2021 CALDOR FIRE

CA-ENF-023040

Burned Area Emergency Response (BAER)

Assessment Report Summary

Eldorado National Forest and Lake Tahoe Basin Mgt Unit

Pacific Southwest Region

USDA Forest Service

October 2021

Caldor Post-Fire Watershed Response—4 Levels of Soil Burn Severity Assessed

CALDOR BAER ASSESSMENT REPORT SUMMARY

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Fire Overview & Burned Area Description

The Caldor Fire started on August 14, 2021, about two miles east of Omo Ranch and four miles south of Grizzly Flat. The fire burned approximately 166,808 acres on the Eldorado National Forest (ENF), 9,885 acres on the Lake Tahoe Basin Management Unit (TMU), 2,076 acres on Bureau of Land Management (BLM) land, 40,183 acres of private or state lands, and in three counties (Eldorado, Alpine, and Amador)—for a total of approximately 218,952 acres--the number of acres analyzed by the BAER team as of September 18, 2021. As of October 19, 2021, the Caldor Fire burned 221,835 acres (See Figure 1).

The regional drought, combined with dry, hot weather and strong winds, resulted in very active fire behavior. Fire spread was a combination of flanking, backing, and sustained up-canyon/upslope runs. Fire spotting ahead of the head of the fire was a constant concern and threat with group torching and short duration crown fire runs. The fire spread through a combination of rapid-fire runs, long and short distance spotting, creeping and burnout operations resulting in a mosaic of fire severity on National Forest System (NFS) lands.

These dominant vegetation communities are found within the fire perimeter areas: alpine dwarf-shrub, annual non-native grassland, blue-oak/foothill pine, chamise/redshank chaparral, Jeffery pine, lodgepole pine, mixed chaparral, montane chaparral, montane hardwood/ conifer, perennial grassland, ponderosa pine, red fir, Sierran mixed conifer, subalpine conifer, wet meadow, and white fir.

The Caldor burned area lies within portions of twenty-two 12-digit Hydrologic Unit Code (HUC) watersheds: Alder Creek, Bear River, Big Meadow Creek-Upper Truckee River, Camp Creek, Caples Creek, Cat Creek-Middle Fork Cosumnes River, Chimney Flat-South Fork American River, Dogtown Creek, Lake Aloha-South Fork American River, Long Canyon-Silver Fork American River, Lower-North Fork Cosumnes River, North Tragedy Creek, Plum Creek-South Fork American River, Silver Lake-Silver Fork American River, Sly Park Creek, Sopiago Creek-Middle Fork Cosumnes River, South Fork Silver Creek, Spanish Creek-Middle Fork Cosumnes River, Steely Fork Cosumnes River, Trout Creek, Upper North Fork Cosumnes River, and Upper Truckee River-Frontal Lake Tahoe (See Figure 1).

The Caldor Fire area is within the Sierra Nevada geologic province, which is characterized by granitic rocks of the Sierra Nevada. The geology is characterized by an array of rock units, generally including Paleozoic meta-sedimentary and meta-igneous rocks, Cretaceous granitics of the Sierra Nevada batholith, and Tertiary volcanics that cap ridges.

The dominant soils are derived from complex geology: within the Cosumnes River basin, the soils are primarily lava caps (lahars) capping either granitic rocks or metasedimentary marine sediments. Where the Cosumnes River has eroded canyons, the granitic and meta-sedimentary derived soils are exposed to relatively rapid erosional processes. The dominant soil textures in this area are loam soils which are prone to erosion and can generate large amounts of sediment when fire removes the protective soil cover. The soils of the South Fork American River and the Lake Tahoe Basin are dominated by glacially scraped granitic types of rock. The lahars found in the Cosumnes River basin have been removed. Those soils derived from the granitic tend to be coarse textured and do not have high erosion rates compared to the Cosumnes soils. Throughout these areas of the fire, glacial re-sorting and deposition result in very rocky coarse textured soils which tend to be armored from erosion.

Table 1. Miles of stream channels by order or class within the burned area

Stream Type	Miles Of Stream
Canal Ditch	14
Ephemeral Stream	1,082
Intermittent Stream	300
Perennial Stream Or River	339
Pipeline	1
TOTAL	**1,735**

Table 2. Miles of NFS trails within the burned area

Type	Miles
Snowmobile	14
Motorized	99
Non-Motorized	92
Unlabeled in GIS	3
Total - Trails	**208**

Table 3. Miles of NFS roads within the burned area

Maintenance Level	Miles
1 - Basic Custodial Care (Closed)	286
2 - High Clearance Vehicles	463
3 - Suitable For Passenger Cars	100
4 - Moderate Degree Of User Comfort	80
5 - High Degree Of User Comfort	64
Forest Service - TOTAL	**993**
Non-Forest Service Roads - TOTAL	**58**

On September 8, a BAER team began assessing the western portion of the fire that had low or no fire activity. The initial team consisted of soil scientists, hydrologists and geologists focused on mapping soil burn severity levels using an initial BARC (burned area reflectance classification) satellite imagery generated map that compares pre- and post-fire images.

