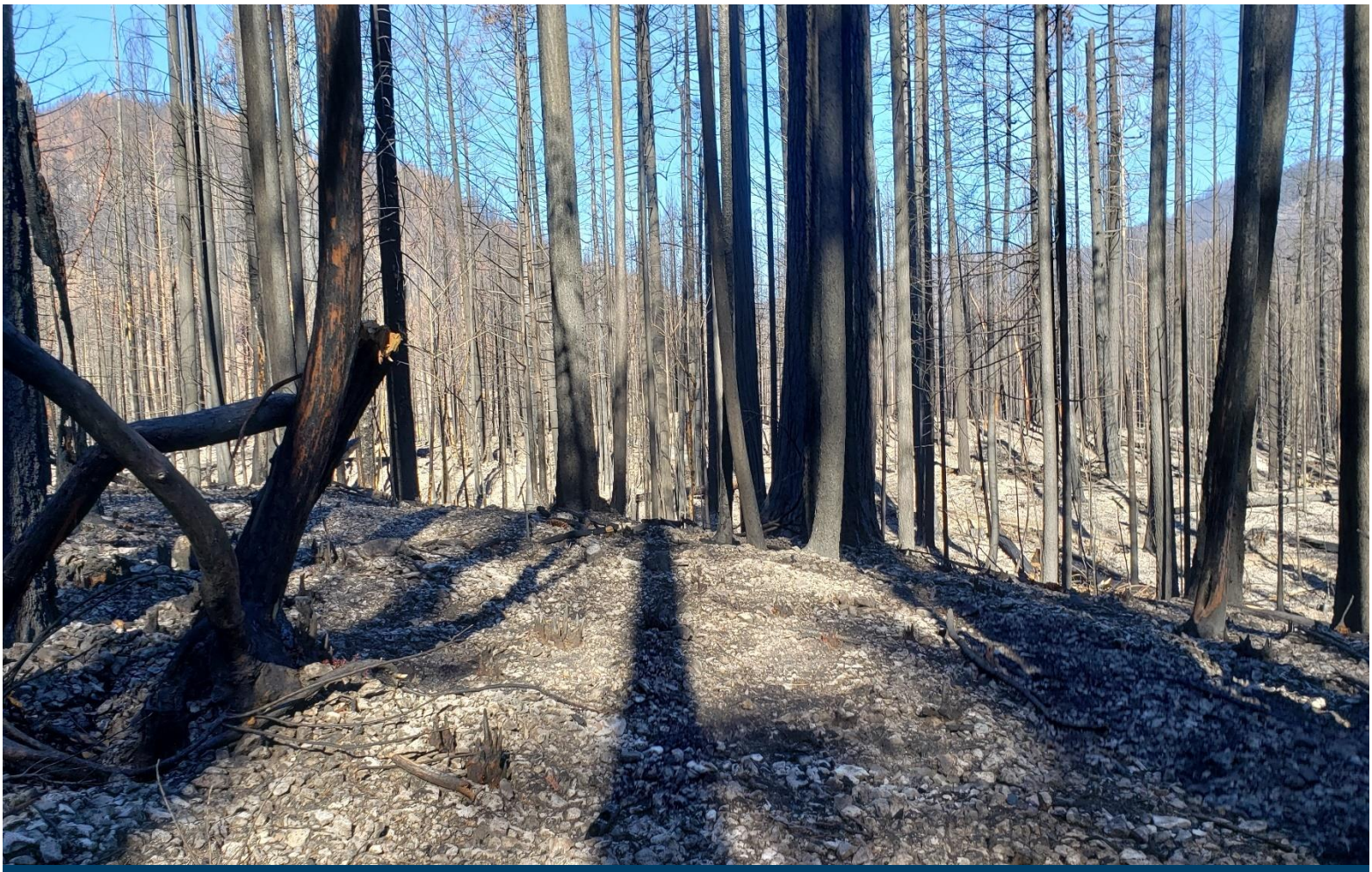

Archie Creek Fire

Erosion Threat Assessment/Reduction Team (ETART) Summary Report

December 2020

FEMA

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Executive Summary

This report summarizes a rapid characterization of post-fire conditions resulting from the Archie Fire and identifies critical values potentially at risk from threats commonly associated with burned areas. In addition, the ETART assessment of drinking water threats from the Archie and other fires are captured in the ETART Water Quality/Drinking Water Supply Resource Report. The area of interest for this report consists of non-federal lands within and downstream of the Archie Fire perimeter. Critical values include human life and safety; improved properties/assets such as roads, bridges, buildings and water systems; important natural resources (soil productivity, water quality and municipal water sources, habitats for wildlife and fish); and cultural resources. Threats that exist or are recognized to amplify in a post-fire setting include accelerated soil erosion and hillslope water runoff that results in increased sediment transport, high stream flows, floods or debris flows; landslides and rock fall; hazard trees; mobilization of hazardous materials; and expansion of invasive or noxious plants. This report does not include an assessment of water quality and water systems that provide safe, clean drinking water. Refer to the ETART Water Quality/Drinking Water Supply Resource Report for information on post-fire threats and response actions for these values.

The essential findings of this evaluation are: 1) to identify where emergency conditions exist as defined by critical values at unacceptable risk from imminent post-fire threats; and 2) to recommend emergency response actions that reduce risk or minimize impacts to critical values. In addition to the emergency response actions, the data, analysis and conclusions supporting this report can be used to develop restoration opportunities leading to long-term recovery of the fire-damaged landscape. Multiple “Specialist Reports” encompassing soils, hydrology and water quality, engineering, fish and wildlife, botany and cultural were used to complete this assessment.

The 2020 fire season in Oregon State affected lands across all jurisdictions and ownerships: tribal, federal, state, local and private. Fires on federal and tribal lands are assessed through the U.S. Forest Service (USFS) Burned Area Emergency Response (BAER) or Department of Interior (DOI) Emergency Stabilization and Rehabilitation (ESR) programs. Given the size and severity of the fires’ impacts to state, local and private lands throughout Oregon, the State of Oregon requested the Federal Emergency Management Agency (FEMA) form a multi-jurisdiction assessment team to assess the state, local and private lands of several fires. FEMA coordinated with Oregon Emergency Management (ODF) and Department of Forestry (ODF), National Weather Service (NWS), U.S. Army Corps of Engineers (USACE) and the USFS to staff the Erosion Threat Assessment and Reduction Team (ETART) to evaluate the fire-affected state and private lands.

The team used the USFS BAER and DOI Emergency Stabilization & Rehabilitation (ESR) assessments for several fires, which established the foundation for the ETART and allowed for comprehensive evaluation of all lands burned within the fires.

2020 Oregon ETART is comprised of personnel from Clackamas County Soil and Water Conservation District (SWCD), Lane County, Linn County, Marion County SWCD, West Multnomah SWCD, OR Department of Environmental Quality (DEQ), OR Department of Fish & Wildlife (ODFW), ODF, OR Department of Geology and Mineral Industries (DOGAMI), OR Department of Transportation (ODOT), OR Water Resources Department (OWRD), Bureau of Land Management (BLM), Environmental Protection Agency (EPA), FEMA, USFS, U.S. Geological Survey (USGS), NWS and the Natural Resources Conservation Service (NRCS). These resource specialists completed the assessments while safely managing COVID-related protections, navigating interagency data sharing barriers, operating in a hazardous post-fire field environment and working across a broad geographic area. ETART members went above and beyond the demands of their normal duties to carry out critical emergency assessments in service of local communities.

1. Overview

1.1. Burned Area Characterization

- Fire Name: Archie Creek
- State: Oregon
- Fire Number: OR-UPF-000436
- County: Douglas
- Date Fire Started: September 8, 2020
- Date Fire Contained: November 16, 2020
- Suppression Cost: $40,000,000 (estimate, ICS-209 dated 10/22/2020)

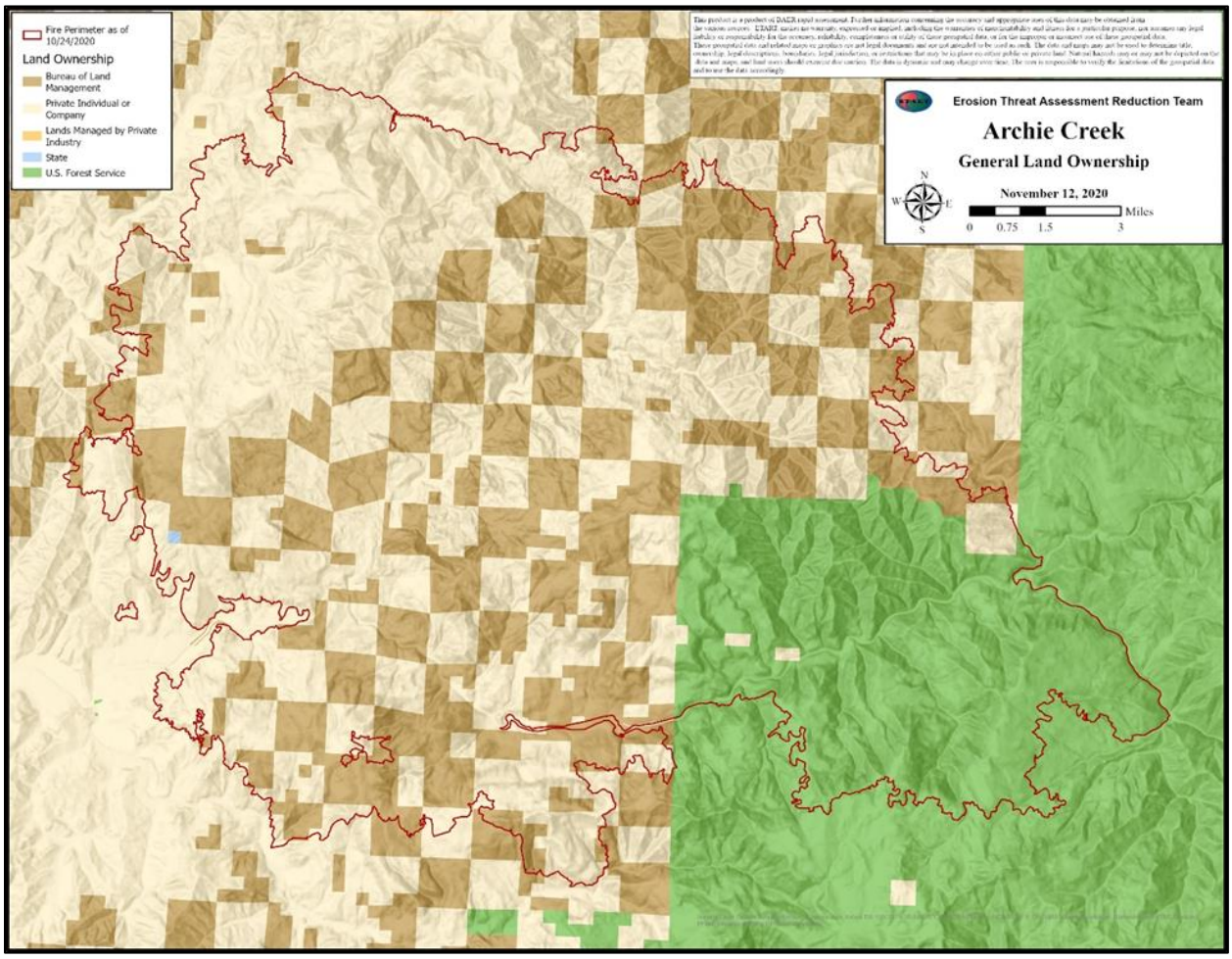


Figure 1. Land Ownership - Archie Creek Fire

The Archie Creek Fire was detected on September 8, 2020, east of Glide, Oregon, in the North Umpqua River drainage during a strong east wind event that passed through the area. The fire merged with the Star Mountain Fire in the Susan Creek area and burned roughly 68,000 acres in one day. On September 9th the fire progressed to 110,000 acres; 109 homes were destroyed, and nine other structures were damage or destroyed over a 2-day burning period. The fire burned across multiple land ownerships, including the Umpqua National Forest, BLM, private timber land, and through the communities of Rock Creek and Steamboat along both sides of the North Umpqua River and the Rogue-Umpqua Scenic Highway. (Figure 1 and Table 1.)

