Chetco Bar

BAER

Specialist Reports

Burned Area Emergency Response Soil Resource Assessment

Chetco Bar Fire

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Rogue River-Siskiyou National Forest
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EXECUTIVE SUMMARY

The Chetco Bar fire occurred on 191,197 acres on the Gold Beach and Wild Rivers Ranger District of the Rogue River-Siskiyou National Forest, BLM lands, and other ownerships in southwestern Oregon. Approximately 170,321 acres of National Forest System (NFS) land, 6,746 acres of BLM land and 14,130 acres of private land were affected by this wildfire. Within the fire perimeter, approximately 14,012 acres burned at high soil burn severity, 64,545 acres burned at moderate soil burn severity, 76,613 acres burned at low soil burn severity, and 36,027 remain unburned. On NFS-managed lands, 10,684 acres burned at high soil burn severity, 58,784 acres burned at moderate soil burn severity, 70,201 acres burned at low soil burn severity and 30,642 acres remain unburned or burned at very low soil burn severity (Figure 1).

The Chetco Bar fire burned area is characterized as steep, rugged terrain, with highly dissected slopes and narrow drainages. Dominant surficial geology is metamorphosed sedimentary and volcanic rocks, peridotite and other igneous rocks. Peridotite has been transformed into serpentine through a process known as serpentinization. This transformation is the result of hydration and metamorphic transformation of ultramafic (high iron and magnesium) rocks. Most sedimentary and metamorphic geological formations are steeply folded and faulted, and in places, intruded by granitic rocks.

Unstable landforms that contribute to landslides are common within the burned area. Both soil erosion rates and landslide potential are influenced by a variety of factors including surface soil profile depth, water holding capacity, internal drainage characteristics, depth to bedrock, slope angle, and soil shear factors. High precipitation rates are a significant driver of both soil erosion and landslides in the area. Soil erosion and landslides are sources of sediment to stream channels within the burned area.

Dominant surface soil texture groups on NFS lands include loams and sandy loams (123,746 ac.), silt loams (31,088 ac.), and clay loams (2,379 ac.). Areas of rock outcrop are common. Soils at higher elevations are generally shallow and have a substantial rock component while deeper and more loamy soils are found on moderately steep slopes and benches where parent material consists of mudstone and schists. The serpentinized parent materials and ultramafic rocks weather slowly to produce shallow, gravelly soils. Slopes within the burned area range from 5 percent to as much as 120 percent, depending on landscape position and presence of rock outcrops.

Effective ground cover (i.e., fine litter and woody debris of various sizes), which is critical for maintaining soil stability and nutrient cycling, has been significantly consumed in areas of high soil burn severity. Areas of moderate and low soil burn severities have either retained some surface organic matter or contributed to reintroduction of post-fire organic matter through needle cast from conifers and leaf cast from deciduous trees and shrubs. This detritus reduces the susceptibility of soils to erosion since ground cover and soil structural integrity remains intact. Soils with low and moderate soil burn severities generally retain surface structure and porosity since fine and medium roots are intact and residual organic matter covers soil surfaces and provide habitat for soil organisms that facilitate pedogenic processes. These soils generally respond rapidly and in a positive manner following low burn severity as short term nutrient cycles are improved, revegetation occurs and soil surfaces regain protective cover. Soils that are subjected to high soil burn severities have evidence of excessive soil heating in isolated patches; these areas usually have long-term soil damage with increased erosion potential. The most severely burned soils generally occur on steep terrain at higher elevations where pre-fire vegetation density and fuels accumulations were higher.

Water repellency, or soil hydrophobic conditions were observed throughout the burned area, including unburned areas. Decomposition of hydrophobic (or water repelling) plant materials that contain waxy residues (aliphatic hydrocarbons) can cause soil particles to become coated, thereby preventing the

infiltration of water into the soil profile. Background soil hydrophobic conditions were found in areas where tanoak, madrone, and fir were common tree species and areas where pre-fire duff accumulations were high.

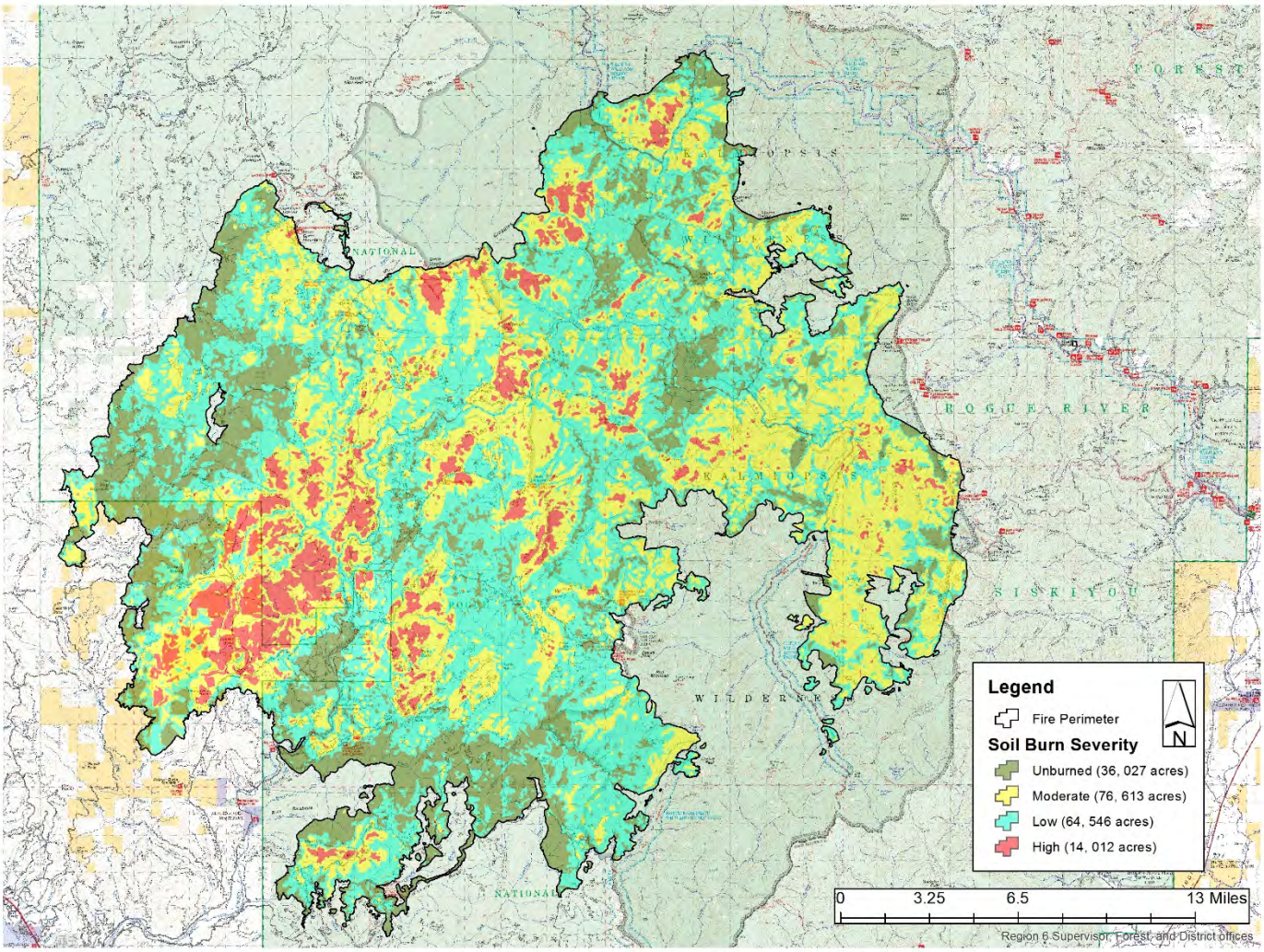

Figure 1. Estimated soil burn severities in the Chetco Bar Fire.

In undisturbed conditions, fungal mycelia can also contribute to soil water repellency through exudates that coat soil particles. Heat generated during a wildfire can vaporize hydrophobic compounds in the litter, humus, and soil organic matter (DeBano et al., 1967, Huffman et al., 2001). These compounds can then move into the soil atmosphere and condense onto soil particles, increasing water repellency and extending this condition to greater depths in the soil profile.

Vegetative diversity within the burned area is very high. Dominant vegetation types on National Forest System (NFS) within the fire perimeter includes Douglas-fir (*Pseudotsuga menziesii*), western white pine (*Pinus strobus*), western hemlock (*Tsuga heterophylla*), sugar pine (*Pinus lambertiana*), incense-cedar (*Calocedrus decurrens*), Port Orford cedar (*Chamaecyparis lawsoniana*), knobcone pine (*Pinus attenuata*), big-leaf maple (*Acer macrophyllum*) redwood (*Sequoia sempervirens*), tanoak (*Lithocarpus densiflorus*), Pacific madrone (*Arbutus menziesii*), chinkapin (*Chrysolepis chrysophylla*), red alder (*Alnus rubra*), rhododendron (*Rhododendron occidentale*), evergreen huckleberry (*Vaccinium oatum*), greenleaf manzanita (*Arctostaphylos patula*), Pacific myrtle (*Myrica californica*), salal (*Gaultheria shallon*), ceanothus (*Ceanothus* spp.), serviceberry (*Amelanchir alnifolia*), blackcap raspberry (*Rubus leucodermis*), bracken fern

(*Pteridium aquilinum*), bear grass (*Xerophyllum* spp.), and a variety of other shrubs, grasses, rushes, sedges and mosses.

Photo 1: Area of Low soil burn severity. Notice green and very little loss of canopy cover.

Photo 2: Area of high soil burn severity. Notice white ash. Most shrubs have been consumed, and there is significant canopy loss.

Photo 3: Area of mixed moderate/high soil burn severity. Notice linear areas of brighter soil surfaces where coarse woody debris laid before total consumption by wildfire.

Soils Resources as a Value at Risk

Soil productivity is considered a natural resource value at risk under post-fire conditions. Loss of effective soil cover (live vegetation, litter and woody detritus of various sizes) on steep terrain typically results in increased soil particle detachment and entrainment during rainfall runoff events. Soils can also erode in high winds when soil surfaces are denuded of vegetation. High winds can detaches soil particles from land surfaces and transport them offsite through suspension in air currents, saltation and surface creep. Wind erosion occurs when forces exerted by wind overcome the gravitational and cohesive forces of soil particles on the surface of the ground.

Runoff and possible hydrophobic soil conditions after a fire can create erosion that far exceed rates of soil formation. While fire and post-fire erosion are natural processes, there can often be excessive rates of erosion associated with higher-than-normal burn severities, or with erosion originating from infrastructure, such as roads and trails, within the fire perimeter.

The Congressional Soil Caucus, which consists of 45 members and four co-chairs, including Democrats and Republicans from the House Appropriations Committee, Agriculture Committee, Committee on Science and Technology, Committee on Natural Resources, and Energy and Commerce Committee recognize soils as a nonrenewable resource that are linked to plants, water, climate, ecosystems, and human health. The Caucus also recognizes that soils are a natural resource essential for all life on earth (SSSA 2013). Soil lost from its native environment cannot be replaced and does not reestablish in the exact same manner as it exists *in situ*.

While soils will be adversely affected in many areas that burned at moderate and high severity, there is no general emergency for soils resources as the predominant wildfire effects are within the natural range of variability for forests of this region. However, downstream effects of erosion and slope destabilization may be considerable. Runoff generated soil erosion provides the materials for damaging debris flows and stormwater bulking.

Land treatments such as seeding and mulching are not proposed since most of the burned area that would be subject to increased erosion and sediment delivery to drainages are either too expansive to treat in an economically viable manner given the identified values at risk, are untreatable due to steep terrain, or were not directly linked to values at risk, making treatments ineffective or unwarranted. Slopes less that 20 percent grade are not recommended for treatment as erosion rates are not typically high due to gentle slope gradients. Slopes steeper that 65 percent are too steep for treatments to be effective since seed and mulch would either wash, slough or blow off of treatment areas. Soils with significant surface rock (greater that 50 percent) are somewhat protected from erosion since much of the precipitation falls on rock surfaces rather than bare mineral soil, reducing particle detachment and transport. Soils that burned at low and moderate burn severity have either retained surface organic matter or reintroduced it through needle cast and leaf fall. Areas where rock outcrops occur would not erode or contribute sediment to drainages. Finally, much of the burned area (80,397 ac.) is in the Kalmiopsis Wilderness. Land treatments in wilderness areas are not generally recommended since they can disrupt natural ecosystem processes, which are the primary purpose of wilderness designation. Many areas that burned at low and moderate soil severity are already exhibiting some natural recovery through resprouting of woody vegetation and grasses. These areas are expected to recover to a more stable condition naturally within a relatively short timeframe (i.e. 1 to 3 years).

Based on an implied minimum commercial value of topsoil of [redacted] per cu. yd. and an average modeled sediment delivery rate of up to 46 tons per acre from areas subjected to moderate and high soil burn severity, the potential soil loss would amount to a loss of financial value of soil resources from a commercial use perspective of [redacted]. Clean fill dirt (i.e., earthy material that is free of rocks, wood and trash) is typically valued at approximately [redacted] per cu. yd. Based on these prices, the loss of economic value of soils resources would be [redacted].

Other Values at Risk Affected by Soil Erosion Processes

Offsite effects of soil erosion include sediment-laden runoff with higher bulk densities and therefore greater destructive power than clean water in stream systems. Eroded soil and associated destabilized hillslopes provide the materials for damaging debris flows and stream bulking, which represent hazards to areas downstream of the fire affected area. This means there is increased potential for adverse effects to facilities such as roads, campgrounds and other Forest Service infrastructure, degradation of stream water quality, and most importantly risk to human life, safety and property from potential flooding and debris flows. Post-wildfire effects to source water quality in the Chetco River could adversely affect the municipal water supply and associated treatment needs for the community of Brookings-Harbor. These threats tend to be site specific in nature, and identified threats (and potential solutions) arise from inter-disciplinary evaluation and assessment among BAER team specialists.

Suitable Timber Producing Soils

Suitability of soils for timber production was one factor considered during soils mapping of the Siskiyou National Forest. There are 19,925 acres identified as suitable timber producing soils within the Chetco Bar Fire burned area. Approximately 1,621 acres of suitable timber producing soils burned at high severity, 7,580 acres burned at moderate severity, 8,655 acres burned at low severity, and 2,070 acres remain unburned or burned at very low severity. Forest productivity will likely be compromised in areas that burned at moderate and high soil burn severity. These area will also remain sensitive to salvage-related disturbance since mineral soils are currently exposed.

1 RESOURCE CONDITION ASSESSMENT

1.1 GEOMORPHIC SETTING

The Chetco Bar Fire occurred over a large geographic area where significant variation in topography, vegetation, and climate occurs. Soils within the fire perimeter therefore represent a broad range of physical properties and characteristics. Additional information specific to watershed and stream channel conditions and processes is presented in the hydrology specialist report, and will therefore not be addressed in detail in this report.

Historic geomorphological processes are evident at some locations within the fire perimeter. Steep drainages have evidence of minor debris loading, where intense precipitation events have destabilized and transported hillslope material into ephemeral channels for subsequent in-channel mobilization. These processes may increase substantially following high severity wildfire (Parise and Cannon 2012). Debris may be mobilized by a variety of processes. For example, during and immediately after a fire, large amounts of sediment can be released that had accumulated over time behind trees and other woody vegetation (Rice, 1982), resulting in pulses of sediment being delivered to ephemeral channels (Florsheim et al., 1991; Wells, 1985).

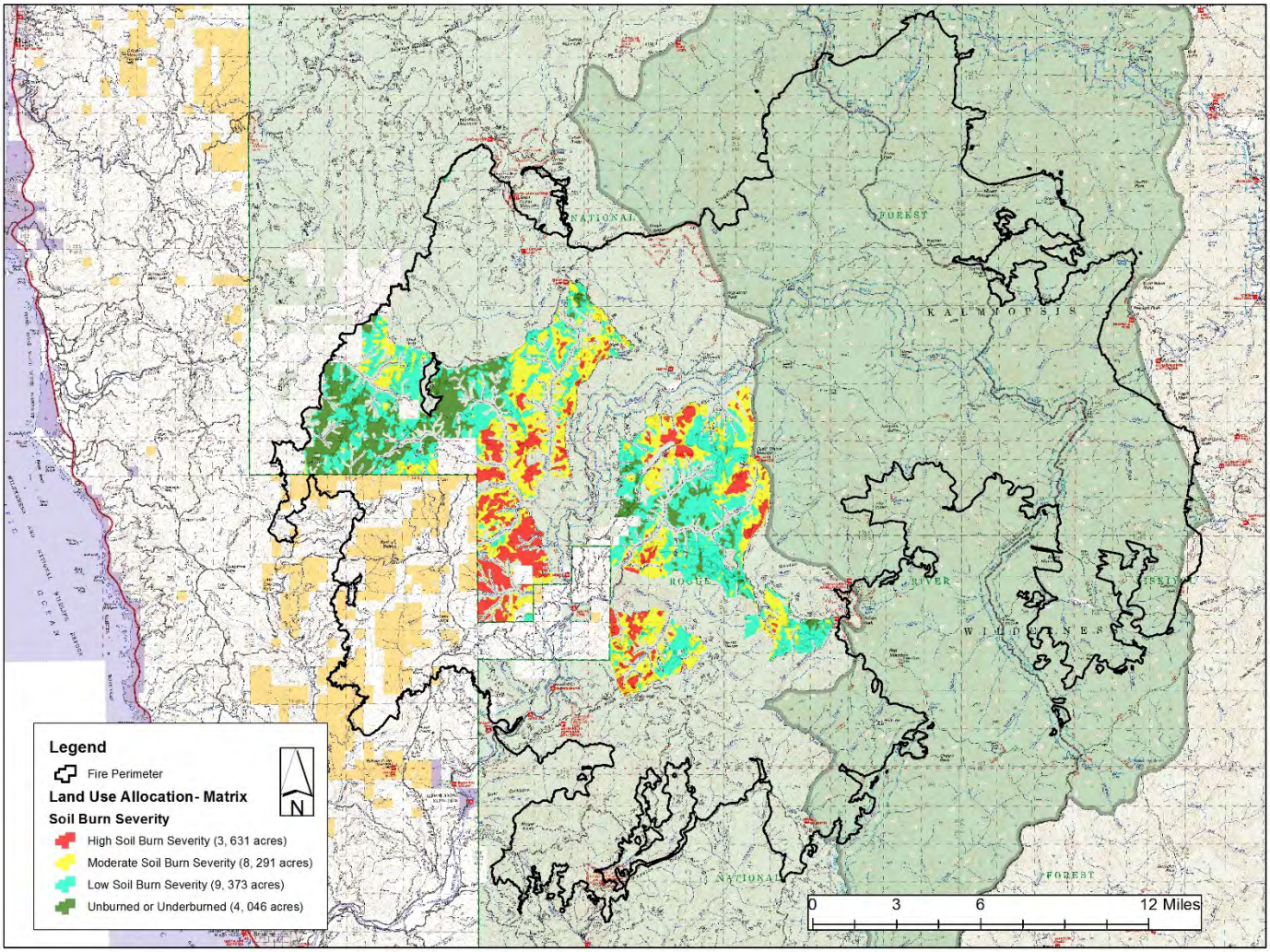

Figure 2. Soil burn severities in relation to Matrix Lands.

In poorly cohesive soils with low shear strength such as those found in some parts of the burned area, landslides may be initiated (Gabet 2003). Most debris flows from burned watersheds result from runoff

processes (DeGraff 2012, Cannon et al. 2001, Gartner et al. 2008). Therefore, post-fire erosion and associated debris flows are likely a common natural process of geomorphic evolution in the burned area with potential for short-term consequences to proximal infrastructure, such as roads, culverts and recreational areas. Some slopes that have previously eroded as a result of historic wildfire occurrence (i.e. Biscuit Fire of 2002) now pose reduced erosion risk in relation to areas that have not had recent wildfire activity; however many areas within the fire perimeter have loamy soil textures with weak cohesive properties, making them very erodible and capable of producing high erosion rates. Absence of soil cover in these areas will produce significant erosion and sediment delivery to stream channels.

1.2 SOILS INVENTORY

Soil coverage was obtained from the Soil Resource Inventory of the Siskiyou National Forest (Meyer and Amaranthus 1979). Soil map units and their taxonomic classifications, characteristics, and associated acreages are summarized in Appendix A and displayed geographically in Figure 3.

Soils range from very shallow to deep, with most soils being moderately deep, depending on landscape position and geologic types. Parent materials include fractured and sheared sedimentary rocks such as mudstone and sandstone, intrusive ultramafic rocks, and marine sedimentary rocks of the Dothan formation. A large portion of the burned area consists of ultramafic rocks and soils. These soils generally have low permeability and low storage capacity, with rapid runoff. In general, soils at higher elevations are characterized by steep slopes and high surface and soil profile rock content. Soils that support timber production are best characterized as deep, loamy soils and have high organic matter content and therefore serve as effective sinks for atmospheric carbon. Soils on northern aspects tend to be deeper and more productive due to higher moisture content while soils on south facing slopes tend to have lower nutrient status and organic matter content due to slightly drier conditions.

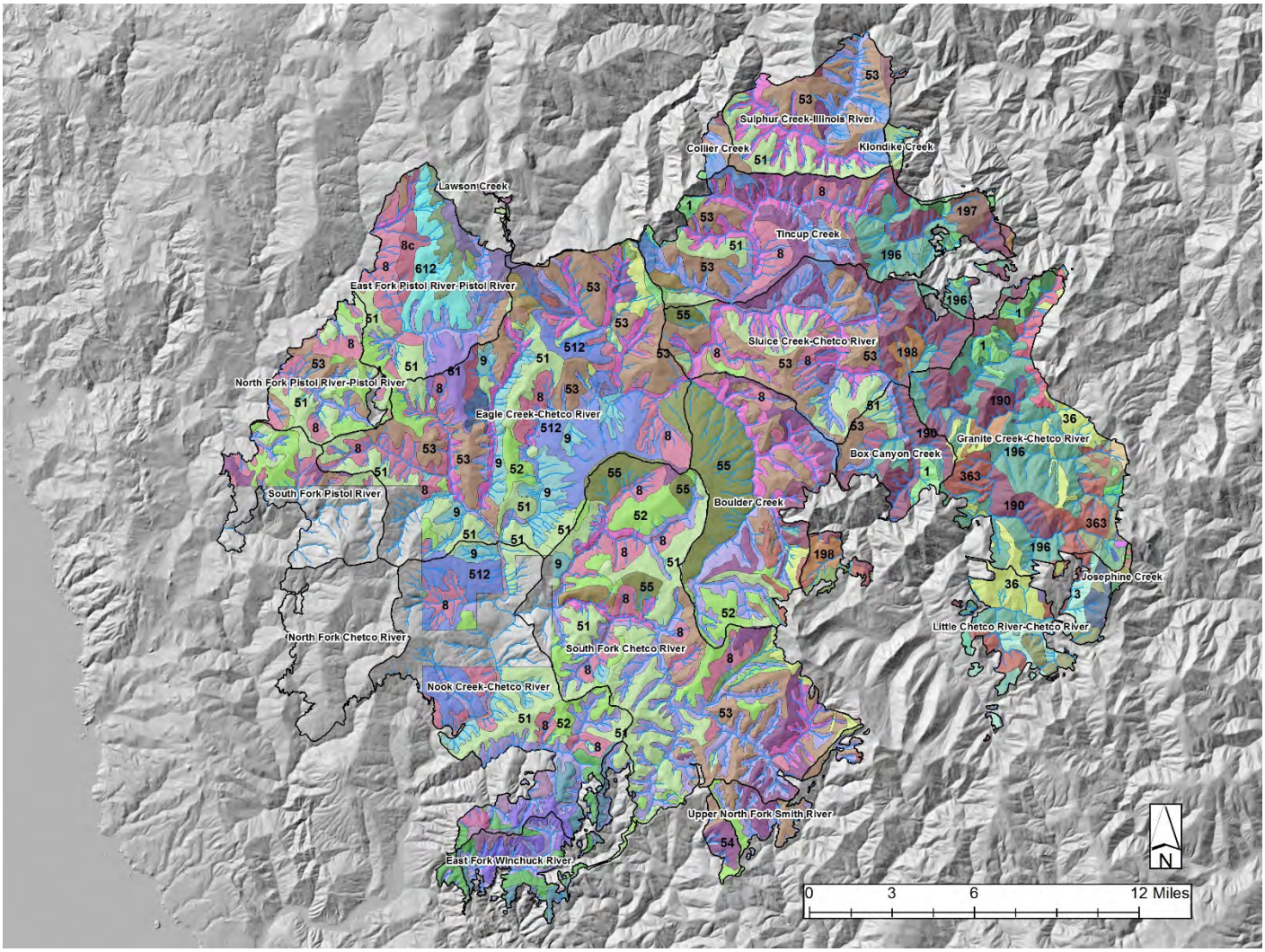

Figure 3. Soils map of the Chetco Bar Fire burned area.

Hydrologic Soil Groups

Soil surveyors delineate soil map units into components and larger map units according to their climate, geology, soils, and potential natural vegetation. Components with similar appearance and attributes are grouped into map units. Map units with a single component are called consociations and those with two or more components are referred to as complexes if the associated components are too intermingled or small to be shown at the designated map scale, typically 1:24000, or they are mapped as associations if the components can be shown separately but use and management does not justify separation. Most of the soils within the Chetco Bar Fire were mapped as associations and complexes. For this reason, some map units have two hydrologic soil groups. For the purpose of this analysis, each map unit component of associations and complexes with multiple soil taxa are assumed to each comprise 50 percent of the overall map unit. The areal extent of hydrologic soil groups are shown in Figure 4 below.

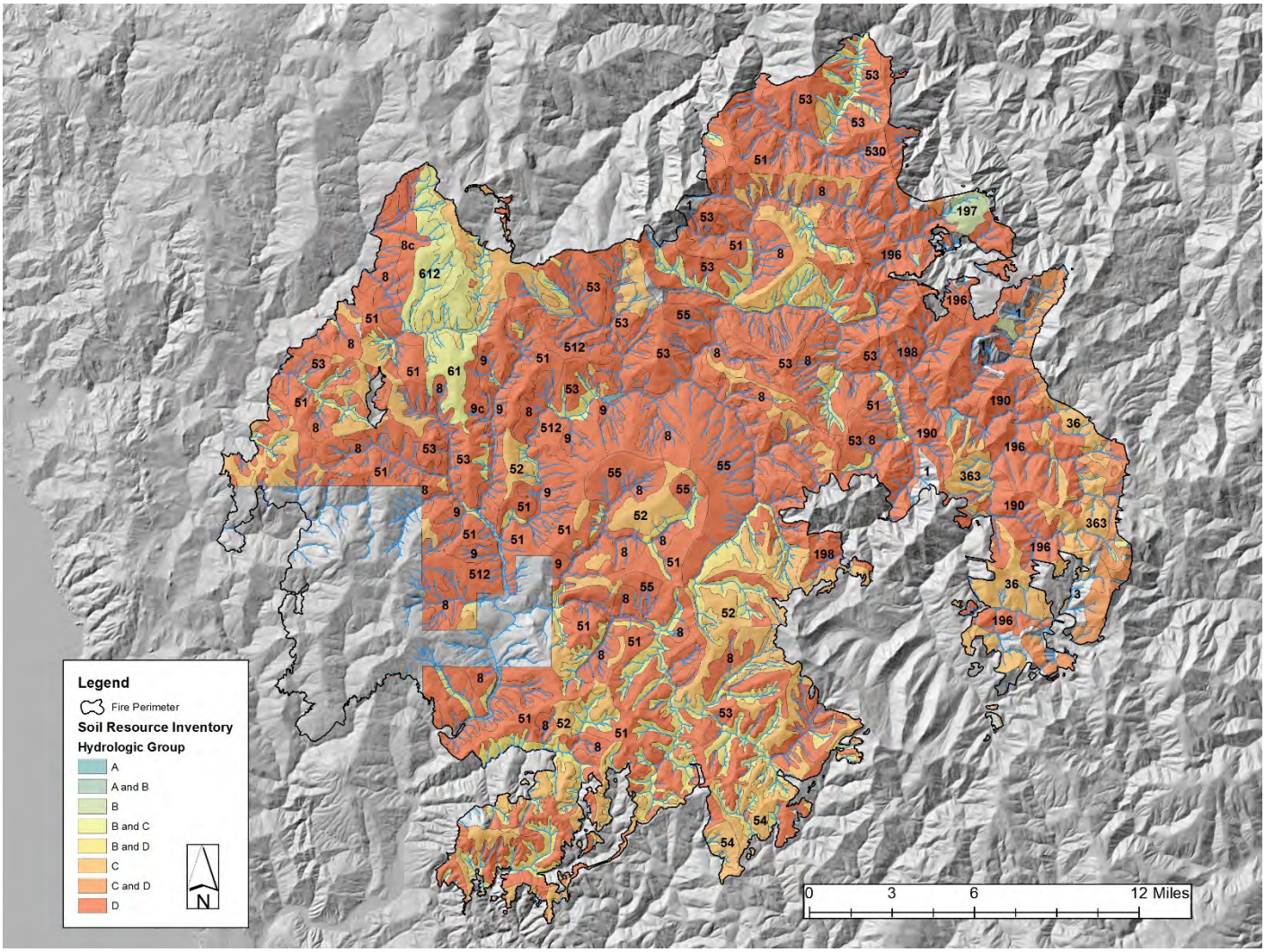

Figure 4. Hydrologic soil groups within the Chetco Bar Fire.

Table 1. Hydrologic soil group acreages and percentages in the Chetco Bar Fire.

Hydrologic Soil Group	Acreage	Percent
A	2,151.65	1.0
B	22,179.93	11.6
C	122,048.65	63.8
C and D	19.01	<1
D	3,962.60	20.5
Not Classified	5,539.29	2.9

Hydrologic Soil Groups are a useful index reflecting a soil's inherent potential for runoff and erosion. Soils in hydrologic group A have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. These soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. Soils in hydrologic group B have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. These soils typically have between 10 percent and 20 percent

clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. Soils in hydrologic group C have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. Soils in Group D have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters (20 inches) and all soils with a water table.

Field investigations were prioritized using the preliminary soil burn severity map or 'BARC' (Burned Area Reflectance Classification) map and an initial assessment of values at risk. The BARC is based on the contrasts in near infrared (NIR) and mid infrared (MIR) reflectance between the pre-fire vegetated areas and post-fire denuded areas. Theoretically, the pre-fire condition has very high near infrared band values and very low mid infrared band values while post-fire imagery will have very low near infrared band values and very high mid infrared band values (see next section). BARC maps are produced by the USFS Remote Sensing Applications Center (RSAC) in Salt Lake City, Utah.

Surveys were conducted in order to verify the remotely sensed BARC data, soil map units and assess fire effects on soil hydrologic function, productivity, and erosion potential. Such effects include vegetative burn intensity, aspect, slope gradient, slope length and profile, soil cover, litter layer consumption, soil heating and char, soil structure, aggregate stability, texture, porosity, residual organic matter, fine root condition, and water repellency. Soil map unit data were combined with field observations to generate interpretations of fire effects on known (examined) soils, and extrapolate interpretations for areas that were not field-verified. Subsequent erosion hazard ratings and sediment production estimates were based in part on soil survey information and final field-verified burn severities.

1.3 SOIL BURN SEVERITY

Rapid assessment and mapping of soil burn severity is necessary to identify and prioritize areas having potential for flooding, erosion, debris flow initiation and landslides and areas where critical ecosystem values may be degraded as a result of the fire. This is accomplished, in part by creating a burn severity map that highlights the areas of high, moderate, and low burn severity. This map then serves as a key component in the subsequent runoff, erosion, sediment transport, debris flow and landslide hazard modeling and other Geographic Information System (GIS) analyses. The BARC data are used as a primary input into the development of the final burn severity map. The BARC map is a satellite-derived map of post-fire vegetation condition. The BARC map has four classes: high, moderate, low, and unburned. Revision of the BARC map is necessary to finalize the burn severity map reflecting field assessed and verified conditions augmented by aerial reconnaissance where applicable.

It is important to understand that this is a rapid assessment process. As such, the final burn severity map is not intended or expected to be perfectly accurate, but it is field-verified and revised as necessary to most accurately represent the size, complexity, and severity of the fire affected areas, given available time for completion. Given the size of the Chetco Bar fire, this map is expected to be approximately 80% accurate. This map is then evaluated in conjunction with other factors such as soil type, slope, hydrologic characteristics, and human and ecological resource values to determine if emergency conditions exist.

The magnitude and duration of potential fire effects may be generally inferred from the soil burn severity ratings. A low rating indicates short-term soil effects; these areas are generally not considered significant sources of accelerated runoff, erosion or sediment delivery to stream courses and do not constitute a potential fire-induced emergency. A high rating indicates rather severe and long-term effects to the capability of soils to recover above- and below-ground structure and function in forest and rangeland ecosystems such as: a) water balance (porosity, water retention, infiltration, percolation), b) nutrient dynamics (C:N ratios), c) support microbial communities, and d) provide suitable habitat for micro- and mesofauna. A moderate rating is intermediate.

Soil burn severity locations and associated acreages are important factors in determining erosion and sediment delivery rates, debris flow potential, and runoff volume predictions. The overall soil burn severity in the Chetco Bar Fire is 19 percent unburned/very low (36,027 ac.), 40 percent low (76,613 ac.), 34 percent moderate (64,545 ac.), and 7 percent high (14,012 ac.). Soils with low burn severity have retained surface structure and much of the organic matter. Surface organic layers are not completely consumed and are often still recognizable to species. Soil aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the intensity and duration of heat below the soil surface was not high enough to consume or char any underlying organic matter. The ground surface, including any exposed mineral soil, is generally brown or black (lightly charred), and the canopy and understory vegetation will likely appear "green." Fine roots of grasses and forbs remain viable and these plants are expected to recover rapidly when adequate moisture returns to the soil through precipitation or spring snowmelt. In low burn severity areas, plants continue to grow vigorously and resprout readily.

Moderate and high burn severity classes have evidence of greater soil heating in isolated patches; these areas have surficial char with light to moderate damage to soil structure, porosity, and roots. The most severely burned slopes occur on steep slopes at higher elevations where pre-fire vegetation density and fuels accumulations were high. Soil burn severity acres by subwatershed (i.e., hydrologic unit code 12) and their relative percentages are listed in Tables 2 through 4 and displayed geographically in Figure 5.

Table 2. Soil Burn Severity Acreages within Subwatersheds (HUC12).

Subwatershed	Unburned	Low	Moderate	High	Total
Boulder Creek	1,147.5	5,869.9	5,296.2	828.4	1,3142
Box Canyon Creek	457.7	1,978.0	2,585.7	194.2	5,215.6
Collier Creek	99.3	428.4	259.6	24.2	811.5
Eagle Creek- Chetco River	2,801.0	10,779.0	12,373.1	3,496.5	29,449.6
East Fork Pistol River- Pistol River	3,298.0	4,771.1	3,081.4	120.4	11,270.9
East Fork Winchuck River	1,751.2	1,753.3	889.9	223.1	4617.5
Granite Creek- Chetco River	1,377.0	3,627.2	10,123.2	451.0	15,578.4
Klondike Creek	269.8	314.2	122.1	6.0	712.1
Little Chetco River- Chetco River	742.2	1,457.5	2,957.0	35.4	5,192.1
Nook Creek- Chetco River	4,390.5	4,543.0	21,66.2	1,659.9	12,759.6
North Fork Pistol River- Pistol River	2,423.8	3,608.7	1,912.6	363.2	8,308.3
Sluice Creek- Chetco River	2729.6	6959.1	3881.8	713.2	14,283.7
South Fork Chetco River	4455.0	14235.7	6387.3	1405.5	26,483.5
South Fork Pistol River	1219.7	896.6	341.3	6.0	2,463.6
Sulphur Creek- Illinois River	1933.9	3041.3	2542.8	489.2	8,007.2
Tincup Creek	2411.5	7355.9	4297.2	1130.2	15,194.8
Upper North Fork Smith River	388.4	1312.8	474.7	4.8	2,180.7

Table 3. Overall Soil Burn Severity Percentages within Subwatersheds (HUC12).

Subwatershed	Unburned	Low	Moderate	High	Total
Boulder Creek	8	42	38	6	94
Box Canyon Creek	5	21	27	2	55
Collier Creek	0	2	1	0	4
Eagle Creek- Chetco River	9	35	40	11	96
East Fork Pistol River- Pistol River	18	26	16	1	60
East Fork Winchuck River	7	7	4	1	19
Granite Creek- Chetco River	7	17	48	2	74
Klondike Creek	3	3	1	0	7
Little Chetco River- Chetco River	3	6	13	0	22
Nook Creek- Chetco River	15	16	7	6	44
North Fork Pistol River- Pistol River	9	14	7	1	32
Sluice Creek- Chetco River	14	36	20	4	74
South Fork Chetco River	15	49	22	5	92
South Fork Pistol River	4	3	1	0	9
Sulphur Creek- Illinois River	12	19	16	3	49
Tincup Creek	11	33	19	5	68
Upper North Fork Smith River	2	7	3	0	12

Table 4. Soil Burn Severity Percentages within Burned Areas of NFS Portions of Subwatersheds.