Additional BAER specialists, including geographic information systems (GIS) specialists, road engineers, aquatic and terrestrial biologists, archeologists, botanists, and recreation managers engaged a few days later in order to assess imminent post-fire threats to human life and safety, property, and critical natural and cultural resources.

BAER Process

Forest Service BAER assessments focus on imminent post-fire threats to life and safety, property, critical natural resources and cultural resources on National Forest System (NFS) lands. Threats include determining where post-fire rain events could increase runoff and flooding, erosion and sediment delivery, debris flows, and high-risk areas for the spread of invasive weeds.

The first step in identifying post-fire threats is development of a Soil Burn Severity (SBS) map to document the degree to which soil properties changed because of the fire. Fire damaged soils have low strength, high root mortality, and increased rates of water runoff and erosion. Soil burn severity is classified according to the Field Guide for Mapping Soil Burn Severity.

Primary soil characteristics considered in soil burn severity classification are forest floor cover, ash color, integrity of roots, integrity of structure, and water repellency. Water repellent soils have reduced infiltration which results in increased runoff. Areas of low and unburned SBS have minimal effects to soil properties, and therefore, little to no post-fire effects. While moderate SBS indicates that some soil properties have been affected and the duff and litter layer that acts as a sponge to absorb precipitation has mostly been consumed. And high SBS areas have significant alterations to soil properties such as complete consumption of littler and duff, loss of root viability and changes to soil structure than often drive substantial watershed response including increased erosion and runoff following precipitation events. The team conducted its field verification surveys to adjust the initial satellite data to create a final SBS map for the Caldor burned area (See Figure 2).

Additionally, the US Geological Survey (USGS) uses the BAER team's SBS findings and models post-fire debris flow hazards potential; the results for Caldor Fire are available at:
https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=382
(Also See Figure 3).

Watershed Condition

Table 4. Acres of soil burn severity (SBS) by ownership.

Ownership	Soil Burn Severity (Acres)				
	Unburned & Very Low	Low	Moderate	High	Total
Bureau of Land Management	16	754	1,287	19	2,076
Bureau of Reclamation	3	1			4
Eldorado National Forest	9,183	64,250	69,639	23,660	166,808
Lake Tahoe Basin Management Unit	1,512	3,903	4,193	271	9,885
Private / Other	2,472	17,944	14,736	4,671	39,848
Regional Agency Land	1	0			25
State Fish and Wildlife	14	105	31		150
State Land Board	1	31	107	18	156
TOTALS	**13,333 (6.1%)**	**86,988 (39.6%)**	**89,992 (41.2%)**	**28,639 (13.1%)**	**218,952**

The table below shows the soil erosion hazard rating in the burned area. This metric is a measure of both impacts from the fire and the inherent erodibility of the soils and landforms.

Table 5. Erosion Hazard Rating

Rating	Acres	Percent of Fire Area
Very Severe	9,398	4.3%
Severe	51,366	23.5%
Moderate	43,218	19.7%
Low	101,292	46.3%
Not Rated (Rock Outcrop)	13,678	6.2%

Erosion and Sediment Potential: Erosion is predicted to be much higher in the Cosumnes River basin than it is in the South Fork American River basin and the Lake Tahoe Basin. Because of burn severity extent, steep slopes and erodible soil in the Cosumnes River basin, the predicted erosion and delivery rates are predicted to be extreme even for a 2-year event. For the South Fork American River and the Lake Tahoe Basin, rates are low relative to the Cosumnes River primarily because the precipitation is much more dominated by snow which does not erode soils whereas the Cosumnes River is primarily rain driven. Sediment potential, fire-wide: 2,330 cubic yards / square mile. In high and moderately burned areas, erosion potential estimates from ERMiT are used as a surrogate for sediment potential, because streamside riparian vegetation consumed, thus reducing its role as a sediment trap, allowing hillslope erosion to reach the channels. In low burn severity areas, more ground cover remains to filter sediment, and less eroded material is likely to make it to channels.

Geological Response: Four geologic hazards were assessed for the Caldor Fire: rock fall, debris slides, debris flows, and sediment-laden flows. Debris flow initiations could happen regardless of post-fire conditions. In this case, post-fire conditions will not be the main reason for debris flow initiations but will exacerbate the issue. Removal of vegetation by the fire, has exposed and weakened soils, changing hydrophobic conditions. Also, rocks on slopes have lost their supportive vegetation. These post-fire conditions in addition to ample supply of woody debris will exacerbate debris flow events occurring in this burn area.

USGS Debris Flow Assessment

The US Geological Survey (USGS) - Landslide Hazards Program modeled the probability and potential volumes of debris flows in the burned area. Their ongoing research has developed empirical models for forecasting the probability and the likely volume of such debris flow events. The USGS models integrates geospatial data related to basin morphometry (hill slope, size), soil burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a local design storm (Staley et al., 2016). Estimates of probability, volume, and combined hazard are based upon a design storm with a peak 15-minute rainfall intensity of 12 – 40 millimeters per hour (mm/h) rate (0.47 – 1.57 inches/hr).