Table 1. Archie Fire Total Acres Burned – 131,596[a] (based on post-fire analysis perimeter)

Ownership	Acres	Sq.Mi.	Percent
Private	64,676	101	49%
State	39	<1	<1%
Federal	66,881	105	51%
Total	**131,596**	**206**	

a: the burned area lies entirely within Douglas County, Oregon.

1.1.1. CLIMATE

The burned area is a region that experiences precipitation patterns of frontal rain/snowstorms and occasional summer convective thunderstorms. Precipitation in the area primarily occurs between October and April as multiple day frontal storms, averaging between 40 and 100 inches annually. The upper regions of the burned area are within the transient snow zone (2,000-5,000 feet elevation). The North Umpqua River gorge and its tributary valleys are below 2000 feet and within the rain zone. Late winter rain-on-snow events can result in extreme flood events. Peak flows can be much higher in the lower tributaries where rainfall and rain-on-snow events are not moderated by the storage capacity of the underlying bedrock, as is the case with streams in the High Cascades geology within the transient snow zone. Wetting rains fell over the western part of the fire area on September 18th, with some areas receiving about 0.25 inch of precipitation. Field reconnaissance reported no observations of overland flow or erosion concerns.

La Niña conditions are present in the tropical Pacific, with an approximately 85% chance of lasting through the winter. Forecasters predict this La Niña will be on the stronger side and peak November through January, with higher than normal precipitation and snowpack.

1.1.2. GEOLOGIC TYPES

The burned area lies within the Western Cascade province of the Oregon Cascade Range, which is characterized by older volcanic rocks, generally steep slopes, and large ancient landslide deposits. The bedrock geology is primarily comprised of Pliocene to Quaternary igneous extrusive rocks: basalt, basaltic andesite, dacite, and rhyolite. In general, the landscape shape and surficial deposits consist of unconsolidated alluvium, terrace deposits, fluvial glacial, glacial till, rockslide, landslide and debris

flow deposits. Weathered rocks in this province support relatively high rates of runoff and erosion. Consequently, mass wasting processes associated with steep mountain slopes include rapidly moving, shallow-seated debris avalanches, debris slides and debris flows. Landslides have been mapped by the State of Oregon Department of Geology and Minerals Industries (DOGAMI), with these features occurring primarily in a tuff and sedimentary geology that is a minor component along the western border of the area.

1.1.3. DOMINANT SOILS

Dominant soils originate from andesites to basalts, as well as minor areas of weathered red breccia, highly weathered breccias, tuffs, and welded tuffs. Outcrops with exposed rocks are common throughout the area. Soils tend to be shallow to moderately deep, depth to bedrock less than 3 feet up to 8 feet. Surface soil textures range from loamy sands, sandy loams, loams and clay loams with varying amounts of gravel and rock content, generally increasing with depth. These soils are moderately well to well drained with rapid to moderate permeability and minimal water-holding (retention). One-quarter (25%) of the fire area has very steep slopes of 60 to 100 percent or more. Primary concerns on the steep slopes are the potential severe surface erosion and for shallow debris slides. Soil textures are mainly very gravelly to extremely gravelly loams and clay loams.

1.1.4. VEGETATION TYPES

Forested areas are primarily Douglas-fir, but with lesser components of incense cedar and western hemlock. Scattered throughout uplands are dry meadows, rock balds and steep rocky slopes dominated by Pacific madrone, Oregon white oak and various grasses. These dry meadows provide habitat for several rare and endemic species. Riparian corridors are hardwood-dominated with tree cover provided by alder and bigleaf maple, with various willow species growing along and within streams. Occasional forested wetlands are also present within riparian corridors. The western extent of the fire, both north and south of the river corridor, are comprised of a patchwork of oak woodlands and meadows used for commercial livestock grazing (cattle and sheep). Oak woodlands are Oregon white oak with an understory of poison oak, oceanspray and other drought-tolerant shrubs. Native and nonnative pasture grasses, including California oatgrass, perennial ryegrass and orchard-grass dominate meadows used for livestock grazing. Although relatively small in area, wet meadows and emergent wetlands occur throughout the burned area with a variety of species ranging from common pasture grasses to common cattail, slough sedge and smallfruit bulrush. There are several known populations of noxious weeds that have been treated with chemical herbicide for decades. These include scotch broom, Himalayan blackberry, English holly, English hawthorn, slender false brome, bull thistle, Canada thistle, St. John’s wort, meadow knapweed, tansy ragwort and medusahead.

1.1.5. WATERSHEDS AND STREAMS

The Archie Creek Fire burned within 17 subwatersheds, the heaviest impacted being Lower Rock Creek, East Fork Rock Creek and Susan Creek-North Umpqua (Table 2, Figure 2). The fire burned both north and south of the North Umpqua River within the area designated as a National Wild and Scenic River. There are 968 miles of streams, (255 miles perennial and 681 intermittent) within the fire perimeter, including about 17 miles of Designated Critical Habitat for Oregon Coast Coho and 18 miles of suitable occupied habitat for Coho. The North Umpqua and its tributaries are listed on Oregon DEQ's 303(d) list of impaired streams for water temperature.

Table 1. Affected Watersheds – Archie Creek Fire (6th Level Hydrologic Unit Name)

Watershed Name	Total Acres	Acres Burned	% Burned
Lower Canton Creek	34,601	7,410	21
Lower Steamboat Creek	33,115	61	0
Panther Creek	24,325	3,961	16
Apple Creek-North Umpqua River	23,453	5,515	24
Williams Creek-North Umpqua River	24,799	20,561	83
Thunder Creek-North Unpqua River	33,164	24,861	75
Susan Creek-North Umpqua River	33,978	32,068	94
Upper Rock Creek	47,658	15,548	33
East Fork Rock Creek	28,619	27,407	96
Lower Rock Creek	49,091	49,091	100
Emile Creek	161	26	16
Middle Little River	31	26	84
Lower Little River	15	13	87
Bradley Creek-North Umpqua River	11,352	8,632	76
Headwaters Calapooya Creek	19,428	5,283	27
Hinkle Creek-Calapooya Creek	23,497	11,400	49
Gassy Creek-Calapooya Creek	25,460	2,618	10
Total	**412,747**	**214,481**	

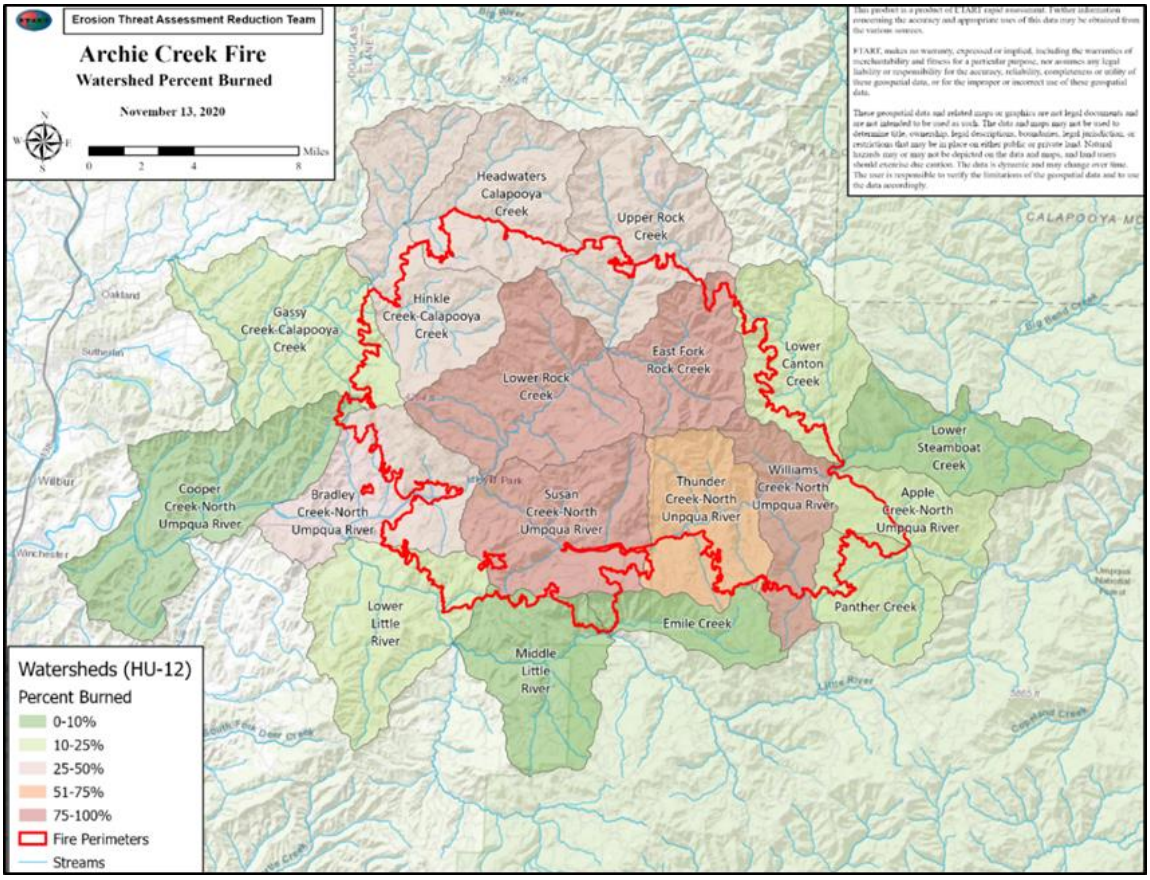


Figure 2. Watersheds Percent Area Burned – Archie Creek Fire

Table 3. Road Miles by Ownership Designation within Fire Perimeter

Owner Designation	Miles[a]
Bureau of Land Management	295.1
County Route	5.1
Forest Service	109.3
Other State Route (e.g., State Park)	0.8
Private Route	511.2
State Highway	16.8
Unknown	1.7
Total Miles	**940.0**

Table 4. Miles of Stream within Fire Perimeter by Type

Stream Type	Miles by Type[b]
Perennial	255
Intermittent	681
Ephemeral	1
Other	31

a: Does not account for priority travel routes below the fire perimeter that may be a "Value" or threatened by flooding or debris flows.

b: Does not account for streams below the fire perimeter that may be a "Value" as domestic or municipal source water, or for aquatic habitat.

1.2. Post-fire Watershed Condition

1.2.1. SOIL BURN SEVERITY (SBS):

The post-fire watershed conditions are mostly driven by fire behavior, which is largely a function of pre-fire fuel conditions (vegetation types, volumes, arrangement and moisture content) as influenced by weather and topography. Soil Burn Severity (SBS) is the fundamental post-fire factor for evaluating changes in soil processes and hydrologic function, which are used to evaluate watershed response, identify post-fire threats and assess the level of risk to critical values.

Prior to the ETART effort, the Forest Service produced a Soil Burn Severity (SBS) map as part of their Archie Creek BAER Assessment (Figure 3). The Forest Service SBS mapping did not field-validate soil conditions on private or state lands. The ETART soils team completed soil burn severity validation on state and private lands with on-the-ground data collection and visual observations (Table 5).

Table 5. Soil Burn Severity (SBS) Acres.

