United States
Department of
Agriculture

Forest Service

**Pacific
Northwest
Region**

Northstar / Tunk Block Fires

BAER Soils Resource Report

Colville National Forest

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Introduction

The Northstar Fire started on August, 13th 2015 as the result of a human caused ignition approximately 25 miles north of Coulee Dam, WA. As of September 24th the fire was 96 percent contained and had burned a reported 217,871 acres. Approximately 44,328 acres or roughly 20 percent of the fire area burned on USFS lands between the Colville and Okanogan-Wenatchee National Forest.

The Tunk Block Fire started on August 14th, 2015 and the cause is reportedly unknown. The fire started ten miles northeast of Omak, WA. As of September 24th the fire was 97 percent contained and had burned approximately 166,000 acres. Roughly 8,636 acres or 5 percent of the total fire area burned on the Okanogan-Wenatchee National Forest.

A Burned Area Emergency Response (BAER) team was assembled on September 19th to assess the portion of both the Northstar and Tunk Block fires that burned on USFS lands. During the period of September 20th – 27th, the team conducted an emergency assessment of post fire resource conditions. The purpose of the burned area assessment was to determine whether or not the fire created emergency watershed conditions and identify the location and extent of those conditions. If an emergency determination is made, the probability of damage and the magnitude of the consequences to the Values at Risk (VARs) drive the development of emergency treatment recommendations.

Objectives

- Identify Values at Risk resulting from post fire conditions.
- Determine soil burn severity throughout the burned area.
- Determine erosion rates under post fire conditions.
- Identify areas of severe erosion hazards associated with post fire conditions.
- Develop treatment recommendations for areas of high risk.

Description of Resource Area

Landscape Characteristics

Both the Northstar and Tunk Block fires lie east of the Cascade Mountain Range. The landscape of both fires was shaped by long periods of glaciation and fluvial processes. The Mt. Mazama (present day Crater Lake) eruption around 7,700 years ago left an extensive ash mantle that is commonly present in the mountainous, forested landscapes today across this region in northeast Washington. The terrain varies from steep slopes to rolling hillsides, and flat river valleys. The general vegetation types within the fire perimeter for both fires are best described as mixed conifer forest, ponderosa pine forest, montane meadows, riparian wet meadows, and cottonwood-alder dominated communities in riparian stream corridors. Climatic patterns across the area are generally defined by dry, warm summer months and winters are typically long, with the majority of the mean annual precipitation occurring from late fall, through winter, and into early spring. The mean annual precipitation ranges from 12 to18 inches and mean annual temperature ranges 30° to 85° F (WRCC, 2015). Average annual snowfall ranges from 4 to 15 inches from late fall to early spring and average annual snow depth during the winter months ranges from 5 to 10 inches (WRCC, 2015).