The USGS provides estimates that can be used to guide the initial establishment of rainfall intensity-duration thresholds for storm peak intensities of 15-, 30-, and 60-minute durations. With larger fires there is a potential for a gradient of precipitation due to the various microclimates associated with elevation and rain-shadow effects. Therefore, we use site specific storm intensities from Atlas 14 to evaluate debris flow modeled responses for the various Critical Values. **Figure 3** displays the debris flow model for the Caldor fire area.

For the Caldor Fire we selected a 1-year, peak 15-minute rainfall intensity of 28 millimeters per hour (mm/h) rate to visually present debris flow potential and volume, for the following reasons:

1. This storm intensity is consistent with the NOAA Atlas 14, Point Precipitation Frequency Data, which is a mid-elevation point within the fire area (USGS / NOAA Atlas 14, 2021); and is generally representative of the Atlas 14 value across the fire, ranging from 25 to 31 millimeters per hour (mm/h);
2. A 28 millimeters per hour intensity matches the USGS estimate for a 15- minute duration, which they described as follows, "most of the burn area requires rainfall rates greater than 28 mm/h to exceed a 50% likelihood of debris-flow occurrence".
3. And, this storm intensity has a geologic response that is generally consistent with debris and sediment identified during our on the ground assessment.

Rockfall Assessment

We used LiDAR data to generate slope maps and identified VARs downslope of areas ≥40% which experienced moderate to high soil burn severity. We overlaid mapped landslides, faults, and colluvial slopes to identify general areas of slope movement or potential movement. Figure 4 displays the rockfall potential assessment.

The assessment of rockfall at a landscape scale was guided by experience to evaluate this geologic hazard methodically and consistently within the knowledge currently available on this phenomenon (Santi et al., 2013; De Graff and Gallegos, 2012). To assess locations for rockfall we performed field surveys and prepared a map showing the road segments and developed recreation situated downslope from areas affected by moderate or higher soil burn severity on slopes inclined at ≥40%. Field survey consisted traveling many of these roads and developed recreation sites and observing the size and number of rocks which had rolled onto the road during or since the fire. This information was used to establish the rockfall hazard.

It is important to note that local data (extent of glaciation, rockfall frequency, colluvial or talus slopes) influences both the probability and volume of rockfall. For example, Lovers Leap Campground is located at the base of a rockfall talus slope and runout zone. The fire burned many of the trees that are adding to the stability of the slope. The post-fire rockfall hazard will be exacerbated until substantial blowdown has occurred and the slope restabilizes.

Landslide Assessment

Landslides within burned areas will likely experience renewed movement, or more likely, movement on a portion or a nested landslide within the existing feature. Post-fire movement of landslides is the result of increased groundwater infiltrations into these features due to reduced evapotranspiration and/or less intercepting foliage to rainfall events and snow accumulation. Landslides and landslide deposits are found in granodiorite along the Highway 50 corridor between Kyburz and Strawberry.

Activation of portions of deep-seated landslides can occur after fires, including debris flows initiating along the edges of landslides. Landslides that channelize and transport downslope as debris flows is a known hazard in this corridor, as discussed by Wagner and Spittle (1997). We observed evidence of this phenomenon at Wrights Lake Road and near Pyramid Guard Station at 39 milestone.

Estimated Vegetative Recovery: Recovery of early successional herbs and shrubs will be within the first few years even in areas of high severity. For areas of low burn severity, estimated full return of soil cover and vegetation structure should be 2-15 years. Moderate and high burn severity areas will take 50-100 years to return to mature forest stands, provided invasive plant colonization and drought years are minimal.

Estimated Hydrologic Response: Hydrologic modeling showed highly-variable increases in post-fire runoff, with roughly half of pour points (certain specific areas identified within the burned area) having high-very high flow increases and half having low-moderate increases in flow. Twenty-nine pour points were modeled for watershed analysis. An additional 11 pour points were modeled for the engineering specialists to determine increased flows at road stream crossings for purposes of determining if treatments were needed. Of the 40 pour points modeled for a 2-year 6-hour storm event, 10 of them showed very high increases in bulked post-fire runoff and 14 showed high increases in bulked post-fire runoff (See Figure 5). These very large runoff responses have the potential to impact life, safety, and property on Forest Service managed lands (particularly roads), pose risk to life and safety in areas under special use permit (recreation residences and organization camps), and affect water quality downstream. Water quality is of particular concern at two locations: Jenkinson Reservoir and Lake Tahoe (See Figures 6,7).

Sly Park Creek and Camp Creek feed Jenkinson Reservoir, which is a domestic water supply utilized by El Dorado Irrigation District (EID). Modeling indicated very high increases in bulked post-fire runoff for both these pour points. In addition, ERMiT modeling indicated a high erosion rate in these watersheds, likely due to loamy soil types that stay well-suspended and elevations subject to rain events (versus higher elevations which are more snow dominated).