Subwatershed	Unburned	Low	Moderate	High
Boulder Creek	9	45	40	6
Box Canyon Creek	9	38	50	4
Collier Creek	12	53	32	3
Eagle Creek- Chetco River	10	37	42	12
East Fork Pistol River- Pistol River	29	42	27	1
East Fork Winchuck River	38	38	19	5
Granite Creek- Chetco River	9	23	65	3
Klondike Creek	38	44	17	1
Little Chetco River- Chetco River	14	28	57	1
Nook Creek- Chetco River	34	36	17	13
North Fork Pistol River- Pistol River	29	43	23	4
Sluice Creek- Chetco River	19	49	27	5
South Fork Chetco River	17	54	24	5
South Fork Pistol River	50	36	14	0
Sulphur Creek- Illinois River	24	38	32	6
Tincup Creek	16	48	28	7
Upper North Fork Smith River	18	60	22	0

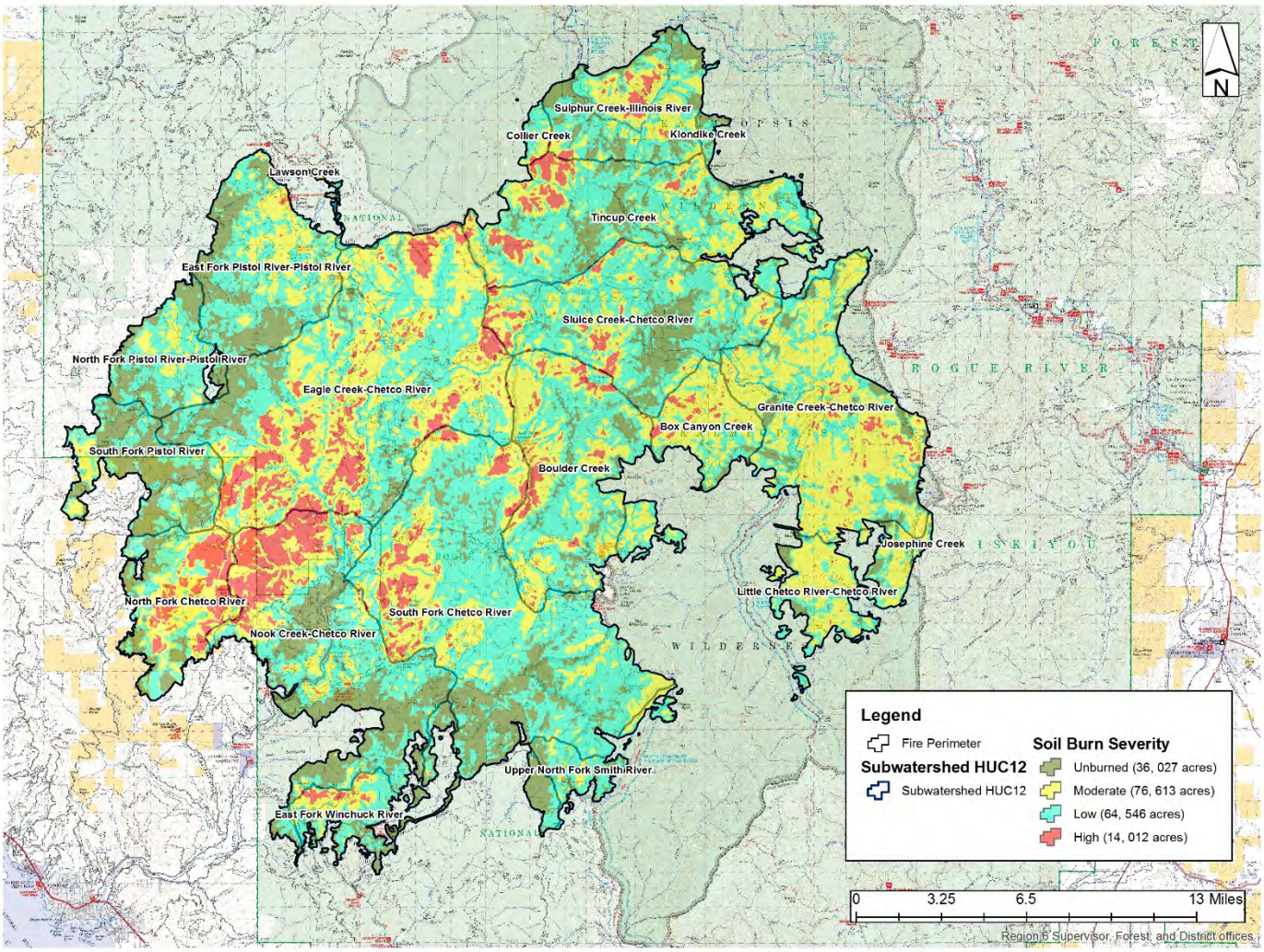

Figure 5. Soil burn severity by subwatershed in the Chetco Bar Fire.

1.4 SOIL HYDROPHOBICITY (WATER REPELLANCY)

Hydrophobic, or water repellant soils are present throughout the fire area, including some unburned areas, but were prevalent in areas impacted by high-severity fire conditions. Repellency in unburned areas is primarily due to the production of organic acids during decomposition of organic matter and other waxy root and fungal exudates, particularly apparent when soils are very dry. Fire-induced hydrophobic conditions are caused by organic matter that is vaporized followed by condensation of long-chain organic molecules onto soil surfaces and into soil profiles when vapors cool. Factors that influence the extent and level of soil hydrophobic conditions include: soil texture, pre-fire organic matter content, soil moisture, rock (coarse fragment) content, and the duration and intensity of soil heating.

High intensity or prolonged duration of soil heating can, in some cases eliminate soil hydrophobic conditions that would occur at slightly lower temperatures through complete volatilization of soil organic compounds. Fire-induced water repellency has the potential to significantly reduce water infiltration and increase runoff and erosion.

Hydrophobic soil conditions were observed under all soil burn severities and under unburned conditions. Since nearly all sampled sites had medium to strong soil hydrophobic conditions, the assumption was made

that most soils within the burned area exhibited drought-induced hydrophobic tendencies before the fire occurred. Figure 6 displays hydrophobic soil conditions on a moderate soil burn severity.

Figure 6. Strong hydrophobic soil conditions on a site that exhibits moderate soil burn severity.

1.5 SOIL EROSION HAZARD RATING

In order to assess the potential risk of accelerated soil erosion, erosion hazard ratings have been applied to soils within the fire affected area. Erosion hazard ratings are designed to assist land managers with assessment of the relative risk of accelerated sheet and rill erosion associated with soil disturbances that result in removal of effective ground cover (vegetation, litter, and surface rock). Erosion hazard is the probability that damage will occur as a result of exposure of mineral soil. A rating of slight indicates that no particular prevention measures are needed under ordinary conditions. A rating of moderate indicates that erosion-control measures are needed to prevent excessive erosion. A rating of severe indicates that special precautions are needed to control excessive erosion following soil disturbance that results in removal of ground cover. Erosion hazard ratings are based on evaluations of several soil factors including soil texture, depth, infiltration rates, permeability, effective ground cover (vegetation, litter, and surface rocks), slope gradient, and climate.

Soil erosion hazard rating acreages were calculated for each watershed, with soil burn severity as a factor in the rating. Ratings therefore represent a summary of soil erodibility as affected by slope gradient, effective ground cover (or lack thereof), and reduced infiltration due to water repellency. Approximately 2 percent of the soils within the Chetco Bar Fire have low erosion hazard, 14 percent have moderate erosion hazard, and 12 percent have moderate to high erosion hazard and 46 percent have severe erosion hazard, 13 percent have severe to very severe erosion hazard, and 13 percent have very severe erosion hazard. A summary of erosion hazard rating acreages by subwatershed are presented in Table 5. The soil erosion hazard rating map is included in Figure 6.

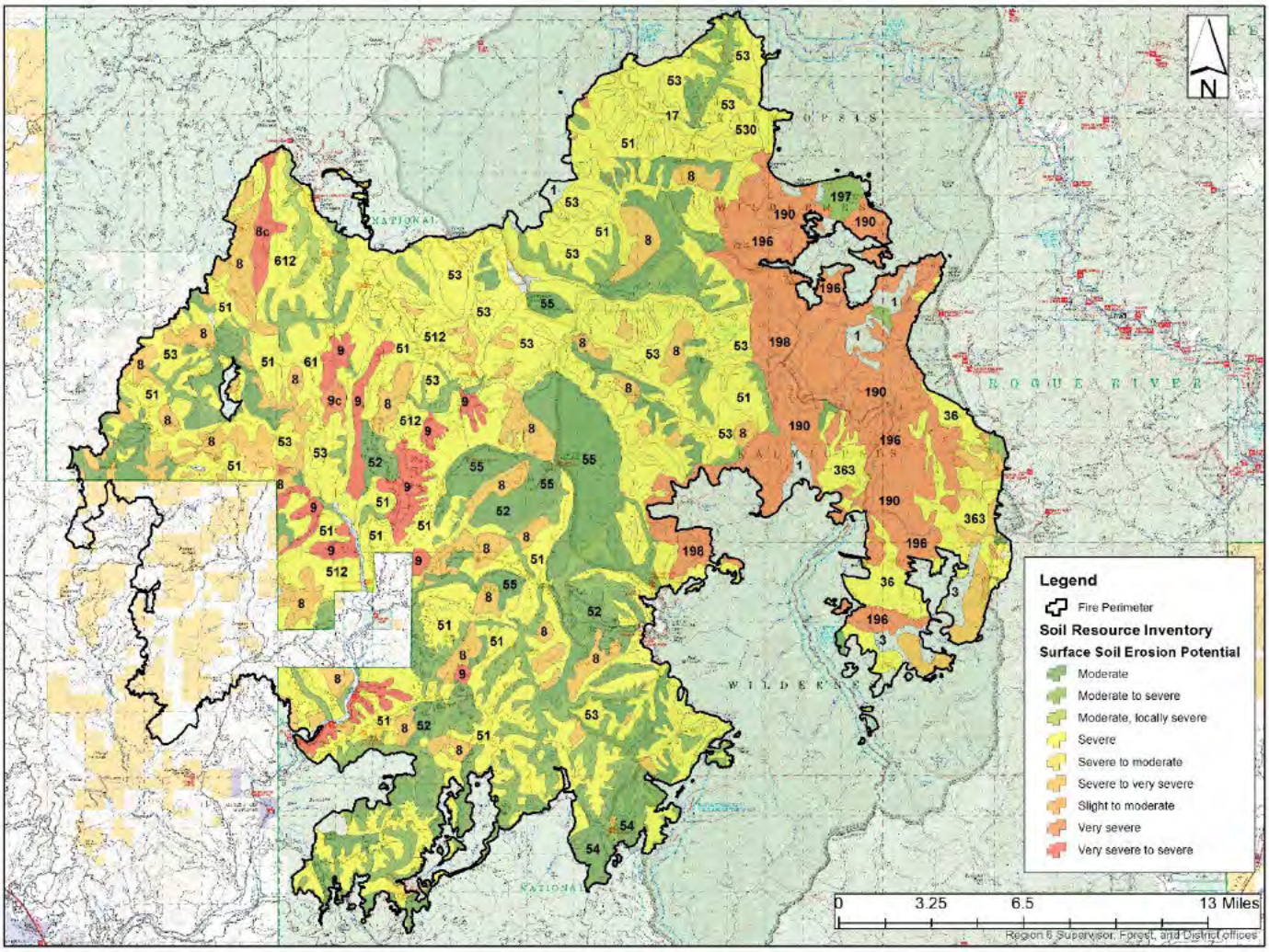

Figure 7. Surface Soil Erosion Potential map for the Chetco Bar Fire.

Table 5. Soil Erosion Hazard Rating Acreages for Subwatersheds within the Chetco Bar Fire.

Subwatershed	NA	Low	Moderate	Moderate to Severe	Severe	Severe to Very Severe	Very Severe
Boulder Creek	7	0	5,795	1, 819	4, 523	362	645
Box Canyon Creek	341	0	0	289	1, 367	190	3, 051
Collier Creek	41	0	0	86	632	16	51
Eagle Creek- Chetco River	201	0	2, 122	1, 026	18, 078	7, 702	323
East Fork Pistol River- Pistol River	0	0	1, 026	2, 026	5, 554	2, 427	0
East Fork Winchuck River	0	0	1, 485	1, 269	1, 913	2	0
Granite Creek- Chetco River	857	0	182	269	4, 233	770	10, 156
Josephine Creek	21	0	0	15	170	2	0
Klondike Creek	108	0	0	12	397	0	207

Subwatershed	NA	Low	Moderate	Moderate to Severe	Severe	Severe to Very Severe	Very Severe
Lawson Creek	0	0	0	0	0	0	0
Little Chetco River-Chetco River	1, 189	0	78	2	2, 053	1, 240	684
Nook Creek- Chetco River	482	0	1, 680	2, 155	5, 853	2, 861	0
North Fork Pistol River- Pistol River	26	0	750	556	2, 423	1, 229	0
Sluice Creek- Chetco River	0	0	1, 212	1, 482	7, 425	860	3, 307
South Fork Chetco River	9	0	5, 994	5, 449	11, 214	3, 837	0
South Fork Pistol River	21	0	1, 027	152	660	609	0
Sulphur Creek-Illinois River	0	0	183	997	6, 841	0	0
Tincup Creek	712	0	1, 710	1, 785	5, 467	1, 205	4, 359
Upper North Fork Smith River	7	0	692	684	793	28	0
Total (acres)	**4, 022**	**0**	**23, 936**	**20, 073**	**79, 596**	**23, 340**	**22, 783**

1.6 ESTIMATED EROSION RESPONSE

Approximately 191,197 acres are within the fire perimeter, of which approximately 155,170 acres or 81% has burned. Accelerated runoff and erosion are to be expected throughout much of the fire area, depending on burn severity, slope, and the amount of precipitation that occurs within a given watershed. Occurrence of landslides and debris flows are also possible. Soil hydrophobicity observed in burned areas is significant, but should not be overemphasized in light of the amount of hydrophobic soils and slightly hydrophobic soils that are found in unburned areas. Hydrologic soil groups are a useful indicator of potential for generation of runoff and associated erosion.

Quantitative erosion values were estimated using the Erosion Risk Management Tool (ERMiT), a Water Erosion Prediction Project (WEPP) modeling application developed by the USFS Rocky Mountain Research Station (USFS, RMRS-GTR188, April 2007). This modeling tool was developed specifically for use with post-fire erosion modeling. The ERMiT model estimates only sheet and rill erosion, which occurs when rainfall exceeds infiltration rates, and stormwater runoff entrains surface soil particles. The model does not account for landslides, gully erosion, effects of roads, or hillslope ravel. Analyses and modeling of debris flow potential conducted by the USGS and hydrologic modeling should better account for channel processes in this setting and the totality of sediment delivery to streams, while ERMiT should better model sheet and rill erosion for assessing onsite soil impacts.

The ERMiT model refines soil erosion estimates by incorporating customized climate parameters that are initially based on readings from local weather stations.

All watersheds having NFS land within the fire perimeter were included in the analysis. ERMiT estimates were generated for each soil map unit and burn severity, and apportioned to watersheds on a per-acre basis. Model output is in tons per acre on a *storm event* basis, so these are not annual estimates. Accuracy of model output is estimated to be +/50%.

Actual soil erosion outcomes will depend upon what future near-term (generally 1 to 3 years) precipitation patterns bring in terms of rainfall amount and intensity. Erosion rates are estimated for a 2-year event which is common in this vicinity. A summary of 2-year (0.50 chance of recurrence) sediment delivery rates by subwatershed is presented in Table 6. The five-year (0.20 chance of recurrence) sediment delivery rates by subwatershed were also modeled and are presented in Table 7. This storm recurrence interval is not as common as the 2-year storm event, but it is reasonable to expect an event of this magnitude. Sediment delivery rates would decline each year as revegetation and natural recovery processes occur.

Table 6. Post-fire hillslope sediment delivery rates for subwatersheds (HUC12) in the Chetco Bar fire burned area based on a 2-year storm event.

Watershed	Sediment Delivery Rate (tons per acre)			
	Unburned	Low	Moderate	High
Boulder Creek	0.1	70.3	80.3	89.6
Box Canyon Creek	0.1	70.1	80.6	88.9
Collier Creek	0.9	81.7	93.2	101.9
Eagle Creek- Chetco River	0.1	66.4	74.6	82.2
East Fork Pistol River- Pistol River	0.1	69.8	78.1	84.6
East Fork Winchuck River	0.1	75.6	84.4	91.0
Granite Creek- Chetco River	0.1	51.8	62.3	71.0
Klondike Creek	0.1	72.9	85.2	93.4
Little Chetco River- Chetco River	0.1	51.7	62.5	71.6
Nook Creek- Chetco River	0.1	67.9	75.6	80.9
North Fork Pistol River- Pistol River	0.1	65.8	73.2	76.9
Sluice Creek- Chetco River	0.1	75.1	85.2	94.5
South Fork Chetco River	0.1	68.0	77.3	85.9
South Fork Pistol River	0.1	75.6	84.4	91.0
Sulphur Creek- Illinois River	0.1	86.6	97.3	106.9
Tincup Creek	0.1	72.6	84.1	94.0
Upper North Fork Smith River	0.1	59.7	68.3	76.0
Acres	**36,027**	**76,613**	**64,545**	**14,012**

Table 7. Post-fire hillslope sediment delivery rates for subwatersheds (HUC12) in the Chetco Bar fire burned area based on a 5-year storm event.

Watershed	Sediment Delivery Rate (tons per acre)			
	Unburned	Low	Moderate	High
Boulder Creek	0.9	47.8	56.0	63.3
Box Canyon Creek	1.2	47.4	55.0	61.9
Collier Creek	1.4	475.8	554.8	624.0
Eagle Creek- Chetco River	1	38.0	42.8	47.0
East Fork Pistol River- Pistol River	1.2	46.0	52.5	57.4
East Fork Winchuck River	1.3	50.2	56.3	62.0

Watershed	Sediment Delivery Rate (tons per acre)			
	Unburned	Low	Moderate	High
Granite Creek- Chetco River	1.1	35.8	43.7	50.1
Klondike Creek	1.1	47.5	55.4	64.1
Little Chetco River- Chetco River	1.1	34.9	42.7	52.3
Nook Creek- Chetco River	1.3	45.8	50.5	55.0
North Fork Pistol River- Pistol River	1.1	55.1	61.7	68.2
Sluice Creek- Chetco River	0.9	50.7	59.0	66.2
South Fork Chetco River	1.4	46.2	53.5	59.8
South Fork Pistol River	1.2	50.2	56.3	62.0
Sulphur Creek- Illinois River	1.3	57.6	65.8	73.7
Tincup Creek	1	49.8	58.2	66.5
Upper North Fork Smith River	1.1	42.0	47.7	53.4
Acres	**36,027**	**76,613**	**64,545**	**14,012**

Sediment delivery rates by subwatershed and SRI map unit are presented in Appendix B.

Based on sediment delivery rates in Table 7 (5-year event), average sediment delivery is expected to be approximately 45.9 tons per acre across the entire Chetco Bar fire burned area. Total average sediment delivery across the burned area is estimated to exceed 7,928,321.40 tons. Maximum sediment delivery rate modeled was 96.8 tons per acre.

Overall ERMiT estimated pre-fire sediment delivery rates are approximately 1.2 tons per acre. This is primarily due to the high surface organic matter content (i.e., forest litter) that protects soil surfaces from rainsplash, soil particle detachment and transport in surface runoff. Other factors that affect the amount of eroded soil delivered to stream systems as sediment include soil texture, proximity to the stream channel, stream channel density, basin area, slope percent, slope length, land use/land cover, and rainfall-runoff factors. In general, coarser textured soils have greater chance of being deposited or captured on hillslopes.

Table 8. Estimated sediment yield (tons) for the Chetco River watershed within the Chetco Bar Fire for the 2 and 5 year storm event.

Subwatershed	Total 5 Year Untreated (tons)	Total 5 Year Treated (tons)	Total 2 Year Untreated (tons)	Total 2 Year Treated (tons)
Boulder Creek	3,560,123	1,685,714	2,556,203	1,077,010
Box Canyon Creek	1,132,323	505,911	807,887	341,108
Eagle Creek	8,372,749	4,408,130	5,466,156	2,643,327
Granite Creek	3,147,772	1,278,853	2,279,788	885,279
Little Chetco River	1,008,752	413,600	680,581	257,694
Nook Creek	3,939,923	2,059,935	2,444,837	1,171,672
North Fork Chetco River	800,535	438,487	443,509	246,118
Sluice Creek	3,909,060	1,881,550	2,692,702	1,199,906
South Fork Chetco River	7,653,951	3,869,145	5,056,866	2,337,396
Tincup Creek	3,479,173	1,657,137	2,456,007	1,087,305
Total (tons)	**37,044,360**	**17,760,035**	**22,439,700**	**11,000,699**

2 EMERGENCY DETERMINATION

2.1 VALUES AT RISK – THREATS TO SOIL PRODUCTIVITY AND HYDROLOGIC FUNCTION

Threats to soil productivity and hydrologic function in fire affected areas were assessed by evaluating soil burn severity, erosion hazard, modeling of post-burn erosion rates, and other soil and site-specific conditions. The combination of loamy-textured soils, steep slopes, and lack of soil cover (vegetation and litter) will result in considerable watershed response in the form of accelerated erosion by both water and wind energy, including increased potential for localized debris flows, the degree of which depend upon localized fire effects, the intensity and duration of the precipitation and runoff events, and rates of natural vegetative recovery.

Soil productivity is considered a critical value under Forest Service BAER policy.

The table below is used for determining magnitude of consequences and probability of damage to soil productivity. The table is used in the context of soil resilience and burn severity/soil development under *natural disturbance regimes* and is used only to evaluate risks associated with effects that are outside of natural range of variability. **Unacceptable risks to soil productivity are those associated with <u>very high</u> risks only.**

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
	RISK		
Very Likely	Very High	Very High	Low
Likely	Very High	High	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

Probability of Damage or Loss: The following descriptions provide a framework to estimate the relative probability that damage would occur within 3 years:

- Very likely. Nearly certain occurrence (90% - 100%)
- Likely. Likely occurrence (50% - 89%)
- Possible. Possible occurrence (10% - 49%)
- Unlikely. Unlikely occurrence (0% - 9%)

Magnitude of Consequences:

- Major - Predicted post-fire erosion rates will result in significant changes in soil functions such that the area:
  A. Will not support potential natural vegetation, pre-fire vegetation or will result in a state change as described in an Ecological Site Description or;
  B. Will no longer provide the soil-dependent ecosystem services established in a Forest Plan (e.g. timber production, big-game winter range).

  Significant = across large contiguous areas and >15% of soil map unit

Based on the BAER risk assessment above, the overall risk determination for soils resources is:

Probability of damage or loss: **Likely**
Magnitude of consequences: **Moderate**

This places soils resources in the risk category of **High**.

Reasons for this determination are as follows:

- Overall, approximately 14,012 acres burned at high soil burn severity and 64,545 acres burned at moderate soil burn severity. Considerable soil loss is anticipated. The soil that is lost (i.e., A horizon) is the most productive layer of the soil and serves a variety of critical ecosystem functions including habitat for micro and meso fauna, organic carbon sequestration, water holding capacity and nutrient cycling. These processes will be altered for a long time in areas of moderate and high soil burn severity. If eroded, these soils will never return to the same condition as they currently exist – even if they eventually support similar vegetative communities in the future.
- There are 19,925 acres of suitable timberland within the fire perimeter (10% of the burned area). Approximately 1,621 of these acres burned at high soil burn severity and 7,580 acres burned at moderate soil burn severity. It is unlikely these acres will be adequately restocked with desirible tree species within 5 years following this fire, so these soils are not likely to return to timber suitability for 5 or more years.

- There's been substantial loss of carbon storage (i.e., significant carbon oxidation and transformations of cellulose, hemicellulose, lignins and lipids in A horizons) from soils that exhibit high and moderate soil burn severities. Organic carbon serves as the long term nutrient supply for vegetation and microfauna. Soil pH has increased due to soil heating in moderate and high soil burn severities that results in denaturation of organic acids. It is reasonable to expect soil temperatures to remain somewhat higher than pre-fire conditions due to increased solar insolation, exacerbating reforestation success. Oxidation of organic carbon has also reduced water holding capacity, increased soil bulk densities and reduced soil porosities, further adversely affecting forest regeneration success and reducing soil microfaunal habitat.
- The risk of slope failure has increased in some areas of high burn severity. If landslides or slope failures do occur, these areas will exhibit a state change since they will not longer support their pre-fire vegetation communities.

The risk to soils resources does not meet the criteria for a determination of Very High for the following reasons:

- Fire is a natural disturbance regime in these forest cover types. Although soil burn severities are high in many areas, these conditions are not beyond the natural range of variation for this forest type.
- Although it will take significant time (i.e., est. in excess of 100 years or more in some areas) for similar forest cover to become sufficiently reestablished at pre-fire maturities and stocking levels, most soils under all burn severities are expected to eventally support a similar potential natural vegetation type in the future (i.e., there is no state change / ecological thresholds have not been exceeded).
- Although perhaps not in the near-term, soils are expected to continue to provide soil-dependent ecosystem services established in the Rogue River - Siskiyou National Forest Land Management Plan and the Northwest Forest Plan.

Probability of permanent damage or loss of soil pedogenic processes and productivity

Onsite fire effects include physical, chemical, and biological changes to soils caused directly by soil heating that damages soil structure, porosity, aggregate stability, and oxidizes nutrients, particularly organic carbon. Indirect effects include subsequent soil loss through wind and water erosion caused by loss of soil cover and decreased soil productivity and hydrologic function. Loss of soil nutrients and microbial communities may be expected, with these adverse effects increasing by soil burn severity class. These conditions result in short-term degradation of ecosystem function. However, most soils in fire affected areas exhibit low to moderate burn severity. Therefore, effects of the fire upon soil productivity and hydrologic function are considered within the 'natural' range of variability at most locations.

Given the slopes, soil properties (loamy textured, with moderate percentages of gravel and rock), and geological characteristics (colluviation) there is little in the way of land treatments that can be done to prevent soil erosion and debris flow initiation, even if funding were unlimited. The summary determination is therefore *no emergency* for the majority of soils resources within the burned area. Fire-induced changes to vegetative communities could represent a long-term threat to the soils resource if changes to historic levels of soil vegetative and litter cover and root-soil interactions were a consequence shifts in plant species assemblages; these conditions are expected to be unlikely, but are outside the scope and time scale of BAER analysis.

The BAER Program requires that proposed treatments must be proven effective, technically feasible, justified by the values at risk, of a magnitude to make a meaningful difference to the resources, and natural recovery must be deemed inadequate. Soils in the burned area have relatively high biological activity with rapid vegetative response within 5 years following wildfires, particularly when storm intensities are light to moderate, soil particle detachment and transport does not occur as a result of wind or rain, and adequate amount and temporal distribution of precipitation occurs to maintain soil moisture to facilitate vegetation reestablishment.

Without an emergency determination, no treatments are proposed for the primary objective of soil stabilization without other collateral 'point' values at risk. There are no other identified Values at Risk downslope of soils resources that justify the cost of land treatments such as mulching and seeding.

Land Treatment Feasibility Analysis

The following criteria were considered during the evaluation of the feasibility of implementing hillslope stabilization treatments such as seeding or mulching:

- Soil burn severities of unburned, low, and moderate do not require treatment as they have not lost critical soil functions and are expected to recover within 1 to 2 years. Surface organic matter is sufficient to provide protective soil cover. Natural revegetation is already occurring on most of these soils through resprouting of woody plants, grasses and ferns.
- Slopes greater than 75% and less than 20% not considered for BAER treatments. This is because mulch is not effective on slopes greater than 75% since the material can be carried off site in runoff or high winds. Slopes less than 20% have gentle angles of repose, so do not contribute significant sources of sediment or have erosion rates that typically result in loss of critical soil functions.
- Soil with substantial surface rock components are not considered for treatment since surface rock fragments provide protective soil cover that intercepts raindrops and gently releases water onto the mineral soil. This prevents particle detachment and entrainment in runoff.
- Rock outcrops are not considered suitable for treatment since they do not substantially erode or contribute large amounts of sediment to drainages. These areas support minimal vegetative cover.
- Slope gradients between 20% and 60%, with moderate and high soil burn severities, and less than 50% rock fragments were reviewed for potential mulch treatment. These areas were so expansive that land treatments would not be feasible to effectively mitigate erosion and sediment delivery at the watershed scale.
- Slope gradients between 60 to 75% with moderate and high soil burn severities, and less than 50% rock fragments were reviewed for potential mulch treatment using wood shreds or strands. There were no Values at Risk below these areas that warranted the expense (minimum $2,000 per acre) of mulching using wood shreds or strands.
- Four of the subwatersheds within the burned area were reviewed for potential mulch treatment. These included Eagle Creek, Nook Creek, Sluice Creek, and East Fork Winchuck River. The risk to soils resources in these four subwatersheds does meet the criteria for a determination of Very High risk. However, treatments were estimated to have a 50% effectiveness and were therefore not recommended for funding.

3 RECOMMENDATIONS

3.1 Point Protection and Stabilization

While no land treatments specifically intended to protect soil resources at the landscape-scale are recommended, several protection measures have been proposed that protect human life and safety and

Forest Service and other downstream resources from flooding, debris flow and accelerated erosion. Most of the proposed protection measures are intended to protect human life and safety through area closures and prevent roads and other infrastructure downstream of fire affected areas from becoming damaged during rainfall-runoff events. Protection measures such as closure of the fire perimeter from public access, road hardening measures (replacing culverts, reestablishing ditches and installing grade control structures) have been recommended.

3.2 Storm Patrol and Monitoring

Storm patrols will be an important component in the effort to mitigate post-fire effects. Frequent and systematic storm patrols allow detection of adverse effects to Values at Risk and provide opportunity to mitigate post-fire effects before damage becomes irreversible.

Where point protection measures are implemented, monitoring of treatment effectiveness is recommended. Treatment monitoring provides assurance that BAER treatments were properly implemented, contract specifications were met and treatments remain effective for their designed purpose.

3.3 Fireline

Construction of firelines was a necessary part of fire suppression operations. Suppression repair such as construction of waterbars to limit sediment movement downslope has been completed. However, suppression repair can have variable outcomes. Firelines are susceptible to both surface erosion and gullying, and can take as long as 5-7 years to naturally revegetate. Eroding firelines may become chronic sources of sediment delivery to surface waters for a longer time period than hillslopes burned at low severity.

It is recommended that firelines be further evaluated in 2018 to detect any additional repair needs and/or longer term rehabilitation needs. Erosion control structures should be maintained using best management practices for reducing cumulative watershed effects.

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Appendix A
Soils Resource Inventory Information of the Chetco Bar Fire Burned Area

Table 1. Soil Resource Inventory map units and taxonomic classifications of soils that occur in the Chetco Bar Fire.

SRI Map Unit	Taxonomic Classifications	Acres
0	NA – Riverwash	323
1	NA – Rock outcrop	2, 074
2	NA – Rock outcrop	29
3	NA – Rock outcrop	1, 223
4	NA – Landflow and landslumps on or derived from metamorphic and sedimentary rocks	139
5	NA – Landflow and landslumps on or derived from serpentine and peridotite	116
6	NA – Wet meadow lands	5
7	NA – Dry non-forested areas	29
8	NA – Landflow and landslumps on or derived from sedimentary rocks	15, 652
8c	NA – Landflow and landslumps on or derived from schists of the Colbrooke schists formation – slightly more unstable and erosive than Landtype 8.	1, 018
9	NA – Landflow and landslumps on or derived from sedimentary rocks	4, 611
9c	NA – Landflow and landslumps on or derived from schists of the Colbrooke schists formation. Slightly more unstable and erosive than Landtype 9, and mass movements are generally larger.	323
13	Loamy skeletal, mixed, frigid, Entic Cryumbrepts	29
15	Loamy- skeletal, mixed, mesic, Ultic Haploxerolls	78
16u	NA	17
17	Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	11, 888
19	Loamy- skeletal, mixed, mesic, Typic Haplumbrepts	18, 434
31	Clayey-skeletal, serpentinitic, mesic, Typic Xerochrepts	9
36	Loamy-skeletal, serpentinitic, mesic, Dystric Eutrochrepts	4, 095
37	Loamy-skeletal, serpentinitic, mesic, Dystric Eutrochrepts	818
39	Loamy-skeletal, serpentinitic, mesic, Lithic Eutrochrepts	76
51	Loamy-skeletal, mixed mesic, Typic Eutrochrepts	21, 037
52	Fine-loam mixed, mesic, Typic Haplumbrepts	8, 212
53	Loamy-skeletal, mixed, mesic, Typic Eutrochrepts	20, 539
53u	NA	59

54	Loamy-skeletal, mixed, mesic, Typic Eutrochrepts	6, 549
55	Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	6, 306
61	Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	1, 240
62	Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	695
76u	NA	111
98	Fine-loamy, mixed, mesic, Ultic Haploxeralfs	108
170	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	497
171	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts; Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	1, 505
190	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	9, 936
191	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	292
195	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts; Loamy-skeletal, mixed, mesic, Umbric Dystrochrepts	755
196	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	9, 988
197	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	735
198	Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	1, 421
313	Clayey-skeletal, serpentinitic, mesic, Typic Xerochrepts	26
363	Loamy-skeletal, serpentinitic, mesic, Dystric Eutrochrepts	3, 640
367	Loamy-skeletal, serpentinitic, mesic, Dystric Eutrochrepts; Loamy-skeletal, serpentinitic, mesic, Dystric Eutrochrepts	1, 591
419[1]	Loamy- skeletal, mixed, mesic, Typic Haplumbrepts; Loamy-skeletal, mixed, mesic, Dystric Eutrochrepts	44
510	Loamy-skeletal, mixed mesic, Typic Eutrochrepts	969
512	Loamy-skeletal, mixed mesic, Typic Eutrochrepts; Fine-loam mixed, mesic, Typic Haplumbrepts	5, 670
516	Loamy-skeletal, mixed mesic, Typic Eutrochrepts; Coarse-loamy, mixed, mesic, Dystric Eutrochrepts	1, 504
519	Loamy-skeletal, mixed mesic, Typic Eutrochrepts; Loamy- skeletal, mixed, mesic, Typic Haplumbrepts	189
527	Loamy-skeletal, mixed mesic, Typic Eutrochrepts; Loamy- skeletal, mixed, mesic, Typic Haplumbrepts	1, 179
530 & 536	Loamy-skeletal, mixed, mesic, Typic Eutrochrepts	2, 276

[1] **41**- Associated with SRI map unit 419-Rhythmically bedded sandstones of the Umpqua Formation. West side of Klamath Mountains.

538	Loamy-skeletal, mixed, mesic, Typic Eutrochrepts; Coarse-loamy, mixed, mesic, Dystric Eutrochrepts	1, 272
549	Loamy-skeletal, mixed, mesic, Typic Eutrochrepts; Coarse-loamy, mixed, mesic, Dystric Eutrochrepts	614
612	Loamy-skeletal, mixed, mesic, Typic Haplumbrepts; Loamy-skeletal, mixed, mesic, Typic Haplumbrepts	2, 271
768	Loamy-skeletal, mixed, mesic, Ultic Haploxeralfs; Loamy-skeletal, mixed, mesic, Lithic Xerochrepts	54
768u	NA	334
778	Loamy-skeletal, mixed, mesic, Ultic Haploxeralfs; Loamy-skeletal, mixed, mesic, Typic Xerochrepts	48
Total		**172, 673**

Table 1. Soil characteristics within the Chetco Bar Fire.

