SIX RIVERS NATIONAL FOREST
BURNED AREA EMERGENCY RESPONSE

MAD RIVER COMPLEX
and
HUMBOLDT LIGHTNING COMPLEX

SOILS RESOURCE ASSESSMENT

Prepared by: Mary Rasmussen-Flores and Kit MacDonald

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OBJECTIVES

The Burned Area Emergency Response (BAER) program is designed to address emergency situations including the protection of life and safety, property, and critical natural and cultural resources.

The objective of the BAER program is to determine whether emergency conditions exist and, if necessary prescribe and implement emergency treatments on Federal Lands to minimize threats to life or property resulting from post-wildfire effects or to stabilize and prevent unacceptable degradation to natural and cultural resources. During the assessment stage, the Burned Area Emergency Response team assesses values at risk that may be affected, but can only recommend treatments on National Forest lands. Treatments on National Forest System (NFS) lands may benefit downstream private ownerships and resources off of NFS lands but treatments on lands other than Forest Service lands must be designed and implemented using other means. It is important for the reviewer of this document to understand that BAER is not a long-term wildfire rehabilitation program nor are BAER assessments intended to provide comprehensive evaluations of all fire or suppression damages, to evaluate post-fire damages after they occur, or to identify long-term rehabilitation or restoration needs.

The purpose of the Mad River and Humbolt Lightning Complexes BAER is to identify values at risk within, adjacent, and downstream of the burned areas; to assess changes to resource conditions as a result of the fire; to identify and describe the level of risk to values, considering direct and indirect effects having substantial threats to human life and safety, property, and important natural and cultural resources.

This report summarizes the potential post-wildfire effects to soil resources within each fire of the Mad River and Humboldt Lightning Complexes. It is based on findings of aerial reconnaissance and field investigations of soil burn severities within each fire perimeter and modeling of soil erosion processes. Field investigations of post-fire forest and soil conditions and model results are used to determine the potential effects to values at risk identified within or downstream of each fire and to determine if treatments

are warranted to protect these values. The BAER assessment was conducted from August 29 through September 5, 2015.

BURNED AREA CHARACTERIZATION

The Humboldt Lightning and Mad River Complexes were started by lightning on July 30th and 31st, 2015, respectively. They burned until contained in late August and early September. Wildfires in both complexes burned in steep, rugged terrain of Humboldt and Trinity Counties, California with relatively poor access and heavy fuel loads. Fires threatened the Mount Lassic Wilderness, USFS land and privately owned commercial timberland. USFS lands burned in these complexes are administered by the Mad River Ranger District of the Six Rivers National Forest and the Hayfork District of the Shasta-Trinity National Forest.

The Mad River Complex consists of 3 fires (Gobbler, Lassic, and Pickett), that burned a total of 37,462 acres. The Gobbler Fire was approximately 8,279 acres, the Lassic fire was approximately 17,938 acres, and the Pickett fire was approximately 10,980 acres. The Gobbler Fire burned approximately 7,496 acres of NFS land on the Mad River Ranger District (MRRD) of the Six Rivers National Forest and approximately 833 acres of non-Forest Service (FS) land. The Lassic Fire burned approximately 17,339 acres of NFS land on the MRRD and 643 acres of non-FS land. The Pickett fire burned approximately 9,365 acres of NFS land on the MRRD and the Hayfork District of the Shasta-Trinity National Forest and approximately 1,620 of non-FS land.

The Humbolt Lightning Complex consists of several small fires (Steelhead, Wildcat, Dobbyn, Bluford, Blocksburg, Pine and Winchester) that burned a total of 4,883 acres. However, only two fires, the Bluford (202 acres) and Pine (1774 acres) in the Humboldt Complex are assessed as part of this resource report. The Bluford fire burned approximately 175 acres of NFS land on the MRRD and 28 acres of non-FS land. The Pine fire burned approximately 1,736 acres of NFS land on the MRRD and 60 acres of non-FS land.

Elevations within the burned areas range from 2,800 ft. near Ruth Lake to 5,900 ft. above mean sea level (amsl) at Black Lassic Mtn. Much of the burned area within these fires occurred on relatively steep terrain with slopes generally ranging from 40 to 70 percent. Many of the soils within the burned area have moderate to severe erosion hazard ratings. Unstable landforms were observed within the burned areas as indicated by historic landslides and soil slumps and creep (hummocks and benching). There is potential for debris flows in steep headwater drainages where soils burned at high severity. Conditions that can lead to debris flow initiation include: 1) very steep slopes, 2) an abundant supply of loose material, 3) a source of adequate moisture, and 4) sparse vegetation. Some of these conditions currently exist within the fire (i.e., very steep slopes, poorly consolidated soils with weak granular structures, and sparse vegetation). When precipitation returns to the burned are, the final condition conducive to debris flow initiation will also be present.

