Kaniksu Complex Fire – Burned Area Emergency Response

Soil Resource Assessment Report

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Figure 1: High Burn Severity Slope, above Browns Lake Bay .

Soils Team

Andy Casillas
R3 Terrestrial Ecological Unit
Inventory, Arizona Zone
Phoenix, AZ
602-225-5207
markcasillas@fs.fed.us

Executive Summary

The Kaniksu Complex Fire is a fire complex made up of the Tower, Grease Creek Fire and Baldy Fires. The Tower fire is the largest of the 3 fires, was started on 8/11/2015 by lightning. The Baldy fire was started on 08/1/2015 by lightning and the Grease Creek Fire was started on 8/14/2015 by lightning. The Baldy and Grease Creek Fires are located within the boundaries of the Colville National Forest (CNF) in the State of Washington. The Tower fire located in the State Washington burned areas that are on the CNF and the Idaho Panhandle National Forest (IPNF) and includes Washington Department of Natural Resource and Private Lands. An interdisciplinary Burned Area Emergency Response (BAER) team started it assessment of the Kaniksu Complex on 10/8/2015 following an inbreafing. The BAER Team using a Burned Area Reflectance Classification (BARC) map, aerial observation and ground verification found a Mosaic burn pattern of unburned, and High, Moderate, and low burn severity (table 1, 2&3). The vegetative communities on the burn area include mixed conifer, montane mixed conifer and subalpine park balds. This mixture of vegetative communities, slope, and past land management all contributed to a mosaic burn pattern.

Soil Resource Setting

Fire area access for field assessment was adequate to allow for a representative survey of most watersheds and those not easily accessible were observed by helicopter reconnaissance. Field surveys were conducted to assess other factors affecting soil hydrologic function, productivity, erosion potential, and fire effects. Such factors include vegetative burn intensity, aspect and slope gradient, slope length and profile, soil cover, duff consumption, soil heating and char, soil structure and aggregate stability, texture, porosity, organic matter, fine root condition, and water repellency. These observations were supplemented with numerous additional spot checks between too quickly assess water repellency and soil heating characteristics in more locations along travel routes. Unburned areas were also looked at to gauge fire effects relative to natural conditions for similar soils, particularly with respect to naturally occurring water repellency without fire.

On the Tower Fire areas of high soil burn severity occur in a small pocket throughout the fire burn area and are in their highest concentration in the western portion of the burn area. This includes one large area of high burn severity at the head waters of Mill and Solo Creek and on a hillslope north-north-west of the Browns Lake Bay. The northwestern fire area also contains high soil burn severity but is dominated by low burn severity. The Grease Creek fire is dominated with low/unburned area with pockets of high and moderate soil burn severity on shallow soils on boney ridges and rock outcrop. The Baldy fire has limited high and moderate soil burn severity that is isolated shallow soils located on ridge lines and rock outcrop.

Table 1: Tower Fire soil burn severity

Soil Burn Severity	Acres	Percent of Fire Area
Unburned/Very Low	4,226	17%
Low	10,001	40%
Moderate	8.373	34%
High	2,102	9%

Table 2: Grease Creek Fire soil burn severity

Soil Burn Severity	Acres	Percent of Fire Area
Unburned/Very Low	628	88%
Moderate	43	6%
High	46	6%

Table 3: Baldy Fire soil burn severity

Soil Burn Severity	Acres	Percent of Fire Area
Unburned/Very Low	144	28%
Low	299	58%
Moderate	35	7%
High	36	7%

The Soil Survey of Pend Oreille County from NRCS (USDA Natural Resources Conservation Service) was used on the Grease Creek Fire, Baldy Fire and the western portion of the Tower fire located on the CNF. Soils data was not available for the eastern portion of the Tower fire located on the IPHNF. The IPHNF did have a Landtype Association map available that was cross walked to the soil mapped on the CNF using spatial extent and tabular data. The Tower fire had 21 soil map units mapped within the fire perimeter, Grease Creek Fire had 8 and the Baldy Fire had 4. Corresponding map unit data and interpretations were obtained for further analyses. This provided the basic soil information for making interpretations of fire effects upon the various soils, particularly as many areas were not field visited due to access and time constraints.

