Cameron Peak Fire Burned Area Emergency Response Executive Summary
Arapaho-Roosevelt National Forests
October 21, 2020

FIRE BACKGROUND

The Cameron Peak Fire started August 13, 2020 near Chambers Lake approximately 25 miles east of Walden and 15 miles southwest of Red Feather Lakes near Cameron Pass Colorado. The fire burned primarily in the Roosevelt National Forest, along with areas of Rocky Mountain National Park and some state and private lands. Extreme fire behavior caused rapid expansion of the fire over Labor Day weekend. The Forest Service initiated a Burned Area Emergency Response (BAER) assessment on September 21, 2020 which covered approximately 99,210 acres. Since that time the fire has continued to grow during periods of high fire activity and is now over 127,000 acres; a follow up BAER assessment to address the additional acres is anticipated this fall.



Figure 1: Poudre River along Highway 14

BAER PROCESS

The BAER assessment focuses on imminent post-fire threats to life and safety, property, natural resources, and cultural resources on National Forest System lands. Threats include determining where post-fire precipitation events could increase runoff and flooding, erosion and sediment delivery, debris flows, and high-risk areas for the spread of invasive weeds.

Hydrologists, soil scientists, engineers, recreation and weed specialists, archaeologists, wildlife and fisheries biologists, and GIS support all contribute to the BAER assessment. Additionally, the US Geological Survey (USGS) provides model results on post-fire debris flow potential. Since the completion

of field work, the fire has grown considerably and there is potential that many areas internal to the fire perimeter may have continued to burn.

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 as a result of the fire. Fire damaged soils have low strength, high root mortality, and increased rates of water runoff and erosion.

The U.S. Forest Service Geospatial and Technology and Applications Center provided the BAER team with an initial Burned Area Reflectance Classification (BARC) map derived from satellite imagery that compares pre and post fire images. The team conducted reconnaissance and field verification surveys to adjust the BARC to create the final soil burn severity map (Figure 2).