Soil Burn Severity Class	All Lands		Federal Lands		Local Lands		Private Lands		State Lands	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
High	43,251	33%	22,384	52%	20,867	48%	0	0	43,251	33%
Moderate	57,900	44%	26,535	46%	31,265	54%	10	<1%	57,900	44%
Low	18,681	14%	10,741	58%	7,911	42%	29	<1%	18,681	14%
Unburned	11,692	9%	7,178	61%	4,514	39%	0	<1%	11,692	9%
Total	**131,524**		**66,838**		**64,557**		**39**		**131,524**	

Though the Archie Creek Fire is dominated by moderate and high burn severities, there was little change to the mineral soil in most instances. Soil structure was generally left intact. Roots were affected in some areas, but 100 percent root mortality was rarely observed. Water repellent soils were variable, but rarely exceeded a medium rating. However, the soils in the area are naturally disposed to erosion risk, and profound loss of vegetation and ground cover will exacerbate soil erosion.

1.2.2. WATER-REPELLENT SOIL (ACRES)

Water repellent soils are present across all SBS classes. Based on field assessments and knowledge of local soil types, some degree of water-repellence is expected to exist on all upland acres. Natural repellency is common in ash-influenced soils in the Cascades. When ground cover and organic soil layers are removed by fire, runoff related to naturally occurring repellency is commonly more pronounced or more efficient. In some locations it is likely longer fire residence time has exacerbated inherent water repellency by increasing areal extent and repellency class, however it is not possible to make reliable predictions without extensive, intensive data collection.

1.2.3. SOIL EROSION INDEX

The soil erosion index (SEI) describes the sensitivity for soil loss after disturbance removes the protective vegetation and litter cover. The SEI is primarily a function of hillslope soil processes and hydrologic function, as influenced by disturbance, such as fire, and slope. The SEI is described as “low”, “moderate”, “high” or “very high”. Low SEI indicates soil erosion is unlikely. Moderate SEI indicates soil erosion is likely with a potential decrease in soil productivity. High SEI indicates soil erosion is very likely to decrease in soil productivity. Very high SEI indicates a high probability for soil loss and decreased soil productivity, where erosion control measures are impractical and cost prohibitive.

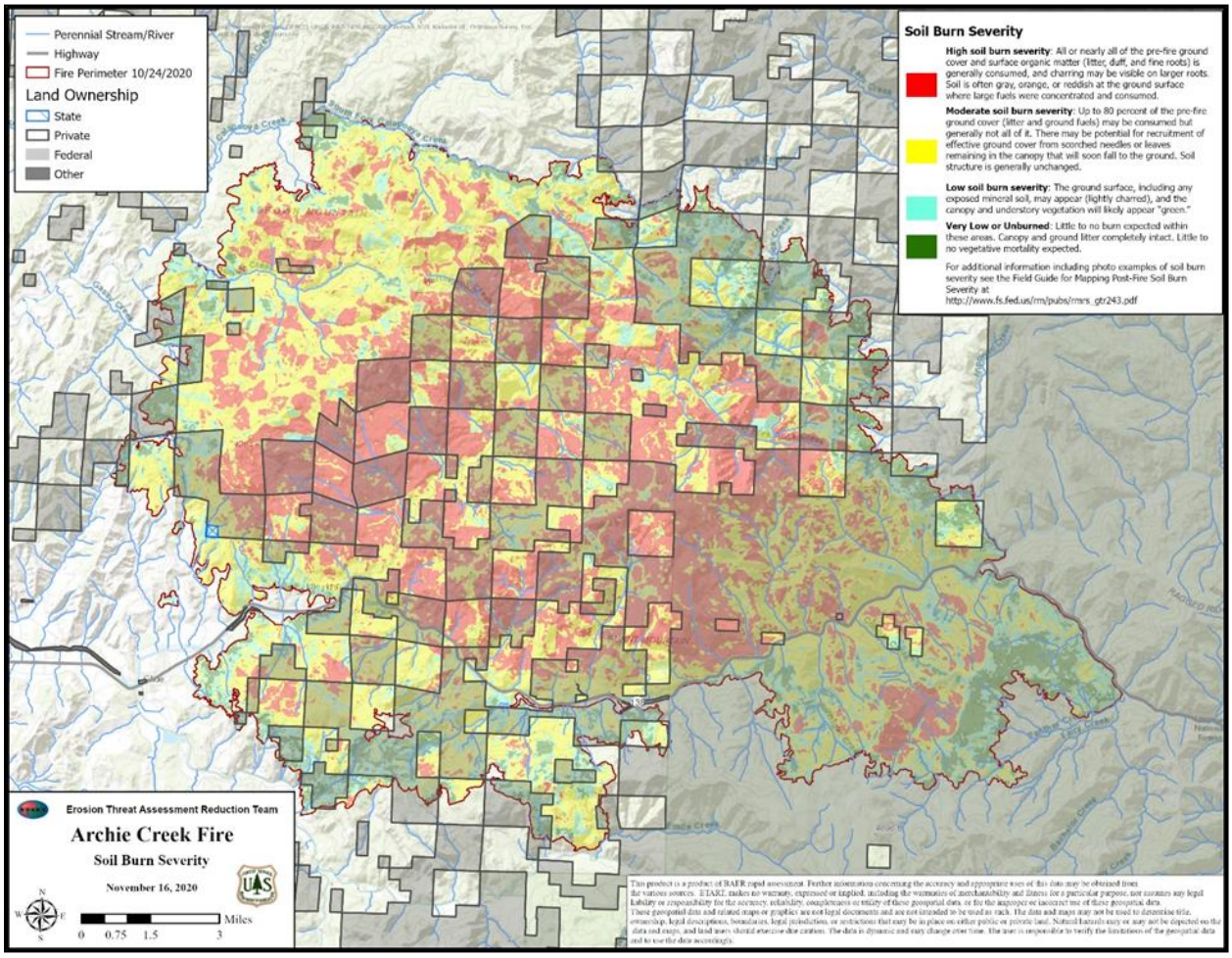


Figure 3. Soil Burn Severity – Archie Creek Fire

Figure 4. displays the spatial distribution and acres by SEI for the area burned by Archie Creek Fire. The matrix values in the map table represent combinations of inherent SEI with SBS. The analysis estimates 76% of the burned area has increased potential for accelerated soil erosion. The very high SEI is generally attributed to over-steepened slopes where SBS has minor influence to change soil erosion.

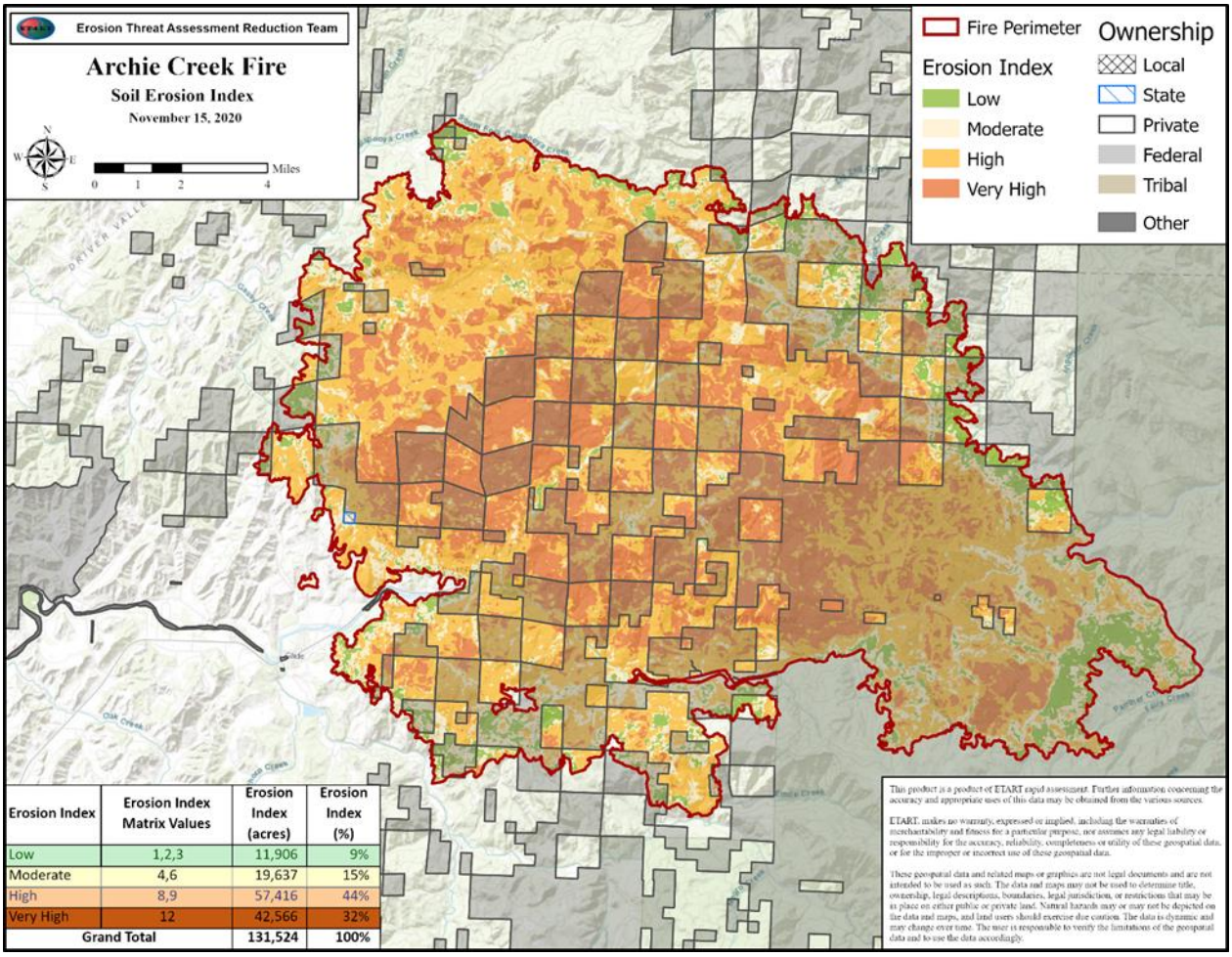


Figure 4. Soil Erosion Index – Archie Creek Fire

1.2.4. EROSION POTENTIAL

This analysis identifies hillslopes where post-fire accelerated erosion elevates the level of threat to downslope critical values. Estimates for hillslope soil loss were generated using the Water Erosion Prediction Project Cloud -Disturbed (WEPPCloud - Disturbed) Model (Robichaud and others 2019). A total of 8 drainages across 4 subwatersheds (HUC12) were evaluated. Each drainage was modeled for post-fire response using the SBS data and compared to unburned conditions. The estimated increase in soil loss per watershed unit area ranges from 0.1 to no change up to 4 tons/acre the first year after the fire, averaging about 2 tons/acre increase across the burned watersheds of interest. On average there is roughly an estimated 10-times increase in potential soil erosion post-fire over undisturbed conditions. The magnitude of increase for post-fire erosion was largest across the Rock Creek tributary near the Rock Creek Fish Hatchery, Harrington Creek, Kelly Creek and McComas Creek. with Hinkle, Beaty and Honey Creek have smaller predicted increases.

1.2.5. ESTIMATED VEGETATIVE RECOVERY PERIOD (YEARS)

This is the estimated period of time (years) for the burned area to develop vegetation sufficient to reduce runoff and erosion potential to essentially pre-fire conditions. Vegetation recovery varies

depending on plant association group, soil type, aspect, and soil burn severity. Areas burned at low severity will generally recover within two years. Areas impacted by moderate SBS may recover the understory and shrub layers in 3-5 years. For areas having high SBS and stand-replacement fire with loss of overhead canopy from conifer tree species, ecosystem recovery will take up to 2-3 decades.