Dominate soil series mapped in the complex are Brickel, Hartil, Huckleberry, Manley, and Newbell in the Tower Fire, Huckleberry, Cryands, Manley, and Buhrig in the Grease Creek fire and Manley, and Buhrig in the Baldy fire. Any additional soil map units that made up were made up less than 1% of the analysis areas for each fire were combined with other similar soil map units.

Soil map unit data was combined with field data and site-specific observations to generate interpretations of fire effects upon known (visited) soils, and extrapolate interpretations for unvisited areas. Subsequent erosion hazard ratings and erosion modeling estimates were based in part upon soil survey information and modified using field-calibrated data where appropriate.

Post-Fire Condition Assessment

Rapid assessment and mapping of areas in soil burn severity (SBS) classes is necessary for incorporation with other site factors such as soil type, slope, hydrologic characteristics, and biological or human resource issues to

identify source areas of potential flooding and erosion, and areas where critical ecosystem values may be degraded.

A Burned Area Reflectance Classification (BARC) map was created by the Remote Sensing Applications Center (RSAC, Salt Lake City, Utah) using satellite imagery and standard pre-post differential processing (dNBR) methods. BARC imagery is a very useful starting point for a SBS map; the BARC only "sees" aboveground effects of the fire, and must usually be modified as appropriate to become the SBS map. BARC imagery was adjusted based on processed field data, and aerial reconnaissance, and then processed into a final soil burn severity map.

Soil burn severity and water repellency (hydrophobicity) are fairly independent aspects of fire effects on soils. While it's generally assumed higher SBS will lead to higher water repellency in repellency-prone soils, this is certainly not always the case, and such relationships must be determined for the individual fire, especially when natural repellency in unburned areas is present. Moderate repellency located at the interface between O and A horizons is present in unburned areas is attributed as natural and not fire-induced. Using the water drop penetration test, hydrophobicity was measured as severe on approximately 100 percent of the moderate and high SBS plots.

It should be understood that **soil burn severity is NOT vegetative burn severity or mortality**. Vegetative burn severity is but one component taken into consideration – soil burn severity goes beyond aboveground vegetation impacts to belowground soil heating effects and associated impacts to soil hydrologic function, runoff and erosion potential, and vegetative recovery. Such additional factors include amount and condition of residual ground cover, viability of native seed banks, condition of residual fine roots, degree of fire-induced water-repellency, soil physical factors (texture, structural stability, porosity, restricted drainage), soil chemical factors (oxidation, altered nutrient status), and topography (slope gradient, length, and profile). While above-ground burn severity is more related to peak temperatures and fire behavior during the fire, below-ground soil burn severity is related strongly to the length of time that heat is in contact with the soil (residence time).

Understanding these differences is crucial to meeting the objectives of the BAER assessment. A high intensity fire (high flame lengths, rapid rate of spread, crown fire, etc.) in a stand-replacement event can result in a moderate (or even low) soil burn severity, if the residence time is short and soil characteristics are not altered significantly. Conversely, a slow-moving fire with complete consumption of accumulated surface fuels can leave trees alive, but heat the soil severely with predictable negative consequences to soils and streams. Soil burn severity, used in this context, is a much better index of soil damage, watershed response, and potential for natural vegetative recovery after the fire. Residual soil cover post-fire is the most crucial aspect of aboveground fire effects for potential erosion, but there is a tendency for some to consider only cover at the expense of belowground soil conditions.

Soil Burn Severity Indicators used for this burned area are generalized best in Parsons et al., 2010 [excerpted]:

- **Low soil burn severity**: Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and understory vegetation will likely appear "green."

- **Moderate soil burn severity:** Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. 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. The prevailing color of the site is often "brown" due to canopy needle and other vegetation scorch. Soil structure is generally unchanged.

- **High soil burn severity**: All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed, and charring may be visible on larger roots. The prevailing color of the site is often "black" due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 inches or 8 cm diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

Figure 2: Soil profile of a sample point taken in the moderate soil burn severity in the preliminary BARC layer

Field sites were evaluated to validate the BARC map and to determine the degree of fire related impact on the soil. There was a very strong correlation between the impact on the soil and the vegetative change picked up by the BARC Map. In high burn severity areas the depth of soil charring was ranged from 2 inch to 4 inches, fine to course roots were commonly absent, organic matter was eliminated and soil structure was completely destroyed. The soil were strongly (>40 seconds) hydrophobic and consistent from half an inch to four inches.