VALUES AT RISK AND THREATS

The BAER team identified several Values-at-risk during the BAER assessment. These values have potential to be adversely affected by a variety of post-fire processes. Due to the relatively small sizes, low overall burn severities, and distances from critical infrastructure, no values-at-risk were identified in association with the Pine or Bluford fires of the Humboldt Lightning Complex. No further assessment of these fires was deemed necessary by BAER team members.

The following table from the Forest Service Manual defines the critical values for which BAER assessments are warranted:

CRITICAL VALUES (FSM 2523.1, exhibit 1)
HUMAN LIFE AND SAFETY
Human life and safety on National Forest System (NFS) lands.
PROPERTY
Buildings, water systems, utility systems, road and trail prisms, dams, wells or other significant investments on NFS lands.
NATURAL RESOURCES
Water used for municipal, domestic, hydropower, or agricultural supply or waters with special Federal or State designations on NFS lands.
Soil productivity and hydrologic function on NFS lands.
Critical habitat or suitable occupied habitat for federally listed threatened or endangered terrestrial, aquatic animal, or plant species on NFS lands.
Native or naturalized communities on NFS lands where invasive species or noxious weeds are absent or present in only minor amounts.
CULTURAL AND HERITAGE RESOURCES
Cultural resources which are listed on or potentially eligible for the National Register of Historic Places, Traditional Cultural Properties, or Indian Sacred Sites on NFS lands.

A number of sites and critical values were identified as being at-risk to post wildfire effects such as erosion, sediment delivery, debris flows, flooding, and falling trees. These risks are summarized in the Burned Area Emergency Response Report (2500-8) and in the applicable resource specialist reports. A summary of some of the values at risk (VARs) identified during the assessment is provided below. These VARs are further discussed in detail with respect to soils resources in the Assessment of Values at Risk section of this report.

VAR	Location and Description	Nature of Threat
Human life and safety	Visitors and residents at the Forest Glen rental cabin, Fir Cove and Bailey Canyon Campgrounds. Residences and occupied structures in Choptoy Creek, Pickett Creek, Sheriff's Cove and Rutledge Opening.* Travelers on roads and at stream crossings downstream of high hazard drainages.	Debris flow
Property	Ruth Reservoir - Humboldt Bay Municipal Water	Sediment delivery

	District (HBMWD) facility and public water supply*.	to Ruth Reservoir ann potential debris flows
	Forest roads and bridges; culverts and other road/stream crossings. These are described in detail in the Engineering report and 2500-8.	sedimentation of culverts causing failure; flood flows that damage/wash road surfaces
	Fir and Bailey Cove campground facilities and water supplies.	sediment delivery debris flow, and potential flood flows
	Forest Glen rental cabin.	sediment delivery debris flow, and potential flood flows debris flow
	State and County roads and bridges.	sediment delivery debris flow, and potential flood flows debris flow
	Ruth Lake hydropower facility - HBMWD	sediment delivery to the facility
	Non-FS campgrounds, businesses, homes, and water systems (Sheriff's Cove, Journey's End, Ruth Lake CSD, Rutledge Opening and other private residences)	Sediment delivery/debris flow

Fir Cove – This watershed is located above Fir Cove Campground on Ruth Reservoir. The drainage area for this watershed is 484 acres. Approximately 4 acres burned at high severity, 45 acres burned at moderate severity, and 60 acres burned at low severity. The channel is steep, linear and flows directly into Fir Cove Campground. Sediment delivery to the campground is possible. Based on the modeled 10-year storm event, sediment delivery to downslope areas in Fir Cover is estimated to be approximately 16,880 tons. Based on the two-year storm event, sediment delivery is estimated to be approximately 6,100 tons. Since moderate and high burn severity are not in close proximity to Fir Cove, it is unlikely that the entire volume of this sediment would be delivered to Fir Cove in a single event (i.e., some sediment would settle from suspension before reaching Fir Cove, particularly heavier particles). However, some sediment delivery to the Fir Cove area can be expected. This will primarily be nuisance and is not expected to pose a risk to human health or safety unless it is associated with debris flows, which cannot be predicted with certainty.

Bailey Canyon – This small watershed above Baily Canyon Campground is approximately 279 acres in size. Approximately 213 acres burned throughout this canyon. There were 72 acres that burned at low severity, 110 acres that burned at moderate severity, and 30 acres that burned at high severity. Sediment delivery to downslope areas is likely. Based on the modeled 10-year storm event, sediment delivery to downslope areas in Bailey Canyon is estimated to be approximately 8,105

tons. Based on the modeled two-year storm event, sediment delivery is estimated to be approximately 3,233 tons. Again, since moderate and high soil burn severities are not in close proximity to the campground, some sediment can be expected to settle from suspension before reaching the campground. It is unlikely that the entire volume of sediment predicted would be delivered directly to Bailey Canyon in a single event.

Glen Creek – This relatively steep headwater is 1,515 acres in size. Approximately 65 acres burned at high severity, 130 acres burned at moderate severity and 318 acres burned at low severity. Hummocks and benches are evident in this watershed indicating unstable soil conditions. Soils have weak granular structures and are poorly consolidated. Sediment delivery to lower portions of this watershed is likely. Based on the modeled 10-year storm event, sediment delivery to downslope areas in Glen Creek is estimated to be approximately 17,695 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 4,807 tons. There is an intermediate risk of sediment being delivered to Glen Creek adversely affecting the bridge and waterline. This would likely occur as a result of winter precipitation.