The fire burned upstream of Lake Tahoe in the Upper Truckee River and Trout Creek watersheds. Pour points in the Lake Tahoe Basin do not show substantial increases in flow. Although increased flow is not a large concern in the Lake Tahoe Basin, there is a concern about impacts of increased sediment inputs and ash reaching Lake Tahoe, as Lake Tahoe is an Outstanding National Resource Water (ONRW). Sediment and ash inputs are anticipated to be partly moderated by Trout Creek flowing into Upper Truckee Marsh, and the Upper Truckee River having had meadow restoration which connects it to its historic floodplain upstream of the lake.

Critical Values/Resources and Threats

The Caldor BAER assessment team evaluated the following BAER critical values for threats from increased post-fire watershed response conditions:

Human Life and Safety
- Forest Service (FS) roads, trails, facilities
- Recreation residence tracts and organization camps (non-FS)

FS Property
- FS roads, facilities, infrastructure
- FS non-motorized and motorized trails

Natural Resources
- Natural Communities
- Threatened and endangered species (TES)
- Soil Productivity
- Hydrologic function and water quality

Cultural Resources
- Historic and pre-historic properties

BAER Emergency Stabilization Treatments

BAER treatment recommendations must undergo an internal review at the local Forest Service Supervisor's Office, Regional Office, and Washington Office, depending upon total treatment funding amounts.

Due to the large size and complexity of the Caldor Fire, on September 17, 2021, the BAER team submitted an initial preliminary request for BAER emergency stabilization treatments for roads and life and safety actions to allow the Eldorado National Forest (ENF) and the Lake Tahoe Basin Management Unit (TMU) to begin some immediate treatments while the burned area assessment was being completed.

The BAER response strategy for and proposed treatments are natural recovery, administrative closures and warning signage, emergency stabilization treatments that are proven effective, treatments that substantially reduces risks within the first year, is a minimal-action treatment, the cost is economically justified, and the treatments can be completed before the first damaging storm that is expected.

In its interim report and funding request, the BAER assessment team recommended the following emergency stabilization treatments and actions for both the ENF and TMU:

Human Life, Safety and Protection Treatments (within high and moderate burn severity areas with the highest predicted watershed responses):

- Implement targeted area, road, trail, recreation facilities, and special uses site closures to protect users from risks caused by post-fire conditions, and to protect BAER critical values from potential damage from users
- Place warning signs on key roads, trails, or entry points to warn users of dangerous post-fire conditions
- Continue interagency and partner coordination and information sharing: with Natural Resources Conservation Service (NRCS), counties, Cal-OES, Cal-WERT team, key stakeholders, partners, agencies, and others, so they can inform the affected private lands and public, and properly prepare them for potential effects of off-forest flooding; Support research and monitoring by academic and other organizations (through research special use permits, etc.)
- Coordinate BAER findings with utility and counties so they can evaluate in detail the integrity of their infrastructure
- Coordinate with CalTrans and counties about flood and rock fall hazards on roads within their jurisdictions (or under FS maintenance agreements)
- Coordinate with FS Special Use permittees and FS permit administrators
- Remove hazard trees to protect FS property and investments, FS employees implementing BAER treatments, and FS non-closed recreation gathering sites such as trailheads
- Close unsafe mines within the burned area

<u>Hillslope Land Treatments</u>

- Fell burned trees to protect soil productivity from uncontrolled dispersed recreation activities.
- Conduct early detection and rapid response (EDRR) actions including the application of chemical herbicide, to prevent the spread of invasive weeds resulting from fire suppression activities and within the Caldor burned areas.

<u>Channel Treatments</u>

- Protect Sierra Nevada yellow-legged frog habitat by installing in-channel wood treatments to minimize sediment delivery

<u>Road Stabilization Treatments</u>

- Conduct storm inspection and response to maintain the roadbed on Forest roads
- Install road drainage stabilization and improvement treatments on 360+ miles of FS roads
- Install warning signs
- Implement temporary road closures

Trail Stabilization Treatments

- Install and improve drainage on Forest trails
- Remove hazard trees
- Install warning signs
- Implement temporary trail closures

Recreation Treatments

- Implement temporary site closures
- Install warning and caution signs
- Conduct treatment effectiveness monitoring and changed conditions

Hazardous Materials (HazMat) Treatments

- Remove hazmat from water sources
- Contain and stabilize hazmat around FS recreation residence tracts and organization camps

Heritage/Cultural Resources Protection Treatments

- Add ground cover to control erosion
- Stabilize rock walls with sandbags
- Place Fiber Rolls (straw wattles) to control water and sediment flows
- Post Archaeological Resources Protection Act (ARPA) "stay on roads" signs

