

Date of Report: 10/4/2016

EXECUTIVE SUMMARY

The Beaver Creek Fire started on June 19, 2016; the cause is under investigation. Due to spotting up to one mile, and burning in extensive beetle kill forest, typical fire-fighting efforts were ineffective and the fire continued to burn and expand throughout the summer and fall. Containment is not expected until the first significant snowstorm, which is estimated as October 21, 2016. It is located northwest of Walden, Colorado on the Parks and Brush Creek Hayden Ranger Districts of the Medicine Bow-Routt National Forests (MBRNF); the bulk of the fire is in Colorado with a small portion in Wyoming. The fire burned primarily in stands of lodgepole pine affected by a mountain pine beetle epidemic with 60-80% of the stands entering the 'gray phase' of the pine beetle epidemic.

Of the burned acres within the perimeter 15% were unburned, 38% were of low burn severity, 36% were moderate burn severity, and 11% were of high burn severity.

Burn Severity By Ownership:

Owner	High	Moderate	Low	Unburned	Total
MBR NF	1891	7368	8451	3557	21267
BLM	2073	5143	5025	1613	13854
PVT	200	874	1156	482	2712
State	71	281	158	36	546
Total	4235	13666	14790	5688	38379

A BAER team was assembled at the end of September when the risk of additional fire growth was low to assess post-fire affects and provide data and modelling information that may be beneficial to the BLM and private land owners. The team considered and addressed post-fire impacts to critical values at risk including life and safety, property, natural resources, and cultural resources. The risk analysis took into consideration the magnitude of consequences and probability of damage to these critical values at risk. Treatments are recommended for those areas where the risk is considered to be high/very high or intermediate if life/safety was at risk. The treatments recommended have a high probability of reducing unacceptable risks in the most cost-effective manner.

The USFS is responsible for addressing risks on NFS lands. This report focuses on risks and proposed treatments to address threats to values at risk on NFS lands, but also provides relevant information for BLM, and private lands. Proposed treatments focus on inter-agency coordination and information sharing to reduce threats to life/safety and property, storm proofing roads, and minimizing the spread of noxious weeds into burned areas which could detrimentally affect native plant communities. Limited hillslope treatments are proposed to protect a high risk area of the Big Creek Campground.

In total the BAER team identified approximately **\$181,214** in potential emergency stabilization treatments to address post-fire impacts from the Beaver Creek Fire.

BURNED-AREA REPORT

(Reference FSH 2509.13)

PART I - TYPE OF REQUEST

A. Type of Report

- ☒ 1. Funding request for estimated emergency stabilization funds
☐ 2. Accomplishment Report
☐ 3. No Treatment Recommendation

B. Type of Action

- ☒ 1. Initial Request (Best estimate of funds needed to complete eligible stabilization measures)
☐ 2. Interim Report # _____
 ☐ Updating the initial funding request based on more accurate site data or design analysis
 ☐ Status of accomplishments to date
☐ 3. Final Report (Following completion of work)

PART II - BURNED-AREA DESCRIPTION

- A. Fire Name: Beaver Creek Fire B. Fire Number: CO-RTF-000088
C. State: CO/WY D. County: Jackson/Carbon
E. Region: 2 F. Forest: Medicine Bow-Routt NF
G. District: Parks/Brush-Creek Hayden RDs H. Fire Incident Job Code: P2KA6716 (0206)
I. Date Fire Started: June 19, 2016 J. Date Fire Contained: Projected 10/21/2016
K. Suppression Cost: Approx. \$30.1 million as of 9/26/16
L. Fire Suppression Damages Repaired with Suppression Funds
 1. Fireline (dozerline) rehabbed (miles): 5.5 miles (NFS land)
 2. Fireline seeded (miles): 3 miles
 3. Handline: 1 mile (NFS land)
M. Watershed Numbers:

Table 1: Fire Affected Sixth-field Watersheds and Soil Burn Severity; watersheds are displayed on Map 3.

			Soil Burn Severity					USFS Lands
Watershed Name	WS Number	Total Area (ac)	Low (ac)	Mod (ac)	High (ac)	Unburned (ac)	% Burned	Area (ac)
Upper North Fork North Platte River	101800010201	23,357	803	409	56	22,089	5	18,470
Lake Creek	101800010203	35,553	2,436	1,707	219	31,191	12	3,239
South Fork Big Creek	101800020301	28,255	5,672	4,420	1,025	17,138	39	17,384
North Fork Big Creek	101800020302	39,097	2,901	3,193	959	32,044	18	36,768

Spring Creek - Big Creek	101800020304	28,478	1,555	1,758	264	24,901	13	3,177
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N. Total Acres Burned: (As of September 26, 2016) Map 1.

NFS Acres 21,389 (56%) Other Federal (BLM) 13,854 (36%) State 547 (1%) Private 2712 (7%)

In general, the fire tended to burn in a mosaic pattern that left pockets of more severely burned areas.

O. Vegetation Types: The Forest Service lands burned in the Beaver Creek fire were primarily composed of lodgepole pine forest, much of which experienced high mortality during the mountain pine beetle epidemic. Engelmann spruce/ subalpine fir, and aspen forest were also found in the area with small patches of limber pine and Douglas fir. Tree density and understory composition and cover varied with aspect and slope. Common understory plants in forested areas include dwarf huckleberry, Ross' sedge, elk sedge, bitterbrush, and currant. Some areas within the fire perimeter were previously logged and were composed of dense stands of young lodgepole pine. Open, non-forested areas on NFS lands were primarily wetlands, small kettle ponds, fens, and larger riparian areas composed of a combination of sedge meadows, willow carrs, and sparsely treed wetlands. Upland open areas were mostly mountain sagebrush and bitterbrush shrublands with herbaceous understories. Plants occurring in sagebrush shrublands include service berry, Sandberg bluegrass, sheep fescue, prairie jungrass, and a variety of forbs. Most of the shrublands and other non-forested vegetation that burned was on lands with other ownership. Disturbed areas along Forest Service road 600, Big Creek Lake Road, and connecting NFS roads within the fire perimeter contain a combination of native vegetation and invasive weeds such as cheatgrass, toadflax, and Canada thistle.

P. Dominant Soils: Dominant soil types within the fire perimeter include the Taglake and Comad series. Smaller components, among others, include the Youga and Granile series. These soils are mostly well-drained and slightly to moderately erosive. They are typically characterized by coarse loam to sandy loam surface textures and many soils in the area have skeletal properties indicative of large amounts of rocks. Soil structure and fine roots were impacted by fire in high soil burn severity areas. Loss of the litter/duff layer and compromised structural integrity will exacerbate post fire erosion and will increase recovery. Areas that remained unburned and those that experienced low burn severities were found to have a more natural structure (generally granular) with more organic matter and higher amounts of soil moisture. Recovery of small amount grasses and forbs was observed throughout the burned area and over the range of burn severities. Based on signs of early recovery, it is likely more extensive recovery will continue following snowmelt if normal soil moisture and climatic conditions exist. Complete consumption of heavy fuels was far less common than partial consumption of heavy fuels. Consumption of heavy surface fuels will likely detrimentally affect soil productivity over small areas but, overall, it is not believed that long term soil productivity will be an impediment to the continued recovery of plants during successive growing seasons. Debris flows and high rates of erosion are likely and expected within drainages that experienced moderate to high soil burn severity, especially in steep drainages where ground cover consumption was high.

