Alexander Mountain Fire Burned Area Summary

Burned Area Report

Figure 1: Mosaic of unburned, low, and moderate burn severity above Big Thompson River

Fire Background

The Alexander Mountain Fire started on the Canyon Lakes Ranger District of the Arapaho and Roosevelt National Forests and Pawnee National Grassland on July 28, 2024. It reached 100 percent containment on August 17, 2024. Final acreage was reported as 9,668.

While many wildfires cause minimal damage to the land and pose few threats to the land or people downstream, some fires result in damage that requires special efforts to reduce impacts afterwards.

The Burned Area Emergency Response (BAER) program is designed to identify and manage potential risks to resources on National Forest System lands and reduce these threats through appropriate emergency measures to protect critical values such as human life and safety, property, and critical natural or cultural resources.

BAER is an emergency program to rapidly assess burned area conditions and post-fire threats and risks for BAER critical values on national forest system lands. Following the rapid assessment phase, the objective is to implement recommended time-critical BAER treatments and response actions before damaging events.

The Forest Service assembled a BAER team on August 5, 2024, for the Alexander Mountain Fire. This team of experts in various resource disciplines assessed potential post-fire effects to critical values on Forest Service lands.

Impacts to the soil are the primary indicator of potential post-fire changes in watershed response, as well as watershed recovery. The team verified a Burned Area Reflectance Classification (BARC) map to document the degree to which the fire had changed soil properties.

Review of burned area conditions, critical values, and potential post-fire threats was coupled with watershed response modelling. The BAER team used soil burn severity, slope and other input variables in models to predict erosion potential and changes to runoff and flood flows. Potential for post-fire debris flows was modelled by the United States Geological Survey (USGS) after the BAER team furnished them the validated BARC map. BAER teams use soil erosion and peak flow models as rapid assessment tools. Outputs are generally useful for considering relative differences between pre- and post-fire conditions and relative differences between watersheds. Field observations, model outputs and professional judgement are used to determine risk to critical values and inform recommendations to address these increased risks.

Soils

Soil burn severity (SBS) is not an assessment of vegetation consumption, but rather an integration of vegetation loss, changes in soil structure and infiltration capacity, remaining vegetation, duff, or ash, and soil color, all of which may indicate relative degrees of soil heating.

The BAER team received a BARC map based on Sentinel-2 satellite imagery from August 3, 2024. The burn severity classifications identified in BARC maps are verified or revised using SBS descriptions and methods defined in the Field Guide for Mapping Soil Burn Severity (Parson et al. 2010). Ground truthing of the Alexander Mountain Fire BARC map was limited because access to a considerable amount of the fire area was difficult due to a lack of roads or trails in the interior portions of the burned area. The BARC map was partially ground-truthed by the team in portions of the southern, western, and southeastern edges of the burn scar. Aerial review was not conducted because a helicopter was not available. The limited field verification was supplemented with discussions with Resource Advisors and fire suppression personnel about conditions they had seen on the ground and by reviewing photos taken from earlier helicopter flights. Based on this information, the BAER team believed the original BARC map was a reasonably accurate representation of soil burn severity and no adjustments to the original BARC map were recommended. The BAER team referred to this map as the Verified BARC map rather than the Soil Burn Severity map to be clear about the process in which it was developed.

Characteristics of high soil burn severity include complete consumption of organic material within the surface layers of the soil resulting in a change to single-grain structure. Fine roots are commonly charred or consumed 3-5 cm deep. Soils in highest-severity areas often display a loose, dusty appearance with complete loss of cohesion and soil strength. Generally, there is less destruction of soil organic matter, roots, and structure in an area mapped as moderate compared to high. In areas mapped as moderate burn severity, up to 80% of the effective ground cover may be consumed or partially consumed but soil structure, roots, and litter layer may remain intact beneath a thin ash layer. Low soil burn severity results in very little alteration of soil organic matter and little or no change in soil structural stability.

The Verified BARC map indicated the burn severity for the fire area is a mosaic of High (2.7%), Moderate (43.5%), Low (45.8%), and Very Low/Unburned (7.2%) (see map on page 9). The more severe a fire's effects are on the soil, the more likely those soils will erode in subsequent rainstorms – especially in locations with steep slopes. In steep areas with contiguous moderate and/or high soil burn severity, high rates of post-fire runoff and erosion are expected.