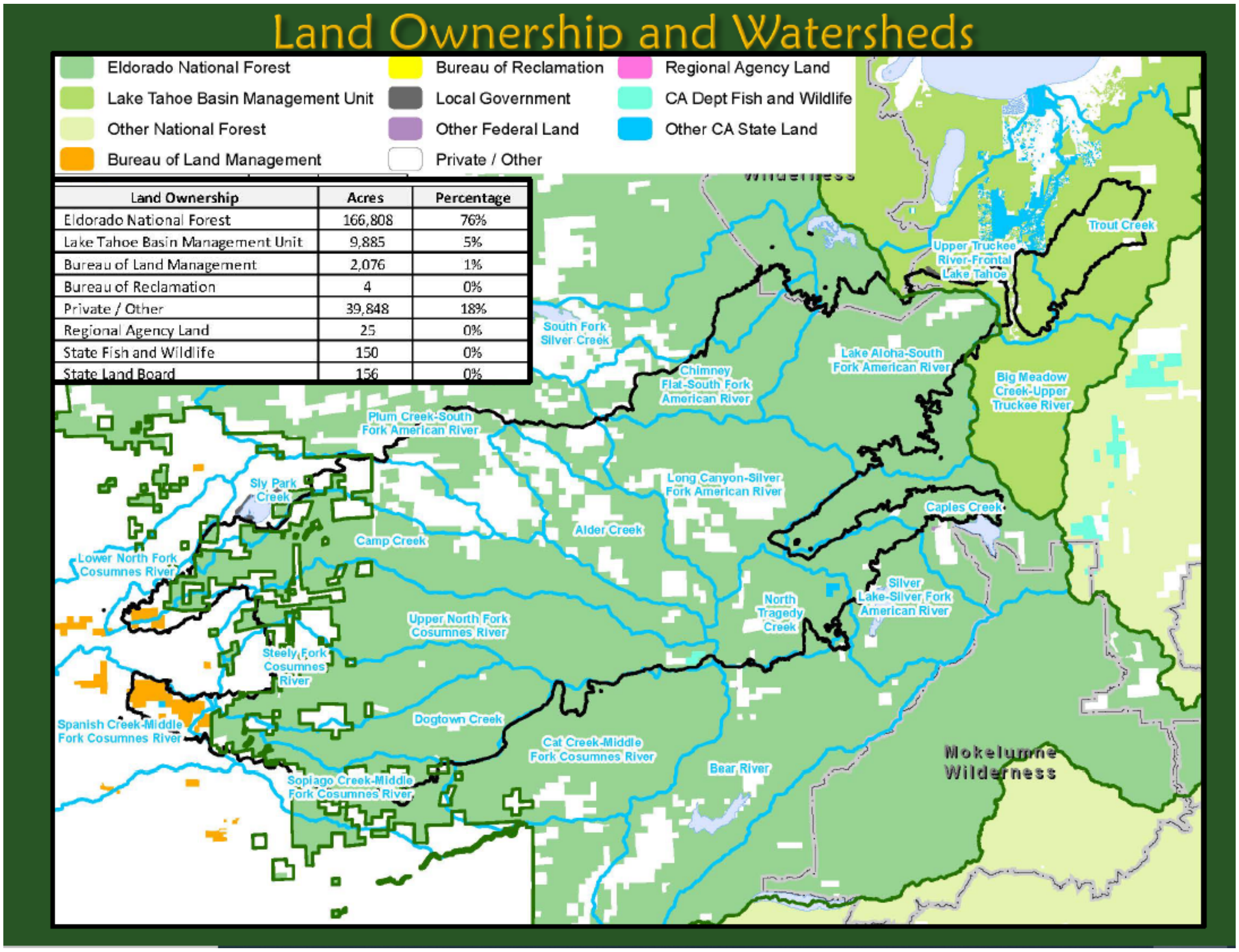
Effectiveness Monitoring

- Conduct monitoring of the team's proposed BAER emergency treatments

Conclusion

Potential post-fire effects from the Caldor Fire and areas of concern for both erosion and post-fire increased flooding, ash and sediment input that impacts water quality and include but are not limited to watersheds that flow into Jenkinson Reservoir and Lake Tahoe. BAER emergency treatments and actions such as area closures, signage where areas are reopened to the public, and stabilizing recreation facilities mitigate risks to human life and safety. Other treatments mitigate post-fire impacts to critical natural and cultural resources as well as critical NFS trail and road infrastructure. Crews will work to implement these measures as soon as possible to effectively reduce post-fire risk.

Figure 1. Map depicting ownership and Hydrologic Unit Code (HUC) watersheds.



Land Ownership	Acres	Percentage
Eldorado National Forest	166,808	76%
Lake Tahoe Basin Management Unit	9,885	5%
Bureau of Land Management	2,076	1%
Bureau of Reclamation	4	0%
Private / Other	39,848	18%
Regional Agency Land	25	0%
State Fish and Wildlife	150	0%
State Land Board	156	0%