Pickett Creek – This watershed is narrow and steep as are most of the watersheds along this southwest-facing slope of South Fork Mtn. It is possible that flood flows and entrained sediment could adversely affect the campground and Ruth Reservoir. Based on the modeled two-year storm event, sediment delivery is estimated to be approximately 13,475 tons. If a 10-year storm occurs, it is possible for sediment be delivered to Ruth Reservoir. It is unlikely that the volume of sediment expected would adversely affect the road, bridge, or waterline.

Choptoy Creek – This watershed is adjacent to the Pickett Creek watershed, but has slightly larger drainage area. Vegetation remains in the lower slope positions, which should help capture some sediments and infiltrate water. Based on the modeled 10-year storm event, sediment delivery to downslope areas in Choptoy Creek, including Ruth Reservoir is estimated to be approximately 18,604 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 6,312 tons. The risk of damaging sediment delivery is low due to gentle toe slopes that remain vegetated. These areas will help capture sediment and infiltrate stormwater runoff.

Sheriff’s Cove – This watershed has potential to deliver sediment directly to Ruth Reservoir. Based on the modeled 10-year storm event, sediment delivery to downslope areas in, including Ruth Reservoir is estimated to be approximately 15,725 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 5,680 tons. There is an intermediate risk

Pickett Creek – This watershed is 500 acres in size. Approximately 190 acres burned at low severity, 92 acres burned at moderate severity and 80 acres burned at high severity. Based on the modeled 10-year storm event, sediment delivery to downslope areas in, including Ruth Reservoir is estimated to be approximately 13,475 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 4,673 tons.

Journey's End – There is an intermediate risk of sediment sediment-laden runoff into this resor area. There are several headwater drainages that burned at high and moderate soil burn severity areas. The model indicates possible debris flows in the channels to the immediate vicinity of the resort. Considerable length of very low to unburned area in and near the lower channel may help reduce this chance.

West Fork Van Duzen River – This watershed area modeled is approximately 5000 acres in size. Approximately 1403 acres burned at low severity, 1122 acres burned at moderate severity and 250 acres burned at high severity. Based on the modeled 10-year storm event, sediment delivery to downslope areas the West Fork Van Duzen River could be as high as 120,600 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 44,208 tons. Burn severities were in the form of a mosaic which limits the spatial extent of high soil burn severity.

Black Lassic Creek flows in close proximity to the community at Rutledge Opening. There is a structure located in close proximity to one of the channel. Lower elevations in this watershed remained unburned or burned at low soil burn severity. Based on the modeled 10-year storm event, sediment delivery to downslope areas, including Rutledge is estimated at 29,417 tons. The modeled two-year storm event indicates that sediment delivery would be approximately 14,150 tons.

Active landslides were observed in the Black Lassic and Red Lassic and Shanty Creek areas of the Lassic Fire. There is some risk of these landslides being reactivated. Please ssee the geologists specialist report for a discussion of geologic features and associated hazards within the Mad River and Humboldt Lightning Fires Complexs. Due to the discontinuous nature of burn severities resulting in a mosaic of fire effects, the risk of reactivating landslides is generally intermediate to low, depending on location.

There are several roads and culverted stream crossings that were identified as values at risk through the burned areas. Some culverts are undersized for anticipated storm flows. Road and stream crossing failures would result in additional accelerated erosion and sediment delivery than those modeled for hillslope processes. These areas can be stabilized using BAER funding where warranted or repaired and replaced where failure occurs. Road closures to prevent risk ti human life and safety could mitigate risks.

There are vernal pools that are surrounded by high and moderate burn severities. These habitat features could be at risk from post fire sediment delivery and hillslope processes, particularly where there are steeper slope segments that could contribute to sheet flow into pools.

Surface water quality in most streams and waterbodies within the fire perimeters and downstream are likely to be adversely by these fires through delivery of sediment, debris and ash. The magnitude and extent of these effects are discussed in the hydrologist specialist report.

There are private residences located in the Choptoy Creek, Pickett Creek and Sheriff's Cove areas. These residences could be subject to sediment laden stormwater runoff where they are located in close proximity to drainageways or in low lying areas.

RESOURCE ASSESSMENT

Field investigations were prioritized using the preliminary soil burn severity map or 'BARC' (Burned Area Reflectance Classification) provided by the Remote Sensing Applications Center, aerial reconnaissance, ground reconnaissance and truthing, and a preliminary review of potential values at risk. On-the-ground assessments were conducted in order to verify soil map units and assess fire effects on soil hydrologic function, productivity, and erosion potential. Such effects include vegetative burn severity, aspect, slope gradient, slope length and profile, remaining soil effective cover, litter layer consumption, soil heating and char, soil structure, aggregate stability, soil texture, root consumption, water repellency, and ash depth. Soil map unit data were combined with field observations to generate interpretations of fire effects on known (examined) soils, and interpretations were extrapolated for areas that were not field-verified. Subsequent erosion hazard ratings and sediment production estimates were based in part on information found in the Soil Survey of the Six Rivers National Forest, California (1993).