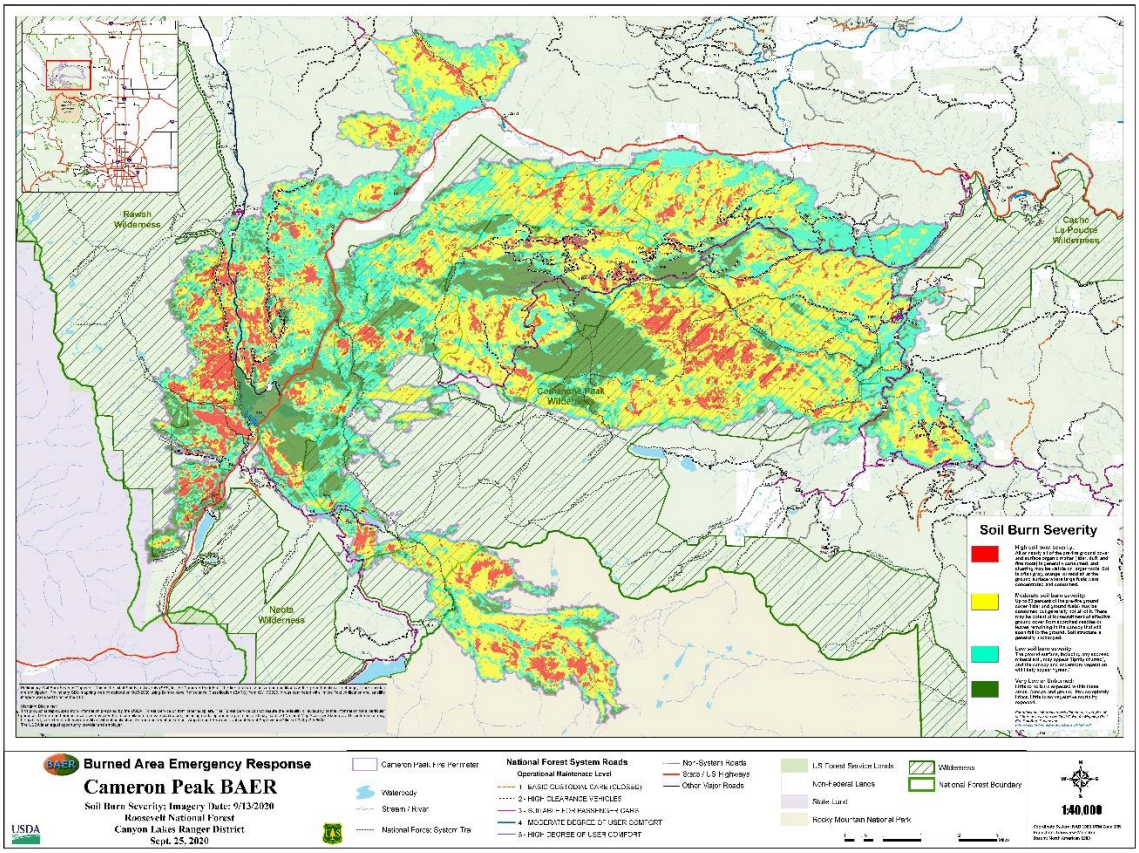

Figure 2. Cameron Peak Soil Burn Severity map from initial assessment

Soil burn severity is classified according to the Field Guide for Mapping Soil Burn Severity (Parsons et al, 2010). Primary soil characteristics considered in soil burn severity classification are forest floor cover, ash color, integrity of roots, integrity of structure, and water repellency[1]. Areas of low and unburned SBS have minimal effects to soil properties, and therefore little to no post-fire effects. 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. 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

[1] Water repellent soils have reduced infiltration which results in increased runoff

structure than often drive substantial watershed response including increased erosion and runoff following precipitation events.



Figure 3: Comparison of moderate burn severity with roots and structure (top of shovel) vs. high soil burn severity with no soil structure or roots to help bind soil (bottom of shovel)

ANALYSIS SUMMARY

SOILS

Fire behavior played a large role in the severity of impacts to soil in the Cameron Peak fire. Longer residence times in the west side of the fire resulted in comparatively higher SBS. While, the east portion of the fire experienced a running crown fire due to the intense winds over Labor Day weekend and was quickly cooled by the snow event. As a result, there was a decrease in forest floor cover but soil structure and root health were largely intact, leading to lower SBS on the eastern side of the fire. To adjust the BARC in a way that best reflected the field observations, the BARC reflectance classes were adjusted in two separate pieces. This break used started at HWY 14 on the north end of the fire perimeter, and then curved east to include Barnes Meadow and Peterson Reservoirs with the west half of the fire. Acres of soil burn severity by ownership are summarized in Table 1.

Table 1: Acres of soil burn severity by ownership

Soil Burn Severity	Colorado State Forest	LOCAL (Includes Bliss SWA)	Private	Rocky Mountain National Park	USDA Forest Service	Grand Total	Soil Burn Severity %
High	0	2	60	1,105	10,151	11,318	11%
Moderate	5	23	591	3,238	36,978	40,836	41%
Low	5	156	1,614	1,538	26,679	29,992	30%
Unburned	61	16	958	939	15,085	17,060	17%

Grand Total	**71**	**197**	**3,224**	**6,820**	**88,897**	**99,209**	

The BAER team members use the SBS to run models to estimate erosion potential, changes in stream flows from summer thunderstorm events, and debris flow potential. The models compare pre-fire conditions to predicted post-fire conditions to determine relative changes as a result of the fire effects.

An estimated 52% of the area within the Cameron Peak Fire perimeter had high or moderate SBS indicating increased erosion potential. Erosion potential post-fire is contingent on a variety of site characteristics including soil texture, rock fragment content, slope, soil burn severity and the distribution of soil burn severity. Soil erosion modelling shows that post-fire erosion rates will range from 0.15 tons/acre/year to 1.4 tons/acre/year. These rates are not expected to affect long-term soil productivity. For perspective, one acre of soil equal to the thickness of one sheet of paper is equal to one ton of sediment. The increased erosion can result in downstream sediment delivery that bulks flows and results in increased flooding effects. Increased erosion can also block culverts and other infrastructure and degrade water quality.

HYDROLOGY

Wildfires result in increased runoff and sediment yield commensurate with soil burn severity. Hydrologic response in the Cameron Peak burned area will include reduced interception and infiltration of precipitation, increased runoff and erosion, higher stream flow volumes for a given precipitation or snowmelt input, and a more rapid rise of stream and river levels compared with those of unburned conditions.

While peak runoff in streams throughout the Cameron Peak burned area occurs during snowmelt in May-June, post-fire conditions have made smaller drainages vulnerable to elevated runoff response. Relatively common precipitation events are likely to cause erosion of vulnerable hillslopes, flash floods, and deposition of ash, sediment, and woody debris. Larger, lower-probability rainstorms could produce extreme runoff events, including debris flows, particularly in steep, heavily burned drainages. Post-fire peak flows will vary depending on the amount of vegetative recovery. Where snow has already fallen and subsequently melted, grasses and some forbs have already begun to re-sprout. Growth in many areas of the burn will be vigorous following spring snowmelt, beginning the process of soil stabilization. However, the risk of flooding and debris flows in and downstream of the burned area will be elevated for at least the next 3 to 5 years. This elevated risk poses a threat to life and safety for forest visitors and workers, and to property including roads, trails, trailheads, campgrounds, picnic areas, and dispersed campsites.