Soils in the Alexander Mountain Fire burned area have a high erosion hazard risk within 68% of the burned area. This risk rating is based on soil properties and slope and assumes a lack of effective ground cover. Steep slopes found throughout the burned area are the primary reason for the high ratings.

Erosion and sediment potential were determined using the Erosion Risk Management Tool (ERMiT) (Robichaud et al. 2006) and Rock: Clime (Elliot et al. 1999) models. Within the first year after the fire, under untreated conditions, hillslope sediment delivery could range from less than 1 to 29 tons/acre, with an average of 10 tons/acre. High rates of hillslope erosion, potentially exceeding 12 tons/acre, could occur on steep slopes (greater than 40 percent) with moderate and/or high soil burn severity. The rocky steep terrain, soil physical properties, high erosion risk potential, and high runoff capacity of soils within the fire area influence the sediment delivery calculations of the ERMiT model. Field assessment and review of photos in the fire area indicated a series of benches, terraces, gentle slopes, etc., where eroded material could be deposited, reducing sediment delivery to stream channels.

Geology

The team reviewed the geologic conditions and processes that have shaped and altered the landscape in this area. Considering how area geology, geomorphic processes, geologic hazards and burned area conditions might affect watershed response and potential impacts to critical values was part of the BAER assessment.

The BAER team provided the Verified BARC map to the USGS Landslide Hazard Program to assist in forecasting the probability and potential volumes of debris flows through their developed empirical models. The USGS Post-fire Debris Flow Hazard Model utilized data on topography, burn severity (from the Verified BARC map), soil properties, and rainfall to provide estimates of debris-flow likelihood, volume, and combined hazard for several design storms with peak 15-minute intensities of 16, 20, 24, 40, and 44 mm/hr. A design storm with a peak 15-minute intensity of 44 mm/hr (approximately 1.7 in/hr or 0.43 in/15-minute period) represents a 1-year recurrence interval storm near the burn area.

The high combined hazard basins within the Alexander Mountain Fire perimeter include the three main tributaries to Cedar Creek, numerous smaller tributaries to Cedar Creek, Sulzer Gulch, unnamed tributaries that flow east towards the Hansen Feeder Canal, and small tributaries that feed directly into the Big Thompson River (see Combined Hazard map on page 10).

USGS debris flow modeling results are available online here with a supporting documentation here.

Hydrology

Watershed response is expected to include initial flushes of ash and burned materials, erosion on steep slopes and within stream channels, increased peak flows and sediment transport and deposition, and debris flows. Watershed response is dependent on the occurrence of rainstorms, particularly high-intensity rainfall events in summer when the area is impacted by monsoonal flow patterns. Increased watershed response is most likely in steep areas with high to moderate burn severity. Disturbances will become less evident as vegetation is reestablished, providing ground cover that reduces erosion and increases surface roughness, which slows flow accumulation and increases infiltration.

A rapid hydrologic assessment was conducted for a 5-year, 1-hour design storm of 1.17 inches utilizing the Wildcat Model (Hawkins and Greenberg 2013) and regional regression equations (Capesius and Stephens 2009, Kohn et al. 2016). Modeling results suggest that the greatest increase in peak flows is expected within the three main tributaries that flow east into Cedar Creek, Sulzer Gulch, and one small tributary that flows directly into the Big Thompson River approximately 2 miles west of Cedar Cove. While hydrologic modeling showed a smaller increase in peak flows in the mainstem of Cedar Creek, other factors may increase post-fire flows in this watershed beyond what the modeling predicted. This includes remaining watershed effects from the Cameron Peak Fire, which burned the upper half of the watershed in 2020, as well as the effects of potential debris flows in tributaries that feed Cedar Creek. Debris flows into the main stem of Cedar Creek would not only bring more sediment and debris into the mainstem of Cedar Creek, bulking the flows, but could cause temporary debris dams that pool up water and then release, sending water downstream in pulses.

Water quality in streams that drain the burned area will be impaired during runoff events, particularly following higher-intensity rain events during the summer. An initial flush of ash and fine sediment is likely with the first high intensity rainfall events. Suspended sediment loading and turbidity levels in streams within and below the burned area will continue to be elevated in response to rainfall in subsequent years, until groundcover becomes re-established. Even after groundcover stabilizes hillslopes in the burned area, eroded fine sediment that is deposited in draws, stream and river channels, and floodplains in the next few years will continue to move through the system.