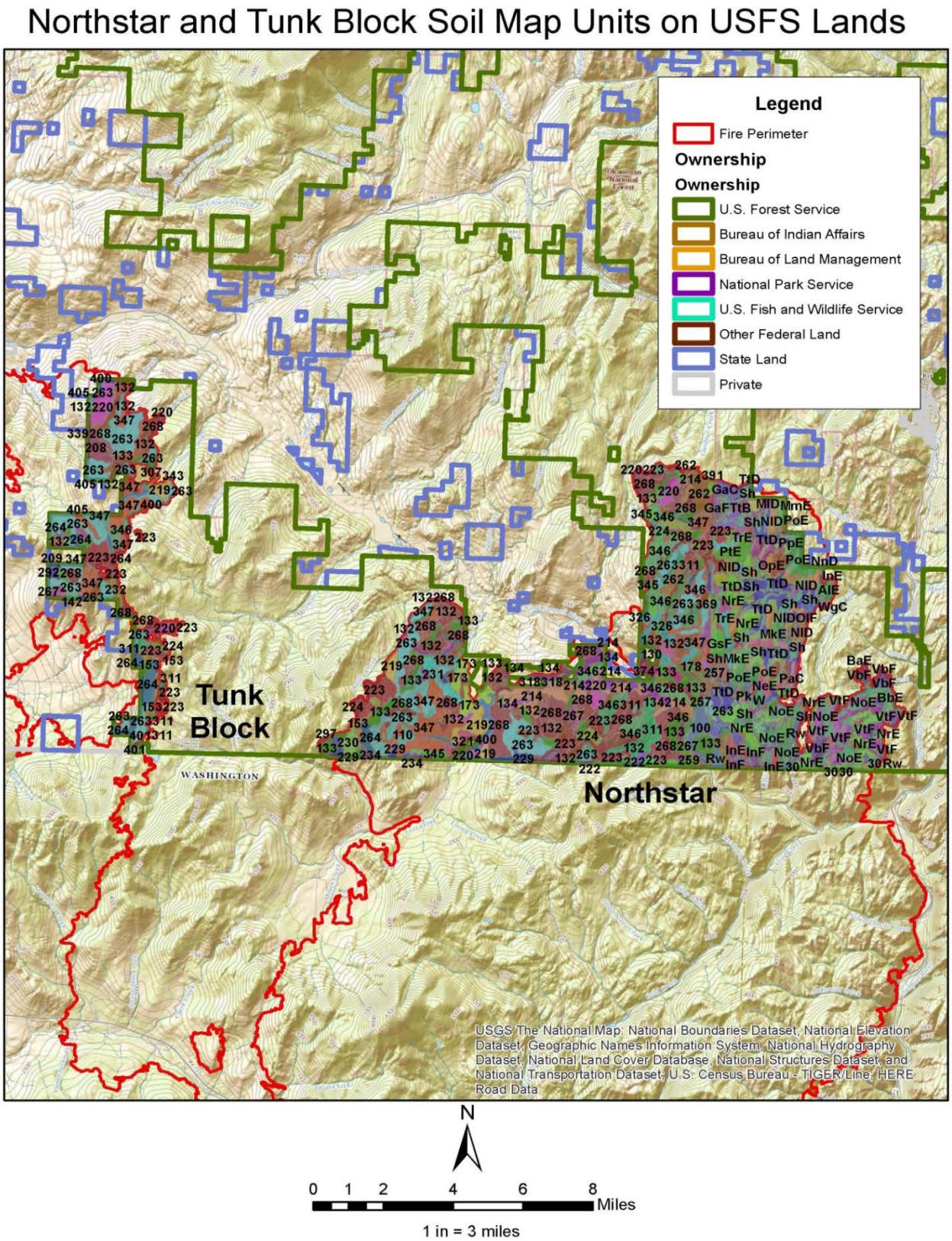

Figure 1: Soils within the Northstar and Tunk Block fire perimeters.

Soils

The soil surveys for soil units found in both the Northstar and Tunk Block fires were created by the Natural Resource Conservation Service and the Forest Service in cooperation with the Washington Agricultural Experiment Station. Survey information for soils within both fires can be referenced in the Okanogan National Forest Area and North Ferry Co. soil survey areas. Soil map unit information can be referenced online at the NRCS's Web Soil Survey Application (USDA-NRCS, 2015). Selected soils information for the units that were modeled for this report can be referenced in **Appendix A**.

In general, soils found within the fire perimeters consist of moderately-well to well-drained soils formed in volcanic ash overlying glacial till or andesitic, rhyolitic, granitic, gneissic, or schist bedrock formations in the higher elevation forested areas. A common characteristic in soils derived from volcanic ash is an inherent ability to erode. Shallow soils and rock outcropping are commonly present and often associated with steeper topography and rock escarpments. Valley bottoms typically include deeper soils that are well to excessively-drained, formed in alluvial material derived from a mixture of volcanic ash, glacial till and/or glacial outwash. Surface soil textures range from loams to silt loams to fine sandy loams with some surface textures exhibiting gravelly surface rock fragment modifiers (15 – 35 percent rock fragment content within the soil horizon) in the higher elevations. Valley bottom soils typically exhibit gravelly to very gravelly (35 – 65 percent rock fragment content) sandy loams to loamy sand soil surface textures with a few locations that may have silt loam to loam surface textures and/or ashy characteristics. While inherent soil characteristics certainly play a role in how soils erode and deliver sediment after a fire, the largest determinates in overall erosion and sedimentation response post-fire at a landscape scale are: soil burn severity, slope, fire intensity, and weather patterns.

Soil Burn Severity

Assessment Protocol

Rapid assessment of soil burn severity classes, including soil water-repellency tests, are necessary for incorporation with other site factors such as soil type, slope, hydrologic characteristics, climate regimes, and potential vegetation types to identify source areas of potential flooding and erosion and locations where critical ecosystem and human resource values may be degraded.

Soil Burn Severity Classes and Soil Water-Repellency are best generalized by the following (Parsons et al., 2010):

Low soil burn severity: Typically less than 20 percent of the pre-fire ground cover may be consumed. Generally, surface organic layers may exhibit some degree of consumption, but are still recognizable. Soil structure is not changed from its unburned condition. 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 majority of the canopy /understory vegetation will likely appear green.

Moderate soil burn severity: Approximately 20 – 80 percent of the pre-fire ground cover may be consumed. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched, but are rarely completely consumed

over the entire area. The prevailing color of the site is often dull gray and white for the ash component intermixed with brown and black organic material that was not completely consumed. Soil structure is generally unchanged. 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.

High soil burn severity: All or near complete (greater than 80 percent) consumption of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is typically consumed, and charring may be visible on larger roots. Bare soil or ash is exposed and susceptible to erosion, and soil 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 and charred. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed.