Soil burn severity was assessed following principles described in Parsons et al., 2010. Members of the BAER team identified hydrophobic soil conditions extending to depths of 7 inches at some locations, with high continuity. Water was applied drop wise to the soil at selected depths below the ash layer. The time required for water to penetrate the soil surface and begin to infiltrate was recorded at each depth. The following soil hydrophobicity categories were assigned based upon observed infiltration rates:

Slight: Less than 10 seconds.
Moderate: Between 10 to 40 seconds.
Strong: Greater than 40 seconds.

Tables 1 through 5 below summarize predicted acreages for each soil hydrophobicity category for each fire in the Mad River and Humboldt Lightning Complexes.

Table 1. Soil hydrophobicity categories and associated acreages in the Gobbler fire.

Category	Acres
Weakly hydrophobic	3549
Moderately hydrophobic	1135
Strongly hydrophobic*	3593

* Note: strong background soil hydrophobicity was observed in many unburned areas in the Douglas fir/white fir vegetation type throughout the Mad River Complex.

Table 2. Soil hydrophobicity categories and associated acreages in the Lassic fire.

Category	Acres
Weakly hydrophobic	2149
Moderately hydrophobic	3958
Strongly hydrophobic*	5359

* Note: strong background soil hydrophobicity was observed in many unburned areas in the Douglas fir/white fir vegetation type throughout the Mad River Complex.

Table 3. Soil hydrophobicity categories and associated acreages in the Pickett fire.

Category	Acres
Weakly hydrophobic	2353
Moderately hydrophobic	5372
Strongly hydrophobic*	3258

* Note: strong background soil hydrophobicity was observed in many unburned areas in the Douglas fir/white fir vegetation type throughout the Mad River Complex.

Table 4. Soil hydrophobicity categories and associated acreages in the Bluford fire.

Category	Acres
Weakly hydrophobic	116
Moderately hydrophobic	94
Strongly hydrophobic	6

Table 5. Soil hydrophobicity categories and associated acreages in the Pine fire.

Category	Acres
Weakly hydrophobic	
Moderately hydrophobic	
Strongly hydrophobic	
Total	

The BARC data were reclassified to better reflect actual soil burn severity as observed in the field. Soil burn severity acreage is summarized in the Tables 6 through 10 below.

It is important to understand that BAER is a rapid assessment process. As such, the final burn severity map is not intended nor 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. The map is expected to be approximately 90 percent accurate.

Table 6. Soil burn severities and overall percentages observed in the Gobbler fire.

Soil Burn Severity		
Severity	**Acres**	**Percent**
Very Low	4732	57

Low	2271	27
Moderate	1202	15
High	74	1
Total	**8279**	

Table 7. Soil burn severities and overall percentages observed in the Lassic fire.

Soil Burn Severity		
Severity	**Acres**	**Percent**
Very Low	8594	48
Low	5314	30
Moderate	3377	19
High	653	4
Total	**17938**	

Table 8. Soil burn severities and overall percentages observed in the Pickett fire.

Soil Burn Severity		
Severity	**Acres**	**Percent**
Very Low	4706	43
Low	4025	37
Moderate	1729	16
High	523	5
Total	**10983**	

Table 9. Soil burn severities and overall percentages observed in the Bluford fire.

Soil Burn Severity		
Severity	**Acres**	**Percent**
Very Low	38	19
Low	157	77
Moderate	8	4
Total	**203**	

Table 10. Soil burn severities and overall percentages observed in the Pine fire.

Soil Burn Severity		
Severity	**Acres**	**Percent**
Very Low	1130	64
Low	505	29
Moderate	125	7
High	11	1
Total	**1771**	

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 sediment 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 mediate above- and below-ground structure and function in forest and rangeland ecosystems such as water balance (porosity; water holding capacity), nutrient dynamics (C:N ratios; macro and micronutrient adsorption and release), microbial communities, etc. A moderate rating is intermediate to low and high burn severity.

Quantitative erosion values were estimated using the Erosion Risk Management Tool (ERMiT), a WEPP modeling application developed by the USFS Rocky Mountain Research Station (USFS, RMRS GTR 188, 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 soil infiltration rates and stormwater runoff is initiated, thus entraining surface soil particles and other material on soil surfaces (i.e., woody debris, gravel, etc.). The model does not account for landslides, gully erosion, effects of roads, or hillslope ravel.

All HUC12 subwatersheds within the fire perimeter were included in the analysis. Model estimates were generated for dominant soil map units and associated burn severities, and apportioned to watersheds on a per-acre basis. Model output is in tons per acre on a storm event basis. The two-year (50 percent chance of recurrence) and ten year (ten percent chance of recurrence) storm frequencies were modeled. Accuracy of model output is estimated to be ± 50 percent.