Figure 3: Strong soil water repellency

In moderate burn severity areas a majority of the Tree species have dead needles or leaves are covering the bare soil with up to 80% litter (figure 2). the depth of soil charring was ranged from ½ inch to 1 inch, very fine to course roots were present, organic matter was present and soil structure was maintained. These soil were strongly (>40 seconds) hydrophobic and consistent from half an inch to three inches.

Low burn severity area of the tree species typically have green needles or leaves in the upper levels of the canopy and have dead needle and leave in the lower canopy covering the charred O horizon (Duff)

with up to 50% new litter. The O horizon (duff) was charred but still present, soil charring was not present or isolated to small pockets very fine to course roots were present, organic matter was present and soil structure was maintained.

The remaining 54% of the burned area contains unburned/very low to low soil burn severity. Very little evidence of significant soil heating was observed; no changes in soil color, structure, organic matter or fine root combustion occurred within these soils. Seed source was present in most topsoils and natural understory revegetation is expected to progress without delay. These areas currently have 50 to 100% soil cover and should produce little accelerated runoff or erosion above natural "background" rates.

Hydrologic soil groups are a standard soil-survey index of potential for runoff generation and subsequent erosion, regardless of fire effects of soil burn severity or water repellency. The greatest majority of soils have a hydrologic soil group C, indicating moderately high potential for runoff when thoroughly wet and water transmission through the soil is somewhat restricted. Additional effects of the fire will cause more runoff, accelerated sheet and rill erosion throughout the fire areas, as well as accelerated occurrence of shallow landslides and debris flows.

Table 4: Tower Fire soil hydrologic groups

Hydrologic Group	Acres	Percent Fire Area
A	262	2%
B	2,379	17%
C	9,606	72%
D	1161	9%

Table 5: Grease Creek Fire soil hydrologic groups

Hydrologic Group	Acres	Percent Fire Area
A	0	0%
B	64	9%
C	520	73%
D	130	18%

Table 6: Baldy Fire soil hydrologic groups

Hydrologic Group	Acres	Percent Fire Area
A	6,2596.2	64%
B	16,472.7	17%
C	10,585.4	11%
D	6,550.21	7%

Quantitative erosion figures were estimated using the ERMiT batch model. ERMiT (Erosion Risk Management Tool) is a WEPP-based application developed by USFS Rocky Mountain Research Station (USFS, RMRS-GTR-188, 2007) specifically for use with post-fire erosion modeling. The model estimates only sheet and rill erosion, which occurs when rainfall exceeds infiltration rates, and surface runoff entrains surface soil particles. The model does not account for shallow landsliding or gullying, stream-bank erosion, road effects, or fire-line erosion and gullying, which could present large additional sources of sediment entering the fluvial systems.

ERMiT models erosion potential based on single hillslopes, single-storm "runoff events," and post-fire soil burn severity. Hillslopes include soil and topography inputs. Soil inputs include texture and matrix rock content, which was based upon soil map unit information and field verified in many areas of the fire as part of the assessment. Generalized hillslope gradients and profiles were developed in GIS by soil map unit, subwatershed, and soil burn severity class to account for fairly site specific differences in topography.

Multiple representative hillslopes were modeled in ERMiT for this fire and results extrapolated in Excel for watershed level analysis. Soil erosion estimates are based upon watershed areas within the fire perimeter only; unburned watershed areas outside the fire area were not modeled. . Increased hillslope erosion is expected to occur throughout the fire area, especially within those areas in the high soil burn severity.