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
0	Misc landtypes	NA	324	NA	NA	NA	Stable	NA	204	63	3
1	Misc landtypes	Witzel rock outcrops	2, 093	NA	NA	NA	Stable	NA	800	827	9
2	Misc landtypes	Witzel rock outcrops	50	NA	NA	NA	Stable	NA	6	12	0
3	Misc landtypes	Pearsoll extremely stony clay loam	1239	NA	NA	NA	Stable	NA	612	338	0
4	Misc landtypes	Pollard-Beekman gravelly loam complex	140	NA	NA	D	Unstable	Moderate to severe	14	93	5
5	Misc landtypes	Dubakella-Pearsoll gravelly loam complex	117	NA	NA	D	Unstable to Very Unstable	Severe	13	81	20
6	Misc landtypes	Bigelow gravelly loam	6	NA	NA	D	Stable	Slight to moderate	1	1	0
7	Misc landtypes	Woodseye-Craggy rock outcrops complex	29	NA	NA	B	Moderately Stable	Very severe to severe	7	23	0
8	Misc landtypes	NA	15, 669	NA	NA	D	Unstable to Very Unstable	Severe to very severe	6, 899	3, 591	1, 022

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
8c	Misc landtypes	NA	1, 018	NA	NA	D	Very Unstable to Unstable	Very severe to severe	602	272	2
9	Misc landtypes	NA	4, 613	NA	NA	D	Unstable to Very Unstable	Very severe to severe	2, 108	1, 533	608
9c	Misc landtypes	NA	323	NA	NA	D	Very Unstable to Unstable	Very severe	95	211	17
13	Deep soils, bedrock undifferentiated	Bigelow gravelly fine sandy loam	29	Extremely stony fine sandy loam	65	B and C	Moderately Stable	Slight to moderate	0	29	0
15	Deep soils, bedrock undifferentiated	Abegg gravelly loam	78	Loam	5	A	Moderately Stable	Moderate	58	2	0
16u	NA	Bigelow gravelly fine sandy loam	17	Very gravelly sandy loam	40	NA		NA	7	0	0
17	Deep soils, bedrock undifferentiated	NA	11, 962	Gravelly loam	30	D	Very Unstable	Severe	6, 530	2, 890	345
19	Deep soils, bedrock undifferentiated	NA	18, 503	Loam	30	B and D	Moderately Unstable to Unstable	Moderate to severe	9, 242	3, 781	412
31	Serpentine and peridotite East side of Klamath Mountains	Dubakella-Pearsoll gravelly loam complex	10	Clay loam	5	D	Moderately Stable	Severe to moderate	6	3	0
36	Serpentine and peridotite West side of Klamath Mountains	NA	4, 113	Cobbly loam	35	C	Moderately Stable to Moderately Unstable	Severe	992	2, 531	62
37	Serpentine and peridotite West side of Klamath Mountains	NA	826	Gravelly loam	45	C	Moderately Stable to Locally Stable	Severe	480	198	32
39	Serpentine and peridotite West side of Klamath Mountains	NA	78	Very gravelly clay loam	45	C	Moderately Stable	Moderate	45	17	0
51	Dothan Formation sediments and related volcanics West side of Klamath Mountains	Beekman gravelly loam	21, 043	Gravelly sandy loam	15	D	Moderately Stable to Moderately Unstable	Severe	8, 735	5, 403	1, 558
52	Dothan Formation sediments and related volcanics West side of Klamath Mountains	NA	8, 225	Gravelly loam	30	C	Moderately Unstable to Moderately Stable	Moderate	3, 701	2, 247	514
53	Dothan Formation sediments and related volcanics West side of	Beekman Colestine gravelly loam complex	21, 020	Silt loam	5	D	Moderately Stable	Severe	7, 788	7, 489	2, 639

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
	Klamath Mountains										
53u	NA	NA	61	Silt loam	5	D		NA	11	4	0
54	Dothan Formation sediments and related volcanics West side of Klamath Mountains	Beekman Colestine gravelly loam complex	6, 554	Silt loam	5	C	Moderately Stable to Moderately Unstable	Moderate	3, 700	1, 261	411
55	Dothan Formation sediments and related volcanics West side of Klamath Mountains	NA	6, 306	Gravelly loam	13	D	Moderately Unstable (locally unstable)	Moderate	2, 016	3, 252	771
61	Colebrooke Formation Schists West side of Klamath Mountains	NA	1, 240	Gravelly loam	25	B and C	Moderately Unstable	Severe	351	277	35
62	Colebrooke Formation Schists West side of Klamath Mountains	NA	697	Loam	5	A and B	Moderately Unstable to Unstable	Moderate, locally severe	154	481	6
76u	NA	NA	112	Gravelly loam	30	NA		NA	47	59	0
98	Gabbros with local diorites East side of Klamath Mountains and in the Siskiyou Mountains	Holland sandy loam	108	Loam	30	A and B	Moderately stable to Moderately Unstable	Moderate	22	77	0
170[2]	70% unit 176 and 30% unit 2	NA	497	176- Very gravelly sandy loam 2- See above	50	C and D	176- Moderately unstable to locally unstable 2-See above	176-Severe to very severe 2- See above	101	381	2
171	60% unit 176 and 40% unit 19	NA	1, 515	176- Very gravelly sandy loam 19- See above	50	C and D	176- Moderately unstable to locally unstable 19-See above	19, 176- See above	389	868	75
190	65% unit 196 and 35% unit 1	NA	9, 969	196- Gravelly loam 1-See above	45	D	196- Moderately stable to Moderately Unstable 1-See above	196- Very severe 1-See above	3, 979	4, 769	172

[2] **176**-Galice Formation metasediments and related sediments and metavolcanics. West side of Klamath Mountains.

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
191	Diorites, granodiorites, quartz diorites, locally, gabbros West side of Klamath Mountains	NA	293	Very gravelly sandy loam	55	C and D	Moderately Stable to Moderately Unstable	Very severe	68	161	0
195	55% unit 191 and 45% unit 192	NA	758	191- See above 192- Loam	55	C and D	191- See above 192- Moderately Stable to Moderately Unstable	191- See above 192- Severe	261	408	1
196	Gabbros with local diorites West side of Klamath Mountains	NA	10, 018	Gravelly loam	45	D	Moderately Stable to Moderately Unstable	Very severe	2, 665	6, 601	296
197	Gabbros with local diorites West side of Klamath Mountains	NA	736	Gravelly loam	55	B	Moderately Unstable to Moderately Stable	Moderate to severe	275	408	0
198	55% unit 196 and 45% unit 197	NA	1, 423	196, 197- See above	45	D	196- See above 197- See above	196, 197 - See above	587	656	2
313	65% unit 31 and 35% unit 3	Dubakella-Pearsoll gravelly loam complex	27	3, 31- See above	5	D	3, 31- See above	3, 31- See above	8	8	0
363	70% unit 36 and 30% unit 3	NA	3, 664	3, 31- See above	35	C	3, 36- See above	3, 36- See above	1, 338	1, 531	8
367	60% unit 36 and 40% unit 37	NA	1, 604	3, 31- See above	35	C	3, 36- See above	36, 37- See above	639	814	19
419[3]	60% unit 41 and 40% unit 19	NA	48	41- Gravelly coarse, sandy loam 19- See above	25	C	41- Moderately Stable to Moderately Unstable 19- See above	19, 41- Severe	12	21	0
510	70% unit 51 and 30% unit 2	Witzel rock outcrops/ Beekman gravelly loam	969	2, 51- See above	15	D	2, 51- See above	2, 51- See above	272	543	139
512	60% unit 51 and 40% unit 52	Beekman gravelly loam	5, 672	51, 52- See above	23	D	51, 52- See above	51, 52 - See above	1, 799	2, 176	1,154

[3] **41-**Rhythmically bedded sandstones of the Umpqua Formation. West side of Klamath Mountains.

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
516	70% unit 51 30% unit 26	Beekman gravelly loam	1, 522	51- See above 26- Sandy loam	10	D	51- See above 26- Moderately Stable	51- See above 26- Severe to very severe	547	154	11
519	60% unit 51 and 40% unit 19	Beekman gravelly loam	194	19, 51- See above	23	D	19, 51- See above	19, 51- See above	46	24	0
527	70% unit 52 and 30% unit 27	NA	1, 192	52- See above 27- Loam	18	C	52- See above 27- Moderately Stable	52- See above 27- Moderate, locally severe	498	102	7
530 & 536	60% unit 53 and 40% unit 2	Beekman-Colestine gravelly loam complex	2, 279	2, 53- See above	5	D	2, 53- See above	2, 53- See above	662	940	0
538	70% unit 53 and 30% unit 28	Beekman-Colestine gravelly loam complex	1, 274	53- See above 28- Sandy loam	5	D	53- See above 28- Moderately Stable	53- See above 28- Very severe to severe	562	455	82
549	70% unit 54 and 30% unit 29	Beekman-Colestine gravelly loam complex	617	54- See above 29- Fine sandy loam	10	C	54- See above 29- Moderately Stable	54- See above 29- Moderate to high	142	122	111
612	60% unit 61 and 40% unit 62	NA	2, 271	61, 62- See above	15	B and C	61, 62- See above	61, 62 - See above	1, 076	944	3
768	65% unit 76 and 35% unit 18	Speaker-Josephine gravelly loam complex	55	76- Gravelly loam 18- Gravelly loam	30	C and D	76- Moderately Stable 18- Moderately Unstable	76- Severe 18- Moderate to severe	12	31	0
768u	65% unit 76u and 35% unit 18u	Goodwin very gravelly fine sandy loam	335	76u- See above 18u- NA	30	C and D	76u- See above 18u- NA	76u- NA 19u- NA	87	221	0
778	60% unit 77 and 40% unit 18	Beekman-Colestine gravelly loam complex; Speaker-Josephine gravelly	46	77- Very gravelly loam 18- Gravelly loam	45	B and C	77- Moderately Stable to Moderately Unstable 18- Moderately Unstable	77- Moderate 18- Moderate to severe	17	18	0

SRI Map Unit	Landtype Units	Soil Series	Acres in fire perimeter	Surface texture	Mean % Surface rock	Soil Hydrologic Group	Natural Stability	Surface Soil Erosion Potential	Soil Burn Severity (acres)		
									Low	Moderate	High
		loam complex									
Total									**71, 300**	**59, 424**	**10, 827**

Appendix B

Sediment delivery rates by subwatershed and SRI map unit

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
Boulder Creek				
17	71,354.05	25,447.71	106,284.95	41,190.61
19	111,263.11	41,682.65	152,542.62	64,823.42
196	21,574.71	7,749.22	29,691.13	11,061.00
36	29,494.28	10,595.74	42,332.58	15,842.41
37	1,884.30	655.46	2,479.41	1,013.85
51	27,745.58	11,764.31	51,455.31	24,306.13
52	26,864.34	11,424.99	44,985.80	20,038.36
53	123,050.53	56,033.21	170,545.11	83,309.51
54	27,161.59	12,805.41	34,442.87	19,430.57
55	282,047.20	102,710.83	372,687.49	162,434.47
8	13,129.69	7,576.82	16,951.65	11,309.11
	735,569.38	288,446.34	1,024,398.93	454,759.44
Box Canyon Creek				
19	18,129.32	6,610.55	24,677.46	10,464.62
196	132,131.28	48,025.53	179,959.82	66,141.61
36	7,761.01	2,745.12	11,152.86	4,139.64
37	5,708.87	1,995.60	7,490.16	3,056.90
51	20,216.53	6,686.12	39,194.95	16,441.84
53	43,207.12	21,560.60	59,839.41	30,871.01
8	7,596.20	3,484.58	9,502.35	5,744.52
98	1.90	0.68	3.13	1.11
	234,752.23	91,108.77	331,820.13	136,861.25
Collier Creek				
17	881.67	304.53	1,344.38	520.01
19	4,839.39	1,791.03	6,614.27	2,806.96
196	1,731.70	616.67	2,400.48	903.20
36	2,295.27	802.15	3,301.46	1,217.97
37	22.23	7.84	29.11	11.91
41	253.64	89.44	487.02	209.29
51	2,502.44	921.06	4,772.58	2,083.45

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
53	31,785.90	14,257.75	44,000.78	21,410.43
8	665.99	303.35	831.74	500.55
	44,978.23	19,093.82	63,781.83	29,663.76
Eagle Creek-Chetco River				
15	1,050.53	445.41	1,802.00	804.55
17	94,952.77	34,278.37	142,086.33	54,731.66
19	71,576.81	28,413.87	99,468.00	42,738.52
36	55,075.66	20,175.37	78,882.89	29,984.53
37	3,503.51	1,353.92	4,509.81	1,920.67
51	565,078.49	245,247.26	1,041,600.12	502,314.05
52	28,844.63	13,614.28	47,616.59	22,360.97
53	384,198.33	183,469.28	530,306.38	269,990.39
54	7,294.88	3,171.00	9,386.40	4,937.85
55	49,482.35	18,181.88	64,501.74	27,633.63
61	34,705.85	13,151.11	51,579.88	20,519.25
8	154,068.00	80,205.33	197,042.35	126,946.33
8c	10,677.94	5,509.61	13,738.68	8,934.39
9	141,718.48	73,834.95	181,067.22	116,447.85
9c	14,741.47	7,884.37	19,064.25	12,586.53
	1,616,969.71	728,936.02	2,482,652.63	1,242,851.16
East Fork Pistol River-Pistol River				
17	4,470.05	1,660.89	6,098.64	2,609.71
19	45,845.13	15,852.58	71,404.27	27,669.39
36	39,585.31	14,400.78	56,740.91	21,450.91
37	3,080.29	1,099.79	3,981.10	1,604.19
41	2,330.80	999.46		
51	28,031.44	10,058.76	53,657.53	23,268.83
52	5,729.92	2,155.95	9,873.64	4,007.11
53	25,983.11	11,220.34	35,916.30	17,210.17
6	9.42	3.43	13.15	5.72
61	148,345.32	54,211.42	220,855.76	86,881.32
62	18,139.71	8,892.28	23,190.42	13,379.68
8	32,089.73	14,172.34	39,767.43	23,448.08

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
8c	29,152.06	13,176.85	36,341.00	21,763.49
9	1,283.92	596.99	1,611.27	982.50
	384,076.21	148,501.87	563,776.94	246,294.46
East Fork Winchuck River				
19	59,071.45	22,302.21	81,000.44	34,627.47
51	33,826.38	12,658.01	64,292.91	28,393.74
52	11,299.89	4,430.65	19,310.45	8,072.27
53	57,326.45	26,502.40	79,424.93	39,181.97
54	9,792.17	5,026.64	12,419.87	7,429.30
8	0.14	0.14	0.19	0.19
	171,316.46	70,920.05	256,448.78	117,704.94
Granite Creek-Chetco River				
13	593.45	208.61	874.71	428.60
176	27,811.60	9,714.73	43,581.93	16,841.27
191	35,051.23	11,344.36	55,354.40	20,818.91
196	423,447.61	155,133.38	574,501.91	211,583.24
197	5,937.10	2,222.77	8,512.06	3,229.30
3	66.23	19.42	123.77	43.59
31	515.11	225.61	747.56	365.46
36	141,171.76	51,209.23	202,466.88	76,236.06
4	6,579.66	3,159.73	7,956.69	4,324.73
5	6,773.69	3,380.47	8,225.48	4,640.30
76	0.92	0.92	1.13	1.13
76u	14,390.87	5,275.30	20,813.78	7,964.40
77	1,025.72	360.62	1,495.21	574.14
98	2,612.56	986.71	4,006.97	1,764.87
	665,977.51	243,241.87	928,662.48	348,816.00
Klondike Creek				
191	1,532.85	472.09	2,397.84	910.89
196	4,467.80	1,602.97	6,154.33	2,294.92
197	162.87	53.70	217.16	86.49
31	5.24	2.06	7.57	3.47
51	15,472.50	5,595.60	29,567.52	12,900.70

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
53	1,740.18	792.94	2,423.41	1,163.67
	23,381.45	8,519.35	40,767.81	17,360.15
Little Chetco River-Chetco River				
16u	63.72	24.18	80.33	38.95
176	51,132.22	16,773.99	80,927.17	30,383.54
196	32,822.48	12,043.73	44,401.11	16,230.11
3	22,716.30	7,056.76	41,313.59	14,996.84
31	307.60	130.26	445.95	213.61
36	74,032.62	27,176.05	106,078.66	40,202.94
39	1,651.27	496.51	2,592.70	976.90
76u	1,362.73	500.18	1,968.21	752.73
	184,088.94	64,201.65	277,807.71	103,795.63
Nook Creek-Chetco River				
15	143.00	59.92	244.38	108.29
19	57,856.20	21,859.55	79,371.29	33,913.50
51	307,244.50	133,329.23	564,958.08	276,970.37
52	24,481.94	9,640.13	41,824.31	17,486.40
53	21,627.16	9,066.89	29,778.25	14,253.05
54	4,180.93	1,871.82	5,367.76	2,896.28
8	54,591.26	32,143.79	70,560.40	47,340.26
9	38,895.95	22,027.74	49,853.65	32,724.87
	509,020.94	229,999.08	841,958.12	425,693.02
North Fork Pistol River-Pistol River				
19	32,169.97	11,903.57	43,967.31	18,657.16
51	67,455.42	24,557.87	128,874.91	56,030.70
52	14,090.78	5,654.00	23,914.45	10,205.85
53	46,565.15	20,149.45	64,390.98	30,847.63
8	30,890.90	14,133.35	38,613.33	23,304.00
	191,172.22	76,398.25	299,760.98	139,045.35
Sluice Creek-Chetco River				

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
17	85,794.93	30,374.86	128,214.29	49,479.13
19	80,572.12	30,352.92	110,432.05	47,182.53
196	120,316.70	43,346.39	165,460.54	61,870.75
51	108,258.37	43,794.25	202,723.68	93,281.45
52	3,939.10	1,548.29	6,716.48	2,819.20
53	190,118.82	87,729.70	262,683.34	130,746.01
54	18,477.17	8,908.13	23,336.14	13,424.50
55	15,025.51	5,202.09	20,612.13	9,021.73
8	37,815.50	19,015.40	48,011.74	30,334.34
	660,318.23	270,272.02	968,190.38	438,159.65
South Fork Chetco River				
17	66,299.33	23,427.11	99,353.22	38,442.34
19	283,279.01	108,768.21	389,501.51	167,575.53
3	194.22	59.96	353.77	127.85
36	14,149.33	5,023.58	20,326.63	7,558.57
37	8,252.11	2,823.86	10,978.11	4,528.86
51	372,144.34	153,242.59	693,520.23	325,012.28
52	74,403.99	31,607.44	125,223.87	55,048.98
53	163,926.30	70,251.69	226,391.85	108,400.63
54	33,956.57	14,455.53	44,042.84	22,656.24
55	120,220.27	43,826.38	160,126.10	71,270.59
8	145,833.51	68,789.05	183,100.59	112,018.34
9	11,778.66	5,497.39	14,772.82	9,002.55
	1,294,437.65	527,772.81	1,967,691.55	921,642.75
South Fork Pistol River				
19	2,733.22	994.66	3,708.23	1,584.99
51	24,284.46	9,315.87	45,980.93	20,453.07
52	7,892.67	3,040.87	13,537.30	5,597.83
53	6,138.48	2,595.28	8,462.45	4,049.67
54	5,926.48	2,755.17	7,448.66	4,209.00
8	11,834.43	5,447.21	14,810.84	8,971.30
	56,076.52	23,154.40	90,240.17	43,280.87

Watershed Name	Total Sediment Yield (Tons)			
	2-Yr Untreated	2-Yr Treated (1 T mulch)	5-Yr Untreated	5-Yr Treated (1 T mulch)
Sulphur Creek-Illinois River				
17	62,417.46	22,057.05	93,454.61	36,084.71
19	53,556.58	21,271.16	74,189.11	32,171.32
51	85,319.29	31,766.88	162,340.53	71,415.79
53	200,476.02	92,915.88	278,054.08	136,830.11
53u	1,006.32	433.11	1,389.66	668.34
54	5,404.81	3,278.31	6,782.59	4,603.02
	408,180.49	171,722.38	616,210.57	281,773.30
Tincup Creek				
17	90,291.75	32,581.08	134,690.52	53,106.47
19	60,132.97	22,518.89	82,220.75	35,190.85
191	1,433.08	415.63	2,217.34	850.68
196	164,520.06	59,261.07	225,966.09	84,101.54
197	23,842.72	8,497.94	33,246.92	12,823.01
36	50.19	18.76	71.82	27.44
51	71,744.02	27,015.53	136,223.37	60,290.04
53	171,733.07	85,236.28	236,631.58	123,882.69
54	32,210.06	14,556.68	41,375.97	22,385.78
55	3,521.95	1,320.63	4,602.06	2,056.62
8	33,284.01	14,823.66	41,346.90	24,528.39
	652,763.89	266,246.14	938,593.31	419,243.48
Upper North Fork Smith River				
19	34,693.76	12,910.75	47,477.08	20,169.50
36	167.49	55.21	5,624.00	2,126.79
52	3,924.70	1,439.15	8,029.83	3,326.06
53	4,688.73	1,811.58	53,638.19	25,730.80
54	38,847.99	16,678.53	14,894.67	8,027.79
8	11,674.08	5,189.37	1,537.94	898.62
	1,244.59	541.31	131,500.97	60,392.88

Burned Area Emergency Response (BAER) Assessment
FINAL Specialist Report – GEOLOGIC HAZARDS

Chetco Fire, Rogue River-Siskiyou N.F.

October 9, 2017

Jonathan Yonni Schwartz – Geomorphologist, Los Padres NF

Introduction

The Chetco Bar Fire started on July 12, 2017, in the Kalmiopsis Wilderness, Chetco River corridor, on the Gold Beach Ranger District of the Rogue River-Siskiyou National Forest. The Chetco Bar Fire burned a total of 191,197 acres, out of which 170,321 acres burned on National Forest lands. Out of a total of 191,197 acres, 14,012 acres were high soil burn severity (7%), 64,545 acres were moderate soil burn severity (34%), 76,613 acres were low soil burn severity (40%) and 36,027 acres were unburned (19% of the total). The unburned acres refer to unburned areas within the fire perimeter. This report describes and assesses the increase in risk from geologic hazards within the Chetco Bar Fire burned area.

When evaluating Geologic Hazards, the focus of the "Geology" function on a BAER Team is on identifying the geologic conditions and geomorphic processes that have helped shape and alter the watersheds and landscapes, and assessing the impacts from the fire on those conditions and processes that potentially could affect downstream values at risk. The fire removed vegetation that helps keep slopes and drainages intact, changed the structure and erosiveness of the soil, and altered the stability of the landscape. Using the understanding of rock types and characteristics, geomorphic processes, and distribution of geologic hazards helps predict how the watersheds will be impacted during upcoming storm seasons. Within the Chetco Bar Fire burned area, a high degree of slope failures as rock fall and debris slides activities have occurred in the past and will increase during future storms.

Wildfire can significantly alter the hydrologic response of a watershed to the extent that even modest rainstorms can produce dangerous debris flows, rock falls and debris slides. Watersheds with steep slopes and significant amounts of moderate to high soil burn severity are especially likely to generate debris flows. The majority of debris flows exacerbated by wildfires usually occurs within 1-3 years after the watersheds burned. Fast moving, highly destructive debris flows triggered by intense rainfall are one of the most dangerous post-fire hazards. As a result of fires, protective vegetation is gone or altered and will not return to the same levels of protection for years. Soil is exposed and has become weakened, and surface rock on slopes has lost its supporting vegetation. Slopes will experience greatly increased erosion. Stream channels and

mountainside ephemeral channels will be flushed of the sediment that in some places is loose and deep, in other places shallow. That sediment will deposit in some channels, choking flow, raising flood levels and covering roads with deep sediments. Risk to human life, infrastructure and natural resources are high in some areas.

I. Resource Setting

The Chetco Bar Fire occurred on the west slope of the Klamath Mountains Geological Province, and through an extension of the California Coast Range Provence. The physiography of the region is dominated by rugged canyons and steep slopes mostly draining into the Chetco River watersheds. Out of 191,197 acres that were burned in the Chetco Bar Fire, 80% burned within the Chetco River watershed.

In total, the Chetco River watershed is approximately 214,000 acres. The Chetco River mainstem is 56 miles long with the first 28 miles of the mainstem in the Kalmiopsis Wilderness. The Chetco River empties into the Pacific Ocean between the towns of Brookings and Harbor. The elevations of the watershed range from sea level to 5,108 feet above sea level at Pearsoll Peak. Slopes range from gentle to vertical but are commonly moderately steep to steep (Figure 1). The watershed is located entirely in Curry County, in Southwest Oregon. Seventy-eight percent of the watershed is Siskiyou National Forest lands.

Geology: The Klamath Mountains include metamorphosed intrusive rocks and the Josephine Peridotite, a large ultramafic body (Figure 2) which supports many endemic plants. The ultramafic rocks consist of peridotite and, where altered, serpentinite (also commonly called serpentine). Amphibole gneisses and schists are believed to be the oldest rocks in the area. These are sandwiched between the ultramafic rocks on the east and the underlying Dothan formation. A thin zone of volcanic rocks which have been warped, dragged, and squeezed into the broad zone of the thrust fault is interpreted to originate from the Jurassic Rogue Formation (Chetco River Watershed Analysis, 1996).

The Dothan Formation is the primary rock unit within the Coast Ranges Province, and is equivalent to the Franciscan Formation to the south in California. The Dothan Formation consists of graywacke sandstone, with interbedded siltstone and shale, occasional pillow lavas, volcanic breccia, chert and conglomerate. Evidence of late Jurassic deposition has been interpreted from fossils in the area. The lenticular-shaped chert bodies are generally light gray, massive and fractured, but occasionally is well-banded and multicolored.

The Dothan Formation has been thrust (a low angle fault) under the Josephine ultramafic sheet. The Valen Lake Thrust is located in the eastern and upper portion of the watershed, and is believed to represent the location of the subduction zone. This major tectonic event occurred

after Dothan rocks were deposited, probably during late Cretaceous time. The Dothan varies in its degree of deformation which must have occurred at least partially during the period of thrusting. Fault zones, shearing, and small-scale tight folding are more common in the less competent shaley interbeds than in the graywacke sandstones, and allow weathering to greater depths. High angle faulting in the Dothan is common, and the major faults are associated with severely sheared host rocks, higher grade metamorphism, and slivers of serpentinite.

Geomorphology of the Chetco River Watershed: The Chetco River has its headwaters in a landscape carved by glaciers, which is unusual for coastal streams in the area. Evidence of glaciation includes both erosional features (cirque basins) and glacial deposits (moraines). Because the cirques and moraines have not been modified by weathering or stream erosion, they were likely formed during the last glacial stage (Wisconsin). The Vulcan Lakes are glacial cirque lakes (tarns) at the head of Box Canyon Creek. Partially developed cirques are also found on the north and east slopes of the highest ridges, such as Big Craggies. Glacial moraine deposits have been mapped in the watersheds of upper Box Canyon and Fresno Creeks. Less extensive, unmapped deposits occur in the U-shaped canyons of upper Madstone and Broken Cot Creeks and in the unnamed creek between them. Moraines can also be found near Babyfoot Lake (also a tarn). The large moraine in the headwaters of Box Canyon Creek below Vulcan Lakes is composed of ultramafic debris. It is uncertain whether deposits extending to the mouth of Fresno Creek were left from glacial ice or outwash (Ramp, 1975).

Between Tincup Creek and the Forest Boundary, the river generally flows southward along the path of less resistant sheared siltstones. The channel narrows into a gorge as it crosses more resistant sandstones and volcanics along its shorter westerly path toward the ocean. Steep inner gorge streambanks are evident from the contrast between more gently sloping uplands and steeper streambank slopes. Inner gorge landforms characterize recently uplifted (rejuvenated) terrain. North and south flowing streams within the Dothan formation tend to follow shear zones, and therefore have a higher proportion of inner gorge landslides. These stream segments in Dothan include: North Fork Chetco, several segments of the mainstem, Mineral Hill Fork of Eagle, Mislatnah/Craggie/Blueslide creeks, a segment of the South Fork, and the mainstem Chetco from the mouth of Boulder to Tincup, and the first four miles of Tincup Creek. The valley becomes less confined within the shear zone along the lower mainstem perhaps because of more easily weathered hillslopes, and the channel stores sediment in large terraces.

The gradient of the mainstem Chetco also reflects the resistance of the underlying rocks, and the glacial history of the upper watershed.

Landslides of various types dominate sediment delivery, and vary in size of material delivered, rate, and effects on stream channels. The geographic distributions of slopes and soil characteristics influence the types of landslides. Soil thickness and drainage characteristics are

influenced by slope angle and bedrock. Soils tend to be thinner and rockier on steeper slopes. Soils developed on all rock types tend to be thicker and wetter in shear zones, where springs emerging from intercepted groundwater are abundant. Thicker soils are generally found on moderately steep slopes and benches in Dothan mudstone and Colebrooke schist. Soils on Dothan mudstone tend to be of moderate to thick depth, and poorly drained. On Dothan sandstones, soils are thin on ridges and steep slopes, but moderate on sideslopes, and the higher sand content provides moderately well drained soils. Volcanic rocks within the Dothan and Colebrooke, Mt. Emily rhyolite, granodiorite and gabbros are resistant to weathering and produce thin rocky or gravelly soils, talus, and rock outcrops. Serpentinized peridotite (ultramafic rock) weathers very slowly to thin gravelly soils, but landslides may fail within the weak sheared bedrock. These landslides revegetate slowly and are visible for long periods after the event.

Rock fall is most common on the steeper slopes within the wilderness part of the watershed. For example, a steep narrow rock slide on the north side of Dry Butte dammed a small tributary of Boulder Creek and formed Valen Lake. Ramp (1975) judged from the size of trees on the deposit, that the rock slide occurred about 300 years ago. Rock fall processes deliver boulders that provide stream structure where runoff rates are high from the rocky slopes, and where large wood is less abundant in channels on ultramafic rocks.

Deep-seated landslides within bedrock are uncommon, but more likely within the sheared ultramafic rocks. An example of a failure within the ultramafic bedrock is the area of Sourdough Flat (north of Slide Creek) which appears to be an ancient, massive slump block (Ramp, 1975).

Streambank landslides are abundant in the inner gorges because of the steep slopes and accumulation of soil and water at the toe of the slope. The more distinct and active inner gorges are located in the less resistant, sheared rocks in North and Mineral Hill Forks of Eagle Creek, and the adjacent mainstem Chetco (Photo 1).

Slump-earthflows are associated with thick, fine-grained, saturated soils, and vary from currently active to older, dormant features. Many of the larger ones are assosciated to timber harvest activities and road construction.

Debris slides, avalanches and flows are more common on steep slopes from headwalls (swales filled with colluvium). These slides are abundant within the wilderness and from the slopes of Mt. Emily, and other steep resistant slopes. These are rapidly moving, scouring events, which transport and deposit large wood as well as sediment. Evidence of fresh debris slide was identified on FS road 1107-620, just above Little Redwood Creek (Photo 2).

Photo 1: Streambank landslides in the inner gorge of the upper Chetco River

Photo 2: Fresh debris slide on FS road 1107-620, just above Little Redwood Creek

In the geology chapter of Checto River Watershed Analysis (1996), Cindy Ricks states that**;** *'The frequency and distribution of landslides has been affected by natural disturbances such as flood and fire, as well as land uses such as timber harvest and mining'*.

Historic landslides and erosion have not been systematically surveyed or inventoried for the Chetco River watershed. Several large older slides along the Chetco River and major tributaries were reactivated during the 1964 flood (Ramp, 1975).

Major factors affecting slope stability in the Chetco Bar fire area include:

Groundwater – Saturation by groundwater is a major cause of landslides. In all rock types and structures, and on a wide range of slope angles, if the materials are saturated, the potential for sliding is significantly increased.

Slope Angle – Based on Ferrero (1991), the general relationship between slope angle and stability in this area is as follow:

- 0 – 40% - Stable when dry or saturated, except in very poorly drained soils where earthflows can develop.
- 40 – 55% - Stable when dry. Marginal when saturated.
- 55 – 75% - Stable to marginal when dry. Unstable when saturated.
- 75+ % - Ravelly when dry. Very unstable when saturated.

The above slope limits vary somewhat depending upon rock type and structure, aspect, etc.

Soil Characteristics – Different soil types have varying stability characteristics. In general, on steep, dry slopes, coarse, less cohesive soils (sand and gravel) tend to be more likely to ravel and slide. On wet ground, finer, more cohesive and poorly drained soils (silt and clay) tend to slide at lower slope angles than course, well drained soils.

Bedrock Characteristics – Different rock types have varying stability characteristics. Soil characteristics on slopes are partially defined by underlying or upslope bedrock. Clayey soils are derived from mudstone and sandy soils are derived from sandstones. Rock types with weak internal structure such as sheared serpentine can be very unstable on steep slopes, especially when saturated. Faults weaken rock, increase the depth of weathering and transport groundwater to surface, all of which are factors contributing to slope instability (Ferrero, 1991).

Fire removes vegetation and alters water infiltration characteristics, which play a key role in holding soil on the slope surface. The more intense the burn, the more severe the consequence to the soil structure and ground cover.

Consequently, the steepest areas, with the most highly fractured or decomposed rock and the thickest accumulation of unconsolidated soil, which were subjected to the most severe burn are now at the highest risk from debris slides, debris flows, rock-fall, and slumping.

Following wildfire, many factors combine to influence the stability of slopes:

- Degree of severity of the burn, relative to destruction of slope cover and alteration of soil properties
- Steepness and configuration of slopes
- Degree of fracturing and/or weathering of rock units, relative to the rate of soil/colluvial material formation and rock strength/competence
- Amount, intensity and duration of precipitation and runoff, and flooding
- Degree of slope saturation and groundwater level
- Intensity and duration of seismic shaking, especially when slopes are saturated
- Alteration of natural slope stability by excavations such as roads
- Undercutting of slopes and channels by stream action and gullying

Just as other BAER assessments revealed, assessment of the Chetco Bar Fire show that steep slopes loaded with loose rock and unsorted, unconsolidated materials that experienced a moderate or high soil burn severity tend to be most susceptible to mass wasting and other failures. In addition, susceptibility to slope instability is associated with watersheds within the fire that have significant volumes of sediment in the channels or are likely to experience increases in sediment volume from fire-affected slopes. Sediment increase is associated with significant areas of susceptible bedrock that were subjected to high or moderate burn severity. The basis for this assumption originated from studies of wildfire-generated debris flows, which can be extrapolated to other types of slope movement. Rather than being the result of infiltration-induced slope movements into the channels, wildfire-generated debris flows are a result of progressive bulking of storm flow with sediment within the channel and washed from the adjacent slopes (Cannon, 2000, 2001). As Cannon and others (2003) state:

"Wildfire can have profound effects on a watershed. Consumption of the rainfall-intercepting canopy and of the soil-mantling litter and duff, intensive drying of the soil, combustion of soil-binding organic matter, and the enhancement or formation of water-repellent soils can result in decreased rainfall infiltration into the soil and subsequent significantly increased overland flow and runoff in channels. Removal of obstructions to flow (e.g. live and downed timber, plant stems, etc.) by wildfire can enhance the erosive power of overland flow, resulting in accelerated stripping of material from hillslopes. Increased runoff can also erode significant volumes of material from channels. The net result of rainfall on burned basins is often the transport and deposition of large volumes of sediment, both within and down-channel from the burned area."

Destructive debris flows bring side-slope materials and channel deposits racing down channel bottoms in a slurry similar to the consistency of concrete, in masses from a few hundred cubic yards to hundreds of thousands of cubic yards of saturated material.