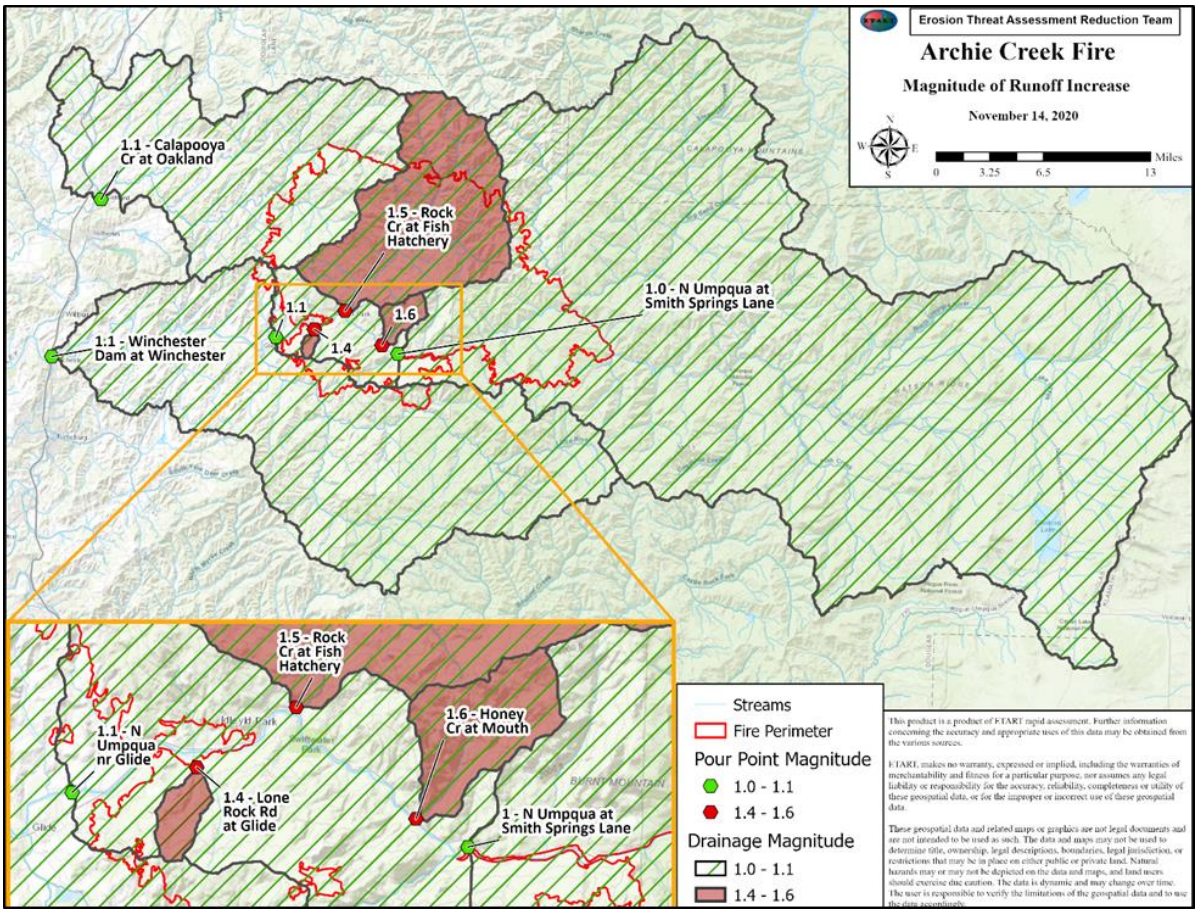


Figure 5. Watershed Response in Runoff Magnitude Increase – Archie Creek Fire

1.2.6. ESTIMATED HYDROLOGIC RESPONSE

Regional regression equations were used to estimate pre- and post-fire peak flows. The relative increase in 5-year post-fire peak flows is expected to be largest in Lone Rock Road, Rock Creek and Honey Creek basins. These drainages are predicted to be roughly 1.4 to 1.6 times greater than the pre-fire peak flow magnitude at the 5-year recurrence interval. The elevated peak flow response is due to greater percentage of area having moderate or high SBS. In contrast, the estimated increase in magnitude for post-fire peak flows in the other basins is 1.1 times the pre-fire peak flow (Figure 5). The 2020 ETART Archie Creek Hydrology Report provides the detailed analysis for post-fire hydrologic response.

These basins were created to estimate watershed characteristics, estimate post-fire response for runoff and assess the need for treatment actions. This analysis of relative stream response should

only be used as a tool to better understand varying levels of risk presented by post-fire peak flows in context of downstream values. Post-fire stream response in smaller watersheds tends to be much greater than those in large watersheds. This is because of the relative volume of water it takes to show an amplified increase from pre-fire flow and the spatial scale of continuous high-severity fire patches in relation to the extent of a storm event in the Cascades.

2. Risk Assessment and Recommendations

The ETART resource groups identified numerous values having varying degrees and types of threats, which are listed in the ETART Archie Creek Fire Values Table. The post-fire watershed conditions determined through field assessment and data analysis were used by the ETART to validate post-fire threats and, subsequently, using the risk assessment matrix assign each specific value a level of "Risk" defined by the probability of damage or loss coupled with the magnitude of consequences (Figure 6). A burned area emergency exists when a value has a risk rating of "very high" or "high" for all values and an "intermediate" risk for life and safety. These values are prioritized for emergency response or stabilization actions known to mitigate potential threats or minimize expected damage.

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

Figure 6. Risk Matrix

2.1. Human Life and Safety Summary

2.1.1. HAZARD TREES

Very High risk to **motorists along roadways, people near structures, and visitors and employees at recreation areas** from falling of hazardous trees killed or damaged by fire. These locations have large numbers of dead and fire damaged trees (>75% basal area (BA) mortality). There is "Very High" risk (likely, major) in areas having 1-75% BA mortality, as well. Although there are generally lower numbers of dead and fire damaged trees, the threat will result in major consequences to human life and safety (and property). An estimated 340 road miles have moderate to high levels of basal area mortality, where fire-killed or damaged trees are within falling distance to reach a road on state and private lands. There are over 263 acres of hazard trees within the 100' buffer surrounding all structures. There are 180 structures in areas that suffered 50% or greater basal area mortality.

Another 76 structures are in areas that suffered less than 50% basal area mortality. Specific areas of concern noted by the ETART include all the Rock Creek Fish Hatchery and the Rock-ed Outdoor Education Center.

Recommendation: Temporary road and sites closures until hazard trees are mitigated, minimize exposure to buildings, fell danger trees within striking distance of roadways and structures. Post hazard warning signs. Inform county emergency management, stakeholders and private landowners. Complete site-specific assessments for specific treatment recommendations.

Available resources for on-the-ground assessment of danger/hazard trees

- OSU Fire Extension has recorded several post-fire webinars. Link to webinars and an extensive summary of available resources: https://extension.oregonstate.edu/fire-program.
- ODF post-fire resources, including information on locating stewardship foresters: (https://www.oregon.gov/odf/fire/Pages/afterafire.aspx).
- Field Guide for Danger Tree Identification and Response along Forest Roads and Work Sites in Oregon and Washington:
- http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512960.pdf).
- Post-fire tree mortality assessment and marking guidelines: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd814664.pdf).

To arrange for on-the-ground training contact ODF or OSU Extension Services. USFS State and Private Forestry also has experts on staff to help with post-fire trainings at the request of ODF.

2.1.2. DEBRIS FLOW, ROCK FALL, AND LANDSLIDES

Very High risk to **life and safety Rock Creek Fish Hatchery and at Rock-ed Outdoor Education Center** from debris flows and landslides. Facilities and structures located on values located in floodplains, debris flow paths or depositional zones. Steep slopes directly adjacent to hatchery; and outdoor education center property and the hatchery is located on toe of active landslide and within in deposition zone of debris flows.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management,

communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, utilize weather alert systems or monitoring.

High risk to **life and safety at Annabell Road and Kelly Creek (private homes), Evergreen Lane and Dogwood Hotel, Hogback Creek, Honey Creek, Moore Hill Lane, OR138, Rock Creek Road, Susan Creek Campground, and Idywild Park** from debris flows, rock fall or landslides. Properties and communities are located in floodplains, at the mouth of channels, and within debris flow deposition zones.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, utilize weather alert systems or monitoring.

Low risk to **life and safety at Richard Baker Memorial Park, Smith Springs County Park, the Narrows Day Use Area, and Nonpareil Road** from debris flows, rock fall or landslides.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations.

2.1.3. POST-FIRE FLOODING, FLOATING DEBRIS, AND OTHERS

Intermediate risk to **visitors and employees at Rock Creek Fish Hatchery and at Rock-ed Outdoor Education Center** from logs, debris and sediment flow into fish hatchery. High mortality of trees upstream, steeps slopes with debris flow hazard.

Recommendations: Close facilities, clean debris and logs as needed and consider berms/debris diversion structures. Inform county Emergency Management, utilize hazard warning signs and early warning system/weather alerts.

2.2. Property Summary

Very High risk to **property at Rock Creek Fish Hatchery and at Rock-ed Outdoor Education Center** from debris flows and landslides, as well as logs, debris and sediment flow into hatchery. Facilities and structures located on values located in floodplains, debris flow paths or depositional zones. Steep slopes directly adjacent to hatchery; and outdoor education center property and the hatchery is located on toe of active landslide and within in deposition zone of debris flows. There is a high mortality of trees mortality upstream, steep slopes with debris flow hazard increases potential for damage, but unlikely to be total loss. A potential threat is clogging of water intakes from increased loading of sediment and large wood (e.g., Rock Creek Fish Hatchery).

Recommendation: For protection of water intakes, increase frequency of inspection and debris removal, and outreach to the private landowners with water intake systems to increase awareness of the potential threats and recommended mitigations. Clean debris and logs as needed; consider berms/debris diversion structures.

Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations for geologic hazards. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, utilize weather alert systems or monitoring.

High risk to **properties at Annabell Road and Kelly Creek, Evergreen Lane and Dogwood Hotel, Hogback Creek, Honey Creek, Moore Hill Lane, OR138, Rock Creek Road, Susan Creek Campground, and Idywild Park** from debris flows, rock fall or landslides. Properties and communities are located in floodplains, at the mouth of channels, and within debris flow deposition zones.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Information sharing with County Emergency Management, communities, and property owners on needs for further evaluation or assessment. Facility closures, education, install hazard warning signs, utilize weather alert systems or monitoring.

Resources for private landowners

The Natural Resources Conservation Service (NRCS) provides information about actions that can be take on your private property. Please see this list of fact sheets (click here) for details different treatment options that can be taken to combat erosion risks.

High risk to **private home and access road at mouth of Honey Creek** from debris and hillslope slump blocking and redirecting flow into floodplain. Narrow channel with adjacent steep slopes and no understory increases potential for channel diversion and overbank flows, depositing sediment on property and impacting water quality.

Recommendation: Property acquisition. Inform stakeholders of risks and advise on threat mitigation recommendations (e.g. engineering teams to inspect culverts and other road infrastructure) and storm alert systems. For hillslope stabilization there are multiple proven treatments effective against low degrees of hillslope erosion: mulching, slash spreading, erosion barriers, wattles, silt fences, debris deflectors, and protective fences.

High risk to **privately-owned land near Honey Creek** from hillslope erosion and sediment bulked flows depositing sediment onto private property/burned homesite. Property is located at the bottom of a confined drainage within the floodplain. There are no structures on the property, but deposited sediment may impede access and use of the site.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Inform stakeholders of risks and advise on threat mitigation recommendations (e.g. engineering teams to inspect culverts and other road infrastructure) and storm alert systems. For hillslope stabilization there are multiple proven treatments effective against low degrees of hillslope erosion: mulching, slash spreading, erosion barriers, wattles, silt fences, debris deflectors, and protective fences.

High risk to **private residences along Evergreen Loop Road and Evergreen Road** from debris, sediment and clogged culverts. Hazard trees with debris in road ditches and culvert inlet basins increasing threat for water diversion to plug culverts and damage road surface.

