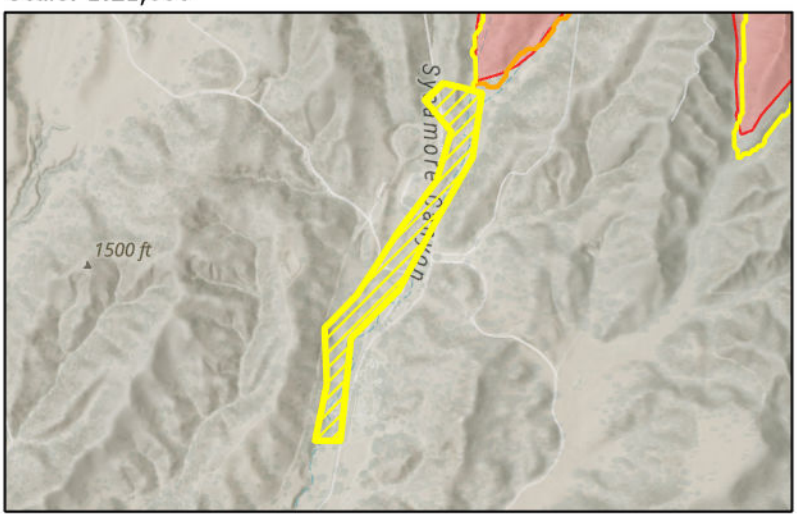


VALUE AT RISK DETAIL

Incident: Lake Fire *Incident Number: CA-LPF-001542*

Community: **Branquinho: The Union Ranch**

Site Number: **SHC-01**

Feature: **Structure and crossing.**

Feature Category: **multiple**

Field Observation or Potential Hazard: Potential flooding to structure and crossings. Unable to access locked gate.

Potential Hazard to Life: **low** *Potential Hazard to Property:* **low**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **NA**

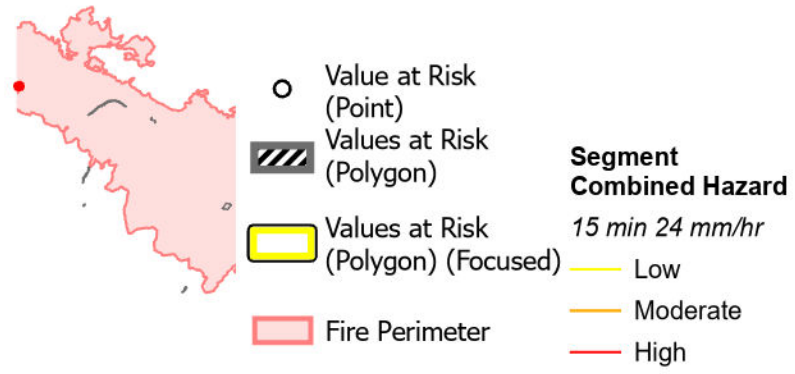
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: Assessment performed remotely.

LOCATION AND PHOTO



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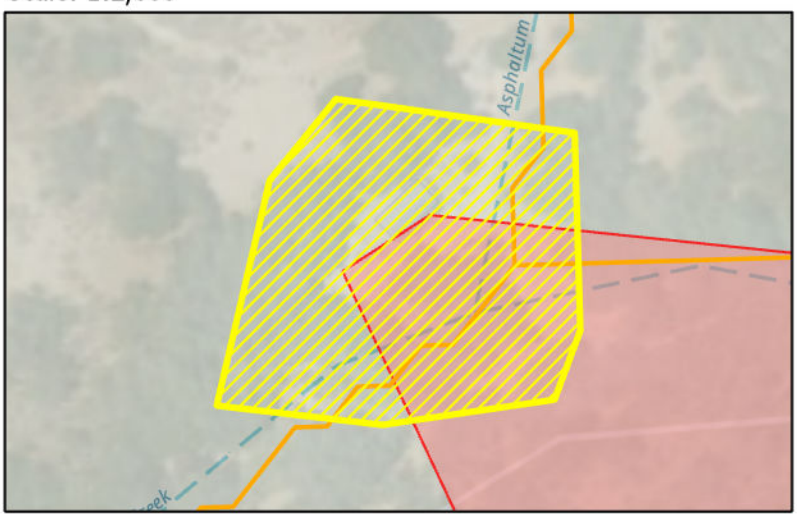