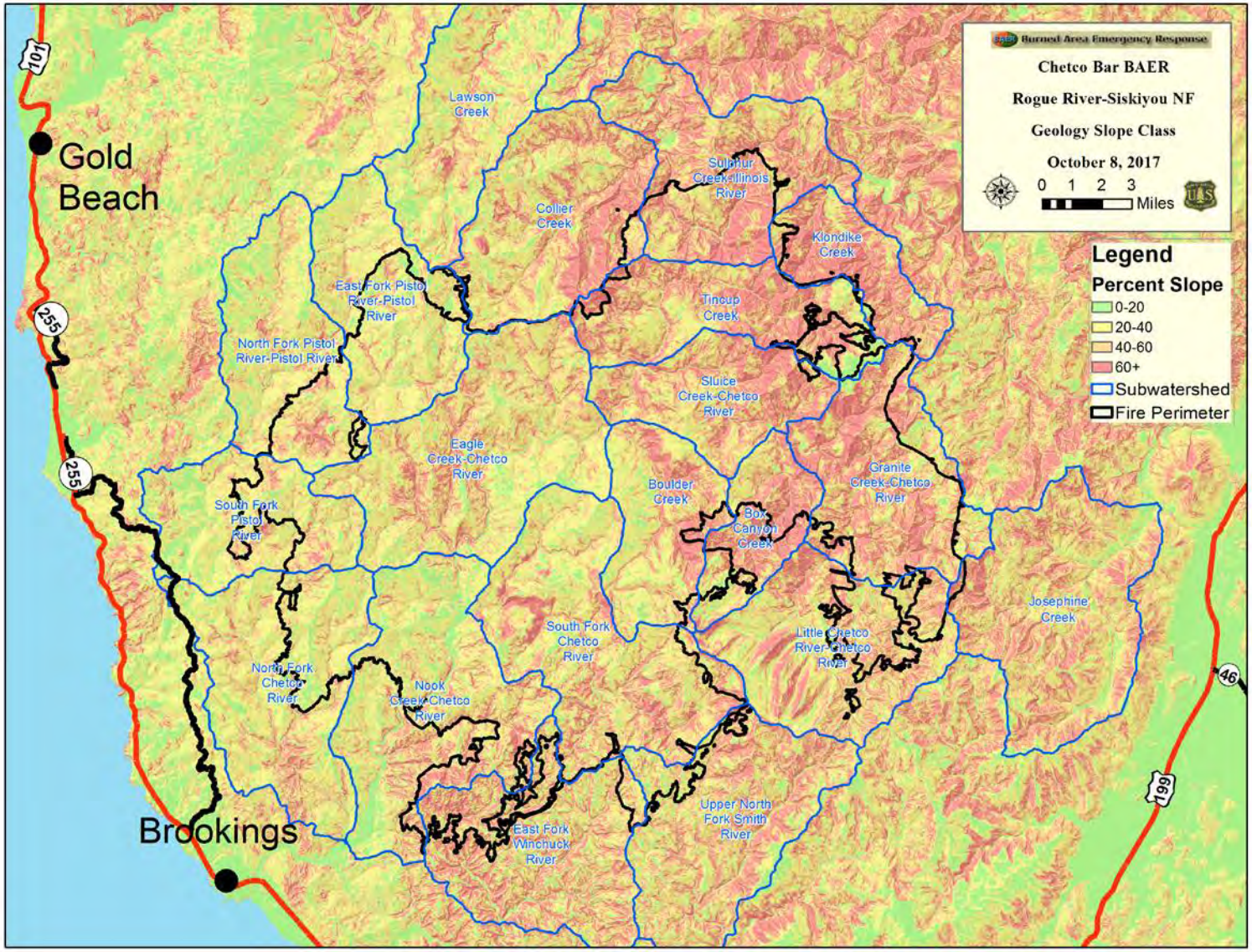


Figure 1: **Slope Map in percent – Chetco Bar Fire**

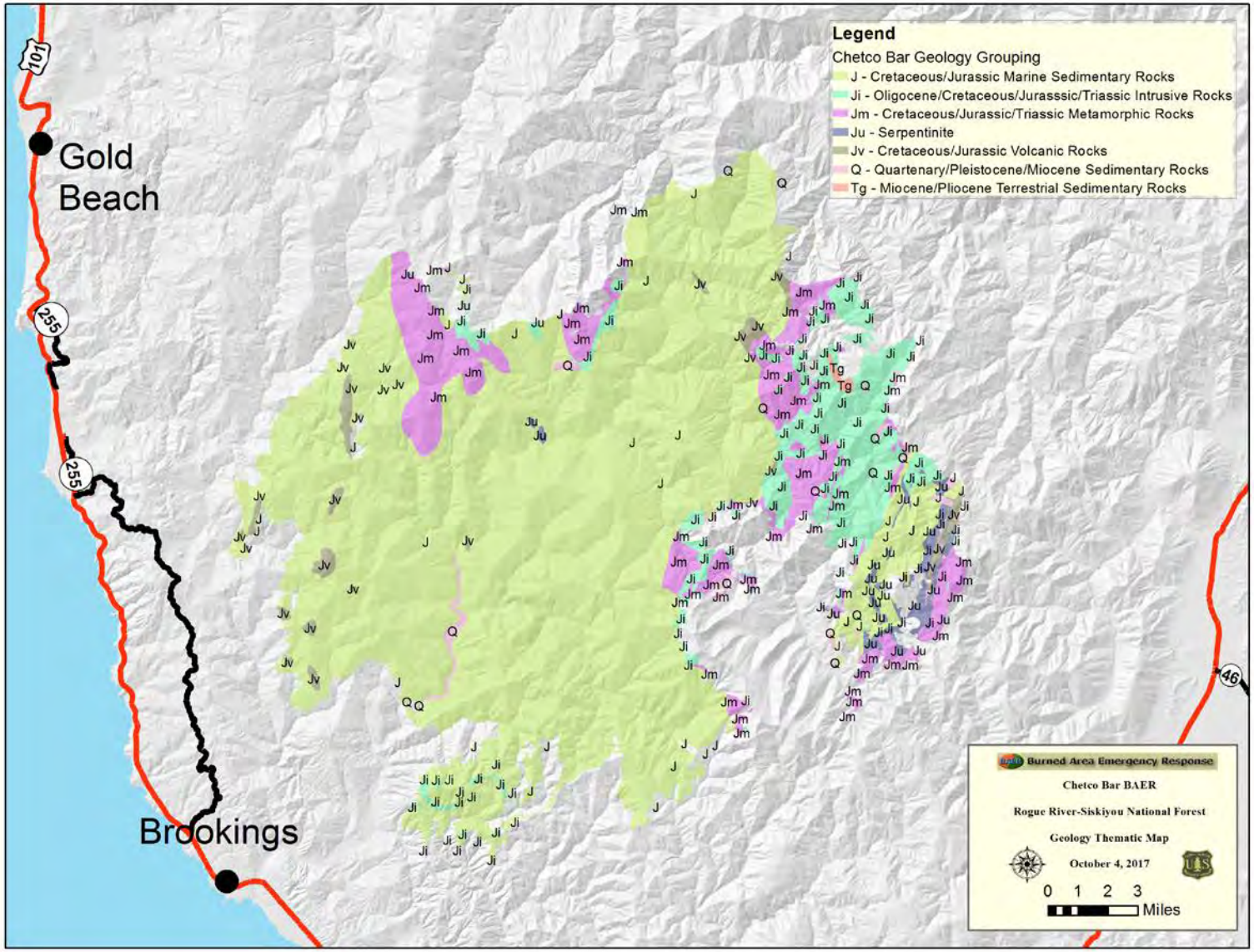


Figure 2: **Geological map - Chetco Bar Fire burned area**

Hydrology: The hydrology of the Chetco River watershed is complex and varied. Precipitation mainly in the form of rain, ranges from 75 inches per year near the mouth of the Chetco River to 160 inches per year near Granite Butte, in the northeast corner of the watershed (from State Isohyetal maps). Seventy-two percent of the watershed is in the rain-dominated zone below 2500 feet, 26% is in the transient snow zone from 3500 to 4000 feet elevation where rain-on-snow events increase peak flows, and only two percent is in the snowpack zone over 4000 feet where winter precipitation is stored until spring snowmelt.

Both elevation and precipitation increase eastward to the Chetco-Rough and Ready Divide. Roughly 50% of the area with over 100 inches of precipitation lies within the transient snow zone, and most of the snowpack zone receives over 130 inches of precipitation in the form of snow per year. Elevation and precipitation combine to increase the influence of both rain-on-snow and snowpack on the hydrology of the watershed.

A large portion of the watershed has ultramafic rocks and soils. These have low permeability and low storage capacity, with rapid runoff and a high density of seeps and springs.

Stream Channel: The Chetco River is a low-gradient stream within a wide valley for most of its length, meandering between large gravel/cobble bars. Most tributaries are steep-gradient transport streams. Some, like Emily Creek, have long low-gradient depositional reaches. Sediment processes are largely a function of slope and gradient, with the added factor of human activities: roads, harvest, and mining.

The human influence on stream channels is mostly outside of the Wilderness, but some effects from mining including mining roads have been observed within the Wilderness. Channel morphology also has an influence on human activities, both recreational and developmental.

The mainstem of the Chetco River is deficient in structure, especially large wood. This is because of its wide channel and high winter flows. Most tributaries have high amounts of large wood (Chetco River Watershed Analysis, USDA, F.S. Pacific Northwest Region, 1996).

USGS Debris Flow Assessment:

In order to assess the probability and potential volumes of debris flows in the burned area the assistance of the US Geological Survey (USGS) - Landslide Hazards Program was obtained. Their ongoing research has developed empirical models for forecasting the probability and the likely volume of such debris flow events. To run their models, the USGS uses geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm (Staley, 2016). Estimates of probability, volume, and combined hazard are based upon a design storm with a peak 15-minute rainfall intensity of 12 – 40 millimeters per hour (mm/h) rate.

We selected a design storm of a peak 15-minute rainfall intensity of 24 millimeters per hour (0.94 inch/hr.) rate to evaluate debris flow potential and volumes since this magnitude of storm seems likely to occur in any given year (Figures 5-7).

Debris flow probability and volume were estimated for each basin in the burned area as well as along the upstream drainage networks, where the contributing area is greater than or equal to 0.02 km^2, with the maximum basin size of 8 km^2.

The **probability model** was designed to predict the probability of debris-flow occurrence at a point along the drainage network in response to a given storm. Probabilities predicted by the model potentially range from 0 (least likely) to 100 percent (most likely). The predicted probabilities are assigned to 1 of 5 equal (20 percent) interval classes for cartographic display.

The **volume model** was designed to estimate the volume (in m^3) of material that could issue from a point along the drainage network in response to a storm of a given rainfall magnitude and intensity. Volume estimates were classified in order of magnitude scale ranges 0–1,000 m^3; 1,000–10,000 m^3; 10,000–100,000 m^3; and greater than 100,000 m^3 for cartographic display.

Debris-flow hazards from a given basin can be considered as the combination of both probability and volume. For example, in a given setting, the most hazardous basins will show both a high probability of occurrence and a large estimated volume of material. Slightly less hazardous would be basins that show a combination of either relatively low probabilities and larger volume estimates or high probabilities and smaller volume estimates. The lowest relative hazard would be for basins that show both low probabilities and the smallest volumes.

Kean et al. (2013) and Staley et al. (2016) have identified that rainfall intensities measured over durations of 60 minutes or less are best correlated with debris-flow initiation. It is important to emphasize that local data (such as debris supply) influence both the probability and volume of debris flows. Unfortunately, local specific data are not presently available at the spatial scale of the post-fire debris-flow hazard assessment done by the USGS. 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. In addition, it is essential to understand that this model was developed based on empirical data from semi-arid climate zones in southern California and west Colorado. Based on the fact that the climate / weather conditions are very different in southwest Oregon, the USGS model results presented in this report should be taken in a relative mode (relative change of pre – post fire conditions). Since this region tends to get long duration rainstorms with relatively low intensities, the magnitude of storm that is analyzed in this report will represent conservative results.

Findings / Observations

The Chetco Bar fire burned 191,197 acres, which included areas that were burned previously by the 2002 Biscuit Fire and the 1987 Silver Fire. The east side of the Chetco Bar fire burned a large portion of the Kalmiopsis Wilderness, which for the most case overlapped the area that was burned by the Biscuit Fire. Five HUC -5 watersheds were impacted by the Chetco Bar Fire. Each one of them include multiple HUC -6 sub-watershed as presented below (Figure 3):

- Illinois River watershed in the north portion of the fire which include the HUC -6 Sulphur Creek – Illinois River watershed.
- Pistol River watershed in the northwest and west portion of the fire including the HUC -6 East Fork Pistol River watershed, North Fork Pistol River watershed and the South Fork Pistol River watershed.
- Winchuck River watershed in the south portion of the fire including the HUC -6 East Fork Winchuck River watershed.
- Smith River watershed in the southeast portion of the fire including the HUC -6 Upper North Fork Smith River watershed.
- Chetco River watershed covering the majority of the burn area (80%) including the following HUC -6 watershed: Nook Creek - Chetco River watershed, South Fork - Chetco River watershed, Eagle Creek – Chetco River watershed, Boulder Creek watershed, Box Canyon watershed, Little Chetco River – Chetco River watershed, Granite Creek – Chetco River watershed, Sluice Creek – Chetco River watershed and Tincup Creek watershed.

During ground surveys, and a flight recon, evidence of some past mass wasting was observed throughout the burned area (photos 3-4). From on-the-ground observations and previous reports and research that has been done in this area it is clear that beyond natural conditions as slope saturation, groundwater levels, slope angle, and soil and bedrock characteristics that effect stability of slopes, past and present human activities as logging, mining and roads have amplified the instability of slopes. Areas that were heavily logged on relatively steep slopes in past years, have poor drainage and a high density of stacked roads, present unstable hummocky slopes with severe gully erosion in some cases (photo 5).

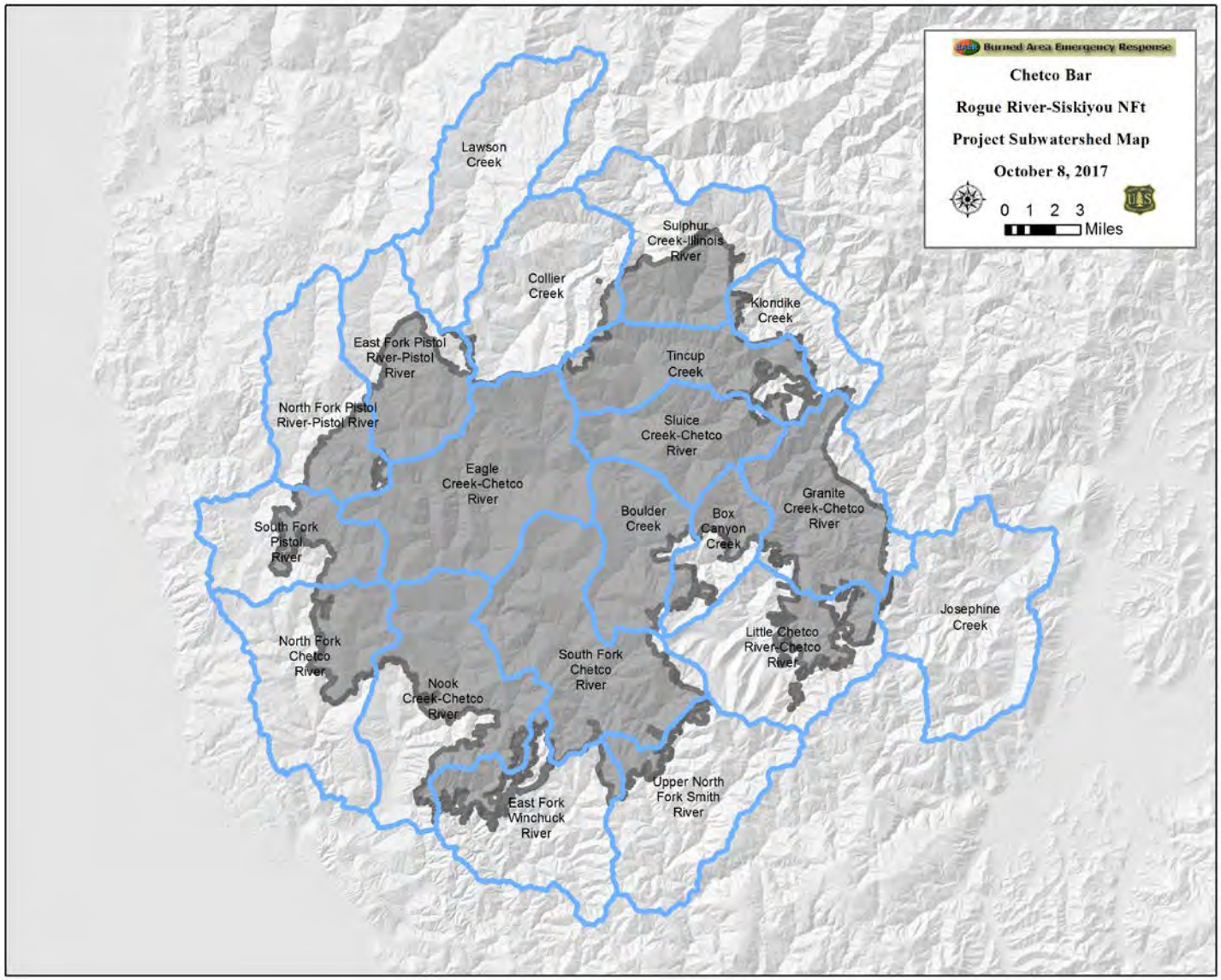


Figure 3: HUC -6, sub-watersheds in the Chetco Bar Fire burned area

Photo 3: Widespread surface erosion – Headwaters of the Chetco River

Photo 4: Drainage scouring by debris flows – Headwaters of the Chetco River

Photo 5: Unstable hummocky slopes with gully erosion as a result of logging activities

Along many of the FS roads system, past road related landslides were documented. Many of these road-related slides were associated with side dich flows, plugged culvers and undermine cutting. Cut-bank failures are found to be another common reason for road related landslides. These failures are less likely to deliver sediment to streams but can cause drainage diversions. Sediment delivery can also result from accelerated channel erosion where hydrologic patterns have been altered by roads and logging activities.

On steep hillslopes, road drainage onto headwalls in many cases results in rapid, scouring flows for long distances down channels. The Chetco River watershed analysis presents the 1993 debris flow in Dry Creek as an example of a plugged culvert causing a drainage diversion and failure of a saturated road fill. Roads constructed on steeper slopes are likely to cause this type of landslide. During this assessment a relatively fresh (last winter storm) road-related landslide was identified along FS road 1107 – 620, just above Little Redwood Creek. This landslide was most likely caused by side-ditch flows plugging a culvert, leading to over-flows on the road and under-cutting below a saturated, steep (60+ %) slope. This slide was estimated at 200 feet wide, 500 feet long and a 15-20 feet scarp. Volume of the slide were estimated at about 2,000,000 cubic feet, which included 200 feet of the road that was washed down stream. From this example and many other road-related slides in the burn area it is clear that future trends in road-related slides are highly dependent on road maintenance.

A survey of Little Redwood Creek between the landslide above and FS road 1376 below revealed large amounts of woody debris and un-consolidated rocky materials available to be transported. At the crossing of Little Redwood Creek and FS road 1376, a potential failure of a road fill above the 7 feet culvert was identified. The road fill at this location is about 30 feet high and could fail as a result of a plugged culvert causing a drainage diversion and failure of the road fill. A road fill failure in this location can impact the only ingress – egress of the community of Wilderness Retreat. This is just one of many road crossing location that has the potential of failure along this specific critical road (FS 1376).

From ground surveys it appears that some of the slopes above the South Fork Chetco River experienced a high soil burn severity and are extremely steep (70+%). On these slopes a large debris slide could occur which might have the potential to dam the narrow gorge of the South Fork. In an event of high flows as a result of rain on snow, long duration rainstorms or high intensity storms, a breach could take place which will lead to a sudden increase in flows below. This could have a catastrophic impact on people traveling or recreating below and along the Chetco River.

Ground observations during this assessment revealed that some slopes in the burned area are loaded with unsorted, unconsolidated rocky materials available to be transported, while other slopes were relatively smooth and void of rocky materials (photo 6), but in many cases have thicker soils. Furthermore, from ground surveys and the flight recon it was shown that some channels in the burned area are loaded with rocky materials and woody debris available to be transported (photo 7), while other channels were flushed to the bed-rock, void of any unconsolidated materials. Based on current conditions, it seems that many culverts crossing below FS roads (including pre-fire conditions) are partially plugged by rocks and sediments. Now as post fire conditions have changed, ground cover and vegetation has been altered or removed and soil properties have altered, surface flows are expected to increase. As a result of expected increases in surface follows, channels that are loaded with rocky materials and woody debris will be transporting these materials downstream, causing culverts to plug and creating wide spread road damage.

Based on the flight recon, it is obvious that the majority of the areas that were burned during the Biscuit fire (the east portions of the Chetco Bar fire), which include for the most part, the Kalmiopsis Wilderness, are subject to mass wasting as landslides, debris flows, rock-fall, shallow slope failures and inner gorge landslides (photo 8). This might be a result of a combination of factors as: unstable geological units in this high country area, steep slopes, high soil burn severity and relatively low vegetation recovery since the Biscuit fire which all add to augment mass wasting and instability features.

Photo 6: Relatively smooth slopes void of rocky materials but with high potential for soil erosion

Photo 7: A channel loaded with rocky materials available to be transported – FS road 1909

Volcanic rocks within the Dothan and Colebrooke, Mt. Emily rhyolite, granodiorite and gabbros are resistant to weathering and produce thin rocky or gravelly soils, talus, and rock outcrops. In areas where these types of rock are exposed steep slopes subject to rock-fall are at high potential.

From studying and comparing the slope map and the soil burn severity map of the Chetco Bar fire it is obvious that there is a high correlation between these maps and the Landslide Potential map that was developed by Gordie Reeves from the Pacific Northwest Research Station. Similar (high) correlation is found between the slope map and the soil burn severity map and the Debris Flow probability map that was produced by the USGS.

Based on the USGS debris flow modeling the probabilities of debris flows occurring in the following HUC -6 watersheds are relatively high: Nook Creek - Chetco River watershed, South Fork - Chetco River watershed, Eagle Creek – Chetco River watershed, Boulder Creek watershed, Box Canyon watershed, Granite Creek – Chetco River watershed, Sluice Creek – Chetco River watershed and Tincup Creek watershed. It should be noted that all of these HUC - 6 watershed are within the Chetco River HUC – 5 watershed. The volumes predicted for debris flows in the above watershed are for the most case in the range of 1K-10K m^3 or smaller. The drainages that are predicted to produce debris flows are steep, side drainages that experienced moderate to high soil burn severity. Many of these drainages flow into the Chetco River, the South Fork Chetco River, the Quail Prairie Creek, Eagle Creek, Mineral Hill Fork, Boulder Creek, Fall Creek, Tincup Creek, Granite Creek, Nook Creek etc. All are in the Chetco River watershed.

During high-discharge flows, steep watersheds can involve mixtures of water and sediment in varying proportions. The relative concentration of suspended sediment play an important role in the behavior and hazards of flows. These basic flow processes are generally recognized in streams, although (1) they represent a continuum, and boundaries between flow types are not sharp, and (2) any one flow event may exhibit different flow types at different points along the flow path and at different times during the same event. These three types of flow include:

- **Water flow** – high discharge, overbank flow involving water flow at 'normal' suspended-sediment concentrations (generally less than 5-10% sediment by volume).
- **Hyper-concentrated flow** – large volumes of sand (20-60%) are transported in dynamic suspension throughout the water column.
- **Debris Flow** – Sediment and water mixture becomes a slurry, similar to wet concrete, capable of holding gravel-size particles in suspension when flowing slowly or stopped. In steep canyons flow can achieve high velocities, transport large boulders in suspension, and cause catastrophic damage from impact or burial (USGS Fact Sheet, 2004).

Beyond the potential for direct impact from debris flows on road crossings, culverts and other infrastructure, it is obvious that regardless of the type of flow, damage could take place within and below the burned area, with highest potentials within the Chetco River watershed.

Photo 8: Mass wasting below Red Mountain, Kalmiopsis Wilderness – Headwaters of the Chetco River

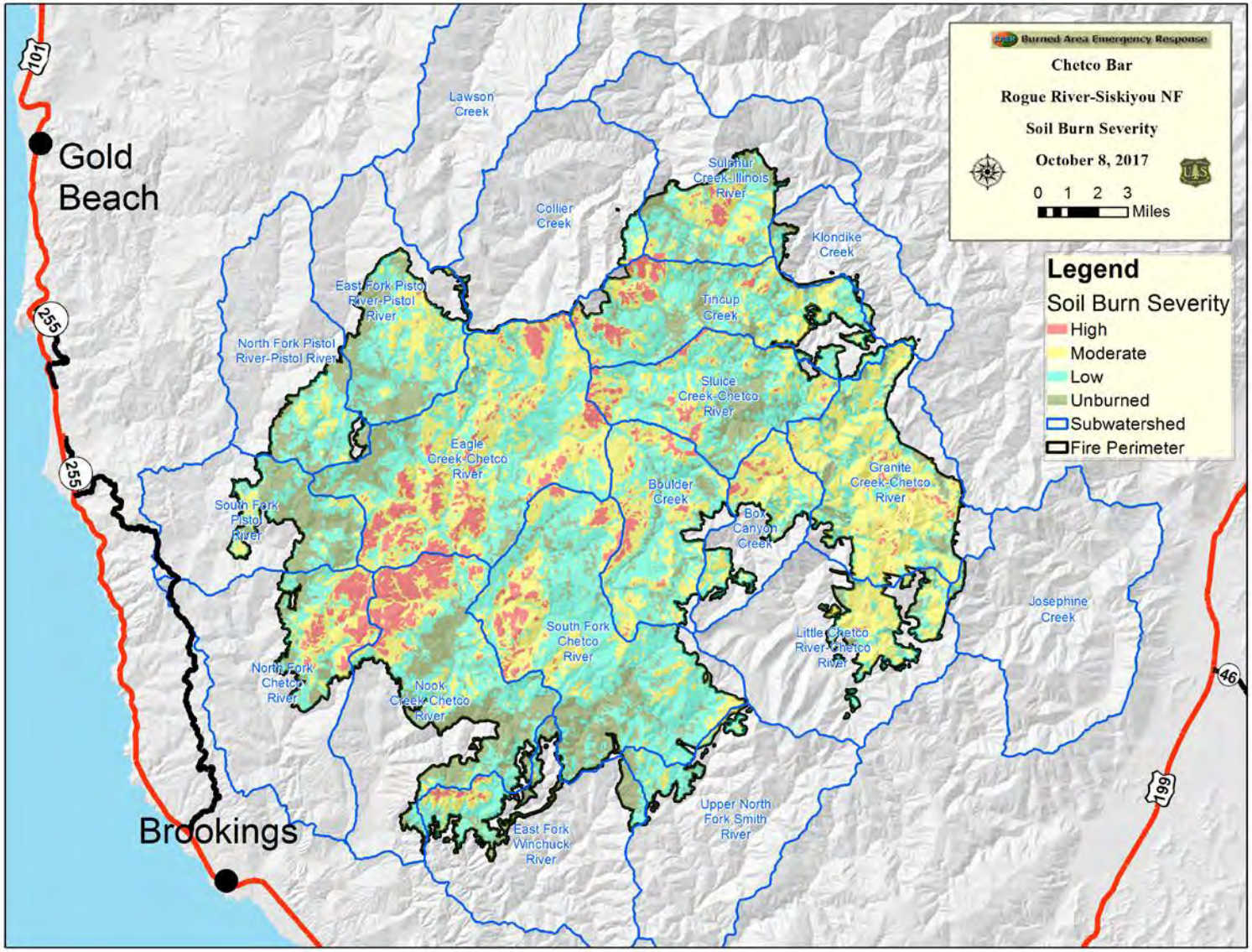


Figure 4: **Soil Burn Severity map - Pier Fire**

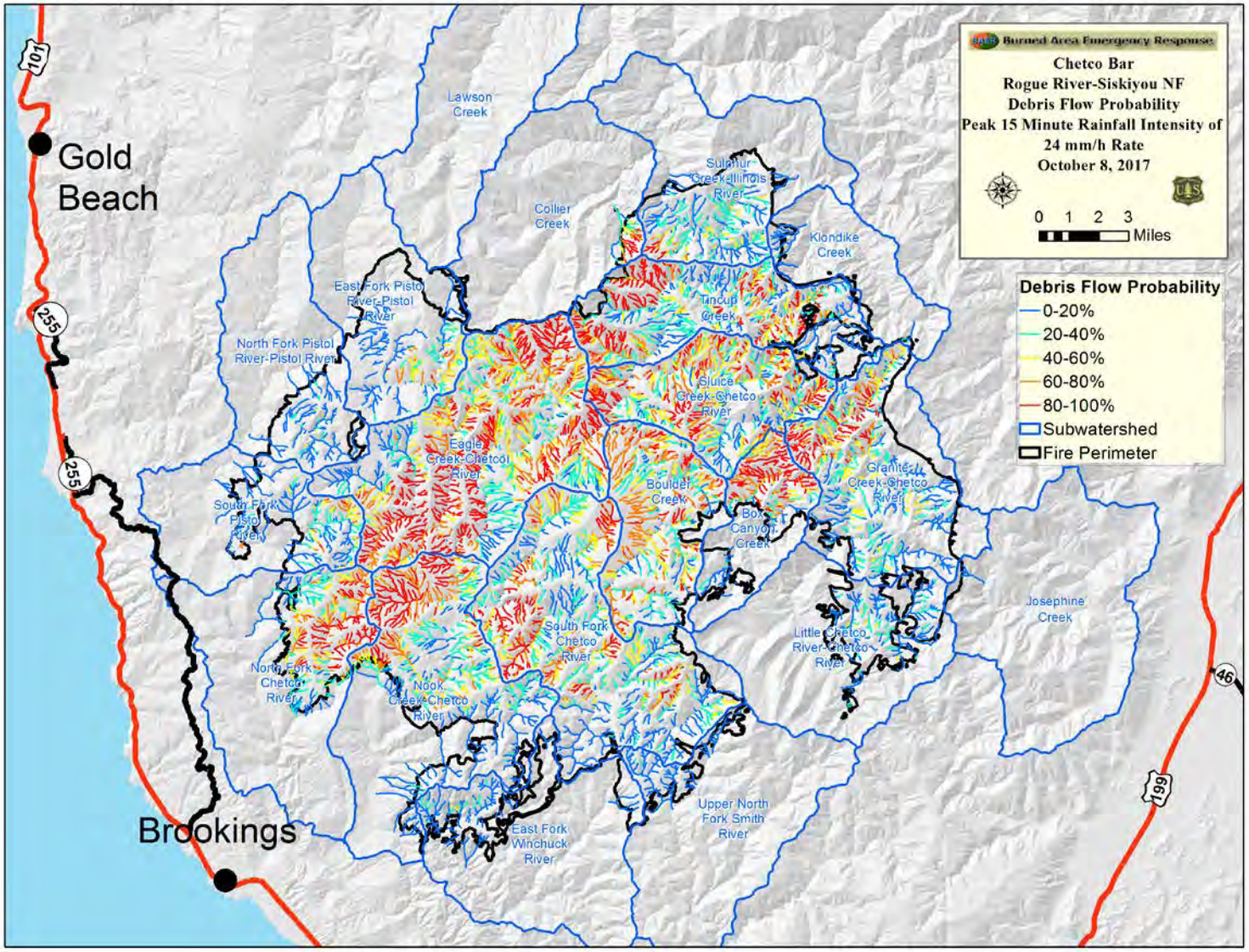
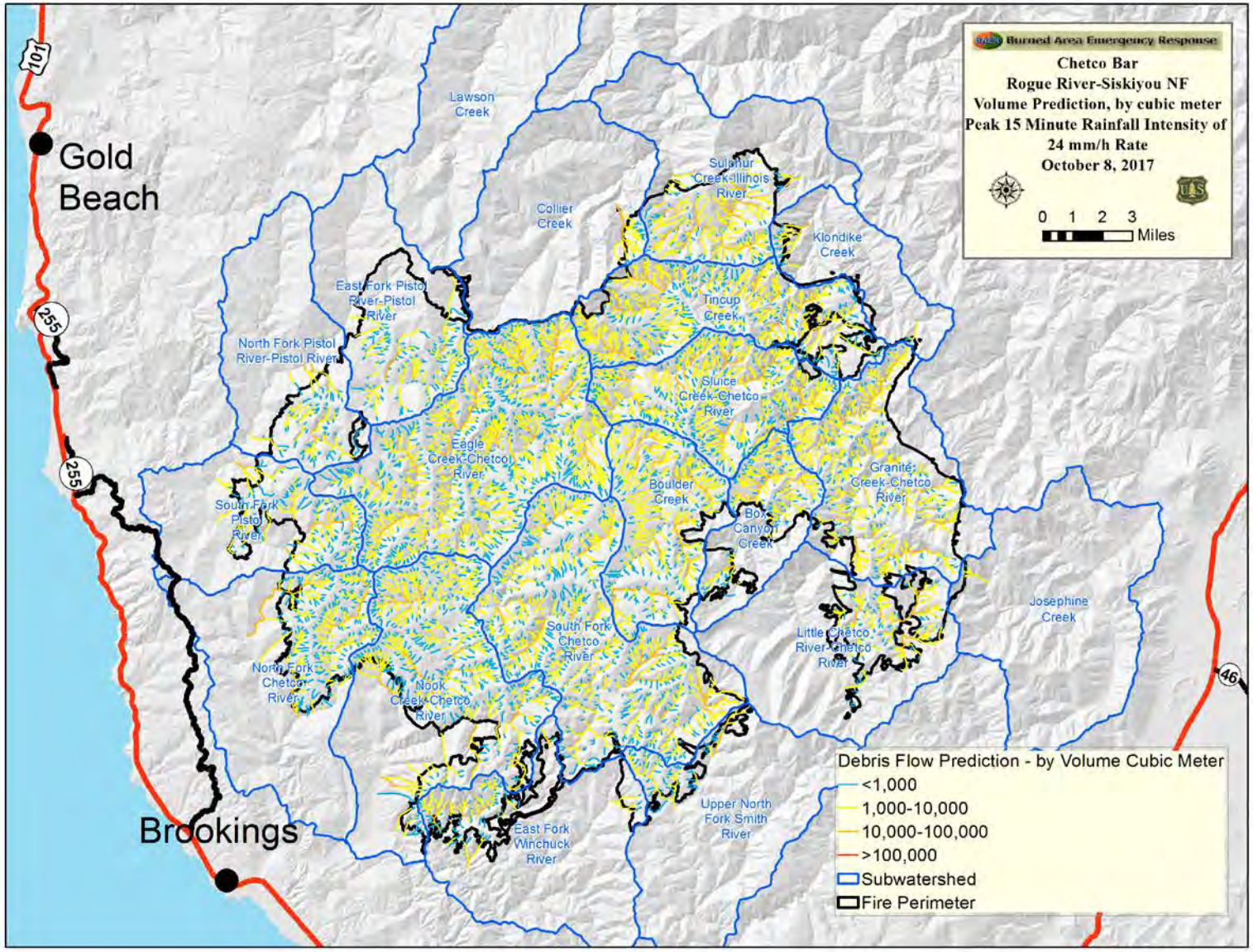


Figure 5: Debris Flow Probability based on a peak 15-minute rainfall intensity storm of 24 mm/h rate storm



<u>Figure 6</u>: Debris Flow volume based on a peak 15-minute rainfall intensity storm of 24 mm/h rate storm

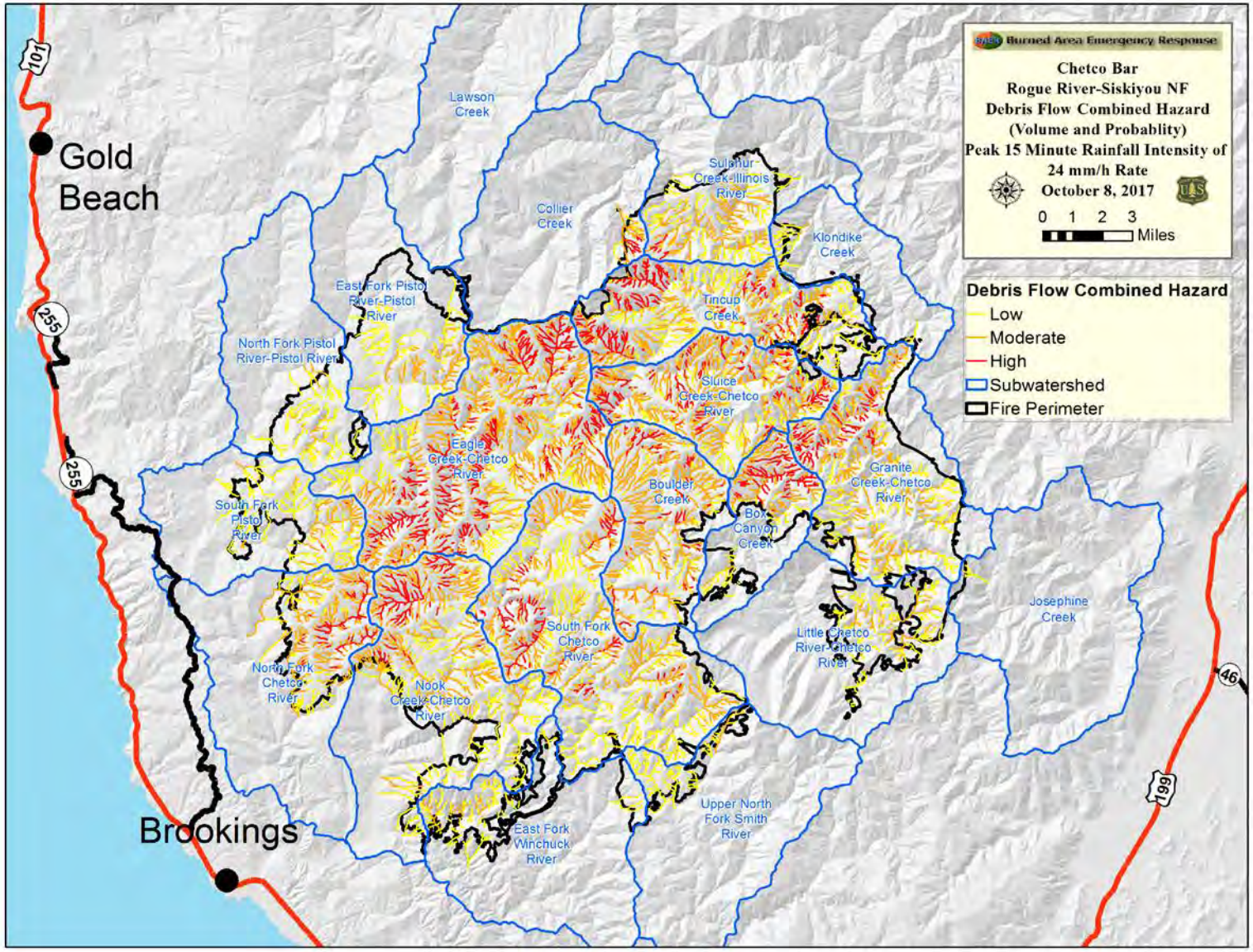


Figure 7: **Debris Flow Combined Hazard based on a peak 15-minute rainfall intensity storm of 20 mm/h rate storm**

II. Potential Values at Risk

The following "values at risk" (VARs) are threatened by debris slides and flows, rockfall, or flooding augmented by the effects of the fire on steep, erosive and unstable slopes and water channels.

Human Life and Safety:

- People recreating and/or traveling through and below burned areas – Loss of life or injury could take place as a result of debris slides and flows, rockfall, or flooding.

Property:

- Forest Service, county and private roads, in addition to trails, and drainage systems – As a result of the fire, excessive runoff and flows, stability of slopes over Forest roads and trails will be compromised. Debris slides and flows, rockfall, and flooding will cause damage to these systems.

Natural Resources:

- Water quality, riparian sustainability and downstream uses – As a result of the fire, excessive sedimentation and debris will adversely affect water quality in and below the burn area.