Recommendations: Hazard tree removal and road maintenance. Inform stakeholders of risks and advise on threat mitigation recommendations (e.g. engineering teams to inspect culverts and other road infrastructure) and storm alert systems. For hillslope stabilization there are multiple proven treatments effective against low degrees of hillslope erosion: mulching, slash spreading, erosion barriers, wattles, silt fences, debris deflectors, and protective fences.

High risk to **Winchester Dam** from woody debris and sediment deposition. Structure is designed to have flow overtop the dam. Steep slopes having high mortality of trees upstream increase potential for mobilized debris; debris will stack up against the dam but should flow over during high water.

Recommendations: Update the Emergency Action Plan to account for woody debris. Remove any logs that threaten the water intake structure or the fish ladder at the ends of the dam.

Intermediate risk to **Quarry on BLM Road 25-2-11 (private property/infrastructure)** because of high probability for debris flow.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations.

Low risk to **property at Richard Baker Memorial Park, Smith Springs County Park, the Narrows Day Use Area, Nonpareil Road, and power transmission lines (south side of the fire and along OR193)** from debris flows, rock fall or landslides.

Recommendation: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations.

Low risk was found for **Douglas County and private roads** from debris flow and plugging potential causing culvert failure. The roads at risk within the Archie Creek Fire burned areas are located primarily within or below areas of high and moderate SBS. There is a future threat to travelers along the roads within the burned area due to the increased potential for culverts plugging with sediment or debris which could washout sections of the roads. With the loss of vegetation, normal storm frequencies and magnitudes can more easily initiate erosion on the slopes, and it is likely that this runoff will cover the roads or cause washouts at drainage facilities (culverts) or stream crossings. These events make for hazardous access to forest roads and put the safety of users at risk. These roads will require minimal action to maintain open and safe to all traffic. See Appendix A for Road Treatment Cost Estimates.

Recommendations: Storm proofing and Storm Inspection and Response

- Bar-L Ranch Road (County). Hillslope and road ditch debris diverting runoff and crossing failures from burned culverts increase potential for road damage. One culvert was burned in fire resulting in collapsed road surface (isolated occurrence). Replace burned culvert.
- Evergreen Loop Road (County) for road surface damage. Hillslope and road ditch debris diverting runoff and debris in culvert basin increase potential for road damage. Evidence of pre-existing culvert plugging which will likely be exacerbated by increased runoff from burned drainages (isolated occurrences).

Recommendations: Coordination with landowner on storm patrol and hillslope stabilization

- Beaty Creek crossing at Road 24-3-33.7 (Federal/Private Industrial). Debris and sediment in culvert basin plugging culvert and impacting surrounding road fill. Small drainage area with gravelly soils and low SBS above crossing. Road primarily accesses private and BLM timberlands.
- Hinkle Creek crossing at Road 24-3-31.1 (Federal/Private Industrial). Debris and sediment in culvert basin plugging culvert and impacting surrounding road fill. Small drainage area with gravelly soils and low SBS above crossing. Road primarily accesses private and BLM timberlands.
- Rock Creek Bridge (Federal/Private Industrial). Large log was anchored under bridge footing, which burned up, resulting in a gap and possible erosion under bridge footing under elevated flows. The stream is large with a wide floodplain, but increased debris and sediment may rise water levels to area of gap in bridge footing. Destabilized bridge footing would require costly repairs; road is a main access route through Rock Creek.
- Harrington Creek Bridge (Federal/Private Industrial). Debris and sediment deposition upstream of bridge possibly damaging bridge footings. Very narrow channel and crossing with moderate SBS and abundant hillslope and channel debris above bridge. Mobilized debris may damage bridge resulting in loss of use; bridge provides access to private industrial and BLM lands.
- Kelly Creek Culvert (Federal/Private Industrial). Debris and sediment deposition upstream of culvert increases potential for damage to or loss of road crossing. Large diameter culvert has restricted in-flow and moderate SBS above stream channel with large amount of standing dead wood. Armored culvert inlet basin, deep fill and paved road would result in substantial cost to repair damage.

Low risk to **private residences along Bar L Ranch Road and Lone Rock Road** from debris, sediment and burned culvert. Potential for hillslope and road ditch debris to divert runoff and cause failure of burned culvert, increasing threat for water diversion to damage road surface. Risk for property damage from falling trees.

Recommendations: Hazard tree removal and replace culvert on Bar L Ranch Road.

Low risk to **private homes along N. Umpqua River on Smith Springs Drive** from increased bank erosion. Existing eddy known to collect debris and logs; expected increase in mobilized debris with potential for bank erosion and nuisance flooding.

Recommendations: Education and outreach with property owners.

Road Treatments

- Storm Proofing. Clean/pull ditches, clean stream crossing culvert inlets/outlets and relief culverts, run out ditches and catchment basins of sediment, debris and rock. Out slope the road prism where appropriate. Replace or repair damaged culverts pending the need of primary maintainers. Slotted riser pipes or culvert end sections could be installed where feasible and appropriate to reduce the potential for sediment and debris plugging of existing culverts.
- Storm Inspection and Response. Follow-up to storm proofing to monitor functionality post-storm event. Monitor road conditions after a storm for the first year, deploying personnel to inspect and react as appropriate. Re-storm proof may be needed after a damaging storm to keep ditches, culverts and critical dips in working order.
- Storm Patrols. Monitor road drainage structures and debris flow treatment structures after significant storm events to ensure the maximum drainage capacity is maintained until the natural revegetation of the burned area has occurred. Maintain and/or repair any damage to road surfaces. Remove sediment and debris from drainage and treatment structures and stabilize head cutting in streams and drainages to prevent further degradation of channels. Monitor the movement of large woody debris, make a determination to remove material before it contacts bridge piers, abutments or culverts.
- If feasible and cost effective, replace culverts to handle the post fire flows. Culverts being replaced should be sized on predicted increase in flows and installed with minimum fill cover and heavy armoring. If culvert is not replaced, proceed with monitoring and ditch cleaning along the roads identified in the Archie Creek Fire Engineering Report.

2.3. Natural Resources Summary

2.3.1. SOIL AND WATER

High risk to **soil productivity** from accelerated erosion. High and moderate SBS on steep slopes increase potential for loss of topsoil. Ground cover in clear-cut areas may take longer than 2-5 years to establish and decrease longer term erosion.

Recommendations: Further evaluation is needed to define site-specific threats to values and identify appropriate mitigations. Apply mulch, preferably by chipping existing dead vegetation. Re-establish vegetation cover.

2.3.2. FISH AND WILDLIFE HABITAT

Very High risk to **T&E fisheries habitat** from water quality impairments (temperature). Loss of riparian shading leading to increased stream temperatures. A number of stream reaches experienced complete or partial loss of trees in riparian areas. This will result in increased solar radiation entering streams until vegetation regenerates. Temperature increases are likely to last multiple years (potentially 10+ years in high burn severity areas) thereby impacting several generations. In a number of locations, stream temperatures during summer were already close to the thermal tolerance limits for fish species. The actual magnitude will depend on future climatic conditions and pace of regeneration.

Recommendations: Work with partners to encourage natural regeneration and/or reforestation with mixed hardwood conifer.

High risk to water quality that supports **T&E habitat in Rock Creek basin** from contaminants from burned debris. Runoff from developed lands containing hazardous wastes poses risk to aquatic species. A number of urban areas were subject to fire damage and are in proximity to waterways. Efforts to remove hazardous wastes are underway but in some instances surface runoff from rains has already occurred or will occur before wastes are removed. Environmentally persistent contaminants introduced to waterways may have multigenerational impacts. Other more transient chemicals will likely impact one to two generations within the area of exposure.

Recommendations: Work with partners to identify and prioritize hazardous waste removal in proximity to waterways.

High risk for decreased **productivity at Rock Creek Hatchery** from debris and/or sediment impinging on water intake screens during high flows. A large amount of the Rock Creek watershed experienced high SBS and vegetation mortality. There is increased potential for delivery of sediment, ash and debris to the river this winter. High volumes of sediment and debris that damage intake systems or impact water quality are likely to have considerable impact on future ability to rear fish on site.

Recommendations: Implement increased monitoring and frequent screen regiment.

Low risk to **T&E fisheries habitat** from water quality impairments (turbidity). Runoff of ash and sediment represents a near-term threat to spawning success for salmonids and lamprey. A large portion of several watersheds containing spawning habitat for salmon, trout and lamprey was burned leaving significant ash deposits. Control measures will not be sufficient to prevent this from entering waterways during rain events. Some areas may experience increased redd failure, but likely there is sufficient alternate spawning habitat to sustain populations.

No treatment recommended.

Low risk to **T&E fisheries spawning, rearing and refugia habitat** access for ESA-listed species. Increased runoff resulting from lack of vegetative cover may result in higher peak flows leading to increased scour of redds and/or displacement of some species. A number of watersheds experienced high levels of vegetative mortality at mid- to low elevations. Winter forecasts suggest a likelihood of wetter weather. This combination of conditions creates higher likelihood of significant rainstorm/runoff events with impacts are likely to be transient (affect 1-2 generations) and spatially heterogenous.

No treatment recommended.

Low risk for impacts to **migration habitats or loss access to rearing and spawning habitats** from damage to Rock Creek Fish Ladder. Rock Creek watershed experienced a large percentage of high SBS and vegetation mortality. There is increased potential for debris to be mobilized and delivered to the river this winter (and in subsequent winters). Debris blocking or damaging the fish ladder will impact the ability of fish to move upstream

Recommendations: Implement increased monitoring and frequent ladder cleaning regiment to remove debris blocking fish passage.

Low risk to **T&E fisheries spawning, rearing and refugia habitat access** for ESA-listed species. Increased runoff resulting from lack of vegetative cover may result in higher peak flows leading to increased scour of redds and/or displacement of some species. A number of watersheds experienced high levels of vegetative mortality at mid- to low elevations. Winter forecasts suggest a likelihood of wetter weather. This combination of conditions creates higher likelihood of significant rainstorm/runoff events with impacts are likely to be transient (affect 1-2 generations) and spatially heterogenous.

No treatment recommended.

General Fish and Wildlife Recommendations

Early Seral Habitat - Seneca Jones Timberlands. Assist landowners with reseeding to benefit deer and elk, provide soil stability and minimize expansion of invasive plants in areas of moderate to high SBS. Timberlands experienced high vegetation mortality (76-100% BA) over a large area. Reseeding and stabilizing roadbeds is known to have major benefits to maintain early successional species as well as reduce erosion and decrease susceptibility for invasive plants to occupy disturbed areas.

Maintain or Restore Aquatic Habitat Connectivity. Work with partners to identify priorities and options for fish passage at stream crossings; implement aquatic organism passage options when upsizing or replacing burned/washed out culverts. Given scale of fires and the number of culverts on the landscape, it is likely some culverts were or will be impacted. Restoring passage allows fish to access suitable habitat or refugia if primary habitats are impacted by post-fire events.

Riparian Shade - Rock Creek Basin, lower reaches of Honey Creek, Susan Creek, Cougar Creek, Williams Creek, Wright Creek and Fall Creek. Work with partners to identify artificial revegetation and/or natural regeneration practices that rapidly restore riparian shading. Locations are variable depending on burn severity and extent of active management. Many streams within the burn areas have summer temperatures close to thermal tolerance limits. Allowing a mix of hardwood/conifer in riparian areas promotes more rapid recovery of intermediate shading from hardwoods may be key to ensuring these streams remain suitable during summer in the near term.