Figure 2: Ash from burned hillsides can mobilize and affect downstream water quality

Critical Values

Human Life and Safety

The first critical value BAER teams assess is always human life and safety on National Forest System lands. During and after heavy rainstorms, Forest Service employees and visitors to National Forest System (NFS) Lands could be threatened by floodwaters and debris flows, falling trees, stump holes, falling rocks, and loose soils. However, there are very minimal opportunities for the public or employees to enter the NFS portions of the burn scar as there are no NFS roads, trails, or other infrastructure within the fire perimeter. Overland travel without the use of roads or trails would be required. Access points include the Bobcat Ridge Natural Area, where considerable overland travel would be necessary before the burn scar is reached, or from private property.

No Forest Service BAER treatments to protect human life and safety were proposed, as typical BAER treatments, such as felling hazard trees and posting warning signs along roads and trails, are not applicable because of the lack of NFS infrastructure within the fire perimeter.

The concern for potential post-fire impacts on human life and safety on private property downstream of the burned area has been well recognized by partnering agencies, organizations and potentially affected communities. The BAER team coordinated with Larimer County Office of Emergency Management (OEM), the National Weather Service (NWS), and other partners in the Larimer Recovery Collaborative: Alexander Mountain Fire (Recovery Collaborative) to discuss risk on private lands and provide data, such as the Verified BARC map and USGS debris flow maps.

The National Weather Service has established weather alert triggers for areas that are potentially at risk from events such as debris flows and flooding. This information is available to the public through Larimer County's emergency alert system. In addition, Larimer County OEM and other members of the Recovery Collaborative has met with private residents at high risk of post-fire flooding and is coordinating with other agencies on potential future treatments to protect those communities.

Roads and Stream Crossings

Roads within and downstream from burned areas are often at risk of damage due to flooding, debris flows, or other post-fire processes. A common threat is clogging of culverts, bridges, and other in-channel infrastructure from sediment, rocks and floatable woody debris mobilized in post-fire run-off, floods and debris flows. Once blocked by debris, road drainage structures no longer function and the stream flows over the road, often causing considerable damage and limiting access. Various measures can reduce this risk, including protecting culvert inlets with debris racks, removing large floatable debris from channels upstream of structures before floods, and making heavy equipment available and readily mobilized during storm events to keep structures clear of debris.

Debris flows can also impact roads through deposition onto the road or severe scouring of the road prism. Potentially affected areas may be identified by intersecting USGS debris flow model segment outputs with the road network. These threats are generally difficult to prevent and/or mitigate.

There are no NFS roads, culverts, or bridges within or downstream of the Alexander Mountain Fire that could be affected by increased potential for flooding or debris flows. Therefore, no road or stream crossing treatments are proposed on NFS lands. However, increased risk to roads, bridges, and culverts downstream from NFS lands has been identified. Through the Recovery Collaborative, Larimer County OEM has coordinated meetings with partners such as the Colorado Department of Transportation (CDOT), Big Thompson Watershed Coalition, Colorado Water Conservation Board, Natural Resources Conservation Service (NRCS), and others to develop plans for addressing these concerns.

Recreation

National Forest System recreation infrastructure commonly includes campgrounds, trails, and day use areas. There were no campgrounds, trails, or day use areas on NFS lands within or immediately downstream of the fire perimeter. Therefore, no treatments are proposed.

Hydrologic Function

Hydrologic conditions within the burned area have changed compared to pre-fire conditions. Under pre-fire conditions, vegetation and underlying organic matter slowed runoff and protected soils from direct raindrop impact, assisted with water infiltration to soil, and released runoff at slower rates. Hydrologic response within the Alexander Mountain 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 levels compared with those of unburned conditions. Additionally, the probability of severe erosion and debris flows is higher and will remain so for at least the next few years.

Fire is a natural process on the landscape and fire-caused alterations in hydrologic processes are expected to recover in the next 3-5 years. No BAER treatments are proposed on NFS lands.

Increased flood risk within and downstream of the burned area on private property is a concern. As part of the Recovery Collaborative, partners such as Big Thompson Watershed Coalition and Colorado Water Conservation Board are working to complete hydrologic and hydraulic modeling of flood risk and to determine potential treatments that may be able to help mitigate impacts to private landowners. The Recovery Collaborative will then work with the NRCS on possible projects for post-fire flood hazards. The Forest BAER Coordinator will continue to coordinate and engage with partners on these efforts.