Table 7: Tower Fire ERMiT modeling results for the 2, 5 and 10 year storms in total sediment and average sediment delivery in tons/acre

ERMiT Results	Tower Fire	Grease Creek	Baldy
Erosion Tons/Acre	2.6	9.7	1.49
Sediment Yards/Mile	1,118	4,438	667

Values at Risk – Threats to Life, Property, and Cultural & Natural Resources

On-site effects of this fire will be some level of topsoil loss via accelerated erosion, with subsequent damage to soil nutrient status and microbial communities. Erosional loss would result in declined soil productivity, which in turn could cause declines in ecosystem productivity in the short-term. Based upon modeling and local knowledge, the decrease in soil productivity is a much less a threat to native plant communities than the potential spread of noxious weeds within the area. Therefore ecosystem stability as a function of soil impacts was not judged to be a serious VAR here. Impacts to soil productivity as a VAR in itself are expected to be low throughout the area.

Off-site effects of soil erosion will be accelerated sediment production into stream systems containing resident wild trout populations (non-T&E), stream bulking leading to increased debris-flow, and increased runoff possibly elevating landslide potential in particular areas. Sediment-laden ("bulked") runoff and stream water has much greater erosive power than similar flows of clean water in the stream system. In addition, risks to roads and trails exist throughout the fire area, which are necessary to the transportation system; these represent valuable

infrastructure investments that warrant protection. Risk management in the form of engineering and trails treatments has been proposed by the team. See the 2500-8 and respective reports for specifics.

Erosion and sedimentation would contribute to debris flows and mudflows if they were to occur, which would have a high potential to threaten life and property in particular drainage outlets, as well as water quality for beneficial uses. Natural hillslope erosion rates are low (< 1 ton/acre) when vegetated and covered with duff; vegetation mortality and lack of cover in high SBS areas will certainly accelerate runoff and erosion processes in the post-fire environment, the degree depending on the magnitude and intensity of coming storm events. While this may or may not pose an unacceptable risk to on-site soil resources, it would contribute to downstream hazards, particularly if larger storm events occur in the first several winters. Modeled post-fire hillslope erosion rates are low for all three fires. On the Tower Fire Downstream reservoirs are also at risk of infilling with sediments, but this reservoir is not a BAER critical.

Emergency Determination

The effects of the fire on the soils in the Kaniksu Complex have not created emergency conditions by posing hazards to critical values at risk. These soils are not naturally prone to flashy runoff and erosion, despite have been affected by the fire with complete removal of soil cover and moderate to high levels of water repellency. There will be an increase peak flows, runoff, stream bulking, flooding and debris flow hazard, and downstream sedimentation. These conditions pose unacceptable threats to values at risk, specifically to life, property, and water quality. Natural recovery and administrative closure will be adequate to reduce threats to values at risk, including life. Therefore, no targeted land treatments are proposed to mitigate on and off-site effects of soil erosion.

Recommendations beyond BAER

Reservoirs: Browns Lake is certainly threatened by pulses of sediment and debris coming from adjacent hillslopes. However Browns Lake is not critical Habitat for any TE species and does not serve as a municipal water source. Thus Browns Lake is not a BAER critical value, so BAER treatments are not possible to respond to such risks. Land (mulch) treatments would certainly benefit these values to some degree, which would also help mitigate impacts of shutting down these facilities and dredging sediments. The same screening procedures that occurred for the Browns Lake Area were applied to the Mill and Solo Creek drainages. Both of these areas have significant High and moderate burn severity. However since there no critical habitat or municipal watershed that can be affected no BAER treatment is recommended. There are roads and culverts that could be at risk in these areas. Treatment and recommendations for the roads and culverts will be addressed in the Engineering section of this report. It is recommended that all intrusion (Recreational and land Management) be prohibited in this area until natural recovery occurs.

The Grease Creek Fire has the highest level of Erosion Potential and Sedimentation Potential due to soil textures and the steepness of the terrain. However most of the areas that have High and Moderate soil Burn Severity are long boney ridges or in areas of Rock outcrop. The limited amount of soil and the mosaic nature of the burn area should limit the amount of soil that is actually transport out of the burn area. The area surrounding the Grease Creek Fire is made up of intact mature Forest that will slow down the water and capture a majority of the sediment before it can reach drainage.

The Baldy Fire has the lowest Potential for Erosion and Sedimentation due to soil texture, slope and low acreage of High and moderate burn severity. The mosaic nature of the burn area should limit the amount of soil that is

actually transport out of the burn area. The area surrounding the Baldy Fire is made up of intact mature Forest that will slow down the water and capture a majority of the sediment before it can reach drainage.

References

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