Large Woody Debris (LWD) - Rock Creek Basin, Hinkle Creek Basin, lower reaches of Canton Creek, South Fork Calapooya Creek and Engels Creek. Work with partners to encourage alternative salvage harvest practices that retain LWD, to the extent practicable, for recruitment into stream channels. Locations are variable depending on extent of post-fire salvage harvest occurring within riparian zones. Many of the rivers and streams have historically low levels of LWD. Maintain standing or dead trees within riparian areas could potentially reset the system and provide substantial long-term benefits in terms of creating suitable habitat for aquatic and terrestrial species. As these trees enter streams and rivers, they create high quality habitat for salmonids.

Keystone species. Work with partners to identify alternative artificial revegetation and/or natural regeneration practices for long-term beaver habitat. Locations are variable depending on management goals. Promoting hardwood regeneration in riparian areas provides conditions for

beaver to construct dams that benefit a range of aquatic species. Beaver are ecosystem engineers that create habitats for many aquatic species, including salmonids. To build dams, beavers require suitable plant materials (typically willow, alder, etc.).

Refugia (Intact Ecosites/Ecosystems). Work with partners to encourage natural regeneration and minimize disturbance to the extent practicable to protect intact landscapes with low burn severity, low vegetation mortality and low road/trail disturbance. These areas are important refugia and source areas for species displaced by the fire, particularly late seral obligates. Given large areas of habitat burned at moderate to high SBS, maintaining high quality core habitat is critical to retaining source populations of some species, as loss of late successional forest will have long-term effect on species such as the Northern spotted owl.

Standing Dead Wood. Work with partners and landowners to encourage natural regeneration and limit salvage harvest, to the extent practicable, to retain burned wood on the landscape. Large areas with moderate to high SBS and high vegetation mortality result in a high density of snags and woody debris that are used by a variety of terrestrial species. Use of severely burned forest by late successional species such as Northern spotted owl will depend on patch size and availability of unburned or lightly burned habitat nearby.

Early-successional Ecosystems. Work with partners to prioritize revegetation and reseeding for native plant species to promote habitats for pollinators, high-value forage and minimize expansion of invasive plant species. Appropriate post-fire management of forest and meadow early seral habitats ensures desirable successional pathways that are critical to recovery of early seral plant species, particularly in moderate to high SBS areas. The fire converted large areas of forest to early seral habitat that are vulnerable to invasive species, unregulated vehicle intrusions and other disturbances. Response actions are needed to regulate disturbances and control expansion of invasive plant species.

Security Cover. Work with partners to maintain existing road closures and identify needs for additional closures that limit motorized disturbances to protect or provide security cover. Previously closed roads may now be accessible to motorized vehicles, exposing areas with reduced hiding cover and sensitive unburned areas. Limiting motorized vehicle access to these areas will protect vulnerable species and preserve secure habitats. Additional road closures may be needed, particularly if deer and elk populations increase.

Slope Stabilization and Erosion Control. Work with partners to implement treatments to stabilize hillslopes, reseed and plant where appropriate. Reseeding, planting or mulching areas with high SBS and high vegetation mortality can improve terrestrial and aquatic habitats by reducing soil erosion and decreasing debris flow risk.

2.3.3. NATIVE PLANT COMMUNITIES SUMMARY[1]

Very High risk to **oak savannah and woodlands in the French Creek area** from the spread invasive plants and/or expansion of established local weed populations. There is increased potential for loss of habitat leading to decline in native plants in areas with high SBS. Significant populations of Oregon Department of Agriculture (ODA) class A and B weeds are documented within or near the burned area. Expansion of noxious weeds could impact both grazing productivity and habitat value.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species within the burned area. Monitor low SBS areas west of drainage (beyond fire line). Explore bio-control options for common tansy via ODA.

Very High risk to **native plant communities bordering Rock Creek Road (78)** from spread of invasive plant species. Fire effects, fire suppression operations, road repair and maintenance, and salvage harvest activities increase the threat for expansion of existing invasive plant populations. Road shoulders and pullouts do not themselves represent significant botanical or habitat resources but are disturbance areas having increased noxious weed populations that threaten all other areas considering the susceptibility of the burned area and increased traffic along the road corridor. High volume of salvage harvest traffic on the Rock Creek road is expected to spread existing populations of weeds to new areas, including mapped populations of slender false brome.

Recommendations: Early Detection, Rapid Response (EDRR) to survey and control priority weed species. Install weed wash station at intersection with Highway 138.

High risk to **native riparian forest communities along Rock Creek and tributaries** from the spread of invasive plants into habitats with high SBS. Dominant hardwoods in riparian areas are more resilient to fire than upland species, based on species response and burn severity, but communities will face threats of increased sediment and noxious weed introduction from nearby roads. Disturbance from fire, fire suppression operations, road repair/maintenance and post-fire salvage activities increase the potential for expansion of invasive species, increasing competition for native plant recovery and loss of native plant habitat.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species (slender false brome, Armenian blackberry, Scotch broom). Consider targeted tree planting. Monitor native vegetation recovery to determine need and efficacy of replanting.

1 See appendix B for Invasive Plant Treatment Design and Cost Estimates

High risk to **dry meadows/rock balds/talus slopes (middle elevations)** from expansion of invasive plants into sensitive habitats. Dry meadows and rock balds are relatively rare habitat types with low commercial or recreational use. Rare and endemic plant populations are present in some locations. They are also often difficult to access making weed control and survey harder than in other areas. Disturbance from fire and fire suppression operations resulting in bare soil increase potential for impacts to rare plants and loss of habitats.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species. Monitor mortality and recovery of native species in select sample locations.

High risk to **wet meadows/palustrine wetlands** from spread of invasive plants into sensitive habitats. Fire effects in wetlands west of the cascades are not well documented, but significant changes to the plant community may occur given canopy reduction and exposed soil. Disturbance from fire resulting in bare soil and loss of canopy raises concerns for impacts to forested wetland habitats.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species, especially in locations near roadways (common teasel, reed canarygrass, Armenian blackberrry). Possible targeted restoration plantings.

Intermediate risk to **Hinkle Creek drainage riparian areas** from expansion of invasive plants into native habitats. Dominant hardwoods in riparian areas are more resilient to fire than upland species, based on species response and burn severity, but communities will face the threat of sedimentation and noxious weed introduction from nearby roads. Disturbance from fire, fire suppression operations, road repair/maintenance and post-fire salvage activities increase the potential for expansion of invasive species, increasing competition for native plant recovery and loss of native plant habitat. Burn severity and vegetation loss is lower than within the Rock Creek drainage, reducing the potential severity of weed establishment and spread.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species along road corridor (slender false brome, Armenian blackberry, Scotch broom). Possible targeted tree planting.

Low risk to **North Umpqua River riparian areas (Rock Creek Road to Umpqua NF boundary)** from spread of invasive plants in riparian habitat along the highway corridor. Burn severity is lower here than in other areas, however significant weed pressure from the highway existed pre-fire.

Recommendations: Early Detection Rapid Response (EDRR) to survey and control priority weed species, particularly slender false brome.

Low risk to **forestlands used for timber resources** from spread of invasive plants into tree plantations along roads and during salvage logging activities. Disturbance from fire and suppression operations resulting in bare soil increases susceptibility for further decreases in productivity from weed populations that may spread into valuable habitat areas. Presence of noxious weed species can inhibit tree growth.

Recommendations: Install weed wash station where fire perimeter intersects Highway 138.

2.4. Cultural Resources Summary

Cultural resources are non-renewable and can be adversely affected by post-fire erosion and related events, such as debris flows, tree falls, exposure of sites and artifacts to looting and displacement. In addition, proposed ETART treatments can also affect cultural resources and if federal funds are involved then S.106 consultation with Tribes and the Oregon SHPO must also be addressed. Under the ETART process, attempts were made to engage state and local cultural resource specialists to assist in determining critical values, risks and treatments, however no individuals were available to perform this work due to staffing and project workload factors in several state and federal agencies. In addition, the acquisition of GIS (feature data classes) from the Oregon SHPO for state and private lands in the fire area was not timely and thus fine-grained analysis of site locations as compared to moderate to high burn severity in the fire area could not be performed.

Given the lack of cultural resource personnel and completion of a critical values analysis, we recommend that FEMA, State and local agencies seek to acquire GIS data on archaeological and historic sites directly with Oregon SHPO and then apply the ETART process to determine the cultural resource critical values, perceived risks and propose treatments where the likelihood of success is greatest. What follows are some general guidelines for addressing values, risks and treatments.

Cultural resources reflect varying social, cultural, and scientific values to society at large and to specific cultural groups, such as area tribes. Cultural resources can be categorized into four broad types: pre-contact archaeological sites, historic archaeological sites, historic structures and traditional cultural properties/sacred sites. The fire area contains cultural resources spanning at least the last 10,000 years of time. These features include task-specific activity areas and camps such as sites of spiritual and cultural value to tribes, pre-contact lithic scatters, fishing stations, rock shelters, vision quest sites, historic trails, wagon roads and highways, historic mining and logging features and artifacts, historic structures, recreation and administrative sites.

In order to determine which cultural resources should be considered as “critical values” under ETART, a triage process is used to identify critical heritage values based on their listing or eligibility to

the National Register of Historic Place, and scientific or cultural values. Not all cultural resource sites should be considered under the ETART process. Ideally a small group of specialists, including representatives of interested tribes should prioritize the site inventory to reflect (in order of value) sites listed on the National Register of Historic Places (NHRP), sites determined as eligible to the (NRHP), and sites identified as having traditional cultural or spiritual values to tribes or other ethnic groups. Cultural resource sites that are designated as unevaluated are not automatically considered under ETART, unless their value is exceptional and would likely be easily determined eligible or listed on the NRHP.

Once the above critical values determination is made, a GIS analysis is used to identify their proximity to Moderate or High soil burn severity areas. The BAER risk matrix (Figure 6) is used to determine if stabilization treatments or other protection actions are warranted. Treatments range from point protection to prevent damage from erosion and/or debris flows, mulching or slash dispersal to cover exposed sites having a high likelihood of looting, directional felling of danger trees to prevent damage to archeological deposits or historic structures and treatment effectiveness monitoring. In addition, S.106 compliance is required for other recommended and federally funded ETART treatments that may affect cultural resources.

3. Monitoring and Management Recommendations

Inform stakeholders of risks and advise on threat mitigation recommendations (e.g. engineering teams to inspect culverts and other road infrastructure) and storm alert systems. For hillslope stabilization there are multiple proven treatments effective against low degrees of hillslope erosion: mulching, slash spreading, erosion barriers, wattles, silt fences, debris deflectors, and protective fences.

3.1. Watershed Response and Hydrologic Analysis - Monitoring Recommendations

Modeling suggests that some watersheds affected by the Archie Creek Fire will experience increased peak flows due to the extent and intensity of the fire. With this in mind, the team recommends installation of one or more near real-time (NRT) precipitation gages in or near the burn area. An NRT precipitation gage provides invaluable information about the localized intensity and amount of precipitation as it happens. Based on these data, the National Weather Service (NWS) can issue alerts to emergency managers, road crews, and other partners to warn of increased potential for flooding and debris flows that could threaten lives or damage homes, roads, and other infrastructure.

In addition to improving emergency response, expansion of the precipitation monitoring network would lead to a better understanding of how the amount and timing of runoff change due to fire in mountainous parts of the Pacific Northwest. At present, little information is available in this regard because large, intense fires have been relatively rare in this region.

Gaging stations are present in watersheds within and adjacent to the burned areas of the Archie Creek Fire with periods of record existing prior to fire outbreak. Such circumstances create opportunities for performing paired-watershed analyses to understand impacts of wildfires on hydrologic response. The paired-watershed method can be used to develop a runoff relationship between an experimental (i.e. burned) and control (i.e. unburned) watershed. Catchments can be instrumented to collect rainfall and runoff data to assess changes in flood flow frequency, magnitude, timing, and hydrograph shape. Further developing these relations can assist with future evaluations of post-fire flood magnitude and hydrologic response in ungaged watersheds (Moody and Martin, 2001).