Figure 2. Soil Burn Severity Map

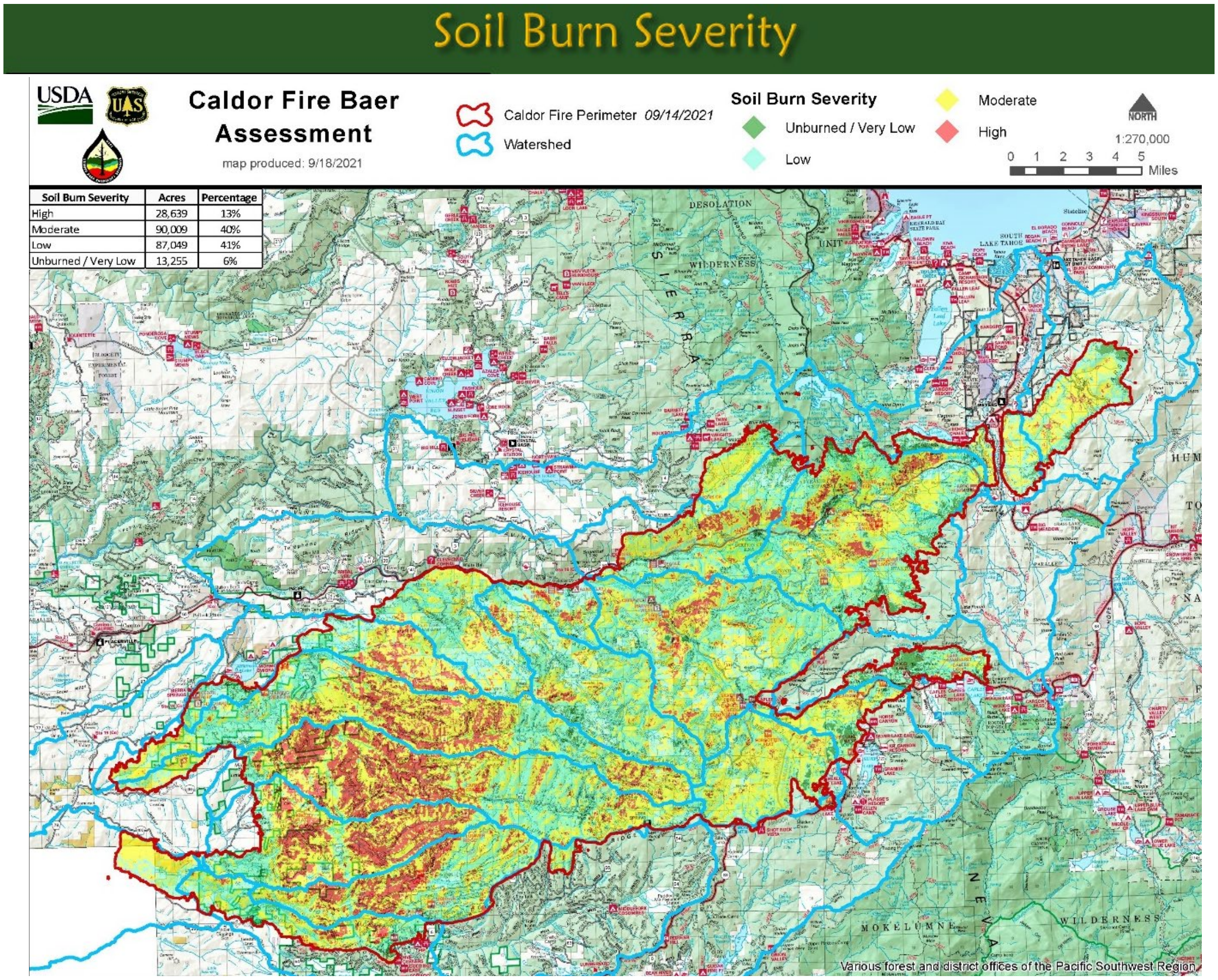


Figure 3. USGS Debris Flow Modeling Hazards.