Water Quality

Soil erosion as well as ash and sediment deposition are expected on NFS land throughout 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, high-intensity rainstorm any time in the next 3 to 5 years, and possibly longer, will have the potential of triggering a major erosion/sedimentation runoff event if it occurs over one of the drainages with a high percentage of high and moderate burn severity. Until stabilizing vegetation has become established, it is very likely that there will be impacts to water quality on NFS lands, but these are anticipated to be minor (having minimal, recoverable, or localized effects) and no BAER treatments are proposed.

There is the potential for degradation of source water quality for water providers within and downstream of the fire that could result in shutoff of water intake systems. The Recovery Collaborative has developed a Water Recovery Work Group, facilitated by the Big Thompson Watershed Coalition, that aims to address concerns such as these and bring forward potential projects to address water quality and other water-related concerns. While no BAER treatments are proposed to address water quality concerns on NFS lands, the Forest BAER Coordinator will engage with the Water Recovery Work Group to provide expertise and support for recovery efforts aimed at protecting downstream water supply infrastructure.

Soil Productivity

A combination of rocky outcrops, coarse-textured soils, and limited understory will result in accelerated post-fire erosion, threatening soil productivity. Impacts to soil erosion are considered likely and the impacts are likely considerable, but not irreversible. No BAER treatments for soil productivity are proposed.

Botany

Invasive plants adversely affect native plant communities through allelopathy (suppression of growth of a native plant by release of a toxin from a nearby invasive plant) and direct competition for water and resources. Over time, native plant diversity decreases as invasive plants expand and reduce habitat for native plant species and wildlife. Shifts from diverse native plant communities to non-native invasive plant dominance could alter future fire behavior, intensity, extent, and season of burning.

Current infestations are primarily located along Cedar Creek, Dry Creek, and unnamed tributaries to Cedar Creek. The burned area creates conditions for invasive species to outcompete native plants. The team recommends a treatment of Early Detection, Rapid Response (EDRR) to monitor and treat noxious weed infestation and expansion in areas impacted by mechanical suppression activities and/or fire. Chemical herbicide treatments using a backpack sprayer would treat approximately 20 acres of known infestations.

Federally Listed Species - Wildlife

The Alexander Mountain Fire contains occupied critical habitat for Preble's mouse. A review of the Verified BARC map indicates that most of the riparian and upland habitat adjacent to the streams identified as Preble's habitat burned with low or unburned classification, with a minor area of moderate. It is expected that fire impacts to Preble's habitat are likely minor and limited and that riparian habitat is largely intact post-fire. Consequently, BAER treatments are not recommended for Preble's mouse habitat.

Cultural and Heritage Resources

The most typical post-fire threats to cultural sites are physical threats such as erosion, flooding, or damage from (now dead) falling trees. In some cases, newly exposed artifacts are threatened by human damaging activities such as looting or vandalism. Post-fire effects to cultural resources were evaluated by the team. Treatments were not deemed necessary to protect these values from post-fire threats.

Non-Forest Service Values

Fire and post-fire impacts cross administrative boundaries making post-fire emergency response and recovery a shared responsibility. Values and/or assets not owned or managed by the Forest Service can potentially be at high risk of being impacted by post-wildfire threats. There are several Federal, State, and local agencies that have emergency response responsibilities or authorities in the post-fire environment. Larimer County OEM is leading the Larimer Recovery Collaborative: Alexander Mountain Fire in a coordinated effort to provide support for those affected by the fire and/or post-fire effects. Multiple agencies, organizations, and partners are involved in this collaborative, including the NRCS, NWS, USGS, CDOT, Colorado Water Conservation Board, Big Thompson Watershed Coalition, the Forest Service and others.

Coordination and sharing of products, such as the Verified BARC map and the USGS debris flow modeling, with partners happened as soon as the information was available as an initial step to support other agencies and organizations in their immediate post-fire emergency response work.

The Forest BAER Coordinator and other Arapaho and Roosevelt National Forests and Pawnee National Grassland personnel are actively participating in the collaborative group and will remain available to coordinate and share information with interagency partners. This is expected to continue beyond the emergency response phase and into the long-term recovery phase of post-fire recovery.

Partner agency contacts:

The list of agencies and organizations to which the BAER team initially outreached has greatly expanded. The Recovery Collaborative, led by Larimer County OEM, has brought in Federal, State, local agencies, and non-profits interested in assisting with post-fire effects and recovery. Contact information for participating personnel at these agencies and organizations can be obtained through the Larimer County Recovery Coordinator. Other organizations, contacts and their roles, not necessarily directly involved in the Alexander Mountain post-fire emergency response or long-term recovery efforts, may be found in the Colorado Post-Fire Recovery Playbook here.