3.2. Geologic Hazards - Management Recommendations

The finding in this report are from a rapid assessment of areas prone to geologic hazards. Most properties identified in this report were not fully assessed. A more complete assessment requires examining the on-the-ground characteristics of each property at risk. In some cases, this report points to high hazard areas that could benefit from "further evaluation", therefore, additional site-specific assessments are recommended. The results of a site-specific evaluation should address protecting homes from the impacts of large debris flows, which may necessitate additional design resources and consultation with engineers that is outside the scope of this evaluation. Engineered debris flow diverting structures were not evaluated by this report. These structures need to be surveyed and designed for specific areas they would be needed.

3.3. Road Management Recommendations

3.3.1. STORM INSPECTION AND RESPONSE

Storm inspection and response should be completed after high rainfall events on all roads open to the public. Subsequent patrols should be coordinated with all the agencies and private ownerships providing public access roads within the fire perimeter, including USFS, the BLM, Douglas County, and ODOT. Continue storm inspection and response until vegetation has reestablished in affected watersheds for at least two years.

3.3.2. ROCK FALL, CHANNEL DEBRIS AND FLOOD MITIGATION ACTIONS

For locations where rock fall may occur, install hazard warning signs and increase frequency to clear and maintain primary travel routes. During storm inspection and response, remove debris from channels upstream of road crossings that may be mobilized by flooding. Roads that become blocked from debris or damaged from road crossing failures could result in loss of access by emergency responders and residents being stranded. Inform county emergency managers of the high-risk locations and post signs to educate residents and the public.

3.4. Fish/Aquatic Habitat - Management Recommendations and Monitoring

With respect to hazard tree mitigations, the primary objective is to ensure exclusion of employees and the public from these sites and to remove the hazard trees. Treatment of large wood is somewhat more complex because it is a beneficial, natural feature in streams. Add to this that many river reaches are difficult for heavy equipment (capable of removing the wood) to access. Thus, the treatment for wood in streams is a combination of good signage and education to warn boaters of the risks posed by large wood.

Near-term success in engaging partners can be monitored by number of projects on which engagement occurs. Over the mid- to longer-terms, success can be measured by habitat variables and populations metrics, such as LWD recruitment into stream channels and escapement of salmonids or population counts of terrestrial wildlife. In addition, partners should prioritize monitoring to increase understanding of species response to fire and post-fire habitat treatments. Likewise, habitats should be assessed over time to determine effectiveness of and responses to treatments, changes in species composition, and presence of invasive species.

4. Archie Creek ETART Members

Archie Creek ETART

Team Member	Resource	Agency
Simon Apostol	Botany (Weeds)	Cascade Environmental Group
Christine Stevenson	Hydrology	Oregon Department of State Lands
Brooke Hogan	Soils	USDA Natural Resource Conservation Service
Shaun Clements	Fisheries	Oregon Department of Fish and Wildlife
Jennifer Ringo	Fisheries	Oregon Department of Fish and Wildlife
Bill Burns	Geologic Hazards	Oregon Department of Geology and Mineral Industries
Brandon Overstreet	Geologic Hazards	USDI Geological Survey
John Hawksworth	GIS	Oregon Department of Forestry
Steve Timbrook	GIS	Oregon Department of Forestry

ETART Resource Leads

Team Member	Resource	Agency
Sarah Callaghan	Botany (Weeds)	USDA Forest Service
Megan McGinnis	Soils	Bureau of Land Management
Mary Young	Soils	USDA Forest Service
Scott Barndt	Fisheries	USDA Forest Service
Spencer Higginson	Hydrology	National Weather Service
Kyle Wright	Hydrology	USDA Forest Service
Barton Wills	Geologic Hazards	USDA Forest Service
Kipp Klein	Engineering	USDA Forest Service
Paul Claeyssens	Cultural Resources	USDA Forest Service
I. Blakey Lockman	Danger/Hazard Trees	USDA Forest Service

ETART Coordination Team

Team Member	Agency
Anna Daggett	FEMA
Kelsey Madsen	FEMA
Katherine Rowden	National Weather Service
Daryl Downing	US Army Corps of Engineers
Ryan Gordon	Oregon Department of Forestry
Cara Farr	USDA Forest Service
Dave Callery	USDA Forest Service
Terry Hardy	USDA Forest Service

ETART GIS Team

Team Member	Agency
Dorothy Thomas	USDA Forest Service
David Askov	FEMA
Yaw Acheampong	FEMA
Sharon Williams	FEMA
Joshua Keller	FEMA
Sean Carroll	US Army Corps of Engineers

Appendix A – Road Treatment Cost Estimates

A total of approximately 8.75 miles of county and private roads within or adjacent to the fire perimeter were examined in detail by ETART Engineering specialists. The following roads were identified of having a risk to property or human life or safety. Other roads within the fire perimeter that were assessed did not pose any potential risks to property or human life and safety.

ROAD	DESCRIPTION & ISSUES
Bar L Ranch Road	▪ Unpaved self-maintaining private road ▪ Provides access to numerous rural residential dwellings. ▪ Connects to additional county road: Doe Road ▪ **Needs**: storm monitoring and ditch cleaning of all culverts, 3 culvert inlet repairs, 1 culvert replacement ▪ Critical values at risk – property
Doe Road	▪ Unpaved self-maintaining private road ▪ Provides access to numerous rural residential dwellings. ▪ Connects to additional county road: Bar L Ranch Road ▪ **Needs**: storm monitoring and ditch cleaning of all culverts ▪ Critical values at risk – property
Lone Rock Road	▪ Paved self-maintaining county road ▪ Provides access to numerous rural residential dwellings and private forestland, large tracts of BLM land. ▪ **Needs:** storm monitoring and ditch cleaning of all culverts ▪ Critical values at risk – property
Kimmel Lane	▪ Unpaved self-maintaining private road ▪ Provides access to numerous rural residential dwellings. ▪ **Needs:** storm monitoring and ditch cleaning of all culverts ▪ Critical values at risk – property
Skyview Drive	▪ Paved self-maintaining county road ▪ Provides access to numerous rural residential dwellings. ▪ **Needs:** storm monitoring and ditch cleaning of all culverts ▪ Critical values at risk – property

ROAD	DESCRIPTION & ISSUES
Rock Creek Road	▪ Paved self-maintaining county road ▪ Provides access to numerous rural residential dwellings and private forestland, large tracts of BLM land. ▪ Connects to additional county road: Anabel Road ▪ **Needs:** storm monitoring and ditch cleaning of all culverts and repair of several culvert inlets ▪ Critical values at risk – property
Anabel Road	▪ Unpaved self-maintaining road (half county, half private) ▪ Provides access to numerous rural residential dwellings. ▪ Connects to additional county road: Rock Creek Road ▪ **Needs:** storm monitoring and ditch cleaning of all culverts and repair of at least 3 culverts ▪ Critical values at risk – property
Evergreen Drive	▪ Unpaved self-maintaining private? road ▪ Provides access to numerous rural residential dwellings. ▪ **Needs:** storm monitoring and ditch cleaning of all culverts and 1 culvert replacement ▪ Critical values at risk – property
Smith Springs Lane	▪ Unpaved self-maintaining private? road ▪ Provides access to a few rural residential dwellings. ▪ **Needs:** monitoring of log jams in North Umpqua River which can cause flooding and bank erosion ▪ Critical values at risk – property

Proposed Engineering Treatments

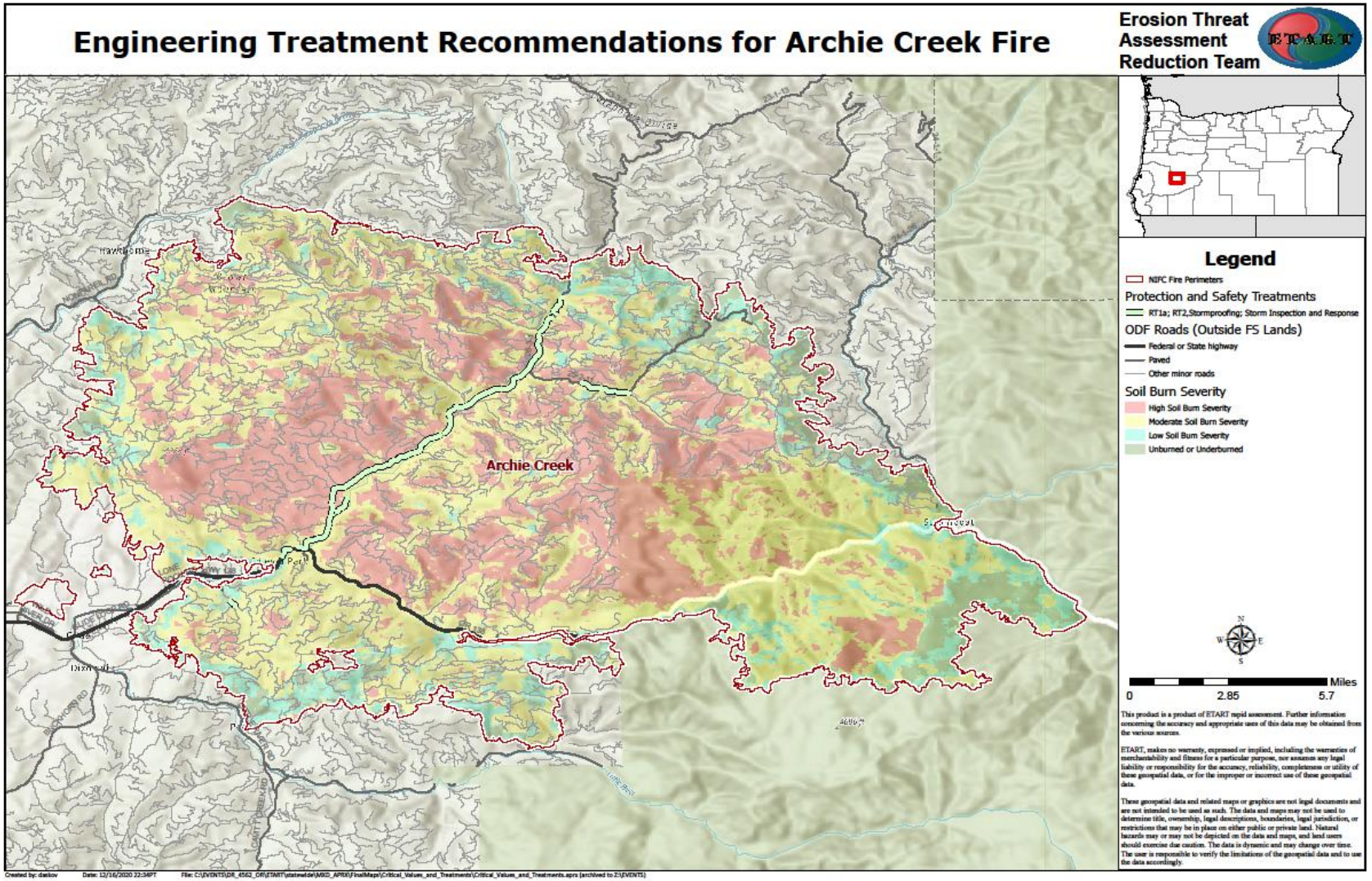
- Bar L Ranch Road - storm monitoring and ditch cleaning of all culverts, 3 culvert inlet repairs, and 1 culvert replacement.
- Doe Road - storm monitoring and ditch cleaning of all culverts.
- Lone Rock Road - storm monitoring and ditch cleaning of all culverts, 2 culvert inlet repairs.
- Kimmel Lane - storm monitoring and ditch cleaning of all culverts.
- Skyview Drive - storm monitoring and ditch cleaning of all culverts.
- Rock Creek Road - storm monitoring and ditch cleaning of all culverts, 2 culvert inlet repairs.
- Anabel Road - storm monitoring and ditch cleaning of all culverts, 2 culvert inlet repairs, and 1 possible culvert replacement.
- Evergreen Drive - storm monitoring and ditch cleaning of all culverts and 1 possible culvert replacement.
- Smith Springs Lane - storm monitoring and ditch cleaning of all culverts.