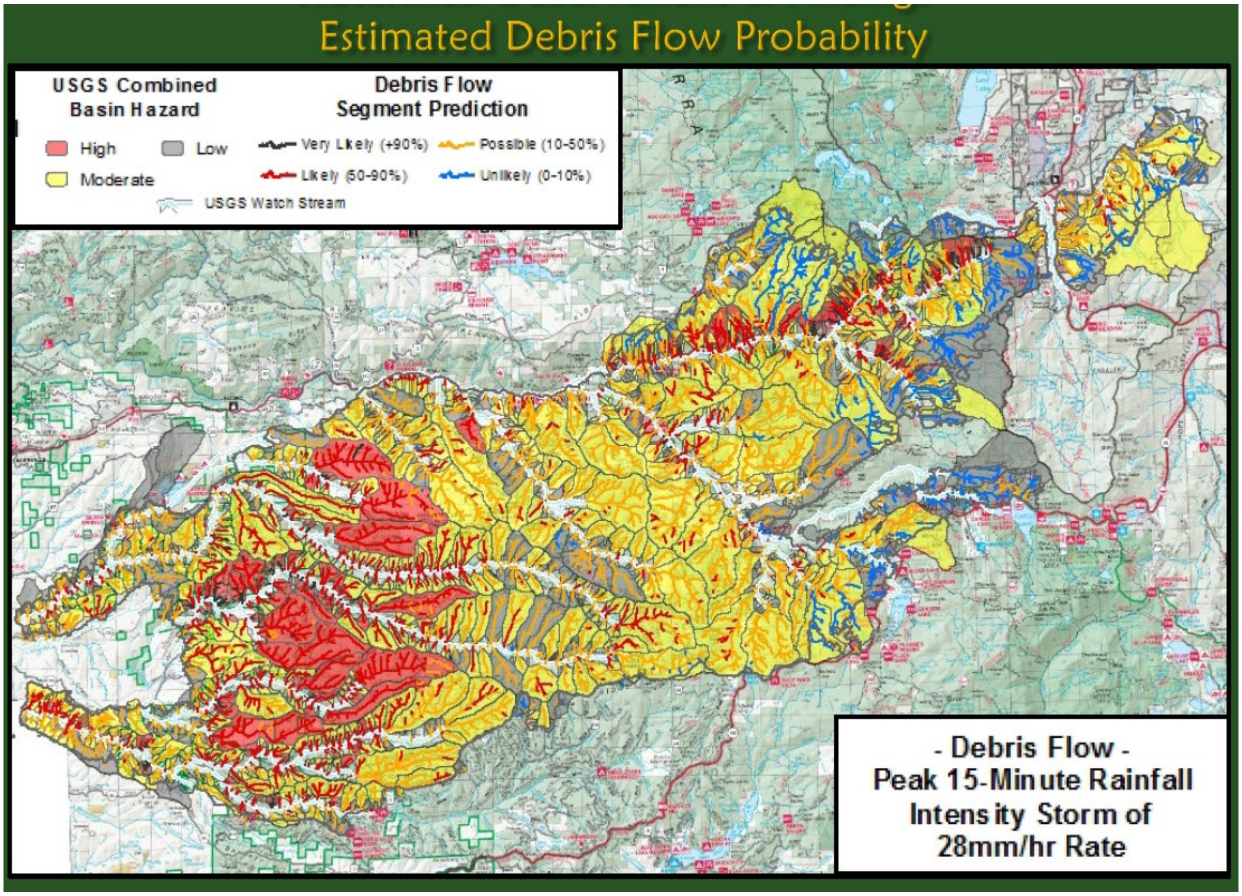


Figure 4. Post-Fire Rockfall Screening Map

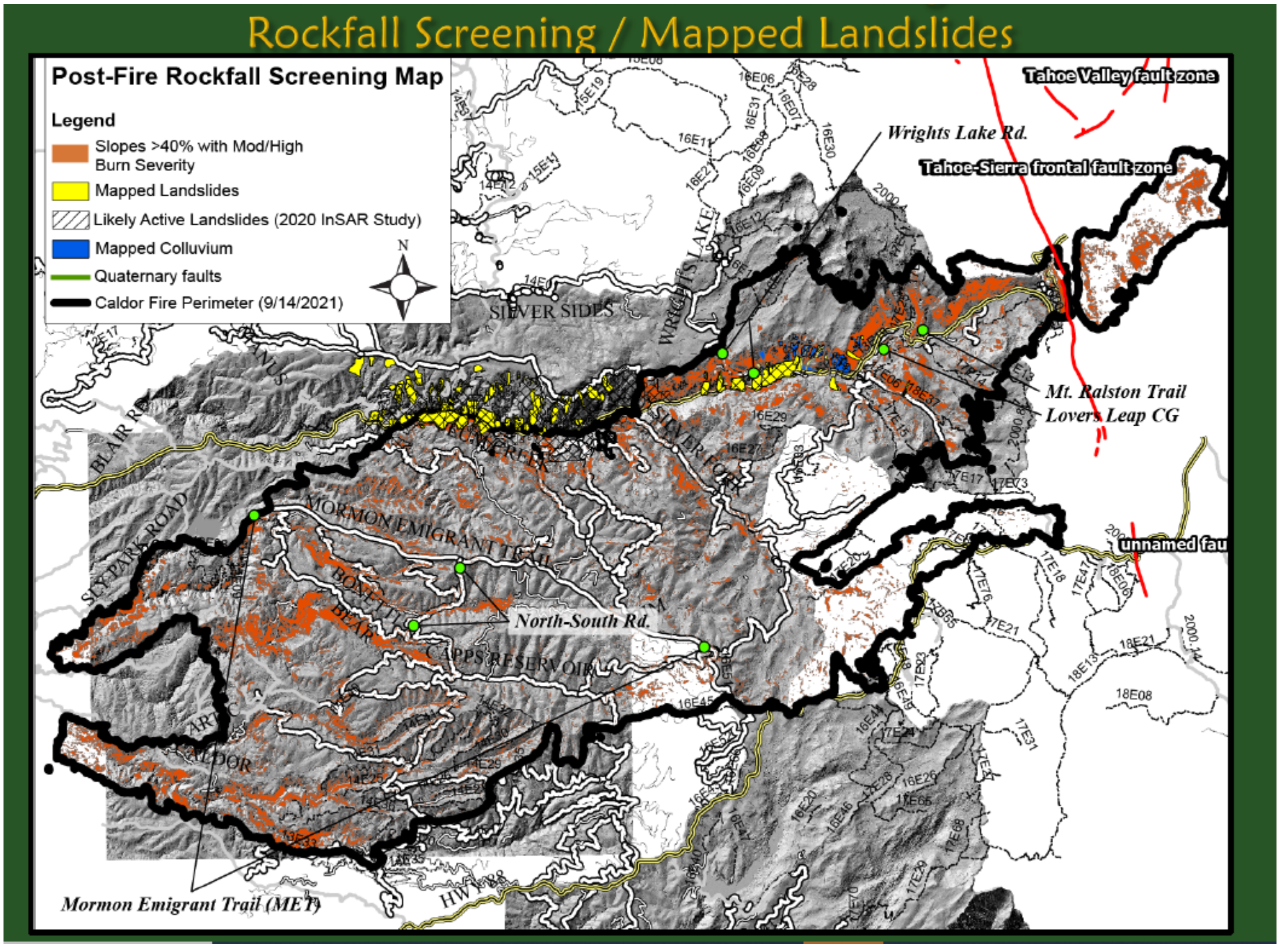