III. Emergency Determination

The emergency to VARs from geologic hazards caused by the fire includes adverse effects to the health and safety of people, property, roads, trails and natural resources. Risk of loss of life and limb is of particular concern.

Discussion / Summary / Recommendations

Based on ground surveys, air recon and analyzing maps and data, debris slides, debris flows, rock-fall and dry ravel are eminent along numerus burned slopes and creeks within and below the Chetco Bar fire area. In addition, with the aid of USGS Debris Flow Modeling, debris flow probabilities and potential volumes have been calculated. Based on these models it appears that under conditions of a peak 15-minute rainfall intensity storm of 24 millimeters per hour (0.94 inch/hr.), the probability of debris flows occurring is high in many sub-drainages within the Chetco River watershed. Under these same conditions, predicted volumes for many of these debris flows are expected to range from 1K – 10K m^3. From the debris flow combined hazard

map it appears that the combined hazard rating in the burn area ranges from low to high in the burn area, with a concentration of high hazard rating in drainages flowing directly into the Chetco River.

In addition to elevated threats from geological hazards along and above FS system roads, people recreating in and below the burn area, particularly along the Chetco River are at great risk during or right after storm events.

Potential impacts from geological hazards to Values At Risk (VAR's) resulting from the Chetco Bar fire include; concerns for life and safety for people traveling and recreating in and below the burn area; Forest Service, county and private roads and trails, recreation facilities; direct impacts to T&E's and degradation to Critical Habitat of T&E's; Impacts to cultural resources; Negative impacts on water quality and water supply to the municipalities of Brookings and Harbor and potential damage to boats from debris.

The conclusion of our field observations is that whether the primary post-fire process is rock-fall, debris slides, debris flows or sediment laden flooding, the cumulative risk of various types of slope instability, sediment bulking, and channel flushing is high along many slopes and creeks in and below the burn area following the Chetco Bar Fire. Based on the above, special attention and caution is recommended in areas where people are traveling through, working or recreating below or in the burned areas of the Chetco Bar Fire during or right after storm events. Recommended treatments for the geological hazards discussed above include notification of the public of these hazards through an early alert notification system, warning signs and road closures.

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Final Thoughts:

Much discussion occurs during BAER assignments about how specialists seldom get to return to burn areas to evaluate how their estimates of watershed response and effectiveness of treatments actually turned out. Our final recommendation is to establish an annual requirement, just as is the fire refresher and walk/pack test, that specialist attend a field monitoring and assessment session, minimum of 3 days, at least once (and preferably much more often) every two years. Without this kind of learning experience, we are likely to keep making the same mistakes over and over, and not truly understand the physical processes we are trying to manage.

We recommend that the Region and local Forests support and require BAER Team specialists to return with other experts in their field, to the same burned area they evaluated, one and/or two years later to monitor and analyze the effects of winter storms and of implemented treatments. We believe that more learning will occur from this experience than from weeks of office study and training sessions.

Photo: Vulcan Lake - Kalmiopsis Wilderness, Rogue River-Siskiyou National Forest

Appendix 1: Geology Inputs to 2500-8

Part II – Burned Area Description:

Geology and Geomorphology: The Chetco Bar Fire occurred on the west slope of the Klamath Mountains Geological Province, and through an extension of the California Coast Range Provence. The east side of the Chetco Bar fire burned a large portion of the Kalmiopsis Wilderness, which for the most case overlapped the area that was burned by the 2002 Biscuit Fire. The physiography of the region is dominated by rugged canyons and steep slopes mostly draining into the Chetco River and Illinois River watersheds. Out of 191,197 acres that burned in the Chetco Bar Fire, 80% burned within the Chetco River watershed.

The Klamath Mountains include metamorphosed intrusive rocks and the Josephine Peridotite, a large ultramafic body which supports many endemic plants. The ultramafic rocks consist of peridotite and, where altered, serpentinite (also commonly called serpentine). Amphibole gneisses and schists are believed to be the oldest rocks in the area. These are sandwiched between the ultramafic rocks on the east and the underlying Dothan formation. A thin zone of volcanic rocks which have been warped, dragged, and squeezed into the broad zone of the thrust fault is interpreted to originate from the Jurassic Rogue Formation

Part III – Watershed Conditions

Within the burned area of the Chetco Bar Fire, some drainages show a great deal of past mass wasting as rockfall, debris slide and debris flows that will be augmented during future storms. Other watersheds have little evidence of recent past slope instability, but as conditions have changed due to the fire, erosion and mass wasting might be initiated.

In watersheds that experienced moderate to high soil burn serverity, as a result of the removal of vegetation by the fire, soils are exposed and have become weakened, and rocks on slopes have lost their supporting vegetation. Due to these post-fire new conditions, some FS roads are at risk from rolling rock, plugged culverts, debris slides and in some cases, debris flows. Risks to human life, roads, trails and natural resources is moderate to high in some areas of the Chetco Bar Fire.

Base on the USGS debris flow modeling some drainages within the Chetco River watershed have a high probability to produce large debris flows. This is confirmed by field and aerial observations which show that some drainages in this area are loaded with large deposits of un-consolidated, un-sorted rocks, and woody debris available to be transported, which increase the threat to human life, safety and property.

Recommended treatments for upsurge of flooding, hyper-concentrated flows, debris flow, mass wasting and rock fall hazards include notification of the public of these hazards through an early alert system, warning signs and road closures; clearing and improvement of catch basins and ditches along the road; maintenance and up-grade of drainage structures.

Debris Flow Potential:

The US Geological Survey (USGS) - Landslide Hazards Program, has developed empirical models for forecasting the probability and the likely volume of post-fire debris flow events. To run their models, the USGS uses geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm (Staley, 2016). Estimates of probability, volume, and combined hazard are based upon a design storm with a peak 15-minute rainfall intensity of 12 – 40 millimeters per hour (mm/h) rate. We selected a design storm of a peak 15-minute rainfall intensity of 24 millimeters per hour (0.94 inches/hr.) rate to evaluate debris flow potential and volumes since this magnitude of storm seems likely to occur in any given year.

Based on USGS debris flow modeling it appears that under conditions of a peak 15-minute rainfall intensity storm of 24 millimeters per hour (0.94 inch/hr.), the probability of debris flows occurring is high in some channel/creeks within the Chetco River watershed. Under these same conditions, predicted volumes of these debris flows are expected to range from 1K -10K m^3 in these channels.

HYDROLOGY REPORT—CHETCO BAR FIRE BURNED AREA EMERGENCY RESPONSE—ROGUE RIVER - SISKIYOU NATIONAL FOREST

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10/08/2017

OBJECTIVES

The objectives of this report are as follows:

- Describe the potential for increased runoff and related impacts from the Chetco Bar Fire, and determine if the post-fire environment has led to an emergency watershed condition.
- Identify values at risk of damage post-fire flooding within and downstream of the burned area, and estimate the location and magnitude of possible effects.
- Develop treatment recommendations intended to mitigate threats to values at risk.

BACKGROUND

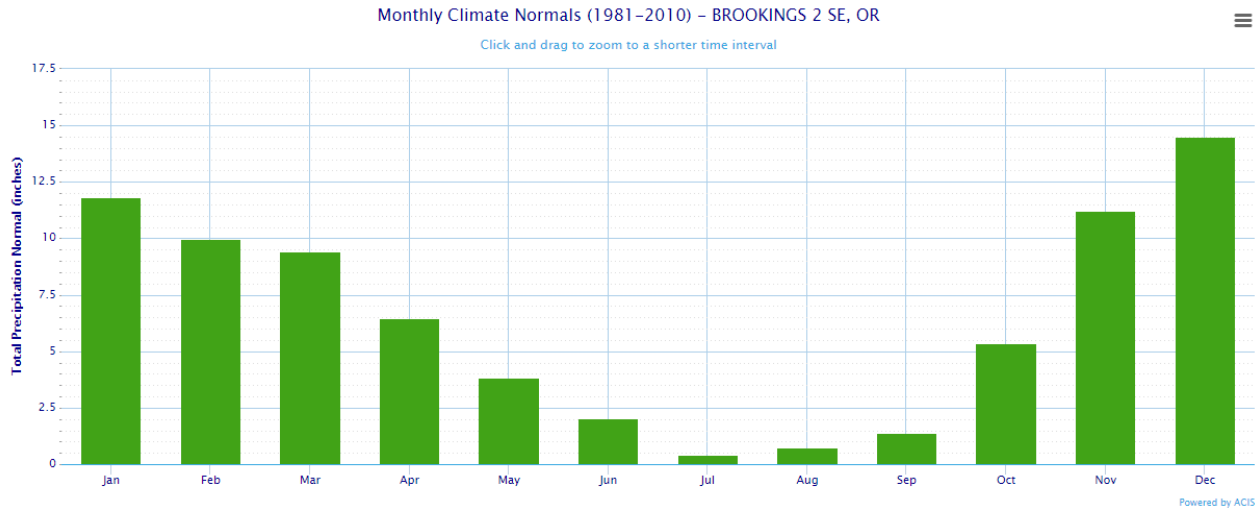
The Chetco Bar Fire started on July 12, 2017. As of the date this report was prepared, the burned area was approximately 191,090 acres, based on the fire perimeter on the date of the acquired satellite imagery (BARC image) used as part of this assessment. Elevations within the fire range from 70 feet above sea level along the Chetco River to just over 4000 feet at several locations in the Kalmiopsis Wilderness. Land ownership within the fire includes 168,724 acres on National Forest System (NFS) land administered by the Rogue River - Siskiyou National Forest, 6,767 acres on public land administered by the Bureau of Land Management (BLM), 225 acres of state lands, and 15,243 acres of private lands.

The burned area is located in the coastal mountains of southwestern Oregon, including areas of temperate rain forest. Average annual precipitation ranges from roughly 80 inches at the lower elevations (Figure 1) to 140 inches near the mountain tops. Precipitation is highly seasonal, the majority occurring from fall to early spring from large frontal systems that tend to be lower intensity, longer duration, and larger in geographic extent. Snowpack accumulates only on the highest peaks ranging between 3000 and 4000 feet above sea level. Summer is much drier and precipitation is from weak frontal systems and localized thunderstorms that tend to be shorter duration, higher intensity, and smaller in size. These storms are relatively infrequent, however. The precipitation season and typical event that will likely drive post-fire flood damage is the November-to-January frontal storm that is larger in spatial extent, longer duration, lower rainfall intensity (inches/hour), but much larger total precipitation amounts.

The Chetco Bar Fire covered parts or all of 20 subwatersheds (6th-level Hydrologic Unit Code basins). Many of them (80% of the area within the fire) are located within the Chetco River watershed, with the remainder in parts of the Illinois, Pistol, Winchuck, and North Fork Smith River watersheds (Table 1). Flow patterns in the area are dominated by periodic heavy rainfall during the winter months (November to April), and much lower precipitation during the summer. The typical seasonal variation for the

Chetco River is an average peak of approximately 40,000 cubic feet per second (cfs), and average low flows less than 100 cfs, based on USGS measurements. Stream flow levels in the river and its tributaries are quite responsive (flashy) during the winter months, dropping or increasing by thousands of cubic feet/second in a matter of days or even hours.

Figure 1. Mean monthly precipitation values for Brookings, Oregon.



A Burned Area Reflectance Classification (BARC) was validated through field review and used to calculate area under different classes of burn severity (Table 2). Soils were tested for hydrophobicity throughout the Chetco Bar burned area to assess the level of water repellency. Under unburned conditions, soils within the fire perimeter are prone to showing some hydrophobicity, especially where soil drying is common during hot, dry summer months. Within the burned area, all areas and soil burn severities (191,197 acres) showed moderate to strong water repellency and hydrophobic conditions. Over time, hydrophobic conditions associated with soil burning diminish as soils undergo freeze-thaw cycling and post-fire revegetation, but recovery of organic material (plants and duff) sufficient to substantially reduce post-fire watershed responsiveness will take from 3-5 years. The soils report for this incident provides more detail on this matter.

Table 1. Sixth-Level Watersheds and Soil Burn Severity within the Chetco Bar Fire. Soil burn-severity area estimates within the 9/28/2017 burn perimeter (acres), derived from the 10/3/2017 Soil Burn Severity (SBS) map.

	Subwatershed			Soil Burn Severity							
Subwatershed Name	Total Acres	% Within Fire	% Outside Fire	High Acres	% Burned	Moderate Acres	% Burned	Low Acres	% Burned	Unburned or Very Low within Fire Acres	% Within Fire
Boulder Creek	13,991	86%	6%	828	6%	5,296	40%	5,875	45%	1,153	9%
Box Canyon Creek	9,561	51%	45%	266	5%	3,166	60%	1,448	28%	358	7%
Collier Creek	22,891	3%	96%	24	3%	261	32%	433	53%	107	13%
Eagle Creek-Chetco River	30,830	91%	0%	4,020	13%	13,028	42%	11,033	36%	2,740	9%
East Fork Pistol River-Pistol River	18,695	38%	45%	39	0%	2,664	26%	4,487	43%	3,144	30%
East Fork Winchuck River	23,846	12%	80%	223	5%	890	19%	1,759	38%	1,799	39%
Granite Creek-Chetco River	21,069	71%	22%	451	3%	10,516	64%	3,928	24%	1,570	10%
Josephine Creek	27,791	1%	99%		0%	82	39%	82	39%	45	22%
Klondike Creek	10,040	4%	93%	6	1%	123	17%	318	44%	280	38%
Lawson Creek	25,256	0%	100%		0%		0%	1	86%	0	14%
Little Chetco River-Chetco River	23,299	19%	77%	35	1%	2,964	56%	1,477	28%	769	15%
Nook Creek-Chetco River	29,150	42%	39%	2,661	15%	3,495	20%	5,962	33%	5,715	32%
North Fork Chetco River	25,618	23%	72%	1,637	23%	2,365	33%	1,835	26%	1,299	18%
North Fork Pistol River-Pistol River	19,241	17%	74%	0	0%	849	17%	2,404	48%	1,730	35%
Sluice Creek-Chetco River	14,478	81%	1%	748	5%	4,026	28%	6,894	48%	2,620	18%
South Fork Chetco River	28,821	79%	5%	1,440	5%	6,644	24%	14,823	54%	4,478	16%
South Fork Pistol River	16,310	18%	61%	7	0%	847	13%	2,115	33%	3,451	54%
Sulphur Creek-Illinois River	22,284	27%	64%	489	6%	2,543	32%	3,043	38%	1,945	24%
Tincup Creek	17,748	72%	14%	1,130	7%	4,307	28%	7,372	48%	2,425	16%
Upper North Fork Smith River	24,536	7%	91%	5	0%	478	22%	1,324	60%	397	18%
Grand Total	**425,455**	**36%**	**55%**	**14,012**	**7%**	**64,545**	**34%**	**76,613**	**40%**	**36,027**	**19%**

POST-FIRE HYDROLOGIC CONDITIONS

Hydrologic response following wildfire in the Chetco Bar burned area will include reduced interception and infiltration of precipitation, increased runoff and erosion, higher stream flow volumes for a given precipitation input, and a more rapid rise of stream and river levels compared with those of unburned conditions. Additionally, the probability of severe erosion, debris torrents, and hillslope failures is substantially higher, and will remain so for at least the next few years. Road-stream crossings and road other drainage systems are particularly vulnerable to damage following wildfire. Culverts throughout the burned area lack the capacity and inlet protection to accommodate elevated peak flows, and prevent inlet plugging.

Water quality in streams that drain the burned area will be impaired during runoff events, particularly in the peak flow season of November to April. An initial flush of ash and fine sediment is expected during and following the first large rain events of the fall season. Suspended sediment loading and turbidity levels in streams within and below the burned area will be elevated during runoff season until groundcover becomes re-established. Even after groundcover stabilizes burned area hillslopes, eroded fine sediment that is deposited in stream and river channels and floodplains in the next few years will continue to move through the system for many years to come. Large woody debris will likely accompany the initial flushes of fine sediments and ash, with continual downstream delivery of large debris throughout the winter high flow season, likely peaking during the first month of high flows (Nov-Dec). This material will likely include logs, wood, and other floating debris that will move downstream,

affecting the Chetco River and Brookings Harbor. Additionally, levels of some nutrients will likely be elevated in concert with higher turbidity and suspended load. Lastly, stream temperature is likely to increase relative to pre-fire conditions where shade has been lost. Riparian vegetation will recover in a relatively short period of time, but shading for larger channels from tall trees will take decades to recover. Changes in water quality can impact aquatic resources and habitat, as well as municipal water treatment facilities and supply.

Recent studies of the effects of wildfire on municipal water supply have identified increases in nitrates, phosphorous, dissolved organic carbon, turbidity, total suspended solids, and metals in streams draining areas affected by wildfire (Emelko et al., 2011; Rhoades et al., 2011; Writer et al., 2012). Elevation of concentrations of some nitrogen compounds in source water can result in higher water treatment costs and other impacts to municipal water quality (Emelko, et al., 2011). The effects of a wildfire on source-water quality can be long-lasting—in the Rocky Mountains of Alberta, post-fire water quality degradation persisted throughout a ten-year analysis period following the fire (Emelko et al., 2011). A USGS assessment of a municipal drainage in Colorado found that poor water quality following the Fourmile Canyon Fire periodically exceeded the treatment capacity of municipal facilities (Writer & Murphy, 2012).

VALUES AT RISK

Values at risk of damage from post-fire erosion, flooding, and debris flows within and below the Chetco Bar fire exist on both private and NFS land. The BAER program assesses and treats values at risk on National Forest System (NFS) land, including FS-maintained roads that cross private property. BAER human life and safety values at risk from flooding-related impacts include campers at riverside camping areas, public safety and egress on FS roads (especially the Chetco River Road to Wilderness Retreat). Human life and safety values potentially at risk off of NFS-managed land include homes and businesses along the Chetco, Pistol and Winchuck Rivers, municipal water intakes for the communities of Brookings and Harbor, and smaller water diversions within or downstream of the burned area, including a diversion in Second Creek servicing some properties in the Wilderness Retreat subdivision. Brookings harbor itself is potentially at risk from an increase in large woody debris carried downstream by the Chetco River. Other values at risk include transportation infrastructure (e.g. roads, trails, and culverts), as well as aquatic habitat (including critical habitat for ESA-listed species), water quality and soils.

Campgrounds where the public may be at risk from more rapid increases in flood flows and debris-laden flood waters include Redwood, Miller, and Nook Bars, as well as the two South Fork Chetco River campgrounds. Chetco River stream flow typically rises beginning in October and depending on the rate of rise, could block egress from the Bars. The South Fork campgrounds may be particularly at risk due to their locations in and directly below a confined reach of the river. The south side of the river just upstream of the upper campground has extensive moderate to high soil burn severity, and shows evidence of previous hillslope failures. A post-fire landslide or debris torrent has the potential to temporarily block the river, which would likely cause a pulse of debris-laden flood waters that could inundate the campgrounds. Redwood Bar is also bisected by Redwood Creek, which has such little flow in the summer that it often does not reach the river. If a debris torrent flowed down Redwood Creek while Redwood Bar was still exposed and occupied, it could inundate a portion of the bar with wood and rock-laden water, as well as isolate the southern part of the bar from the egress road. This steep, unstable, roaded drainage shows evidence of a recent massive landslide (likely in the winter of 2016-17)—the probability of such events is higher following the fire. Winchuck Campground is also below the burned area, but is unlikely to be vulnerable to post-fire inundation due largely to its position on a high terrace, but also due to the relatively low percentage of burned drainage area above it.

Several road-stream crossings identified on Forest Service roads within and immediately below the burned area are at risk of damage from elevated post-fire runoff. Many ditch relief culverts are partially plugged, and most of these cross drains are likely to become plugged by erosion from burned, over-steepened cut-slopes and increased ditch flow eroding into the ditch and culvert inlet. Post-fire peak flow estimates demonstrate that several stream culverts are undersized for potential post-fire flow events. Moreover, many culverts drain steep, burned drainages that are likely to deliver debris flows that could plug inlets and lead to culvert and road failures. Several such culverts exist on the paved section of FSR 1376 downstream from Wilderness Retreat. Maintaining flow through these culverts will be critical in protecting this egress route.

Numerous rivers and streams within the Chetco Bar Fire are designated critical habitat for Coho salmon, and are at risk of sedimentation from the large area of high and moderate burn severity within most of these watersheds. Soil development and productivity are also at risk from extensive overland flow, rilling and rutting, and related erosion—particularly within the areas with highest-severity burn impacts.

Although the municipal water supply for Brookings and Harbor is not a BAER value, it is certainly a value at risk of impact from reduced water quality in the Chetco River. While the systems of collection for both supplies have the advantage of filtration through gravel bars, both intakes are likely to be exposed to levels of turbidity that could impact the systems' ability to adequately treat it. Brookings' system is more likely to be able to cope with higher turbidity given its secondary sand/anthracite treatment module, but Harbor does not have this system. The intake systems are also potentially vulnerable to lateral and vertical channel scour from higher peak flow events. Higher levels of dissolved organic compounds in the water could also pose a problem when exposed to chlorine, in the form of disinfection byproducts that could temporarily exceed water quality standards.

Using the BAER risk assessment matrix, the risk level for road damage ranges from Very High (Very Likely Probability, Moderate Consequence) to High (Likely Probability, Moderate Consequence).

Table 2. BAER risk assessment matrix.

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
	RISK		
Very Likely	Very High	Very High ***Roads/culverts, Water Quality***	Low
Likely	Very High	High ***Roads/culverts, soil quality/stability***	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

<u>POST-FIRE PEAK FLOW ESTIMATION – TABLE LOCATED IN APPENDIX 1</u>

To estimate potential effects to identified values, pre and post-fire peak flows were modeled for numerous drainages within the fire, including 5 larger drainages (1000 acres+), and 15 smaller drainage basins (Appendix 1). Smaller drainages were generally selected based on concerns to specific road/stream crossings. The drainage basins were analyzed in burned and unburned conditions for a 24 hour storm, with a 25 year return interval. Precipitation inputs were determined with the Precipitation-

Frequency Atlas of the Western US (NOAA, 1973) and a 2008 regional precipitation frequency analysis for Oregon (Schaefer et al, 2008). The larger drainages were evaluated using USGS regression equations for ungauged basins (Cooper, 2005), and the smaller drainages were evaluated using Fire Hydrology (Cerrelli, 2002, 2005). Fire Hydrology is a runoff curve number method using a spreadsheet version for calculations and depends on use of soil runoff curve numbers to estimate runoff. Runoff curve numbers for modeled watersheds were derived from the tables within the NRCS spreadsheet, SCS reference and local knowledge of infiltration conditions, in conjunction with burn severity and hydrophobicity data collected by the BAER team. The RCN values selected as input for the analysis were based on soil hydrologic groups B, C, and D and are shown in Table 2.

Table 2. Soil Curve Numbers Used in Model Analysis

	Soil Burn Severity			
Soil Hydrologic Group	Unburned	L	M	H
A	None within fire area			
B	55	62	75	80
C	68	76	88	93
D	76	81	91	96

Table 3. Flow Estimates for 25 Yr Return Interval

Modeled Drainage	Pre Fire Q (ft^3/s)	Post Fire Q (ft^3/s)	% Increase
1376_01	78	89	14%
1376_02	9	11	22%
1376_03	70	103	47%
1376_04	76	114	50%
1376_05	59	82	39%
1376_06	57	74	30%
1376_07	65	86	32%
1376_08	34	41	21%
1376_RedwoodCk	189	250	32%
1376_BigRedwoodCk	767	978	28%
1376_SecondCk	380	494	30%
1376_FirstCk	191	248	30%
1983_01	56	120	114%
1983_02	27	66	144%
ChetcoBrookingsIntake	84200	111312	32%
ChetcoGage	72500	99543	37%
QuailPrairie 1909	328	428	30%
SFChetco	11500	14732	28%
Winchuck_Lower	13600	14062	3%

WinchuckRiverCG	10300	10764	5%

Estimated post fire flows in range from an increase of 3% - 144%, and are a much higher percentage increase on smaller, headwater channels. These estimates predict the increase in water runoff, but do not account directly for sediment bulking that is can occur during post fire runoff events. While significant flow bulking is an unpredictable phenomenon, it is most commonly seen in steep watersheds with extensive areas of moderate and severe burn severity. Some degree of flow bulking is likely to occur in the watersheds affected by the Chetco Bar Fire if the area experiences a strong convective storm or rain-on-snow event within the next few years. With bulking, an elevated risk of culvert failure exists, where culverts are unable to pass the increased amount of material delivered to the culvert. Likewise, flow estimates do not predict or account for large debris that is readily available and more easily transported post fire, making plugging of culverts at stream/road crossings more likely to occur.

Recommendations

Downstream private landowners, agencies, and communities are strongly encouraged to evaluate the risk to individual values on private land within and below the burned area, and explore avenues for mitigating those risks through NRCS, ODF, and other agencies. Mitigations could include debris deflectors above buildings, installation of larger culverts where pipes are currently undersized or damaged, and stream crossing fill-slope hardening. The City of Brookings and Harbor municipal water treatment facilities are strongly encouraged to evaluate the risk to water quality, increased scour and erosion, and channel migration. Local communities are also encouraged to work with the National Weather Service to identify opportunities for early warning systems.

Treatments recommended under BAER authority for values at risk on Forest Service land are presented in the following section.

Treatments For Hydrologic Values at Risk

As described above, the primary critical values at risk from increased runoff and associated debris include human life and safety, property, and downstream impacts to aquatic habitat, including critical habitat for Coho. Roads have culverts at which post-fire precipitation runoff and associated debris would likely not pass existing sizes. Culverts and road prism failures can deliver road sediment and debris to streams, affecting aquatic habitat locally and downstream. Road failures may cut off egress routes, affecting human life and safety. The affected area also includes campgrounds and river access within the active floodplain. Egress for recreationists may be affected by shortened rise time of post-fire flood events during the high flow season (fall, winter, spring). Depending on the location of the road-stream crossing, critical habitat for Coho may also be affected (for more information on critical habitat, see fisheries report).

Treatment recommendations have been developed to mitigate risk to BAER critical values. Treatment recommendations include roads maintenance, signage, temporary and/or seasonal closures, and monitoring. General treatment recommendations are described in greater detail in Table A2-1 in Appendix 2.

Signage should be placed and maintained for a period of two years, in areas of common ingress to the burned area, warning users of the increased risk of recreating next to streams. Monitoring should also be included in the Chetco Bar Fire BAER effort. Specialists should monitor regional streamflow and weather due to increased chance of flooding throughout and downstream of the burned area. The funding request should include days for evaluating the effectiveness of the treatments proposed in this report, particularly following high storm or runoff events in the first year following treatment.

On FS lands, several roads have culverts that would not accommodate post-fire runoff—particularly when bulked with sediment and large woody debris. At these sites, culverts are recommended for upgrade or removal. If upgrade or removal is not feasible, overflow diversion features should be installed to reduce the potential for diversion down the road and to divert water off of road surfaces. Examples include drain dips, armored sags/dips, water bars, and deep water bars immediately downslope of stream crossings on insloped roads. Debris deflectors should be installed at culvert inlets downstream of moderate and high-severity burned areas to reduce the probability of culvert plugging from debris. Culvert inlets and ditches should be cleared during the fall of 2017, and periodically during the first years following the fire, as they are likely to become clogged repeatedly until watershed groundcover becomes re-established. Culverts at high risk of failure should be upgraded or removed on specific roads.

A number of stream crossings were identified as having treatment recommendations above and beyond the general prescriptions described above and in Table A2-1 in Appendix 2. Field evaluation and post-fire flood predictions identified select stream crossings as being insufficient to meet the post-fire flood predictions, as described in the analysis and methods sections above. These treatments are recommended in addition to other treatments such as storm patrol, ditch cleaning, etc. described above. Treatment recommendations at site-specific stream crossings are described in greater detail Table A2-2 in Appendix 2.

In addition to the high risk of flooding and debris flow events throughout the burned area, streams and steep mountainous areas will have increased geomorphic instability, leading to an increased risk of hillslope failures. This is a particular concern in the South Fork Chetco River and other creeks where hillslope instability and ongoing slumping upslope has been identified. For more information on landslide vulnerability, see the geology report. While these areas have been unstable for many years, the post-fire conditions have greatly exacerbated instability and substantially increased the risk of broad-scale failure at the site. Road treatment recommendations below are not directed at mitigating the risk of landslides, but are designed to mitigate the risk of damage from debris flows.

Excerpt from 2500-8

PART IV - HYDROLOGIC DESIGN FACTORS

A. Estimated Vegetative Recovery Period, (years): 1-3 years grass (achieve % effective ground cover), 5-15 years shrubs, 20-70 years conifers

B. Design Chance of Success, (percent): 50-90%, depending on site and treatment

C. Equivalent Design Recurrence Interval, (years): 25-year post-fire

D. Design Storm Duration, (hours): 24-hour

E. Design Storm Magnitude, (inches): 8.7 inches

F. Design Flow, (cubic feet/second/square mile): varies by drainage—see hydro report

G. Estimated Reduction in Infiltration, (percent): See Soils Report; there was already an induced background hydrophobicity, so the fire did not result in substantially increased hydrophobic conditions

H. Adjusted Design Flow, (cfs per square mile): n/a

Design Storms used in flow calculations

Chetco Bar - RI	6 hr	24 hr
2 yr	2.4	5.5
5 yr	2.8	6.5
10 yr	3.2	7.7

Chetco Bar - RI	6 hr	24 hr
25 yr	3.8	8.7
50 yr	4.1	9.5
100 yr	4.5	10

2 values given due to large analysis area with substantial elevation range, area of concern crosses isopluvial line. Lower value applies to a greater area due to topography. Source NOAA Atlas 2 Volume 10.

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Appendices:

Appendix 1- pre- and post-fire hydrologic modeling

Appendix 2- treatment recommendation tables

Appendix 3- maps

Appendix 1- pre- and post-fire hydrologic modeling

Appendix 1. Estimated post-fire peak flow magnitudes in cubic feet per second (cfs) for 15 drainages; 5 larger drainages used USGS regression equation and modeled for 50 year pre and post fire event; 15 smaller drainages used Fire Hydro for 2, 5, 10, 25, and 100 year return interval events. Pre-and post-fire peak flow normalized by watershed area (cfs/mi^2) is reported for the Q25 design flow.

			Pre-fire (cfs)					Post-fire (cfs)					Q25 (cfs/mi^2)	
Model Drainage Name	Water-shed Area (ac)	% High & Mod SBS	Q2	Q5	Q10	Q25	Q100	Q2	Q5	Q10	Q25	Q100	Pre-fire	Post-fire
*ChetcoBrookings-Intake	214538	32.2	41400	58600	69800	84200	106000	54731	77469	92276	111312	140132	251	332
*ChetcoGage	173581	37.3	35900	50700	60200	72500	90800	49291	69611	82655	99543	124668	267	367
*SFChetco	28790	28.1	5390	7810	9430	11500	14800	6905	10005	12080	14732	18959	256	327
*Winchuck-Lower	33179	3.4	5750	8780	10900	13600	17900	5946	9079	11271	14062	18509	262	271
*WinchuckRiver-CG	24620	4.5	4350	6650	8220	10300	13600	4546	6949	8590	10764	14212	268	280
1376-01	71	5.6	32	45	62	78	96	43	58	75	89	108	699	807
1376-02	7	14.3	4	5	7	9	11	6	7	9	11	13	796	1012
1376-03	65	81.5	28	40	56	70	88	58	72	89	103	122	688	1016
1376-04	72	84.7	31	44	61	76	96	65	80	99	114	135	677	1017
1376-05	54	53.7	24	34	47	59	73	45	56	70	82	97	694	971
1376-06	52	25	23	33	46	57	72	39	50	63	74	89	706	916
1376-07	61	36.1	26	38	52	65	82	46	58	73	86	103	684	906
1376-08	31	10	14	20	27	34	43	20	27	35	41	50	700	855
1376-BigRedwoodCk	881	19	302	435	611	767	965	505	651	828	978	1176	557	710
1376-FirstCk	196	27.6	76	109	152	191	240	130	166	210	248	297	623	809
1376-RedwoodCk	194	35.1	75	108	151	189	238	133	169	213	250	300	623	826
1376-SecondCk	408	29.7	151	217	303	380	478	259	331	419	494	593	596	775
1909-01	286	87.1	153	209	275	328	398	245	301	370	428	503	733	957

			Pre-fire (cfs)					Post-fire (cfs)					Q25 (cfs/mi^2)	
Model Drainage Name	Water-shed Area (ac)	% High & Mod SBS	Q2	Q5	Q10	Q25	Q100	Q2	Q5	Q10	Q25	Q100	Pre-fire	Post-fire
1983-01	102	82.4	13	25	41	56	77	58	78	101	120	145	350	753
1983-02	46	98	6	12	20	27	37	36	45	57	66	79	379	925

*Utilized USGS regression model

Appendix 2. Treatment recommendations

Table A2-1. Treatment recommendations. Sites assessed for potential treatments due to elevated risk of damage from post-fire runoff.