Sediment yield rates will depend upon future precipitation and runoff patterns bring in terms of rainfall frequency, intensity, and duration and the amount of winter snowpack that contributes to spring runoff. Erosion rates are expected to decline each year as revegetation and natural recovery processes occur. Soil erosion will decrease soil productivity through nutrient losses, prolonging vegetative recovery, depending upon soil loss rates. Soil organic carbon has been reduced substantially in areas subjected to moderate and high burn severities, limiting the amount of atmospheric carbon sequestered in these soils.

Modeling included estimation of natural or ‘background’ erosion rates for unburned portions of the fire. Soil burn severity is accounted for throughout these modeled estimates; other erosional processes as previously discussed are not. It is important to note that many areas that were classified as moderate burn severity using remote sensing methods are actually high burn severity. The BARC map was therefore revised following field verification of burn severities to produce the final burn severity map.

Major soils within the Mad River and Humbolt Lightning Complexes include the Doty-Hecker Association (Fine-loamy, mixed, superactive, mesic Pachic Humixerepts); Clallam-Hugo-Holland Association (Fine-loamy, mixed, mesic Dystric Xerochrepts); Clallam, moderately deep, unstable Melbourne Association (Fine-loamy, mixed, mesic

Dystric Xerochrepts and Fine, mixed, superactive, mesic Ultic Palexeralfs); Deadwood-rock outcrop, metasedimentary-Voorhies Association (Loamy-skeletal, mixed, superactive, mesic Lithic Dystroxerepts and Loamy-skeletal, mixed, superactive, mesic Mollic Haploxeralfs). There are other map units within the fire that comprise small percentages of the burned area. Rock outcrops are also common throughout the burned area. Many of the soils within the burned area formed from weathering of sedimentary and metasedimentary rocks and have high erosion hazard ratings.

Relevant soils resource inventory information for each fire within the Mad River Complex are listed in tables 11 through 15 below.

Table 11. Gobbler soils inventory (includes unburned acreages).

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
100	TYPIC XEROFLUVENTS-RIVERWASH	MIXED ALLUVIUM		Low	11.0
236	DOTY-HECKER, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	High	2642.6
237	CLALLAM, MOD. DEEP, UNSTABLE-MELBOURNE	SCHIST & FRACTURED SHALE	B-C	High	954.9
238	MELBOURNE-SOULAJULE, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	C	High	6.6
250	OXALIS-HECKER-DOTY, DEEP	SHEARED SHALEY SEDIMENTS	C	High	447.5
259	NANNY, DEEP-WOODSEYE-BINS, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	High	89.1
260	SKALAN-KISTIRN-HOLLAND, DEEP	METASEDIMENTARY ROCK	B	Moderate	589.2
261	HOLLAND-GOLDRIDGE, DEEP	METASEDIMENTARY ROCK	C	Moderate	298.6
265	CLALLAM-HUGO-HOLLAND, DEEP, DRY	METASEDIMENTARY ROCK	B	Moderate	1380.2
266	CLALLAM-HUGO-HOLLAND, DEEP	METASEDIMENTARY ROCK	B-C	Moderate	202.3
280	DEADWOOD-CLALLAM, DEEP, EXT. GRAVELLY	SEDIMENTARY, METASEDIMENTARY & METAIGNEOUS ROCK	C	Low	682.9
281	CLALLAM, DEEP, EXT. GRAVELLY-DEADWOOD	SEDIMENTARY & METASEDIMENTARY ROCK	C	Moderate	217.5
282	DEADWOOD-ROCK OUTCROP, METASEDIMENTARY-VOORHIES	SEDIMENTARY & METASEDIMENTARY ROCK	C	Low	751.6
300	ROCK OUTCROP, METAIGNEOUS-LITHIC XERORTHENTS COMPL	----------	D	Low	4.6

Table 12. Lassic soils inventory (includes unburned acreages).

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
236	DOTY-HECKER, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	High	190.4
237	CLALLAM, MOD. DEEP, UNSTABLE-MELBOURNE	SCHIST & FRACTURED SHALE	B-C	High	1022.9
238	MELBOURNE-SOULAJULE, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	C	High	979.7
250	OXALIS-HECKER-DOTY, DEEP	SHEARED SHALEY SEDIMENTS	C	High	131.4
254	DEADWOOD-SKYMOR	SEDIMENTARY & METASEDIMENTARY ROCK	C	Moderate	183.9
257	BINS-NANNY, DEEP-WOODSEYE	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	Moderate	2352.2
259	NANNY, DEEP-WOODSEYE-BINS, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	High	6251.0
260	SKALAN-KISTIRN-HOLLAND, DEEP	METASEDIMENTARY ROCK	B	Moderate	171.6
261	HOLLAND-GOLDRIDGE, DEEP	METASEDIMENTARY ROCK	C	Moderate	166.7
265	CLALLAM-HUGO-HOLLAND, DEEP, DRY	METASEDIMENTARY ROCK	B	Moderate	2078.6
266	CLALLAM-HUGO-HOLLAND, DEEP	METASEDIMENTARY ROCK	B-C	Moderate	1872.2
280	DEADWOOD-CLALLAM, DEEP, EXT. GRAVELLY	SEDIMENTARY, METASEDIMENTARY & METAIGNEOUS ROCK	C	Low	339.8
300	ROCK OUTCROP, METAIGNEOUS-LITHIC XERORTHENTS COMPL	----------	D	Low	298.7
411	HUNGRY, DEEP	SERPENTINITE ROCK	C	Moderate	883.2
412	MADDEN, MOD. DEEP	SERPENTINITE ROCK	C	Moderate	800.9