VALUE AT RISK DETAIL

Incident: Lake Fire — *Incident Number: CA-LPF-001542*

Community: **Zaca Lake**

Site Number: **ZC-04**

Feature: **NA**

Feature Category: **NA**

Field Observation or Potential Hazard: Potential flooding of the westernmost cabins at culvert. At cabins near lake, stream takes sharp turn to parallel road and flows to the northwest; stream could overbank over small berm along road.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Deflection structure**

Preliminary Emergency Protective Measures (2): **Debris barrier**

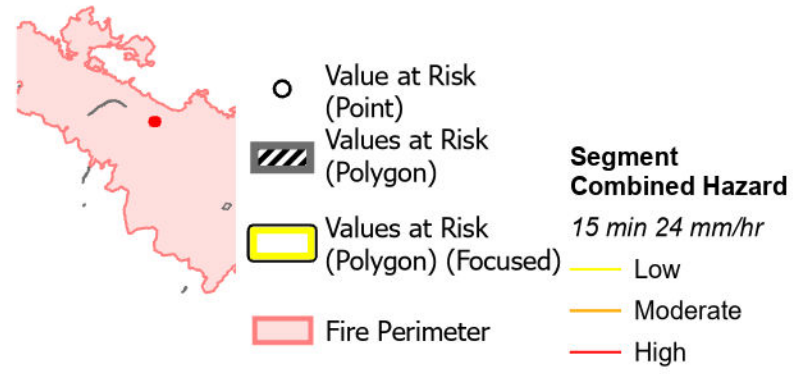
Preliminary Emergency Protective Measures (3): **Early Warning**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): Consider installing deflection structure near cabin at lake near 24" culvert. Heighten berm along road.

Description: Land manager noted substantial flooding to cabins during large storm in January 2023. Floodplain was graded after January 2023 storm.

LOCATION AND PHOTO



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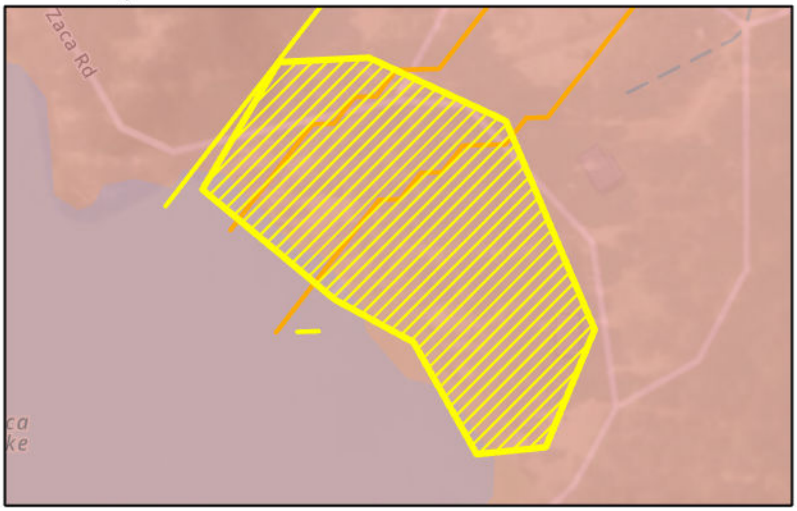


VALUE AT RISK DETAIL

Incident: Lake Fire — *Incident Number: CA-LPF-001542*

Community: **Zaca Lake**

Site Number: **ZC-05**

Feature: **Two story and single story log cabins**

Feature Category: **home**

Field Observation or Potential Hazard: Potential debris flood of multiple, single-story structures upslope of new construction on lake shore.

