Williams Fork Fire
Forest Service Burned Area Emergency Response Executive Summary
Arapaho-Roosevelt National Forests
December 14, 2020

FIRE BACKGROUND

The Williams Fork Fire, seven miles southwest of Fraser, Colorado, started near the Henderson Mill on August 14th and quickly grew due to high winds, steep slopes, and dense fuels. Working with fire behavior analysts, foresters, and other natural resource specialists, Williams Fork firefighters successfully contained the southwest flank along County Road 3 and 30, and the Williams Fork River, preventing damage to the Henderson Mill.

The BAER assessment started on September 21, 2020 utilizing the September 11, 2020 fire perimeter of 12,153 acres with the final report completed on October 2, 2020. After completion of the BAER assessment, fire activity increased, and the fire perimeter expanded to the east on the northern and southern ends.

The fire was fueled by wide-spread drought, numerous dead and down beetle-killed trees, red flag weather conditions created by high winds, dry conditions, and poor humidity recovery overnight. The combination of these factors led to active fire behavior with rapid spread.

BAER PROCESS

USFS BAER assessments focus on imminent post-fire threats to life and safety, property, natural resources, and cultural resources on NFS lands. Threats include determining where post-fire snowmelt and 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 specialists all contribute to the BAER assessment. During and following the BAER assessment phase, the BAER team also coordinates and shares information with a variety of other agencies and organizations and works with public information officers from the fire suppression team and local forest to provide routine updates for the public and media.

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. 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].

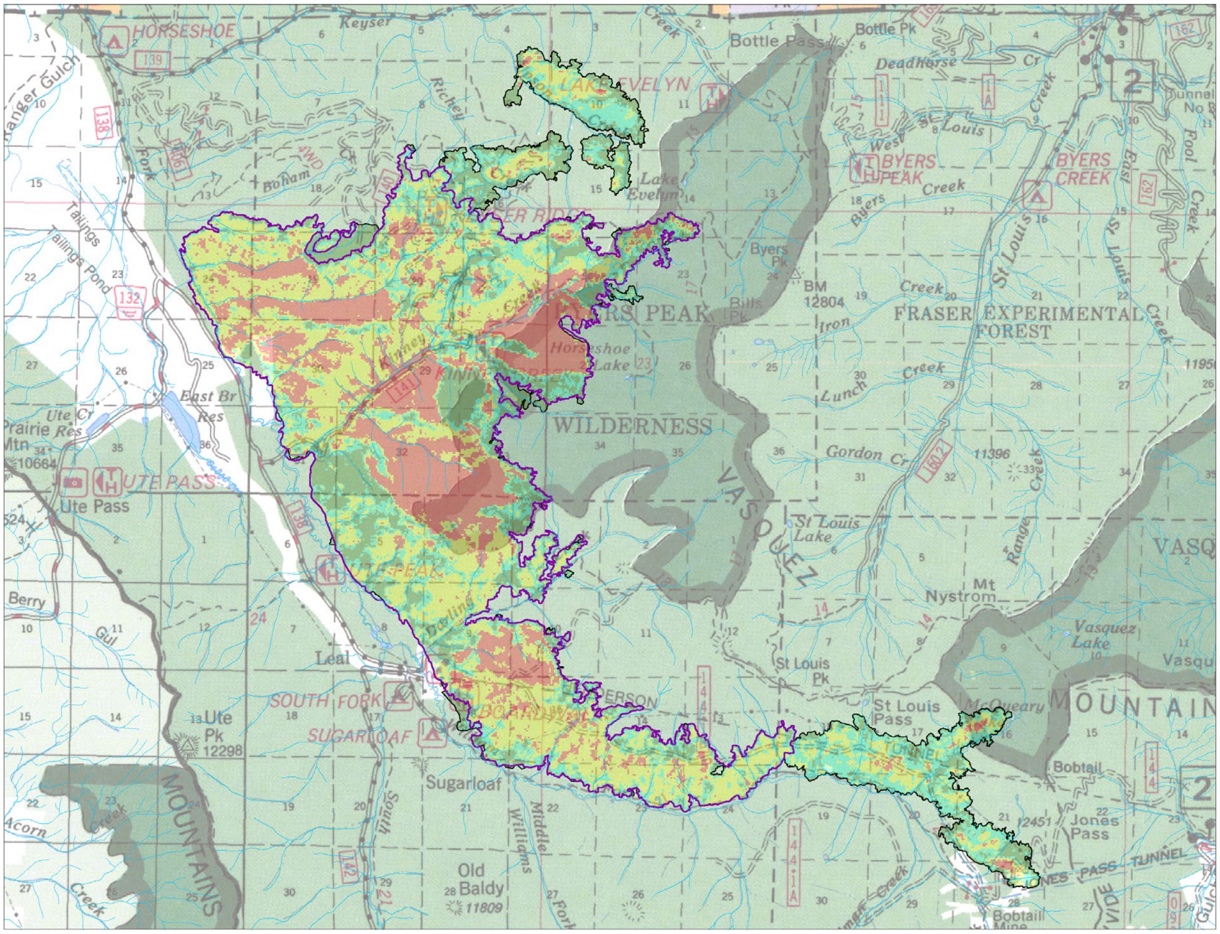
Areas of low and unburned SBS have minimal effects to soil properties, and therefore little to no post-fire effects. Moderate SBS indicates that some soil properties have been affected and the duff and litter layer that acts as a sponge to absorb precipitation has mostly been consumed. High SBS areas have significant alterations to soil properties such as complete consumption of littler and duff, loss of root viability and changes to soil structure than often drive substantial watershed response including increased erosion and runoff following precipitation events.