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Conclusion

The BAER team completed a rapid assessment of the area burned by the Alexander Mountain Fire. The assessment was conducted following BAER processes and using rapid assessment tools and methods to analyze the potential for damage from post-fire threats, including flooding and debris flows. The findings provide the information needed to request emergency funding to manage unacceptable post-fire threats to National Forest System critical values.

Critical values assessed included human life and safety, property (roads and stream crossings and recreation infrastructure), natural resources (hydrologic function, water quality, soil productivity, botany, and wildlife), and cultural resources. Treatments are proposed on NFS lands to reduce the risk to native plant communities posed by expansion of invasive plant species in post-fire conditions. No other BAER treatments were proposed and natural recovery of watershed hydrologic response to approximate pre-fire conditions is generally anticipated in the next 3-5 years.

The Forest Service will continue to provide information and participate in interagency efforts to address threats to public and private values resulting from the Alexander Mountain Fire.

Local Forest Service BAER Coordinator

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References:

Capesius, J.P. and Stephens, V.C., 2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U.S. Geological Survey Scientific Investigations Report 2009-5136, 32 p (http://pubs.usgs.gov/sir/2009/5136/)

CDPHE. 2021. Colorado Post-Fire Recovery Playbook: Guidance for Counties, Tribes, Municipalities, and Water Providers. 13 p (Post-Fire Playbook | Department of Public Health & Environment (colorado.gov))

Elliot, W.J., Scheele, D.L., Hall, D.E. 1999. Rock: Clime. Rocky Mountain Research Station Stochastic Weather Generator. (Rock:Clime Documentation (wsu.edu))

Hawkins, R.H. and R.J. Greenberg. 2013. WILDCAT5 flow model. [This edition further enhances Moore's version] School of Renewable Resources, University of Arizona. Tucson, AZ.

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A., 2016, Paleo flood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016-5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)

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. (Field guide for mapping post-fire soil burn severity | US Forest Service Research and Development (usda.gov))

Robichaud, Peter R.; Elliot, William J.; Pierson, Fredrick B.; Hall, David E.; Moffet, Corey A., 2006, Erosion Risk Management Tool (ERMiT) Ver. 2006.01.18., U.S. Forest Service, Rocky Mountain Research Station.

USGS Post-Fire Debris Flow Hazard Assessment Viewer. (https://usgs.maps.arcgis.com/apps/dashboards/c09fa874362e48a9afe79432f2efe6fe)