Soil Water-Repellency: Soils high in organic matter commonly exhibit natural water repellency (hydrophobicity). Fire induced hydrophobicity is usually associated with areas experiencing moderate to high burn intensity. Identification of the presence, degree, and spatial extent of hydrophobic layers is important in evaluating post-fire hydrologic response of a burned watershed and associated risks because it can amplify watershed response. The BAER team used the Water Drop Penetration Time (WDPT) method to identify hydrophobicity at varying depths. Water was applied and the time to infiltration was recorded. According to the WDPT method, soil hydrophobicity was categorized based on observed time to infiltration:

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

Understanding the difference between *fire intensity* and *soil burn severity* are critical concepts in the evaluation and analyses of the soil team. Fire intensity is generally defined by parameters such as flame height, rate of spread, fuel loading, thermal potential, canopy consumption, tree mortality, etc. For example, a high intensity fire crown fire in a stand-replacement event may result in a moderate to low soil burn severity if the residence time of the fire is short on the ground where soil characteristics may not be altered to a large degree. Conversely, a slow-moving surface fire with complete consumption of heavily accumulated fuels can spare some high intensity burning on trees but penetrate and heat the soil severely which can have major implications on soil structure and overall aggregate stability at the surface. Soil burn severity, used in this context, is a better indicator of overall watershed response to burning and natural vegetative recovery after the fire than purely vegetation burn intensity. It is also important to note the role soil water repellency plays in a burned watershed. Hydrophobic layers may amplify watershed response and accelerate erosion. However, it is not the presence or absence of fire-induced water repellent layers that will drive the overall watershed response overtime; rather, the driving factor will be the lack of effective ground cover and the loss of raindrop interception via the absence of vegetation canopy cover.

Soil Burn Severity

The field verification of soil burn severity took place from September 20th – 23rd. It included assessment of ash characteristics, ground cover, roots, soil structure, and soil hydrophobicity. Assessments were stratified in priority areas for potential land treatments where erosion and sediment production pose a threat to Values at Risk. Burned areas within the moderate to high severity burn intensities were consider of high importance. Access to some of the burn was limited due to continued fire activity within the perimeter. In these cases the Burned Severity Map was used to justify validations.

A Burn Severity map was provided to the BAER team by a tribal response team responsible for assessing the portion of the Northstar and Tunk Block fires on the Colville Indian Reservation. The burn severity map was completed for the entire extent of both fires, including USFS lands. Field verification of the burn severity map by the BAER team took place from September 20th – 23th. Results for Soil Burn Severity for both the Northstar and Tunk Block Fire are outlined below:

Soil Burn Severity	Total Acres	Percent Value
Unburned/Very Low	10,875	25
Low	15,016	34
High	13,723	32
Moderate	4,080	9
Total Burned	**43,694***	**100**

Table 1: Soil Burn Severity for Northstar on USFS Land. *****Difference between the reported acreage on USFS land due to a no data gap in the available Burn Severity GIS layer.

Soil Burn Severity	Total Acres	Percent Value
Unburned/Very Low	1,456	17
Low	3,812	44
High	2,419	28
Moderate	950	11
Total Burned	**8,636**	**100**

Table 2: Soil Burn Severity for Tunk Block on USFS Land.