Figure 2: Comparison of low soil 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)

The U.S. Forest Service Geospatial and Technology and Applications Center provided the BAER team with an initial Burned Area Reflectance Classification (BARC) maps derived from satellite imagery that compares pre and post fire images. The team conducted limited field verification surveys to adjust the initial BARC to create the initial SBS map. Additional BARC imagery was obtained in late October to cover additional acres burned following the initial assessment. A final SBS map was developed using both images (Figure 3).

Figure 3. Williams Fork Soil Burn Severity Map

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



ANALYSIS SUMMARY

SOIL

Fire behavior, residence time and vegetation and downed fuel type/density influenced the severity of impacts to soil. Longer residence times result in higher SBS.

Table 1: Soil Burn Severity

Soil Burn Severity based on 2 BARC Images and Ground Based Observations

SBS	Acres	Percent Area
High	3412	23
Low	3019	21
Moderate	5386	37
Unburned/Very Low	2792	19
	14609	100

The BAER team members use the SBS information to run models to estimate erosion potential, changes in stream flows from snowmelt and summer thunderstorm events, and the USGS use the SBS map to model 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 60% of the area within the Williams Fork Fire perimeter had high or moderate SBS. Increased erosion and flood flow potential are expected within and from these areas. 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 predicts that post-fire erosion rates are generally very low (close to pre-fire conditions) in areas with minimal fire impacts on ground cover and soils. However, rates of erosion increase dramatically relative to pre-fire conditions in moderate and high soil burn severity areas, especially on steeper slopes.

The predicted erosion 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

The Williams Fork Fire burned high elevation, snowmelt-dominated watersheds tributary to the Williams Fork River. Snowmelt peak flows occur each spring (April-June), followed by the summer monsoon season (July-August), which brings short duration high intensity thunderstorms.

Watershed response within the burned area will likely include an initial flush of ash, rill and gully erosion in headwater drainages and on steep slopes, sediment-laden flash floods following high-intensity rain events, and potentially debris flows. Water quality will be diminished during seasonal peak runoff, as well as after high-intensity summer rains, due to elevated ash, fine sediment, and nutrient loading. This elevated post-fire response will gradually diminish as vegetation and groundcover levels recover each growing season, although some impacts including elevated snowmelt runoff are likely to persist for a decade or longer.

The degree of watershed response is commensurate with soil burn severity; Table 2 summarizes acres burned by sixth level watershed.

Table 2: Summary of 6th Level HUC watersheds burned by Williams Fork fire.

Watershed	Watershed Acres	Acres Burned	Percent Area
Headwaters Williams Fork	28329	4527	16
Keyser Creek	17469	1249	7
Upper Williams Fork	25811	8833	34
		14609	

The Wildcat Rainfall-Runoff Hydrograph Model (Hawkins and Greenberg 2013) was used to predict increases in peak flows resulting from the fire.