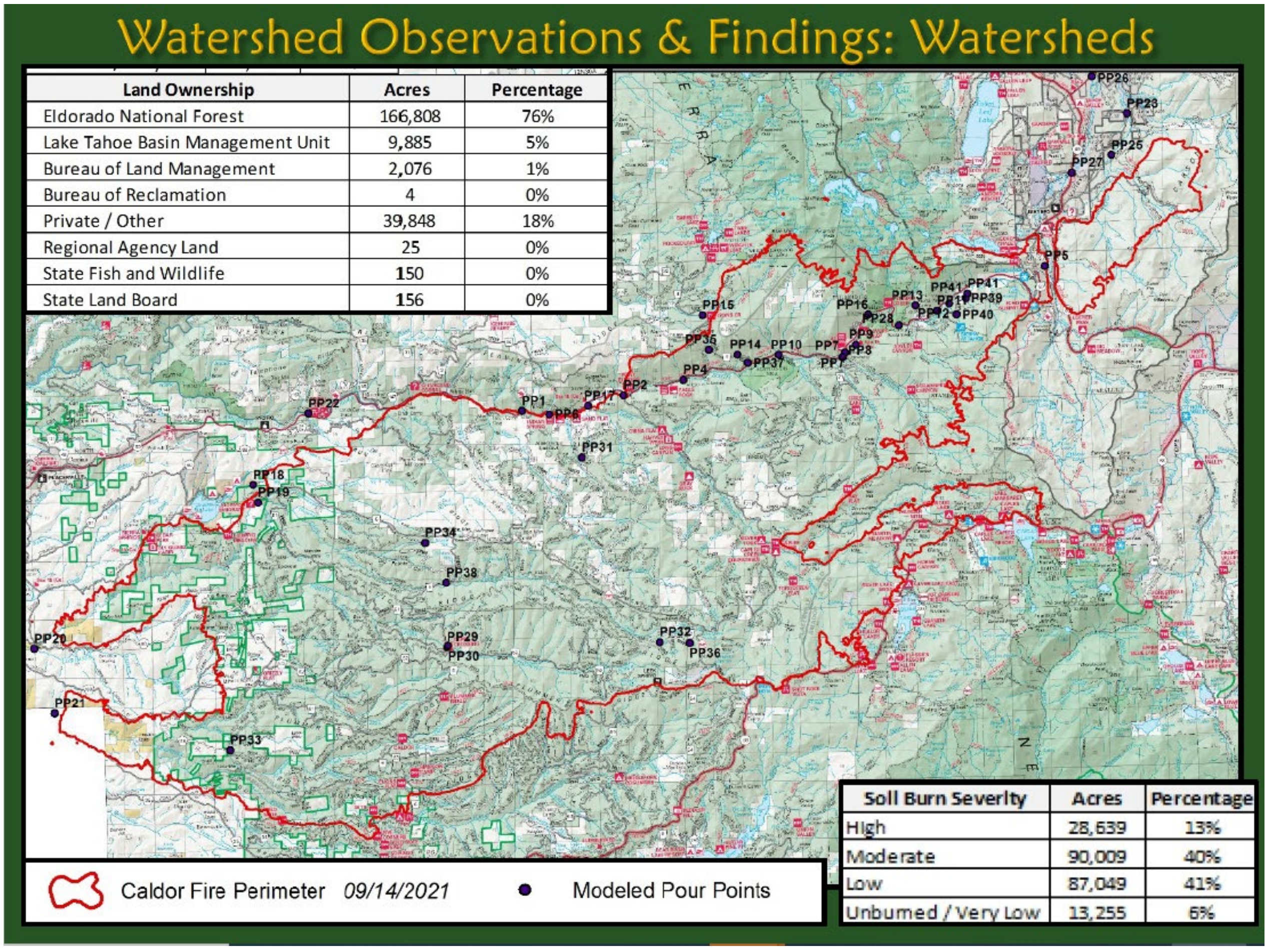


Figure 5. Pour Points Map.



Figures 6, 7, 8. Post Fire Flows; (Blue=Pre-Fire Flows) (Red=Post-Fire Flows)