Q. Geologic Types: The Park Range of Colorado borders the western side of North Park and represents a long north-south trending range extending from the Wyoming Border down toward the center of Colorado through Jackson and Routt counties. The range also marks the path of the continental divide, separating the Platte River drainage to the east from the Elk River watershed to the west. Continuing north, the range extends into Wyoming where it is known as the Sierra Madre Range. North Park, bordered to the west by the Park Range, is a large intermountain basin situated between the Park Range to the west and the Medicine-Bow mountains to the East. This basin marks the eastern extent of the fire. Geology within these landforms is highly diverse and represents many geological eras. The Park Range is a large linear anticline bounded by faults. Most of the mountains in the area are the result of highly localized movements of the crust as the Rocky Mountains were thrust upward. These movements broke deep massive igneous basement rocks and bent the more flexible Paleozoic and Mesozoic layered rocks above until they arched upward. As these mountains rose, the forces of erosion stripped away many of the Phanerozoic

sedimentary layers and exposed the Precambrian basement rocks that now make up many of the peaks in the area. The landscape today is representative of glaciation events experienced in Colorado. The most recent of these events is known as the Pinedale glaciation, preceded by the more extensive Bull-Lake glaciation.

R. Miles of Stream Channels by Order or Class: 32 Perennial, 14 Intermittent 7 Ephemeral

S. Transportation System: Trails: 4 miles Roads: 60 miles system roads within the burned area were assessed

PART III - WATERSHED CONDITION

A. Burn Severity (acres): See Table 2 and Map 2.

Table 2. Burn Severity By Ownership.

Owner	High	Moderate	Low	Unburned	Total
MBR NF	1891	7368	8451	3557	21267
BLM	2073	5143	5025	1613	13854
PVT	200	874	1156	482	2712
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Total	4235	13666	14790	5688	38379

The BAER team utilized a Burn Area Reflectance Classification (BARC) map to produce an accurate soil burn severity map in a short timeframe. The Burn Area Emergency Response (BAER) team acquired and utilized two BARC images which covered most of the burned area. Following field review, minor systematic adjustments to the classification were made and the BARC map was adjusted to reflect a greater area of moderate soil burn severity, and less area of high soil burn severity (Table 3). In many areas fine roots were intact immediately below the soil surface, indicating more of a moderate burn severity.

Table 3: Adjustments to the BARC classifications following field review.

SBS	Original Classification (RSAC)	Adjusted Classification (SBS)
Unburned	0-71	0-71
Low	72-123	72-132
Moderate	124-189	133-201
High	190-255	202-255

B. Water-Repellent Soil (acres): 4498 (25% of NFS lands). Observations indicated strong repellency within a ¼ inch of the surface over moderate to high burn severities. Areas with coarse textured surface layers, high burn severities, and/or thick ash layers commonly had strong water repellency at depths of greater than ½ an inch. The pattern of water repellent soils is likely to be patchy and mosaic. While insufficient field data was collected to determine precise acreages of water repellent soils, the extent of water repellent soils is estimated to be 4,498 acres or 25% of the moderate and high burn severity areas.

Increased runoff due to hydrophobic conditions is reflected in the peak flow analysis contained in the Hydrology report. Increased overland flow due to the hydrophobic conditions may increase hill-slope rill and sheet erosion. Hydrophobic layers will usually take six months to two years to break down. Plant root development, soil microbial activity, and freeze-thaw cycling all contribute to the degradation of hydrophobic conditions.

C. Soil Erosion Hazard Rating (acres): See Table 4.

Table 4: Erosion hazard ratings for the Beaver Creek Fire.

Erosion Hazard Ratings for the Beaver Creek Fire	
Erosion Hazard Rating	Acres
Slight	6,461
Moderate	25,495
Severe	6,421

* Acreages are for entire fire, not just for USFS lands.

A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised. More detail on specific soils is available in the soils specialist report.

D. Erosion Potential: Erosion response is heavily influenced by soil burn severity and hill slope. Before the fire, most of the forested areas had protective ground cover in the form of litter, duff, or ground vegetation. Before the fire, minimal soil erosion occurred on forested hill-slopes within the burned area. Following the fire, the rates of erosion are expected to increase significantly because the burn affected soil aggregate stability, canopy cover, ground cover, and infiltration rates.

Map 4 is based on a GIS intersection of slope and soil burn severity. A color ramp from dark green to light green to yellow to orange to red was applied. Generally minimal, if any, increased erosion is expected to occur in dark green areas. Significant increases in the rates of erosion are anticipated where colors range from yellow to red.

In high and moderate soil burn severity areas, it is highly likely that increased rates of soil erosion and sediment delivery to stream channels will occur, in the first 3-5 years following the fire, particularly on steep slopes.

E. Sediment Potential: 5818 cubic yards / square mile

PART IV - HYDROLOGIC DESIGN FACTORS

The fire burned portions of five 6th field watersheds. All of the watersheds are within the North Platte River basin. South Fork Big Creek contained the largest proportion of the fire, where 39% of the watershed was burned. Only a small portion (5%) of the Upper North Fork North Platte River watershed was burned (Table 1).

Streams in the upper portions of the watersheds are steep, step-pool systems with bedrock and cobble substrates. Streams in the lower portions of the watersheds are low gradient riffle-pool systems with gravel and cobble substrates, and are often associated with broad wetland and beaver dam complexes in the valleys.

Within the 6th field watersheds, four subwatersheds were delineated to evaluate specific values at risk. These were Line Creek above Forest Service Road (FSR) 80, the watershed draining Twisty Park (aka

Twisty Creek) above FSR 600.1 to Big Creek Lake, and two small watersheds that drain hillslopes above private residences along South Fork Big Creek. Table 5 and Map 1 show the modeled drainages and main streams within the larger 6th field watersheds.

Table 5: Sub-watersheds within the 6th level watersheds.

6th field Watershed	Modeled sub-watershed	Total acres	Percent of 6th field watershed
South Fork Big Creek	Twisty Creek	1338	5%
	SF Big Cr Home 1 West	1.2	Less than 0.1%
	SF Big Cr Home 2 East	0.8	Less than 0.1%
North Fork Big Creek	Line Creek	5667	14%

Hydrologic conditions in the burned watersheds have changed significantly as compared to pre-fire conditions. In unburned condition, herbaceous vegetation, litter and duff serve as a sponge and filter to protect the forest floor from erosion and absorb water. Much of the precipitation that falls in a watershed infiltrates and travels slowly through the soil profile or as shallow groundwater to the stream network, and overland flow is rare. Areas that burned at moderate and high burn severity have lost the sponge and filter. Overland flow becomes much more common and precipitation travels quickly to the stream channel carrying eroded soil. Peak flows and sedimentation from summer thunderstorms increase significantly. Debris flows are much more likely to occur. Some metals, such as mercury may become mobilized as a result of the fire, and may move in ash and sediment. The primary threat to values at risk for hydrology are associated with flooding, debris flows, sedimentation, and water quality. These increased risks typically persist for 3-5 years until hillslope vegetation recovers to levels that allow recovery toward pre-fire hydrologic conditions. Table 6 summarizes soil burn severity for the modelled sub-watersheds, and Table 7 summarizes expected hydrologic changes caused by wildfires that may impact values at risk.

Table 6: Soil burn severity acres and percent by modeled sub-watershed.

Modeled drainage	Unburned acres (%)	Low acres (%)	Moderate acres (%)	High acres (%)
Twisty Creek	643 (6%)	216 (20%)	266 (51%)	213 (23%)
SF Big Cr Home 1 West	0 (4%)	0.5 (8%)	2.0 (53%)	3.1 (36%)
SF Big Cr Home 2 East	0 (<1%)	0.5 (4%)	1.7 (52%)	4.1 (44%)
Line Creek	5005 (89%)	232 (4%)	312 (5%)	139 (2%)

Table 7: Hydrologic changes induced by wildfire.

Hydrologic Process	Type of Change	Specific effects
Rainfall Interception	Reduced	Greater runoff in small storms Increased water yield
Litter storage of water	Reduced	Less water stored Overland flow increased Peak flow increase
Transpiration	Temporary Elimination	Water yield increased Soil moisture increased

		Streamflow increased
Infiltration	Reduced	Overland flow increased Stormflow increased
Streamflow	Changed	Peak flow increased
Metal Pollutants	Increased mobilization	Increased transport from soils to streams and lakes

Increased surface runoff and erosion are expected to result in increased sedimentation in streams. Increased flow and sediment is likely to result in both increased scour and deposition in stream channels. Accelerated rates of flow and sediment are likely to persist until vegetation re-establishes and provides ground cover. Sediment bearing flood flows are likely. Along with sediment, it is expected that burned wood and other organic materials will be entrained in the flows, which increases the risk of debris plugging and potential failure of culverts and other road-stream crossings. If high intensity rainfall events occur, it is likely that debris flows may initiate in the upper basins and steeper tributary channels and move downstream. Material from debris flows would accumulate on alluvial fans or be deposited in stream channels.