Table 3 shows a comparison of pre to post-fire flow projections for three modeled precipitation events for selected drainages. Increases in flows are expected within the drainages as a result of the three design storms simulated.

Table 3: Percent Increases in Peak Flows based on the Pre to Post Fire Conditions for Selected Drainages and 3 Storms (Wildcat Rainfall-Runoff Hydrograph Model)

Modeled Drainage Names	2-year, 60-min (0.7 in/hr)	5-year, 60-min (0.8 in/hr)	10-year, 60-min (1 in/hr)
	Percent Increase	Percent Increase	Percent Increase
NFSR 139 Bridge over Williams Fork	180%	146%	153%
NFSR 141.1 Bridge over Williams Fork	164%	135%	142%
NFSR 141.1 Culvert @ Kinney Creek (lower)	682%	548%	574%
NFSR 141.1 Culvert @ Kinney Creek (upper) / Kinney Creek TH	70%	100%	254%
NFSR 141.1 Culvert @ Tributary to Kinney Creek	449%	484%	843%
Sugarloaf CG Site #3 on Williams Fork	22%	18%	19%
Tributary @ Kinney Creek Trail	35%	58%	195%

The model outputs show relative increases for summer thunderstorms as this is when the most damaging post-fire effects are likely to occur. These model outputs are useful for comparing pre and post fire conditions and/or comparing on watershed to another. The modeling indicates substantial post-fire storm response is likely within many burned area drainages.

Although adjustments were made for the hydrologic modeling, including increasing curve numbers, the rapid analysis may not fully capture the flood flows and post-fire storm response.

- The post-fire peak flows outputs from the Wildcat model do not include a sediment bulking factor and this may cause underestimation of impacts downstream
- 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.
- 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 may 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.

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/

Post-Fire Treatments/Response Actions to Lower Risk to BAER Critical Values

The BAER assessment focused on actions to mitigate post-fire threats to human life and safety, roads, trails, campgrounds and natural resources. Unacceptable risk to these critical Forest Service values were identified and treatments to reduce the risk to an acceptable level were identified.

Human Life and Safety - Protection/Safety Treatments:

Hazard Warning Signs and Gates

- Install burned area warning signs to caution forest visitors recreating and administrative users about the potential hazards that exist within the burned area.
- Place closure signs, hazard warning signs and information signs at key entry points or trail junctions, and numerous recreation trailheads.
- Inform users of the dangers associated with entering/recreating within a burned area as well as inform them of closures and ensure users can access available routes in a safe manner

Roads, Trails, Recreation Facilities and other USFS Property

Road drainage and storm proofing (storm proofing existing drainage features)

- Storm proof drainage features where identified to protect the road investment

- Clean culvert inlets, road ditches, and ensure water does not concentrate on the road

Storm Inspection and Response:

- Keep culverts and drainage features functional by clearing sediment and debris between storms to retain the effectiveness of these features

Additional Road Drainage Features

- Install armored dips to direct high flows across the road with minimal damage to the road surface and prism.

Trail Drainage and Stabilization

- Improve surface drainage on the trail tread to limit erosion and to ensure safe use and travel
- Clear and improve existing drainage structures (water bars, rolling dips) to accommodate increased runoff
- Out-slope trails where appropriate and feasible.
- Remove hazard trees as appropriate for worker safety

Natural Resources – Noxious Weeds Treatments

- Early detection surveys and rapid response treatments in areas of unimpaired native plant communities that burned at high or moderate soil burn severity and are adjacent to known Colorado State listed noxious weeds, as well as areas disturbed by suppression activities
- EDRR will be used to minimize the potential for new noxious weed infestations and ensure the natural recovery of native perennial grasses and forbs.

CONCLUSION

The BAER team identified imminent threats to critical values. The assessment was conducted using the best available methods to analyze the potential for erosion, flooding, debris flows, and hazard trees 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, and damage to property. These mitigations include road and trail closures, road and trail stabilization, warning signs and weed treatments.

The soil erosion, hydrology, and debris flow modelling results 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

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 Williams Fork 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.