Table 13. Pickett soils inventory (includes unburned acreages).

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
100	TYPIC XEROFLUVENTS-RIVERWASH	MIXED ALLUVIUM	*	Low	705.3
226	KISTIRN-GOLDRIDGE, DEEP-DEADWOOD	SEDIMENTARY & METASEDIMENTARY ROCK	C	Moderate	77.7
237	CLALLAM, MOD. DEEP, UNSTABLE-MELBOURNE	SCHIST & FRACTURED SHALE	B-C	High	1416.6
238	MELBOURNE-SOULAJULE, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	C	High	40.3
250	OXALIS-HECKER-DOTY, DEEP	SHEARED SHALEY SEDIMENTS	C	High	8.6

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
252	MELBOURNE-HOLLAND, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	C	High	202.6
254	DEADWOOD-SKYMOR	SEDIMENTARY & METASEDIMENTARY ROCK	C	Moderate	1131.2
257	BINS-NANNY, DEEP-WOODSEYE	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	Moderate	76.2
258	ALBUS-RACE, DEEP	MICA SCHIST	B-C	High	1832.1
259	NANNY, DEEP-WOODSEYE-BINS, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	High	2295.8
260	SKALAN-KISTIRN-HOLLAND, DEEP	METASEDIMENTARY ROCK	B	Moderate	2338.4
265	CLALLAM-HUGO-HOLLAND, DEEP, DRY	METASEDIMENTARY ROCK	B	Moderate	323.6
266	CLALLAM-HUGO-HOLLAND, DEEP	METASEDIMENTARY ROCK	B-C	Moderate	87.8
280	DEADWOOD-CLALLAM, DEEP, EXT. GRAVELLY	SEDIMENTARY, METASEDIMENTARY & METAIGNEOUS ROCK	C	Low	562.4
281	CLALLAM, DEEP, EXT. GRAVELLY-DEADWOOD	SEDIMENTARY & METASEDIMENTARY ROCK	C	Moderate	142.6

Table 14. Bluford soils inventory (includes unburned acreages).

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
238	SKALAN-KISTIRN-HOLLAND, DEEP	METASEDIMENTARY ROCK	B	Moderate	162.6
260	MELBOURNE-SOULAJULE, DEEP	SEDIMENTARY & METASEDIMENTARY ROCK	C	High	12.3

Table 15. Pine soils inventory (includes unburned acreages).

Soil Map Unit	Association	Parent Material	Hydrologic Group	Average Erosion Hazard Rating	Acres
257	BINS-NANNY, DEEP-WOODSEYE	SEDIMENTARY & METASEDIMENTARY ROCK	B-C	Moderate	121.3
260	SKALAN-KISTIRN-HOLLAND, DEEP	METASEDIMENTARY ROCK	B	Moderate	472.0
261	HOLLAND-GOLDRIDGE, DEEP	METASEDIMENTARY ROCK	C	Moderate	34.3
265	CLALLAM-HUGO-HOLLAND, DEEP, DRY	METASEDIMENTARY ROCK	B	Moderate	800.6
412	MADDEN, MOD. DEEP	SERPENTINITE ROCK	C	Moderate	323.7

Hydrologic soil groups are assigned based on water transmissivity in the soil. The soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less water impermeable (such as a fragipan or duripan) or depth to a water table (where present). The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below. The hydrologic soil group is a useful index reflecting a soil's inherent potential for runoff and erosion. Soils in hydrologic soil group B have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B 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, or a shallow restrictive layer near the soil surface. In some areas, they may 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 within 24 inches of the surface are in this group.

Hydrologic soil groups within both complexes range from B to D. Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr.). Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine textures. These soils have a low rate of water transmission (0.05-0.15 in/hr.). Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted. Within the burned area, Group D soils consist chiefly of shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

ASSESSMENT OF VALUES AT RISK

The BAER Risk Level Matrix below is used to evaluate the risk level for each of the values-at-risk identified during the BAER assessment for potential increased run-off and soil erosion downstream of burned areas following major rain events.

2523.1 - Exhibit 02

BAER Risk Assessment

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 or loss would occur within 1 to 3 years (depending on the resource):

- 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. Loss of life or injury to humans; substantial property damage; irreversible damage to critical natural or cultural resources.
- Moderate. Injury or illness to humans; moderate property damage; damage to critical natural or cultural resources resulting in considerable or long term effects.
- Minor. Property damage is limited in economic value and/or to few investments; damage to critical natural or cultural resources resulting in minimal, recoverable or localized effects.