Potential Hazard to Life: **moderate**

Potential Hazard to Property: **moderate**

Preliminary Emergency Protective Measures (1): **Early Warning**

Preliminary Emergency Protective Measures (2): **Deflection structure**

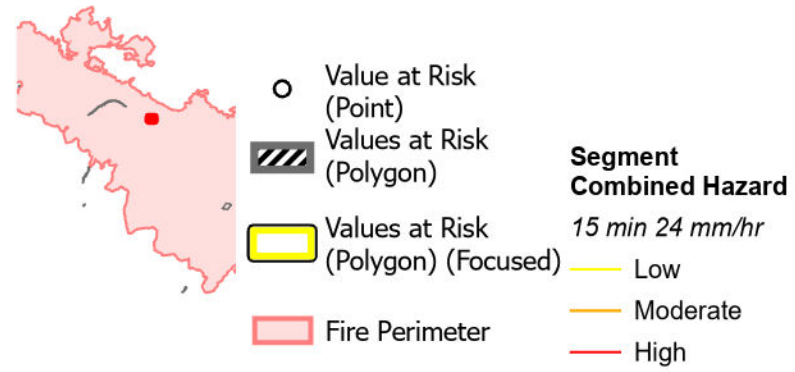
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): NA

Description: Flow from primary drainage could cause potential flooding to two-story house (northern-most structure). Small swale to the west was unchannelized. Electrical infrastructure present near channel.

LOCATION AND PHOTO



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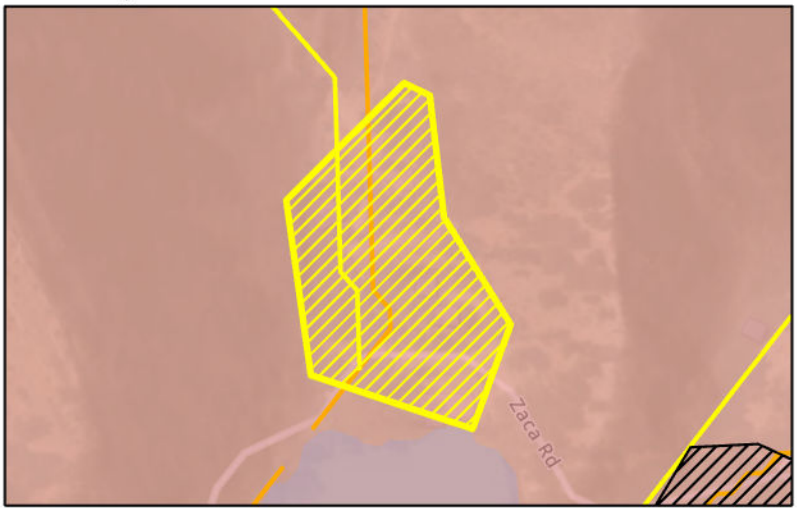


VALUE AT RISK DETAIL

Incident: Lake Fire — *Incident Number: CA-LPF-001542*

Community: **Zaca Lake Road**

Site Number: **ZC-06**

Feature: **Zaca Lake Road**

Feature Category: **other**

Field Observation or Potential Hazard: Low-water crossings are at risk of being overtopped with flow and debris. Increased erosion and deposition could occur along roadway.

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**

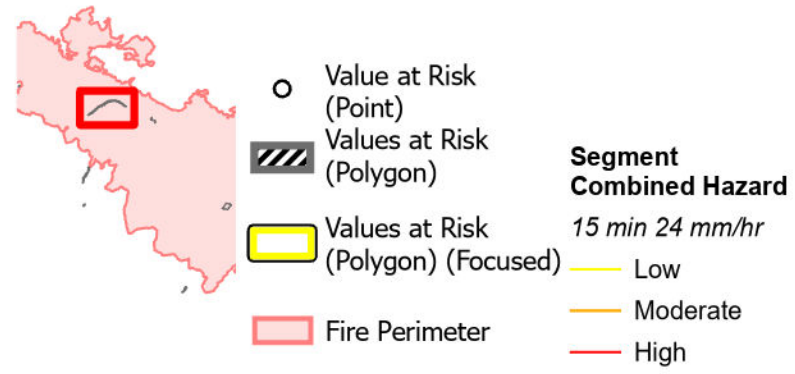
Preliminary Emergency Protective Measures (3): **NA**

Preliminary Emergency Protective Measures (4): **NA**

Preliminary Emergency Protective Measures (text): Access along road should be avoided during storm events. Monitor and maintain road and crossing structures.

Description: Tributary drainages can deliver sediment and debris that can impact road.

LOCATION AND PHOTO



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