Portions of sixteen watersheds were affected by the fire (Table 2). All of these watersheds flow into the Cache la Poudre River, with the exception of Rawah Creek-Laramie River which flows into the Laramie River. However, there is an inter-basin diversion just downstream of the fire perimeter that diverts water from the Laramie River over to the Cache La Poudre River via a tunnel through the mountain.

Select drainages were modelled to determine increased flood flow potential based on critical value concerns. Modelling showed an 80-2400% increase in flood flows from a 5 year-1 hour thunderstorm. Figure 4 displays the modelled watershed and relative percent increases.

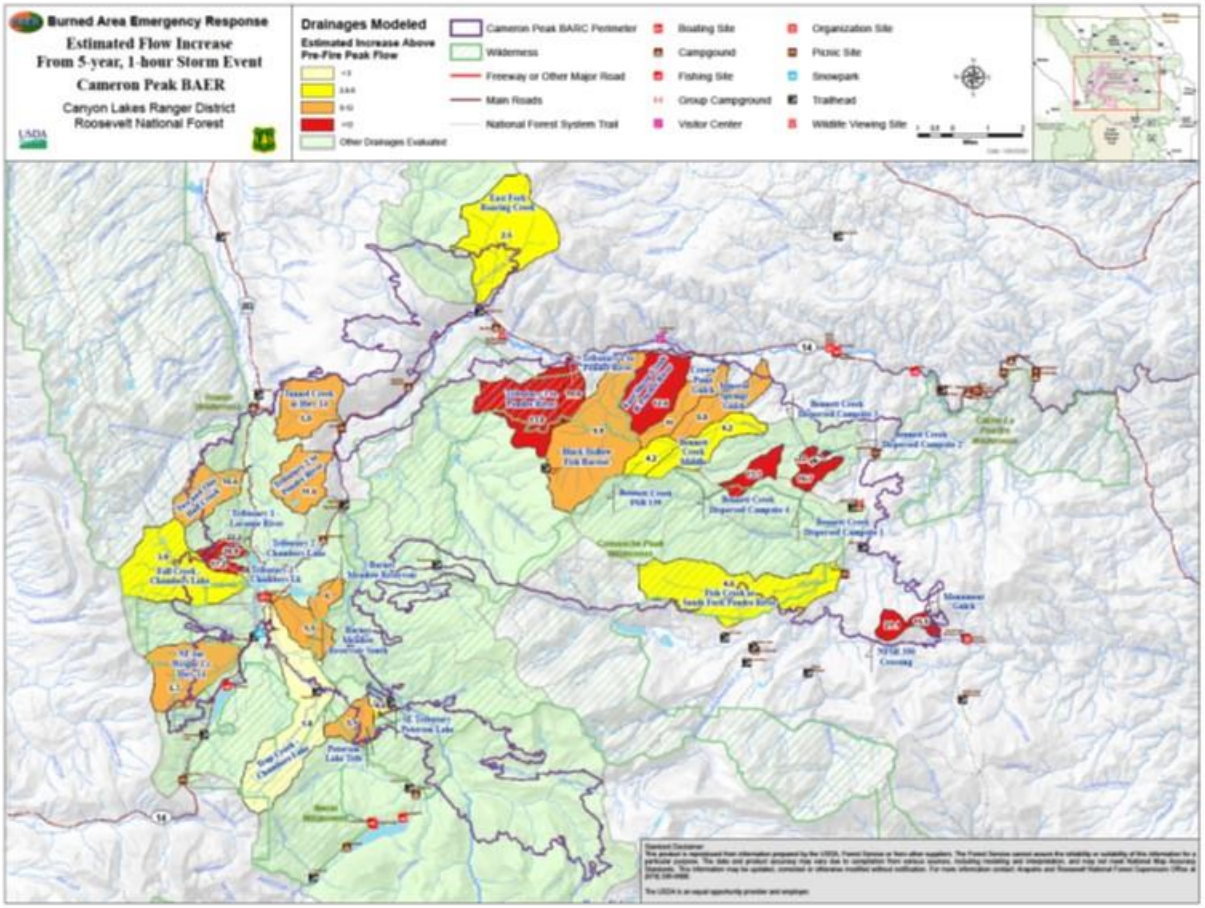

FIGURE 4: Relative increases in flood flows for a 5-year 1 hour thunderstorm for modelled watersheds.

In addition to the increase in volume of flows, the time for summer thunderstorm flood flows to reach a downstream area will also be more rapid following the fire. This shorter duration in the time to flood flows being translated downstream means less time to respond to these flood events.

It is important to note that these are relative increases for summer thunderstorms as this is when the most damaging post-fire effects are likely to occur. In addition to these model results, there is a chance that debris will collect and create debris dams which can subsequently dislodge during later storms. These debris dam outburst floods could pose additional risk to life and property downstream during high flow events since they carry logs, rocks, and a deluge of mud.