Loss of ground cover, litter, and duff reduce the ability of the burned slopes to detain water and sediment. This will increase the potential for flash floods and will increase the distance that eroded materials are transported. However, several factors favor a quick recovery in terms of normal hydrologic response of some hillslopes. The existence of fine roots in the low and moderate severity burn areas just below the surface will likely aid plant recovery and will serve as a source for natural vegetation recovery. The major factor in hydrologic recovery is development of ground cover and vegetative recovery in the moderate and high soil burn severity areas.

Increase peak flows and woody debris are likely to cause debris jams and localized flooding at channel constrictions such as culverts and other stream crossings. The post-fire flows greatly increase the risk of undersized culverts, plugged culverts, flow over road and trail surfaces, rill and gully erosion, and threats to human safety.

The results of the pre- and post-fire hydrologic modeling are shown in Table 8 below. Modeling results were based on a 10 year-1 hour design storm. Within the burned area, this is predicted to be a 1.01 inch storm. This storm simulates a high intensity summer thunderstorm that has been shown to cause damaging flood events in other burned areas in Colorado. Increases in peak flow are expected within the modeled drainages as a result of the design storm.

Model results are best interpreted by looking at relative predicted increases. While absolute flow magnitudes may contain considerable uncertainty, relative increases in peak flow provide a more useful guide for understanding the extent of alteration of a watershed's soil hydrologic function. It is expected that flash floods and debris flows are likely to occur under sufficient rainfall and intensity. A general rule of thumb, based on anecdotal information from previous fires is that in burned areas, a ½ inch of rain in one ½ hour is sufficient to initiate debris flows.

Table 8: Pre and post-fire peak flow predictions from Wildcat Rainfall-Runoff Hydrograph Model.

Sub-Watershed	10-year, 1-hour event	
	Pre-fire estimated discharge (cfs)	Post-fire estimated discharge (cfs)
Twisty Creek	13	192
SF Big Cr Home 1 West	0	1.5
SF Big Cr Home 2 East	0	1.65
Line Creek	79	227

Summary of Hydrologic Assessment

Wildfires result in increased runoff and sediment yield commensurate with soil burn severity. Minor precipitation in high and moderate soil burn severity areas is likely to produce runoff that would not have occurred previously, and moderate or major precipitation could produce extreme runoff events, particularly in steep drainages. Thunderstorms moving through the area may cause increased flow. Post-fire peak flows will vary depending on the amount of vegetative recovery and the degree that hydrophobic soil layers are broken up before the next high-intensity storm. Other post-fire water related effects include changes in water quality and risks to Forest infrastructure, including roads, crossings and campgrounds. Increased risk of ditch failure could lead to damage of NFS lands

Table 9: Hydrologic design summary.

Estimated Vegetative Recovery Period	3 to 5 years
Design Chance of Success	80%
Equivalent Design Resource Interval	10 years
Design Storm Duration	1 hour
Design Storm Magnitude	1.01 inches
Design Flow	8.9 cfs/mi ²
Estimated Reduction in Infiltration	24%
Adjusted Design Flow	25.6 cfs/mi ²

Note – Design flow and adjusted design flows are shown for Line Creek. Values for other modeled watersheds are different but show the same trends.

PART V - SUMMARY OF ANALYSIS

A. Describe Critical Values/Resources and Threats:

THREATS to HUMAN LIFE/SAFETY

Hazard trees-- Hazard tree safety concerns existed prior to the fire due to the beetle-kill timber, but these hazards have been further exacerbated by the fire. While previous mitigation addressed much of the infrastructure, the remaining trees that were previously considered a low risk hazard are now

high risk hazard. Additionally, there is increased hazard for forest users such as hunters outside of this infrastructure. There is a high likelihood of hazard trees falling in the vicinity of Forest users.

Private Home Flooding and Debris Flow - Two private homes along the south side of the South Fork Big Creek are located immediately below burned hillslopes of high and moderate severity. Small ephemeral channels are located directly above each of the houses. While the watersheds above the houses are small, watershed modelling indicates that storms that produced no surface flow in the watersheds prior to the fire are now likely to produce flow. The flows predicted by modelling are fairly small, so it may be that small or less intense storms may produce nuisance flows that may damage property, but that larger, more intense storms may produce debris flows that could be very damaging for property and could threaten life and safety. The USGS debris flow model predicts an increased risk of debris flow for the hillslopes above these homes.

Recreation Residences – There are several recreation residences located along South Fork Big Creek and one along the shore of Big Creek Lake. Post-fire surveys indicate that risks to the residences are limited. Some residences that are directly adjacent to burned hillslope may experience nuisance flows of sediment and ash, but the contributing hillslopes are short and of small enough area that threats to life and safety is low, but there may be some minor property effects.

Water Quality – In addition to greatly increased erosion and sedimentation, there is likely to be increased mobilization of mercury and other metal pollutants in ash and sediment transported from hillslope soils to streams and lakes following the fire. The Big Creek Lakes are already listed on the Colorado Department of Public Health and Environment (CDPHE) 303(d) list of impaired water bodies because of elevated mercury levels, and there is a public health warning recommending that ingestion of fish from the lakes be limited because of elevated mercury levels; post-fire effects are expected to increase mercury levels.

Emergency Determination: The probability of increased health and safety hazard from hazard trees and debris flows is likely, and the magnitude Major resulting in a Very High risk rating. A threat to water quality for both natural resources and human health/safety was determined; the probability of loss is Very Likely and the magnitude of consequence is Moderate; therefore the BAER risk is Very High.

THREATS TO PROPERTY

Roads:

Roads and road/stream crossings within the burned area are at risk from impacts from increased water, sediment, and/or debris. Impacts include damage to the road and/or loss of access due to severe erosion of the road surface, or deposition of sediment or debris. Roads within the burned area are also likely to exacerbate the risk of flooding and erosion by collecting surface water, concentrating it and delivering it to hillslopes or stream channels.

There are 60 total miles of system roads within the burn perimeter. Of these 60 miles, approximately 21 miles of road travel through high and moderate burn severity which were determined to be at risk of adverse consequences.

Summary of road conditions that warrant treatment as a result of the fire:

- a. Of the 60 miles of road within the burn perimeter, 21 miles were found to have issues with their drainage system. Severely burned slopes and drainages exist above several roads in many locations. These burned drainages present increased hazards to road infrastructure and life and safety from increased erosion and flood flows.
- b. Two culverts on perennial streams were identified as being undersized or at high risk of

being overtopped due to the expected increase in runoff from their particular watershed. These two culverts are located on level 3 and 4 roads that provide primary access to the Forest.

- c. One road/stream crossing is at risk of plugging due to increased debris which could be mitigated by installation of a 'trash rack'
- d. Three culverts on streams with live water require removal of the culvert and conversion to a low-water crossing to accommodate increased flood flows.
- e. Removal of severely burned and/or structurally compromised trees will be needed in isolated areas to protect the life and safety of Forest Service workers implementing road stabilization treatments.

Emergency Determination: An emergency for roads was determined for property. The probability of loss is Likely and the magnitude of consequence is Moderate. Therefore, the BAER risk is High.

Recreation Resources

Big Creek Campground – Sites 32-37 are adjacent to burned hillslopes along the lateral moraine. The hillslopes may contribute ash and sediment that would deposit in campsites, possibly damaging them. Sediment flows and ash are unlikely to be of depth and volume that would threaten human health and safety.

Big Creek Campground Water System – The water system may be damaged by runoff, erosion and sedimentation. Most likely damage would be by either covering or exposing infrastructure. It is very unlikely that fire-induced water or sediment could be introduced into the water system.