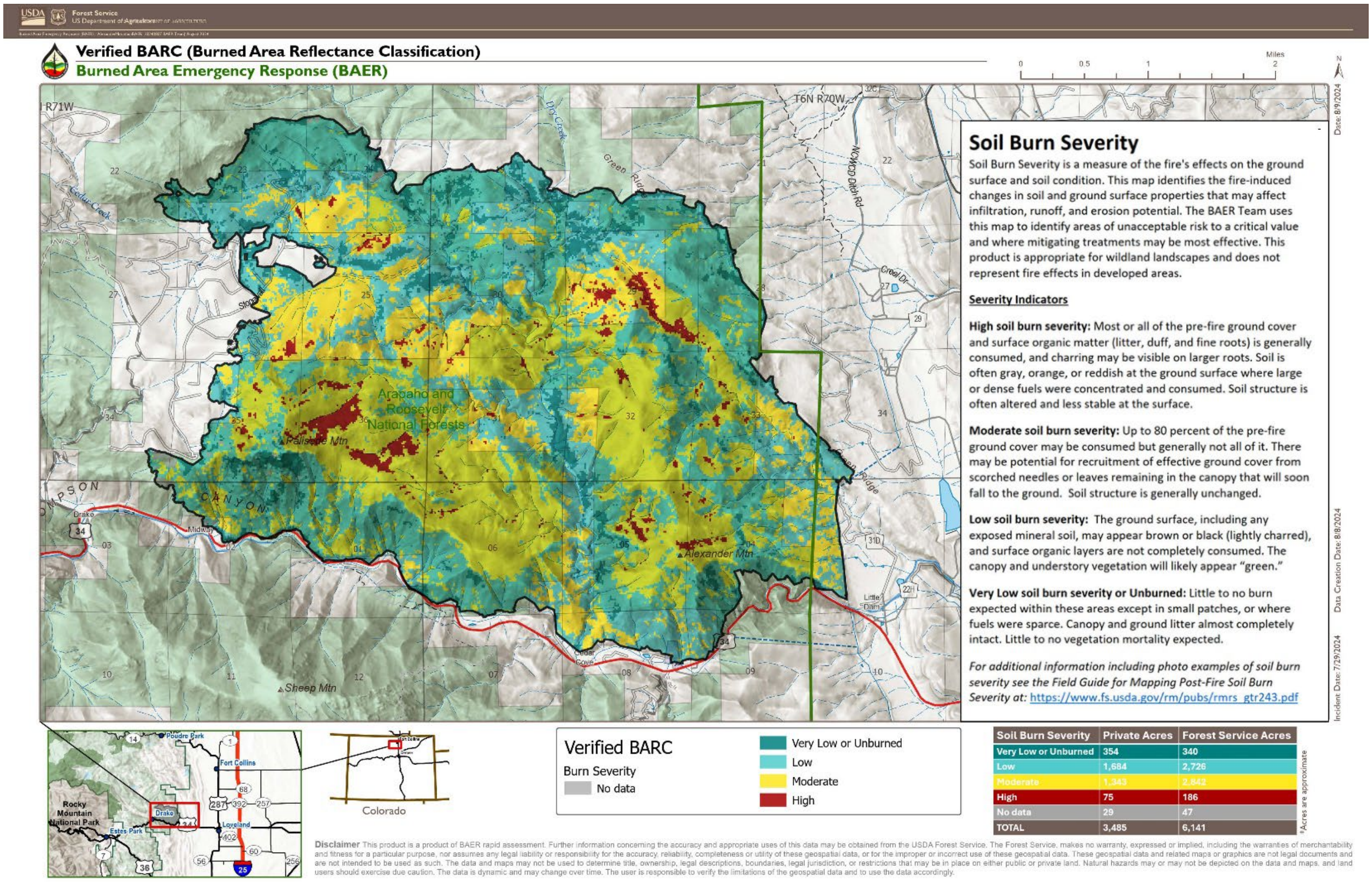
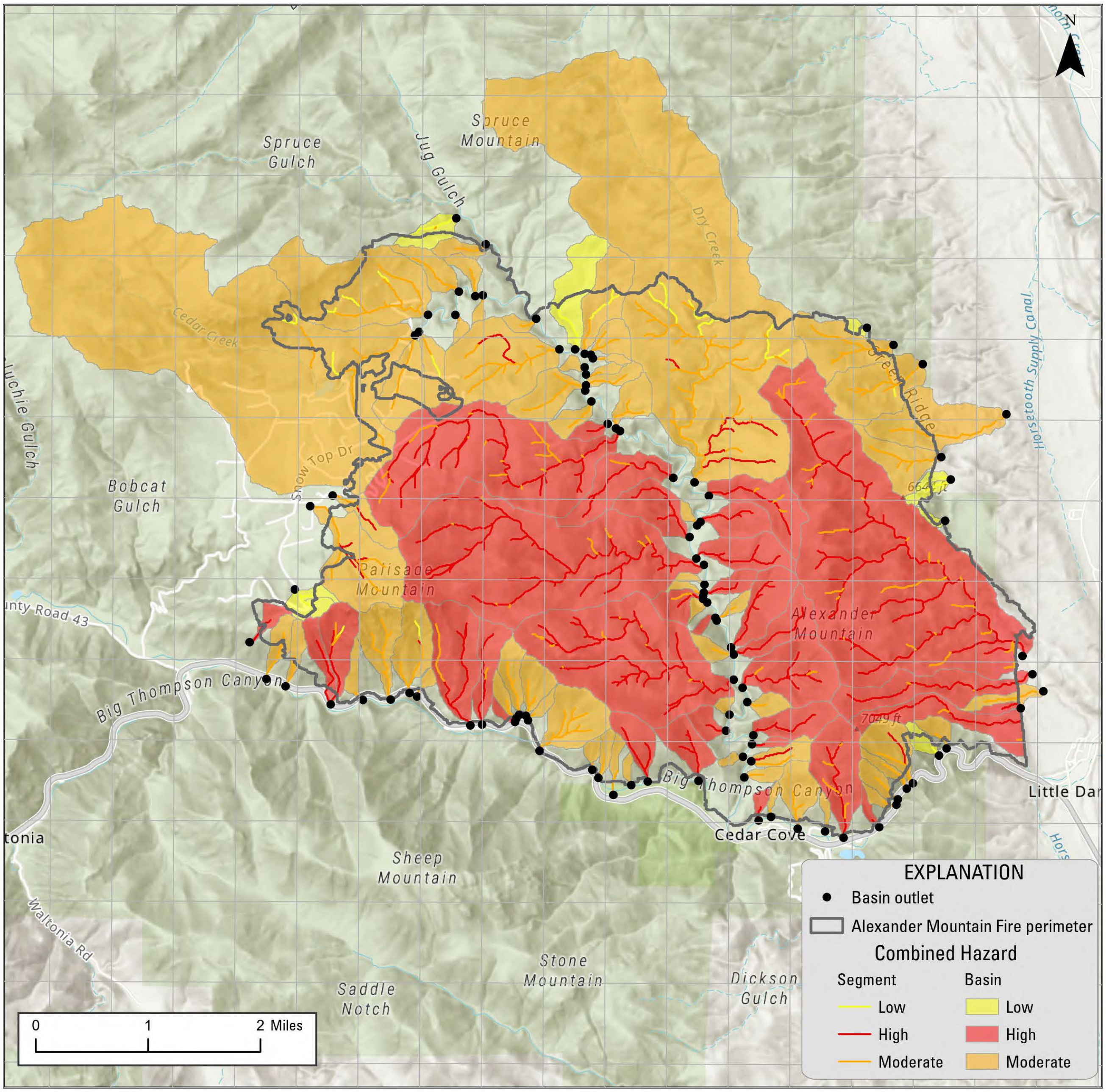