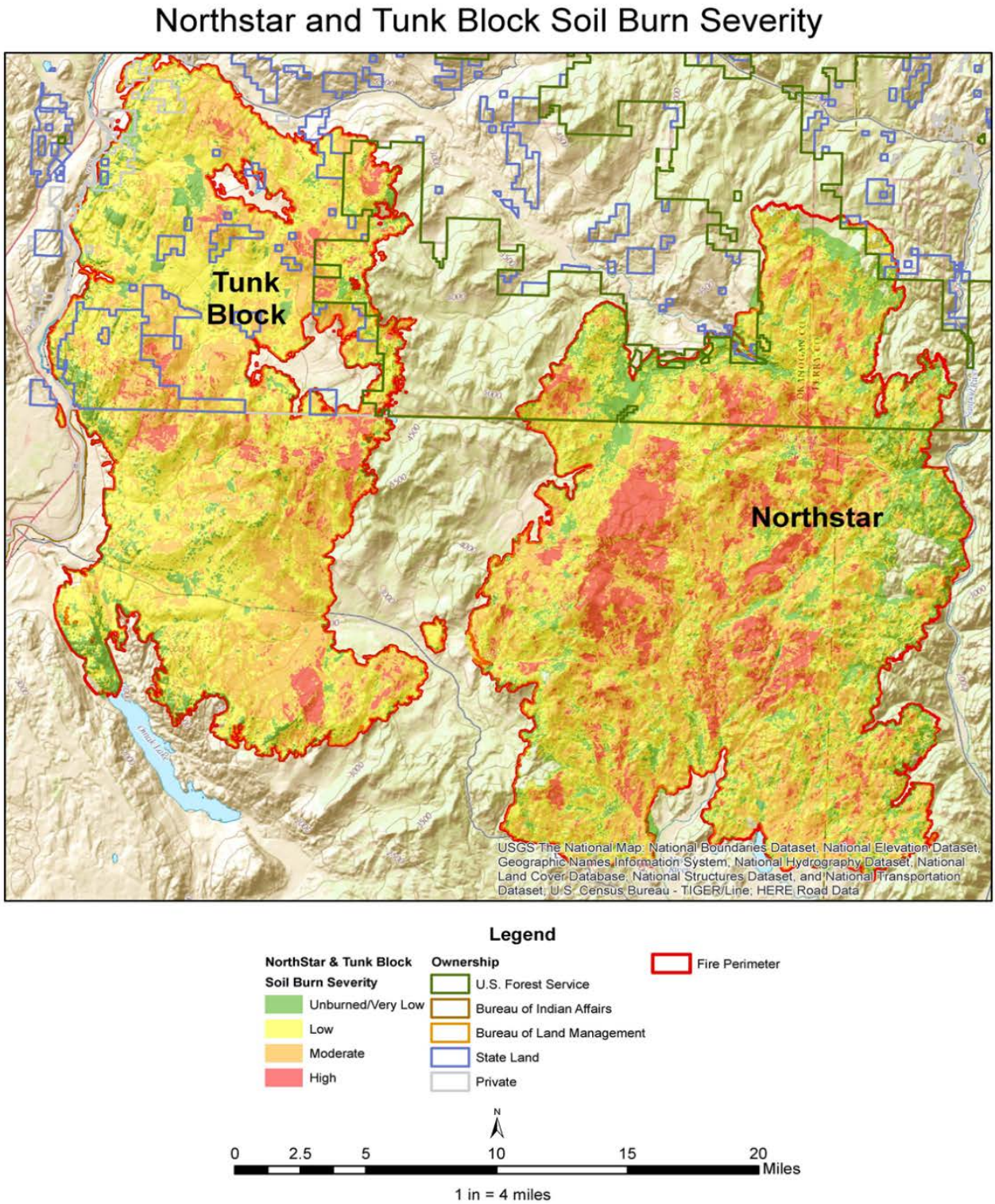

Figure 2: Soil Burn Severity for the entire extent of the Northstar and Tunk Block fires.

Modeling and Analysis

Modeling Pre-Work and Assumptions

A filtering and stratification GIS workflow was used to concentrate on soil map units that would contribute the greatest to overall post-fire erosion and sedimentation response at a watershed level (HUC_12 code). Watersheds from the Colville and Okanogan-Wenatchee National Forest that had some extent within the burn perimeter of either fire were queried out. The forests' soil layers were then clipped to those watersheds. High and moderately burn severity was then clipped to the soils layer for analysis.

The following assumptions were used during the modeling based upon the experience of the BAER soils team:

- Low-burn severity erosion and sedimentation rates are the same or very close to rates under natural, unburned conditions. The overall effect in these areas on hydrologic response at a watershed level is negligible so they were not modeled.
- Map units that occupied less than 1% of the total high and/or moderate burned area within a watershed were not modeled as they will not significantly contribute to overall post-fire erosion and sedimentation response in a watershed.
- Natural and fire induced hydrophobicity do occur to some degree and extent but will not be the factor driving post-fire erosion, sedimentation, and hydrologic response.
- Removal of vegetative canopy and ground cover will be the factor driving post-fire erosion, sedimentation, and overall hydrologic response.

Erosion Modeling

Erosion modeling included the use of the Forest Service Disturbed Water Erosion Prediction Project (WEPP) model. The model utilizes the power of a large, physically based erosion interface that simplifies input data requirements. The general data requirements for Disturbed WEPP are climate data, soil texture, rock fragments, general vegetation type, slope gradient, horizontal slope length and burn severity. The Republic, WA National Oceanic and Atmospheric Administration (NOAA) cooperative climate station was used for the climatic inputs for the model. The erosion output values generated by WEPP are based on the average of various storm events within a 30-year period.

Modified Climate Station	Precipitation (in)	Elevation (ft)	Location
Republic, WA +	15.7	2,650	Lat: 48.39° Long: -118.44°

Table 3: Climate parameters for the Republic, WA NOAA cooperative climate station.

Specific input variables used for WEPP included: burn severity, percent slope gradient for an upper and lower section, slope length, ground cover (litter + surface rock fragments + veg. basal area), rock content by percent volume in the soil and soil texture. WEPP does not have a moderate soil burn severity input so the high severity input was used for both high and moderate burn severity runs for each soil unit. Slope gradients were derived from soil map unit slope class ranges. Erosion and sedimentation runs generate larger values based upon a longer hillslope length. 500 feet was used as the input for the upper section and lower for all runs as it represented the longest hillslope length across the burned areas based on various field observations and measurements of slope lengths in ArcMap. Ground cover inputs were based upon cover values that represent the high end of remaining ground cover after a high severity fire and a midpoint value for the range of ground cover values associated with moderate burn severity (Parsons et al., 2010) (i.e. 20 percent for high severity and 50 percent for moderate severity). Rock fragment content inputs were derived from soil surface texture rock fragment modifier ranges: no modifier (0-14 percent rock content), gravelly, cobbly, or stony (15-34 percent rock content), very gravelly, very cobbly, or very stony (35-59 percent rock content), and extremely gravelly, extremely cobbly, or extremely stony (60-90 percent rock content). The rock content input requires one value, so the midpoint value for the above ranges was used. Surface soil texture was used for the soil texture input in the model. A detailed spreadsheet of map unit input values can be referenced in **Appendix B**.