NFS Trails-- Within the fire perimeter there are 4 miles of non-motorized trail (Seven Lakes trail). Of the four miles of trail, 2.1 miles were identified as being burned over by fire of Moderate to High Severity. The Seven Lakes trail is heavily used due to its proximity to the Big Creek Lakes campground, and the access it provides to the upper Big Creek Lake. Values at risk include the trail infrastructure and water quality. It is anticipated that increase in flows associated with the fire effects could cause trail rilling and erosion. While no immediate needs were identified for trail stabilization, it is recommended that storm patrol be performed following spring runoff and significant summer thunderstorm events to ensure that increased erosion and sediment have not caused loss of trail tread.

Emergency Determination: An emergency for recreation resources was determined for property. The probability of loss is Likely and the magnitude of consequence is Moderate; therefore, the BAER risk is High.

THREATS to NATURAL RESOURCES

Ditches – Several ditches traverse the burned area, including the Independence and Pleasant Valley ditches. Ditches are at increased risk of blockage and failure following the fire. Burned trees and other debris can block the ditches, causing overflow and ditch failure. Debris flows can block the ditch or cause failures. While all ditches within the burned areas are at increased risk, the Independence and Pleasant Valley ditches are at particular risk because they traverse long stretches of burned areas and cross steep burned slopes that are at greater risk of debris flow. Headgates may also require more frequent cleaning because of increased debris and sediment.

Kettle Lakes Research Natural Area (RNA): Established in 2001, the Kettle Lakes RNA contains the largest and densest known concentrations of glacially derived lakes in Colorado (250 within RNA boundary). The 6350 acre area includes outstanding examples of fens, kettle pond wetlands, wetlands occupying glacial kettles and beaver ponds, and supports significant populations of rare

plant and wildlife species. Approximately 15% (938 acres) of the RNA is within the Beaver Creek Fire. Of that, approximately 24% burned at moderate or high severity. Although the wetlands themselves generally did not burn, immediately adjacent areas did. Post-fire conditions favor expansion of existing invasive species populations as well as colonization of new areas including wetlands is highly likely. Populations of Canada thistle and musk thistle exist in and immediately adjacent to the RNA. Spotted knapweed populations occur in the vicinity. Areas within and immediately adjacent to moderate and high soil burn severity are at greatest risk for invasion.

Native or Naturalized Plant Communities: There are no known occurrences of Threatened or Endangered plant species within the fire perimeter.

The integrity of native plant communities are at risk from non-native plant (weed) invasion following the Beaver Creek fire. Forest Service policy mandates the Forest to minimize the establishment of non-native invasive species to prevent unacceptable degradation of the burned area. Plant communities most at risk include areas with the highest soil burn severity, those closest to roads and other disturbances, those closest to known populations of weeds, and the lowest elevation areas with southernly aspects where the climate is more mild and the greatest number of weed species can persist. Native plant communities are a critical resource for maintaining the ecological integrity of Forest Service lands and providing habitat for a large variety of wildlife species. Mostly notably the lower elevation woodlands, grasslands and sagebrush shrublands on the eastern flanks of the fire comprise or support adjoining Greater Sage-Grouse habitat.

A large number but limited distribution of non-native and noxious weed species were known to occur in the fire scar previously. Populations were relatively small and almost exclusively restricted to roadsides, campgrounds, and other disturbed areas. However, all of these species are known to increase in patch size and distribution post-fire event. The 8 noxious weeds known from roadsides in the area include musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), dalmation toadflax (*Linaria dalmatica*), yellow toadflax (*Linaria vulgaris*), oxeye daisy (*Leucanthemum vulgare*), spotted knapweed (*Centaurea maculosa*), and field bindweed (*Convolvulus arvensis*).

Most significant and likely most deleterious, cheatgrass (*Bromus tectorum*), also listed as a noxious weed in Colorado, is known from the area and typically experiences landscape-scale population explosions post-fire. The native plant communities and wildlife habitat in the appropriate vegetation types and elevational zones (grasslands and shrublands 9,500 feet and below) are most at risk from cheatgrass invasion.

Patches spread and multiply due to conveyance post-fire of seeds along transportation corridors by vehicles and animals. 30 miles of roadside are mapped as having existing patches or individual noxious weed plants and believe another 10 miles of previously un-infested roadside are at risk. When burned areas are opened to the public or used administratively post-fire, weed seeds will be spread along roads and will easily establish with ample nitrogen and little competition. By accounting for a 50 foot right-of-way along burned roadsides (some roadsides were unburned and thus dismissed), we estimate that approximately 164 acres of roadside will need to be monitored and spot treated by hand or ground-based boom spraying in 2017.

Emergency Determination: Threats to natural resources exist from ditch breaches, the Kettle Lakes RNA, and native plant communities. The probability of loss from ditch breaches and to the RNA is Likely and the consequences are Moderate, therefore the BAER risk is High. For native plant communities the probability is Very Likely, and the magnitude of consequences is Moderate, resulting in a risk rating of Very High.

Wildlife/Aquatics: Critical TES Habitat or Suitable Occupied Habitat

Habitat of one federally listed species, Canada lynx, exists within the fire perimeter. An estimated 47% of the acreage burned at moderate or high severity. Cover for the lynx' main prey, snowshoe hare, was removed in those areas. Little to no lynx/snowshoe hare habitat was removed within low severity burn areas (38%), however. In addition, approximately 15% of the area was unburned, resulting in a desirable mosaic across the landscape.

Canada lynx and critical habitat:

Most forest cover within the fire perimeter is classified as Canada lynx habitat, but there is no designated Critical Habitat. In areas of low burn severity some lynx habitat should remain suitable. However, the majority of the habitat was already unsuitable due to the existing, extensive mountain pine beetle-caused tree mortality. Most areas classified as moderate or high burn severity contained large volumes of dead trees and did not support lynx or snowshoe hares. Those areas will recover naturally and no emergency treatments are proposed.

Sensitive Species

Boreal toad:

This species of toad is currently under consideration for listing under the Endangered Species Act (ESA). A boreal toad breeding site, one of only a handful across the Forest, is located within the fire perimeter in a wetland on a private land inholding. This site is fairly broad and surrounded by moderate to low-gradient slopes. Sedimentation resulting from runoff of adjacent burned slopes is a potential threat. However, the likelihood of damage is low and no treatments are proposed to remediate that potential issue.

Greater sage grouse:

Greater sage grouse were proposed for listing under the ESA, but was found not warranted for such in 2016. Within the fire perimeter, on Forest Service lands, minimal amounts of sage grouse habitat were burned. Those sites are on the margins of mapped habitat and represent a minimal loss of suitable habitat. The greatest threat to sage grouse habitat is the potential establishment of invasive weeds, particularly cheatgrass. Early detection rapid response surveys proposed to maintain native plant communities will address threats to sage grouse habitat.

Emergency Determination –No emergency exists pertaining to the federally listed or Forest Service Sensitive wildlife or aquatic species that are not adequately addressed by other treatments.

Known cultural sites exist within the fire perimeter. All cultural resources within the burn area were identified using best available information from MBRTB spatial and tabular databases. It is likely that not all known cultural resources (and subsequently identification of all potential high cultural values at risk) within the Beaver Creek Fire boundaries were located during this initial BAER assessment.

Risk to high value cultural resources was defined as being:

- 1) located within areas having high or moderate soil burn severity identified by either BARC or professional evaluation of the post-fire landscape, or
- 2) immediately adjacent to these same areas
- 3) burn soil severity and topographic location may result in a risk of post-fire deposition or erosion, or
- 4) removal of onsite vegetation could increase *in situ* or anthropogenic effects

Threats fitting a combination of these criteria have the potential to affect those qualities of the cultural resource that make it eligible for inclusion to the NRHP. Post-fire impacts and/or BAER

treatments that result in an unmitigated adverse effect will be recommended for emergency treatment/mitigation.