Sediment, minerals and nutrients from the burned area will likely pose an elevated threat to municipal water quality for the next several years as widespread soil erosion as well as ash and sediment deposition are expected throughout and downstream of the burned area. These processes will attenuate over time and should recover to pre-fire conditions over the next several years. The greatest impacts are most likely to occur in the first year or two following the fire, though a low-probability rainstorm any time in the next 5-7 years will have the potential of triggering a major erosion/sedimentation runoff event. Over this time, there is high potential for degradation of source water quality for the Cities of Fort Collins and Greeley, as well as other municipalities who draw water from the watershed impacted by the fire.

Debris Flow Potential

Debris flows are among the most hazardous consequences of rainfall on burned hillslopes. Debris flows pose a hazard distinct from other sediment-laden flows because of their unique destructive power. Debris flows can occur with little warning and can exert great impact loads on objects in their paths. Even small debris flows can strip vegetation, block drainage ways, damage structures, and endanger human life. Additionally, sediment delivery from debris flows can "bulk" the volume of flood flows, creating an even greater downstream flooding hazard. The U.S. Geological Survey (USGS) used the SBS to inform their model and the results of the modelling effort are available at: https://landslides.usgs.gov/hazards/postfire_debrisflow/

Summary of Observations:

- Debris flows are eminent in the Cameron Peak Burned Area in response to a peak 15 minute intensity of 36 mm/h rainfall event (typical high intensity summer thundershower)
- Most stream reaches and watersheds require 15-minute rainfall intensities exceeding 36 mmh^{-1} to have a greater than 50% likelihood of producing debris flows.
- Small high hazard basins require more modest 15-minute rainfall rates of 20-28 $mmhr^{-1}$ to exceed a 50% likelihood of debris-flow occurrence

Several small watersheds above the Poudre Canyon Hwy along the northern burn perimeter and along Roaring Creek have moderate to high levels of debris-flow hazard, with debris-flow probabilities exceeding 40 percent. Most watersheds are estimated to produce between 1,000 – 100,000 m^3 resulting in overall low to moderate combined debris-hazard throughout the burn area. The hydrology and debris flow modelling results together indicate that post-fire there will be an increase in watershed response. This means:

- Increased erosion and sedimentation
- Areas that flood or have debris flows pre-fire will have larger magnitude events
- Areas that occasionally flood or have debris flows will see more frequent events
- Areas that previously did not have streamflow or debris flows may now flood or have debris flows

TREATMENTS TO ADDRESS POST-FIRE THREATS

The BAER assessment identified the following actions to mitigate post-fire threats to Forest Service users, property, and natural resources to an acceptable level.

Human Life and Safety

Threats to human life and safety have increased due to hazard trees. Even trees that still appear green may have a weakened root system due to smoldering at the base of the tree. Warning signs will be placed to warn Forest users of these hazards. Some roads, trails and campgrounds or portions of campgrounds will be closed due to hazard tree threats, and/or increased flood and debris flow potential.

Roads and Trails

Actions will be taken to improve road drainage and road-stream crossings to accommodate increased erosion and flood flows. This includes removing some road culverts and hardening low water crossings

so that debris and flood flows are able to pass without washing out the road or trail prism. Drainage will also be increased on trails, and four trail bridges will be removed to prevent washing out due to increased flood flows.

Noxious Weeds

Noxious weeds are a serious ecological threat due to the fact that large burned areas open the watersheds to the rapid spread of species adapted to colonizing disturbed soils. Noxious weeds displace native species and can disrupt ecological relationships and connections, reducing ecosystem stability. The appearance, function, economic values, and resilience of large landscapes can be substantially changed by invasive species. Noxious weed surveys will occur in areas of moderate to high burn severity which are most prone to the spread of noxious weeds (along roads and trails) and new populations will be treated.

CONCLUSION

The BAER team has identified imminent threats to critical values based on a rapid scientific and engineering assessment of the Cameron Peak Fire area. The assessment was conducted using the best available methods to analyze the potential for flooding and debris flows in a rapid manner. Options for reducing post-fire peak stream flows, soil erosion, and debris flow potential are limited due to the nature of the burn and slope characteristics. As a result, treatment recommendations focus on mitigation measures to minimize life/safety threats, damage to property, and loss of native plant communities. These mitigations include road and trail closures and stabilization, campground closures or partial closures, warning signs, and invasive species surveys and treatment.

The findings provide information that can assist other agencies and landowners in preparing for post-fire threats. The US Forest Service will continue to participate in interagency efforts to address threats resulting from the Cameron Peak Fire.

REFERENCES

Parson, Annette; Robichaud, Peter R.; Lewis, Sarah A.; Napper, Carolyn; Clark, Jess T. 2010. **Field guide for mapping post-fire soil burn severity.** Gen. Tech. Rep. RMRS-GTR-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p.