Resource Catagory	Value-at-Risk	Description of Threat	BAER Critical Value	Probability of Damage or Loss	Magnitude of Consequences	Risk
Property	Bailey and Fir Campgrounds	The campgrounds are closed during the winter season when sediment delivery is most likely to occur. There could be damage from flood flows and sediment delivery to campground infrastructure. These damages could be repaired. If a	Yes	Likely	Minor	Low

		storm event were to occur during the season of use, the risk to human life and safety would increase. A closure order would mitigate risk to forest visitors. The risk is therefore intermediate.				
Property and Natural Resources		Sediment delivery to the Glen Creek cabin area would most likely occur as the result of a winter storm. Since the cabin is not used during the winter, sediment delivery to this area would not cause a significant risk to human health or safety. Sediment delivery to the bridge over Glen Creek could further compromise the integrity of the bridge. However, repairs to the bridge over Glen Creek are planned in order to reinforce the bridge abutments. The consequences of sediment delivery to the bridge at Glen Creek are therefore moderate. Sediment delivery to Glen Creek is not expected to adversely affect the waterline. Therefore the consequences of sediment damaging the waterline are moderate, and the risk is intermediate.	Yes	Possible	Moderate	Intermediate
Property	Choptoy Creek Properties and Road Infrastructure	There are private residences in the vicinity, and a private road crosses channels with debris flow probabilities rated as possible. Road damage would probably consist of crossing failure that could be repaired. Ingress/egress could be temporarily compromised. Structures in the area appear to be situated at adequate distances from the channels to generally avoid threats to human life and safety.	Yes	Unlikely	Moderate	Low
Property	Humboldt Bay Municipal Water District ar Ruth Reservoir	Threats to public water supply intake from ash, sediment and debris that could overwhelm the the system's ability to treat water for municipal use. Sediment sources include Choptoy Creek, Pickett Creek and Sheriff's Cove.	N			
Natural Resources	Soils	There will be a long term reduction of soil productivity on areas that burned at moderate and high soil burn severities. It is reasonable to expect much higher erosion and sediment delivery from these areas for at least the next 3 years.	y	Likely	Moderate	High
Natural Resources	Vernal Pools	These areas are at risk from increased erosion and sediment deliver from upslope sediment sources.	Y	Very Likely	Moderate	Very High
Property and Human Health	Private water intakes	There is risk of contaminants such as organic matter, ash, and soil particles being introduced to private water intakes	N			
Natural Resource	Vernal Pools	Increased erosion and sediment delivery are threats that can decrease the capacity of the vernal pools.	N			
Natural Resource	Surface Water Quality	Many of the streams and rivers in close proximity to the fire affected areas are listed on the impaired waters list (i.e., 303d). Those that are affected by the fires will continue to fail to meet water	Y	Very Likely	Moderate	Very High

		quality standards for designated uses for the foreseeable future. Continued impairment of surface water quality could pose an ongoing threat to ESA-listed aquatic species, domestic water supply intakes and hydropower facilities.				
Natural Resource	Seeps and Springs	Threats from Increased erosion and sediment can alter the hydrogeomorphology and functional condition of groundwater dependant ecosystems (GDEs)	Y	Possible	Intermediate	Moderate

Threats to Soils Resources

Threats to soil productivity and hydrologic function in fire affected areas were assessed by evaluating soil burn severity, erosion hazard, modeling of pre- and post-burn erosion rates, and other soil and site-specific conditions. The combination of deep, medium-textured (i.e., loamy) soils, steep slopes, and lack of soil cover (vegetation and litter) in moderate and high severity burn areas will likely result in accelerated erosion of these areas, the degree of which will depend upon geographic fire effects, the intensity and duration of future precipitation events, and rates of natural vegetative recovery. Accelerated soil erosion and associated sediment delivery to ephemeral streamcourses will not be as pronounced in areas subjected to low burn severitiy. These areas are expected to recover more rapidly than moderate and high burn severity areas. Improved effective ground cover (vegetation and litter) is anticipated on low burn severity areas within one year.

Onsite fire effects include physical, chemical, and biological changes to soils caused directly by soil heating that damages soil structure, porosity, and aggregate stability, and oxidizes nutrients. Indirect effects include subsequent soil loss through wind and water erosion caused by loss of soil cover leading to decreased soil productivity and hydrologic function. Loss of soil nutrients and microbial communities will occur in some areas, with these adverse effects increasing by soil burn severity class. These conditions result in short- to long-term degradation of ecosystem function, depending on site specific effects. However, most soils in fire affected areas exhibit low burn severity. Therefore, effects of the fire upon soil productivity and hydrologic function are considered within the ‘normal’ range of variability at most locations within the fire perimeters. However, soils that were burned at moderate and high burn severity have been identified as Values at Risk since the potential loss in soil productivity that would occur on these soils if eroded would be substantial. The identified areas encompass approximately 7558 acres, or 20 percent of the burned area.