Site Type	Site Name	Values at Risk	Recommendation(s)
Campgrounds and river access roads in the active floodplain	South Fork Chetco (upper and lower), Redwood Bar, Miller Bar, Nook Bar	Human life and safety, egress	• flood warning signs • temporary (1-3 year) seasonal closures • physical closure device (i.e. gate) at road entrance • temporary (1-3 year) seasonal restriction of overnight camping
FS road access to private inholdings	FSR 1376 paved road downstream from Wilderness Retreat (Chetco River Road)	Human life and safety, egress, road infrastructure, water quality in Chetco River (critical habitat for Coho)	• entering burned area warning sign at entrance to FS lands • replacement of high-priority undersized culverts • overflow protection at stream crossings to prevent diversion potential • inlet debris deflectors at stream crossings to catch large wood and debris • storm patrol • clean ditches and ditch-relief culverts
Select FS Maintenance Level (ML) 2 and 3 roads	FSR 1376 road above private inholdings, All ML 2 and 3 roads downslope of moderate-high burn severity areas	Human life and safety, egress, Road infrastructure, water quality, hydrologic function, water quality in critical habitat	• temporary closure (1-3 years) to reduce probability of injury or stranding from road failure • replacement of high-priority undersized culverts • high flow relief at stream crossings to prevent diversion potential • inlet debris deflectors at stream crossings to catch large wood and debris • storm patrol • clean ditches and ditch-relief culverts

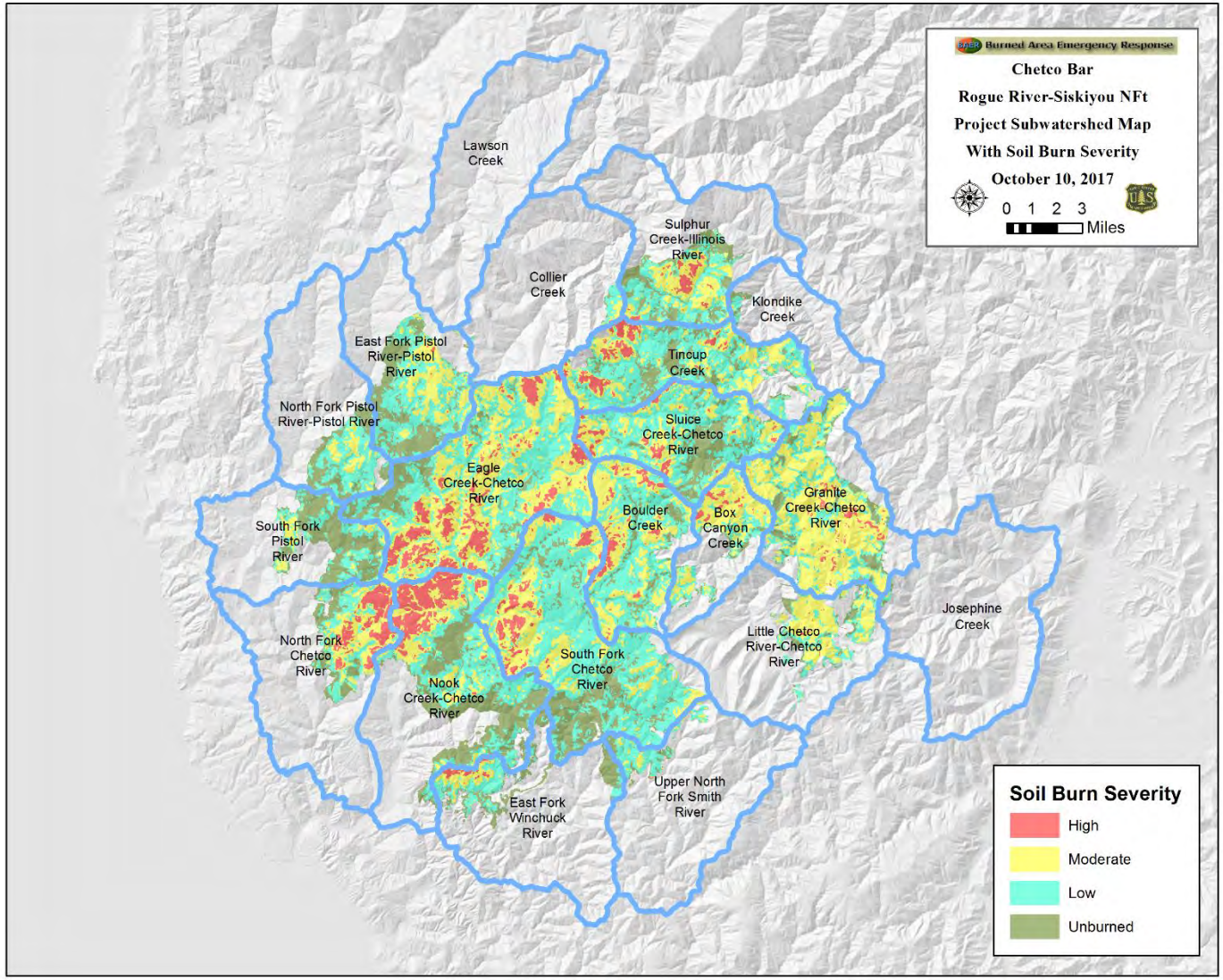
Site Type	Site Name	Values at Risk	Recommendation(s)
Select FS Maintenance Level (ML) 1 roads and inaccessible ML 2 roads	FSR 1107620, ML 1 roads and non-system roads downslope of moderate-high burn severity areas	Road infrastructure, water quality (WQ), hydrologic function	• physical barriers to restrict access • where feasible, remove culverts to reduce probability road failure
Monitoring	Roads receiving BAER treatments		• Specialists should monitor regional weather for upcoming storm events to anticipate demand for storm patrol • Specialists should evaluate the effectiveness of the road treatments proposed in this report, particularly following runoff events in the first year following treatment

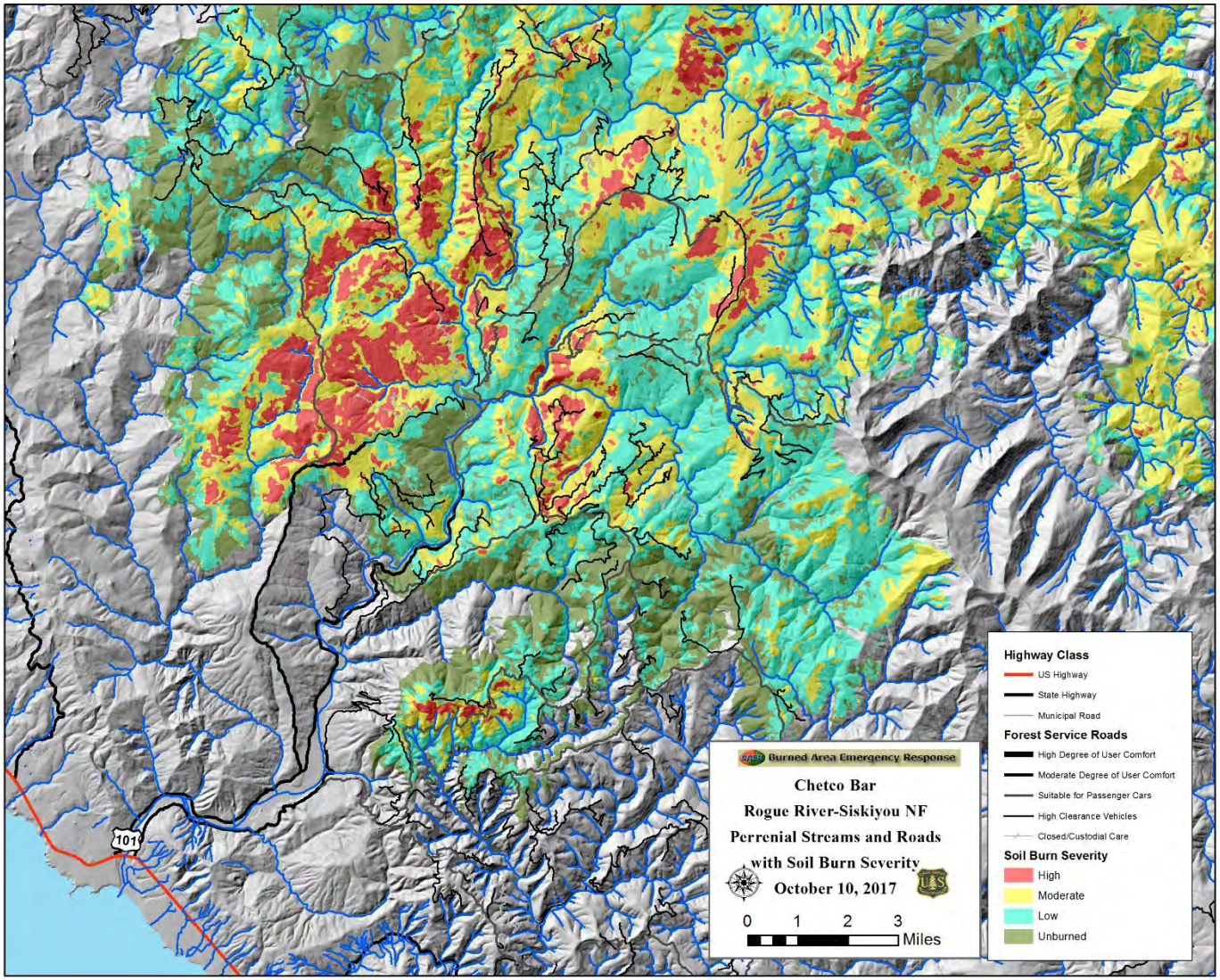
Table A2-2. Table Site-specific road treatment recommendations

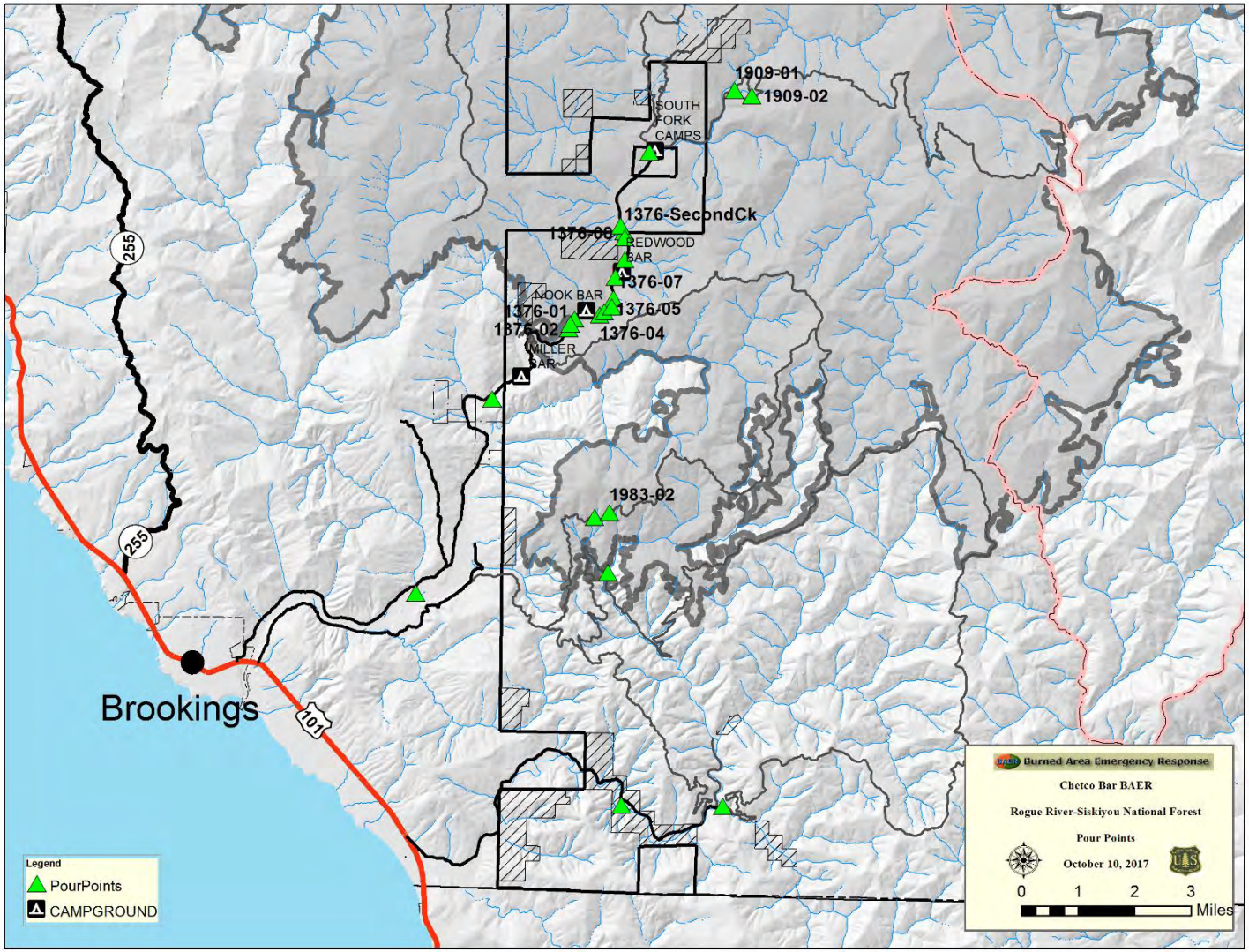
Road number	Site ID *(see map)*	VAR (values at risk)	Proposed Treatment
1376	1376-01 1376-02 1376-03 1376-04 1376-05 1376-06 1376-07 1376-08	Human life and safety, egress, road infrastructure, water quality in Chetco River (critical habitat for Coho)	• High flow overflow T-riser at the stream crossing to increase flow capacity • Install inlet debris deflectors at stream crossings to catch large wood and debris

Road number	**Site ID** *(see map)*	**VAR** (values at risk)	**Proposed Treatment**
1376	1376- Second Creek	Human life and safety, egress, road infrastructure, water quality in Chetco River (critical habitat for Coho)	• Replace culvert with arch pipe. Meet all forest plan standards for culvert replacement (as amended by the NW Forest Plan). Design for the post-fire 25 year event (or pre-fire 100 year event) • Install deflector posts to catch large wood and debris
1909, 1983	1909-01 1909-02 1983-02	Human life and safety, egress, road infrastructure, aquatic habitat	• Replace and upsize culvert to handle the post-fire 25 year event. Meet all forest plan standards for culvert replacement (as amended by the NW Forest Plan). • Install inlet debris deflectors at stream crossings to catch large wood and debris

Appendix 3. Hydrology maps




Burned Area Emergency Response
Chetco Bar
Rogue River-Siskiyou NF
Perrenial Streams and Roads
with Soil Burn Severity
October 10, 2017
0 1 2 3
Miles
101
Highway Class
US Highway
State Highway
Municipal Road
Forest Service Roads
High Degree of User Comfort
Moderate Degree of User Comfort
Suitable for Passenger Cars
High Clearance Vehicles
Closed/Custodial Care
Soil Burn Severity
High
Moderate
Low
Unburned


1909-01
1909-02
SOUTH FORK CAMPS
1376-SecondCk
1376-08
REDWOOD BAR
1376-07
NOOK BAR
1376-01
1376-05
1376-02
1376-04
MILLER BAR
1983-02
255
255
101
Brookings
Legend
PourPoints
CAMPGROUND
Burned Area Emergency Response
Chetco Bar BAER
Rogue River-Siskiyou National Forest
Pour Points
October 10, 2017
0 1 2 3
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ROGUE RIVER - SISKIYOU NATIONAL FOREST
BURNED AREA EMERGENCY STABILIZATION PLAN

CHETCO BAR FIRE

ENGINEERING RESOURCE ASSESSMENT – TRANSPORTATION SYSTEM

I. OBJECTIVES

A field investigation of existing forest transportation system within the boundaries of the Chetco Bar Fire located mainly on the Gold Beach Ranger District of the Rogue River - Siskiyou National Forests was conducted between the dates of September 30th to October 4th, 2017.

The purpose of the engineering investigation was to assess potential negative effects on roads, bridges, culverts and other hydraulic structures attributable to the post-fire condition of the watersheds. The investigation also looked at those safety and warning structures required to provide safer passage to motorists accessing the Forest on authorized roads within the burn area. This report provides a general summary of the issues, findings and recommendations resulting from the investigation.

This report only addresses roads on the Gold Beach Ranger District; although the fire did burn over the district boundary into the Wild Rivers Ranger District, no roads were burned over or impacted by suppression activities.

II. ISSUES

The watersheds burned in the Chetco Bar Fire will show the effects of the fire due to increased runoff rates, erosion, sediment, and debris transport creating a future concern for roads, culverts, bridges, and channels along the drainage paths of the burned watersheds in that they may be plugged, overtopped or washed away more frequently than in its pre-fire condition. There is also increased danger to structures that remain in the flood path due to the increased risk for debris slides and flooding.

This report identifies roads and structures that will continue to be impacted by post-fire debris flows and flooding, assesses their current condition and vulnerability, and where necessary, recommends treatments to minimize the risks to public safety and protect the investment of the transportation system from the expected increased post-fire runoff.

III. OBSERVATIONS

A. Background

The Chetco Bar Fire contains segments of forest system roads within the fire perimeter. The total mileage per maintenance level is shown in the table to the right.

User created routes are also contained within the fire perimeter but were not assessed.

SYSTEM OF ROADS WITHIN THE FIRE PERIMETER	
Maint. Level	Miles
5	0.0
4	5.4
3	83.4
2	176.5
1	16.7
Total -	282.0

B. Reconnaissance Methodology and Results

The engineering team was able to field visit most of the Forest's maintenance level two thru five roads within the fire perimeter. Priority was given to roads that traversed areas showing high burn severity. The roads that were not examined were blocked by large downed trees, or were not in high or moderate burn severity areas.

The roads that were examined included the following:

NFSR 1107 (Winchuck-Chetco)
NFSR 1107570 to 1107577
NFSR 1107620
NFSR 1205 (Lower Wheeler)
NFSR 1376 (Chetco River)
NFSR 1376310 to 1376311
NFSR 1376080 (Nook Bar Campground)
NFSR 1407 (Chetco-Pistol)
NFSR 1407150
NFSR 1407180
NFSR 1909 (Pollywog Butte)
NFSR 1909050
NFSR 1909200
NFSR 1917 (Long Ridge)
NFSR 1983 (Emily)
NFSR 3680360

The results of the field investigation identified threats to public safety, loss of government property, threats to downstream property and deterioration of the roadway system due to increased runoff and sedimentation.

A more detailed description of the proposed treatments and corrective action for the road infrastructure, as well as for the critical drainage crossings that were observed on these roads, is included in this report.

C. Findings

The reconnaissance of the roads and upstream drainages during the field investigations identified several issues pertaining to road stabilization and public safety. The major road stabilization issues identified were debris flows that consist of woody debris, rock and soil deposition that when being washed downstream will potentially plug culverts, damage road infrastructure, and wash heavy debris and sediment into the surrounding drainages. The main issue identified with public safety was the risk of adjacent hazard trees falling across the roads, traffic warning signs burned and no longer warning drivers of road hazards, and the shoulders of the road on the downslope side slumping off and causing the width of the road to narrow.

Table-1 contains a list of the roads that were examined during the field investigations along with their associated issues. There are also additional roads that were not examined but have been added because based on the BARC map, it appears they would have the same issues as the roads they intersect.

Table-1 Issues identified during field investigations

Road Number(s)	Maint. Level	Issues / Observations
1107000	3	A large sum of the road traverses through the fire perimeter but very little runs through a section of high severity burn and where it does the road is on top of a ridge line. Basically no real issues to report and only recommendation is to clean the ditches and culvert catch basins in those areas where the road is located in the high and moderate burn severity.

1107550 thru 559[1]	2	These sum of roads all lie within a majority of high and moderate burn severity. These roads are situated high on the ridge top and shed their runoff in side channels that run to the South Fork of Chetco River. Based on the burn severity these roads will also contain hazard trees. Even though these roads were not inspected during the field reconnaissance they are typical of roads similar nearby, which means they contain several cross draining culverts with or without downspouts. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1107570 to 1107577	2	These sum of roads were heavily burned over and thus mainly lie within a high burn severity with a small portion in moderate. These roads are situated approximately 2/3 the way up between the creek bottoms and ridge top. Based on the burnt vegetation it appeared these roads would have been difficult to drive on before the fire as they would have been heavily brushed in. Because of the burn severity these roads contain dead trees. They also contain several cross drainage culverts and shed their runoff either directly down to the South Fork of Chetco River or to drainages adjacent to the river. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1107620	2	This road runs through all three types of burn severity with the high severity mostly being on the downslope side of the road. The road is located about a quarter the way up from the Chetco River and the ridge line. The survey ended at milepost 1.36 due to down trees blocking the path. The section observed contains several cross drainages. Because of the burn severity this road contains dead trees. All drainages shed their runoff down to the 1376000 road which runs along the Chetco River. Other teams reported a 36-inch culvert being nearly plugged by a debris flow that had occurred before the fire. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1205000	3	Mostly the entire length of this road section within the fire perimeter traverses through unburned. Where the road does run through a very small section (approximately 0.8 mile) there is no concerns of doing any stabilization treatments.
1376000	3 & 4	The 1376000 road is probably the most important route accessing the fire perimeter. The first 3.1 miles of this road is paved and within that distance provides access to the private lands within the Wilderness Retreat Subdivision where several permanent residences reside. Also within this section are roads that access two campgrounds and several gravel bars used for camping. The road within the 3.1 miles is mostly surrounded by low to no burn intensities with a section between the Nook Bar CG and the Redwood Bar CG being moderate with patches of high intensities. Within that same section the

		hardwood trees that were burned are posing a threat of falling onto the road now that they are dead and in fact some have already fallen across the road. Some of the major stream crossings were observed to have culverts that were partially plugged with woody and depositional debris. In the proximity of the Nook Bar CG the shoulder on the downslope side was sunken due to a burned out root wad. Finally, at the end of the pavement is a concrete bridge that crosses the Chetco River. A portion of the guardrail posts were burned during the fire. The road surface turns to gravel after crossing the bridge. This section is 17.7 miles long and provides access to one business entity, a trailhead and intersects with other maintenance level 3 and 2 roads. The road segment runs through a vast majority of high severity burn. There are several culverts placed across the road as cross drains or within side channels. The ditches were also full to partially full in several areas along the route. Many of the culvert inlet catch basins were full of sediment and there was observed a lot of woody debris lying in the side channels above the culverts. Also observed were a few burned traffic warning signs. There are several recommendations for treating this long section of road. First things to do are to clean the culvert catch basins and the roadside ditches, install inlet protection devices where they are determined to be effective, repair the hole in the shoulder, install new traffic warning signs, cut the hazard trees leading up to the subdivision, and replace the guard rails. Also, after checking to see if post fire flows will pass through culverts of interest decide then to upsize the existing culvert or install relief culverts above.
1376310 to 1376311	2	These sum of roads were heavily burned over and thus mainly lie within a high burn severity with a small portion in moderate. These roads are situated approximately 2/3 the way up between the creek bottoms and ridge top. Based on the burnt vegetation it appeared these roads would have been difficult to drive on before the fire as they would have been heavily brushed in. Because of the burn severity these roads contain dead trees. They also contain several cross drainage culverts and shed their runoff either directly down to the South Fork of Chetco River or to drainages adjacent to the river. It is recommended to have the ditches and culvert catch basins cleaned along with reshaping the existing rolling drain dips and possibly adding more where determined it would be effective.
1376300, 360, 362, 363, 365, 370, 374,375, & 390[1]	2	These sum of roads all lie within a majority of high and moderate burn severity. These roads are situated on or near the tops of the ridges and shed their runoff in side channels that run to the Chetco River and several other secondary creeks that run into the Chetco River. Based on the burn severity these roads will also contain hazard trees. Even though these roads were not inspected during the field reconnaissance they are typical of roads similar nearby, which means they contain several cross draining culverts with or without downspouts. It is recommended these roads have the ditches and culvert catch basins cleaned, downspouts installed

		or repaired, and reshape any existing rolling drain dips and add more where determined it would be effective.
1407000	3	A large segment of this road that is forest maintained lies within the fire perimeter but most of that segment runs through mostly non burned areas. The segment that might have issues because it runs through mostly moderate to some high severity is located between where it intersects with the 1376000 road and further south where it intersects with the 1407900 road. There is also a section of this road that is surrounded by high severity and that is located in a half mile section starting north of the forest boundary. Basically no real issues to report and only recommendation is to clean the ditches and culvert catch basins in those areas where the road is located in the high and moderate burn severity.
1407150	2	A large segment of this road is heavily surrounded by high severity burn. The road does not provide access to any specific permanent facility and dead ends at the Rainbow Creek crossing where the forest, sometime in the past, pulled a culvert that was buried under an extremely deep fill. The drainage from the road runs down to Eagle Creek which flows into the Chetco River. The road has a concrete bridge over an unnamed stream at milepost 4.0 along with a couple Hilfiker walls, which one was found near milepost 2.6 to have failed due to rusting of the wire baskets (see photo below). Also, the inlet to the culvert installed within the Hilfiker wall was partially plugged. Another possibly pre-fire issue that was discovered was a large sinkhole (see photo below) approximately 13 feet in diameter and 12–14 feet deep in the downslope side of the road. This road contains several cross draining culverts with downspouts and culverts in side channels. Due to the high severity burn the road does have a high probability with the dead trees falling across the road. It is recommended to have the ditches and culvert catch basins cleaned, install or repair downspouts where necessary, install inlet protection devices where necessary, and inspect the pre-fire issues to see if they will further degrade with the expected increase in runoff then provide the necessary mitigations to prevent further damage.

1407180	2	Approximately half of the road segment that is within the fire perimeter is surrounded by high and moderate severity. The drainage from the road runs to Eagle Creek which flows into the Chetco River. The road contains cross drains and culverts in side channels. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1407210, 211, 212, & 900[1]	2	These sum of roads all lie within some majority of high and moderate burn severity. These roads vary from where they traverse the channels, some being on ridge tops to some distance below them. Based on the burn severity these roads will also contain hazard trees. Even though these roads were not inspected during the field reconnaissance they are typical of roads similar nearby, which means they contain several cross draining culverts with or without downspouts. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1909000	3	This road intersects the 1376000 road on the west end and traverses towards the east ending at the wilderness boundary. Approximately one third of the whole road is surrounded by mostly high to some moderate severity. That section of road within those severities contains some larger cross drainages that have culverts underneath fairly large fills. It is recommended to clean the culvert catch basins and ditches, install or repair downspouts where necessary, and install any relief culverts and inlet protections if a culvert is deemed to possibly fail because the expected runoff may not be able to pass through.
1909050	2	Approximately half of the road segment lies within high and moderate burn severitys. The drainages from this road shed their runoff to the Quail Prairie Creek which runs into the South Fork of Chetco River. Based on the burn severity these roads will also contain hazard trees.

		It is recommended to have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.
1909200, 202, 220, & 222[1]	2	These sum of roads all lie within some majority of high and moderate burn severity. These roads vary from being on top of ridge tops to below them and all of them shed their runoff in side channels that run to the South Fork of Chetco River. Based on the burn severity these roads will also contain hazard trees. Even though these roads were not inspected during the field reconnaissance they are typical of roads similar nearby, which means they contain several cross draining culverts with or without downspouts. It is recommended these roads have the ditches and culvert catch basins cleaned and down spouts repaired or installed.
1917000	3	This road intersects the 137600 road on the west end and the 1909000 road on the east end. Approximately half of the whole road is surrounded by mostly high to some moderate severity. That section of road with those severities contains some larger cross drainages that have culverts underneath fairly large fills. It is recommended to clean the culvert catch basins and ditches, install or repair downspouts where necessary, and install any relief culverts and inlet protections if a culvert is deemed to possibly fail because the expected runoff may not be able to pass through.
1983000	3	This road intersects the 1205000 road on the south end and the 1107000 road on the north end of its termini. The majority of this road traverses through mostly low severity to unburned. The section where it traverses through high to moderate severity is below the ridge line that runs up to Mount Emily. This road segment contains several larger cross drainages that have culverts underneath fairly large fills and numerous culvert cross drains. It is recommended to clean the culvert catch basins and ditches, install or repair downspouts where necessary, and inlet protections if a culvert is deemed to possibly fail because the expected runoff may not be able to pass through.
3680360 and 362	2	These two roads traverse through a fair amount of high and moderate burn severity. These roads vary from being on ridge tops to below them and they shed their runoff in side channels that run to the East Fork Pistol River. These roads contain several smaller cross drainages, the largest being 48-inch diameter culvert along with numerous culvert cross drains. It is recommended these roads have the ditches and culvert catch basins cleaned, down spouts repaired or installed, and install appropriate inlet protections where it is deemed necessary.

[1]Denotes roads that were not examined in the field.

IV. RECOMMENDATIONS

A. Fire Suppression Rehabilitation: Remove berms along the outer edges of the road that were created from the fire suppression blading.

B. Emergency Stabilization: Emergency stabilization treatments should be implemented as quickly as possible to protect public safety and minimize negative impacts to roads and identified values from expected debris flows and flooding.

1. Road Stabilization

a. Road Drainage Stabilization

Situation: Historically, roads within burned areas have been impacted by increased flows due to burnt hillslopes and flash floods causing roads to be overtopped and culverts to become clogged with sediment and woody debris. This has also caused roads to become damaged, resulting in channeled runoff and deposition of sediment into adjacent streams. The effects of this fire caused approximately 110.9 miles of road to traverse through high and moderate burn severities.

The probability of losing segments of these roads within those burned severity areas is high. This is based on what the field observations revealed which showed the existing drainage system within these roads are currently not fully stabilized to handle the expected higher than normal runoffs that is expected to occur.

Recommendations: There are several methods of stabilizing roads to ensure the impacts from increased flows next to, and over the roads can be minimized. The following is a list of some of the methods that will be used to stabilize the road drainage system. These mitigations have been shown to be the minimum treatments necessary to stabilize roads for expected increased runoff:

- Clean culverts, catch basins, ditches, and low points of rolling drain dips of sediment and debris.
- Repair and/or install downspouts on the ends of culverts to ensure to carry the drainage as far away from the fill slopes as necessary.
- Install, next to the smaller diameter cross drain culverts, white carsonite posts with green reflective markers on each side of the posts to provide a quick reference where the pipe inlet is located if overtopped with sediment and debris.

b. Culvert Installation/Upsizing

Situation: During the field observations, some culverts underneath roads traversing through high severity burn drainages were identified as being at high risk of being overtopped because they may not be able to pass the expected increase in runoff.

Recommendation: Of those culverts identified as being undersized either remove the existing culvert and upsize with a larger culvert that can pass the expected post fire flows or if the fill over the pipe is too high then install relief culverts, where determined, above the existing culvert to act as a backup to relieve any flow the existing culvert is unable to pass. Also, determine if

any type of inlet protection is necessary in order to reduce the chance of the culvert inlet being plugged (see section 'c' below). The culvert at Second Creek on FSR 1376000 is undersized for the calculated post fire flow and is being recommended for upsizing. In conjunction with up sizing the culvert, it is currently a fish barrier and when replaced, will need to be an aquatic organism passage culvert.

c. <u>Inlet Protection</u>

Situation: Several of the roads within the fire perimeter contain culverts, of numerous sizes, that are installed in side channels that vary in drainage size. These side channels have the potential to release and transport a large amount of deposition and/or a mass amount of woody debris, that if not controlled could flow directly to the pipe inlets and plug them. A plugged culvert then is at risk of causing the runoff to overtop the road and possibly wash a segment of it away to the point it could become impassable.

Recommendations: There are a couple items that can help protect the culvert inlets from becoming plugged or continuing to pass flow if they do happen to get plugged. The following is a list of some of those items that have been shown to be the minimum treatment necessary to decrease the chance of a culvert plugging or allowing it to still drain the runoff if it does get plugged:

- Riser Tee – This device is essentially an extension of the existing culvert inlet with a pipe of similar size and a vertical pipe attached to the top (see image below for example). The vertical pipe is a backup if the inlet of the pipe were to become plugged.

  This device is best used when access to culvert inlet is limited by typical heavy equipment (i.e. backhoe) used to remove debris plugging culverts.

- Debris Deflector – A debris deflector is an A-frame deflector where the apex of the frame points upstream and the wide end is positioned over the pipe inlet. This devise performs similar to a trash rack except debris is deflected away from the culvert inlet allowing unobstructed flow to continue through the pipe. They are typically installed above smaller dimeter culverts where not as much debris is

expected but enough that it could plug the inlet. They are typically smaller than a trash rack and thus easier to install.

- Trash Rack – A trash rack is a barrier placed a determined distance upstream of a culvert to prevent woody debris and large deposition from becoming imbedded into the inlet of the pipe. These devices can be built of timber materials found on-site or fabricated out of steel (see images below). They are typically larger than debris deflectors because to be fully effective should be installed at a minimum of the bank full width and at a determined distance above the inlet of the pipe to allow the flow to come back into the channel prior to passing through the culvert.

d. <u>Patrols for Storm Induced Road Hazards</u>

Situation: The roads at burned areas have increased potential for rolling and falling rock and trees from uphill burned slopes and increased potential for sediment flows and drainage issues. With the loss of vegetation, normal storm frequencies and magnitudes can more easily initiate erosion on the slopes and it is likely that this runoff will cover the roads or cause plugging and/or washouts at drainage facilities (culverts) or stream crossings. These events make for hazardous access to forest roads and put the safety of users and employees at risk.

Recommendation: Monitor road drainage (i.e. culverts, ditches, debris racks and deflectors, etc.) and roadbed conditions after significant storm events to ensure the maximum drainage

capacity is maintained until the natural re-vegetation of the burned area has occurred. Maintain and/or repair any damage to road surfaces. Remove sediment and debris from ditches and entrances to culverts.

2. Public Safety

a. Install Warning Signs

Situation: The severity of burn in some watersheds, combined with road location, high possibility of flash flooding and debris flows has increased the risk to road users.

Recommendation: Install warning signs for flash flooding and potential debris flows. Install "Burn Area Warning" signs where necessary to properly alert the travelers of the dangers ahead. Install "Road Closed" signs where necessary to temporarily close roads that have received extensive damage. "Road Closed" signs should also be used in conjunction with gated closures. Replace all traffic warning and cautionary signs (i.e. object markers, curve ahead, etc.) in the same location as the ones that were severely damaged.

b. Road Closure Gates

Situation: Slopes within the burned watersheds have been made unstable due to the severity of burned soils. Increased flows from these slopes will likely cause road damage. The burn also increased the risk of adjacent hazard trees falling across the road. These issues are very apparent on the 1909 Road which runs closely along the North Fork Chetco River, and is at the bottom of a steep canyon that received high to moderate severity burn.

Recommendation: Install a closure gate with a special order on all roads where travel has been determined to be unsafe or where culverts are being removed on roads previously open to the public.

c. Repair Bridge Approach Guardrail System

Situation: The fire burned some of the posts holding the guardrail for the bridge crossing the South Fork Chetco River on FSR 1376000.

Recommendation: Remove and replace the burnt posts, then reattach the railing.

d. Hazard Tree Removal

Situation: This treatment would remove standing danger/hazard trees that are identified as having an imminent failure potential and are likely to damage values within the potential failure zone of the tree as identified in the Field Guide for Danger-tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington. Locations for the treatments are the identified areas adjacent to where people congregate on NFS lands and sites where there will be stationary workers accomplishing BAER treatments on NFS lands.

Recommendation: Mitigate the threat of hazard trees falling over roads by falling those that have been identified to be hazardous.

C. Rehabilitation: None

D. Management Recommendations (non-specification related)

1. Area closure along Forest Roads Receiving Treatments From This Fall to Next Spring

Situation: A significant amount of work will be ongoing during implementation causing roads within the fire perimeter to be blocked.

Recommendation: Continue with road closures on the roads until the work has been completed.

2. Patrols for Storm Induced Road Hazards

Situation: Storm inspection and response is only funded by BAER funds for the initial year of implementation.

Recommendation: Continue storm inspection and response until vegetation has reestablished in affected watersheds or for at least a total of two years.

3. Gated Closures

Situation: Some water sheds may require multiple year seasonal closures until the watershed has recovered. Second and third year storms can produce debris flows and floods as extreme as first year flows.

Recommendation: Monitor first year activity and watershed rehabilitation to determine if a second or third year road closure would be required.

V. CONSULTATIONS

VI. REFERENCES

Burned Area Emergency Response Treatments Catalog December 2006 National Technology & Development Program Watershed, Soil, Air Management 0625 1801-SDTDC

Project Identification Report for PFH 191 (FSR 1376000), North Bank Chetco Road, 2011, Western Federal Lands Highway Division

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United States
Department of
Agriculture

Forest
Service

Pacific Northwest Region

Chetco Bar Wildfire BAER

Resource Report

Heritage

October 10, 2017

Rogue River – Siskiyou National Forest

R. Heath Bailey, Heritage BAER Team Lead, Archaeologist, Great Smoky Mountains National Park

Penni Borghi, Forest Archaeologist, Deschutes & Ochoco National Forests

NOTE: Releasing information about the nature and location of archaeological and historic resources is restricted under Section 304 of the National Historic Preservation Act (16U.S.C. 470w-3) and Section 9 of the Archaeological Resource Protection Act (16 U.S.C. 470hh; 36CFR296.18).

Disclosure

This assessment includes sensitive archaeological site location data and information on sites and areas of significance obtained through consultation with affiliated Indigenous Tribal entities. As such, public dissemination of these data is prohibited. Pursuant to 43 CFR 7.18, 16 USC 470hh, Section 304 of the National Historic Preservation Act (NHPA), and Section 9 of the Archaeological Resources Protection Act of 1979 (APRA), such proprietary information contained within the BAER Cultural Resources Assessment will be redacted for external use.

Resource Team Members

R. Heath Bailey, Heritage BAER Team Lead, Great Smoky Mountains National Park; and Penni Borghi, Forest Archaeologist, Deschutes & Ochoco National Forests.

Background

Heritage, or cultural, resources are non-renewable resources that include archaeological sites, historic structures, and areas significant to contemporary Native American Tribes. These resources are susceptible to effects from wildland fires and may be completely destroyed or significantly altered as a result of direct or indirect effects from fire.

Post-fire soil and vegetation conditions resulting from the Chetco Bar Fire have the potential to directly or indirectly impact cultural resources located on Forest Service lands. Post-fire erosion threats include gullying or rilling, which can expose and remove subsurface cultural deposits or inhumations; increased levels of sheet-wash can erode archaeological features and/or remove artifacts from site locations; and fire-killed trees that fall up-end root systems resulting in the destruction of archaeological features and subsurface archaeological deposits including human remains. In addition, consumption of vegetative ground cover leads to increased site visibility, making cultural resources susceptible to looting.

Objective

The goal in performing a post-fire Burned Area Emergency Response (BAER) assessment allows for the site-specific identification of threatened cultural resources and provides an opportunity to recommend stabilizing treatments that may mitigate short term post-fire effects to cultural resources. Objectives of this assessment are as follows:

- Identify previously documented cultural resources located on Forest Service lands within the Chetco Bar Fire area of potential effect (APE) that may be at risk.
- Analyze direct effects of the fire to cultural resources, as well as the potential for indirect, post-fire effects on cultural resources.
- Propose specific BAER treatments for previously inventoried sites in jeopardy, in order to prevent and mitigate future damage to cultural resources determined “eligible” or “potentially eligible” for listing on the National Register of Historic Places (NRHP), per criteria in 36 Code of Federal Regulations (CFR) 60.4.

Potential Values at Risk (VAR)

The Chetco Bar Fire burned area encompasses prehistoric and historic cultural sites ranging in occupational dates from the Early Archaic period (i.e., 9,000 years ago) to the middle of the 20th century. Prehistoric sites include lithic scatters, temporary camps, and habitation sites. Local historic sites include 19th and 20th century mining sites, cabin sites, and fire lookouts. The heritage sites which hold the greatest risk of fire damage tend to be historic structures made of combustible material, notably wood. Also at risk are Native American sites that may be impacted by vandalism, looting, and erosion; all are irreplaceable resources.

Area of Potential Effect (APE)

The APE for the Chetco Bar wildfire is identified as:

- All areas within the fire perimeter on Forest Service lands (170,321 acres);
- Areas with potential for fire-related soil erosion, flooding, debris flows, hazard trees, etc.;
- Locations where looting and vandalism will be increased due to increased visibility of sites resulting from fire consumed vegetation.
- Areas proposed for ground-disturbing watershed rehabilitation-related treatments (e.g. culvert pulling, construction of dikes and barring associated with point protection).

Methodology Process

The analysis process began with a review of the Rogue River – Siskiyou National Forest's archaeological site geo-spatial database and the Oregon State Historic Preservation Office (SHPO) geo-spatial database. Using geo-spatial software (ARCMap), archaeological site layers were overlaid with a Burned Area Reflectance Classification (BARC) map displaying Chetco Bar Fire intensity dated 9/21/2017. Site points that fell within high and moderate intensity were prioritized for assessment as well as sites at risk from falling snags, flooding, or other post-fire conditions likely to adversely affect heritage resources. A total of 27 sites were initially selected for the assessment (Figure 1), but this number was further refined to 9 after the first day of field visits. Due to the limited field time available for the assessments, a decision was made to concentrate on sites that were of greater significance, such as those listed on the NRHP and those that were likely candidates for listing. Sites identified as sparse lithic scatters were eliminated from review, as well as sites in which historic buildings had been removed or destroyed prior to the fire. Sites within the Kalmiopsis Wilderness were not considered for assessment as recommendations for treatment will not be made within the Wilderness Area.