WEPP outputs indicated that the average total erosion potential and total sediment delivery combined for the modeled soil units in high and moderate burn severity within the Northstar fire is 6.6 tons/acre and 392 cubic/yards per sq. mile, respectively. The average total erosion potential is 5.6 tons/acre and total sediment delivery is 337 cubic/yards per sq. mile for the modeled units in high and moderate burn severity within the Tunk Block fire. An erosion prediction spreadsheet from which the above values were derived can be referred to in **Appendix C**.

Fire	Avg. Total Erosion Potential (tons/acre)	Total Sediment Delivery (yd^3/sq. mi)
Northstar	6.6	392
Tunk Block	5.6	337
Total	12.2	729

Table 4: Average total erosion potential in tons/acre and total sediment delivery in cubic yards per square mile for both the Northstar and Tunk Block fires.

Soil Erosion Hazard Ratings

Generally, soil erodibility tends to increase with greater silt content, steepness of slopes, and loss of organic matter. Conversely, erosion will decrease as sand and clay contents increase, presence of organic matter increase binding strength, and erosion risk will decrease if the infiltration rates are greater than rainfall rates.

Soil Erosion Hazard Ratings indicate the degree of potential erosion for a given soil map unit. The Universal Soil Loss Equation (USLE) provides a framework for factors that affect soil erosion and is used in a large capacity to rate the severity of erosion for a soil map unit. The USLE equation describes a function of rainfall and runoff, soil erodibility, slope length, slope steepness, soil management, and conservation

practices (Hairston et al., 2001). Class ratings are slight, moderate, or severe as listed in the Land Management: Erosion Hazard query in Soil Data Explorer for Web Soil Survey (USDA-NRCS, 2015).

An Area of Interest (AOI) spatial extent was set in Web Soil Survey for the soil surveys used in this assessment. The erosion hazard class ratings were recorded for each soil unit and cross referenced with the total number of combined high and moderate severity burn acres for those units. This was done for both fires and the results are listed below:

Soil Erosion Hazard	Acres	Percent of Area
Slight	1,580	11
Moderate	10,487	74
Severe	2,163	15
Total	14,230	100

Table 5: Northstar fire Soil Erosion Hazard ratings for modeled units within high and moderate severity.

Soil Erosion Hazard	Acres	Percent of Area
Slight	360	9
Moderate	3,354	87
Severe	157	4
Total	3,871	100

Table 6: Tunk Block fire Soil Erosion Hazard ratings for modeled units within high and moderate severity.

Treatment Rationale and Recommendations

Land treatment recommendations are driven by the level of unacceptable risk posed by the fire to human life, property, or irreversible damage that may ensue to natural or cultural resources. Warranting the use of post-fire seeding or mulching erosion mitigation treatments for the Northstar and Tunk Block fires based on the low level of risk to human life and infrastructure and small probability of irreversible damage or loss to natural and cultural resources was deemed not to be the most economical method of treatment. Specific areas of higher risk and higher magnitude of consequences will be addressed through less expensive methods such as adding drainage features for roads, hazard tree removal on roads, or closure signs on forest trails where hazard trees present a safety concern to the public.

That being said, understanding high severity burn damage to soil productivity is outside of the human lifespan. Natural re-establishment of cover can take many years to reach natural pre-burn cover conditions resulting in excess runoff and erosion until adequate cover is achieved. If extreme rainfall events occur within a five year period, high runoff and erosional events could occur resulting in a loss of soil productivity, affects to water quality, or an increase in the potential for damage or loss of resource values downstream. This would further delay natural cover re-establishment and cause longer term accelerated erosion and high

runoff events. This is particularly true in regions where frequent fires, steep terrain, vegetation, and post-fire seasonal precipitation interact to produce dramatic impacts (Neary, G., et al. 2005).

Seeding in areas of high and moderate burn severity has the potential to reduce downstream impacts and help retain site productivity. Though seeding does not provide immediate ground cover (within the 1st year), it has been found to be an effective treatment in helping re-establish herbaceous vegetation and ultimately providing ground cover within the second year depending on rainfall events. The loss of overall overstory and understory vegetative cover within the fire perimeters will exasperate the time in which the soils are reestablished to pre-fire conditions. The loss of soil productivity should not be viewed as just the loss of soil rather the loss of inputs to rejuvenate the soil.

References

Hairston, J.E., Stribling, L., and Beck, J.M. 2001. "Estimating Soil Erosion Losses and Sediment Delivery Ratios". Alabama Cooperative Extension System. Alabama A&M and Auburn Universities.