Six eligible cultural resources identified during the records search meeting the above criteria; two resources (5JA1996 and 5JA1548) were visited in the field. Two resources (5JA698 and 5JA499) were omitted from visit as describe above. One resource, 5JA690 and its associated segments (5JA690.1, 5JA690.2, and 5JA690.3) are not accessible through the burned areas, and omitted from field visit. One resource, 5JA498 (the Wolverine Mine), as also omitted from field visit (described below). One high value cultural resource, 5JA1996, has proposed treatments.

Of the resources assessed none were in areas where high runoff, erosion, flooding, or debris flow could pose a potential threat. The soil burn severity was moderate in the resource locations. No previously identified resources determined to be either eligible or unevaluated for inclusion to the NRHP were immediately adjacent to moderate or high intensity soil burn severity areas or in drainages The moderate burn areas within the sites were patchy and did not adversely impact the site's integrity. There is a higher likelihood of looters and vandals removing prehistoric artifacts uncovered by the fire at 5JA1996. Proposed mitigation should be minimal and allow natural flora to revegetate the area and obscure cultural resources from public view. Periodic monitoring of the site 5JA1996 over the next year is recommended to ensure that no looting or vandalism is transpiring.

The probability that fire-induced runoff from typical high intensity/short duration summer thunderstorms may impact the archaeological record is possible and, if impacted, the consequences would be major damage or loss. For this reason cultural surveys in 2017 are recommended to assess this risk. There is potential for previously unknown cultural sites to have been exposed by the fire, and which are now subject to post-fire effects including looting, and erosion and sedimentation. It is recommended that surveys be conducted to determine if an emergency exists for previously unknown sites.

BAER treatments are subject to Section 106 of the National Historic Preservation Act and 36 CFR 800.2(0). Prior to the implementation of any proposed BAER treatment, consultation with the MBRTB National Forest Heritage Staff and is required. If cultural resources are present within the proposed BAER treatment area, protective measures and mitigation may be necessary before proposed treatments are implemented. Areas designated for stockpiling and disposal of materials will also need to be inspected for cultural resources.

Emergency Determination: The threat of post fire-induced impacts to a cultural site is Moderate, and the consequences are Moderate; therefore the BAER risk is High.

Table 10: Summary of BAER Risk Assessment where treatments may be warranted

Value at Risk	Critical Value	Probability of Loss	Magnitude of Consequences	BAER Risk
Public Safety	Life and Safety	Likely	Major	Very High
Houses/structures downstream	Life and Safety	Likely	Major	Very High
Roads	Property	Likely	Moderate	High
Campground	Property	Likely	Moderate	High
Campground water system	Property	Likely	Moderate	High
Trails	Property	Likely	Moderate	High
Water quality	Human Health	Very Likely	Moderate	Very High
Ditches/infrastructure	Natural Resources	Likely	Moderate	High
Kettle Lakes RNA	Natural Resources	Likely	Moderate	High
Native plant communities (from weed infestation); soil productivity	Natural Resources	Very Likely	Moderate	Very High

B. Emergency Treatment Objectives:

Land Treatments

- Reduce erosion and damage to Forest Service property
- Maintain the unique plant communities and ecological function of the Kettle Lakes Research Natural Area
- Maintain native plant communities by preventing the establishment of weeds

Road and Trail Treatments

- Storm proofing and patrol to maintain the integrity and investment in the roads and trails for public and administrative access, and address life/safety concerns with road failure or loss of access

Protection/Safety Treatments

- Minimize life/safety threats
- Interagency and public information sharing

Cultural Resources

- Prevention of irretrievable loss of archeological information by locating and assessing heritage sites exposed by the fire.

C. Probability of Completing Treatment Prior to Damaging Storm or Event:

Land 80 % Channel N/A % Roads/Trails 80 % Protection/Safety 90 %

D. Probability of Treatment Success

	Years after Treatment		
	1	3	5
Land	70	80	80
Channel	N/A	N/A	N/A
Roads/Trails	80	90	100
Protection/Safety	80	90	100

E. Cost of No-Action (including Loss): \$535,000—reflects monetary cost only, does not reflect non-market values

Extensive repair or reconstruction of roads at increased risk of post-fire effects is estimated to be \$445,000 based on the existing IDIQ contract on the Forest. Loss of access for recreation/tourism, permittees, and administration is estimated at \$70,000. Reconstruction and repair of the Big Creek Lakes campsites and water system is estimated to be \$10,000, and the Seven Lakes trail is \$10,000. There is a threat to life and

safety as well as natural resources that have non-monetary value. The VAR tool was used to assess the cost benefit of implementing the treatments, and indicated that treatments were justified with a ratio of 1.6. The VARTool Calculation Spreadsheet is available in the project file. As described in this report, increased risk for impacts to life/safety and non-market cultural and ecological values exists throughout the burned area. These values were not addressed in the VAR Assessment nor considered in the benefit/cost ratio.

F. Cost of Selected Alternative (including Loss): \$181,214

G. Skills Represented on Burned-Area Survey Team:

<input checked="" type="checkbox"/> Hydrology	<input checked="" type="checkbox"/> Soils	<input type="checkbox"/> Geology	<input checked="" type="checkbox"/> Range
<input type="checkbox"/> Forestry	<input checked="" type="checkbox"/> Wildlife	<input type="checkbox"/> Fire Mgmt.	<input checked="" type="checkbox"/> Engineering
<input type="checkbox"/> Contracting	<input type="checkbox"/> Ecology	<input checked="" type="checkbox"/> Botany	<input checked="" type="checkbox"/> Archaeology
<input checked="" type="checkbox"/> Fisheries	<input checked="" type="checkbox"/> Research	<input type="checkbox"/> Landscape Arch	<input checked="" type="checkbox"/> GIS

USFS Team Leader: Liz Schnackenberg. Email: lschnackenberg@fs.fed.us. Phone: 970.870.2234

Forest Service BAER Team Members

Forest Service Team Lead	Liz Schnackenberg/Dave Gloss
Soils	Eric Schroder/Ryan Adams (trainee)
Hydrology	Carl Chambers/Tyler Carleton (trainee)
Invasive Weeds	Brad Weathard/Katie Haynes
Botany	Marti Aitken
Engineering	Ryan Nupen/Jake Brown (trainee)
Recreation	Jon Myers
Wildlife	Darrell Freeman
Fisheries	Bill Baer
Cultural Resources	Bridget Roth
GIS	Marti Aitken
Research	Chuck Rhoades (RMRS/biogeochemist)
BLM BAER Team Liason	Zach Hughes
NRCS liason	Deb Heaney
Wyoming Game and Fish	Katie Cheeseborough

H. Treatment Narrative:

The proposed treatments on National Forest System lands can help to reduce the impacts of the fire from storm events, but treatments cannot fully mitigate the effects of the fire on the watershed. Detailed information of the treatments summarized below can be found in the specialist reports prepared in support of this funding request. The treatments listed below are those that are considered to be the most effective on National Forest System lands to protect identified values at risk.