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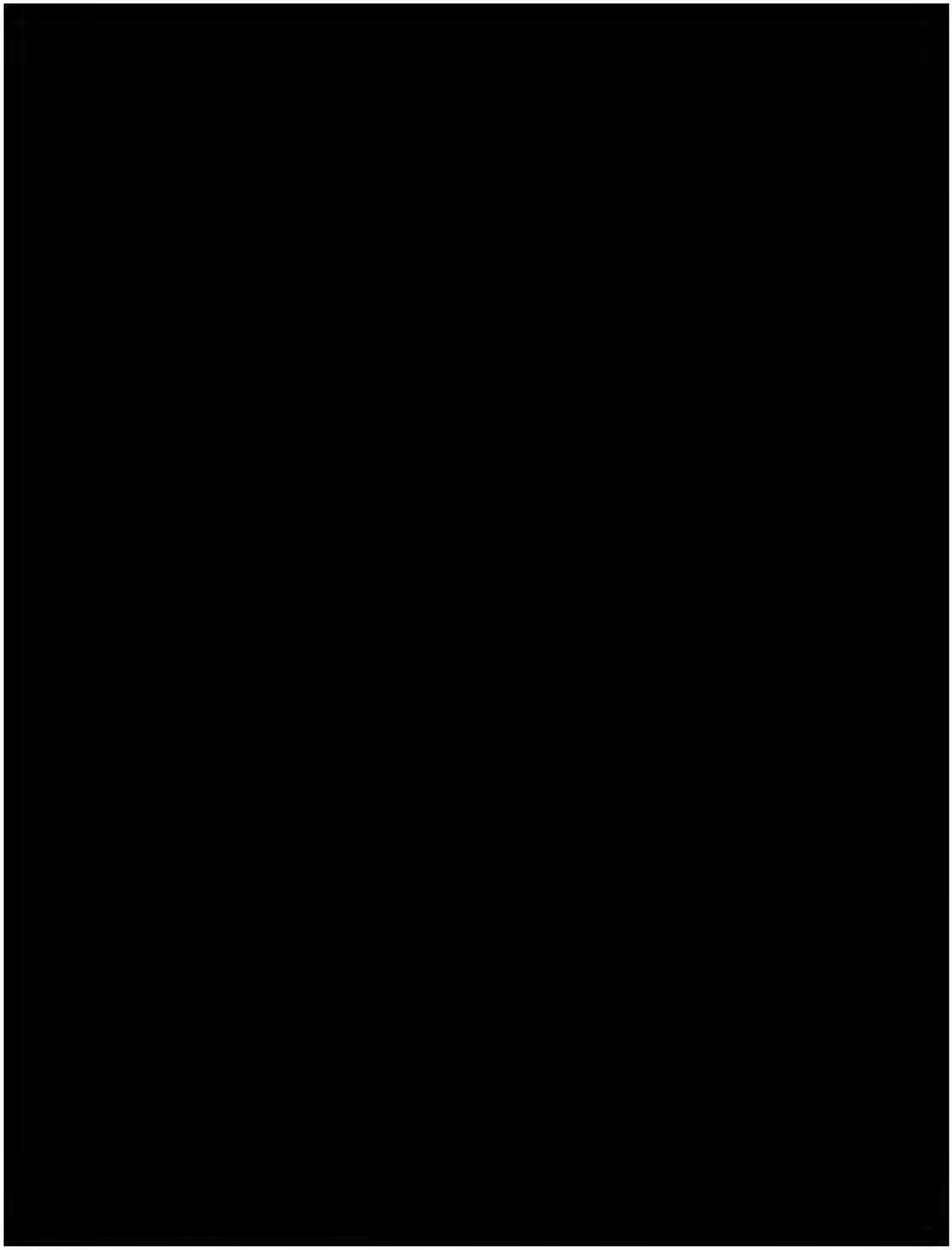

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Figure 1. Heritage Resources selected for Chetco Fire BAER assessment. Site labels reference soil burn severity.

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To summarize, the assessment process focused on:

- Sites located within areas of high/moderate burn intensity.
- Sites that are fire-sensitive (sites with combustible components).
- Prehistoric sites susceptible to post-fire effects.
- Certain properties important to local Tribes (based on forest consultation with Tribes).
- Sites that have been determined to be eligible for the NRHP within the fire perimeter.

The Rogue River – Siskiyou Forest Archaeologist, Melissa Julien, provided records for heritage sites within the fire perimeter. While reviewing the records it was noted that there were two sites that had not been incorporated into the geo-spatial data, these were a historic mining area on Mount Emily and the historic Wheeler Bomb Site; both are located within high and moderate intensity burn areas.

There are 130 known and recorded cultural resources within the fire perimeter. Of the 130 known resources, 49 are characterized as isolated artifacts, which commonly contain no more than one to three artifacts comprised of lithic debitage. These resources were eliminated from further assessment due to the assumed limited data contained within these locations.

Four days were allocated to field assessments, which began on 10/1/2017 and ended on 10/4/2017. Field assessments were focused on the high site density areas of Snow Camp Mountain, Quail Prairie Mountain, Mount Emily, and the Wheeler Bomb site. A total of nine sites were visited for assessment. Of these 9 sites, only one, the Wheeler Bomb Site, is listed on the NRHP; three have been evaluated for listing on the NRHP, with two being found eligible to the NRHP and one not eligible. The remaining five sites, which were burned over in the 2002 Biscuit fire, remain unevaluated.

Eight former fire lookouts or guard stations stood within the Chetco Bar burned area: Bear Wallow Lookout, Chetco Peak Lookout, Johnson Butte Lookout, Long Ridge Guard Station, Mislatnah Peak Lookout, Mount Emily Lookout, Quail Prairie Lookout, and Snow Camp Lookout. None among them are considered VARs, and only Quail Prairie Lookout (Figure 2) remains standing as it was spared from the Chetco Bar Fire, thanks to the coordinated efforts of Chetco Bar Incident resource advisors and suppression operations. It is not threatened by indirect effects post-fire given its hilltop location. The remaining non-extant structures are not recommended eligible to the NRHP, and as such were not considered for BAER assessment.

Figure 2. Post-fire conditions at Quail Prairie Lookout.

While areas surrounding the NRHP-listed Wheeler Bomb Site did experience moderate-high intensity fire,

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the site itself saw only light intensity fire, with some portions having been unburned. Interpretive infrastructure on site remains intact. There is a single stump hole in close proximity to the site's obelisk marker and 'peace tree' components (Figure 3); however, the single stump hole does not threaten the stability or character of the site. As such, the Wheeler Bomb Site is not considered a VAR.

Figure 3. Post-fire conditions at the NRHP-listed Wheeler Bomb Site. Stump hole and obelisk marker in foreground, peace tree in background.

Post-fire assessments were completed for each of the nine sites through the Survey 123 application. The information collected was specific to cultural resources and included data on site condition, VARs, and recommended treatments. Data collected was submitted electronically to GIS analysts for incorporation into the BAER database. VAR data collected during the assessments were then incorporated into the BAER team VAR spreadsheet.

Fire intensity was also assessed at each site. Burn classifications are as follows:

Unburned – Little to no burn expected within these areas. Canopy and ground litter completely intact. Little to no vegetative mortality expected.

Low - The ground surface, including any exposed mineral soil, may appear lightly charred, and the canopy and understory vegetation will likely appear green.

Moderate - Up to 80 percent of the pre-fire ground cover may be consumed but generally not all of it. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will soon fall to the ground. Soil structure is generally unchanged.

High – All or nearly all of the pre-fire ground cover and surface organic matter is generally consumed, and charring may be visible on larger roots. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

Contacts Made During Assessment

Contact was made with the Rogue River – Siskiyou Forest Tribal Liaison, Melissa Julien for the purpose of identifying areas of interest and concern for the Confederated Tribes of the Siletz Indians of Oregon and the Tolowa Dee-ní Nation. Melissa Julien and Matthew Timchak, Rogue River-Siskiyou Forester, relayed information from the Tribes regarding Tribal concerns and areas of interest from both Tribes.

On 10/5/2017 contact was attempted by phone and email with the Cultural Resource Director of the Confederated Tribes of the Siletz Indians of Oregon and the Tolowa Dee-ní Nation Tribal Historic Preservation Officer regarding the two sites that were identified as Values at Risk,

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which needed treatment. No response was received; however, the BAER Team continues to coordinate with the Forest on Tribal areas of interest and concern.

Values at Risk

Site 1PS-808 / Chetco River Village Site

Figure 4. Human-modified features at terrace edge.

This 5 acre site is situated on a high terrace east [redacted] The site is considered as a prehistoric Native American village site and population center. Records for this and other archaeological resources within the Chetco River drainage identify this village as a significant resource in a larger sphere of Indigenous interaction and network of prehistoric Native American travel. The site's prime location allows for the utilization of ocean, upland, and connecting watershed resources. Numerous structural features are located at the southern edge of the terrace as it gives way to the Chetco River below. Post-fire conditions on site allow the deflated remnants of these formalized structural features to be easily observed at ground surface level as soil/duff and vegetation no longer mask them (Figure 4). Whether these features represent small habitations or large roasting pits for food preparation was unclear at the time of assessment, and perhaps would be better analyzed by a local subject matter expert. A propensity of lithic debitage was associated with each of these mentioned structures. Set central to the site's southern boundary, there exists an apparent south-

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Figure 5. Post-fire conditions at site [redacted].

facing plaza at the terrace edge. It is plausible that this landscape feature was intentionally modified into its distinct three-tier form that begins at the elevation of the high terrace that surrounds it on three sides and descends downslope towards the river. In the site's northwest portion, evidence of illegal looting activity was noted by the presence of a concave surface disturbance measuring three meters in width and one and a half meters in depth and an adjacent backfill pile of similar dimension above ground (Figure 9). It is also of note that the site and surrounding area sees traditional use by contemporary Indigenous groups as a shrine or traditional observance area is located west of Mislatnah Creek upon the inheld private property at Tolman Ranch.

Post-Fire Conditions

Vegetation upon the site landform experienced moderate intensity fire effects. Western and southern portions of the site are devoid of vegetation and ground cover, allowing for 100% visibility of the ground surface, as well as associated artifacts and features (Figure 5). Mineral soil was also exposed in northern and northeastern portions of the site, however post-fire needle cast now blankets the ground below fire-killed conifer stands. Structural fabric on site evidences discoloration/sooting, spalling,

Figure 6. Lithic artifact exhibiting discoloration/sooting and combustive residue.

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Figure 7. Tree throw and collapsed stump hole disturbance on site.

and combustive residue (Figure 4). Likewise, artifacts on site exhibit discoloration/sooting and combustive residue (Figure 6). No cracking, crazing, or spalling was noted upon surface artifacts. Tree throw disturbance of site features and deposits was noted across the entirety of the site landform at the time of assessment (Figures 7, 8). The burning of trees' root structures on site has adversely affected the site and its future research potential as it destroys archaeobotanical remains within subsurface features and disturbs the reliability of numerous absolute dating techniques. Hundreds of burned stump holes were also noted on site during the post-fire assessment (Figure 7).

Post-Fire Threats

The complete consumption of surface fuels on site makes certain the occurrence of post-fire erosion, particularly at the terrace edge where a multitude of site-defining features are located. Likewise, the site's increased surface visibility and lack of canopy cover make looting an even greater threat post-fire (Figure 9). Tree throws and associated disturbances will adversely affect deposits and features on site as fire-killed and fire-weakened trees fall post-fire (Figure 8). The inevitable collapse of burned stump holes will deflate and disturb deposits, features, and artifacts on site (Figures 7).

Figure 8. Post-fire tree throw on site. Note displaced lithic artifact at bottom left.

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Figure 9. Looters' pit and adjacent backfill pile on site.

Treatment Recommendations

Figure 10. Successful post-fire native grass seed treatment at left. Untreated and eroded area at right.

The reestablishment of ground cover vegetation is necessary to abate erosion and discourage looting on site. Aerial mulching of the site landform was proposed but considered cost prohibitive. As such, the application of native grass seed across the entirety of the landform is instead proposed as a cost-effective means to achieve desired post-fire conditions on site. Native grass seed, approved by Rogue-Siskiyou National Forest resource managers, will be sown by hand as soon as it can be accomplished (Figure 10). An additional round of seeding will take place in the spring of 2018. The treatment will be supervised by an archaeologist, and monitored for effectiveness for one year after its application. Additionally, periodic resource patrols will be conducted in order to monitor conditions and discourage the illegal looting activity that has been experienced on site in the past (Figure 9).

Detailed documentation and scaled mapping is recommended for the entirety of the site as post-fire conditions allow a rare and unencumbered view of the site landscape, as well as its surface features and artifacts. This brand of inventory is not provided for through the BAER process; however, and so is recommended for the attention of Forest and District-Zone Archaeologists.

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[redacted]

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Site [redacted] / Mount Emily “Vision Quest Site” / Prayer Seats

[redacted]

Figure 12. Mount Emily, [redacted] location indicated by red arrow.

This one-acre site is situated [redacted] et upon a bench sloped 20-30%, the site comprises three circular rock rings of one to five dry-stacked courses and two potential features of similar modification, however deflated (Figure). Two rock cairns are also found on site, perhaps in the likeness of a sundial or celestial calendar. While it is known that the site sees traditional cultural use by contemporary Native groups, an Archaic stemmed projectile point observed on site serves notice to its use for thousands of years (Figure). A light-moderate density lithic scatter is also associated with the circular features. Additionally, an unburned wooden sign exists on site reading, “STUB AND ROSIE STEINEKE”. Metal wire was also found in proximity to the sign, presumably the remnants of an historic telephone line that ran along the mountain’s southwest side, providing communication to the former lookout and cabin at the summit.

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Figure 13. Two of three circular features on site. Note colluvial fill in upslope feature. Chetco River and Pacific Ocean in background.

Figure 14. Archaic stemmed projectile point at site [redacted]. Note discoloration/sooting.

Post-Fire Conditions

Vegetation upon the site landform experienced moderate-high intensity effects. The entirety of the site is devoid of vegetation, allowing for 100% visibility of the ground surface and associated artifacts. Little soil exists on site, save for colluvial sheet deposits that have filled in one of the circular structural features (Figure 13). Soil does exist upon a 50% slope uphill within a fire-killed stand of trees some 200m northeast (Figure 15), where there also exists a collapsed mining pit and more metal telephone wire. Structural fabric and artifacts on site exhibit discoloration/sooting and combustive residue where flame and smoke were directly encountered (Figure 14).

Figure 15. Post-fire conditions upslope from site [redacted].

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Post-Fire Threats

The overall lack of ground cover and overhead canopy make the site highly erodible and highly visible. Taking example from the site feature already filled with colluvium prior to the Chetco Bar Fire (Figure 13), similar or greater downslope sedimentation can be expected post-fire. While the site is a considerable distance from the [redacted], site features are visible from as far away as 300 meters upslope, making looting and other disturbances a greater threat post-fire.

Treatment Recommendations

Maintaining the integrity and feeling of the site post-fire is of the utmost importance in order that it retains its character for traditional use by contemporary Indigenous groups. For this reason, installation of a locked gate near the intersection [redacted] is recommended where it is plausible and practical from an engineering and safety standpoint. Such a gate would mitigate potential damage and disturbance at the site by discouraging access. Contemporary Indigenous groups using the site for traditional purpose would be provided access as needed.

Figure 16. Post-fire application of coconut fiber wattles for erosion abatement.

In order to abate the downslope movement of colluvium from the denuded hillslope above onto the site, three tiers of coconut fiber wattles will be installed 30, 60, and 90 meters upslope from the site features (Figure 16). Each tier will comprise 200 feet of wattle, and will be aligned in the form of a chevron with its apex point at the center of the slope above the site landform. 100 feet of wattle on either side of the apex will be angled downslope in such a way that colluvial sedimentation will be directed off the two sides of the slope above the site landform, effectively preventing colluvial sediments from entering into the site area. In order for this treatment to be effective, it is important that the wattles be well anchored and held fast to the ground surface throughout their total length of 600 feet. Treatment installation will be supervised by an archaeologist and a hydrologist. Treatment will be monitored for effectiveness for a period of one year after their installation. The coconut fiber wattles are biodegradable; however, consideration should be given to their removal once an archaeologist has determined their period of effectiveness has expired.

Detailed documentation and scaled mapping is recommended for the entirety of the site as post-fire conditions allow a rare and unencumbered view of the site landscape, as well as its surface features and artifacts. This brand of inventory is not provided for through the BAER process; however, and so is recommended for the attention of Forest and District-Zone Archaeologists.

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[redacted]

NOTE: Releasing information about the nature and location of archaeological and historic resources is restricted under Section 304 of the National Historic Preservation Act (16U.S.C. 470w-3) and Section 9 of the Archaeological Resource Protection Act (16 U.S.C. 470hh; 36CFR296.18).

Recreation and Trails Resource Assessment
Chetco Bar Fire BAER, Rogue River-Siskiyou National Forest

Eric Amstad, Malheur National Forest,
October, 2017

A. RESOURCE CONDITION ASSESSMENT – WHAT ARE THE VALUES AT RISK?

Overall, recreation resources play an important role in the economic contributions to the communities around the Chetco Bar Fire perimeter. The June, 2016 "Recreation Economics Contribution Report" estimated that in 2014, recreation on the Rogue River-Siskiyou National Forest contributed 4.4 million dollars of labor income for wage earners and business sole proprietors. And a recent study by the Outdoor Industry Association found that, in Oregon, outdoor recreation annually generates $12.8 billion in consumer spending, $4.0 billion in wages and salaries, 141,000 direct Oregon jobs, and $955 million in state and local tax revenues. This highlights the need to improve trails damaged by the Chetco Bar Fire and to consider the facilities needed to support these activities in the future. The proposed treatments will help to maintain the investment in developed recreation and trail infrastructure, and reduce threats to human life and safety.

A variety of recreation resources were impacted by the Chetco Bar fire. The fire burned through popular developed recreation sites along the Chetco River, destroying facilities, creating dangerous hazard trees, and increasing danger from rapidly rising river levels. Trails have damaged tread where roots and stump holes burned and collapsed the walking surface. Many fire-killed trees have fallen across trails and ravel and rocks that have rolled onto the tread have impeded trail access. High danger from falling snags will persist for many years. There will also be increased risk to hikers from debris flows in cases of large precipitation events.

Potential values at risk identified and addressed in this report include human life and safety, and recreation facilities and trails, as well as associated post-fire impacts to ecosystem recovery related to recreation. Risks include threats to life and safety of public and administrative personnel, threats to recreation facility infrastructure, and threats to ecosystem recovery.

1. Resource Setting

Recreation infrastructure identified for unacceptable risks to BAER critical values are:

- ***Trailheads:***
    - Tincup trailhead
    - Upper Chetco trailhead
    - Chetco Divide / Vulcan Peak trailhead
    - Bomb Site trailhead

- ***Non-Motorized Trails*:**
    - Snow Camp trail #1103
    - Panther Lake trail #1104
    - Tincup trail #1117
    - Boulder Tie trail #1117B
    - Tincup Creek trail #1117C
    - Mislatnah trail #1119

- Upper Chetco trail #1102
- Gardner Mine trail #1122
- Johnson Butte trail #1110
- Chetco Divide trail #1210
- Red Mountain trail #1105
- Navy Monument trail #1105A
- Japanese Bombing Site trail #1118
- South Bend Mountain trail #1189
- Little Chetco trail #1121
- Bailey Mountain trail #1109
- Bailey Cabin trail #1131
- Emily Cabin trail #1129
- Kalmiopsis Rim trail #1124

The trailheads vary in level of development from a simple trail sign to small campgrounds with toilet buildings, tables, and fire rings. The system of non-motorized trails within the burn perimeter is typically Trail Class 2 or 3 level developed and improved trails. A number of these trails access various points of interest within the Kalmiopsis Wilderness and provide connectivity throughout. Infrastructure associated with these trailheads and trails includes the trail tread, drainage features, constructed features such as staircases, signage and kiosks, retaining wall, and directional signage.

- ***Developed Campgrounds***
  - Miller Bar
  - Nook Bar
  - Redwood Bar
  - Little Redwood
  - Upper South Fork
  - Lower South Fork

- ***Recreation Rental***
  - Packers Cabin

The developed campgrounds within the affected area vary in level of infrastructure. Little Redwood campground contains vault toilets, gray water drainage, signage, barrier posts, interior roads, campfire rings, and picnic tables. The rest of the campgrounds are unique due to the fact that the campsites are located on dynamic gravel bars that are under water for much of the year. Because of that, there are no designated campsites or associated amenities. The gravel bar campgrounds do contain facilities such as vault toilet buildings, signage, fee stations, and interior road. These sites received varying degrees of fire damage to infrastructure, depending on location and burn severity. Little Redwood campground has been unofficially closed on the ground for the past several years, but has been in the process of being analyzed for reopening.

The gravel bar campgrounds are very popular during the summer months, but also receive significant use in the off season for fishing. The winter steelhead fishery on the Chetco River runs from November to April. Outfitters and private recreational fisherman depend on the gravel bars up to Lower South Fork Chetco River for access to prime fishing areas. With 24 commercial outfitter guide permits on the Chetco River from Miller Bar campground to the Lower South Fork campground, the winter steelhead fishery is an important piece of the local economy. For the years of 2009 to 2016, Outfitter guides had an average of 550 annual use days with approximately $220,000 in revenue per year. On an average trip, fishery tourists pay $400 to the outfitter guide, spend an average of $350 on lodging for three days and two nights, and spend an average of $500 on food, gas, and gear. That brings the average spend per visit to $1,662. In summary, annual revenue loss to the local economy by closing this section of the Chetco River for the winter season would be nearly one million dollars.

Packers Cabin is one of two recreation rentals within the fire perimeter, and is the only one that requires treatment.

2. Findings of the On-The-Ground Surveys

From September 30th through October 5th, each of the developed recreation sites within the fire perimeter was visited to determine overall condition and identify health and safety risks. A preliminary assessment of the trails and trailheads was completed using the Burned Area Reflective Classification (BARC) map. Trail segments to be checked were identified based on slope, soil, and the BARC map.

Non-motorized Trailheads and Trails:
An on the ground survey was conducted for the above mentioned trailheads, and most of the above mentioned trails. The trailheads were assessed to determine levels of risk based on the value of and risk to the facilities, as well as risk to human life and safety based on the post-fire facility conditions and overhead hazards from dead or dying trees. The trails within the burn area were assessed to determine individual levels of risk based on gradient, soil type, and burn severity. Following this survey, it was determined that 20 of the 25 trails and 4 of the 11 trailheads within the burn have an unacceptable level of risk to BAER critical values, and require emergency treatments in order to stabilize, stormproof or otherwise mitigate the anticipated impact of post-fire storm events. Hazard signage is recommended to inform users of anticipated hazards within the burn area.

These trails and trailheads contain segments that lie within and/or below areas that experienced moderate to high burn severity. Each of these trailheads experienced some level of damage requiring removal of hazard trees and/or replacement of sign boards to post fire related information. Watershed response is expected to increase in these areas due to lack of vegetation, impacted soils and increased runoff of water during storm events. Additionally, there is potential for sedimentation, dry ravel, rock-fall, and loss of trail tread in these affected areas. If this damage was to occur, it would represent a loss to the forest investment in the construction

and maintenance of the infrastructure of these recreation features, as well as decreased public and administrative access.

The existence of fire-damaged hazard trees presents a life and safety risk to administrative and public users. However, the risk to public use is contained to areas of known or expected congregation such as trailheads. There is a risk to implementation and administrative personnel which requires mitigation in the focused areas where workers will spend blocks of time performing work, which will effectively increase hazard tree exposure time to an unacceptable level.

Nearly 63 miles of trail lies within the Chetco Bar Fire perimeter. Damage to trailhead facilities and trails varied from no impact to high severity fire that damaged trailheads and trail tread, removing organic matter within and outside the trail prism. Without the soil and organic matter, the trail and surroundings can be damaged by water runoff due to rain and snow. This damage can be extensive and has the potential to impact not only recreation assets, but other resources.

Nearly 19 miles of trail was identified as needing stabilization work related to soil burn severity. The soils in these areas have experienced a loss of structure resulting in trail tread degradation. The needed work includes, but is not limited to installing drainage (rolling grade dips, grade reversals, knicks), installing water bars (only where necessary and then only with rock), cleaning out existing rock water bars, armoring drainage crossings, and snagging trees as appropriate for worker safety. Work will be completed on trail tread potentially impacted by slopes above with a high or moderate severity burn.

Developed Campgrounds:
Following the ground assessment, it was determined that there were values at risk requiring treatments at the Miller Bar campground, Nook Bar campground, Redwood Bar campground, Little Redwood campground, and Upper and Lower South Fork campgrounds. All of these campgrounds, which have been identified as posing unacceptable risk to human life and safety due to hazard trees or the potential of a rapidly rising water level, are recommended to have gates installed (except Little Redwood, which already has a gate) for seasonal closures, as needed.

Miller Bar did not sustain fire damage but will receive treatments to protect human life due to an increase in flood potential on the Chetco River. Redwood Bar and Little Redwood campgrounds sustained the heaviest fire damage, with the loss of such facilities as signs, tables, and plastic toilet vault vent pipes, as well as extensive tree mortality. The concrete portions of the CXT toilet buildings are intact at both campgrounds, but the plastic vent pipes burned off, leaving open exposure to the sewage in the vaults below. At Little Redwood campground, the gray water drain riser has collapsed in on itself, and the exposed toilet vaults have already completely filled with run-off. Emergency treatment will be needed for human safety, as well as ecosystem protection. The toilet vaults will need to be pumped, and the open holes on the toilet vaults and gray water will need to be sealed off. The field assessment indicated that the toilet building at Redwood Bar campground may have a compromised lining within the vaults. It will be important,

for ecosystem protection, to pump the vault so that the lining can be properly inspected. Hazard trees that pose risks to administrative personnel and/or toilet building facilities will need to be mitigated at Nook, Redwood Bar, and Little Redwood campgrounds.

Packers Cabin itself survived the fire, but the surrounding infrastructure was highly impacted. One of the two toilet buildings at the site burned to the ground, leaving an open pit with potential raw sewage exposure. The adjacent wood shed also burned to the ground. Both burned buildings left behind metal debris with points and sharp edges. Site cleanup will be needed before opening the site to the public. Hazard trees will need to be removed to protect implementation personnel. Closure of the site is recommended until hazards are mitigated. The site can be closed by installing a gate across Forest Service Road 1917110.

3. Consequences of the Fire on Values at Risk

The Chetco Bar Fire has resulted in a “very likely” probability of moderate to major threats to life, public safety, property, and ecosystem recovery at several recreation facilities and trails. Each trail, trailhead, and recreation site within the burn has been evaluated for risk assessment. Those findings are included in the remainder of this report, along with treatment recommendations to minimize the anticipated impacts and effects.

B. RISK ASSESSMENT

The Values at Risk to trailheads, trails, recreation facilities, and wilderness through an increased number of hazard trees, erosion, runoff and sediment flows caused by hydrologic response, infrastructure failure or loss, and hazardous waste presence are:

- Life and safety
- Public health
- Infrastructure
- Ecosystem recovery

The following conditions describe in detail the consequences of the fire on Values at Risk:

- There is an immediate risk of hazard trees, posing life and safety threats to BAER implementation team members and public visitors within and adjacent to recreation facilities. Treatment of hazard trees on trails and trailheads will be exclusively limited to areas where hazard trees present an imminent threat to implementation team members, or recreation facilities of offsetting value.
- Burned infrastructure has resulted in a hazardous material exposure to the public and environment at Redwood Bar and Little Redwood campgrounds, Upper Chetco trailhead, and Packers Cabin recreation rental. This includes the burning of outhouse facilities, which exposes the public and surrounding resources to the potential effects of raw sewage.

- Segments of numerous trails within the burn area are subject to increased erosion from winter storm runoff. Without emergency storm proofing, further loss of trail tread, trail instability and incision are likely to occur.
- Signs and sign posts were burned resulting in protruding hardware fasteners and debris with sharp metal edges within campgrounds, trailheads, and Packers Cabin. The loss of these signs and bulletin boards could present a threat to life and safety, as well as ecosystem recovery based on our inability to communicate critical messages to the public.

C. TREATMENTS TO MITIGATE THE EMERGENCY (per FSM 2523.2):

The BAER team has concluded that the above post fire conditions constitute an emergency due to an immediate:

- Risk to life and safety
- Risk to infrastructure
- Risk to ecosystem recovery

Recreation Facility Treatment Descriptions: An emergency determination was made that the following BAER treatments are required for recreation facility treatments in the Chetco Bar Fire burned area for the protection of life/safety hazards and infrastructure. The timeframe of work completion, hazard signing, and monitoring is to be no longer than one year.

- Site Closures - It was identified that the following recreation sites pose threats to 'values at risk' that need to be mitigated. All of them except for Miller Bar, Upper South Fork, and Lower South Fork campgrounds should be temporarily closed until health and safety concerns are addressed.
    - Miller Bar, which lies outside the fire perimeter, but still poses a threat to human life and safety from a rapidly rising Chetco river.
    - Nook Bar, which poses a threat to human life and safety from a rapidly rising Chetco river, and hazard trees. A threat exists to property (CXT toilet building) from hazard trees.
    - Redwood Bar, which poses a threat to human life and safety from a rapidly rising Chetco river, hazard trees, and raw sewage exposure. A threat exists to property (CXT toilet building) from hazard trees.
    - Little Redwood, which poses a threat to human life and safety from a rapidly rising Chetco river, hazard trees, and raw sewage exposure. A threat exists to property (CXT toilet buildings) from hazard trees. A threat exists to the environment from overflowing sewage vaults.
    - Upper and Lower South Fork, which pose a threat to human life and safety from a rapidly rising Chetco river.
- Hazard Signs – Will be posted at Forest Service designated recreation sites that serve as portals into the fire perimeter. See the list in Appendix A for specific locations.

- Treatment of Hazard Trees:
    - Trails – Remove hazard trees for employee safety while they perform trail drainage work. Remove hazard trees for interpretive sign protection at mid-trail interpretive sign location along Bomb Site trail.
    - Trailheads, Campgrounds and Packers Cabin Recreation Rental – Remove hazard trees for infrastructure protection and for employee safety while they perform site specific clean-up of hazardous debris.
- Storm-proof Trails – Work will include repairing and installing drainage structures such as rolling grade dips, grade reversals, knicks, and armoring drainage crossings. Restore outslope where necessary.
- Secure Exposed Hazardous Waste at Packers Cabin, Upper Chetco trailhead, Redwood Bar, and Little Redwood:
    - Pump vault toilets at each location (total of 7 vaults)
    - Clean up debris, remove debris and foundations, crush vaults, and backfill with appropriate material at Packers Cabin and Upper Chetco trailhead. Ensure no waste remains in vault before crushing.
    - Secure openings with ¾" plywood at Redwood Bar and Little Redwood.
    - Monitor vaults to ensure openings remain secure.
- Monitor treatments at all recreation sites for effectiveness and for additional threats to values at risk that were not identified in this assessment. Monitor for hazard trees that were not evident at the time of the initial survey.
- Monitor hazard warning signs and repair and replace them as needed.

D. ESTIMATE OF TREATMENT COSTS:

TRAILHEADS – Protection of Life and Property

Cost Estimate for Trailhead – Work will include removal of hazard trees around the immediate vicinity of valuable property and BAER implementation areas, and removal of debris from signs, buildings, and fee stations (hazards from exposed nails, bolts, brackets and rebar). Exposed toilet vaults will be pumped, crushed, and filled.

Hazard Tree Removal: estimated at [redacted]
Pumping exposed vaults: estimated at [redacted]
Crushing and filling vaults: estimated at [redacted]

TRAILS – Protection of Property

Cost Estimate for Trail Stabilization and Hazard Mitigation – Work will include installing drainage (rolling grade dips, grade reversals, knicks), water bars (only where necessary, and then only with rock), armoring drainage crossings, and snagging trees as appropriate for worker safety.

Trail Force Account Crew – Local Forest Service Crew

Trail Force Account - Costs Estimate (per mile)						
Item	**Cost**	**Non-Wildernss Qty (Days)**	**Total**	**Wildernss Qty (Days)**	**Total**	**Notes**
GS11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Administration
GS7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Oversight
GS7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Leadership
GS5	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Crew
GS5	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Crew
Supplies	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Miscellaneous
Per Diem	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted] per day multiplied by 'X' days for 3 people
Overtime	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted] per day assuming 5 hours per day for 3 days multiplied by 3 people.
Total:			[redacted]	**Per mile**	[redacted]	**Per mile**

Trail Contract Crew – Forest Service Administered Contract – Including costs associated with trail design, layout and administration.

Trail Contract - Costs Estimate (per mile)						
Item	**Cost**	**Non-Wildernss Qty (Days)**	**Total**	**Wildernss Qty (Days)**	**Total**	**Notes**
GS11	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Contract Admin-istration is 12%
GS9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
GS7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Contract	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total:			[redacted]	**Per mile**	[redacted]	**Per mile**

For the Chetco Bar Fire Trail Stabilization, [redacted] per mile is proposed for non-wilderness trail, and [redacted] per mile is proposed for wilderness trail. That will allow the district the decision space to use either Force Account labor or Contract labor to complete the work. This would also allow the district to use other partnership organizations to complete the work.

CAMPGROUNDS & RECREATION RENTAL – Protection of Life, Property, & Resources
This cost estimate is for protecting human life and safety, and mitigating damage to campground facilities. Work will include installing closure gates, removal of debris (hazards from exposed metal, concrete, nails and other building materials), pumping of human waste, closure of vaults, and the removal of hazard trees.

- Hazard Tree removal and debris cleanup – lump sum estimate for each site.

HAZARD SIGNS – Protection of Life
This cost estimate is for placing information boards and posting hazard related signs to notify the public of post fire hazards.

- Install adequate signs to post information - [redacted] each
- Maintenance of hazard signs for one year. Estimate includes labor, travel time, and vehicle - [redacted] each

E. TREATMENT COSTS:

Trailheads – Mitigate (clean up) damage associated with the burning of toilet buildings, signs, registration boxes, and picnic tables. This includes removal of hazard trees to protect infrastructure and for worker safety.
Total request is for [redacted]

Trailhead	Units	# of Units	Unit Cost	Total Cost
Tincup trailhead	Trees	[redacted]	[redacted]	[redacted]
Upper Chetco trailhead	Lump: [redacted]	[redacted]	[redacted]	[redacted]
Chetco Divide/Vulcan Peak trailhead	Trees	[redacted]	[redacted]	[redacted]
Bomb Site trailhead	Trees	[redacted]	[redacted]	[redacted]
Total				[redacted]

Trail Stabilization and Hazard Mitigation – Work will include installing drainage (rolling grade dips, grade reversals, knicks), water bars (only where necessary, and then only with rock), armoring drain crossings, and snagging trees as appropriate for worker safety. This work is necessary to protect the trail asset by diverting anticipated increases in surface run-off over and off of the trail. This request also includes felling of hazard trees along the portion of trail to be worked on to mitigate safety concerns.
Total request is for [redacted]

Trail Name & Number	Units	# of Units	Unit Cost	Total Cost
Snow Camp trail #1103	Miles	1.7	[redacted]	[redacted]
Panther Lake trail #1104	Miles	0.4	[redacted]	[redacted]
Tincup trail #1117 (Wilderness)	Miles	2.5	[redacted]	[redacted]
Tincup trail #1117 (Non-wilderness)	Miles	1.5	[redacted]	[redacted]
Boulder Tie trail #1117B	Miles	0.1	[redacted]	[redacted]
Tincup Creek trail #1117C	Miles	0.1	[redacted]	[redacted]
Mislatnah trail #1119	Miles	0.7	[redacted]	[redacted]
Upper Chetco trail #1102	Miles	5.1	[redacted]	[redacted]
Gardner Mine trail #1122	Miles	0.1	[redacted]	[redacted]
Johnson Butte trail #1110	Miles	0.9	[redacted]	[redacted]
Chetco Divide trail #1210	Miles	0.1	[redacted]	[redacted]
Red Mountain trail #1105	Miles	0.5	[redacted]	[redacted]
Navy Monument trail #1105A	Miles	0.1	[redacted]	[redacted]
Japanese Bombing Site trail #1118	Miles	0.4	[redacted]	[redacted]
Little Chetco trail #1121	Miles	1.0	[redacted]	[redacted]
Bailey Mountain trail #1109	Miles	1.0	[redacted]	[redacted]
Bailey Cabin trail #1131	Miles	0.3	[redacted]	[redacted]
Emily Cabin trail #1129	Miles	0.7	[redacted]	[redacted]
Babyfoot Lake Rim #1126	Miles	0.1	[redacted]	[redacted]
Kalmiopsis Rim trail #1124	Miles	1.2	[redacted]	[redacted]
Total		**18.5**		[redacted]

Campgrounds & Recreation Rental – This cost estimate is for mitigating damage to campground and recreation rental facilities, and for the protection of workers. Work will include installing gates, removal of debris (hazards from exposed metal, concrete, nails and other building materials), pumping of human waste, crushing, backfilling, and covering of vaults, and the removal of hazard trees. Total request is for [redacted]

Campground/Rec Rental Name	Units	# of Units	Unit Cost	Total Cost
Miller Bar	Gate	[redacted]	[redacted]	[redacted]
Nook Bar	Lump [redacted]	[redacted]	[redacted]	[redacted]
Redwood Bar	Lump: [redacted]	[redacted]	[redacted]	[redacted]
Little Redwood	Lump: [redacted]	[redacted]	[redacted]	[redacted]
Upper South Fork	Gate	[redacted]	[redacted]	[redacted]
Lower South Fork	Gate	[redacted]	[redacted]	[redacted]
Packers Cabin	Lump: [redacted]	[redacted]	[redacted]	[redacted]
Total		[redacted]		[redacted]

Hazard Signage - In addition to the initial installation, there will be a need to monitor and reinstall signage as it becomes worn or is otherwise damaged. Total request is for $8,450.