Napper, C. 2006. "Burned Area Emergency Response Treatments Catalog". United States Department of Agriculture, United States Forest Service.

Neary, Daniel G.; Ryan, Kevin C.; DeBano, Leonard, F. 2005. "Wildland Fire in Ecosystems Effects of Fire on Soil and Water". United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report Report RMRS-GTR-42-volume 4.

Parsons, A., Robichaud, P.R., Lewis, S.A., Napper, C., Clark, J.T. 2010. "Field Guide for Mapping Post-Fire Soil Burn Severity". United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-243.

U.S. Department of Agriculture, Forest Service. 1995. Forest Service Handbook 2509.13 Burned-Area Emergency Rehabilitation Handbook. Amendment No. 2509.13-95-7. pp 23.

U.S. Department of Agriculture, Forest Service. 2015. Remote Sensing Applications Center. Salt Lake City, UT. BARC map data is available at: http://www.fs.fed.us/eng/rsac/baer/barc.html.

U.S. Department of Agriculture, Natural Resources Conservation Service. National Soil Survey Handbook, title 430-VI. Available online at http://soils.usda.gov/technical/handbook/. Accessed [06/6/2012].

U.S. Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS). 2015. Web Soil Survey Application. Available online at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Okanogan National Forest Area, WA and North Ferry County, WA Soil Survey data retrieved 26 September 2015.

Western Regional Climate Center (WRCC) Climate Summaries. 2015. Republic, Washington NOAA Coop Period of Record Monthly Climate Summary, Period of Record: 10/01/1899 – 01/20/2015. Retrieved online 26th September 2015 at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa6974

Appendix A

Associated NRCS Map Units, Soil Properites: Northstar Fire

Map Unit Symbol	Soil Series	Parent Material	Soil Surface Texture	Slope Range	Percent of Analyzed Acres within Fire Perimeter	Total Acres Burned within Analyzed Area
100	Aitis	Volcanic	loam	15-35	1.97	286
132	Chumstick-Mineral-Rock	Volcanic	sandy loam	15-35	3.94	571
133	Chumstick-Mineral-Rock	Volcanic	sandy loam	35-65	6.09	883
153	Devore-Rock	Volcanic	sandy loam	15-35	0.59	86
214	Lithic Haploxerepts-Wima-Rock	Volcanic	sandy loam	35-65	2.41	349
220	Louploup-Stepstone	Volcanic/ Till	sandy loam	15-35	2.78	402
223	Manley-Devore	Volcanic	sandy loam	15-35	9.98	1445
224	Manley-Devore	Volcanic	sandy loam	35-65	1.43	208
230	Merkel	Volcanic/ Till	sandy loam	35-65	0.67	98
257	Nevine	Volcanic/ Till	silt loam	15-35	0.99	143
262	Nevine	Volcanic/ Till	sandy loam	15-35	1.23	178
263	Nevine_Merkel	Volcanic/ Till	sandy loam	15-35	7.5	1086
264	Nevine_Merkel	Volcanic/ Till	sandy loam	35-65	1.59	230
268	Nevine-Wilma-Rock	Volcanic/ Till	sandy loam	15-35	13.36	1935
311	Resner-Sitdown	Volcanic/ Till	silt loam	0-15	4.72	683
345	Stepstone	Volcanic/ Till	sandy loam	0-15	0.93	134
346	Stepstone	Volcanic/ Till	sandy loam	15-35	7.2	1043
347	Stepstone-Torboy	Volcanic/ Till	sandy loam	0-15	3.23	467
BaE	Bamber	Volcanic	loam	15-35	1.44	208
InE	Inkler	Volcanic/ Till	silt loam	15-35	1.6	231
IrE	Inkler-Rock	Volcanic/ Till	silt loam	15-50	0.19	28
MkE	Merkel	Volcanic/ Till	sandy loam	15-35	2.16	313
NeE	Neuske	Till	silt loam	15-35	0.96	140

NID	Nevine	Volcanic/ Till	loam	0-30	2.3	334
NoE	Nevine	Volcanic/ Till	loam	15-35	2.3	332
NrE	Nevine-Rock	Volcanic/ Till	loam	15-50	6.62	958
OpE	Oxerine-Pepoon	Volcanic/ Till	loam	15-35	0.77	112
PoE	Pepoon-Edds	Volcanic/ Till	loam	15-50	1.65	239
PtE	Pepoon-Togo	Volcanic/ Till	loam	15-50	1.3	188
Sh	Shaskit-Tonata	Till/ Alluvium	silt loam	0-15	2.04	295
TrE	Togo-Rock	Volcanic/ Till	loam	15-50	1.65	239
TtD	Torboy	Volcanic/ Till	sandy loam	15-25	2.63	381
VtF	Vallan-Tenas	Volcanic	loam	35-65	1.78	257