Life and Safety Treatments

Treatments to address life and safety concerns include:

- Posting of hazard warning signs at key portal entrances notifying the public of post-fire hazards. This signing will address the threats of hazard trees as well as flood and debris flow potential.
- Communication and Interagency coordination: Interagency coordination with the NRCS, BLM, National Weather Service, and Jackson County will help facilitate dissemination of BAER assessment results including the change in watershed response, and potential threats to life and safety as well as private property. This is considered the most effective treatment as well as cost effective way to address life/safety and property concerns. This information could be utilized in the development of emergency response plans and public education. This should include:
 - Coordination with the NWS, County Emergency Services (Sheriff's Office) and NRCS to discuss potential threats to life, safety and private property residences along the South Fork of Big Creek and in the vicinity of Twisty Park. The primary objective is to share information and discuss potential protective measures that could be implemented.
 - Coordination with Colorado Parks and Wildlife and Wyoming Game and Fish to provide information about post fire threats to life/safety of people with permits to hunt in the burned area
 - Coordination with CDPHE to discuss increased potential for heavy metal contamination in Big Creek Lake
 - Coordination with DRMS to discuss burned area conditions, safety concerns and increased risk for mobilization of heavy metal laden materials
 - Coordination with NRCS and USFS permit administrators to discuss potential impacts on agricultural water supply ditches and hay meadows, and response actions to maintain the functioning condition of the ditches and lower risk for damage to NFS natural resources
 - Coordination with BLM to discuss potential post fire issues regarding property boundaries, range fences and noxious weeds

Land Treatments:

- Invasive weeds-- Early Detection Rapid Response surveys: This treatment is to reduce the potential for impaired vegetative recovery and loss of native plant communities due to the spread of invasive weeds by conducting detection surveys and rapid response eradication efforts in the areas identified as being at the highest risk. High risk areas are those of moderate or high burn severity that contain known weed populations, or suppression disturbances (ie dozer line etc) adjacent to known weed population, and where vectors exist such as roads and trails. This treatment also addresses the threat to the Kettle Lakes Research Natural Area
- Hand mulching: This treatment would mulch high soil burn severity areas immediately uphill of five campsites in the Big Creek Lakes campground to reduce the potential impacts to Forest Service property from increased erosion and sediment deposition. Mulching would only occur on hillslopes directly uphill of the at risk campsites.
- Fence construction to minimize potential looting and destruction of one cultural site integrity adjacent to an open road due to exposure of the site due to vegetation removal.
-

Channel Treatments:

No channel treatments are proposed on USFS lands.

Road and Trail Treatments:

The following treatments were identified to reduce the risk and threats from increased bedload

movement, flood flows, and debris flows from the Beaver Creek Fire burned area:

- Road stabilization with rolling dips, waterbars, and cleaning of culvert inlets and ditches
- Installation of a 'trash rack' at one road-stream crossing on a level 3 road that provides access to the campground, two trailheads, and the two highest concern ditch headgates
- Treatment of hazard trees where necessary to protect workers implementing BAER treatments
- Replacement of undersized culverts with appropriately sized culverts on open roads
- Removal of existing culverts and creation of low-water crossings where practicable
- Storm patrol

Specific treatments and cost estimates for road treatments are based on costs from an existing IDIQ contract that the MBR NF already has in place. Specific treatments by road are detailed in the engineering report.

Part VI – Emergency Stabilization Treatments and Source of Funds: Beaver Cr Initial

Beaver Cr BAER-- Medicine Bow-Routt NFs		NFS Lands				
Line Items	Units	Unit Cost	# of Units	BAER \$	Other \$	# of units
A. Land Treatments						
Nox. Weeds Detect. And Treat						
Personnel Cost	days	218	75	\$16,350	\$0	
Fleet	mile	2	2000	\$1,144	\$0	
Agreement Cost- existing contract	each	84	164	\$13,776	\$0	
Water system protection	days	300	1	\$300		
Cultural site fence	each	800	1	\$800		
Hand mulch	days	600	5	\$3,000		
Insert new items above this line!				\$0	\$0	
Subtotal Land Treatments				\$35,370	\$0	
B. Channel Treatments						
				\$0	\$0	
Subtotal Channel Treat.				\$0	\$0	
C. Road and Trails						
Trash rack	each	1000	1	\$1,000		
Restoring road ditch	feet	2.5	1350	\$3,375		
Drivable waterbar	each	500	16	\$8,000		
Hazard tree removal for crews	each	1000	8	\$8,000		
Rolling Dip	each	1200	6	\$7,200		
Low water xing/hardened overflow	each	4000	3	\$12,000		
Remove slide and slump	yd ³	50	40	\$2,000		
Ditch cleaning/re-establish	LF	2	2162	\$4,324		
Replace end section- 18"	each	780	2	\$1,560		
Add flared end section-18"	each	650	1	\$650		
Add flared end section-24"	each	780	1	\$780		
Add flared end section 32"x 48"	each	1600	2	\$3,200		
Install drainage	yd ³	200	165	\$33,000		
Add culvert 18"	LF	60	30	\$1,800		
Upsize culvert- 6'x8'	LF	500	55	\$27,500		
Storm patrol (rds and trails)	days	900	10	\$9,000		
Engineering oversite	days	420	15	\$6,300		
Heritage surveys for treatments	days	400	6	\$2,400		
Insert new items above this line!				\$0	\$0	
Subtotal Road & Trails				\$132,089	\$0	
D. Protection/Safety						
Warning and Closure Signs	each	1100	7	\$7,700		
Interagency coordination	days	400	10	\$4,000		
Implementation team leader	days	400	10	\$4,000		
Insert new items above this line!					\$0	
Subtotal Structures				\$15,700	\$0	
E. BAER Evaluation						
Assesment Team Costs				\$27,750		
Insert new items above this line!						
Subtotal Evaluation				\$25,805	\$0	
F. Monitoring						
Cultural site temp closure effectiveness	days	400	2	\$800	\$0	
				\$0		
Insert new items above this line!				\$0	\$0	
Subtotal Monitoring					\$0	
G. Totals						
Previously approved				\$208,964	\$0	

PART VII - APPROVALS

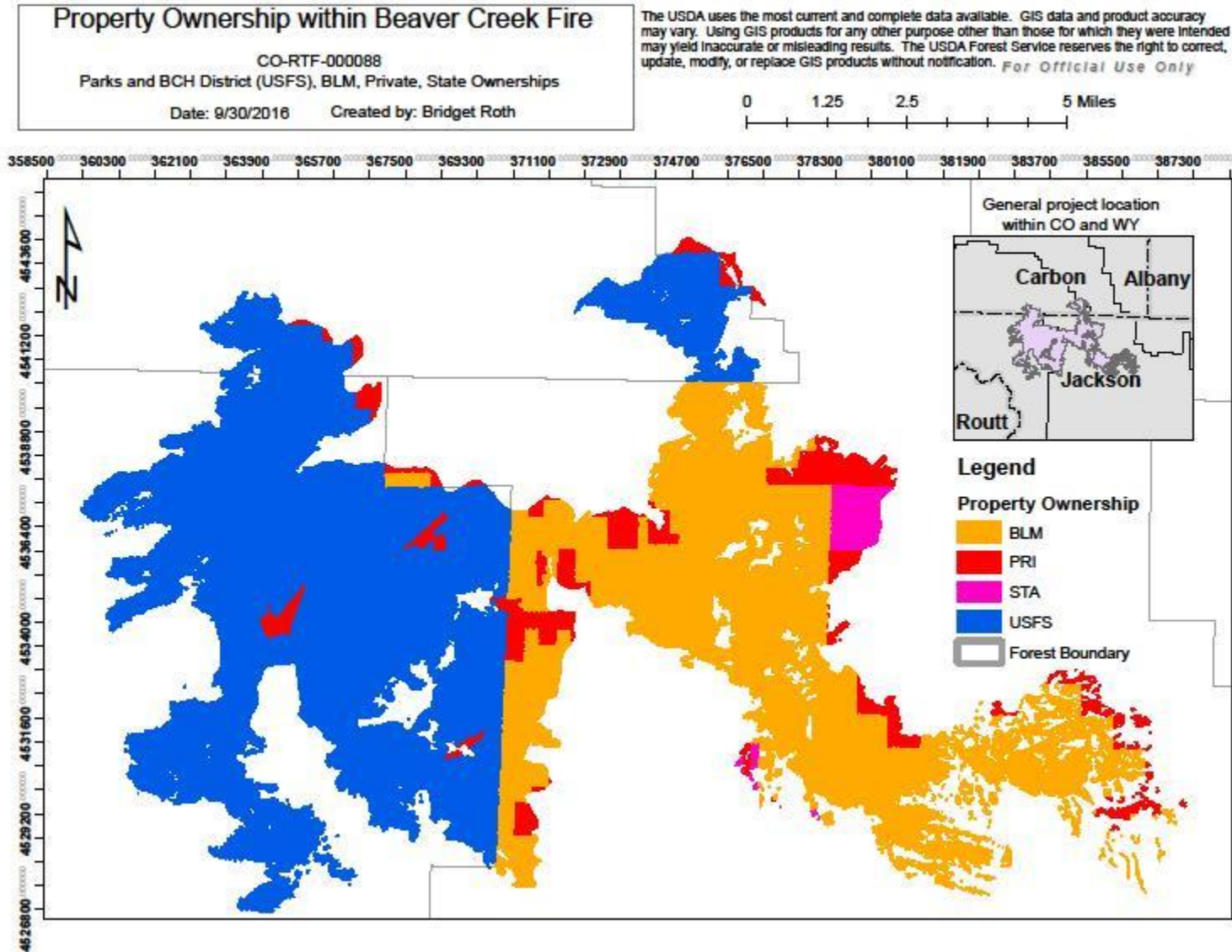
1. /s/ Carolyn P. Yon
Medicine Bow-Routt NFs Forest Supervisor (signature)