Soil loss is expected to be deposited in low gradient toe slopes where the angle of repose is reduced in relation to upslope locations, in low gradient valley bottoms and associated riparian areas, and in low gradient stream channels as increased bedload resulting in channel aggradation.

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 is 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 2015). Soil lost from its native environment cannot be replaced and does not reestablish in the exact same manner as it exists *in situ*.

For the modeled 10-yr (10%) recurrence interval, high burn severity acres average 54 tons per acre of sediment delivery to downslope locations, including stream channels. Moderate burn severities average 40 tons per acre of sediment delivery to downslope locations, including stream channels, and low burn severities are averaging 33 tons per acre of sediment delivery to downslope locations, including stream channels.

For the modeled 2-year (50%) recurrence interval, high burn severity acres are averaging 19 tons per acre of sediment delivery to downslope locations, including stream channels. Moderate burn severities are averaging 12 tons per acre of sediment delivery to downslope locations, including stream channels, and low burn severities are averaging 11 tons per acre of sediment delivery to downslope locations, including stream channels

The weighted average among low, moderate and high burn severities is 37 tons per acre for the 10-year recurrence interval. If one considers that a cubic yard of soil weighs about 1.4 tons then 26 cu yds. of sediment per acre are being delivered to downslope areas.

Based on an implied minimum commercial value of topsoil of $24.00 per cu. yd. and estimated soil erosion rates of up to 54 tons per acre from areas subjected to high soil burn severity and 40 tons per acre from areas subjected to moderate soil burn severity, the potential soil loss would amount to a maximum financial loss of value of soil resources from a commercial use perspective of $23,010,048.00. However, soils within the burned perimeters are not of a productive quality for use as commercial topsoil. Based on the productive capacity of soils within the burned perimeters, their commercial value would approximately equal the value of screened fill dirt, which has a commercial value of approximately $6.00. The financial loss of the productive capacity of soils burned at moderate and high severity is there estimated at soils resources $5,752,512.00

Offsite effects of soil erosion include sediment-laden runoff with higher bulk densities and therefore greater destructive power than clean water in the stream system. Eroded soil could provide material for initiating damaging debris flows and stream bulking, which represent widespread hazards to resources downstream of the fire affected area. This increases the risk for adverse effects to facilities such as road stream crossings and structures in low lying areas, degradation of stream water quality, and most importantly risk to human life, safety and property from potential flooding and debris flows.

Given the slope, soil properties (loam textures with low aggregate stability, loose consistence, moderately deep to deep profiles with moderate to high percentages of gravel, rock and cobble), and geological characteristics (known landslide potential), long-term soil productivity is at risk in moderate and high burn severity areas. Fire-induced changes to vegetative communities are expected to represent a long-term threat to the soils resource in the Douglas fir and white pine vegetation types.

Hillslopes in the burned areas are generally steep to very steep in the headwall basins, with long, linear concave slopes. These hillslopes respond in a predictable manner to rainfall. Runoff water gains energy and momentum as it collects in concave headwall basins and high gradient channels until it develops sufficient erosive energy to mobilize and entrain soil particles and other in-channel debris (i.e., rocks, cobbles, stones, boulders and woody material). The erosive power of sediment-laden runoff increases with distance and flow volume. These flows will mobilize increasing amounts of sediment and have the power to overtop or redirect stream channels until low gradient stream segments are reached to dissipate momentum and allow sediments to settle from suspension. Burned watersheds will produce substantially greater response to typical rainfall events since water interception by vegetation is lost and soil infiltration rates are reduced.

RESPONSE ACTIONS RECOMMENDED TO MITIGATE THE RISK (measureably reduces the threat and passes the benefit:cost test)

Land treatments in the form of hillslope agricultural straw mulch treatments are proven effective at mitigating sheet and rill erosion processes on slopes less than 60% gradient; they are proven ineffective on steeper slopes and slopes dominated by ravel and debris flow processes. Hydrologic forces that entrain soil and debris overwhelm the treatment and the mulch simply moves downslope with the soil. Wood strand mulch has been proven effective on slopes up to 70%, but such undertakings are extremely costly due to the weight of the material and therefore high expense of application using helicopters. Conversely, treating low gradient slopes (i.e., less than 15%) is not advised, as they are usually not active erosion surfaces or major source areas of significant sediment production, so widespread or costly treatments are not warranted. Soils within the burned areas are generally adapted to infrequent wildfires. Land treatments such as straw mulching have the potential to introduce invasive and noxious weeds and are therefore not recommended for these fires.

CONSULTATIONS (People who provided assistance in completing the resource assessment)

Name, Title, and Agency	Telephone
Angela Coleman, Hydrologist, USFS	
Frederick Levitan, Geologist, USFS,	
Jason Pollard, Harvest Inspector, USFS	
Hannah Stone, Natural Resource Specialist (Recreation), USFS	

Yvette Paroz, Fisheries Program Leader, USFS

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