Associated NRCS Map Units, Soil Properites: Tunk Block Fire

Map Unit Symbol	Soil Series	Parent Material	Soil Surface Texture	Slope Range	Percent of Analyzed Acres within Fire Perimeter	Total Acres Burned within Analyzed Area
132	Chumstick-Mineral-Rock	Volcanic/ Colluvium	sandy loam	15-35	8.53	197
133	Chumstick-Mineral-Rock	Volcanic/ Colluvium	sandy loam	35-65	2.27	52
153	Devore-Rock	Volcanic/ Colluvium	sandy loam	15-35	0.78	18
208	Lithic Haploxerepts-Conconully	Volcanic/ Bedrock	loam	15-45	2.89	67
220	Louploup-Stepstone	Volcanic/ Till	sandy loam	15-35	11.82	274
223	Manley-Devore	Volcanic/ Till	sandy loam	15-35	3.32	77
224	Manley-Devore	Volcanic/ Till	sandy loam	35-65	1.49	34
263	Nevine-Merkel	Volcanic/ Till	sandy loam	15-35	43.12	998
268	Nevine-Wilma-Rock	Volcanic/ Till	sandy loam	15-35	5.89	136
292	Peka-Donavan	Volcanic/ Till	sandy loam	15-35	3.09	72

311	Resner-Sitdown	Volcanic/ Till	silt loam	0-15	2.1	49
343	Stapaloop	Volcanic/ Till	sandy loam	0-25	0.79	18
346	Stepstone	Volcanic/ Till	sandy loam	15-35	3.05	71
347	Stepstone-Torboy	Volcanic/ Till	sandy loam	0-15	10.86	251

Appendix B

Disturbed WEPP 1.0 Inputs: Northstar Fire

Map Unit/Burn Severity	Surface Texture	Slope Gradient (Upper and Lower %)	Slope Length (ft)	Forest Type	Rock Fragments (surface)	Cover (%) High	Cover (%) Moderate
100 / H, M	loam	15-35	500	Forest	8	20	50
132 / M, H	sandy loam	15-35	500	Forest	48	20	50
133 / M, H	sandy loam	35-65	500	Forest	48	20	50
153 / H, M	sandy loam	15-35	500	Forest	25	20	50
214 / H, M	sandy loam	35-65	500	Forest	25	20	50
220 / H, M	sandy loam	15-35	500	Forest	8	20	50
223 / H, M	sandy loam	15-35	500	Forest	8	20	50
224 / H, M	sandy loam	35-65	500	Forest	8	20	50
230 / H, M	sandy loam	35-65	500	Forest	25	20	50
257 / H, M	silt loam	15-35	500	Forest	8	20	50
262 / H, M	sandy loam	15-35	500	Forest	8	20	50
263 / H, M	sandy loam	15-35	500	Forest	8	20	50
264 / H, M	sandy loam	35-65	500	Forest	8	20	50
268 / H, M	sandy loam	15-35	500	Forest	8	20	50
311 / H, M	silt loam	0-15	500	Forest	8	20	50
345 / H, M	sandy loam	0-15	500	Forest	8	20	50
346 / H, M	sandy loam	15-35	500	Forest	8	20	50
347 / H, M	sandy loam	0-15	500	Forest	8	20	50
BaE / H, M	loam	15-35	500	Forest	8	20	50
InE / H, M	silt loam	15-35	500	Forest	25	20	50
IrE / M only	silt loam	15-50	500	Forest	25	20	50
MkE / H, M	sandy loam	15-35	500	Forest	8	20	50
NeE / H, M	silt loam	15-35	500	Forest	8	20	50
NID / H, M	loam	0-30	500	Forest	8	20	50
NoE / H, M	loam	15-35	500	Forest	8	20	50
NrE / H, M	loam	15-50	500	Forest	8	20	50
OpE / H, M	loam	15-35	500	Forest	25	20	50
PoE / H, M	loam	15-50	500	Forest	8	20	50
PtE / H, M	loam	15-50	500	Forest	8	20	50
Sh / H, M	silt loam	0-15	500	Forest	8	20	50
TrE / H, M	loam	15-50	500	Forest	8	20	50
TtD / H, M	sandy loam	15-25	500	Forest	8	20	50
VtF / H, M	loam	35-65	500	Forest	8	20	50

Disturbed WEPP 1.0 Inputs: Tunk Block Fire

Map Unit/Burn Severity	Surface Texture	Slope Gradient (Upper and Lower %)	Slope Length (ft)	Forest Type	Rock Fragments (surface)	Cover (%)	
						High	Moderate
132 / H, M	sandy loam	15-35	500	Forest	48	20	50
133 / H, M	sandy loam	35-65	500	Forest	48	20	50
153 / H, M	sandy loam	15-35	500	Forest	25	20	50
208 / M only	loam	15-45	500	Forest	75	20	50
220 / H, M	sandy loam	15-35	500	Forest	8	20	50
223 / H, M	sandy loam	15-35	500	Forest	8	20	50
224 / H, M	sandy loam	35-65	500	Forest	8	20	50
263 / H, M	sandy loam	15-35	500	Forest	8	20	50
268 / H, M	sandy loam	15-35	500	Forest	8	20	50
292 / H, M	sandy loam	15-35	500	Forest	292	20	50
311 / H, M	silt loam	0-15	500	Forest	8	20	50
343 / H, M	sandy loam	0-25	500	Forest	8	20	50
346 / H, M	sandy loam	15-35	500	Forest	8	20	50
347 / H, M	sandy loam	0-15	500	Forest	8	20	50