10/13/16
Date

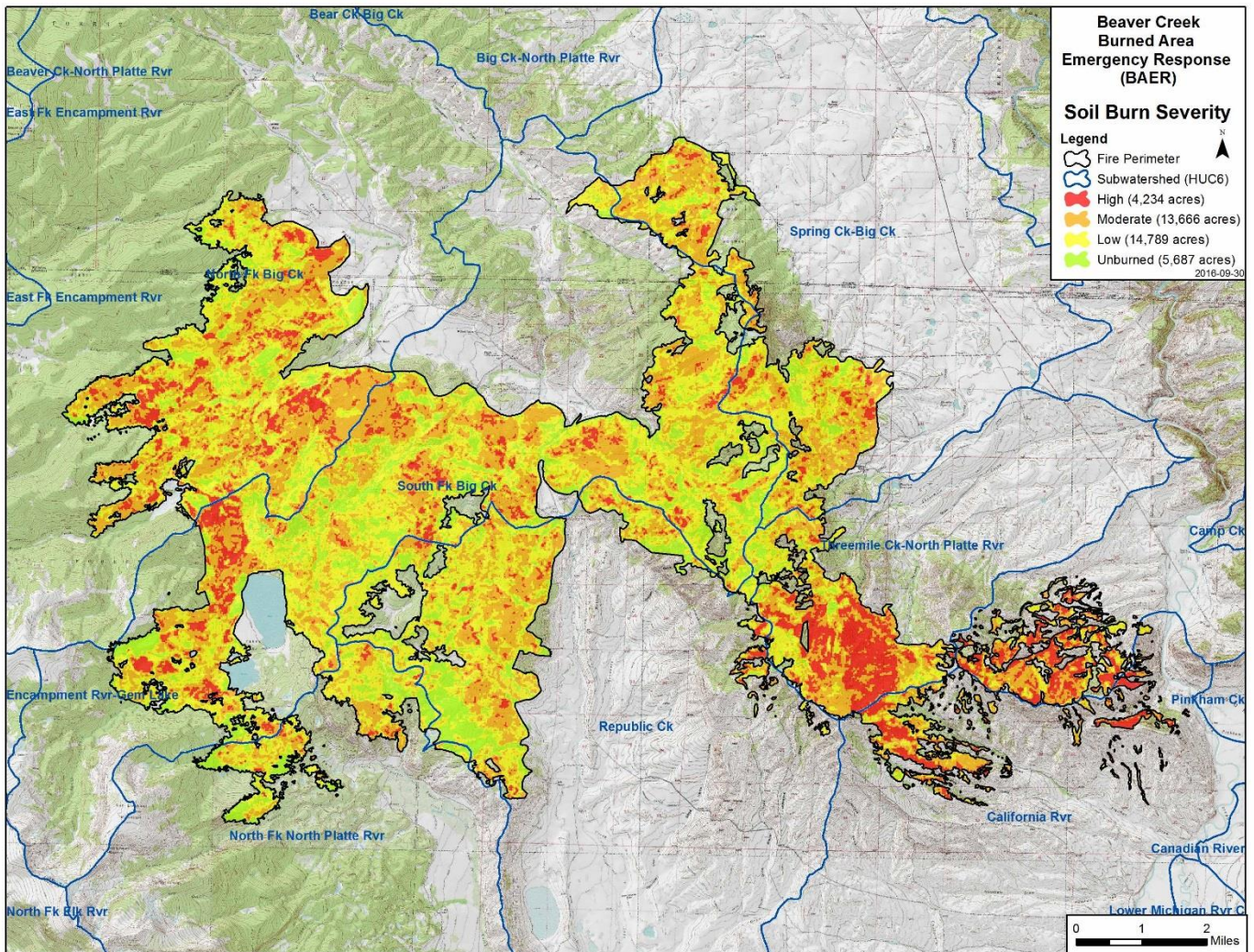
2. /s/
R2 Regional Forester (signature)