Figure 3: Verified Burned Area Reflectance Classification (BARC) Map

Alexander Mountain Fire, Arapaho and Roosevelt National Forests, Colorado
Combined Hazard
Design storm: Peak 15-minute rainfall intensity 44 mm/h



Disclaimer - Limitations of Hazard Assessment

Hazard assessments use a design rainstorm with a given peak 15-minute rainfall intensity to predict the probability, volume, and combined relative hazard of debris flows in basins burned by the fire. Differences in model predictions and actual debris-flow occurrence will arise with differences in actual storm duration and intensity. The occurrence of higher rainfall intensities or longer storm durations may increase the probability or volume of potential debris flows.

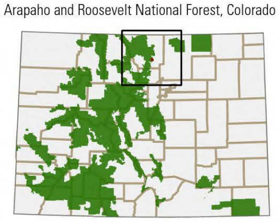
The models were developed, calibrated, and tested using data from the western United States. The models have not yet been tested in burn areas in the eastern United States, western Oregon, or Washington (west of the Cascade Range). Currently, efforts are being made to validate model predictions in the eastern United States, western Oregon, and Washington.

In addition, this hazard assessment relies upon readily available geospatial data, the accuracy and precision of which may influence the estimated likelihood and magnitude of post-fire debris flows. However, local conditions (such as debris supply) certainly influence both the probability and volume of debris flows. Unfortunately, locally specific data are not presently available at the spatial scale of the post-fire debris-flow hazard assessment. As such, local conditions that are not constrained by the model may serve to dramatically increase or decrease the probability and(or) volume of a debris flow at a basin outlet. The input geospatial data are also subject to error based upon mapping resolution, elevation interpolation techniques, and mapping and(or) classification methods. Finally, this assessment is specific to debris-flow hazards; hazards from flash-flooding are not described in this study and may be significant.

This assessment also characterizes potential debris-flow hazards at a static point in time immediately following wildfire. Studies of post-fire debris flow in the western United States have indicated that debris-flow activity in recently burned areas typically occurs within 2 yr of wildfire. As vegetation cover and soil properties return to pre-fire conditions, the threat of debris-flow activity decreases with time elapsed since wildfire. Conversely, the hazards from flash-flooding may persist for several years after the wildfire.

Finally, this work is preliminary and is subject to revision. It is being provided due to the need for timely "best science" information. The assessment is provided on the condition that neither the U.S. Geological Survey nor the United States Government may be held liable for any damages resulting from the authorized or unauthorized use of the assessment.

Arapaho and Roosevelt National Forest, Colorado



Projection: NAD1983, UTM Zone 13N

Figure 4: USGS Debris Flow Combined Hazard Map