Road Treatment Cost Estimates – Archie Creek Fire

Mobilization	Qty	Rate	Method	Unit	Total
Mobilization (Total for all treatments)	1	$6,500.00	LSQ	Lump Sum	$ 6,500.00
Mobilization Total					**$ 6,500.00**

Storm Proofing Surveyed Roads	QTY	Rate	Method	Unit	Total
Clean and Pull Ditches	8.75	$750.00	AQ	Mile	$6,562.50
Clean Culvert Inlets and Outlets	26	$250.00	AQ	Each	$6,500.00
Treatment Total					**$13,062.50**

Storm Inspection and Response	Qty	Rate	Method	Unit	Total
Monitoring crew (2 personnel)	3	$900.00	NA	Day	$2,700.00
Vehicles, Equipment and Misc.	1	$15,000.00	LS	Lump Sum	$15,000.00
Treatment Total					**$17,700.00**
Archie Creek Fire – Road Treatment Total					**$37,262.50**


Engineering Treatment Recommendations for Archie Creek Fire
Erosion Threat Assessment Reduction Team
ETART
Archie Creek
Legend
NIFC Fire Perimeters
Protection and Safety Treatments
RT1a; RT2,Stormproofing; Storm Inspection and Response
ODF Roads (Outside FS Lands)
Federal or State highway
Paved
Other minor roads
Soil Burn Severity
High Soil Burn Severity
Moderate Soil Burn Severity
Low Soil Burn Severity
Unburned or Underburned
Miles
0
2.85
5.7
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Appendix B – Invasive Plant Species Treatment Design and Cost Estimates

The analysis in the 2020 ETART Archie Creek Botany report should serve as a starting place for addressing weed threats. Weed detection surveys and treatments should begin Spring 2021 and continue over the next 3-5 years, as resources are available. Weed treatments, including Early Detection and Rapid Response (EDRR), were considered to rehabilitate and recover the Archie fire burn areas. This may include the use of herbicides, biocontrols, and in rare cases, mechanical methods. Rehabilitation of burned and disturbed areas via seeding and planting was also considered in some cases.

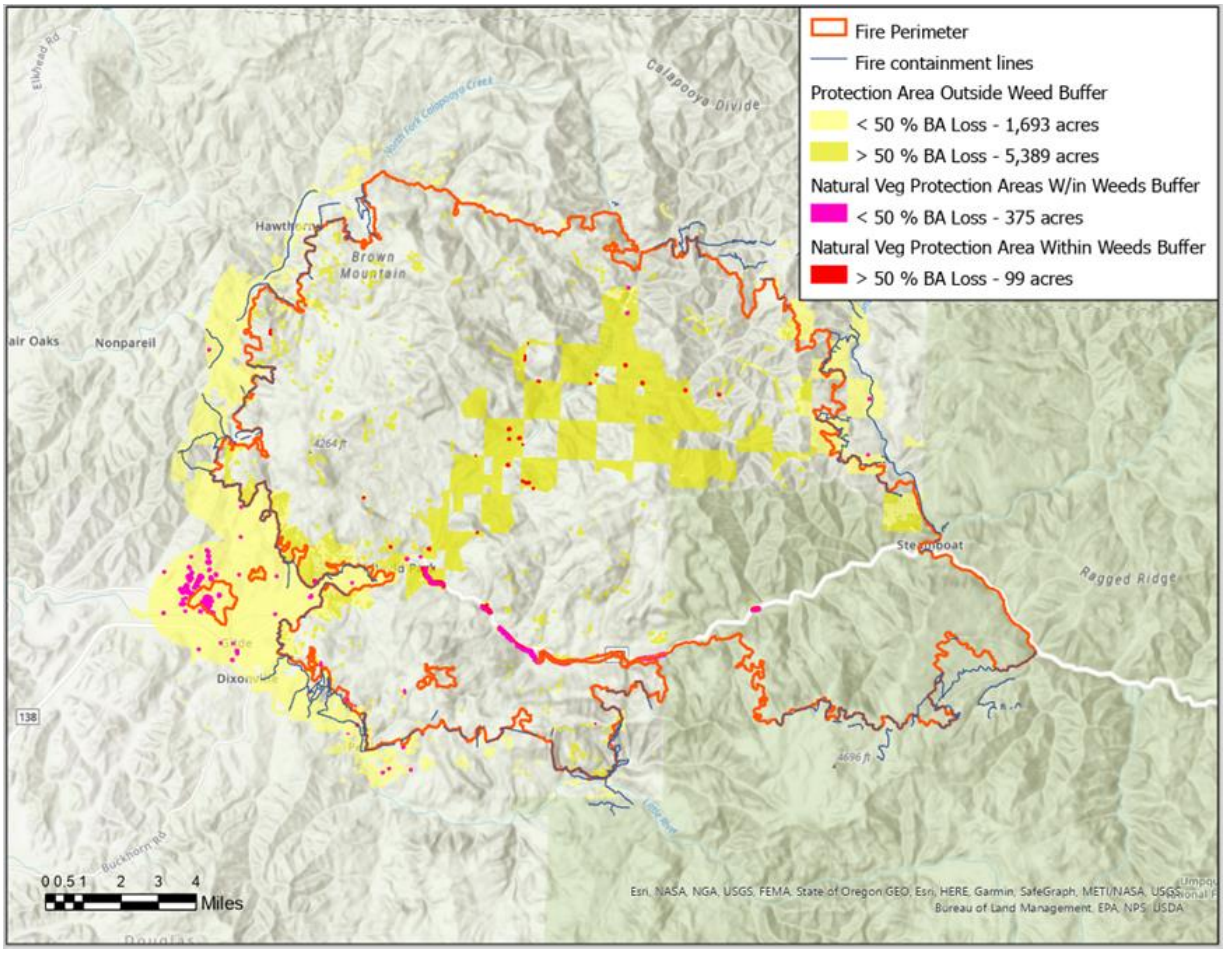

Figure 7. ETART EDRR Survey and Treatments – Archie Creek Fire

Revegetation

Revegetation and restoration efforts are likely to be minor, initially. Any seeding that occurs on roadways or in other disturbed areas should utilize 100% native plant seeds. Seeding should be prioritized to suppression areas and along high-traffic roadways. Seeding native species in protected areas may hinder the response of existing vegetation, and in areas of rare plants or habitats may be harmful by increasing resource competition. However, seeding of blue wild rye or similar woodland grasses may be useful along fire suppression lines to limit invasive spread, given the possibility of equipment already introducing new weed seeds.

Tree planting needs in the Rock Creek and other riparian areas should be assessed after thorough documentation of canopy mortality during the Spring 2021 growing season. Planting efforts, if required, can then be targeted for winter 2021/2022.

Monitoring

Initial post-fire assessments should begin the spring of 2021. This can be conducted simultaneously with EDRR surveys. Design protocols to monitor changes to site conditions that occur during the growing season and over longer time frames. A permanent photo point should be established, representing a mix of the habitats and categories represented in the Critical Values Table. Quantitative monitoring of changing plant communities could be useful but may not be feasible given the affected area's scale. During visits to photo points, general qualitative notes on species present and relative abundance are essential to document changing conditions. Annual monitoring visits should also consider whether new factors impact plant communities, such as landslides, grazing, road maintenance, etc. Monitoring should occur for at least 3, but ideally 5-10 years post-fire. Monitoring for two years after the final treatment of EDRR weed species will help document whether treatments are effective.

The Early Detection Rapid Response (EDRR) treatments are designed to protect sensitive native plant communities and supplement remaining native seed banks that promote native plant community recovery. The EDRR survey and treatment actions take into account known weed infestations, sensitive natural habitat types, rare plants, fire suppression lines and existing riparian restoration investments. This assessment identifies response actions to protect native plant communities by reducing the threat of weeds from fire disturbance, fire suppression operations and during post-fire recovery efforts. Cost estimates for implementing these treatments are in Table 8. It is critical to perform EDRR actions in the spring and fall of 2021 to prevent invasive plants from establishing in weed-free burned areas.

Extensive EDRR mapping and treatment of weed populations in all vegetation protection areas is desirable but given resource limitations, priority should be given to monitoring and treatment of areas with the most potential disturbance and possibility to act as pathways for invasive spread, particularly the Rock Creek road corridor and the fire containment lines. If resources allow, EDRR survey and treatment can extend into other critical habitats/resource protection areas.

ETART EDRR

The assessment identified roughly 99 acres of high-priority EDRR survey and treatment for locations with greater than 50% vegetation mortality, within 50 meters of points where priority weeds have been previously observed. A total of 375 acres of EDRR survey and treatment is also recommended in areas with less than 50% vegetation mortality. EDRR surveys are concentrated within the Rock Creek road corridor and riparian area (central portion of the fire), along Highway 138 and west of the main fire perimeter. Biocontrol is also recommended for tansy ragwort if suitable populations are located.

ETART Fire Suppression EDRR

A total of 87.1 miles of fire containment lines were created during fire suppression efforts, including hand lines, dozer lines and vegetation removal along roads (Table 7). The majority of these areas lie outside of the burn perimeter. Ideally, EDRR survey and treatment would be completed for all suppression areas. However, if funds are limited, prioritization should be given to areas with the high SBS as these locations will have lower likelihood for rapid recovery of native vegetation without intervention.

Treatment Schedule and Associated Costs

Given the terrain and the unknown density of weed populations post-burn, it is likely that most weed treatments, with the exception of roadsides, will be done via foot and handheld/backpack sprayer. Access for mechanized equipment is limited, although it may be useful in some cases. For purposes of efficiency and to target weeds during the first growing season, it may be useful to have fully equipped spray crews perform the surveys and treat on the spot if conditions and timing are appropriate. The estimated treatment costs in Table 8 are based on rates for contracted work in the Portland and Salem region and may differ locally. Costs do not include direct supervision, training and certification of EDRR crews.

Table 7. Fire Suppression Lines and Burn Severity - Archie Creek Fire

Fire Suppression Line	Burn Severity	Acres
Completed Dozer Line	Outside fire perimeter	38.2
Completed Dozer Line	High	0.1
Completed Dozer Line	Low	3.9
Completed Dozer Line	Moderate	2.0
Completed Dozer Line	Unburned	3.8
Completed Hand Line	Outside fire perimeter	0.9
Completed Hand Line	Low	0.1

Fire Suppression Line	Burn Severity	Acres
Completed Hand Line	Moderate	0.0
Completed Hand Line	Unburned	0.3
Road as Completed Line	Outside fire perimeter	31.1
Road as Completed Line	High	0.0
Road as Completed Line	Low	1.3
Road as Completed Line	Moderate	0.4
Road as Completed Line	Unburned	5.0
Total		**87.1**

Table 8. Cost Estimates for Invasive Plant and Noxious Weed Treatments - Archie Creek Fire

Resource/Area	Treatment	Unit	Cost per Unit	Number	Total Cost
Natural Vegetation Protection Areas Greater than 50% Mortality	EDRR Survey and Treatment	acre	$250	99	$24,750
Natural Vegetation Protection Areas Less than 50% Mortality	EDRR Survey and Treatment	acre	$250	375	$93,750
Rock Creek Road	Weed Wash Station	each	N/A	N/A	$3,500
Natural Vegetation Protection Areas	Tansy Ragwort Biocontrol (ODA)		$60	60	$3,600
Suppression Areas Adjacent to Roads or Salvage Harvest	Seeding: blue wild rye grass @ 20 lbs/acre	acre	$200	~50	$10,000