Appendix C

Erosion/Sediment Delivery Predictions: Northstar Fire

Map Unit Symbol	**Moderate** EROSION (t ac-1)	**High** EROSION (t ac-1)	**Mod.** Sed. Delivery (t ac-1)	**High** Sed. Delivery (t ac-1)	**Mod** Burned Acres	**High** Burned Arces	Total Cubic Yards
100	6.90	12.73	69.83	384.54	84	201	324.55
132	4.81	8.68	295.41	77.03	512	59	266.02
133	8.1	14.5	728.78	288.82	750	133	726.85
153	5.37	9.23	50.61	10.16	79	7	43.41
214	9.06	15.37	340.20	82.35	313	36	301.82
220	4.59	7.86	190.14	67.21	345	57	183.82
223	4.59	7.86	408.97	828.25	743	703	883.73
224	7.93	13.21	147.35	104.48	155	53	179.88
230	9.06	15.37	100.31	12.54	92	5	80.6
257	3.85	6.72	58.55	16.39	127	16	53.53
262	4.59	7.86	57.96	85.91	105	73	102.76
263	4.59	7.86	484.35	244.1	879	207	520.32
264	8	13.21	173.85	92.91	183	47	190.54
268	4.59	7.86	761.43	650.97	1382	552	1,008.86
311	2.85	4.97	123.30	240.35	361	322	259.75
345	1.86	3.34	27.15	6.36	122	13	23.94
346	4.59	7.86	434.91	298.78	790	253	524.07
347	1.86	3.34	80.66	53.17	361	106	95.59
BaE	6.9	12.73	122.83	114.67	148	60	169.64
InE	7.11	12.63	143.04	120.3	168	64	188.1
IrE	9.32	16.35	30.28	1.18	27	0	22.47
MkE	4.59	7.86	113.23	127.18	206	108	171.72
NeE	2.91	9.02	39.89	34.49	114	25	53.13
NID	5.63	10.43	185.03	93.71	274	60	199.1
NoE	6.9	12.73	237.78	86.39	287	45	231.54
NrE	9.34	16.23	895.26	387.77	799	159	916.45
OpE	4.59	7.86	58.64	6.4	106	5	46.46
PoE	9.94	16.23	239.18	94.51	201	39	238.35
PtE	9.34	16.23	202.99	17.89	181	7	157.77
Sh	2.85	4.97	86.61	31.05	253	42	84.05
TrE	9.34	16.23	218.54	107.29	195	44	232.74
TtD	3.51	6.19	148.52	26.32	353	28	124.88
VtF	11.71	20.63	345.54	35.68	246	12	272.3

		Totals	**10,939**	**3,543**	**8,879**
Total Acres of Moderate/High	**14,482**	**Avg. Erosion Potential (t ac^{-1})**		**6.6**	
		Total Sed. Delivery (yd^3/mi^2)		**392**	

Erosion/Sediment Predictions: Tunk Block Fire

Map Unit Symbol	**Moderate** EROSION (t ac-1)	**High** EROSION (t ac-1)	**Mod.** Sediment Delivery (t ac-1)	**High** Sediment Delivery (t ac-1)	**Mod** Burned Acres	**High** Burned Arces	Total Cubic Yards
132	4.81	8.68	102.62	25.6	178	20	91.58
133	8.1	14.5	47.08	8.68	48	4	39.83
153	5.37	9.23	8.51	6.67	13	5	10.84
208	8.68	14.96	69.67	0	67	0	49.77
220	4.59	7.86	137.19	28.94	249	25	118.67
223	4.59	7.86	34.68	16.33	63	14	36.44
224	7.93	13.21	24.37	17.52	26	9	29.92
263	4.59	7.86	275.25	587.27	500	498	616.08
268	4.59	7.86	53.71	45.75	98	39	71.04
292	5.37	9.23	24.49	46.52	38	34	50.72
311	2.85	4.97	10.17	14.1	30	19	17.34
343	5.73	3.24	10.82	1.24	16	3	8.62
346	4.59	7.86	38.61	0.68	70	1	28.06
347	1.86	3.34	44.49	26	199	52	50.35
				Totals	**1,594**	**720**	**1,219**
Total Acres of Moderate/High			**2,314**	**Average Erosion Potential (t ac^{-1})**		**5.5**	
				Total Sediment Potential (yd^3/mi^2)		**337**	