Date _____

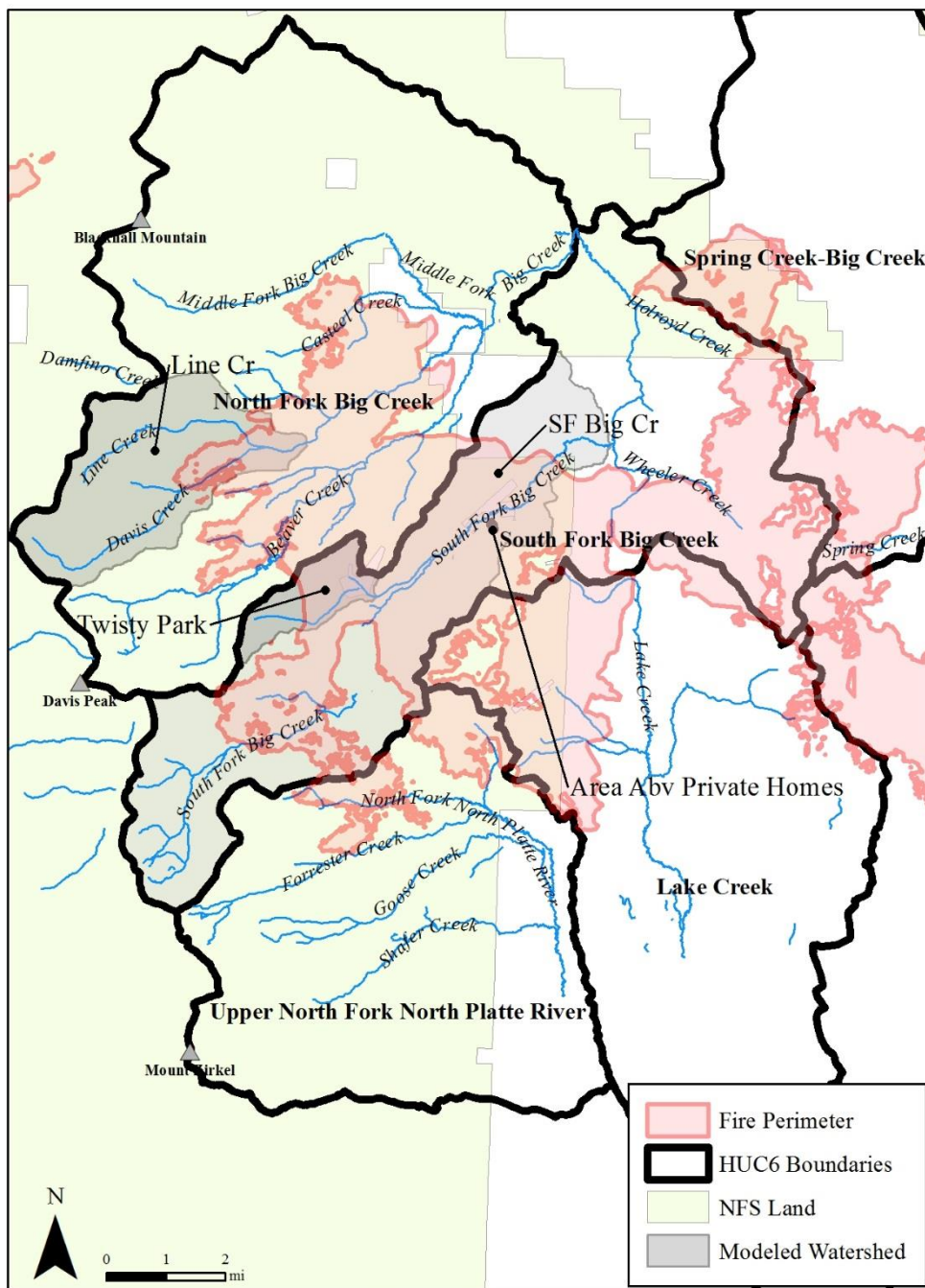
Map 1: Ownership



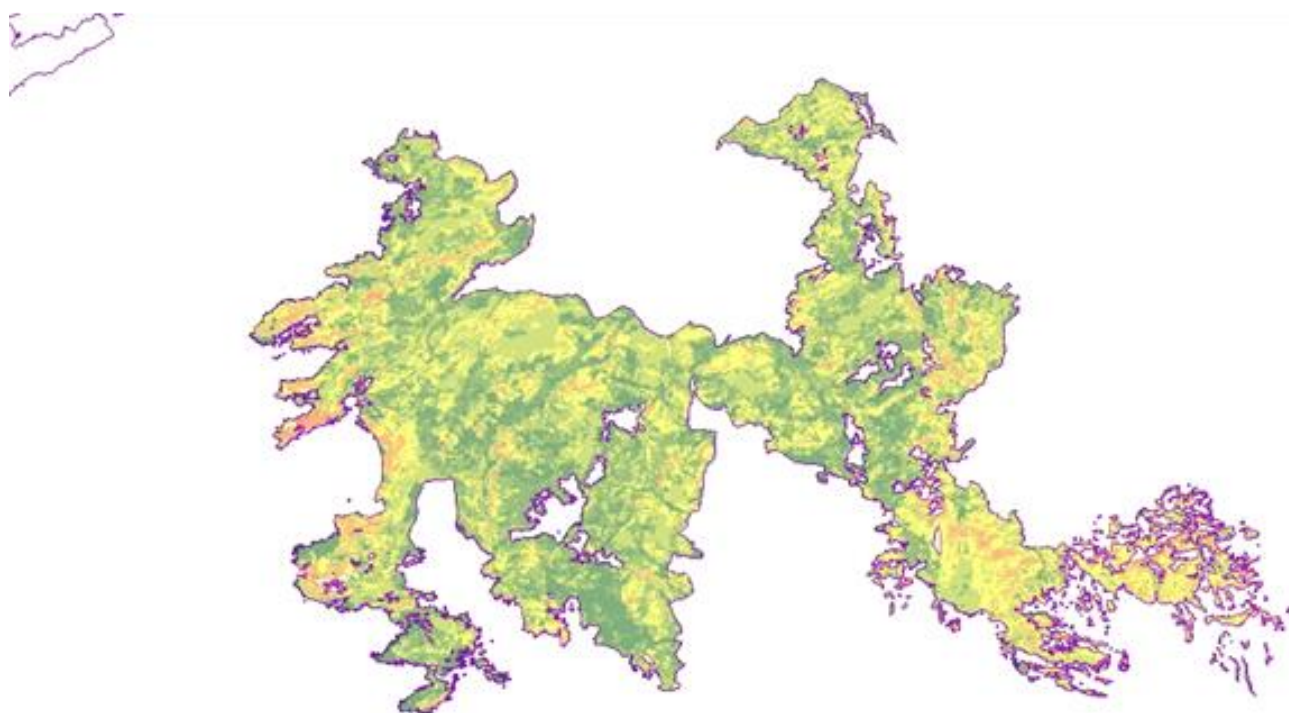
Map 2: Final soil burn severity



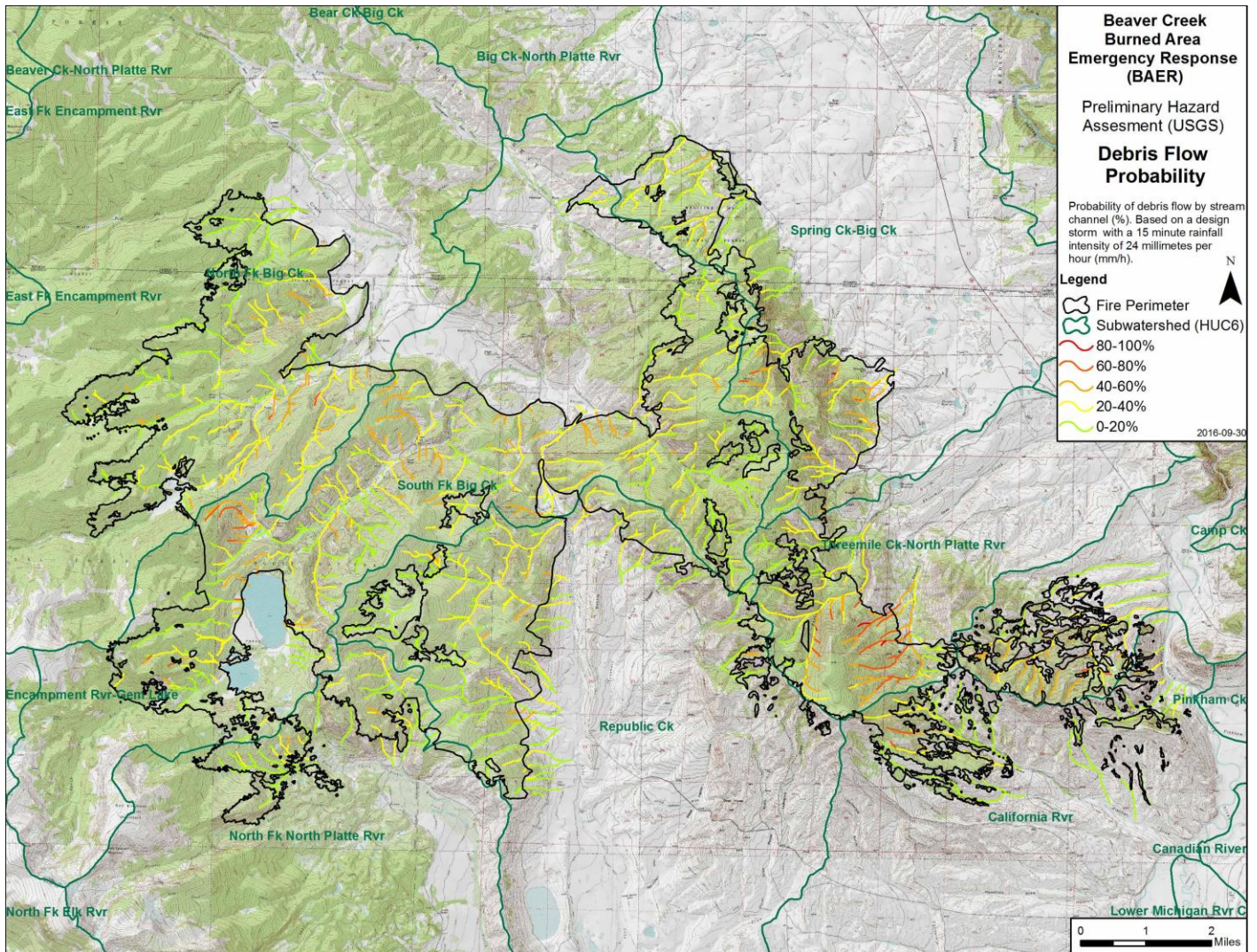
Map 3 : Sixth Level Watersheds, Burn Perimeter, and Modeled Watersheds



Map 4: Erosion Potential



Map 5: Debris Flow Probability



Additional information pertaining to debris flow potential, volumes etc is available in the project file and at:

http://landslides.usgs.gov/hazards/postfire_debrisflow/