Site/Treatment	Units	# of Units	Unit Cost	Total Cost
Installation of Warning Signage	Sign/Post	[redacted]	[redacted]	[redacted]
Maintenance of Warning Signage for 12 Months	Reposting	[redacted]	[redacted]	[redacted]
Total				[redacted]

The total cost of implementing the treatments discussed in this document is [redacted].

F. THE COST OF NOT TREATING

When the resource at risk is property, it is prudent to evaluate the cost of treatments versus the replacement cost of the property if it is lost to post-fire events. According to the de facto authoritative book "Trail Solutions" by IMBA, a hand constructed trail would cost $26,000 to construct under typical conditions.

I was able to obtain toilet building replacement quotes from CXT concrete buildings, Inc., and from Romtec Inc. A CXT "Gunnison" single vault toilet (such as what Little Redwood campground contains) would cost [redacted] for the basic building, delivery, and installation. A CXT "Double Cascadian" double vault toilet (such as what Nook and Redwood Bar campgrounds contain) would cost [redacted] for the basic building, delivery, and installation. A

Romtec basic SST model 1006 would cost [redacted] for the pre-fabricated building, delivery, and installation. It appears that even with a loss of the older “stick built” vault toilets, the lowest cost option of replacement would be the CXT “Gunnison” building. Please note that none of these quotes take into account Forest Service administrative overhead costs, NEPA costs, or implementation oversight costs associated with building replacement.

At a cost of [redacted] dollars to [redacted] per mile for proactively treating trails, versus [redacted] per mile to reconstruct the trails, it becomes clear that the best decision would be to administer the treatments to the trails to protect the infrastructure. For the protection of recreational toilet buildings by mitigating snag hazards, the decision becomes even more apparent. Even in the largest hazard tree treatment prescription recommended in this report (160 hazard trees), the [redacted] cost is much less than the nearly [redacted] (not including Forest Service analysis, administration and oversight costs) that would be spent to replace the building.

G. DISCUSSION/SUMMARY/RECOMMENDATIONS:

In summary, the proposed treatments for trailheads, trails and recreation facilities will be implemented in concert with larger scale watershed treatments to help preserve life, public and administrative safety, infrastructure, cultural resources, and post-fire ecosystem recovery. Trailhead treatments are intended to ensure protection of infrastructure from further damage and to provide for worker safety while implementation occurs. Trail treatments are designed to minimize damage caused by increased runoff and sediment transport across steep slopes, and erosion from drainage channels in correlation with burn areas. Implementation of the prescribed trail treatments will mitigate potential risk to trail infrastructure and reduce further erosion and sediment transport. Campground and Recreation Rental treatments are proposed to control exposed hazardous waste, secure remaining portion of facilities and to provide for worker safety while implementation occurs. Temporary closures, along with extensive Hazard signage, are recommended for immediate implementation in order to inform public users of the known and unknown hazards present within the burn area.

The risk assessment for recreational sites and trails revealed areas of very high probability of future threats to life or property, or unacceptable degradation to natural resources. For this reason, it is recommended that the above treatments be fully funded as requested.

F. APPENDICES:

A. Locations of hazard warning signage
B. Example of hazard warning signs
C. Treatment diagrams
D. Photographs
E. References

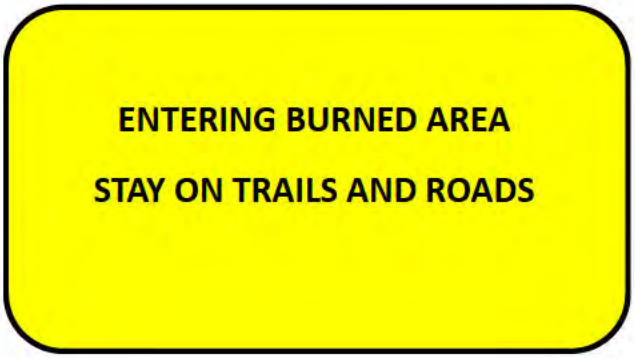
Appendix A: Hazard Signage Location

Num	Site Name	Num	Site Name
1	Snow Camp North / Fairview Meadow trailhead	14	Little Redwood
2	Snow Camp South trailhead	15	Upper South Fork
3	Snow Camp Lookout Trailhead	16	Lower South Fork
4	Panther Lake trailhead	17	Packers Cabin
5	Tincup trailhead	18	Snow Camp Lookout
6	Upper Chetco trailhead	19	Persoll Peak Lookout trailhead
7	Vulcan Lake/Johnson Butte trailhead	20	Kalmiopsis Rim/Chetco Pass trailhead
8	Chetco Divide/Vulcan Peak trailhead	21	North Kalmiopsis Rim trailhead
9	Red Mountain trailhead	22	Kalmiopsis Rim/Onion Pass trailhead
10	Bomb Site trailhead	23	Babyfoot Lake trailhead
11	Chetco Gorge trailhead	24	Canyon Creek trailhead
12	Nook Bar	25	Buckskin Peak trailhead
13	Redwood Bar	26	Miller Bar

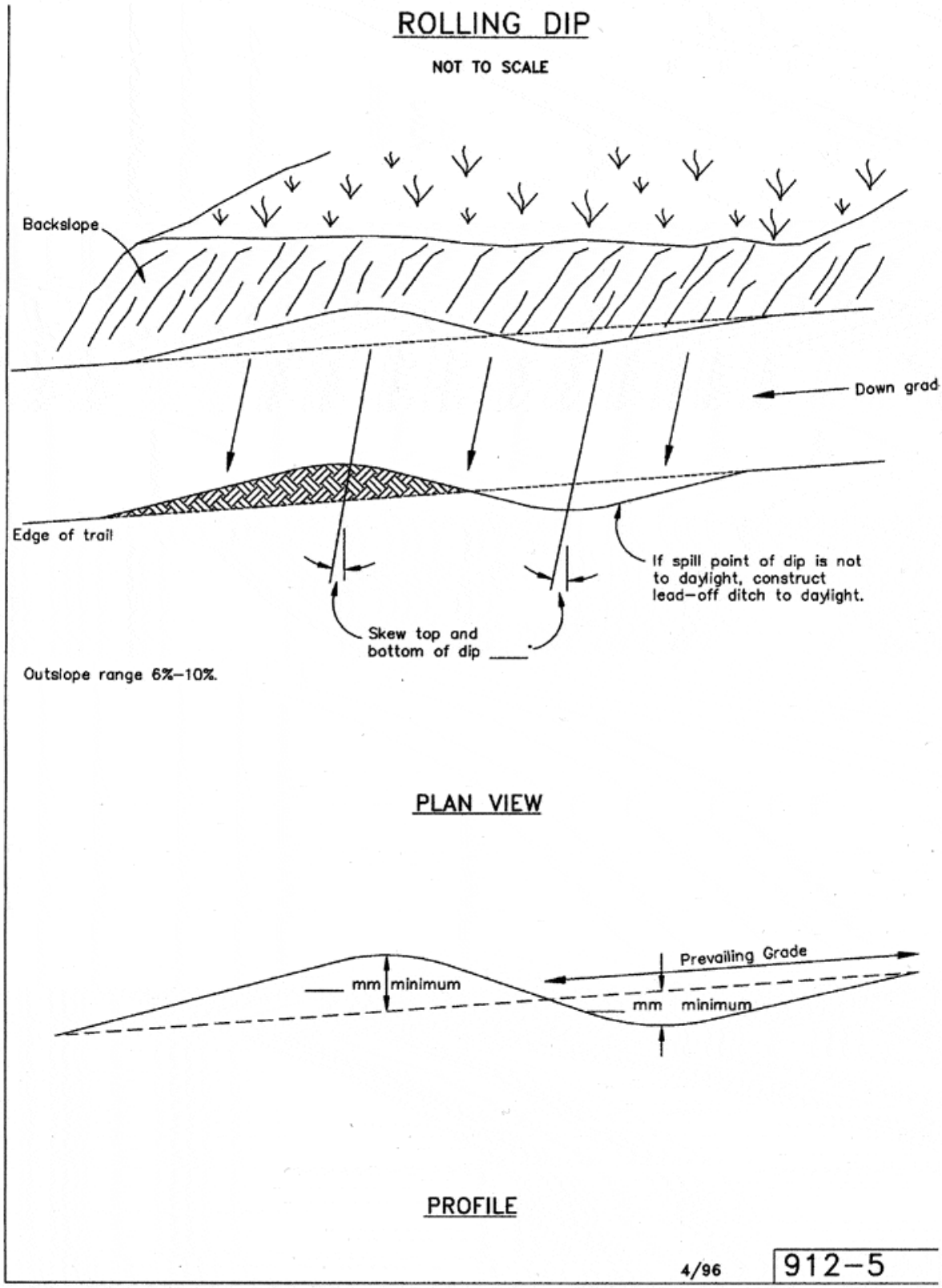
Appendix B: Sample Hazard Signs

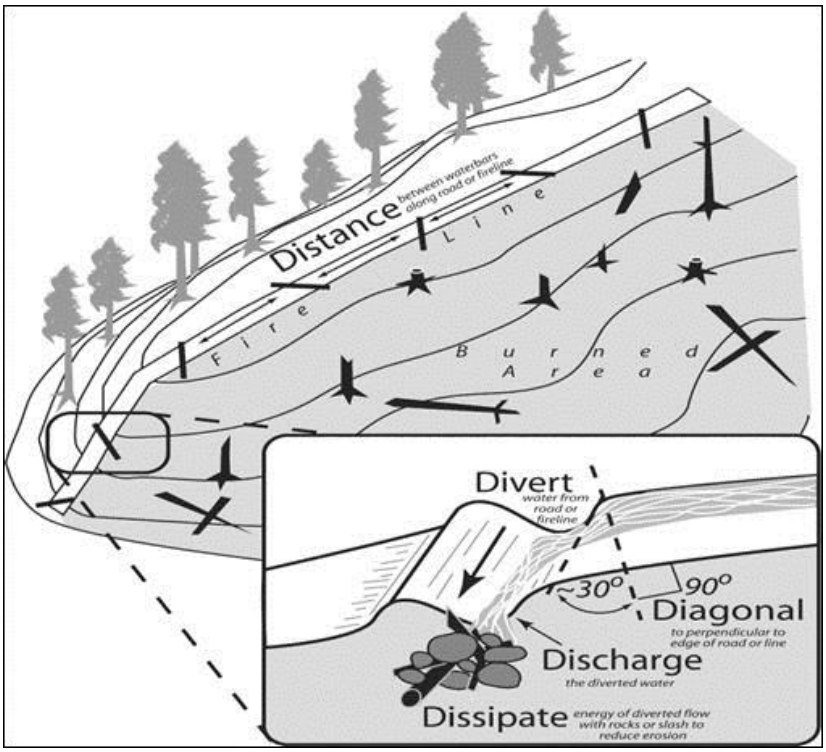
Recreation Sign 1 (example): Caution – Burned Area – Potential Hazards Include

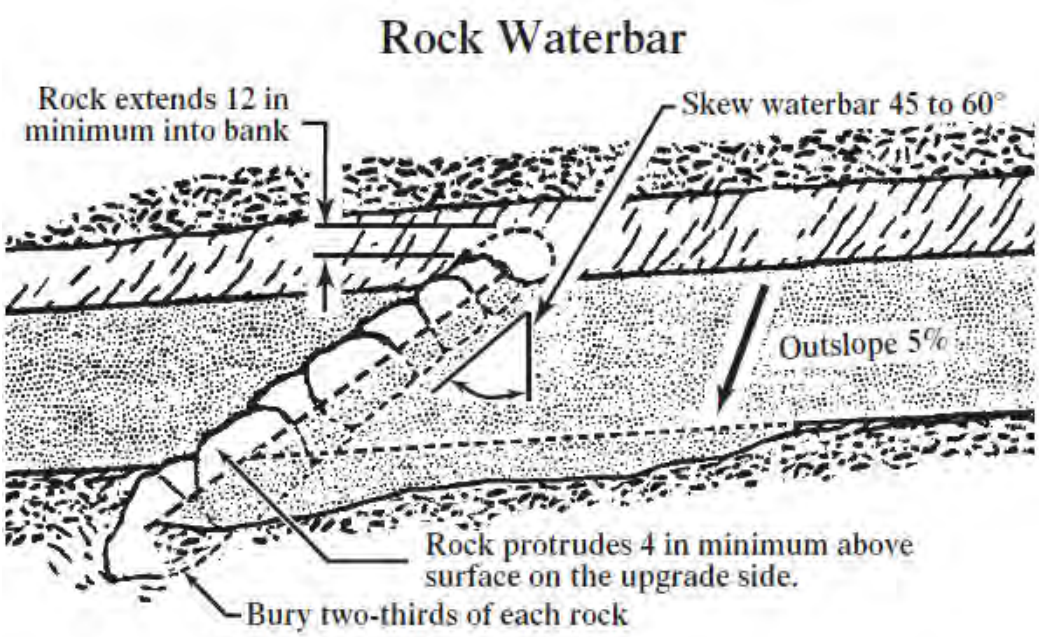
Recreation Sign 2 (example): Entering Burned Area- Stay On Trails And Roads



Appendix C: Treatment Details




Distance between waterbars along road or fireline
Fire Line
Burned Area
Divert water from road or fireline
~30°
90°
Diagonal to perpendicular to edge of road or line
Discharge the diverted water
Dissipate energy of diverted flow with rocks or slash to reduce erosion


Rock Waterbar
Rock extends 12 in minimum into bank
Skew waterbar 45 to 60°
Outslope 5%
Rock protrudes 4 in minimum above surface on the upgrade side.
Bury two-thirds of each rock

Appendix D: Photographs

Trailhead Signage Damage (typical)

Damage at Trailhead

Trail drainage crossing in need of armoring (typical)

Trail bed in need of drainage features to stabilize (typical)

Toilet and other facilities destroyed

Appendix E: References

- BAER Guidance Paper, Hazard Trees, April 2013
- BAER Response Treatments Catalog: Watershed, Soil, Air Management, 0625 1801—SDTDC, December 2006, figure 110, page 181
- The 2013 "Recreation Economics Contribution Report" found at http://www.fs.fed.us/emc/economics/recreation-contributions
- Oregon Resident Outdoor Recreation Demand Analysis – Curry/Josephine County Summary, appendix 5.
- Trail Construction and Maintenance Notebook, 2007 Edition, Surface Water Control, page 29-42.
- Trail Solutions. 2004. IMBA. Boulder, Colorado
- USDA Forest Service. 1989. Siskiyou National Forest Land and Resource Management Plan. USDA Forest Service, Siskiyou National Forest, Medford, Oregon. Available online at: https://www.fs.usda.gov/main/rogue-siskiyou/landmanagement/planning

BAER SPECIALIST REPORT:
Botany and Invasive Plants
Rogue River- Siskiyou National Forest
Gold Beach and Wild Rivers Ranger District

Figure 1. Cedar Creek, a tributary to the Pistol River, before and after the Chetco Bar Fire.

October, 2017

Kailey Clarno
Gold Beach Ranger District Botanist
Rogue River- Siskiyou National Forest

I. Resource Condition Assessment

A. Resource Setting

This report has been completed as part of FSM 2523 direction for burned area emergency response (BAER) to the Chetco Bar Fire on the Rogue River- Siskiyou National Forest. The Chetco Bar Fire burned approximately 191,197 acres across private, BLM and Forest System Lands including 170,321 acres of Forest System Lands on the Rogue River- Siskiyou National Forest. This report addresses only the resources associated with the National Forest System lands which are comprised of five major drainages including: Chetco River, Pistol River, Illinois River, Winchuck River, and North Fork Smith River.

Vegetation varies widely within the Chetco Bar Fire area. Jeffrey pine, western white pine, incense cedar, Douglas-fir, and knobcone pine are common on well-drained ultramafic soils over much of the Kalmiopsis Wilderness in the eastern portion of the burned area. Port-Orford-cedar is found on poorly-drained soils in moderate to high concentrations in the upper portion of the Chetco River, associated largely with wet sites on ultramafic terrain in the Kalmiopsis Wilderness. Huckleberry oak, coffeeberry, small leaf tanoak, labrador tea, western azalea, and tan oak are common shrubs. Concentrations of Brewer spruce are scattered in the Wilderness. The western portion of the Chetco Bar Fire has many hardwood stands which include tanoak, madrone, big leaf maple, vine maple, chinquapin, and alder. The western portion of the burned area also contains old growth stands of Douglas fir as well as numerous Douglas fir plantations. There are many unique habitats within the Chetco Bar Fire which include meadows, rock bluffs, *Darlingtonia californica* wetlands, springs, ponds, lakes, a diversity of pines and hardwoods, open ultramafic areas with Jeffrey pine savannahs, and the northernmost stands of coast redwood along the lower Chetco River and Wheeler Creek (USDA 1996).

The Kalmiopsis Wilderness is legendary for its diversity of plant life. This is largely a result of plants adapting to the serpentinite and peridotite soils, geological, erosional and depositional influences, and periodic fire regime (USDA 1996). A large number of endemic and sensitive plant populations are associated with the Kalmiopsis Wilderness.

Burn severity on forest system lands within the Chetco Bar Fire area varied by drainage with 10,684 acres burned at high severity, 58,784 acres moderate severity, 70,201 acres of low severity and 30,642 acres of very low or unburned.

Approximately 58.3 miles of dozer lines were constructed or reconstructed in and around the Chetco Bar Fire perimeter on National Forest System Lands, as well as 51 miles of hand line. Rehabilitation and repair of areas disturbed by suppression included pulling back hand line and dozer line berms and slash and seeding with native grasses where appropriate, installing water bars on fire lines, and grading road surfaces affected by fire vehicle and equipment use.

B. Values at Risk

1) "Critical Habitat or Suitable occupied habitat for federally listed threatened or endangered plant species on NFS lands"

There are seven documented populations of the federally endangered plant species, *Arabis macdonaldiana* (McDonald's rockcress), on the Rogue River- Siskiyou National Forest. Of these seven populations, three occur in California and four occur in Oregon. One of these populations occurs within the Chetco Bar Fire Area on Chetco Peak in the Kalmiopsis Wilderness.

The taxonomic relationship between *Arabis macdonaldiana* on Red Mountain (in Mendocino County, California) and the more northern populations of *Arabis macdonaldiana* in the North Fork of the Smith River watershed (Den Norte County, California, and Curry County, California) has long been a source of confusion.

This species is found on barren to shrub covered rocky serpentine soil and Jeffrey pine woodlands at 500 to 4000 ft elevation and is currently considered to be restricted to Curry and Josephine Counties in southwest Oregon on Forest System Lands and private land, and in adjacent Del Norte County, California south to Mendocino County, California. Its range is confined to the heavily serpentinized bands of soil located along the far western portion of the California-Oregon border within or near to the Kalmiopsis Wilderness south to Red Mountain, California.

The habitat occupied by McDonald's rockcress in the Chetco Bar Fire burned with low severity and was not affected by suppression activities. Fire is an important factor affecting vegetation in the Klamath Bioregion, including areas where *Arabis macdonaldiana* occurs, and appears particularly important in maintaining open habitats (U.S. Fish and Wildlife Service 2013).

2) "Native or naturalized plant communities on NFS lands where invasive species or noxious weeds are absent or present in only minor amounts."

Plant communities affected by the Chetco Bar Fire and suppression activities on the Rogue River-Siskiyou National Forest include western white pine, incense cedar, Douglas-fir and knobcone pine forests associated with well-drained ultramafic soils; Port-Orford-cedar dominated riparian areas on ultramafic terrain; Serpentine scrub which include huckleberry oak, coffeeberry, small leaf tanoak, labrador tea, western azalea; hardwood stands which include tanoak, madrone, big leaf maple, vine maple, chinquapin, and alder; Darlingtonia wetlands; Jeffrey pine savannahs; the northernmost stands of coast redwood; douglas fir/tanoak forests, and meadows which are home to native grass species including *Festuca idahoenisis*, *Festuca californica*, *Danthonia californica*, and *Elymus glaucus*.

Figure 2. Ericameria arborescens, a R6 Regional Forester Sensitive Species, growing in the Chetco Bar Fire area pre-fire.

The natural plant communities affected by the Chetco Bar Fire include unique habitats with documented populations of plant species on the R6 Regional Forester's Sensitive Species Plant List (USDA 2017), and provide important habitat and ecological values for wildlife and human uses. Documented occurrences of the R6 Regional Forester's Sensitive Species Plant List within the Chetco Bar Fire perimeter include *Arctostaphylos*

hispidula (Gasquet manzanita), *Bensoniella oregana* (Oregon bensoniella), *Ericameria arborescens* (goldenfleece) (Figure 2), *Erigeron cervinus* (Siskiyou fleabane), *Gentiana setigera* (Mendocino gentian), *Lupinus tracyi* (Tracy's lupine), *Monardella purpurea* (serpentine monardella), and *Saxigragopsis fragariodes* (strawberry saxifrage) (**Table 1**).

Table 1. Federally listed and R6 sensitive plant species documented within the Chetco Bar Fire containment area.

Species	Occurrence ID	Area (acres)
Arabis macdonaldiana (Federally endangered)	061126_ARMA33_0001	0.1
	061126_ARHI5_0001	0.1
	061126_ARHI5_0002	0.2
	061126_ARHI5_0004	0.1
	061126_ARHI5_0013	0.1
	061126_ARHI5_0029	0.1
	061126_ARHI5_0031	0.07
	061126_ARHI5_0032	0.02
Arctostaphylos hispidula	061126_ARHI5_0009	0.61
	061126_BEOR_0007	0.1
Bensoniella oregana	061126_BEOR_0025	0.1
	061126_ERAR27_0002	0.1
	061126_ERAR27_0003	0.56
	061126_ERAR27_0001	0.1
	061126_ERAR27_0004	1.45
Ericameria arborescens	061126_ERAR27_0005	0.02
	061122_ERCE_0022	0.1
	061126_ERCE_0002	0.1
	061126_ERCE_0005	0.1
	061126_ERCE_0008	0.1
	061126_ERCE_0009	0.1
	061122_ERCE_0004	1.97
Erigeron cervinus	061126_ERCE_0001	4.18
Gentiana setigera	061126_GESE2_0017	0.1
Lupinus tracyi	061122_LUTR_0012	0.1
	061122_LUTR_0013	1.94
Monardella purpurea	061122_MOPU2_0007	0.1
	061126_SAFR5_0002	0.1
Saxifragopsis fragarioides	061122_SAFR5_0011	0.08
	Total	12.9

Of the total 12.8 acres of documented sensitive species populations in the Chetco Bar Fire Area, 6.86 acres burned at moderate intensity, 4.43 acres burned at low intensity, and 1.61 acres underburned or were

unburned. No documented sensitive plant populations have been impacted directly by fire suppression activity. Other sensitive plant species on the R6 Regional Forester's list have habitat but have not been documented within the fire perimeter area.

Most of the native vegetation in the area is adapted to historical levels of wildfire, so there are no expected long-term negative impacts on these native plant communities and their associated sensitive plant populations due to the fire itself. Dozer lines resulting from fire suppression activity have a devastating effect on native plant species both directly, by physically damaging the plants and indirectly, by creating ground disturbance which can be readily colonized by invasive plants. The primary threat to these existing sensitive plant populations and other suitable sensitive plant habitat is the invasion of non-native plant species including state listed noxious weeds that could displace sensitive plant populations, lower plant community diversity and negatively affect ecosystem services. The risk of invasion of non-native and noxious weeds has increased due to suppression activity and wildfire (Asher et al. 2001). Other threats include the dispersal of invasive plant seeds and propagules by vehicles and suppression equipment. Non-native species can aggressively take over burned open spaces and crowd out native species (USFWS 2010).

C. Other desirable vegetation

Other desirable plant communities include native plant species that provide food or habitat for a variety of wildlife species. The primary threat to these communities is the invasion by non-native invasive plants that readily colonize burned areas. Non-native invasive plants reduce diversity and abundance of native plant species with a corresponding decrease in diversity and quality of wildlife habitat. Rapid colonization and expansion of non-native invasive plants also increases erosion, and decreases water quality and forage.

Open meadows and prairies are an important unique plant and wildlife habitat. Meadows within the Chetco Bar Fire area are predominantly associated with ridges along the main stem and tributaries of the Chetco River, such as Long Ridge meadows, Low and High Prairie, Mislatnah Prairies, and Red Mountain Prairie. Native grass species common in these areas are *Festuca roemeri, F. californica, Danthonia californica,* and *Elymus glaucus.* Additionally, Windy Valley is habitat for the sensitive

butterfly species, Mardon Skipper (*Polites mardon).*

Figure 3. Windy Valley Meadow post Chetco Bar Fire, an important breading habitat for the Mardon Skipper, a sensitive butterfly.

D. Invasive Plants

There are 13 species of non-native invasive plants on the Oregon Department of Agriculture's List of Noxious Weeds (ODA 2001) that are documented and mapped within the burned area. Several species were discovered during field recon for the Chetco Bar BAER analysis that are not documented in the Invasive plant data base (NRM TESP-IS) and therefore there is no data on population size and distribution for these species (Table 2). In addition to ODA listed noxious weeds, wheatgrass is present at the Tin Cup Trailhead and may spread up the nearby dozer line (USDA 1996), and various non-native grasses and forbs are present within the fire area.

Table 2. Documented Invasive plant sites on the Rogue River- Siskiyou National Forest within the Chetco Bar Fire perimeter:

Chetco Bar Fire on NFS lands				**acres**
Species	**common**	**ODA Status**		**total**
Brachypodium sylvaticum	Slender false brome	List B		**21.15**
Centaurea pratensis	Meadow knapweed	List B		**0.24**
Centaurea solstitialis	Yellow star-thistle	List B		**2.61**

Cirsium arvense	Canada thistle	List B		**2.46**
Cirsium vulgare	bull thistle	List B		**23.8**
Cortaderia selloana	pampas grass	List B		**0.76**
Cytisus scoparius	Scotch broom	List B		**24.84**
Genista monspessulana	French broom	List B		**2.42**
Hedera helix	English ivy	List B		**1.66**
Rubus armeniacus	Himalayan blackberry	List B		**10+**
Senecio jacobaea	stinking willie	List B, List T		**19.27**
Spartium junceum	Spanish broom	List B		**0.26**
Ulex europaeus	common gorse	List B, List T		**0.32**
Total				**109.8**

In addition to invasive plant infestations documented on forest system lands, there are similar infestations on adjacent BLM and private lands.

Figure 4. Armenian Blackberry, a persistent invasive plant, is one of the first plants to re-sprout post fire. This species is likely to take over larger areas with more open space post fire.

Figure 5. Known problem scotch broom site pre-burn. Site was used as a medevac site and staging area during the Chetco Bar Fire.

E. Other botanical considerations

The Chetco Bar Fire burned through three botanical areas (Snow Camp, Big Craggies, and Vulcan); as well as one Research Natural area (Wheeler Creek).

A small portion of the Vulcan Botanical Area burned at low or very low severity; the entirety of the Big Craggies Botanical Area burned at high or moderate severity; and a small portion of the Snow Camp Botanical Area burned at moderate or low burn severity. Of the three botanical areas that burned, Snow Camp is at the most risk of negative effects to native plant communities due to invasive plant invasion. There are three large scotch broom infestations and one large bull thistle infestation within a half-mile of the botanical area, and a dozer line was built along the border of the botanical area ending at a known scotch broom infestation (Figure 5).

Figure 6. Rehabbed dozer line along the boundary of Snow Camp Botanical Area.

Wheeler Creek Research Natural Area (RNA) in the Winchuck Watershed is set aside to represent the northern extent of coast redwood. This ridgetop redwood stand is thought to be younger in average age than old-growth redwood at Redwood National Park in Northern California, 300 years old compared to 700 years old. This is due to more frequent fire history and less favorable growing conditions (shallow ridgetop soils and less year-round fog). Frost limits the northern extent of coast redwood, so migration northward depends largely on climate changes over time. Planting of redwood has extended its range unnaturally

northward, although it is scattered and limited in size (USDA 1996).

Figure 7. Burnt coast redwood within the Wheeler Creek Research Natural Area.

The Wheeler Creek RNA is 356 acres. The Chetco Bar Fire burned 223 acres (63%) of the RNA, 9 acres (3%) at moderate soil burn severity, 79 acres (22%) at low soil burn severity, and 135 acres (38%) at very low soil burn severity. The Wheeler Creek RNA is a portion of a larger coast redwood area which is 610 acres. The Chetco Bar Fire burned 355 acres (58%) of the larger wheeler creek redwood area, 22 acres (4%) at moderate soil burn severity, 115 acres (19%) at low soil burn severity, and 218 acres (36%) at very low soil burn severity. Roughly 6 acres (1%) of the redwood area had 75-100% basal area loss; 18 acres (3%) had 50-75% basal area loss; 45 acres (7%) of the redwood area had 25-50% basal area loss; and 121 acres (20%) of the wheeler creek redwood area had 0-25% basal area loss. Of the entire 610 acre Wheeler Creek redwood area, 272 acres contain large old growth (4-6’ DBH) redwood trees. Only 2 acres (<1%) of the large old growth redwoods along Wheeler Ridge had 75-100% basal area loss; 2 acres (<1%) had 50-75% basal area loss; 22 acres (8%) had 25-50% basal area loss; and 69 acres (25%) had 0-25% basal area loss.

	High soil burn severity		**Moderate soil burn severity**		**Low soil burn severity**		**Very low soil burn severity**		**Total acres**		
	acres	%	acres	%	acres	%	acres	%	Total	Total Burned	% burned
Wheeler Creek RNA	0	0%	9	3%	79	22%	135	38%	356	223	63%
Wheeler Creek Redwood area	0	0%	22	4%	115	19%	218	36%	610	355	58%
Large Old Growth Redwood area (4-6' DBH)	0	0%	3	1%	44	16%	111	41%	272	158	58%
	75-100% Basal Area Loss		**50-75% Basal Area Loss**		**25-50% Basal Area Loss**		**0-25% Basal Area Loss**		**Total acres**		
	acres	%	acres	%	acres	%	acres	%	Total	Total Burned	% burned
Wheeler Creek RNA	3	<1%	9	2.5%	32	9%	94	26%	356	138	39%
Wheeler Creek Redwood area	6	1%	18	3%	45	7%	121	20%	610	190	31%
Large Old Growth Redwood area (4-6' DBH)	2	<1%	2	<1%	22	8%	69	25%	272	95	35%

Figure 8. Soil burn severity and basal area loss within the Wheeler Creek Redwood Area including Wheeler Creek Research Natural Area.

Figure 9. Aerial photograph of Wheeler Creek Research Natural Area and the Wheeler Ridge Redwood Stand.

II. Emergency Determination

The values at risk are: 1) Critical Habitat or Suitable occupied habitat for federally listed threatened or endangered plant species on NFS lands and 2) Native or naturalized communities on NFS lands where invasive species or noxious weeds are absent or present in only minor amounts.

1) Federally listed plant species, Mcdonald's rockcress

The likelihood that Mcdonald's rockcress will be damaged or lost due to the Chetco Bar Fire is low. No fire suppression efforts took place in the vicinity of Mcdonald's rockcress populations, and fire is likely to have beneficial effects to the species' habitat by reducing competition with the species (USFWS 2013).

Probability of Damage or Loss	**Magnitude of Consequences**		
	Major	Moderate	Minor
	RISK		
Very Likely	Very High	Very High	Low
Likely	Very High	High	Low

Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

2) Native and naturalized communities

The values at risk are native plant communities. Particularly sensitive are meadows (Long Ridge, Low Meadow, High Prairie, Mislatnah Prairies, Red Mountain Priarie, and Windy Valley), open ultramafic areas, the coast redwood stand along Wheeler Creek Ridge, endemic and sensitive serpentine plant populations, and native plant communities associated with the Snow Camp Botanical Area. The threat to these native plant communities is the invasion of non-native invasive plants colonizing these habitats and displacing native plants, reducing species diversity. Because it is well known that vehicles traveling along heavily infested corridors and heavy equipment that has not been properly cleaned can introduce and spread noxious weeds into new areas, it is very likely that non-native invasive plants were transported into the Chetco Bar Fire perimeter. Several infestations of invasive plants within the fire perimeter occur along roads, meadows and plantations where fire fighting vehicles, heavy equipment, hoses, and foot traffic likely picked up seeds and spread them to new areas. Seed rain from nearby invasive populations along with existing seed beds in the soil will result in a high likelihood of colonization into burned areas. New infestations may be detected Spring/Summer of 2018 and the seasons following.

Probability of Damage or Loss	**Magnitude of Consequences**		
	Major	**Moderate**	Minor
	RISK		
Very Likely	Very High	Very High	Low
Likely	Very High	High	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

The suppression effort created approximately 58.3 miles of dozer line and 51 miles of hand line as well as several staging areas, helispots and safety zones. Although a weed washing station was set up at base camp after the fire started, much of the firefighting equipment came onto the fire from outside the area before being washed, and therefore new weed species have most likely been introduced. Assessing the establishment and treating new invasive plant infestations on vectors in 2018 as part of early detection and rapid response program will be critical to the recovery of the native plant communities within the burned area.

III. Treatment to Mitigate the Emergency

A. Recommended BAER Treatments

1) Non-native Invasive Plant Monitoring and Treatment

Prevention, combined with early detection and rapid response, is the most effective means of controlling invasive plants and protecting native plant communities. Post-fire non-native invasive plant detection

monitoring is recommended the first year “to determine the post-fire presence of invasive species” on fire lines and burned areas. This is consistent with Forest Service Manual direction of BAER treatment of invasive plants. (FSM2523.2(f)) (USDA, 2017). Detection surveys will be focused in areas of increased probability of infestation including areas of high and moderate burn severity within a half- mile of known invasive plant infestations, roads, trails, fire lines, drop points, helispots, staging areas, safety zones, and BAER implementation impacts.

Manual invasive plant control would occur in order to reduce the potential for spread of weeds within the fire perimeter. Current NEPA covering herbicide treatment on the Gold Beach and Wild Rivers Ranger Districts is limited, therefore the majority of the invasive plant treatments will be manual. Treatment effectiveness monitoring is also required under the FSM direction of BAER treatment of invasive plants (USDA, 20017). The priority areas for invasive plant treatments are areas that burned at moderate to high severity, especially near meadows (Long Ridge, Low Meadow, High Prairie, Mislatnah Prairies, Red Mountain Priarie, and Windy Valley), the coast redwood stand along the Wheeler Creek drainage, known sensitive plant locations, and the Snow Camp Botanical Area.

Effectiveness monitoring will answer these questions:

1. What invasive plant species are colonizing burned areas and to what spatial extent?
2. Are invasive plant treatment actions working as planned? Compare initial population sizes (polygons) with population sizes after treatments at the first year mark.

Measurement indicators:

1. Invasive species list comparison before and after detection surveys are completed
2. Polygon size comparisons before and after treatments

Reporting and timeframe:

1. Collection of monitoring data in spring and fall of 2019.
2. Analysis and comparison of 1st year data in winter 2019/2020.
3. 1st year monitoring report provided in spring of 2020.
4. All data collected regarding invasive plant treatments and reconnaissance findings will be compiled into a database (TESP-IS /FACTS) for further tracking and treatment of infestations identified during this monitoring process.
5. Monitoring will be conducted for the first year under BAER authorization. Monitoring needs following this period will be conducted under normal program authorities. A minimum of three years of monitoring should be implemented in combination between BAER and other program authorities.

IV. Discussions/Summary/Recommendations

Based on this analysis of known invasive plant populations, potential seed rain from nearby populations and the mixed severity nature of this fire it is recommended that an Early Detection Rapid Response (EDRR) invasive plant treatment effort be implemented in order to abate negative effects to native plant communities within the fire. The Klamath Mountains, particularly the areas where these fires burned, are renowned in the nation as having some of the highest levels of plant biodiversity and endemic plant species. This is attested to by the fact that three designated botanical areas were burned during these fires

as well as the northernmost coast redwoods. The Rogue River-Siskiyou National Forest has gone to great lengths to manage invasive plant species in this area because of the high value native plant natural resource that is found here. It is imperative that this effort is doubled down on now that large scale fires have left many acres vulnerable to colonization to the invasive plant species discussed in this report. Considering all this it is strongly recommended that EDRR efforts are fully funded and implemented for at least the next season. Based on the efficacy of treatments in 2018 there may be a need to ask for additional funds in 2019 and 2020.

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